Occupational exposure to dust in the mining industry context – a short review

J. Duarte[1], Mário Vaz[2], J. Torres Costa[3], J. Santos Baptista[4]

[1]Associated Laboratory for Energy, Transports and Aeronautics (PROA/LAETA), Faculty of Engineering, University of Porto, PT (jasduarte@fe.up.pt) ORCID 0000-0002-5856-5317, [2]Associated Laboratory for Energy, Transports and Aeronautics (PROA/LAETA), Faculty of Engineering, University of Porto, PT (gmavaz@fe.up.pt) ORCID 0000-0002-6347-9608, [3]Faculty of Medicine, University of Porto, PT (zecatoco@sapo.pt), [4]Associated Laboratory for Energy, Transports and Aeronautics (PROA/LAETA), Faculty of Engineering, University of Porto, PT (jsbap@fe.up.pt) ORCID 0000-0002-8524-5503
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Abstract

Introduction: The exposure to breathable particulates pose a significant threat to human health globally. Several occupational activities can contribute to this problem, being mining one of them. The dust generated from mining activities such: as drilling, crushing, loading, and unloading can reach the alveolar region of the lung, representing an occupational hazard. Miners are considered a high-risk group for respiratory morbidity and premature death since workers usually stay for an extended period of time on the mining front, for instance. The main objective of this short review was to characterise the occupational exposure to dust in the mining context, determining the main exposure values, occurrence circumstances, leading occupational diseases and their prevalence. Methodology: The PRISMA Statement guidelines were used in order to conduct the research. Engineering and health databases and journals were screened and the combinations of the following keywords were used in the first phase: “dust” and “particulate”, “open pit”, “open cast”, “quarry”, “mining industry”, “underground mining” and “extractive industry”. Later, the keywords “pneumoconiosis”, “silicosis” and “respiratory impairment” were added to the study. The prior defined exclusion criteria were date (only papers published after 2015 were considered), type of document (scientific papers and articles in press), type of source (journals and trade publications), language (English only) and a first screening was performed through the titles and abstracts in order to determine the scope. The included articles would have to be related to the main objective and reporting any outcome related to dust occupational exposure. Results: A total of 4,430 records were identified. After applying the exclusion criteria, only 17 remained. The references of the included studies were screened so to add other relevant articles, in the known snowballing technique process, where six more results were found. From those 23 final studies, 18 focused on dust collection processes and data, while five studied the occupational diseases related to the topic. Discussion: The interaction between the different variables – place, equipment, and activity – determine and influence the dust generation and spreading. However, the breathable dust concentration tends to be higher in the milling processes (crushing, concentration and pelletizing), than in the non-milling processes (mining, shop, and office or control rooms). The prevalence of diseases such as silicosis tend to increase with increasing age and may be highest among former smokers. The duration of exposure was also associated with an increase in the prevalence rate; for each additional year of silica exposure, this ratio increase was of about 4%. Conclusions: Mining activities are severely associated with the dust generation process. The overall objectives of the short review were achieved: the actual exposure values to dust were collected, and the circumstances in which it occurs were addressed. This study provided data to be considered in a dust mitigation process.

Keywords: Breathable particulates, Mining activity, Occupational disease, Short review.

INTRODUCTION

Inorganic atmospheric particulates pose a significant 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). However, according to the World Health Organization, no safe limit exists concerning community exposure to particulate pollution. This has several consequences for industries such as mining, since they are one of the primary sources of particulate emissions worldwide, especially for those countries where the open cut mining activity is abundant (Richardson, Rutherford, & Agranovski, 2019). Different mining activities can be linked to the occupational exposure to dust, cutting, drilling, crushing, loading and unloading (Andraos, Utembe, & Gulumian, 2018; Baur et al., 2019; Piras, Dentoni, Massacci, & Lowndes, 2014). Despite studies relate the exposure to the production phase of a mine, the non-production operations should, as well, be carefully studied. Miners are considered a high-risk group for premature death related to respiratory complications. Workers usually stay for an extended period of time on the mining front, so the dispersed dust particles in the respiratory area pose a significant problem (Xie, Cheng, Yu, & Sun, 2018). In the last decade, the incidence of mine dust related diseases has shown an increase (Mabila, Almberg, Friedman, & Cohen, 2018). This short review main objective was to characterise the

occupational dust exposure in the mining industry by determining the actual exposure values, the circumstances in which the exposure occurs, the occupational diseases associated with it and the prevalence of such diseases.

METHODOLOGY

This short review was carried out following the Preferred Reporting of Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009). In a first phase, the set of keywords defined was “dust” and “particulate”. These two were sequentially combined with “open pit”, “open cast”, “quarry”, “mining industry”, “underground mining” and “extractive industry”, separated by the Boolean operator “AND”. The main databases and journals within the scope of the review were selected (Current Contents, Scopus, Web of Science, SAGE, Academic Search Complete, ACS, DOAJ, Science Direct, Emerald, Inspec, IEEE Explore, Taylor and Francis, MEDLINE and PubMed). Only papers published between 2015 and 2019, written in English, with any applicable outcome, were considered. Then, from the selected studies, all references were screened in order to detect other relevant studies published before 2015, and new keywords were added to the research: “pneumoconiosis”, “silicosis” and “respiratory impairment”. Although the authors acknowledge these keywords do not reflect completely the occupational diseases that can be linked with the occupational exposure to dust, they focused in the results they found in a first research phase. Concerning the inclusion criteria, all type of studies analysing and collecting data regarding occupational exposure to dust will be considered. Any kind of outcome related to such exposure was also included.

RESULTS

Following the proceedings from the PRISMA Statement (Moher et al., 2009), 4,430 records were identified, after which 3,099 papers were excluded by date. The second exclusion criteria were “type of paper” where 285 records were eliminated. The paper source was considered, leading to the rejection of 16 more papers. Manuscripts not written in English were disregarded, rejecting 72 texts. Duplicates (52 articles) and works without full-text access (after trying to reach the authors), three papers, were removed. After reading the title and the abstract, 868 articles did not comply with the proposed objective. After this process, 35 papers were considered eligible and were full-text screened. After the selection process (full-text reading) regarding the previously mentioned parameters, 17 articles were included for qualitative synthesis. After analysing their references by title and abstract, another 6 papers were added to the study. The main findings (23 studies) related to the subject can be divided into two types: dust-related data (18 studies) and health-related data (5 studies). Table 1 shows the main focus of each of the studies.

CONCLUSIONS

Mining activities are intimately linked with the dust generation process, thus the importance of studying it, characterise it and, ultimately, minimize it. The overall objectives of the short review were achieved: the actual exposure values to dust were collected, and the circumstances in which it occurs were addressed. The breathable dust concentrations are usually higher in the milling processes such as crushing, concentration and pelletizing. Drilling was also found to be one of the activities with higher risk. A lot of diseases have been associated with occupational exposure to dust over time. This short review focused in five papers reporting silicosis, obstructive lung disease, coal workers pneumoconiosis and respiratory impairment, not because

they stand as the only concerns, but because they were the only found works when applying the investigation criteria. The prevalence of these diseases also increases with increasing age. Relating technical issues with health, the absence of adequate ventilation in the underground, and the use of dry drilling was associated with an increase in the prevalence rate of silicosis.

Table 1. Studies' related data

Author (year)	Commodity (and type of mine)	Study focus
Churchyard et al. (2004)	Gold (not mentioned)	Health
Mukherjee et al. (2005)	Coal (surface and underground)	Activity, worker
Reed and Organiscak (2005)	Stone and coal (surface)	Equipment
Hayumbu et al. (2008)	Copper (underground)	Place
Onder & Yigit (2009)	Coal (surface)	Activity
Aydin (2010)	Coal (underground)	Health
Prostański (2015)	Coal (underground)	Place
Lashgari & Kecojevic (2016)	Coal (surface)	Equipment
Lebecki et al. (2016)	Coal (underground)	Activity
Rabeiy et al. (2016)	Gold (surface and underground)	Place
Hwang et al. (2017)	Taconite (not mentioned)	Activity, worker
Johann-Essex et al. (2017)	Coal (underground)	Not specified
Pandey et al. (2017)	Coal (underground)	Activity
Souza et al. (2017)	Amethyst (underground)	Health
Brodny & Tutak (2018)	Coal (underground)	Place, activity
Jiang et al. (2018)	Not applicable (laboratory)	Activity
Mabila et al. (2018)	Not mentioned	Health
Prakash et al. (2018)	Coal (underground)	Activity
Rusibamayila et al. (2018)	Gold (surface and underground)	Health
Sairanen & Rinne (2018)	Aggregates (surface)	Equipment, activity
Sairanen & Selonen (2018)	Aggregates (surface)	Equipment
Wanjun & Qingxiang (2018)	Coal (surface)	Activity, equipment
Richardson et al. (2019)	Coal (surface)	Activity

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