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Interactive hearing health education campaign for noise-exposed workers

Campanha interativa de educação em saúde auditiva para trabalhadores expostos à ruído

Campaña interactiva de educación sobre salud auditiva para trabajadores expuestos al ruido

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Abstract

Introduction: Continuous exposure to high levels of occupational noise poses a threat to workers' hearing health. Hence, strategies to promote and protect their health, such as interactive campaigns, can help minimize these risks. **Objective:** To evaluate the effectiveness of an interactive hearing health education campaign for noise-exposed workers. **Methods:** One hundred workers from private companies in inland São Paulo participated in the campaign, which featured a giant inflatable ear and a dummy equipped with an attached decibel meter. Workers explored the materials and received information about the structure and function of the hearing system, the importance of hearing health, ear hygiene, the impacts of noise, and the use of hearing protectors. Questionnaires were administered to the workers before and after the intervention to assess the campaign's effectiveness. The study calculated the absolute (total) and relative (percentage) frequencies and used the Wilcoxon test ($p < 0.05$). **Results:** The sample comprised 54% males and 46% females, aged 18 to 64 years. Most were high school graduates (39%), and 43% had worked at the company for more than 5 years. There was an increase in correct answers, ranging from 1% to 46%, with a significant difference between the groups – those with a college degree ($p = 0.03$) and postgraduate degree ($p = 0.01$) had better results. **Conclusion:** The interactive hearing

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MRLR: research design, data collection and analysis and article writing.
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health education campaign proved to be an effective strategy for raising awareness about the importance of hearing preservation among workers exposed to high noise levels.

Keywords: Hearing; Noise, occupational; Hearing loss, noise-induced; Health education; Speech, language and hearing sciences.

Resumo

Introdução: A exposição contínua a elevados níveis de ruído no trabalho é uma ameaça à saúde auditiva dos trabalhadores, e estratégias de promoção e proteção à saúde como campanhas interativas podem auxiliar na minimização destes riscos. **Objetivo:** Avaliar a eficácia de uma campanha interativa na educação em saúde auditiva para trabalhadores expostos a ruído **Métodos:** Participaram da campanha 100 trabalhadores de empresas privadas do interior de São Paulo. A ação incluiu uma orelha gigante inflável e um manequim com decibelímetro acoplado, permitindo que os trabalhadores explorassem os materiais e recebessem informações acerca da estrutura e funcionamento da audição, importância da saúde auditiva, higienização da orelha, impactos do ruído e protetores auditivos. Questionários pré e pós-intervenção foram aplicados com os trabalhadores para verificação da eficácia da campanha. Foi realizado cálculo de frequência absoluta (total) e relativa (porcentagem) e utilizado o teste de Wilcoxon ($p < 0.05$). **Resultados:** Destes, 54% eram do sexo masculino e 46% feminino, com idades entre 18 e 64 anos. A maioria tinha ensino médio completo (39%) e 43% trabalhavam há mais de cinco anos na empresa. Houve aumento nas respostas corretas, variando de 1% a 46%, com diferença significativa entre os grupos, com melhores resultados entre participantes com ensino superior completo ($p = 0.03$) e pós-graduação ($p = 0.01$). **Conclusão:** A campanha interativa de educação em saúde auditiva demonstrou ser uma estratégia eficaz para conscientizar os trabalhadores expostos a altos níveis de ruído sobre a importância da preservação da audição.

Palavras-chave: Audição; Ruído ocupacional; Perda auditiva provocada por ruído; Educação em saúde; Fonoaudiologia.

Resumén

Introducción: La exposición continua a altos niveles de ruido en el trabajo es una amenaza para la salud auditiva de los trabajadores, y las estrategias de promoción y prevención de la salud como las campañas interactivas pueden ayudar a minimizar estos riesgos. **Objectivo:** Evaluar la efectividad e impacto de una campaña interactiva en educación para la salud auditiva para trabajadores expuestos a ruido en empresas privadas. **Métodos:** La acción incluyó un oído inflable gigante y un maniquí con un medidor de decibelios adjunto, permitiendo que cien trabajadores exploraran los materiales y recibieran información sobre la estructura y el funcionamiento de la audición, la importancia de la salud auditiva, la higiene auditiva, los impactos del ruido y los protectores auditivos. Se aplicaron cuestionarios pre y post campaña. Se calculó la frecuencia absoluta (total) y relativa (porcentaje) y se utilizó la prueba de Wilcoxon ($p < 0,05$). **Resultados:** De estos, el 54% eran hombres y el 46% mujeres, con edades comprendidas entre 18 y 64 años; la mayoría había completado la escuela secundaria (39%) y el 43% había trabajado durante más de cinco años en la empresa. Se observó un aumento en las respuestas correctas, que osciló entre el 1% y el 46%, con una diferencia significativa entre los grupos, con mejores resultados entre los participantes con educación superior completa ($p = 0,03$) y con estudios de posgrado ($p = 0,01$). **Conclusión:** La campaña interactiva de educación auditiva demostró ser una estrategia eficaz para concienciar a los trabajadores expuestos a altos niveles de ruido sobre la importancia de la preservación auditiva.

Palabras clave: Audición; Ruido en el ambiente del trabajo; Perdída auditiva provocada por ruido; Educación en salud; Fonoaudiología.

Introduction

According to the Brazilian Ministry of Health, noise-induced hearing loss (NIHL) is characterized by a gradual decrease in hearing acuity due to continuous exposure to noise in the workplace. This loss is always sensorineural, usually bilateral, irreversible, and unlikely to progress once noise exposure has ceased[1]. The audiometric configuration is initially notched, with hearing thresholds impaired at one or more frequencies in the 3 to 6 kHz range[2]. Although NIHL is irreversible, it is completely preventable, and its prevention is considered a priority[3].

Occupational hearing loss continues to be a relevant public health issue, ranking among the most common occupational disabilities worldwide[4]. In Brazil, NIHL accounts for approximately 30% of work-related illnesses, as recorded by the Notifiable Diseases Information System (SINAN)[5]. Between 2015 and 2022, 6,515 cases of work-related hearing loss were recorded, with the peak incidence in 2016, which corresponded to 21.15% of the total recorded since 2015. In 2023, there were 468 notifications, 86% of which were in men and 14% in women[6]. Although NIHL is a notifiable disease, underreporting is a significant challenge, hindering the implementation of effective public health actions[7]. This condition is more prevalent in industrialized areas, particularly in Southeast Brazil, and the incidence tends to increase with age, being more common among workers over 50 years old[8].

Furthermore, regulatory standard NR-15 establishes a limit of 85 decibels (dB) for an 8-hour workday[9]. However, it is known that many workplaces can have noise levels higher than the established limit, potentially causing significant hearing damage without adequate protection.

In addition to the consequences for hearing, such as tinnitus and hearing loss, excessive noise exposure can harm other systems as well. Common manifestations of noise exposure include physiological responses such as increased heart rate, increased blood pressure, and vasoconstriction, difficulties with concentration and attention, memory impairment, nervousness, and excessive fatigue[10].

Brazilian law established the Hearing Loss Prevention Program, with a set of measures to prevent the onset or progression of occupational hearing loss. It includes noise monitoring, periodic hearing assessments, audiometric management, the use of hearing protection, worker training and education, and evaluation of the program's effectiveness[11].

The most effective procedure for mitigating or eliminating the risks associated with noise exposure to both hearing and general health would be to reduce or eliminate the noise itself through engineering and administrative controls. However, most companies and employers predominantly adopt the faster and cheaper strategy of personal hearing protection. Worker training and education are essential to ensure the successful use of these devices, requiring the implementation of effective hearing health education strategies, which are crucial for preventing occupational hearing loss and promoting safer work environments. Through educational programs, workers can be informed about the risks of continuous noise exposure, the importance of using personal protective equipment (PPE) correctly, and the need for periodic audiometric testing. Furthermore, raising awareness contributes to employee engagement in adopting safe practices and strengthening a culture of prevention within companies[12].

Thus, this research aimed to evaluate the effectiveness of an interactive hearing health education campaign for workers exposed to noise in private companies.

Methods

The research project was submitted to and approved by the Ethics Committee of the Universidade de Sorocaba under number 6,504,893. All participants signed an informed consent form, in accordance with Resolution 466 of the Brazilian National Health Council. This descriptive observational research collected data with a single Hearing Health Awareness Assessment questionnaire, developed by the authors. It was administered at two moments: before the campaign began, called "Questionnaire A," to assess workers' prior knowledge of hearing health, and after finishing the interactive education, called "Questionnaire B," to measure the effectiveness of the campaign and the changes in knowledge it provided. The questionnaire had five identification questions on sex, date of birth, level of education, and length of service at the company, and four questions about the topics covered in the campaign, three of which were multiple-choice and one with five true-or-false statements. One multiple-choice question

addressed topics such as earwax, noise levels, and hearing protection. The true-or-false question approached the auditory and extra-auditory effects of noise.

The campaign was carried out by speech-language-hearing undergraduate students of a private university in the state of São Paulo and by a professor who taught "Professional Practice in Occupational Health" to eighth-term students. The campaign was held at two multinational companies in inland São Paulo, one in the technology and industrial automation sector, in Sorocaba, and the other in the food sector, in Itu. It consisted of displaying a giant inflatable ear (Figure 1) and a mannequin (a human replica named Foneca [Figure 2], similar to Jolene from the Dangerous Decibels® program) in the companies' patios. The giant inflatable ear is a larger-than-life imitation of a real ear, representing the main structures of the outer, middle, and inner ear, for visitors to explore its interior. It begins at the auricle, which is 4.5 meters high, followed by a tunnel 6 meters long and 3.2 meters wide. It represents the main structures of the outer, middle, and inner ear, from the external auditory canal to the cochlea, where the hair cells are symbolized with LED lights. It also shows the auditory nerve, ending in an image of the brain. The Foneca has a silicone ear that measures the sound intensity of audio devices by connecting it to a sound level meter.

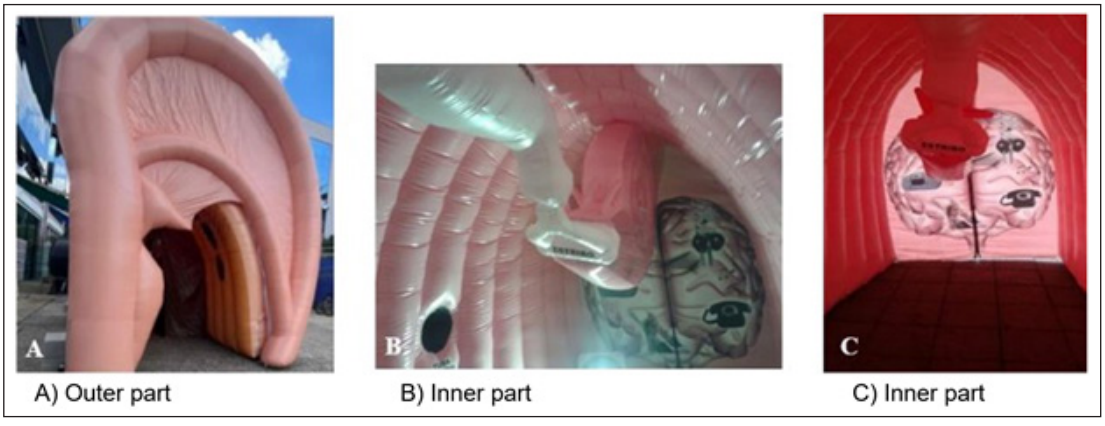

Figure 1. Giant inflatable ear

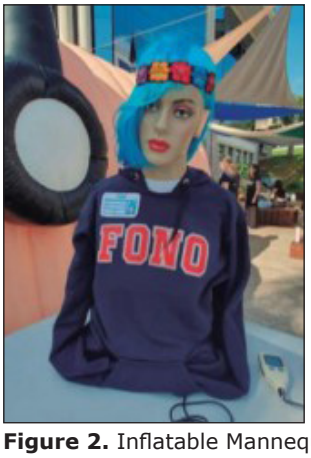

Figure 2. Inflatable Mannequin (Foneca) with the sound level meter attached

Research participants took a guided tour inside the giant ear, receiving information about the path sounds take to the brain, hearing function, hearing care, and the harmful effects of noise on our hearing health and quality of life. Upon exiting the ear, workers were asked how many decibels they usually listen to music on their mobile phones. After being instructed to adjust the music on their devices to the volume they typically enjoy, their headphones were placed on Foneca's ear. The measurement took approximately 1 minute, and then participants were informed whether the measured levels were harmful to their hearing and were instructed on safe levels, according to the National Institute for Occupational Safety and

Health (NIOSH). At this point, photos of enlarged hair cells, both healthy and damaged, were shown to the workers to reinforce awareness of the dangers of loud sounds and noise exposure without hearing protection. They were instructed on the importance of wearing hearing protection during the workday and how to properly fit it. Workers could ask questions and make comments throughout the activity to reinforce the educational process. In addition to guiding them regarding the giant ear and Foneca, the university students were available to answer and clarify any questions the workers had.

The campaign's effectiveness was assessed for all participants by comparing their scores in the first and second questionnaires. Data on age, sex, education level, and length of service at the company were analyzed by absolute (total) and relative frequencies (percentage). Statistical analysis of pre- and post-intervention data was performed using the Wilcoxon test, with a significance level of $p < 0.05$.

Results

Most of the 100 participants were males (54%). The youngest was 18 and the oldest was 64 years old; the majority (43%) were 30 to 41 years old. Also, 39% were high school graduates, and most participants (43%) had worked for more than 5 years at the companies (Table 1).

Table 1. Participant data

Variable	Absolute frequency and simple percentage
Sex	Males – 54 (54%) Females – 46 (46%)
Age	18-29 – 29 (29%) 30-41 – 43 (43%) 41-52 – 26 (26%) 53-64 – 02 (2%)
Education level	High school graduates – 39 (26%) Bachelor's degree – 26 (19%) Higher education incomplete – 19 (16%) Postgraduate degree – 16 (16%)
Length of service at the company	Under 1 year – 30 (30%) 1 to 3 years – 17 (17%) 3 to 5 years – 10 (10%) Over 5 years – 43 (43%)
Total N	100 (100%)

Source: Developed by the authors

The workers' questionnaire results before and after the campaign are described in Table 2. The number of correct answers increased in all questions, ranging from 1% to 46%.

Table 2. Participants' responses

QUESTION TOPIC	BEFORE THE CAMPAIGN	AFTER THE CAMPAIGN	DIFFERENCE BEFORE AND AFTER
Earwax	72%	85%	13% increase
Noise levels	52%	98%	46% increase
Exposure to high sounds	73%	92%	19% increase
Damage to inner hair cells	88%	99%	11% increase
Exposure to high sounds	86%	96%	10% increase
Consequences of exposure to high sounds	98%	99%	1% increase
Prolonged noise exposure	82%	93%	11% increase
Forms of protection	94%	96%	2% increase

Source: Developed by the authors

An analysis compared sociodemographic categories (sex, age, education, and length of service at the company), finding a difference between the groups, with better results among participants with bachelor's (p-value = 0.03) and postgraduate degrees (p-value = 0.01) in relation to the other variables. No statistically significant difference was found regarding the other sociodemographic variables, as shown in Table 3.

Table 3. Association between sociodemographic variables

Variable	Category	p-value	Statistical difference between groups
Sex	Males	0.20	–
	Females	0.30	–
Age (years)	18–29	0.50	–
	30–41	0.40	–
	42–53	0.30	–
	54–64	0.20	–
Education level	High school	0.40	–
	Bachelor's degree	0.03	BD differs from HS and HEI
	Higher education Incomplete	0.20	–
	Postgraduate	0.01	PG differs from HS, HEI, and BD
Length of service (years)	Up to 1 year	0.40	–
	1 to 3	0.50	–
	3 to 5	0.40	–
	Over 5	0.30	–

Caption: HS (high school); BD (bachelor's degree); HEI (higher education incomplete); PG (postgraduate)
Source: Developed by the authors

Discussion

Promoting hearing health in the workplace is essential for workers' well-being and NIHL prevention, as it is one of the main causes of hearing impairment in factories[11]. Speech-language-hearing therapy plays a central role in this process, working to educate and raise awareness among workers and transforming the workplace into a health-promoting space[12].

Educational campaigns strengthen self-care and encourage the prevention of occupational hearing disorders, promoting a culture of health in companies[13]. Raising awareness of auditory risks and the correct use of PPE should involve the workers' participation, encouraging critical reflection on working conditions[7].

In this study, workers experienced firsthand how hearing works and the harmful effects of loud noise. Interaction with anatomical elements, the students' accessible language, and reflective discussions helped them understand the risks and learn the content[14]. Immersion in the activities reinforced emotional engagement, making learning more meaningful.

Workers with bachelor's and postgraduate degrees performed better, suggesting a relationship between education and understanding of preventive practices[10]. Most participants were males, with 1 to 3 years of service, and high school graduates. This profile is common in factories and technology companies, highlighting the importance of recurring campaigns tailored to the workplace.

The data showed that correct answers increased by up to 46% after the intervention, indicating that the campaign positively expanded knowledge and changed attitudes[15]. The question about "noise levels capable of causing hearing loss" had the greatest gain (46%), reinforced by using the sound level meter and giving a practical explanation based on the NIOSH table[16].

Other questions, such as the one addressing earwax, also improved significantly, correcting misconceptions about the need for frequent re-

moval. Correct answers in questions about PPE and prolonged noise exposure varied less (1% to 4%), as participants already knew about PPE use.

Some limitations should be pointed out. Implementing the campaign in only two companies and in a timely manner limits the generalizability of the results. The timing of the campaign, which occurred after lunchtime, may have affected participants' attention and engagement, as many use this time to rest. On the other hand, the timing of the post-intervention questionnaire favored better results, though not guaranteeing that the knowledge would be retained. Furthermore, the lack of a control group prevents us from conclusively stating that the gains were due solely to the intervention.

One of the workers had hearing loss, requiring interpreters of the Brazilian Sign Language (Libras). This highlights the importance of an inclusive approach, considering each worker's specific communication needs.

Future studies should increase the number of participating companies and include long-term monitoring to assess the retention of acquired knowledge. This approach will allow for a more detailed analysis of the effects of educational campaigns and the maintenance of preventive practices in the workplace. Considering these future directions, educational initiatives tailored to the workers' profile and reality, using accessible language and inclusive approaches, can achieve an even greater impact, contributing to healthier work environments and promoting ongoing hearing health.

Conclusion

The interactive hearing health education campaign proved to be a highly effective strategy for raising awareness among noise-exposed workers about the importance of hearing preservation.

The results of the intervention confirmed the success of the participatory method, demonstrating a significant increase in participants' knowledge about hearing care before and after the intervention.

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