

## **Ergonomics and Work-related Musculoskeletal Disorders in Small and Medium-sized Enterprises.**

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### **Abstract**

The Small and Medium-sized Enterprises (SMEs) are the key source of employment in Europe and South America. However, their workers may be exposed to less favourable working conditions. The objective of this study was to analyse and characterise working conditions, with a special focus on ergonomics and work-related musculoskeletal disorders (WMSDs), of a group of Portuguese and Chilean enterprises. The method consisted in the application of an online survey in a range of enterprises. The result of this research shows, among other things, that a great number of differences exist between SMEs and large enterprises in what working conditions concerns. However, this situation does not exist between the two considered countries. In conclusion, those results corroborate the idea that SMEs have disadvantages, moreover, will be more difficult to implement actions to correct and improve these situations. Therefore it is essential that this can be implemented using a SMEs-oriented ergonomic strategy.

## Key words

SMEs, Ergonomics, Work-related musculoskeletal disorders, Portugal, Chile.

## Introduction

Micro, small and medium-sized enterprises (SMEs) are the engine of the European economy. They are an essential source of jobs, create entrepreneurial spirit and innovation in the EU and are thus crucial for fostering competitiveness and employment (European Commission, 2005). Also, it is possible to argue strongly that almost all South American countries give great importance to SMEs, in terms of developing their economies (Hiba, 1997). Table 1 shows an example of this, despite the differences between Portugal and Chile in terms of SMEs classification, which is verified mainly in the annual turnover criterion.

Country	SMEs		
	% of total enterprises	% of Employment	% Gross Domestic Product (GDP)
Chile	99.0	80.0	21.7
Portugal	99.6	75.1	56.8

Table 1 – Resume of the situation of the SMEs in Chile and Portugal (Governo do Chile, 2003; IAPMEI, 2009)

Despite this economical importance, it seems that for several reasons workers in SMEs may be exposed to less favourable working conditions, therefore are subject to higher risk than the workers in large enterprises (Hasle & Limborg, 2006; Hiba, 1997; Malchaire, 2006; Sørensen et al., 2007). The WMSDs are the single largest category of work-related illness, representing a third or more of all registered occupational diseases in the United States, the Nordic countries, and Japan (Punnett & Wegman, 2004).

The total cost of WMSDs for the economy and society is estimated at 0.5–2 % of GDP every year (Caffier et al., 2007), due to the large amount of direct and indirect costs related to the fall in

production, administrative overhead, overtime pay, training and replacement of personnel, replacement of injured workers, and compromise in the quality of the product (Alexander & Albin, 1999; Oxenburgh et al., 2004). Indirect costs may be several times greater than direct costs and are often not measured by enterprises (Hagberg et al., 1995), which may lead them to underestimate the scope of the problem.

The main objective of this study was to analyse and characterise working conditions in SMEs, with a special focus in ergonomics and WMSDs, from a group of Portuguese and Chilean enterprises.

## **Approach and methods**

### *Characteristics of the survey*

Associated with the difficulty of applying the survey in two countries, for practical reasons and treatment of responses, it was decided that two web platforms should be developed, thus allowing collecting answers online through a specific website for each one of the countries separately.

In order to encourage the response to the survey, it was decided that the survey should be as simple and short as possible. These characteristics allowed an estimated response time between 6 and 8 minutes.

Before applying the survey, a preliminary study with a group of about 25 people in each country was conducted. The group was formed by workers, entrepreneurs and other people with different basic backgrounds such as Ergonomics, Engineering, Law, Occupational Safety and Health (OSH), and others. This test intended to check their understanding of the language used, to obtain an estimate of the time that would take to respond, the suitability of the questions and evaluate the functioning of the automatic data collection system.

Figure 1 shows the structure adopted in the developed survey, based on the 4 areas that are intended to be addressed: the characterisation of the enterprise, the quantification of the problem of WMSDs, existent knowledge of ergonomics and, finally, how enterprises had approached the working conditions in relation to ergonomics.

In the last part of the survey, it was referred the possibility to receive additional information on overall results of the survey. Thus, by indicating the e-mail, enterprises could ask the sending back of information about the final results of the survey, the final report of the project, or both. This option was included considering that there is a frequent request for answer electronic surveys and therefore, giving feedback is, or intends to be, an element of motivation to fill in the survey.

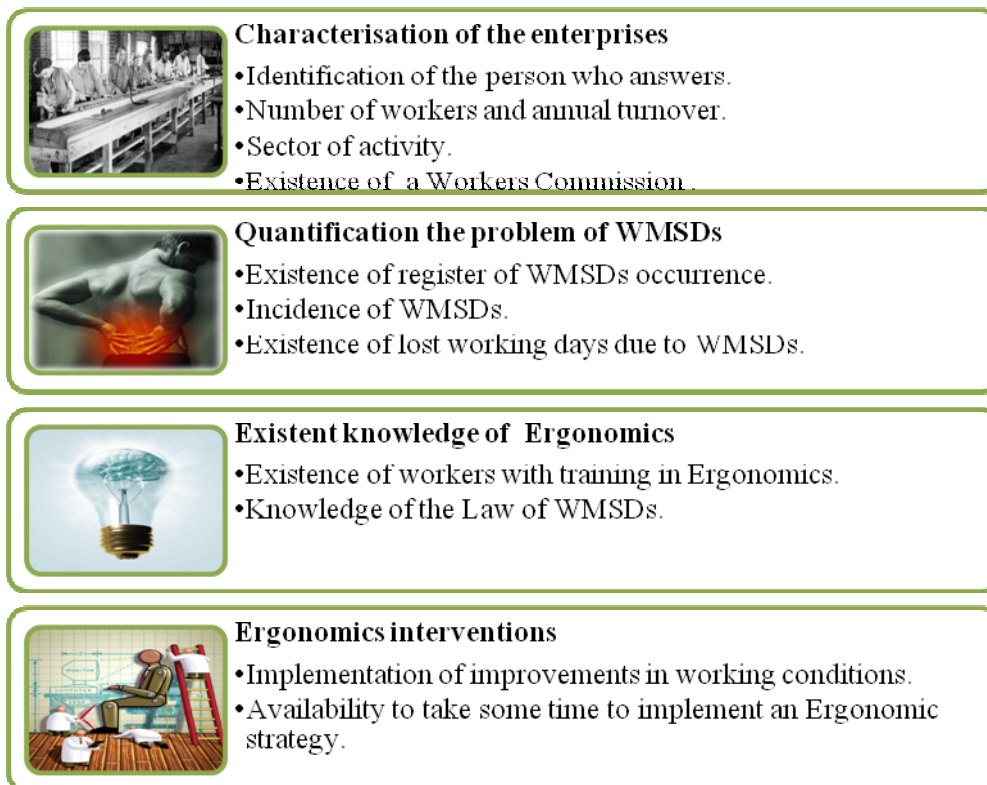


Figure 1 – Structure of the survey.

### ***The sample***

Given the objective of the study, the sample tried to represent the largest amount of enterprises in Chile and Portugal. It should be noted that this was a sample of convenience obtained from 2

electronic databases for each reported country. It is important to mention the use of a exclusion criterion, which was to have deliberately not made contact with the enterprise through OSH Practitioner, this forced the exclusion of the databases of the Laboratory of Ergonomics, at the University of Minho, which has the contacts of 5515 OSH Practitioners in Portugal.

In Chile, one of the used databases correspond to the PRO Chile (2009), an agency that belongs to the Directorate General for International Economic Relations of the Ministry of Foreign Affairs of Chile. The data base of about 5800 enterprises that account for exports made in the year 2007, of which 4395 (75.8%) have e-mail contact. At this respect, it is important to mention that, according to the Government of Chile (2003), 64.7% of the exporting enterprises are SMEs.

The other used database was the website for SMEs Chile (Pymes de Chile, 2004), which serves as a online guide on a diverse group of topics such as: management, productivity, business opportunities, human resources, etc.

One of the used databases in Portugal was a database enterprises belonging to the University of Minho, from 2005 and with a total of 1401 e-mails from enterprises. However, to reach a greater number of enterprises, the database of the Agency for Investment and Foreign Trade of Portugal was also used (AICEP Portugal Global, 2009). This database contains a total of 7764 exporting enterprises, of which 5387 have e-mail.

The selection of these databases meant that the responses corresponded to enterprises with size and sector of activity quite different, where it was possible to be sampling micro, small, medium and large enterprises in several sectors of activity such as manufacturing, construction, education, accommodation, catering and similar services, financial activities and insurance, among others. The inclusion of large enterprises in the sample was done in order to compare and check the differences between them and SMEs.

As presented in Table 2, the used databases contained 11372 e-mails addresses. However, this number should be withdrawn by the number of error messages received, which totalised a value of 1817 and those messages that were not delivered to the recipient (for incorrect/outdated addresses, full e-mail boxes, etc.). Thus, the message had the potential to reach 9555 possible answers.

In conclusion, considering the number of responses received, 639, we can estimate the response rate in about 6.7% (639 responses in 9555 possible). However, the real value of this rate can be slightly higher as some respondents, while filling the survey, reported by e-mail some situations of message filtering by their own anti-spam filters.

Finally, it is important to notice that the difference in the amount of answers submitted between the 2 countries (Table 2) may have been influenced by the number of possible answers, since the Portuguese sample had more than 48% of the Chilean sample and the double of the response rate. It is difficult to justify the latter situation, but there may be a group of possibilities, such as period used for sending the e-mails (December-April), which was the season of summer holidays in Chile, and the greater knowledge of the University of Minho by the respondents in Portugal.

Country	Database	E-mails	Possible Answers	Answers	Answer Rate	
					Database	Country
Chile	PRO Chile	4395	3670	149	4.1%	4.2
	Pymes de Chile	189	179	12	6.7%	
Portugal	U. Minho	1401	828	51	6.2%	8.4
	Aicep	5387	4878	427	8.7%	
<b>Total</b>	4	11372	9555	639	6.7%	6.7%

Table 2 – Characterisation of the survey used data.

### *Statistical analysis*

All data were entered into Microsoft Office Excel 2007 and analysed using SPSS v16.0. Categorical data were summarised using percentages and analysed using the chi-square test (cross table) with 95

% confidence interval, which was performed for testing the independence between the variables and the enterprises size.

## Results and Discussion

### *Characterisation of the enterprises*

Based on 639 responses from the 2 countries, figure 2 shows the distribution of enterprises according to their size. Comparing the sample with the economical reality of these 2 countries, mentioned above and described in table 1, it can be stated that the sample is considered to be biased. However, there is a difference in the "gap" between both countries, being more pronounced in the case of Chile, while the Portuguese sample is more representative of reality. This situation may have been caused by the fact that the Portuguese sample (478 responses) is considerably higher than the Chilean sample (161 responses).

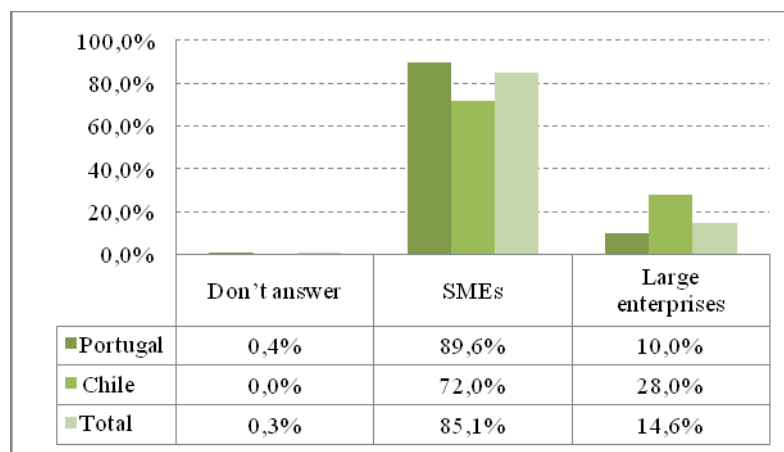


Figure 2 – Characterisation of the sample according to country and the size of the enterprise.

Considering the variable “person who answers” and “the size of the enterprise”, figure 3 shows 3 situations that would be, in some way, expected. The first one is related with the large number of owners of the enterprise that answered the survey in micro enterprises, which decreases as long as

the size of the enterprise increases. The other 2 cases are the increase of responses of "OSH Practitioner" and "other worker responsible for SH" as long as the size of the enterprise increases. These trends, previously noted, were tested for statistical significance and the obtained result ( $X^2 = 1.044$ ;  $p < 0.05$ ) has shown that these 2 variables are statistical dependent.

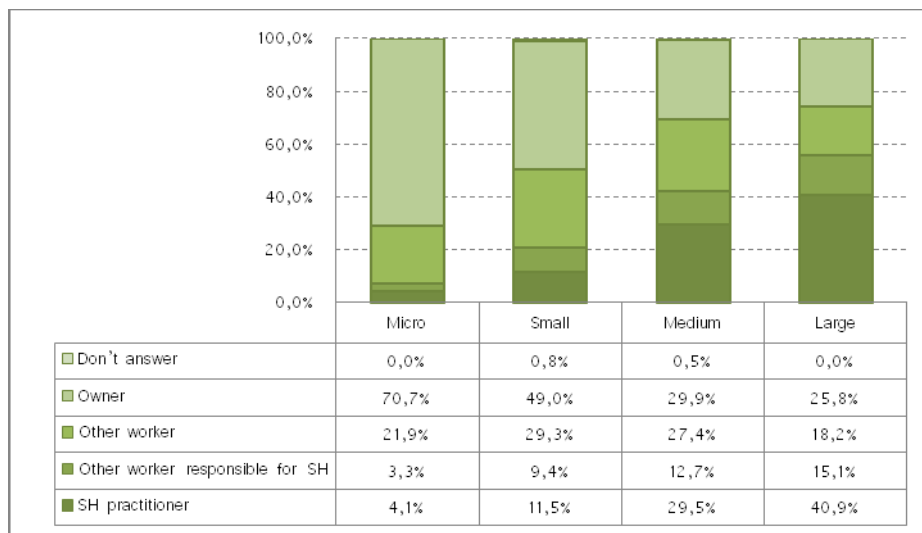


Figure 3 – Characterisation of the sample according to the person who answers and the size of the enterprise.

From the analysis of the data in figure 4 it is possible to see an increasing number of enterprises with workers commission, as the size of the enterprise increases, with a significant "jump" in the categories with different requirements in the Chilean law. This condition suggests that the law can be an important factor of influence. This situation was also found during the implementation of the Workplace Assessment (WPA), where complying with legislative demands was the basic motive of management to initiate the process (Jensen et al., 2001).

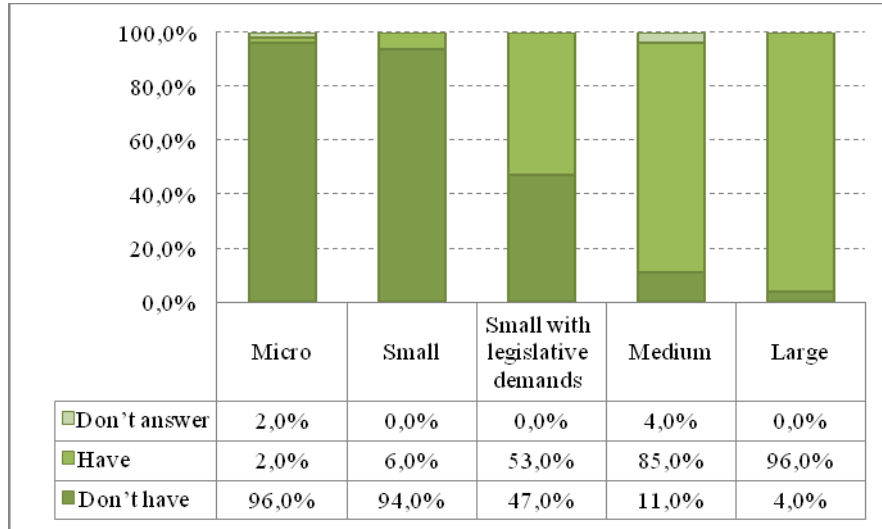


Figure 4 -Characterisation of the Chilean sample according to the existence of “workers commission” and the size of the enterprise.

In what regards Portugal use data, in figure 5, even if there is an increase of “workers commission” in relation to the enterprise size, it is not possible to see a clear "jump. However, as in the Chilean sample, these variables are dependent and this dependency is statistically significant ( $X^2=36.371$ ;  $p < 0.05$ ).

Considering those situations it is possible to conclude that the presence of “workers commission” is not simply influenced by legal requirements, but also by the size of the enterprise.

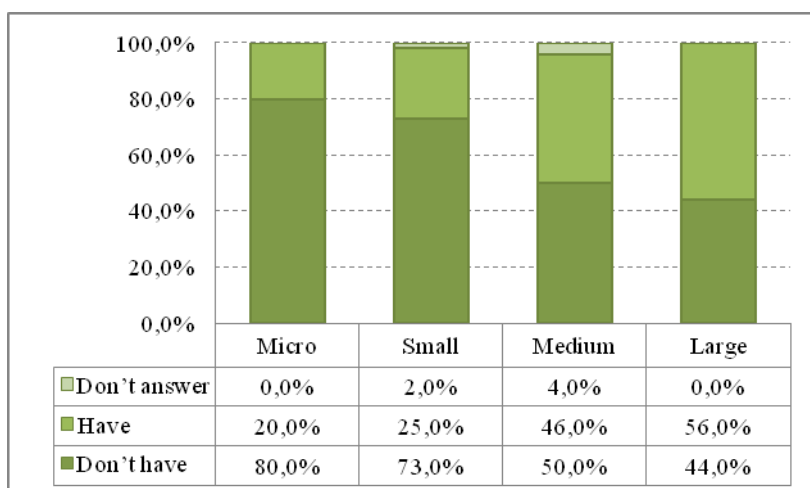


Figure 5 - Characterisation of the Portuguese sample according to the existence of “workers commission” and the size of the enterprise.

### *Quantifying the problem of WMSDs*

Before any analysis between the considered variables of this area and the size of the enterprises, it is important to mention that only 23.5% of enterprises had a register of WMSDs occurrence.

Nevertheless, 27% of the respondents have reported that they had some lost working days due to WMSDs.

Regarding to the variables “size of the enterprise” and “register of WMSDs occurrence”, represented in figure 6, it is possible to determine a statistical significant association between them ( $X^2=59.543$ ;  $p < 0.05$ ), which may be caused by the low number of responses in micro enterprises.

As already stated, there is an increase on the WMSDs registry as the size of the enterprise increases.

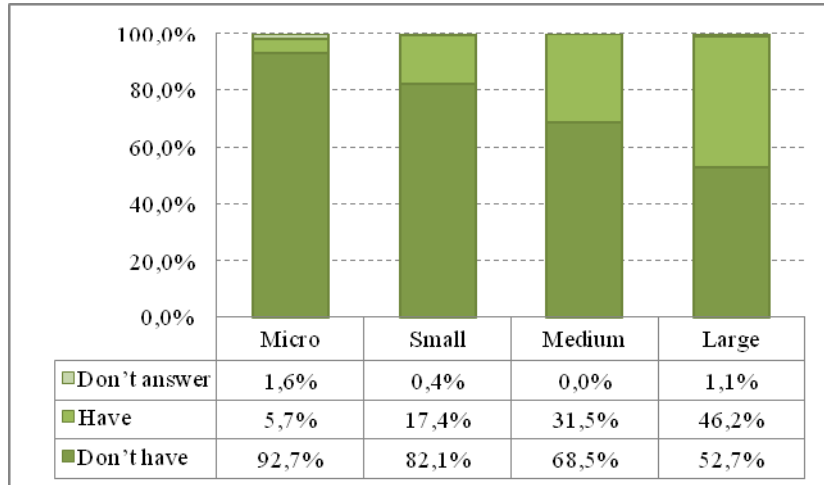


Figure 6 - Characterisation of the sample according the register of WMSDs occurrence and the size of the enterprise.

Figure 7 shows a directly proportional relationship between the variables “existence of lost working days due to WMSDs” and the size of the enterprise, which is more obvious in large enterprises. This relationship shows significant differences, determining that the variables are dependent ( $X^2=77.747$ ;  $p < 0.05$ ).

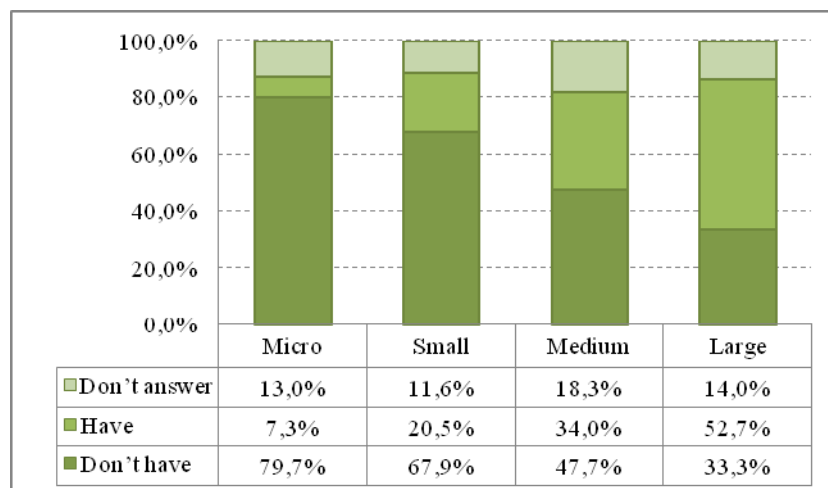


Figure 7 - Characterisation of the sample according to the existence of lost working days due to WMSDs and the size of the enterprise.

In conclusion, it is possible that the low value of reported WMSDs (figure 6) may be underestimated, as the majority of enterprises, in particular SMEs, did not have a reliable and systematic WMSDs control and register. Moreover, this situation seems to be associated with an inadequate organization structure and knowledge.

### ***Knowledge of ergonomics***

Considering the variables “existence of worker with training in ergonomics” and the size of the enterprise” (Figure 8), it is not possible to detect any particular influence of the size of the enterprise in the workers` training between the micro and small enterprises. However, this influence can be somehow observed in other categories, which present a greater number of workers with training. The application of a statistical test shows that these variables are statistically dependent ( $X^2 = 57.387$ ,  $p < 0.05$ ).

This result is in accordance with previous studies (Lehtinen, 2006; Stuart-Buttle, 1999), in which was referred that the workers in small enterprises have low level of educational and vocational training and that their knowledge about occupational safety and health is practically inexistent.

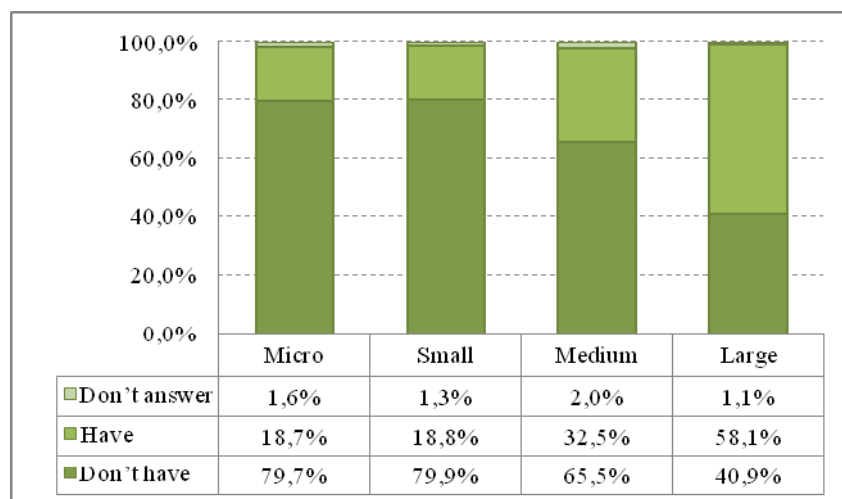


Figure 8 - Characterisation of the sample according to the existence of worker with training in ergonomics and the size of the enterprise.

From the carried out statistical analysis, it is possible to verify that there is a statistically significance dependency between the variables "person who answer" and "knowledge of the legislation of WMSDS" ( $X^2=84.449$ ;  $p < 0.05$ ). Figure 9 shows, as would be expected, less knowledge of the legislation by the owners of enterprises and superior knowledge in the categories of "another worker responsible for the OSH". This value is even greater in the OSH Practitioner category.

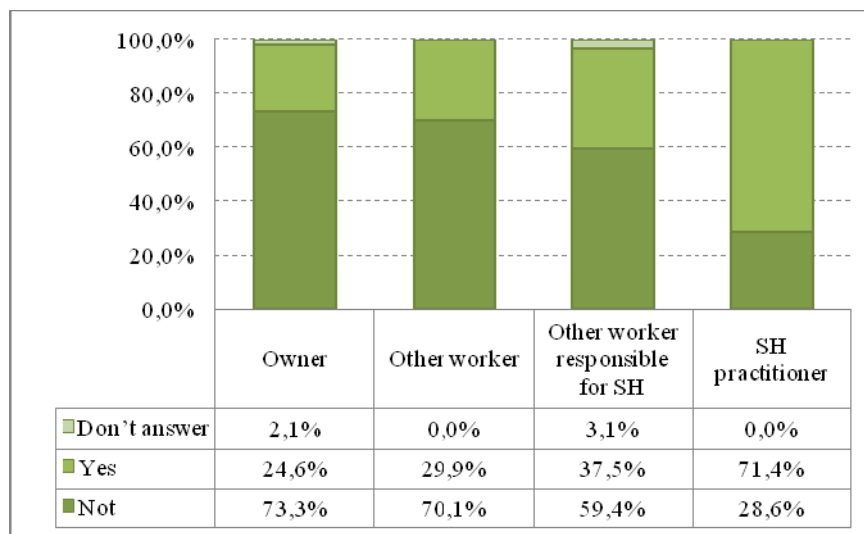


Figure 9 - Characterisation of the sample according to the knowledge of the legislation of WMSDS and the person who answer.

If one considers a number of factors, such as the legislation regarding the obligation of the existence of OSH Practitioner, the enterprise's employees with low training in Ergonomics and the fact that the owners have little knowledge of the legislation regarding WMSDs, it can be concluded that SMEs are at a disadvantage when addressing the problems associated with working conditions in general and those of ergonomics in particular.

### *Ergonomics interventions*

Considering the obtained results of the variables “size of the enterprise” and “the total number of implemented improvements” (Figure 10), it is possible to determine an increased number of improvements implemented as the size of the enterprise increases. The obtained results show that there is a dependence between these 2 variables ( $X^2=1.311$ ;  $p < 0.05$ ). This situation can be associated with the lack of time and economical resources in the smaller enterprises (Jensen, 2001).

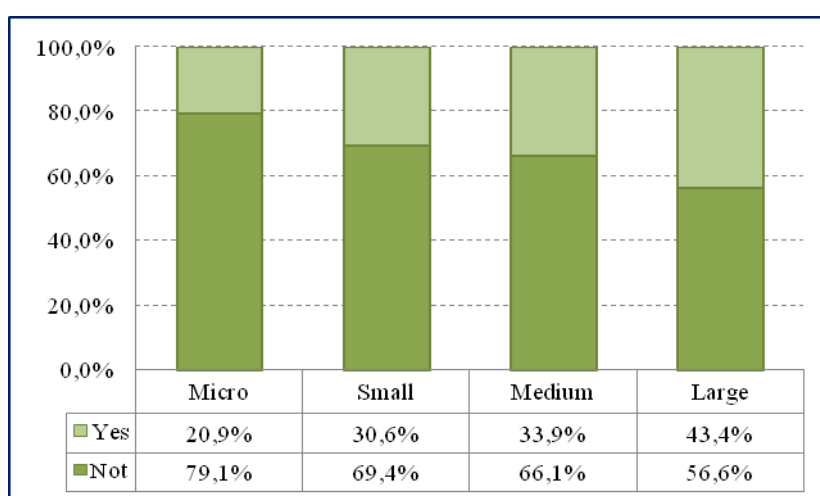


Figure 10 - Characterisation of the sample according to the total number of implemented improvements and the size of the enterprise.

Finally, the respondents were asked whether they will to participate in the implementation of an ergonomic strategy, with the aim of improving working conditions. The results (Figure 11) show a large number of enterprises that are willing to participate in an ergonomic strategy. Despite the greater number of positive responses in the Chilean sample, the difference between the two countries is not statistically significant ( $X^2=1.339$ ;  $p > 0.05$ ).

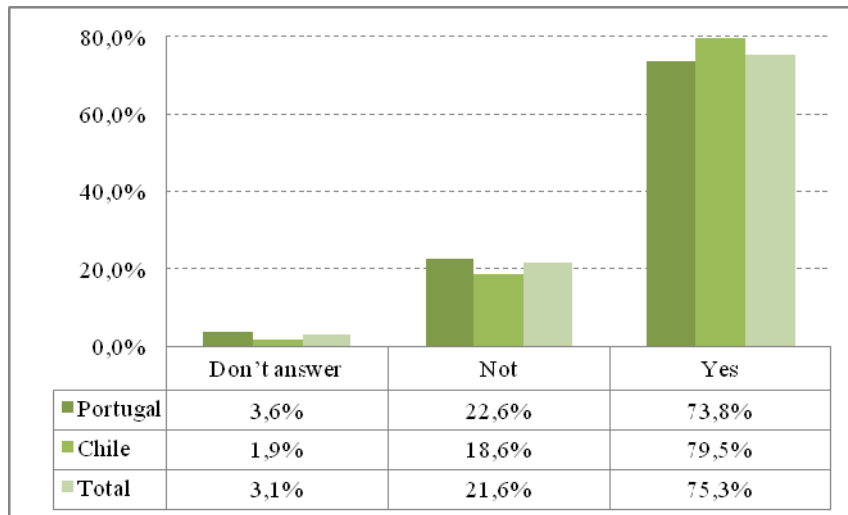


Figure 11 - Characterisation of the sample according the willingness to participate in an ergonomic strategy.

## Conclusion

This study intended to generically analyse and characterise the working conditions, with a special focus in Ergonomics and WMSDs, of a group of Portuguese and Chilean enterprises, based in online survey sent to 9555 enterprises.

According to the obtained data, it can be concluded that there are not great differences between the 2 countries. However, between SMEs and large enterprises, it was possible to observe a significant number of differences. These results corroborate the idea that SMEs are at a disadvantage regarding to the working conditions and, moreover, the implementation of actions to correct and improve inadequate work situations will be more difficult. Nevertheless, there are a greater number of large enterprises with lost days due to WMSDs when compared with other categories, but it is important to notice, that without a real quantification of them, the number of WMSDs in SMEs may be underestimated.

A final result that needs to be highlighted is the fact that 75.3% of the respondents expressed willingness to dedicate some of their time in the implementation of an ergonomic strategy to

improve working conditions. Considering all the information, it is important to apply an Ergonomic Strategy that keeps the control of WMSDs, using simple procedures, and adequate external support. It is also important to execute specific training programmes and give information with low cost ideas to improve SMEs working conditions.

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**Word count:** 2.768

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