International Journal of Occupational and Environmental Safety

Evidence of occupational accidents with equipment in mining – a systematic review protocol

J. Duarte[a], J. Santos Baptista[b], A. T. Marques[c]

[a]*LAETA*, Faculty of Engineering of University of Porto, Porto, PT (jasduarte@fe.up.pt) ORCID: 0000-0002-5856-5317, [b]*LAETA*, Faculty of Engineering of University of Porto, Porto, PT (jsbap@fe.up.pt) ORCID: 0000-0002-8524-5503, [c]Faculty of Engineering of University of Porto, Porto, PT (marques@fe.up.pt) ORCID: 0000-0001-9388-2724

Article History

Received 13 September 2018
Accepted 30 September 2018
Published 3 October 2018

Keywords

Mining industry
Mining equipment
Fatal accident
Severe injuries
Occupational risk

DOI:
10.24840/2184-0954_002.002_0009

ISSN:
2184-0954

Type:
Protocol

Open Access
Peer Reviewed

Abstract

Mining industry due to its great technical challenges continues to be one of the main high-risk industries. Many features can be attributed to this issue, such as worker's age and experience, but also to environmental factors as well as equipment failure and misuse. This systematic review protocol outlines the principal procedures to conduct a systematic review which intends to find evidence of occupational accidents due to mining equipment usage. In order to accomplish this primary objective, the main engineering databases and journals were selected (i.e. Scopus, Science Direct and Web of Science) and a set of keywords was defined to latter sequenced combination. The selection process of the papers is also described, in an attempt to contribute to further research on this field. All of the data treatment is detailed, including the risk of bias and attempts to manage it.

1. INTRODUCTION

The mining industry includes the production of coal, metals and non-metals (stone, sand and gravel) and plays a vital role on the economy worldwide (Nowrouzi-Kia et al., 2017; Onder & Mutlu, 2017; Sanmiquel, Rossell, & Vintró, 2015). However, its workers are exposed to hazardous environments on a daily basis and the industry continues to be associated with high levels of accidents, having one of the highest fatal occupational injury rates when compared to other industry sectors including agriculture and forestry, construction, and even transportation, across multiple countries (Berriault, Lightfoot, Seilkop, & Conard, 2017; Nowrouzi-Kia et al., 2017). Features such as environmental conditions with a significant presence of humidity, dust, noise or falling rocks have a great impact on the number and severity of the occurring accidents (Sanmiquel et al., 2015).

Inadequate management can also lead to occupational accidents (Sanmiquel et al., 2015). Accidents investigation is an essential first step when designing and implementing adequate preventive measures (Salguero-Caparros, Suarez-Cebador, & Rubio-Romero, 2015). By understanding the nature of injuries occurring on the occupational activity, and the most common factors contributing to them, the foundation for future researchers investigating injury prevention in mines will be provided (Nowrouzi-Kia et al., 2017). In addition to that, the process

of reporting and collecting accident occurrences helps companies to correct existing situations, with the consequence of preventing further similar incidents (Comberti, Demichela, & Baldissone, 2018). Therefore, it is observed in many industries that safety culture and organisational performance are key factors in a safety climate (Sanmiquel et al., 2015).

The tasks of planning, programming and implementing the health and safety models should be controlled with regular monitoring and control activities, requiring systematic tailored safety measures and programs (Berriault et al., 2017). Moreover, training related to work accidents should be considered and workers should be educated about possible hazards (Onder & Mutlu, 2017).

The predictors of lost-time injuries include slips and falls, electric injuries, worker's age, occupational experience, working in underground mining and using mining equipment. Production equipment used in many mines (and some construction sites) is often outdated, defective or has been neglected (Nowrouzi-Kia et al., 2017). As a consequence, many fatal occupational accidents occur due to the machines and hand tools used in the exploitation (Yilmaz & Tosun, 2018)

The main objective of this research is to find evidence of the mining equipment resulting in occupational accidents and what are the conditions more prone to accidents.

2. METHODS

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses protocols (PRISMA-P) guidelines have been used to guide the reporting of this protocol (Shamseer et al., 2015).

2.1. Eligibility criteria

2.1.1 *Study characteristics*

Participants

The study does not focus on a specific population: both men and women driving or operating mining equipment are considered, regardless of age, as the main focus is the overall accidents occurring with the equipment used in the mining industry.

Type of interventions and comparators

Any kind of outcome related to accidents in mining, quarrying or in similar works with any kind of mining equipment will be considered. All type of studies analysing accidents with equipment used in mining activities, reporting type of equipment, type of accident and, when possible, main causes will be considered. Any information comparing mining accidents, with accidents in another kind of industry, using the same kind of outcomes will also be included.

Study design

In the systematic review, research articles, available official reports, thesis and dissertations focusing accidents with mining equipment will be included.

Non-research articles (i.e. opinion articles, conference abstracts, literature reviews), simulation models research, studies providing risk assessment only, papers only providing the total number of accidents without further development, will be excluded.

Any setting in any country, in any kind of mine or similar work and with all kind of mining equipment are taken into account. The time frame of the study will not be a reason for exclusion of the 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 2010 to April 2018 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, thesis, dissertations and articles published before 2010 will be considered.

2.2. Information sources

The research includes some of the main engineering databases: Web of Knowledge (Current Contents, Inspec and Web of Science), Scopus, SAGE journals and Academic Search Complete. Scientific journals databases are also going to be screened from: Cambridge Journals Online, Directory of Open Access Journals (DOAJ), Elsevier (Science Direct), Emerald, Geological Society of America (GSA), IEEE Xplore, Ingenta, and Taylor and Francis.

2.3. Search strategy

The keywords defined to conduct the study are "accident" and "hazard", which are going to be sequentially combined with "mine", "open pit", "open cast" and "quarry". Additionally, the word "equipment" is going to be added, in order to refine the search. All of these keywords are going to be separated by the Boolean operator "AND", as the list as it follows:

("accident" OR "hazard") AND (mine* OR "extractive industr*" OR "open pit" OR "open cast" OR "quarry") AND ("equipment")

In each data base / journal, the results of the selection with each set of keywords are pre-screened before the selected records being stored in Mendeley. With this procedure, the searching time and the number of records to analyze further are minimized.

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, the new keywords will be used in new search combinations with the previous keywords. In the selected articles, the respective references are going to be checked in order to find other relevant information sources not searched in the initial survey. In this second search step, conference papers, primary sources as reports, thesis, dissertations and also articles published before 2010 will be considered. All these procedures are going to be repeated until no more relevant information is obtained.

2.4. Study records

2.4.1 Data management

The selected records from all the sources will be retrieved and managed by Mendeley software for de-duplication. Then, both title and abstracts are rescreened. In this process, the papers with titles showing a relation with the research question will be assessed. In the cases where any doubts concerning the title or abstract are raised, the inclusion of the paper and its full-text assessment will also be done. The resultant papers are combined and, finally, full-text copies assessed.

2.4.2 Selection process

All collected full-texts are going to be assessed in order to verify if they have relevant information and, if so, with the objective of extracting the needed information/data. This process will be achieved considering the inclusion criteria (papers with a well-defined period range of data, with accident quantitative analysis and equipment description). 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. To assist in this step, a pre-constructed, pre-defined Excel form sheet will be used (Duarte, Castelo Branco, Matos, & Santos Baptista, 2018).

2.4.3 Data collection process

All of the studies meeting the defined criteria are going to be screened, with the aim to collect the interest data. This information will be assembled in a form sheet that will be developed by the research team, gathering all the needed data to answer the research questions and objectives. The main author will collect the data and the team will discuss the results to improve the analysis and solve further disagreements.

2.5. Data items

Descriptive tables will be built with data including publication details, instrument details, as well as feasibility: name of the first author, year of publication, objective, type of mine/quarry, period

range, data source, risk assessment (if any), standards (if any), accident type, involved equipment, accident consequences, main results, main causes, prevention, population and bias. The main data to be retrieved consists of accident data: number of accidents, equipment involved and root causes. The PRISMA checklist to guide the reporting of systematic reviews will be used (Moher et al., 2009).

2.6. Outcomes and prioritization

The primary outcome of this research is to analyse the accidents occurring in the mining environment, with reference to the equipment which is more often linked to such issue. As a secondary outcome, an analysis of the root causes of those accidents is going to be performed, in order to develop a safety management plan.

2.7. Risk of bias in individual studies

The risk of bias is going to be analyzed on study level, considering the categories of greater importance in accordance with the systematic review goals, determined by the review team in two major groups: general categories and study-specific categories. The considered general categories are: data source, risk assessment tool and used standards. Concerning study-specific categories, they are going to be determined after analyzing the papers content. Each of the former 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

In case there is any missing data, the authors of the studies will be contacted to retrieve the wanted information; in case it is not possible, authors will discuss whether to exclude the paper from the study.

The data synthesis will be carried through a narrative, based on the assembled data tables (with information from the eligible papers), considering that the outcome is to provide an overall assessment of accidents occurring in the different mining equipment, enlightening the main root causes. With this perspective, bias will also be taken into consideration when analyzing the data.

2.9. Meta-biases

This parameter does not apply to the study which will be carried out.

2.10. Confidence in cumulative evidence

This parameter does not apply to the study which will be carried out.

2.11. General Information

2.11.1 Registration

The protocol is under revision by PROSPERO.

2.11.2 Authors' contributions

Study design and development: JD, JSB, ATM

Full-text screening: JD

Data extraction: JD

Critical appraisal: JD, JSB, ATM

Data analysis and interpretation: JD, JSB, ATM

Draft of the protocol: JD

Support in the draft of the protocol: JSB, ATM

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

2.11.3 Support

The authors would like to thank the Portuguese Working Conditions Authority (ACT) for funding through the project.

REFERENCES

Berriault, C. J., Lightfoot, N. E., Seilkop, S. K., & Conard, B. R. (2017). Injury mortality in a cohort of mining, smelting, and refining workers in Ontario. *Archives of Environmental and Occupational Health*, *72*(4), 220–230. https://doi.org/10.1080/19338244.2016.1265479

Comberti, L., Demichela, M., & Baldissone, G. (2018). A combined approach for the analysis of large occupational accident databases to support accident-prevention decision making. *Safety Science*, *106*(December 2016), 191–202. https://doi.org/10.1016/j.ssci.2018.03.014

Duarte, J., Castelo Branco, J., Matos, M. L., & Santos Baptista, J. (2018). A systematic review protocol: Examining the evidence of whole body vibration produced by mining equipment. *International Journal of Occupational and Environmental Safety*, *2*(1), 53–58. https://doi.org/10.24840/2184-0954_002.001_0006

Higgins, J. P. T., Altman, D. G., Gøtzsche, P. C., Jüni, P., Moher, D., Oxman, A. D., … Sterne, J. A. C. (2011). The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ (Online)*, *343*(7829), 1–9. https://doi.org/10.1136/bmj.d5928

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., Altman, D., Antes, G., … Tugwell, P. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine*, *6*(7). https://doi.org/10.1371/journal.pmed.1000097

Nowrouzi-Kia, B., Sharma, B., Dignard, C., Kerekes, Z., Dumond, J., Li, A., & Larivière, M. (2017). Systematic review: Lost-time injuries in the US mining industry. *Occupational Medicine (Oxford, England)*, *67*(6), 442–447. https://doi.org/10.1093/occmed/kqx077

Onder, S., & Mutlu, M. (2017). Analyses of non-fatal accidents in an opencast mine by logistic regression model–a case study. *International Journal of Injury Control and Safety Promotion*, *24*(3), 328–337. https://doi.org/10.1080/17457300.2016.1178299

Salguero-Caparros, F., Suarez-Cebador, M., & Rubio-Romero, J. C. (2015). Analysis of investigation reports on occupational accidents. *Safety Science*, *72*, 329–336. https://doi.org/10.1016/j.ssci.2014.10.005

Sanmiquel, L., Rossell, J. M., & Vintró, C. (2015). Study of Spanish mining accidents using data mining techniques. *Safety Science*, *75*, 49–55. https://doi.org/10.1016/j.ssci.2015.01.016

Shamseer, L., Moher, D., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., … Whitlock, E. (2015). Preferred reporting items for systematic review and meta-analysis protocols (prisma-p) 2015: Elaboration and explanation. *BMJ (Online)*, *349*(January), 1–25. https://doi.org/10.1136/bmj.g7647

Yilmaz, F., & Tosun, S. B. (2018). EVALUATION OF SAFETY TRENDS IN CONSTRUCTION , MINING AND TRANSPORTATION SECTORS IN TURKEY. *SIGURNOST*, *60*(1), 13–23.