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USING A SMARTPHONE APPLICATION TO PERFORM A FAST QUALITATIVE NOISE EXPOSURE EVALUATION IN A MINE SITE

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The Sensorineural Hearing Loss presents a high prevalence in the population, being one of the most important professional diseases. The number of people in the world affected by this pathology is estimated near 360 million. In Chile, in 2011, the Protocol of Occupational Noise Exposure (PREXOR) was released, which establish ambient and health vigilance programs for the workers exposed to occupational noise. In this legal framework, in 2015 the Exempt Resolution 859 was released which involve the implementation of qualitative noise exposure evaluations. In this work, an Android platform mobile application is presented, which aims to ease and develop the implementation of this protocol. The data collected by the application are sent to a web interface where PREXOR's compatible qualitative files can be downloaded. The results from qualitative noise exposure evaluation in a mine site are presented.
Keywords: SHL, noise, qualitative, risk, PREXOR

1. Introduction

Quantitative measurements of noise in the workplace, by sound level meters or dosimeters, can be a very good way of determine the risk of hearing loss. Another way is developing qualitative evaluations [1].

In Chile, the prevalence of Sensorineural Hearing Loss (SNHL) is very high [2]. The Chile Social Security Superintendence (SUSESO by his initials in Spanish) elaborates an annual statistic report to study the security and occupational safety system, including work and journey accidents, fatal injuries, and professional diseases reported. Regarding the origin of them, the audiological pathologies have the highest work qualification, with around the 65% of them [3]. The Metropolitan Environmental Health Service (SESMA by his initials in Spanish) took noise measurements in the year 2000. The results showed that 30% of the Chilean workers are exposed to levels that cause hearing loss. SNHL represents the main cause of compensations and allowances, conferring the data managed by the SUSESO. In the year 2000 represented 65% of them. Also, the 80% of the permanent disabilities produced by professional diseases are caused by noise [4].

In Chile, all workers are protected by the "Professional diseases and work accidents social insurance". Therefore, in the year 2011 the Chilean Ministry of Health (MINSAL by his initials in Spanish) presented the "Protocol on minimum standards to develop noise induced hearing loss in the workplace surveillance programs" (PREXOR by his initials in Spanish) [2], which encourages companies to develop a management system for the evaluation and control of occupational noise. It was updated later in the year 2013 [5]. It sets the standards about the environmental and health monitoring of the workers exposed to occupational noise. According to this legislation, a surveillance of all the workers

must be done through the implementation of a management system. One of its requirements is to develop a qualitative noise exposure risk map. To avoid uncertainty, the Chilean Institute of Public Heath (ISP by his initials in Spanish) created the "Questionnaire for noise exposure in the workplace qualitative evaluation" to study the presence of risk, and starting from there, build the qualitative risk map [1]. Questionnaires for noise evaluation can be found in the literature [6] [7] [8].

In this work, the results of the assessment using a smartphone application and the later qualitative noise exposure evaluation are presented. In Section 2, a detail of the ISP questionnaire and the smartphone application is presented. Section 3 shows the data collected in site and an analysis of the results. Conclusions and remarks are presented in Section 4.

2. Presentation of the application

The questionnaire contains two sections. First Part comprises items A to C, and consist in a set of questions aimed the owner, general manager, risk prevention manager or supervisor. Second Part contains questions that must be answered by the worker. Item A has 4 questions of general diagnosis of the company and must be answered YES or NO. If all the questions are answered NO, then the whole questionnaire is complete and the evaluation must conclude "There is no presence of risk". Conversely, if at least one of the questions is answered YES, then the rest of the questionnaire must be completed. Item B consists in 8 questions and Item C in 4 questions, all of them about a specific workplace. Each of these questions must be answered with 1 if it's affirmative or 0 if the answer is negative. Item D consists in 6 questions that must be answered 1 or 0 as well. If a Similar Exposure Group (SEG) is being evaluated, at least 5 workers must be considered. If the SEG is formed by less than 5 workers, then all of them must be assessed. There are 7 questions marked as Critical Questions (CQ), 5 in item B and 2 in item D. A diagram of the questionnaire structure is presented in Fig. 1.

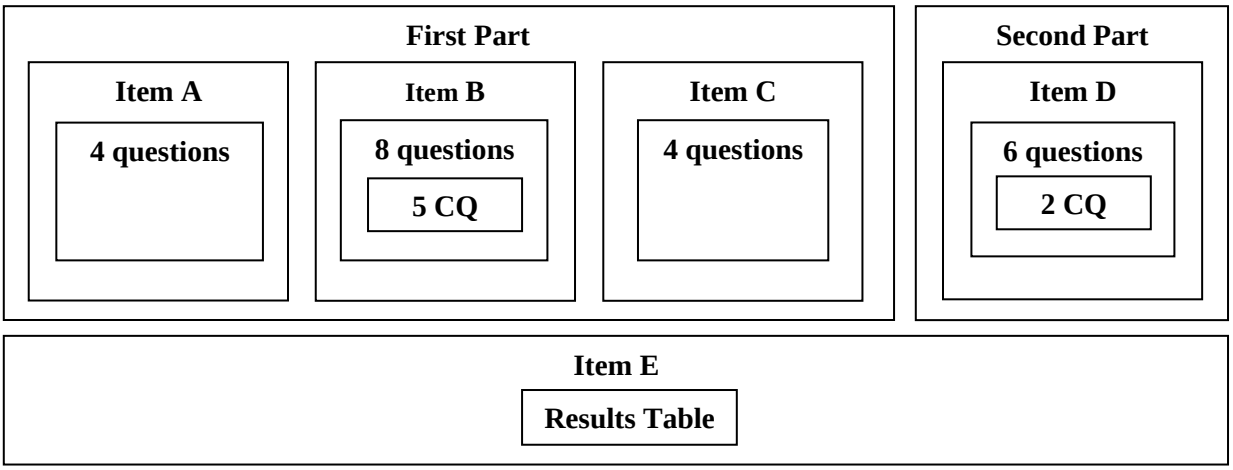

Figure 1: Structure of the questionnaire.

After filling the questionnaire, the results must be summarized on the Results Table in Item E. It shows the sum of all the answers in item B and C, the sum of all critical questions, the sum of all the answers in item D (the result stay as 1 if at least one worker answered affirmatively and 0 if all of them answer negatively) and the sum of all the previous results. If the sum of the answers in items B and C is equal or more than 6, the cell next to it must say "There is presence of risk". The same criterion applies if the sum of the critical questions is equal or more than 1. Conversely if the sum of the answers in items B and C is less than 6 or the sum of the critical questions is less than 1, the cell next to them must say "There is no presence of risk". Examples of the Results are presented in Table 1.

Table 1: Example of the Results Table.

Score:		**Classification:**	
Items B and C:	12	There is presence of risk	
Critical questions:	0	There is no presence of risk	
Item D	6	**Total:**	18

2.1 The application

The application is currently available for the Android operating system. It works the questionnaire in three tabs. The company tab includes the questions of Item A, and information of the enterprise can be entered. Once it's completed, the workplace tab is available. Here, the name, description of the workplace and questions of the items B and C can be completed. In the worker tab the questions from Item D are presented. A database included in the application allows the user to save the answers and continue with the questionnaire later. Finally, is possible to send the information to a cloud database, where through a web interface the final qualitative noise exposure evaluation can be downloaded. Screenshots of the application are shown in Fig. 2.

(a) (b) (c)

Figure 2: Screenshots of the application, company tab (a), workplace tab (b) and worker tab (c).

3. Case study

The questionnaire was taken during a consultation of the PREXOR implementation in a mining site, both in paper and using the application. Item A was answered by the occupational health manager, item B and C by the chief engineer of each workplace and finally Item D by the workers. Results are shown in Table 2.

The workers were really collaborative answering the questionnaire. Question 1 in item D caused some misunderstood, because the term "raise your voice" was interpreted for some of the workers as scolding somebody. Personal of the company find out that the questionnaire was a really fast and a very accurate tool to characterize the noise exposure. As they know where the problems are present, the results show correlation with that information. The time spent in filling the questionnaire wasn't more than five minutes, both in paper and with the application. The application showed improvements in the ease to delete and edit the information and most of all in the final download of the evaluation, where it only takes seconds to generate a PDF format report with the results. In general the application was always a useful tool for developing the risk map presented.

Table 2: Results of the in site evaluation.

Nº	Item B a C	CQ	Item D	Total	Evaluation
1	4	3	6	13	There is presence of risk
2	7	5	5	17	There is presence of risk
3	9	6	4	19	There is presence of risk
4	9	5	5	19	There is presence of risk
5	9	6	6	21	There is presence of risk
6	9	6	6	21	There is presence of risk
7	8	6	3	17	There is presence of risk
8	8	4	2	14	There is presence of risk
9	8	4	1	13	There is presence of risk
10	8	5	3	16	There is presence of risk
11	4	2	4	10	There is presence of risk
12	4	3	6	13	There is presence of risk
13	10	7	6	23	There is presence of risk
14	8	6	3	17	There is presence of risk

4. Conclusions

The questionnaire for noise exposure in the workplace qualitative evaluation is a fast tool for developing qualitative risk maps. The characterization of the workplace by the score obtained, delivers a first view on the state of the noise exposure, and starting from there, measurements of dose and administrative or engineering solutions can be implemented. The use of the smartphone application, eases the process of answering the questionnaire, saving the answers to complete them later, and avoids the use of land records. After the information is gathered and sent to the web platform, is easy to download the results of the evaluation and build the qualitative map of noise exposure.

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