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The noise exposure of workers of the footwear industry

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ABSTRACT: The purpose of this study was to evaluate the noise exposure of workers of the footwear industry. Four footwear manufacturing companies of northern Portugal took part in this work. The assessment of the noise was made with a Brüel & Kjaer sonometer. Equivalent continuous A-weighted sound level, $L_{Aeq,T}$, and the C-weighted peak sound pressure level, L_{Cpeak} were recorded. Quantification of sound level exposure comprised 248 measurements. 22.6% of these measurements were above the Lower Action Value (LAV) and 11.7% above the Upper Action Value (UAV) for the daily noise exposure level. According to Directive 2003/10/EC of the European Parliament and of the Council when these values are exceeded the adoption of preventive measures is required to reduce the risk to the health and safety of the worker. The sites or sections of the plant identified with the higher sound levels were the sewing, assembly and finishing sections.

1 INTRODUCTION

The footwear industry is a traditional industry in Portugal, representing 3.6% of national exports and the employment of 37 000 workers. In 2013, there were 1400 companies, mainly located in the north of the country, namely in the districts of Porto, Aveiro and Braga (APICCAPS 2014).

The process of manufacture of footwear can be divided into the following steps or tasks (Figure 1), and may or may not have some of the steps according to the type of footwear.

The footwear industry has several machines and equipment for the manufacture of the shoe, which produce very high sound levels.

Long periods of noise exposure may cause hearing loss, hearing difficulties, muffled hearing, intolerance to loud sounds, constant headaches and irritability (Jiang 1997, Sá *et al.* 2014). Bibliographic revision points out other symptoms such as sleep, cardiovascular, and gastrointestinal disorders due to the consequences of noise exposure (Floru & Cnockaert 1994, Melamed & Bruhis 1996, Toppila *et al.* 2000).

The Directive 2003/10/EC on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise), transposed to Portuguese legislation by the Decree-Law 182/2006 of 6 September, states the minimum health and safety requirements regarding the exposure of workers to noise, stipulating the lower and upper exposure action values.

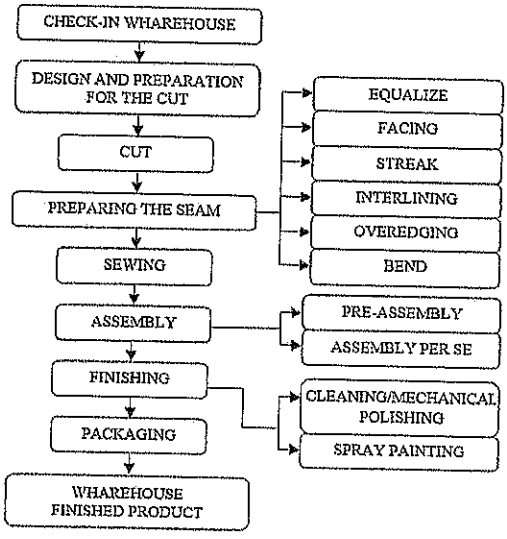

Figure 1. Productive process and steps of the footwear industry (FESETE, 2010).

As daily noise exposure level, $L_{EX,8h}$, this decree-law considers a value of 80 and 85 dB(A) and a peak sound pressure, of 135 and 137 dB(C) respectively, which when exceeded will imply the adoption of preventive measures to reduce the risk to the health and safety of the worker. It also defines

the personal exposure limit values, $L_{EX,8h}$ = 87 dB(A) and L_{Cpeak} = 140 dB(C), which must never be exceeded.

This paper aims to evaluate the noise in the footwear industry and identify the tasks where workers have a greater risk of exposure to noise.

2 MATERIALS AND METHOD

The noise measurement was made on four different companies employing approximately 450 workers. Of these workers, 68.8% were female and 32.2% were male. 80.1% had an education level no higher than the 9th grade (medium school). The age ranges from 20 to 57 years old, with mean age of 41.1 years (standard deviation of 8.6 years) and median of 43.6 years.

Sound levels were measured using the Brüel and Kjaer class 1 integrating sound level meter, 2260 and 2236 models, equipped with a ½-inch diameter condenser microphone, model 4189. The devices were calibrated by an accredited laboratory according to standard IEC method 61672–1:2002, and has a standard uncertainty of 0.7 dB, which is specified for class 1 sound levels (ISO 9612: 2009).

Equivalent continuous sound level, $L_{Aeq,T}$, and the C-weighted peak sound pressure level, L_{Cpeak} were recorded. Two hundred and forty eight noise measurements were accomplished comprising all tasks performed in each section of the four companies included in the study.

All the measurements took in to account the methodology proposed in the Annex I of the Decree Law 182/2006 of 6 September and the ISO 9612:2009.

3 RESULTS AND DISCUSSION

The results obtained can be seen in Table 1 that shows the minimum and maximum values of $L_{Aeq,T}$ measured for each of the tasks evaluated in the four companies.

Whereas the workers are 8 hr in the workplace, the sound levels found are equivalent to the daily noise exposure level, $L_{EX,8h}$.

Of the 248 performed measurements, 163 (65.7%) are below the Lower Action Value (LAV); 56 (22.6%) above the lower action value; 29 (11.7%) above the Upper Action Value (UAV).

All the values that registered a higher value than LAV, 80 dB(A) are showed in bold in Table 1.

Table 2 presents the logarithmic average of the sound levels, $L_{Aeq,T}$, by task, for the four companies. This table also presents the highest value of peak sound pressure, L_{Cpeak} for each task, in the four companies.

Table 1. Minimum and maximum values of the $L_{Aeq,T}$ per task, in the four companies.

Section	Task	L_{min} dB(A)	L_{max} dB(A)
Cutting preparation	Vamping	72.8	78.4
Cut	Cut—Punch	74.3	80.0
	Automatic/laser/blade	73.4	**84.2**
Pre-sewing	Facing	73.0	79.7
	Stamping	77.4	**81.1**
	Equalize	76.0	79.6
	Overedging	74,2	77,7
	Interlining	73,8	75,9
	Placing eyelets	**80,2**	**82,1**
	Glue sponge (insole)	75.8	76.5
Sewing	Sewing	71.3	**93.6**
	Piece Crop	75.2	**88.3**
	Paste vamp	79.5	**86.7**
	Put buckles/line	75,4	78,1
Assembly	Marking	73.3	**83.9**
	Heel Stiffener	73.5	78.1
	Gluing the linings, soles, insole	70.4	**91.6**
	Staple insole	74.5	**83.6**
	Close sides/heels	77.8	**90.9**
	Furnaces	77.8	**83.0**
	Pressing	76.0	**87.8**
	Sanding	**84.2**	**94.7**
	Beat sewing	75.2	**91.8**
	Pierce	73.4	**89.5**
	Cooling the piece	74.6	**80.1**
	Unmold	75.7	**83.2**
	Greenhouse	79.2	**80.8**
	Beat to attach	77,3	79,0
	Straighten seams	76,1	77,9
	Controller	78,1	**80,8**
Finishing	Paint	74.0	**85.4**
	Cleaning	72.4	**82.8**
	Insoling	73.9	**83.4**
	Polishing	73.3	**84.8**
	Shine/cream	74.5	79.3
	Place accessories	71.8	76.0
	Burn edges	71.4	76.1
	Sew soles	**91,4**	**93,7**
Packaging	Packaging	68.8	76.2

As performed in Table 1 all the values that registered a higher value than LAV, 80 dB(A) are showed in bold.

We verify that the Sewing, Assembly and Finishing sections are the ones that presented the higher values of noise. Four of these values have an average equal or greater than the UAV 85 dB(A), corresponding to the tasks "piece crop" in the "seam", "sanding" and "close sides" in the "assembly" section and "sole sewing" in the "Finishing" section.

ues of the $L_{Aeq,T}$

L_{min} dB(A)	L_{max} dB(A)
72.8	78.4
74.3	80.0
73.4	**84.2**
73.0	79.7
77.4	**81.1**
76.0	79.6
74,2	77,7
73,8	75,9
80,2	**82,1**
75.8	76.5
71.3	**93.6**
75.2	**88.3**
79.5	**86.7**
75,4	78,1
73.3	**83.9**
73.5	78.1
70.4	**91.6**
74.5	**83.6**
77.8	**90.9**
77.8	**83.0**
76.0	**87.8**
84.2	**94.7**
75.2	**91.8**
73.4	**89.5**
74.6	**80.1**
75.7	**83.2**
79.2	**80.8**
77,3	79,0
76,1	77,9
78,1	**80,8**
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72.4	**82.8**
73.9	**83.4**
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80 dB(A) are

ly and Finish-
ted the higher
have an aver-
5 dB(A), cor-
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ssembly" sec-
ing" section.

Table 2. Average value of the $L_{Aeq,T}$ per task, and the highest value of L_{Cpeak}, for the four companies.

Section	Task	*Mean* $L_{Aeq,T}$, dB(A)	*Max* Lc_{peak} dB(C)
Cutting preparation	Vamping	75.6	110.8
Cut	Cut—Punch	76.9	119.7
	Automatic/laser/blade	78.3	128.8
Pre-sewing	Facing	75.7	113.1
	Stamping	78.1	119.5
	Equalize	78.1	114.0
	Overedging	76.2	109.7
	Interlining	75.0	104.1
	Placing eyelets	**81.3**	110.6
	Glue sponge (insole)	76.2	105.4
Sewing	Sewing	77.9	128.1
	Piece Crop	**84.6**	131.1
	Paste vamp	**81.9**	122.3
	Put buckles/line	77.2	115.7
Assembly	Marking	79.2	113.2
	Heel Stiffener	76.0	117.1
	Gluing the linings, soles, insole	78.3	118.5
	Staple insole	79.2	132.4
	Close sides/heels	**83.1**	121.5
	Furnaces	**80.8**	122.4
	Pressing	**80.6**	127.1
	Sanding	**89.4**	120.3
	Beat sewing	**81.9**	123.1
	Pierce	**81.0**	134.3
	Cooling the piece	77.4	114.0
	Unmold	79.5	120.0
	Greenhouse	79.9	105.4
	Beat to attach	78.4	105.4
	Straighten seams	77.4	106.9
	Controller	**80.3**	115.1
Finishing	Paint	**80.4**	114.9
	Cleaning	76.5	111.2
	Insoling	78.5	123.0
	Polishing	**80.7**	111.8
	Shine/cream	76.7	106.4
	Place accessories	74.0	109.6
	Burn edges	73.5	106.0
	Sew soles	**93.1**	119.3
Packaging	Packaging	72.2	110.1

4 CONCLUSIONS

The results show that the sewing and assembly tasks present a higher risk of exposure to noise.

The values registered are related with the use of old machinery and out-to-dated productive processes. On the other hand it was registered some layout problems such as overcrowded workplaces. These facts contributed to the increase of noise in several tasks that should not registered such higher values.

As a consequence companies concern should rely on up-to-dating the machinery and the productive processes implemented, reconsider the layout of the plant in order to diminish the higher values registered namely in the tasks of sewing and assembly.

Complementary measures may also be applied—construction collective protection such as coatings or sound absorption panels, the implementation of organizational measures, such as rotation of workers by several tasks to reduce daily personal exposure to noise.

In the moment of the accomplishment of the evaluations, it was verified that most of the workers was not equipped with hearing protectors that demonstrates they not have perception of the risk which are exposed. Of the 29 tasks equal or above the upper action value, where it is necessary to ensure the hearing protection, only in 5 (17.2%) workers wore hearing protection. As a consequence hearing protection should be used whenever noise level exposition exceeds the value of the lower action.

Controlling worker exposure will also require improved training in short and long term in order to raise awareness for these issues and protect own health and safety.

According the Directive 2003/10/EC all these measures should be from the responsibility of the employer.

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