

DEVELOPMENT OF THE SUBJECTIVE EVALUATION METHOD OF HEARING PROTECTORS

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1 Introduction

Exposure to high sound levels causes hearing loss [1]. Using hearing protection devices is one of the ways to prevent exposure to loud noises, reduce noise-induced hearing loss and prevent other problems such as cardiovascular disorders, blood pressure or noise annoyance. This study was conducted due to the prevalence increase of hearing loss in industries, despite the outspread in hearing protection programs. One of these reasons in increasing noise-induced hearing loss can be related to the inefficiency of hearing protector evaluation methods. Hearing Protective tools are not evaluated at actual levels and therefore may perform differently when used in the field than in laboratory conditions. There are various methods in order to evaluate the reduction of the noise in ear protectors, which are divided into two general subjective and objective categories [2].

As the current subjective method of evaluation of the ear protector, ISO standard 4869-1, is not based on industrial noise and in the field, a suggested way is developed for the evaluation of hearing protectors based on the subjective feedback of the volunteers [3]. In fact, the instructions for obtaining a feedback are completely subjective, and after extracting the results, these qualitative values are converted into quantitative values. In this method, one step is completed by using the person's subjective response to the received sound before and after using the ear protector. This part is developed by defining the subjective perception of people and their feelings towards understanding the sound and scoring the answers and then converting it into decibel values of the sound. This research is somehow aimed at developing of subjective method for the measurement of sound attenuation-based ISO standard 4869-1. This method makes it possible to evaluate hearing protectors completely subjectively.

2 Method

2.1 Exposed to 85 dB (A) noise

This experimental study was conducted on 64 students between the ages of 18 and 25. The measurements were carried out in semi-free field conditions. In this study, pink noise as well as pure noise at frequencies of 500, 1000, 2000 and 4000 have been used. First, people were talked about the testing process and how to be exposed to sound and how to respond were explained [4].

First, the person sat in a chair in a quiet room and listened to the sound played at a level of 85 dB (A). The sound of

85 dB was played for at least 1 minute for the volunteer to remember this sound level. Subjects were asked to listen carefully to the produced sound after hearing it. The volunteers were not aware of the level of sound produced. They only tried to remember based on what they heard in this stage (without protection) and remembered for the next stage (by using ear protectors).

2.2 Exposed from 85 dB (A) noise while using hearing protection

In the second stage after using earmuff, ear plug or both, the sound level of 85 dB was played again for at least 1 minute for the volunteer. The volunteers were asked to announce when they felt the same sound level as they heard in the first stage. As a matter of fact, they were asked to remember the noise level of the sound that they heard before by recalling the level of the sensed sound.

In this stage, because the goal is to determine the amount of reduction of the protectors in a subjective method, the sound level started from 85 dB and increased until the candidate feels the same sound level as the first stage. The difference between the level of 85 and the maximum level declared by the person indicates the amount of reduction of the noise.

3 Results

3.1 Subjective responses of individuals before and after using hearing protectors

People's responses were collected after receiving their hints. Pointing people indicates the same level of level received in the first stage. It is obvious that the feeling of the person after using the protection is expressed at higher levels. At the time of pointing candidates, the levels of the sound played have been recorded.

3.2 Evaluated noise reduction between objective and subjective method

In this step, we compare the recorded sound levels according to people's feelings with the sound level of 85 dB and obtain their difference. The noise reduction values of the ear protectors have been extracted and given in a subjective and objective way separately in Figure 2.

In fact, the ability of efficiency of ear protectors to reduce noise has been evaluated in two quantitative and qualitative ways. Then two methods have been compared in terms of accuracy and efficiency. As the results show, the subjective method is reported with a slight difference compared to the objective method. Using earmuff and ear plug simultaneously has demonstrated more reduction noise. And this

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reduction is shown in the subjective method as well as the objective method.

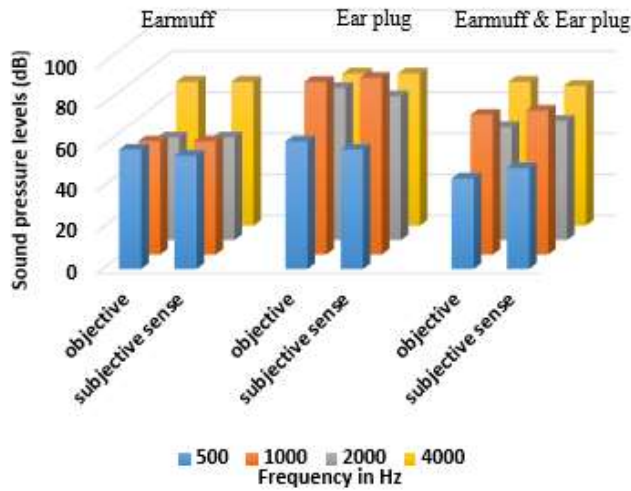


Figure 1: Comparison of two subjective and objective evaluation method of ear protectors

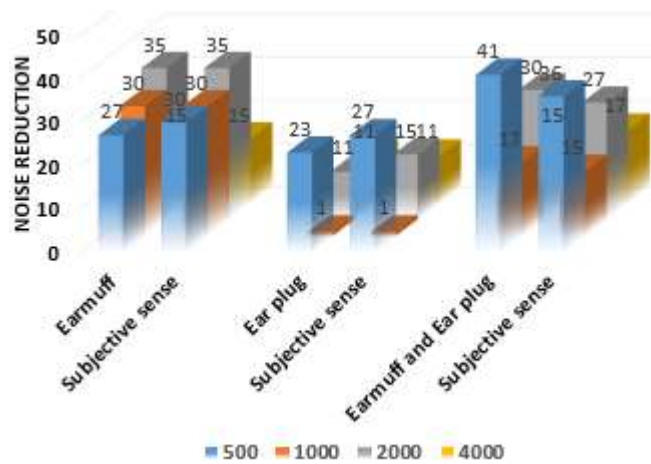


Figure 2: Evaluation method of ear protectors in noise reduction

4 Discussion

In Figure 1, based on the results, the proposed method has been compared with the objective method. To increase accuracy, measurements have been made separately for earmuff, ear plug and their combined use. It is clear that in all three cases the difference between the obtained values is very small. It means that the subjective method performed has an acceptable accuracy. The results of pink and sinusoidal sound were similar to each other.

This section is developed by defining the subjective perceptions of individuals and their feelings with respect to the sound comprehension, the score of responses, and then converting them into level amounts of the sound. A number of students between the ages of 18 and 25 were selected. First, a hearing test was performed on their ear to determine their hearing threshold. They were then confronted with a distinct sound level. When using the ear protector and without using it, they were asked how they felt about the amount of sound

received. This qualitative feeling was converted into level amounts and compared with a quantitative method. Of course, more candidates are needed to improve the accuracy of the test results.

5 Conclusion

To have better results, it is necessary to perform subjective methods to test hearing protectors and compare them with other techniques with a greater number of samples to reach a result as Figure 2. As a result of the laboratory evaluation of ear protectors, it is possible not to justify the proficiency of ear protectors in a subjective method. The method is suggested by using the individual's subjective response before and after using the ear protector. This method is based on the subjective perceptions of individuals and their feelings with respect to the sound comprehension, in an acceptable noise level for occupational and environmental fields.

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