EXPOSURE TO NOISE IN THE MANUFACTURING INDUSTRY IN BRAZIL

Exposição ao ruído na indústria de transformação no Brasil

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ABSTRACT

Occupational noise exposure is the most important modifiable risk factor for hearing loss in adults. The manufacturing industry has elevated levels of noise exposure that affect a large number of workers. The Brazilian norms state that noise and hearing function must be monitored, along with safeguards to protect workers, these are compulsory for all companies. However norms enforcement is weak and little is known about noise exposure distribution in the country. The purpose of this study is to investigate and summarize the distribution of noise exposure and use of hearing protection devices among workers in the manufacturing industry in Brazil. Among the manufacturing industry trends the minimum prevalence of noise exposure is 45%, and there are only a few data on the use of hearing protection device against hearing loss. Comparing available data from different industry trades, levels of noise exposure are higher in the logging and wood processing industry, together with a lower proportion of hearing protection device usage. The lack of data on work conditions, noise exposure and hearing protection limits the strength of hearing health among public health priorities in Brazil.

KEYWORDS: Noise; Industry; Noise-Induced Hearing Loss; Occupational Health

INTRODUCTION

Exposure to high levels of environmental sound pressure is associated with negative effects for humans[1]. In the production plants of the factories, processes mediated by the functioning of machines produce unwanted noise, usually intense, with the potential to cause damage to the hearing of workers[2]. The loud noise is common in many production processes and hence the exposure to noise at work is considered a most relevant modifiable risk factor to hearing loss in adults[3].

The gradual decrease in hearing acuity, usually bilateral and symmetric, due to continuous exposure to high sound pressure levels, featuring noise-induced hearing loss (NIHL) – work related disease, common in industrialized countries and which stands out as one of the main hazards in the health of the worker from the Brazilian industry[4,5]. The individual with NIHL may present intolerance to loud sounds, tinnitus, and have compromised speech intelligibility, which impacts negatively on their communication process[6] and therefore in their quality of life. In addition to the auditory effects, others may arise from exposure to noise, including headache, gastric disturbances, increased blood pressure, insomnia and irritability[7,8].

Brazil, in its legislation, recognizes that activities or operations that expose workers to noise levels above 85 dB (A) for eight hours or more without adequate protection, offer serious and imminent risk to health[9]. Brazilian standards set as mandatory for all companies, the monitoring of occupational noise and hearing status of workers, as well as guarantees

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Funding: Scientific initiative scholarship- "Permanecer" Program-PIBIC (Cavalcante, F); PIBIC/CNPq (Meira, TC).

Conflict of interest: non-existent

for the protection of workers[10]. Although collective measures, implemented to reduce the noise level in plants, are the most effective in protecting the hearing health of workers, individual measures are the most commonly used by the employer, usually limited to the provision of hearing protection equipment[11-13]. It is known that simply supplying the equipment does not guarantee the adoption of its use by the employee. The security behavior is influenced by several factors such as the security climate in the company, recognizing the benefit to their own health, frailty surveillance, among others[14,15].

In Brazil, there are few data on noise exposure in the economically active population, hindering the projection of estimates of the number of workers exposed and the identification of the industries that offer higher risk; useful information for the surveillance and prevention of NIHL.

The industry focuses work processes most commonly linked to prolonged exposure of workers to noise, but little is known about the distribution of exposure among its various sections and divisions. According to the National Classification of Economic Activities (CNAE – Classificação Nacional de Atividades Econômicas), companies usually noisy, such as lumber and metallurgic, are classified in the section named "Manufacturing Industry". Regulatory norm number 4 (RN-4) assigns to the Manufacturing Industry risk levels 2, 3 and 4, on a scale 1-4, whose values measure the Specialized Services at Safety Engineering and Occupational Medicine (SESMT[9] – Serviços Especializados em Engenharia de Segurança e em Medicina do Trabalho).

METHOD

Searches were conducted in the LILACS and SciELO electronic databases, covering the period from January 1995 to August 2011, using combinations of the key words, terms and expressions: "noise", "industry", "hearing loss" and "induced hearing loss by noise". The reference lists of identified articles were also used as a data source. As inclusion criteria, studies should have been conducted with data from companies based in the country, with activity classified in the "C" session of the National Classification of Economic Activities (CNAE – Classificação Nacional de Atividades Econômicas), corresponding to the Manufacturing Industry, besides the publications should contain specific information on the intensity of noise in the workplace, and/or allowing the estimation of at least one of the following measures: prevalence of noise-exposed workers in the company, the proportion of hearing protector use among those exposed to noise.

The CNAE is the national instrument of standardization of codes of economic activity and the criteria framework used by the various organs of public administration in the country. This standardization helps to improve the quality of information systems that support the decisions and actions of the state, and also enable greater interaction intersystem. The most current version of this classification is the CNAE 2.0, hierarchically structured in five levels with 21 sections, 87 divisions, 285 groups, 672 classes and 1301 subclasses. The Manufacturing Industry corresponds to the "C" session of the CNAE, including activities that involve significant physical, chemical and biological materials, substances and components in order to obtain new products. This section has 24 divisions, numbered from 10 to 33, which correspond to different types of economic activity, presented in Table 1.

The purpose of this research is to organize and present, in a summarized way, information and/or conducted estimates based on the data identified in the articles selected for the following measures, when available: noise intensity in the workplace, prevalence of workers exposed to noise the company, and the proportion of hearing protector use among workers exposed.

Table 1 – Divisions and corresponding branches of activity of "C" Section – Manufacturing Industry, according to the National Classification of Economic Activities

CNAE Division	Branches of Activities
10	Manufacture of food products
11	Manufacture of beverages
12	Manufacture of tobacco products
13	Manufacture of textiles
14	Manufacture of articles of clothing and accessories
15	Preparation of leather and manufacture of leather goods, travel items and footwear
16	Manufacture of wood products
17	Manufacture of pulp, paper and paper products
18	Printing and reproduction of recordings
19	Manufacture of coke, petroleum products and biofuels
20	Manufacture of chemicals
21	Manufacture of pharmaceutical chemicals and pharmaceuticals
22	Manufacture of rubber and plastic
23	Manufacture of non-metallic minerals
24	Metallurgy
25	Manufacture of fabricated metal products, except machinery and equipment
26	Manufacture of computer, electronic and optical products
27	Manufacture of machinery, equipment and materials
28	Manufacture of machinery and equipment
29	Manufacture of motor vehicles, trailers and bodies
30	Manufacture of other transport equipment, except motor vehicles
31	Manufacture of furniture
32	Manufacture of miscellaneous products
33	Maintenance, repair and installation of machinery and equipment

CNAE: Classificação Nacional de Atividades Econômicas (National Classification of Economic Activities).
Source: CNAE 2.0 / Brazilian Institute of Geography and Statistics, 2012.

LITERATURE REVIEW

25 studies were identified from which 18[1,2,5,16-30] met the inclusion criteria, i.e., using data from the manufacturing industry in Brazil and reported specific measures for the noise intensity, and/or data that allowed an estimated proportion of exposed workers or the use of hearing protectors in the exposed group. Out of the 24 divisions of the "C" session of the CNAE – Manufacturing Industry – only 13 were represented in the studies (Table 2). The division corresponding to metallurgy stood by the largest number of studies (n = 8), followed by manufacturing wood products (n = 6), food products (n = 4), and the divisions corresponding to the manufacture of non-metal mineral products (n = 3), textiles (n = 2), articles of apparel and accessories (n = 2), pulp, paper and paper products (n = 2), among others that were considered in only one study. Four studies investigated workers in different industries, being classified then in more than one division of the CNAE. Based on the criteria for inclusion, no study included workers from the other 11 from the 24 divisions of the Manufacturing Industry, such as the manufacture of motor vehicles, furniture manufacturing and maintenance and repair of equipment, and involving a potentially noisy substantial number of workers in the country. Thus, there is a shortage of information, with few studies which limit themselves to about half of the manufacturing industries in. This condition can be the result of several factors such as the barriers imposed by certain industries to access to data of the conditions of the work environment and on workers themselves, lack or inaccurate data presented in the publications, and the invisibility of the possible noise problem in some industries.

The noise intensity in plants was recorded in 17 (94%) of these studies, establishing itself as the

Table 2 – Exposure to noise and hearing protection for workers in the branches of activity of the manufacturing industry in Brazil (1995-2011)

Divisions of "C" Section from the CNAE	Author/Year	Noise intensity in dB(A)	Prevalence of exposure to noise (%)	Use of the EPA among the exposed workers (%)
(01) D.10. Manufacture of food products	- Gonçalves & Iguti, 2006[18]	65 a 105	51,6[a]	86,0[a]
	- Teles & Medeiros, 2007[19]	> 80	45,2[b]	-
	- Vivan *et al.*, 2008[20]	> 85	-	100,0
	- Oliva et al., 2011[21]	79 a 98,8	-	-
(02) D.11. Manufacture of beverages	- Teles & Medeiros, 2007[19]	> 80	45,2[b]	-
(03) D.12. Manufacture of tobacco products	NI			
(04) D.13. Manufacture of textiles	- Caldart *et al.*, 2006[2]	65 a 103	-	-
	- Teles & Medeiros, 2007[19]	> 80	45,2[b]	-
(05) D.14. Manufacture of articles of clothing and accessories	- Caldart *et al.*, 2006[2]	65 a 103	-	-
	- Teles & Medeiros, 2007[19]	> 80	45,2[b]	-
(06) D.15. Preparation of leather and manufacture of leather goods, travel items and footwear	-Teles & Medeiros, 2007[19]	> 80	45,2[b]	-
(07) D.16. Manufacture of wood products	- Zocoli & Silva, 1995[22]	78 a 126	-	-
	- Rocha, *et al.,* 2002[23]	81 a 93	-	-
	- Pignati & Machado, 2005[16]	85 a 115	92,0	-
	- Teles & Medeiros, 2007[19]	> 80	45,2[b]	-
	- Boger *et al.,* 2009[24]	84,3 a 108,5	-	29,6
	- Lopes *et al.*, 2009[25]	-	-	50,0
(08) D.17. Manufacture of pulp, paper and paper products	- Fassa *et al.*, 1996[17]	> 85	82,1	-
	- Teles & Medeiros, 2007[19]	> 80	45,2[b]	-
(09) D.18. Printing and reproduction of recordings	NI			
(10) D.19. Manufacture of coke, petroleum products and biofuels	- Gonçalves & Iguti, 2006[18]	65 a 105	51,6[a]	86,0[a]
(11) D.20. Manufacture of chemicals	- Teles & Medeiros, 2007[19]	> 80	45,2[b]	-
(12) D.21. Manufacture of pharmaceutical chemicals and pharmaceuticals	NI			
(13) D.22. Manufacture of rubber and plastic	- Teles & Medeiros, 2007[19]	> 80	45,2[b]	-
(14) D.23. Manufacture of non-metallic minerals	- Queiróz & Maciel, 2001[26]	92 a 109	-	-
	- Ribeiro *et al.*, 2002[27]	84 a 110	-	-
	- Boger *et al.,* 2009[24]	82,5 a 104,5	-	91,5
(15) D.24. Metallurgy	- Araújo, 2002[1]	> 85	-	84,5
	- Abreu & Suzuki, 2002[28]	80 a 118	-	-
	- Gonçalves, 2004[29]	83 a 105	-	67,2
	- Guerra *et al.*, 2005[5]	83 a 102	-	55,8
	- Gonçalves & Iguti, 2006[18]	65 a 105	51,6[a]	86,0[a]
	- Teles & Medeiros, 2007[19]	> 80	45,2[b]	-
	- Botelho *et al.,* 2009[30]	80,5 a 99,5	-	-
	- Boger *et al.,* 2009[24]	91,0 a 103,3	-	94,5
(16) D.25. Manufacture of metal products, except machinery and equipment	NI			
(17) D.26. Manufacture of computer, electronic and optical products	- Teles & Medeiros, 2007[19]	> 80	45,2[b]	-
(18) D.27. Manufacture of machinery, equipment and materials	NI			
(19) D.28. Manufacture of machinery and equipment	NI			
(20) D.29. Manufacture of motor vehicles, trailers and bodies	NI			
(21) D.30. Manufacture of other transport equipment, except motor vehicles	NI			
(22) D.31. Manufacture of furniture	NI			
(23) D.32. Manufacture of miscellaneous products	NI			
(24) D.33. Maintenance, repair and installation of machinery and equipment	NI			

CNAE: Classificação Nacional de Atividades Econômicas (National Classification of Economic Activities). EPA: equipamento de proteção auditiva (hearing protection equipment). D: division of CNAE. NI: not identified.

[a] Overall proportion among workers from four industries.

[b] Overall proportion among workers in various industries.

most common of the information of interest in this research (Table 2). The values included consistently higher levels of 85 dB (A). However, specific data for the minimum and maximum sound pressure were identified in only 13 studies (72%). The maximum recorded among the companies reached 126 dB (A) – corresponding to the division of the lumber industry – although most have registered maximum sound pressure level between 102-115 dB (A). These results demonstrate that the sound pressure levels observed in this sub-sector of the industry outweigh significantly the tolerance limit of 85 dB (A), reaching 126 dB (A) at its plants. Companies with the highest levels of noise were lumber and metallurgical. Accordingly, they are classified into branches of economic activities that pose the greatest risk levels 3 and 4, respectively, according to the Labor Department[9].

Information or data that allowed an estimated prevalence of noise exposure in the companies were registered in only four studies (22%) (Table 2). Specifically, the share of workers exposed to noise reached 92.0% in lumber industries[16] and 82.1% in the pulp and paper industry[17], 51.6% in four industries (three sugarcane and one metallurgical)[18], and 45.2 % in a group of companies representing various branches of the industry, but that included different activities, such as service[19]. The estimated prevalence of noise exposure to some of the other branches of the CNAE would be feasible if it were available the total number of employees of the respective companies, however, this was rarely presented in a given studies. The results presented here suggest that, in general, more than half of the individuals employed in manufacturing work exposed to loud noise.

Data recorded in seven studies (39%) allowed identifying and/or estimating the proportion of the use of hearing protection equipment among workers exposed to noise (Table 2). This measure showed significant variation among workers exposed to different branches from the Manufacturing Industry. However, there were 19 branches with no information available. A smaller proportion of the hearing protector use was observed in the manufacturing industry and wood products (29.6% and 50.0%). Consistently, the study by Pignati and Machado (2005) shows a serious situation after analyzing 1,381 loggers in the state of Mato Grosso: 73% of jobs in sawmills did not provide any type of personal protective equipment to workers.

It should be emphasized that the lumber industry had the highest measure of sound pressure of noise in the workplace, 126 dB (A), the highest proportion of exposed workers, and poorest use of hearing protection equipment often unavailable for worker. Thus, the results reveal, in a special way, the situation of vulnerability in which workers are manufacturing wood products (D.16), suggesting them as a priority group for intervention.

The lack of basic data on noise exposure in publications restricted the number of articles included in the analysis, and hence the representation of the divisions of this branch of industry. Thus, the results should be interpreted appropriately, considering the limitations of the study's findings, especially in the comparison between these divisions. Despite the limitations, the lack of information was one of the reasons for its development, with the intention of revealing the accumulated knowledge, and the weaknesses and omissions in the data area publications, and thus encouraging the inclusion of data from epidemiological interest in the production knowledge about exposure to noise.

The potential harmful effects of noise on health, especially hearing health, reinforce the need for investment in management actions and continuous evaluation of the Hearing Loss Prevention Programs in the manufacturing industries in the country.

The presentation of epidemiological data in the scientific literature on noise exposure among workers in Brazil is still insufficient, restricting knowledge about the working conditions and hearing health of the population. Consequently, there are difficulties in identifying priority areas for intervention, and important limitations to the efforts that could be undertaken to include hearing health among public health priorities in the country. This type of information is essential to generate estimates and support decisions and actions in favor of the health of individuals exposed to risks in their work routine.

CONCLUSION

The results of this review reveal a gap in information about noise exposure on almost half of the industries in the manufacturing industry in Brazil. Among the industries with information, noise exposure reaches at least 45% of the workforce. The sound pressure level exceeds 85dB in all branches, and achieves 126dB (A) in the lumber industry. There is little information on the proportion of workers using hearing protection equipment, with wide variation between branches. Noteworthy is the branch of manufacture of wood products, with evidence of non-availability of equipment to workers, a situation aggravated by presenting the highest level of noise intensity, and also the higher prevalence of exposed workers. The absence of the total number of employees by industry in scientific production was a common problem, and therefore it should be reinforced the importance of this practice,

which contributes to an estimated prevalence of noise exposure in different industries. New research on the topic is needed, in particular, focusing on working conditions and hearing protection for workers in fields of activity for which there is no information.

RESUMO

A exposição ao ruído no trabalho é o fator de risco modificável mais importante para a perda auditiva em adultos. Na indústria de transformação, a exposição a níveis elevados de pressão sonora afeta um grande número de trabalhadores. As normas brasileiras estabelecem como obrigatório, para todas as empresas, o monitoramento do ruído ocupacional e da condição auditiva dos trabalhadores, assim como garantias para a proteção do trabalhador. No entanto, a aplicação das normas é frágil e pouco se sabe sobre a distribuição de exposição ao ruído no País. Este estudo tem como objetivo investigar e sumarizar a distribuição da exposição ao ruído e do uso do equipamento de proteção auditiva entre trabalhadores da indústria de transformação no Brasil. A menor prevalência de exposição ao ruído dentre os ramos da indústria da transformação é de 45% e poucos são os dados sobre o uso do equipamento de proteção auditiva entre os trabalhadores expostos. Comparando-se os disponíveis para os diferentes ramos de atividade, a exposição ao ruído alcança níveis mais altos no ramo da fabricação de produtos de madeira, onde também se observa a menor proporção de uso do equipamento de proteção auditiva. A escassez de dados sobre as condições de trabalho, exposição ao ruído e proteção auditiva, limita os esforços em fazer com que a saúde auditiva seja incluída entre as prioridades da saúde pública no Brasil.

DESCRITORES: Ruído; Indústrias; Perda Auditiva Provocada por Ruído; Saúde do Trabalhador

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Received on: January 18, 2012
Accepted on: April 27, 2012

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