THE EVALUATION OF COMFORT OF THE PERSONAL HEARING PROTECTION DEVICES AS AN INTERVENTION FOR HEARING LOSS PREVENTION

Avaliação do conforto do protetor auditivo individual numa intervenção para prevenção de perdas auditivas

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RESUMO

Objetivo: analisar o conforto do protetor auditivo individual como parte de uma intervenção para prevenção de perdas auditivas em trabalhadores expostos a elevados níveis de ruído, por meio da utilização de um questionário de avaliação de conforto. **Método:** realizou-se análise dos documentos da empresa, investigação do ruído e uso de protetor auditivo individual anterior, seleção do protetor auditivo individual, atividades educativas, aplicação de questionário e realização audiometrias. A população foi composta de 20 trabalhadores expostos a ruído acima de 80 dB(A). Os trabalhadores utilizaram protetores tipo inserção e concha, cada um durante 15 dias e responderam ao questionário de avaliação do conforto em duas ocasiões. **Resultados:** dentre os participantes 85% eram homens e 15% mulheres, idade média 35 anos. O Índice de Conforto do protetor tipo inserção foi 4,6 e concha 6,1, com tempo médio de utilização de 6 horas 40 minutos. Dentre as razões negativas ao uso do equipamento destacaram-se: interferência com a comunicação (20%), diminuição da audição (10%) e não sentir necessidadede usar (10%). **Conclusão:** os protetores auriculares estudados tiveram seus escores cotados em níveis aceitáveis, sendo considerados ambos confortáveis. Contudo, existiu uma diferença significante no Índice de Conforto entre protetores de diferentes tipos (inserção e concha). Com isso, pôde-se concluir que, o protetor auditivo individual tipo concha foi considerado o mais confortável e melhor aceito pela população estudada.

DESCRITORES: Ruído; Perda Auditiva; Prevenção de Doenças

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INTRODUCTION

The health of people inside their workplace is a segment of occupational health that has the purpose to adjust the workplace to indivivuals and consequently to their work environment [1-3].

In Brazil, the *Portaria 3214* of the Ministry of Labor and Employment from 06.07.1978 regulates the health, safety and industrial hygiene in public and private institutions, they are called *Normas Regulamentadoras (NR)*. Among these standards, NR 9 classifies the environmental risks, dividing them into physical, chemical and biological, which

are capable of causing damage to the workers' health [4] due to its nature, concentration and / or intensity and exposure time.

From all the physical hazards, noise is now considered the most common health aggressor agent found at theworkplace, impacting a significant number of workers [5-7]. The exposure to this risk for years can cause damage to the workers hearing health, mainly causing Hearing Loss, a pathology easily preventable [7-9].

Therefore, Hearing Conservation Programs arise, characterized as a set of actions in order to eliminate or minimize the effects of noise in the human hearing, thus avoiding the triggering and / or worsening Hearing Loss [5,10]. One of its stages refers to the adoption of individual hearing protection devices, however its choice should take into consideration cost, accessibility, safety and comfort for workers [11-15].

The selection of a proper hearing protector device, attention to some factors is necessary such as attenuation, comfort, acceptability, price, individual characteristics both from the user and the device, among others. Nevertheless the best hearing protector device is the one that the employee believes to be comfortable and is willing to use correctly during the entire work shift [16].

The adaptation of the worker to the hearing protector device is a challenge because while there is resistance to its use by workers, employers may also neglect to provide adequate hearing protection to the employees [14]. There are also other factors that influence workers' decision whether or not to use the hearing protector devices. These include comfort, interference to communication and to job performance, lack of sense of self-effectiveness (belief that the individual is able to make the best judgement regarding ones ownmedical health), among others[17].

For hearing protection devices to be successfully implemented, it is vital to count on employees own willingness towards its use, the model of the device and the adaptation of the equipment insinde employees' external auditory canal. Such features neglected can cause decrease in the level of hearing protection, if compared to what is obtained in the laboratory[18].

The hearing protection device should adapt to the worker, but there still is a significant concern with its attenuation, and the comfort is left behind [19]. Each employee reacts individually to the use of these devices and a successful Hearing Conservation Program should be able to meet the needs of each worker. To make sure that these devices are comfortable and effective to protect the employees' hearing demand a huge effort from everyone inside the company, including supervisory and the impacted workers [20].

Based on this need, this study had the objective to analyze the comfort of the individual hearing devices as part of an intervention to the prevention of hearing loss in workers exposed to high noise levels, using a questionnaire which evaluates the comfort of these equipments.

METHOD

The research was conducted in a frigorific in Curitiba, using an intervention study type.

To select the population for this study, two types of criteria were used: exposure to occupational noise above 80 dB (A) during the working shift and the use of hearing protector devices, by workers during the execution of their daily working activities. Thirty workers were eligible and were invited to participate. Twenty (66.6%) workers accepted to be in this study (N = 20). Workers who refused to participate in this study (34.4%) were afraid that there could be negative consequences to their careers if they participated in the research.

Among the participants, three were women (15%) and seventeen were men (85%), aged between 18 and 72 years old (average 35 years old, median 32 years old), having worked for the company from 2 months to 5 years (average 2 years and 6 months) with an 8 hour working shift, five days during the week, with no possibility of overtime work.

Regarding the level of education, 10% of the workers were illiterate, 40% had completed basic education and 50% had completed high school.

The study took place in six distinct steps:

1 – Analysis of company documents: *Programa de Prevenção de Riscos Ambientais* (*PPRA* – Brazilian Law), *Programa de Controle Médico e de Saúde Ocupacional* (*PCMSO* – Brazilian Law) and medical records;
2 – Research of the history of the use of hearing protectors devices and work with noise;
3 – Selection of the individual hearing protectors devices for the study in the company, following the criteria of mitigation cost, approval certificate (*CA – Certificado de Aprovação* – Brazilian Law) and ease in handling;
4 – Conducting an educational activity inside the company, by the researchers, obtaining 100% of participation from those who were involved in the research. There were ten meetings focusing on hearing health, involving two employees in each activity;
5 – Testing the comfort and effectiveness of individual hearing devices: hearing protector devices were delivered: earplug and earmuff

types. The researchers performed individual guidance on their correct use. The workers used each individual hearing protector device while performing their activities for a period of 15 consecutive days. After using this hearing protector device, employees completed the Arezes questionnaire [14], reporting the characteristics of comfort and effectiveness of each hearing protector device (Image 1);

6 – Conducting audiometry to assess whether the employees' hearing study participants and their possible influence on the comfort Index presented by workers.

Feeling related to the HPD	1	2	3	4	5	6	7	Feeling related to the HPD
Painless								Causes pain
Uncomfortable								Comfortable
Not too much pressure								Excessive pressure
Intolerable								Tolerable
Tight								Loose
Convenient								Nuisance
Heavy								Lightweight
Awkward								Pleasant
Flexible								Hard
Fresh								Hot
Soft								Rough
Feeling of isolation								No feeling of isolation
Easy to put								Complex to put
Complex								No complex
Difficulties to move the head								Easy to move the head
Feeling of clogged ears								No feeling of clogged ears

Figure 1 – Bipolar Grid Coded

The questionnaire used in the evaluation of these devices contained an evaluation grid, previously validated by Casali Park [21] in another study, and years later, translated and adapted to Portuguese by Arezes [14].

The grid data contains 16 bipolar scales that are formed by a descriptor for a particular sensation, relating to one side comfort and its opposite on the other side.

The sixteen sensations related to discomfort are: causes pain, uncomfortable, excessive pressure, intolerable, tight, nuisance, heavy, awkward, hard, hot, rough, feeling of isolation, complex to put, complex, difficulties to move the head and feeling of clogged ears. The sixteen sensations associated with comfort on the grid are: painless, pleasant, fresh, soft, no feeling of isolation, easy to put, not complex, easy to move the head, no feeling of clogged ears. The central scale of the questionnaire refers to that which describes the sensations of "comfortable" and its opposite as "uncomfortable".

To record the feeling of comfort, workers would have to evaluate the hearing protector devices, after using the equipment, placing an "X" in the 16 assessment scales that contain the sensations (vertical grid), to the right or to the left as horizontal scale (1, 2, 3, 4, 5, 6, 7) which separate the sensations on one side to the other as comfort and discomfort.

In order to avoid a biased opinion, the scales were coded by Arezes [14], with some of their descriptors switched in relation to the comfort central scale. After applying this questionnaire these grids were decoded into the following: pain, pressure, convenience, flexibility, thermal sensation, texture and placement (Image 2).

Feeling related to the HPD	1	2	3	4	5	6	7	Feeling related to the HPD
Causes pain								Painless
Uncomfortable								Comfortable
Excessive pressure								Not too much pressure
Intolerable								Tolerable
Tight								Loose
Nuisance								Convenient
Heavy								Lightweight
Awkward								Pleasant
Hard								Flexible
Hot								Fresh
Rough								Soft
Feeling of isolation								No feeling of isolation
Complex to put								Easy to put
Complex								No complex
Difficulties to move the head								Easy to move the head
Feeling of clogged ears								No feeling of clogged ears

Figure 2 – Bipolar Grid Decoded

Once obtained the answers in the questionnaire, the grids that required inversion, taking values 1-7 respectively replies closest descriptor of left and right. Thereafter, for the scales whose orientation was reversed scale office (" uncomfortable – comfortable "), the values would also be reversed, for example, the value of 1 would be 7, and the value of 2 goes to 6, and so on.

Once decoded all responses, it was necessary to determine correlations between each scale (sensations) and central scale (scale "uncomfortable – comfortable") in line with Spearman correlation test.

It started from the assumption that the central scale, or comfort, indicated the subjective feeling that corresponds to the best indication of the overall assessment of hearing protector devices to the user. All scales that had a high correlation with the central scale would be likely to be included in the quantification of the Comfort Index and thus intervene in the global perception of comfort. The Comfort Index was obtained by calculating the average of the responses which obtained correlation with the central scale of comfort.

To be considered statistically significant, the variables should present P value < 0.05 to be correlated with the central scale of comfort, thus presenting statistical significance level of 95%.

The closer employee´s response was to the comfort central scale index, the more comfortable hearing protector device was considered. Thus the closer to 7 the response rate the greater the comfort of the device.

In the same questionnaire workers recorded how long they used the devices for on a daily basis, and at the same time,in case they did not find a feeling of discomfort which described the use of the hearing device they could use the same material to document that. The questionnaire was read along with the workers during two sessions (for the earplug and for the earmuff groups). The workers used the hearing protector devices during two stages, for a period of time of 15 days and after that, they had to answer the questionnaire mentioned, expressing their subjective feeling of comfort (16 grids) based on seven scales that compose the bipolar grid of comfort.

This study was approved by the Ethics in Research on October 27, 2008, through the case number 00079 /2008.

The Spearman correlation coefficient was also performed regarding the Comfort Index and the following variables: age, sex, education, length of employment with the company, working time with noise, previous work with noise, use of hearing protector devices in another company, audiometric change and justification for disliking hearing protectors devices.

To be considered statistically significant, the variables should present P value <0.05 to be correlated with the score of each of the two questionnaires (earplugs and earmuffs), thus presenting statistical significance level of 95%.

The statistical tests used in this study were obtained through the Average of Excel software (version 2007), Spearman correlation test and Spearman correlation coefficient, obtained through *Statistica* software (version 07). The survey data was categorized into an Excel spreadsheet (version 2007) and then discharged into the *Statistica* (version 07) for calculating the Spearman correlation test and Spearman correlation coefficient.

RESULTS

The Company has a history of working with hearing protector devices (earmuffs and earplugs) since the implementation of the occupational health program (10 years ago) done by an outsourced Company.

According to *PPRA* (occupational health program – Brazilian Law) that was written for the company, the frigorific presents occupational hazards of the following groups: chemical, biological, physical, ergonomic and for accidents. Among the physical risks, there is noise measured between levels 60 dB (A) 99 dB (A).

Regarding workers history with hearing protection devices in other companies, the results were: 60% of workers had never used the devices and 40% had already used hearing protection devices in previous companies they worked for.

Out of the twenty workers participating in this study, twelve (60%) of them had already worked with noise at another company before joining the frigorific and eight (40%) had never worked with noise before.

For this study, two models of hearing protector devices were chosen (earplugs and earmuffs), both with attenuation of 14dB (A), the following technical specifications were from Ministry of Labor, following four fundamental aspects: mitigation, cost, valid certificate of approval by the Ministry of Labor and ease in handling.

Prior to the data collection an activity of health education was carried aimingthe promotion of hearing health, in loco, achieving 100% of participation of those involved in the research.

The health education activity was based on:

- Hearing physiology;
- Auditory and extra-auditory effects of noise in the human body;
- Noise emission sources in daily life and at work;
- Prevention of diseases caused by occupational noise exposure;
- Hearing protector devices;
- Care, handling, placement and packaging of the hearing protection devices.

However, during the health education activity, it was noted that 100% of participants did not know how to care, handle, condition or even put the hearing protection devices properly. These aspects can affect the attenuation and comfort provided by the equipment. This was the first event of health education, focused on health promotion and prevention of hearing that the company participated in 10 years of practice with occupational health.

After the health education session, workers used the hearing protector devices (earplugs and earmuffs) in two occasions, during 15 days each, and after that, workers responded to the questionnaire of comfort evaluation from Arezes [14] for both hearing protector devices (earplugs and earmuffs).

To compose the Comfort Index the bipolar grid was decoded for both questionnaires (earplugs and earmuffs). After this procedure, it was possible to observe the percentage of responses for the two questionnaires related to the two hearing protector devices (Images 3 and 4)

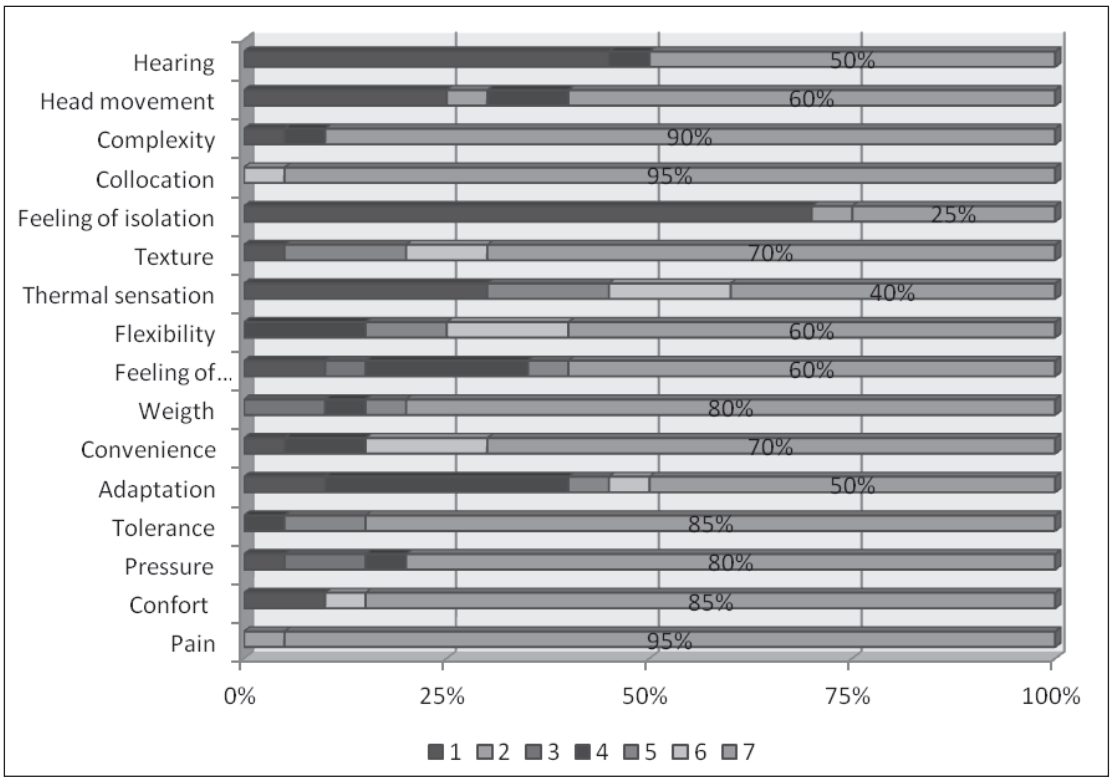

Figure 3 – Questionnaire answers percentage related to hearing protector device type earmuffs

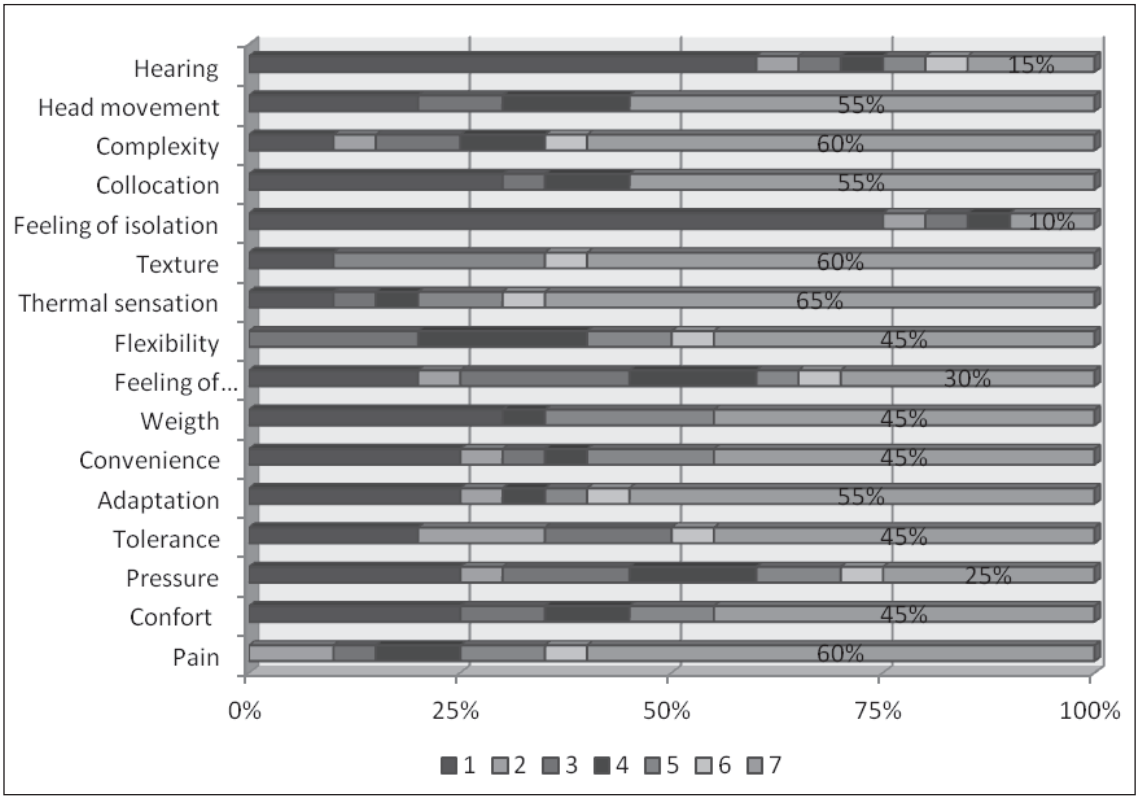

Figure 4 – Questionnaire answer percentages related to hearing protection device type earplugs

The Comfort Index was calculated using a selection criteria to include scales, which consists in the presence of statistical significance (| rs |> 0.45 and p <0.05) between the central range studied and the comfort feeling. The elimination criteria described above was used, and after that, three scales were selected and the remaining 13 were eliminated for the calculation of the Comfort Index of each hearing protector device (Table 1 and 2).

Table 1 – Spearmann correlation between comfort question of the questionarie and other questions from the questionarie for earplugs

QUESTIONNARIE QUESTIONS	n	Rs	p
COMFORT AND PAIN	7	0,7027	0,0782
COMFORT AND PRESSURE	7	**0,9009**	**0,0056**
COMFORT AND TOLERANCE	7	-0,0909	0,8463
COMFORT AND ADAPTATION	7	0,2477	0,5922
COMFORT AND CONVENIENCE	7	0,7364	0,0591
COMFORT AND WEIGHT	7	**0,8228**	**0,0230**
COMFORT AND WELL BEGIN	7	0,6545	0,1106
COMFORT AND FLEXIBILITY	7	**0,8091**	**0,0275**
COMFORT AND THERMAL SENSATION	7	0,7207	0,0676
COMFORT AND TEXTURE	7	0,5049	0,2478
COMFORT AND ISOLATION FEELING	7	0,1284	0,7837
COMFORT AND COMPLEXITY TO PUT	7	0,5984	0,1558
COMFORT AND COMPLEXITY	7	0,3000	0,5133
COMFORT AND DIFFICULTIES TO MOVE THE HEAD	7	0,6358	0,1249
COMFORT AND HEARING	7	0,2455	0,5957

n= Comfort Index (scale 1 to 7)

Tabela 2 – Spearmann correlation between comfort question of the questionarie and other questions from the questionarie for earmuffs

QUESTIONNARIE QUESTIONS	n	Rs	p
COMFORT AND PAIN	7	0,3686	0,4159
COMFORT AND PRESSURE	7	0,2658	0,5645
COMFORT AND TOLERANCE	7	0,1957	0,6742
COMFORT AND ADAPTATION	7	0,5766	0,1754
COMFORT AND CONVENIENCE	7	**0,8383**	**0,0185**
COMFORT AND WEIGHT	7	0,0613	0,8961
COMFORT AND WELL BEGIN	7	0,0895	0,8487
COMFORT AND FLEXIBILITY	7	0,6338	0,1264
COMFORT AND THERMAL SENSATION	7	**0,8383**	**0,0185**
COMFORT AND TEXTURE	7	0,6952	0,0829
COMFORT AND ISOLATION FEELING	7	0,5761	0,1759
COMFORT AND COMPLEXITY TO PUT	7	**0,8847**	**0,0081**
COMFORT AND COMPLEXITY	7	0,4674	0,2903
COMFORT AND DIFFICULTIES TO MOVE THE HEAD	7	0,3680	0,4166
COMFORT AND HEARING	7	0,5761	0,1759

n= Comfort Index (scale 1 to 7)

Items that did not make the composition of the Comfort Index for earplugs were: pain, comfort (central grid), tolerance, tight, convenience, pleasantness, flexibility, softness, feeling of isolation, complexity, difficulties to move the head and feeling of clogged ears. Items that did not make the composition of the Comfort Index for earmuffs were: pain, comfort (central grid), tolerance, tight, weight, flexibility, softness, feeling of isolation, difficulties to move the head and feeling of clogged ears.

Items that made the composition of the Comfort Index for earplugs were: pressure, weight and softness, since they were statistically significant. Items that made the composition of the Comfort Index for earmuffs were: uncomfortable, hot and difficult to put, since they were statistically significant. (Table 1 and 2).

The Comfort Index for the devices tested was obtained by means of the averages of the responses that obtained correlation with the comfort scale (Table 3). The end result of the Comfort Index was 6.1 (87.1% Comfort Index) for earmuffs and 4.6 (65.7% Comfort Index) for earplugs.

Tabela 3 – Average to compose the Comfort Index based on the workers answers for the questionnaire

Workers	Average Earmuffs	Average Earplugs
1	6,8	4,5
2	6,0	2,3
3	6,3	7,0
4	7,0	5,5
5	7,0	5,0
6	6,5	4,0
7	7,0	7,0
8	7,0	7,0
9	6,5	2,8
10	5,5	3,8
11	4,8	4,0
12	5,5	5,5
13	4,8	3,5
14	4,0	4,0
15	5,5	4,0
16	7,0	3,3
17	6,5	4,8
18	5,5	6,0
19	5,5	3,5
20	7,0	5,5
Average	6,1	4,6

Other feelings described by users regarding the use of the hearing protector devices included: the need to communicate (20%), hearing loss (10%) and does not feel the need to use (10%).

The average time use of the hearing protection devices by employees during the study period was approximately 6 hours and 40 minutes daily during the workday. The workers did not use hearing protection devices during lunchtime rest period, or during the 15 minute breaks in the morning and in the afternoon.

Regarding the audiograms, 90% of audiometry results were classified as normal and 10% were classified as altered suggesting Hearing Loss caused by noise exposure.

For both types of hearing protector devices (earplugs and earmuffs) correlations were performed between Comfort Index and the following variables: age, education, length of employment with the company, occupational noise, change in the audiograms and reasons for disliking using hearing protector device. These correlations were

performed to check whether there was a correlation between these variables and the Comfort Index found in this research.

It was not possible to apply a statistical test to the variable sex of the participants for the two types of hearing protector device, because of the number of female subjects composed by 3 individuals. Additionally the occurrence of statistical correlations between the two types of hearing protector device and variables change in the audiograms and reasons to dislike the use of hearing protector devices could not be studied, due to the number of selections being less than five, not enabling a specific statistical test.

For the earplugs, there was no significant correlation between age and the questionnaire specific questions regarding the equipment, as well as no significant correlation between the results of the audiometry exams and the questionnaire score. To calculate the correlation between educational level and questionnaire score, the following coding was considered :1 (illiterate), 2 (elementary eduaction) and 3 (high school education). However, there was no significant correlation between these variables. As per period of time working for the Company and the question data significant correlation was found between length of service and the question 11 (texture, $p = 0.0151$, $r = 0.5348$) and the question 14 (complexity, $p = 0.0238$, $r = 0.5029$). When the questionnaire score and the occupational noise in the workplace were studied, a statistically significant correlation was found only between occupational noise and the question 7 (weight, $p = 0.0015$, $r = 0.6605$).

For the earmuffs there was no significant correlation between the results of the audiometry exams and the questionnaire score. When the questionnaire score and age were studied, a significant correlation between question 5 (adaptation, $p = 0.0457$, $r = 0.4515$) was found. For the correlation of the questionnaire score and education the following coding was considered: 1 (illiterate), 2 (elementary eduaction) and 3 (high school education) in this case a significant correlation with the question 10 was found (wind chill, p = 0, 0455, r = 0.4518). To calculate the correlations of the questionnaire score and time working in this Company, significant correlations were found between question 8 (sense of well-being, $p = 0.0039$, $r = –0.6150$), the question 11 (wind chill, p = 0, 0019, r = –0.6502), the question 15 (handling, $p = 0.0376$, $r = –0.4676$) and the question 16 (hearing, $p = 0.0012$, $r = –0.6708$). When the questionnaire score and the occupational noise in the workplace were studied a statistically significant correlation was found between question 3 (pressure, $p = 0.0396$, $r = 0.4635$), question 7 (weight, $p = 0.0316$, $r = 0.4814$), question 8 (sense of well-being, $p = 0.0306$, $r = 0.4839$), question 9 (flexibility, $p = 0.0385$, $r = 0.4656$), and question 11 (texture, $p = 0.0200$, $r = 0.5154$).

DISCUSSION

This study analyzed the comfort of the hearing protector devices as part of an intervention for prevention of hearing loss in workers exposed to high noise levels, using a questionnaire that evaluated the comfort of these devices.

By monitoring workers exposed to occupational hazards, mainly to noise, it is clear that many are still unaware of their rights and duties regarding their occupational health, and are afraid to engage in activities targeted towards that. This can be seen since 33.33% of the population where the study was conducted did not want to take part in this study, justifying that they were uncertain regarding the results of the study and possible retaliation from company's management. Such information shows a point to be worked with the workers and companies leadership team, regarding their participation and interaction in their own process for producing healthy work environment, so that everybody is engaged in activities aiming everybody's health and safety and knows both their rights and responsibilities regarding their own occupational health.

The choice of hearing protection devices used in this research considered the following aspects: mitigation, working hours, approval certificate (*CA*) by the Ministry of Labor, cost and ease for handling, consistent with the reality of the company and the literature [4, 21, 22].

The workers that participated on this research had lack of prior knowledge about how to use properly the hearing protection devices, and this aspect would have negative influence on comfort and acceptance of these devices by employees in the period prior to the beginning of this investigation. Upon completion of the educational activity, the hearing protection devices were better accepted by the employees. It was observed that the educational activities have contributed to the perception of comfort and acceptability of the hearing protection devices, and fostered more involvement of the employees in their own hearing health process.

The educational activity conducted on this research contributed to check the knowledge of the participants regarding hearing protection, which was low. When it comes to comfort of the hearing protection device, the practical activities and the perception of workers are essential to reach the comfort and acceptability of hearing protection devices by the employees. Knowing how to properly

use and handle the equipment can prevent errors and false analyses from the worker regarding the comfort of the device [14, 15, 19, 20, 23, 24].

The questionnaire results indicated a significant difference between the perception of different models of hearing protection devices (earplugs and earmuffs). The earplugs received a score of 4.6 (65.7% Comfort Index) and earmuffs received a score of 6.1 (87.1% Comfort Index). In both cases, specific issues were raised related to the comfort of the equipment, which may contribute to the selection of an even more comfortable device. To consider a hearing protection device comfortable or uncomfortable it is necessary to observe its Comfort Index. The closer the Comfort Index is to 7, the more comfortable it is, whereas the closer the Comfort Index is to 1, the more uncomfortable the equipment is [19].

In a similar study, Arezes and Miguel [19] used the same tool to compare two types of earplugs and two types of earmuffs. Earplugs received scores of 4.1 (58.5% of Comfort Index) and 3.7 (52.8% Comfort Index) while the earmuffs received scores of 6.4 (91, 4% Comfort Index) and 6.2 (88.5% Comfort Index), equivalent to those found in the present study. The difference between the two protectors of each type was not significant, but it was significant among the protectors of different types, also found in the present study. In the study of Arezes and Miguel [19] it was noted a statistically significant association between the Comfort Index and the time of its use, which cannot be assessed in this study because the workers were ordered to wear the device throughout their work shift and request was followed. The authors also indicated that the feeling of comfort may vary not only from device to device, but also with the thermal and acoustic environment.

Other perceptions were raised, not restricted to the comfort, but that may influence this aspect and hence the acceptability of the hearing protection devices. Among those reasons the following were identified: the need for communication (20%) insertion type, hearing loss (10%) insertion type and lack of feeling of necessity (5%) for earmuffs (5%) for earplugs. These can be compared to those reported by the literature, which identifies several barriers perceived by users for regular use of hearing protection devices [14, 16, 19, 24]. These barriers include apart from the discomfort, interference with communication and job performance, lack of sense of self-efficacy (clarity or belief that the individual has the need to use the equipment and that one is able to take effective measures to protect their medical health) and others [18, 25]. These results suggest that the Comfort Index alone is not enough to evaluate the acceptability of hearing protection device, but should be complementary to the evaluation of these other issues raised.

Regarding the results of the questionnaires and other variables, it was observed that for the earplugs there were significant correlations between length of service and the perception of texture and complexity of the equipment. This demonstrates that the bigger the knowledge about the equipment, the most detailed it is the knowledge about it [19, 25]. There has also been a significant correlation between occupational noise and weight of the hearing protector device, a correlation that has no other similar findings in literature, allowing only speculation of possible explanations that may involve the level of stress associated with higher noise.

For earmuffs, there was a significant correlation between age and adaptation to the hearing protection devices, suggesting that age is a factor to be considered in the selection of the equipment [19,25]. There also was a significant correlation between education and thermal sensation, which can suggest that education should be considered in the adaptation of earmuffs, through health educational activities. There were also significant correlations between occupational noise and pressure, weight, sense of well-being, flexibility and texture. These features suggest that high noise level can enhance the general feeling of discomfort, which is expressed to various aspects of the device.

However, there are other aspects that must be taken into consideration when choosing a hearing protection device. According to the results of this research, these aspects include excessive pressure on the head of the worker, the weight of equipment, flexibility of the device, ear discomfort that is caused by pressure of the equipment into the ear canal, auricular heat and difficulty to put the equipment caused by lack of knowledge from the user or complexity of the equipment. If such aspects were evaluated before the choice of the device, they could help professionals when choosing a good hearing protector device, therefore the equipment could be more easily accepted and more comfortable to the user

This study had some limitations, especially regarding the number of subjects, in particular females. It is recommended to carry out a further study with a larger number of participants, and uncontrolled duration of the use of the equipment, to better assess these aspects.

The health education activity and the application of the questionnaire assessing the comfort of hearing protection presented in this research had a positive impact on the acceptability of the indicated hearing protectors. This questionnaire points directly to the professional which is the aspect that bothers the

employee on equipment usage, that way, it is easier to act correctively on this process, and in ultimately achieve success in the prevention of Hearing Loss caused by exposure to noise.

The noise attenuation provided by hearing protection devices depends on several asscoaited parameters, including: the user (shape and geometry of the ear, canal, user experience related to the usage of the equipment), shield type (mechanical design of the hearing protector device including the geometric shape, materials, dimensions, size, arc force) and the environment in which the worker is inserted (noise levels, frequency, usage of other protective equipment) [16].

The greatest difficulty in choosing and obtaining appropriate hearing protection device is caused because each worker has their own anatomical and physiological characteristic of the ear, and it can be the cause of many problems related to the difficulty of getting good isolation from the universal size of the devices found in the market. Inherent attenuation aspects of device(quality), the user's personal characteristics (size of the external auditory canal, shape of the face and head), compatibility with other personal protection equipment , type of duties, proper use, preferences and level of noise where the worker works must always be taken into consideration [26-28].

For the correct selection a good hearing protection device three factors must be taken into account: attenuation, comfort and communication [22].

As seen, the hearing protectors should not be chosen only by their noise attenuation. The hearing protectors should be comfortable in order for them to be effective [14]. Therefore, it is necessary that employees have choices of different types of devices that can provide the necessary attenuation [25] so that each individual can find the most comfortable type of the device [25].

In Brazil, this choice has usually been made from a combination of factors such as: cost, attenuation and comfort, but in an empirical way, without a thorough analysis. The comfort is taken into account, for some agents; there is no individual work in order to ergonomically adapt to devices, when individual and collective adaptation of all workers to the use of hearing protection takes place. The attenuation is not sought for the specific noise level, but the maximum attenuation that the device can provide, which is also not advisable as it creates communication difficulties and the feeling of isolation [13].

The hearing protector devices, noise control and health education contribute in significant ways to minimize the effects of noise on workers' health. However, the provision of hearing protection devices should not be done without an adaptation campaign.

The results of this study suggest that the Comfort Index alone is not sufficient to assess own comfort of the hearing protection devices and its acceptability, but it should be supplemented by the following items: analysis of adequate attenuation offered and interference of the device in the communication, emphasizing the need for the use of hearing protection devices in pathophysiological terms, instruction for correct placement and use of the device and conducting practical exercises and activities of health education aimed at handling, cleaning, maintenance and proper custody of such equipment.

CONCLUSION

The hearing protection devices studied, had their scores at acceptable levels quoted above 4 (57.1% to show Comfort), both being considered comfortable. However, there was a significant difference in the Comfort Index between different types of protectors (earplugs and earmuffs). Thus, it was concluded that the earmuff hearing protection device type was considered the most comfortable and best accepted by the population of this study.

ABSTRACT

Purpose: to analyze the comfort of the individual hearing protectors as part of an intervention for prevention of hearing loss in workers exposed to high noise levels, using a questionnaire of comfort assessment. **Method:** company safety and health records were reviewed, noise measurements were performed, new HPDs were selected, the comfort of the devices was evaluated and audiometric tests were conducted. The study population was 20 workers exposed to noise levels above 80 dB(A). The workers used two types of HPD (earplugs and earmuffs), each for 15 days, followed by an application of the questionnaire after each trial period. **Results:** 85% of the participants were males and 15% females and their average age was 35 years old. The comfort index for the studied earplug was 4.6, and for the studied earmuff was 6.1. The participants wore the HPDs during their full work shift which lasted 6 hours and 40 minutes. Other barriers were indentified to the use of hearing protection: interference with communication (20%), decreased hearing (10%) and lack of clarity on the need to use it (10%). **Conclusion:** the HPDs analyzed in this study had their scores acceptable and were considered both comfortable. However, there was a significant difference in the comfort Index between protectors of different types (earplug and earmuff). The conclusion was that the earmuff is considered the most comfortable and more accepted HPDs by this population.

KEYWORDS: Noise; Hearing Loss; Disease Prevention

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