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Occupational noise in urban buses - A short review

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Abstract
The aim of this study is review systematically relevant literature in order to explore noise exposure in professional bus drivers. The search was performed based on PRISMA statement methodology. Using a set of key words as occupational noise; noise exposure, urban bus and driver and exclusion and eligibility criteria, nine studies were screened under the subject in analysis. These studies were analysed in order to extract information about: sources of noise, methodologies applied to noise measurement, noise effects, prevention and control of noise. All researches found use the methodology presented in ISO standards (ISO 5128:1980, ISO 1999:1990 and ISO 9612:2009). In some of the analyzed studies, bus drivers were exposed to high noise levels, which can be influenced by the type of bus, age and number of passengers inside the bus.

Keywords: Occupational noise, urban bus, driver

1. INTRODUCTION
Road transport drivers are regularly exposed not only to the dangers of the road, but to a broad range of other hazards and OSH (Occupational Safety and Health) issues associated with both driving and non-driving tasks. These include: drive loading and unloading vehicles; slips, trips and falls climbing in and out of the cabins; vehicle design and maintenance, musculoskeletal and vibration-related disorders, temperature inside of the cabins (hot and cold), noise, stress, number of working hours, shift work and fatigue, passengers violence, unhealthy lifestyle – for example lack of exercise and poor eating habits. In a study developed by EU-OSHA (2011), carried out in different European states, workers point out the noise as one of the biggest risk factors in their working environment.
Noise is a major cause of discomfort, an obstacle to verbal communications and can cause general fatigue. In extreme cases can also cause auditory trauma and extra-auditory physiological changes (Miguel, 2014). Noise sources are increasing considerably as well as their intensity levels. This makes its consequences becoming more common and more severe. It is therefore increasingly important to study this exposure and the possible measures for their control (Freitas, et al., 2013). So, in order to do a contribution to the systematization of the current knowledge, it is aim of this paper to systematize some of the existing knowledge regarding bus drivers.

2. MATERIALS AND METHOD
The literature search was based on PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) Statement. The resources used for searching scientific articles were essentially databases and peer reviewed journals. Were also included articles from the references of the articles found in the systematic search. The used keywords were: occupational noise; noise exposure, urban bus and driver. These words were combined in pairs and searching on tittle, abstract and keywords when it was possible.
For select the articles, the exclusion criteria were:
- Language: not published in English;
- Access: not available in full text, even after acquisition attempt.
- Publication date: published before 2010 (The older ones were collected from the references of the articles found on the previous search);
- Relevance to the purpose of the review: were excluded articles that did not address occupational noise and urban bus drivers. Were also excluded medical articles focused on diseases caused by noise exposure;
- Finally duplicated articles were excluded.

On selected articles is applied the inclusion criteria and those articles that were eligible complied with the requirements: include in the abstract the keywords, address the subject at issue and they have not been excluded by the exclusion criteria. The research was done in the databases and scientific journals, then refined following the order of presentation of the exclusion criteria and the eligibility criteria.

3. RESULTS AND DISCUSSION
3.1. Research diagram
The databases with larger number of results during the research were Academic Search Complete, Business Source Complete, CiteSeerX, MEDLINE (EBSCO) and SCOPUS. The scientific journals with larger number of results during the research were: AIP Journals, BioMed Central Journals, Directory of open Access Journals (DOAJ), Informaworld (Taylor and Francis), ScienceDirect (e Journals) and Scitation. However, the relevant information for the research was found in the Academic Search Complete, MEDLINE (EBSCO), SCOPUS and Directory of open Access Journals (DOAJ). Taking into account the selected keywords combinations that allowed greater results were "occupational noise" & "driver" with 1484 results and "noise exposure" &" driver" 886 results. The Search results after application of the exclusion and eligibility criteria are presented in Figure 1.

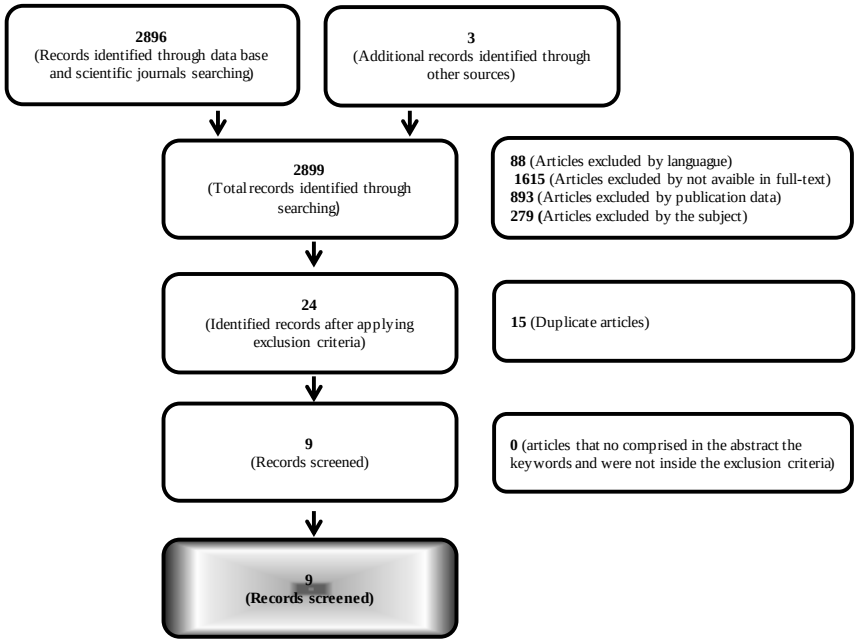

Figure 1 - Flow diagram of studies included in the review.

3.2. Sources of noise in bus

Noise exposure level in a bus depends on factors such as motor noise in high speeds, traffic sound, bus route and number of passengers. Noise is majorly created by the engine, gear, pedal, accelerator and breaks. (Nassiri, Ebrahimi, Monazzam, Rahimi, & Shalkouhi, 2014; Nadri, et al., 2012).

It was also found that the engine and wheels are the major sources of noise inside the buses (Nassiri, Ebrahimi, Monazzam, Rahimi, & Shalkouhi, 2014).

Additionally, the windows type and the vehicle age can influence on the noise levels, in the measurement showed a tendency to higher noise levels in vehicles with windows impossible to open. (Damas, Simões, Figueiredo, & Ferreira, 2012).

3.3. Methodologies applied to the measurement of occupational noise

The methods for to measuring noise exposure were defined according to the following ISO standards:

- ISO 5128:1980, standard for measuring noise inside motor vehicle (Nassiri, Ebrahimi, Monazzam, Rahimi, & Shalkouhi, 2014; Anuund, Lathi, Fros, & Genell, 2015; Nadri, et al., 2012),
- ISO 9612:2009, standard for determination of occupational noise exposure (Portela, Queiroga, Constantini, & Zannin, 2013),
- ISO 1999:1990, standard for determination of occupational noise exposure and estimation of noise-induced hearing impairment (Portela & Zannin, 2010; Mohammadi, 2015),
- Portuguese legislation - DL 182 (2006) (Damas, Simões, Figueiredo, & Ferreira, 2012).

In most studies were used sound level meters for de measurements (Nadri, et al., 2012; Mohammadi, 2015; Portela & Zannin, 2010; Portela, Queiroga, Constantini, & Zannin, 2013, Nassiri, Ebrahimi, Monazzam, Rahimi, & Shalkouhi, 2014) except (Damas, Simões, Figueiredo, & Ferreira, 2012). All the equipments used for measuring were calibrated before the measurements. The interpretation of the results was based on the legislation of the country where the study was done.

As a consequence of the different measurement methods, the presentation of the results is obviously different. However, there is one common feature, none of the authors present the uncertainty associated with the results obtained. From the analysis of the selected articles it is clear that the presented results do not consider the two main details to ensure the best quality of the results: the traceability of data and the measurements' uncertainty. Without them, the results are not reliable and cannot accurately be compared (Costa & Arezes, 2012).

However all articles are limited by the absence of some parameters as: floor characteristics, time and duration of data collection, weather conditions, vehicle speed, engine location and the number of passagers.

3.4. Effects of noise exposure

Work-related hearing loss is one of the common occupational diseases with greater progression. Extended exposure to occupational noise can cause physical, physiological and mental harms, interfering with communication and individual's quality of life (Lopes, Otowinz, Lopes, Lauris, & Santos, 2012).

3.5. Prevention and noise control

For prevention and noise control in order to contribute to a better working environment for these professionals were suggested (Portela, Queiroga, Constantini, & Zannin, 2013):

- noise control regarding the engine and tires of the buses (Nassiri, Ebrahimi, Monazzam, Rahimi, & Shalkouhi, 2014)
- use of vehicles with rear engine.

Considering that NIHL (Noise Induced Hearing Loss) is preventable, is justified the importance of coordinated and multidisciplinary involvement not only from health and safety, but also of the institutions involved in preserving workers' health (Lopes, Otowinz, Lopes, Lauris, & Santos, 2012).

According with some authors, the noise levels to that bus drivers are exposed are not coming only from their workplace. As the bus is permanently moving, the noise characteristics also change whit that movement, influenced by the environmental noise. So, in these conditions, noise's control is not an easy task. (Damas, Simões, Figueiredo, & Ferreira, 2012).

4. CONCLUSIONS

Only in some of the studies are considered the characteristics of the bus, their age and the number of passengers as variables that can affect the noise in its interior. However, the engine and wheels maintenance conditions are generally considered main sources of noise inside buses.

For noise levels from engine, traffic and passengers, the results indicate that the vehicle engine is the major source of discomfort, followed by the noise from traffic and finally from passengers.

The drivers working with rear-engine vehicles are exposed to lower noise levels than those working in buses with front-engine design.

Some authors suggest that more research is necessary to evaluate de noise exposition of bus drivers, in particular about passengers, in order to create viable strategies for prevention and intervention.

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6. REFERENCES

Anuund, A., Lathi, A., Fros, C., & Genell, A. (2015). The Effect of Low-Frequency Road Noise on Driver Sleepiness and Performance. *Plos One, 10*(4), 1-13. doi:10.1371/journal.pone.0123835

Costa, S., & Arezes, P. (2012). A retrospective reflection/investigation on occupational noise exposure. *Occupational Safety and Hygiene - SHO 2012 - Book of Abstracts* (pp. 161-162). Gimarães: Portuguese Society of Occupational Safety and Hygiene (SPOSHO).

Damas, P., Simões, H., Figueiredo, J., & Ferreira, A. (2012). Occupational noise in buses. *Occupational Safety and Hygiene - SHO 2012* (pp. 211-217). Guimarães: Portuguese Society of Occupational Safety and Hygiene (SPOSHO).

DL 182 (2006). Decreto-Lei n.º 182/2006, transposes into Portuguese legal system the Council Directive 2003/10 / EC of the European Parliament and of the Council of 6 February, concerning the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise). Diário da República 172, SÉRIE I.

EU-OSHA (2011). *https://osha.europa.eu/.* doi:10.2802/5632, accessed: July 2015.

Freitas, L. C., Parreira, A., Baptista, C., Frade, F., Marçal, J. E., Ferreira, P., Marques, V. (2013). *Manual de Segurança e Saúde do Trabalho.* Lisboa: Edições Lusófanas.

Lopes, A. C., Otowinz, V. G., Lopes, P. M., Lauris, J. R., & Santos, C. C. (2012). Prevalence of noise-induced loss in drivers. *International Archives of Otorhinolaryngology, 16*(4), pp. 509-514. doi:10.7162/S1809-97772012000400013

Miguel, A. S. (2014). *Manual de Higiene e Segurança do Trabalho.* Porto: Porto Editora.

Mohammadi, G. (2015). Noise exposure inside of the Kerman urbam buse: measurements, drivers and passengers attitudes. *Iranian Journal of Health, Safety & Environment, 2*(1), 224-228.

Nadri, F., Monazzam, M. R., Khanjani, N., Ghotbi, M. R., Rajabizade, A., & Nadri, H. (2012). An Investigation on Occupational Noise Exposure in Kerman Metropolitan Bus Brivers. *International Journal of Occupational Hygiene, 4*(1), 1-5.

Nassiri, P., Ebrahimi, H., Monazzam, M. R., Rahimi, A., & Shalkouhi, P. J. (2014). Passenger Noise and Whole-Body Vibration Exposure - A Comparative Field Study of Comercial Buses. *Journal of Low Frequency Noise, Vibration and Active Control, 33*(2), 207-220.

Portela, B. S., & Zannin, P. H. (2010). Analysis of factors that influence noise levels inside urban buses. *Journal of Scientific & Industrial Reserch, 66*(9), 684-687.

Portela, B. S., Queiroga, M. R., Constantini, A., & Zannin, P. H. (2013). Annoyance evaluation and the effect of noise on the health of bus drivers. *Noise & Health, 15*(66), pp. 301-306.