International Journal of Industrial Ergonomics 67 (2018) 60–66

Contents lists available at ScienceDirect

International Journal of Industrial Ergonomics

journal homepage: www.elsevier.com/locate/ergon

A longitudinal study of noise exposure and its effects on the hearing of olive oil mill workers

Juan Carlos Rubio-Romero[a,*], Jesús A. Carrillo-Castrillo[b], Manuel Soriano-Serrano[c], Fuensanta Galindo-Reyes[d], José de la Varga-Salto[d]

[a] Cátedra de Prevención y Responsabilidad Social Corporativa, School of Industrial Engineering, Universidad de Málaga, C/Dr.Ortiz Ramos, s/n, 29071, Málaga, Spain
[b] R&D, Health Department, Government of Andalusia, Spain
[c] Occupational Risk Prevention Centre, Government of Andalucía, Spain
[d] Faculty of Economics, Universidad de Málaga, Spain

ARTICLE INFO

Keywords:
Occupational
Hygiene
Industry
Noise
Olive oil mill
Level
Health

ABSTRACT

In occupational health and safety, noise is one of the biggest worldwide risk factors and it is a particularly big problem in industry. Olive oil mills play an important role in Spanish industry since they account for 45% of the world's olive oil production. Although noise is a serious occupational hazard in this industrial sector, scientific literature does not seem to contain any research study on the subject. The aim of this paper is to analyse noise exposure levels and their effects on the hearing of olive oil mill workers. For this purpose, a retrospective longitudinal observational study was conducted over the course of a decade, using a sample of 115 olive oil mill workers and analysing their exposure to noise and hearing levels. Among the main results it must be highlighted that, during the period under study, there was a notable rise in the noise levels to which these workers are exposed, although the results of the Early Loss Index (ELI), which measures hearing loss in each ear separately only at a frequency of 4000 Hz and adjusted for presbycusis by age and sex, for olive oil mill factory managers with the highest noise exposure, underwent an improvement in contrast with reception yard workers, whose ELI index did not.

1. Introduction

Noise is one of the risk factors with the biggest worldwide impact on occupational health and safety. According to the 6th European Working Conditions Survey, 19% of all workers are exposed to such loud noise levels that they have to raise their voices to talk for over one quarter of the working day. The survey also associates noise with other illnesses, particularly cardiovascular problems, in addition to stress and an increased risk of accidents (Eurofound, 2015). Links between noise and other health problems are extensively documented in another study (Ganime et al., 2010).

Noise exposure as a serious problem has been analysed in various different sectors. For instance, Aybek et al. (2010) analysed tractor drivers' exposure to noise in Turkey, related to the type of tractor cabin. Fernández et al. (2009) studied 40 building workers over the course of 2 h, using a sound meter and noise dosimeter, finding that between 60% and 70% of the typical tasks they do exposed the workers to over double the maximum permitted noise limits. Zytoon (2013) analysed the noise exposure of fishermen from 24 small or medium-sized fishing boats in Egypt, finding high noise levels in the engine room and even on deck, handling the tackle. Chen et al. (2012) analysed the noise exposure of 9 workers in hospital operating rooms (surgical technicians, nurses and a surgeon) over the course of two days using a noise dosimeter. They found that the legal limits were not surpassed, although noise levels were exceeded during certain intermittent activities with drills or other power tools and during cleaning work.

Hearing loss has also been studied by other researchers, like Singh et al. (2013), who analysed it in 165 metalworkers in India, finding that over 90% of the workers in the sample suffered from a significant loss of hearing at medium and high frequencies. Sahdra et al. (2002) studied 14 workers before and after work at discotheques and other university entertainment venues, finding significant hearing losses of over 30 dB at high and low frequencies in more than 29% of them. Irgens et al. conducted a study of 605 members of the Norwegian Royal Navy, finding that 31.4% had hearing losses of over 25 dB in each ear at 3,000, 4000 or 6000 Hz, with a particularly high prevalence among sailors, engine room workers and electricians.

Research studies can also be found that relate measurements of both

* Corresponding author.
E-mail address: juro@uma.es (J.C. Rubio-Romero).

https://doi.org/10.1016/j.ergon.2018.04.003
Received 1 November 2017; Received in revised form 30 March 2018; Accepted 12 April 2018

factors: noise exposure and hearing loss or other damage. For example, Noweir and Zytoon (2013) conducted a cross-sectional study of 200 civil aircraft maintenance operators in Saudi Arabia, finding that over 89% were exposed to noise levels of over 85 dBA and, although consequent hearing losses might have been expected, the audiometric results did not find the envisaged severe loss.

Among this last group of studies, longitudinal ones are less common. One such study by Gordon et al. (2017) is a retrospective analysis of 100 veterans from the US army, conducted over a 20-year period and aimed at finding the relationship between changes in hearing and noise or other ototoxic exposure during military service. They found that most of the participants had normal hearing, although 27% said that they thought they suffered from a medium or moderate loss of hearing.

The updated review of Lie et al. (2016) did not found any research on olive mills workers so there is a gap of evidences for occupational exposure in this sector. This review identified several factors of hearing loss. For occupational exposure there are identified 96 published studies describing hearing loss in various professions: 65 cross-sectional, 27 with a longitudinal design and 4 review articles. The evidence is high risk with unprotected noise exposure Lex, 8 h > 90 dB and low risk for Lex, 8 h < 85 dB but they highlighted the importance and difficulties of determining the level of use of Personal Protective Equipment (PPE) and the inconclusive results for self-reporting. PPE use assessment is not an easy task.

Noise is a particularly serious problem in industry (Eurofound, 2015). In the Spanish industrial sector, olive oil mills play an important role, since this is the country with the greatest surface area of olive trees in the world, accounting for 60% of Europe's olive oil production and 45% of the world total, with an average of over 1.7 million tons of olive oil being produced per year.

Andalusia accounts for 82% of all olive oil produced in Spain, with the province of Jaen alone producing 40% of the Spanish total. Regarding the figures of Olive Oill mills, In Spain, there are 1750 olive mills, according to the Olive Oil Agency (International Olive Counc, 2014), distributed throughout 13 Autonomous Communities. Andalusia has the greatest percentage, almost 47% of the total, with 816 mills and 4074 workers estimated using the Continuous Sample of Working Lives (Carrillo-Castrillo et al., 2015).

Of the 816 olive mills located in the Autonomous Community of Andalucía, 323 (40% approx.) can be found in Jaén. The olive oil industry in Jaén, as the largest producer of olive oil in the world, as its olive oil production constitutes about 30% of the worldwide production and 80% of the Spanish national production, has important economic relevance in the province of Jaén (Spanish Ministry for Agri, 2014; Parejo-Moscoso et al., 2013).

It is important to remark that olive mill technology is almost the same in all the world, with a limited number of manufacturers of extraction machinery. Differences in noise exposure are mostly related to isolation and PPE use more that to equipment used.

In literature on olive oil mills and occupational health and safety, in particular noise exposure, mention must be made of two studies by Parejo-Moscoso et al. (2012, 2013), who pointed out that “the risk of noise exposure, characteristic of the sector, is only assessed in 73% of the olive oil mills examined, and of this 73%, only 75% of the olive oil mills implement a protocol to adequately monitor their employees' health in relation to noise exposure.” Among the most hazardous work conditions, Rubio-Romero et al. (2013) highlighted the high level of noise to which workers from this sector are exposed.

To assess the impact of noise on the workers' health, there are different indexes, as the Social Adequacy Index (according to ANSI 1969), CHABA from the National Academy of Sciences, ASHA from American Speech-Language-Hearing Association or the standard ISO 1999.

Regarding other indexes and criteria to assess noise induced hearing loss (NIHL) in other countries is in most cases based in international standards, although International Labour Organization has not published any yet. The most used are the following according to Monash University Centre for Occupational and Environmental Health (Monash University Centre for Occupational and Environmental Health, 2010):

- ISO 7029 has published a second Edition in 2000 that replaces the first Edition. It provides descriptive statistics of hearing thresholds for populations of various ages up to 70 years for the range of frequencies of 0.25 up to 8 kHz.
- ISO 1999 (1990) or the ANSI s3.44 (1996) provide risk estimates of hearing loss due to noise exposure (taking level and duration into account).
- AMA (American Medical Asociation) guides 4th, 5th and 6th Edition advise on the assessment of NIHL; they use the ANSI s3.44 tables for their calculations. AMA 5th Edition particularly states that no correction for presbycusis should be made. AMA 6th Edition suggests to use 8 frequencies (up to 8 kHz) for the calculation of NIHL.
- NIOHS (National Institute of Health and Safety in USA) has as own developed audigram evaluation criteria.
- ACOEM (American College of Occupational and Environmental Medicine) criteria on NIHL states that rate of hearing loss due to noise exposure is greatest during the first 10–15 years and hearing loss due to noise does not progress after the exposure has been stopped.
- ASOHNS (Asociation of Ear Nose and Throat Head and Neck Surgeons in Australia) use NAL tables to calculate hearing loss thresholds taking age and gender into account. Their tables are based on the ISO 7029 first Edition data from 1984. The frequency range is 0.5 up to 4 kHz, but can be extended to 8 kHz.

The aim of this study is to analyse noise exposure levels and their effects on the hearing of workers from the olive oil sector. For this purpose, a retrospective observational study was conducted of 115 workers from the sector over the course of a decade, analysing their exposure to noise and their hearing levels.

2. Methodology & data

The starting point for this research study was data supplied by Spain's leading occupational risk prevention consultancy agency, Fremap, which, according to the Catalan Association for Prevention Services, supplied 22.5% of these services in Spain in 2015, making a corresponding turnover of over 123 million euros (Castejón Vilella, 2015).

The noise exposure data was taken from noise exposure assessment reports for the whole workforce of all the olive oil mills in the province of Jaen dealt with by Fremap in 2003/2004, 2007/2008 and 2012/2013. This data included information on individual workers for each of area of work at each olive oil mill, such as the results of measurements carried out in accordance with the requirements of the EU directive in force at the time: the LAeq,d, Lpeak, LAeq,t, and exposure time of the workers in each work area. Also used were the results of questionnaires given to each of the above workers, where they rated the availability and use of PPE. More specifically, for 2003/2004, data was compiled for a total of 48 olive oil mills, with information on 47 factory managers (*maestros molineros*) and 43 reception yard workers (*peones de patio*). For 2007/2008, the data covered 60 olive oil mills, with information on 58 factory managers and 53 reception yard workers. For 2012/2013, data was gathered for 54 olive oil mills, with information on 50 factory managers and 47 reception yard workers. The other staff in these mills mainly worked in the offices and so they were not included in the analysis.

As for the healthcare data gathered by the consultancy firm, it was available the following information on the above workers for the three different periods (2003/2004, 2006/2007 and 2012/2013): their age, the date of medical check-ups, their audiometric results conducted in accordance with guidelines by the Spanish Ministry for Healthcare, and information concerning related healthcare habits.