



How well does Spain manage occupational noise and vibration risks?

M^a José García Tomás
Instituto Nacional de Seguridad y Salud en el Trabajo
Torrelaguna 73, 28027 Madrid. SPAIN

Rafael Sánchez-Guardamino Elorriaga
Instituto Nacional de Seguridad y Salud en el Trabajo
Camino de la Dinamita, s/n, 48903 Cruces-Barakaldo. SPAIN

ABSTRACT

From the analysis of Spanish national statistics on occupational diseases notification during the period 2009 – 2018, a prospective study on the level of compliance with the national implementation of both European Union directives 2003/10/EC and 2002/44/EC, is undertaken. Research is developed by Occupational Health and Safety National Institute (INSST) in liaison with Spanish autonomous regional governments. Questionnaires were designed by technical personal from the national Institute in order to collect relevant information. These questionnaires were fulfilled in situ by specialized and qualified civil servants from several autonomous regions. Up to 566 companies take part of the study from different economic activities, in which outstanding noise and/or vibration risk is present. The study concludes in relation to preventive management of noise that both, there are serious deficiencies in the characterization of the exposure, and it also entails a very low effectiveness in reducing risk. As far as vibration risk management is concerned, a deficient specific legal regulatory implementation is found. As a result, of such conclusions, an action plan is being designed to improve working conditions by means of assuring the compliance with legislation.

1. INTRODUCTION

This paper presents a study, which consists of a diagnosis related to occupational noise and vibration exposure management. It is aimed at designing future actions which promote a reduction of such exposures by Public Administration, mainly for those workers groups with more incidence of noise induced hearing loss and diseases due to mechanical vibrations.

The objectives of this study are both:

- Identifying the groups most exposed to noise and mechanical vibrations in Spanish companies.
- Checking the Spanish level of compliance with national implementation of both European Directives 2003/10/EC y 2002/44/EC, from European Parliament and Council. These Directives lay down minimum requirements for the protection of workers from risks to their health and safety arising or likely to arise from both exposure to noise, particularly the risk to hearing, and exposure to mechanical vibrations, especially musculoskeletal disorders, respectively.

mariajose.garcia@insst.mites.gob.es

rafael.sanchez-guardamino@insst.mites.gob.es

2. METHODOLOGY

In this section it is depicted how the noise and vibrations diagnosis was undertaken. The study is based on two independent sources, and therefore the used method is split into two different procedures, which are individually described below.

The referred sources are as follows:

- The public registration of Occupational Diseases Notification System of the Social Health Service (CEPROSS).
- Field research through a set of companies in order to determine how they performance the preventive management of noise and vibrations risks by a survey.

2.1. Diagnosis from statistical data.

The occupational diseases analysis is based on the data registered by CEPROSS system during the period 2009-2018.

Firstly, the total cases from Group 2A “Noise induced hearing loss and deafness” and Group 2B “Osteoarticular or angioneurotic disorders caused by mechanical vibrations” were computed, so that the relative weight of damages caused by both physical agents could be calculated over the whole set of occupational diseases.

In order to locate workers groups on risk according to their tasks, it is preferred using the administrative classification system of economic activities which companies are registered on, to referring to their specific tasks which cause such pathologies. For this reason, when analyzing by economic activity, this study is based on the Spanish system “National Classification of Economic Activities”, CNAE

The cases incidence by activity depends on two combined parameters: Inherent risk of noise or vibration exposure due to critical tasks operating and number of exposed workers. This study has identified the activities, which most contribute to the actual damage during the period of the study, according to the criteria of the minimum CNAE codes, which together involved half the cases. Thus, it could be set up the target groups.

Other considered criteria are age and sex of the affected workers, as well as the companies’ size and location. Nevertheless, this paper is solely focused on the analysis according to companies’ size and CNAE code.

The singular company’s size affects the enterprise organizational capacity and management, hence the interest in studying the notified cases according to the number of employees. In order to make some comparison analysis, it is useful to determine the number of cases per 100,000 workers. The calculation is based on published data by the Ministry of Labor and Social Health over the computed workers in December 2018.

In section 3, results are graphically introduced by showing which economic activities mostly occupational deafness and diseases induced by vibrations are reported in, as well as, the influence of the companies’ size. Thus, essential information is provided so as to locate the most affected groups in pursuit of targeting future intervention campaigns directly to the highest risky scenarios.

2.2. Diagnosis from survey results

A diagnosis resulted from a prospective fieldwork, which was designed with the aim of having an approach about the compliance level with the national implementation of both directives 2003/10/EC and 2002/44/EC.

The choice of the companies, which take part of this study, was undertaken by Occupational Health & Safety Officer from the public Autonomous Regional Technical Bodies specialized in Occupational Health and Safety (ARTBOHS). They focused on relevant presence of noise and/or vibrations at workplaces, according to their professional technical expertise.

Likewise, Officers from ARTBOHS have been in charge of fulfilling the questionnaires during their usual visits. To do this, they looked at the preventive documentation contents available in the company: Prevention plan, general occupational risks assessment, specific noise and vibration assessment, preventive action plan and technical and management measures to reduce noise and vibration exposures, training registration, etc.

The highly proved qualification of the regional civil servants assures an adequate selection of the sample and an accurate fulfilling of the questionnaires, which endorses the study reliability.

The questionnaire consists of a set that encompasses a brief common items group for both, noise and mechanical vibrations, and two specific items groups, for each one of both physical agents. The questions are easily understandable and they do not require any additional instruction for their comprehension.

Up to 566 companies took part of the study. Firstly, the whole sample was analyzed according to section 2.2.1. Subsequently, several sub-groups were identified, which the same analytical procedure was applied again on.

The studied sub-groups are listed below:

- One sub-group integrated by those questionnaires which unveil a guarantee-based compliance of assessment legal proceedings.
- Ten sub-groups set up according to different preventive interest criteria such as companies' size, their activities, and the chosen Preventive Service System.

A questionnaire classification was held according to the number of workers employed by each company, in order to check whether the company's size affects on the proper management of workers' health. Thus, the following three partial samples were obtained, each one with more than 100 questionnaires:

- Micro-enterprise, from 1 to 10 employees (123 questionnaires)
- Small enterprise, from 11 to 50 employees (300 questionnaires)
- Medium enterprise, from 51 to 250 employees (115 questionnaires)

Questionnaires from big companies, i.e. more than 250 employees, were excluded from this study, because their weight on the global sample was insignificant, and therefore of scarce representativeness.

As far as activity analysis is concerned, the number of questionnaires fulfilled for most of the activities codes, CNAE, was very low, except from two specific activities "Metallic parts manufacture for construction sector" and "Metal treatment and coatings. Mechanical Engineering on behalf

of another”, which more than 80 questionnaires are available for. This is enough to pose both partial samples.

In order to undertake the study according to activity, qualitative grouping was accomplished based on different types of raw materials, which are used for product manufacture. It allows classifying questionnaires into four categories, which consist of other three samples.

- Metal Industry and similar (235 questionnaires), it is characterized by the use of metallic raw materials
- Plastic and wood Industry (39 questionnaires). It is on charge of wood processing and vegetal binder transformation and petroleum products.
- Food Industry (74 questionnaires). Group which encompasses process related to food chain.
- Others. In this category, companies from the sample, which cannot be allocated in any of the three categories noted above, are considered. This category is not analyzed as a partial sample, because companies within this group do not share any specific property.

At the aim of knowing how the Occupational Health and Safety Officer nearness to workplaces affects the company preventive management, another classification of the questionnaires was undertaken, using the chosen preventive service system criterion. Hence, two more partial samples were found.

- Companies, whose preventive service system is agreed with an external preventive service (522 questionnaires)
- Companies which assume the preventive management with their own resources (43 questionnaires)

In contrast to noise analysis, the low number of questionnaires registered regarding mechanical vibrations risk management has restricted the sample study solely to the whole sample.

2.2.1. Indicators Setting:

Concluding from the responses in questionnaires, the actual compliance level of companies related to the legal requirements on Occupational Risk Prevention due to noise and mechanical vibrations exposure, demands setting up some indicators, which report about this.

Noise and mechanical vibrations are individually studied, considering for each one, the following basic indicators depicted by mathematical expressions:

- Agent identification. Referred to Initial Risk Assessment (IRA).

$$\frac{\text{N}^{\circ} \text{ of companies which identify noise expsoure in IRA}}{\text{N}^{\circ} \text{ of companies with noise exposure}} \times 100 \quad (1)$$

$$\frac{\text{N}^{\circ} \text{ of companies which identify vibrations expsoure in IRA}}{\text{N}^{\circ} \text{ of companies with vibrations exposure}} \times 100 \quad (2)$$

- Agent Assessment. In order to calculate this indicator companies with complete specific assessment are computed, i.e. those that included all the positions where risk were identified. Whereas, for next indicators companies either which have complete assessment or those that only assessed some of the positions with exposure to such agents.

$$\frac{\text{N}^\circ \text{ of companies with complete noise assessment}}{\text{N}^\circ \text{ of companies with noise exposure}} \times 100 \quad (3)$$

- Legal noise assessment proceeding. This indicator consists of setting up the representativeness of the assessment. To this end, it is required the enclosure of either the uncertainty calculation according to scientific-technical methodology, or the reference and commitment to the strategy of the measurements endorsed by technical guidance, technical standards or criteria documentarily depicted, such as UNE-EN-ISO 9612:2009 "Acoustics. Determination of occupational noise exposure. Engineering method."

$$\frac{\text{N}^\circ \text{ of companies with noise assessment + strategy}}{\text{N}^\circ \text{ of companies with noise exposure}} \times 100 \quad (5)$$

$$\frac{\text{N}^\circ \text{ of companies with noise assessment + uncertainty}}{\text{N}^\circ \text{ of companies with noise exposure}} \times 100 \quad (6)$$

- Legal vibrations assessment proceeding. In this case, the indicator focusses on knowing whether assessment is undertaken by estimation or measuring method, without detailing the representativeness of it.

$$\frac{\text{N}^\circ \text{ of companies with vibrations assessment by estimation}}{\text{N}^\circ \text{ of companies with vibrations assessment}} \times 100 \quad (7)$$

$$\frac{\text{N}^\circ \text{ of companies with vibrations assessment by measuring}}{\text{N}^\circ \text{ of companies with vibrations assessment}} \times 100 \quad (8)$$

- Risk confirmation. Companies that have specific assessment, in which one or both upper exposure action value (noise) or any daily exposure action value (vibrations) were exceeded at least in one position, are considered.

$$\frac{\text{N}^\circ \text{ companies with assessment } \{L_{ex,8} > 85 \text{ dB(A)} \text{ or } L_{Cpeak} > 137 \text{ dB(C)}\}}{\text{N}^\circ \text{ of companies with noise assessment}} \times 100 \quad (9)$$

$$\frac{\text{N}^\circ \text{ companies with assessment } \left\{ \left(A(8)_h > 2.5 \frac{m}{s^2} \right) \text{ or } \left(A(8)_w > 0.5 \frac{m}{s^2} \right) \right\}}{\text{N}^\circ \text{ of companies with vibrations assessment}} \times 100 \quad (10)$$

- Risk management. Referred to those companies, which performed technical and organizational programmes, and they were efficient on reducing the noise and/or vibrations exposure level.

$$\frac{\text{N}^\circ \text{ of companies with programmes which reduced noise}}{\text{N}^\circ \text{ companies with assessment } \{L_{ex,8} > 85 \text{ dB(A)} \text{ or } L_{Cpeak} > 137 \text{ dB(C)}\}} \times 100 \quad (11)$$

$$\frac{\text{N}^\circ \text{ of companies with programmes that reduced vibrations}}{\text{N}^\circ \text{ companies with assessment } \left\{ \left(A(8)_h > 2.5 \frac{m}{s^2} \right) \text{ or } \left(A(8)_w > 0.5 \frac{m}{s^2} \right) \right\}} \times 100 \quad (12)$$

3. STATISTICAL ANALYSIS RESULTS

In this section it is depicted how the noise and vibrations diagnosis was undertaken. The study is based on two independent sources.

Data on all professional diseases are summed up in table 1, pointing out how many are due to noise exposure (Group 2A) and how many to mechanical vibrations (Group 2B). Behaviour according to different parameters: sex, age, task nature, CNAE, enterprise's size and autonomous region was analysed. In this paper, only enterprise's size and economic activity were enclosed, because they are crucial to identify the risk groups.

Table 1: Number of notified cases during the period 2009-2018, noting additionally the percentage, which accounts for each group out of total occupational diseases.

| Hearing loss | Diseases caused by vibrations | Total occupational diseases |
|--------------|-------------------------------|-----------------------------|
| 9897 | 1688 | 186640 |
| 5.3 % | 0.9 % | 100 % |

3.1. Statistical Analysis according to enterprise's size

See charts 1 and 2.

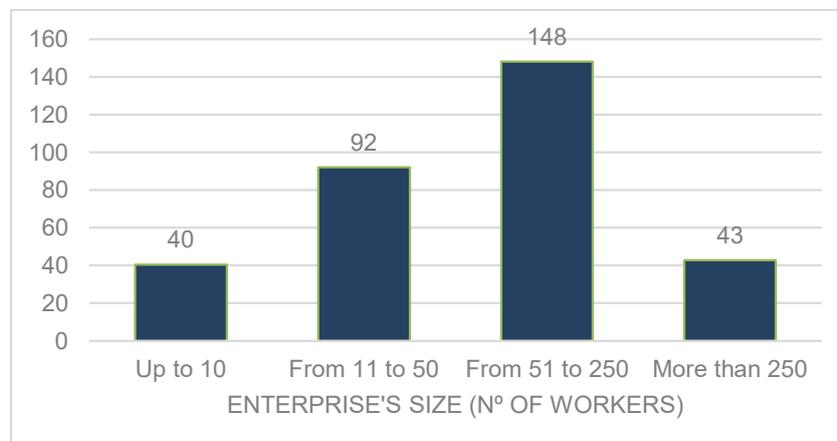


Chart 1. Group 2A diseases cases per 100,000 workers according to enterprise's size

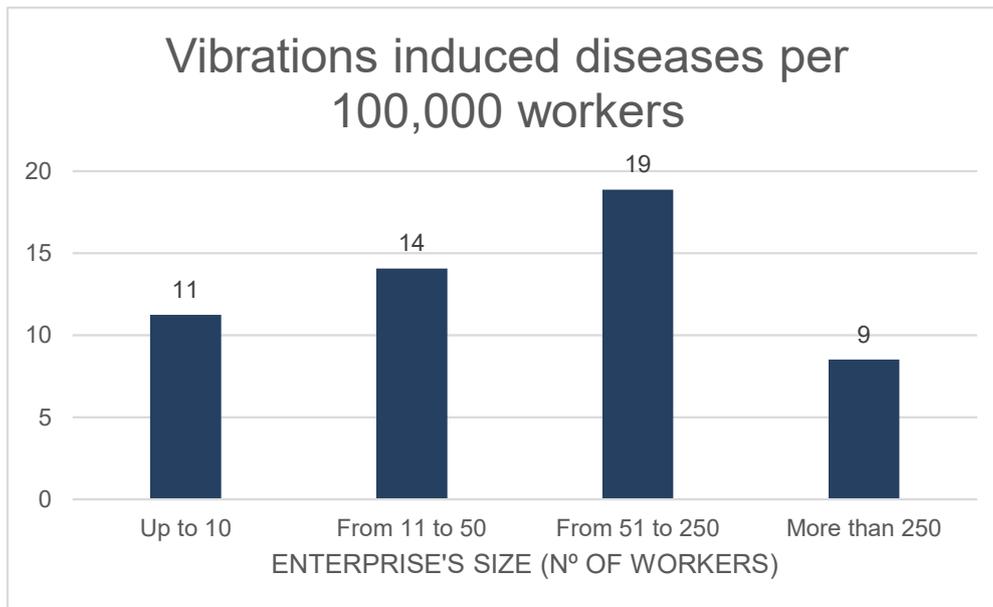


Chart 2. Group 2B diseases cases per 100,000 workers according to enterprise's size

3.2. Statistical analysis according to activity

In charts 3 and 4, the percentage distribution of occupational deafness and diseases caused by mechanical vibrations, respectively, is given.

Chart 3 shows that 13 economic activities congregate 50 % of occupational deafness during the study period (2009-2018). These activities belong mostly to metal sector.

Chart 4 shows a greater dispersion for diseases caused by mechanical vibrations according to economic activity.

4. SURVEY RESULTS

4.1. Noise survey results

In this section, values of the indicators set up in section 2.2.1 are presented when applying to the whole sample (table 2). In a comparable way, in such table is shown how these indicators change when considering Assessment Legal Proceedings (ALP). Results for partial samples profiled according to chosen preventive service system, activity and enterprise's size are collected in tables 3, 4 and 5.

% HEARING LOSS (2009-20018)

- Forging, stamping and powder metallurgical forming
- Components, parts and accesories for motorised vehicles
- Ferrum, steel and ferroalloys basic products manufacture
- Metal treatment and coatings. Mechanical Engineering on behalf of another
- Metal casting
- Ship building
- Metallic parts manufacture for construction sector
- Other steal first transformation products manufacture
- Building
- Other machinery manufacture for specifical usages
- Ceramic products manufacture for cosntruction sector
- Cutlery items manufacture, tools and hardware
- Other general machinery manufacture
- Other CNAE

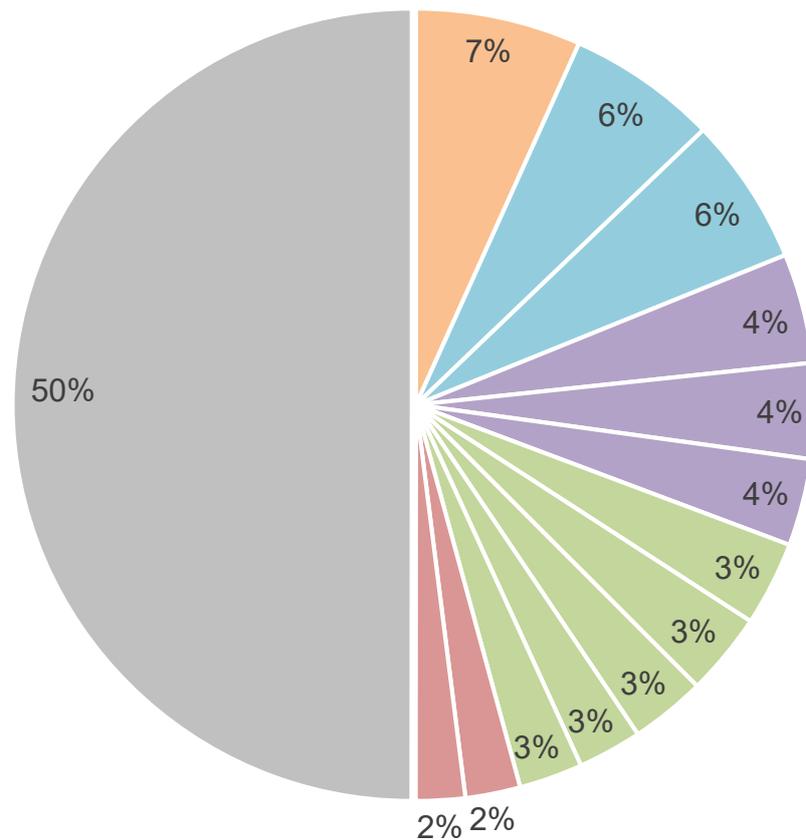


Chart 1. Percentage distribution of occupational hearing loss according to activity

% DISEASES CAUSED BY MECHANICAL VIBRATIONS (2009-2018)

- Motorised vehicles manufacture
- Components, parts and accesories for motorised vehicles
- Building
- Meat processing and preservation and other meat-based products elaboration
- Cleanliness activities
- Public administratoion. Economic an social politics
- Motorised vehicles maintenance and rapair
- Retail trade in non-specialized establishments
- Electrical installations, plumbing and other construction works installations
- Temporary Employment Agencies' activities
- Restaurants and snack stalls
- Drinks sales outlets
- Other personal services
- Ferrum, steel and ferroalloys basic products manufacture
- Metallic parts manufacture for construction sector
- Other CNAE

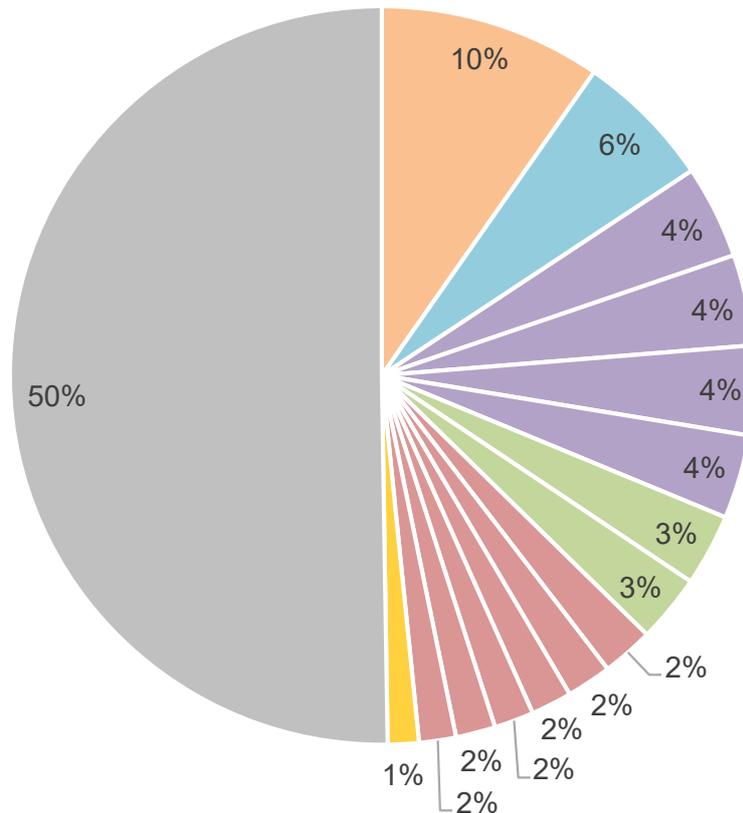


Chart 2. Percentage distribution of occupational diseases caused by mechanical vibrations according to activity

Table 2: Noise survey results

| | Noise Identification | Noise Assessment | Incomplete Assessment | ALP | Risk Confirmation | Risk Management |
|--|----------------------|------------------|-----------------------|-------|-------------------|-----------------|
| Whole Sample (566) | 532 | 284 | 88 | 47 | 252 | 53 |
| | 94 % | 50 % | - | 8 % | 68 % | 21 % |
| Sample complied with UNE-EN-ISO 9612:2009 (47) | 47 | 47 | - | 47 | 38 | 15 |
| | 100 % | 100 % | - | 100 % | 81 % | 39 % |

Table 3: Noise survey results according to preventive service system

| | Noise Identification | Noise Assessment | Incomplete Assessment | ALP | Risk Confirmation | Risk Management |
|------------------------|----------------------|------------------|-----------------------|-----|-------------------|-----------------|
| External Service (522) | 495 | 251 | 83 | 47 | 30 | 12 |
| | 95 % | 48 % | - | 9 % | - | 19 % |
| Own Resources (43) | 37 | 32 | 5 | 0 | 221 | 43 |
| | 86 % | 74 % | - | 0 % | - | 40 % |

Table 4: Noise survey results according to activity

| | Noise Identification | Noise Assessment | Incomplete Assessment | ALP | Risk Confirmation | Risk Management |
|------------------------------|----------------------|------------------|-----------------------|------|-------------------|-----------------|
| CNAE 251 (83) | 80 | 44 | 10 | 3 | 31 | 3 |
| | 96 % | 53 % | - | 4 % | 57 % | 10 % |
| CNAE 256 (87) | 81 | 41 | 12 | 1 | 21 | 2 |
| | 93 % | 47 % | - | 1 % | 40 % | 10 % |
| Metal Sector (235) | 226 | 130 | 31 | 17 | 98 | 22 |
| | 96 % | 55 % | - | 7 % | 61 % | 22 % |
| Food Sector (74) | 71 | 51 | 9 | 6 | 48 | 12 |
| | 96 % | 69 % | - | 8 % | 80 % | 25 % |
| Wood and Plastic Sector (39) | 34 | 17 | 9 | 6 | 25 | 6 |
| | 87 % | 44 % | - | 15 % | 96 % | 24 % |

Table 5: Noise survey results referred to enterprise's size

| | Noise Identification | Noise Assessment | Incomplete Assessment | ALP | Risk Confirmation | Risk Management |
|----------------------|----------------------|------------------|-----------------------|------|-------------------|-----------------|
| Micro-company (123) | 104 | 50 | 6 | 6 | 37 | 6 |
| | 85 % | 41 % | - | 5 % | 66 % | 16 % |
| Small company (300) | 278 | 134 | 57 | 21 | 111 | 19 |
| | 93 % | 45 % | - | 7 % | 58 % | 17 % |
| Medium company (115) | 111 | 78 | 21 | 19 | 86 | 23 |
| | 97 % | 70 % | - | 17 % | 84 % | 27 % |

4.2. Mechanical vibrations survey results

In this section, values of the indicators for mechanical vibrations set up in section 2.2.1 are presented when applying to the whole sample (table 6).

Table 6: Mechanical vibrations survey results (287)

| Vibrations Identification | Vibrations Assessment | Incomplete Assessment | Estimating Assessment | Measuring Assessment | Risk Confirmation | Risk Management |
|---------------------------|-----------------------|-----------------------|-----------------------|----------------------|-------------------|-----------------|
| 175 | 33 | 11 | 12 | 32 | 20 | 6 |
| 61 % | 12 % | - | 27 % | 73 % | 45 % | 30 % |

5. CONCLUSIONS

From the study obtained data, it can be concluded several statements from a qualitative point of view.

5.1. Noise

From the field study output, only one out of five companies, which had identified noise exposure risk, achieved to reduce it to acceptable levels through a performance as a result of preventive planning. Moreover, it is highlighted that most assessment reports lack of uncertainty value as well as of reference to the used measuring method. This could lead up to a non-representative exposure characterization, which undervalue the risk, hence not adopting the required preventive action to avoid future damages to workers.

Other conclusions from the study are as follows:

- Companies, which comply the assessment legal proceeding, raise the probability of succeed in risk management. In contrast, when the assessment does not meet the proceeding requirements (see the samples analysis related to CNAE 251 and 256) the control measures efficiency is reduced.
- Companies, which agreed preventive activity with external services, have less capacity to reduce noise occupational exposure than those, which assume it with internal resources.

- The studied activity sectors (metal, food industry, wood and plastic) do not have significant differences as far as compliance level with occupational health legislation related to noise is concerned.
- Medium enterprises assess greater, with more accordance to standard UNE-EN ISO 9512:2009 and their risk management is more efficient than that undertaken by small and micro enterprises.

Besides, by means of statistical analysis could be identified the most vulnerable groups. Conclusions are pointed out below:

- The risk situation happens frequently in a short list of CNAE codes, where it is likely to suffer from a great exposure because of typical tasks undertaken in boiler making, forming, stamping and metal forging.
- Medium enterprises seem to have greater noise exposure, which is consistent with the fieldworks results, which reported about a higher percentage of risk confirmation.

5.2. Vibrations

The study shows a very high percentage of companies with exposed workers to vibrations, which lack of specific assessment of such risk. Actually, in most of them were not even identified its presence. For these reasons, it is hard to find companies which performance control measures against vibrations. Subsequently, it could be stated that **the compliance level with Spanish implementation of Directive 2002/44/EC is very poor.**

For companies, which assess, the preferred procedure related to mechanical vibrations is measuring.

As far as critical groups are concerned, it is deduced that:

- A set of CNAE codes could be listed, which hand-arm vibrations exposure has a high-risk likelihood in.
- Medium enterprises seem to have higher exposure to vibrations, although this tendency is smoother than for noise.

6. REFERENCES

1. Ley 31/1995, de 8 de noviembre, de Prevención de Riesgos Laborales.
2. Real Decreto 39/1997, de 17 de enero, por el que se aprueba el Reglamento de los Servicios de Prevención.
3. Real Decreto 1311/2005, de 4 de noviembre, sobre la protección de la salud y la seguridad de los trabajadores frente a los riesgos derivados o que puedan derivarse de la exposición a vibraciones mecánicas.
4. Real Decreto 286/2006, de 10 de marzo, sobre la protección de la salud y la seguridad de los trabajadores contra los riesgos relacionados con la exposición al ruido.
5. Real Decreto 1299/2006, de 10 de noviembre, por el que se aprueba el cuadro de enfermedades profesionales en el sistema de la Seguridad Social y se establecen criterios para su notificación y registro.
6. UNE-EN ISO 9612:2009 “Acústica. Determinación de la exposición al ruido en el trabajo. Método de ingeniería. (ISO 9612:2009).