Original Article

An Educational Intervention for Improving the Use of Hearing Protection Equipment among Operational Oil Refinery Workers Based on the Health Belief Model

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Abstract

Aim: The use of hearing protection equipment is the last solution to decrease noise exposure in industries. This study aimed to evaluate the effect of educational intervention on improving the use of hearing protection devices based on the health belief model (HBM). **Methods:** The 100 male workers exposed to noise in an oil refinery participated in this study. The intervention was conducted in 12 sessions (40–60 min for each session and three times per week). Data were collected using a validated and reliable questionnaire made by the researcher before and after the intervention. **Results:** The results showed that the dimensions of the HBM had no significant difference between the two groups before the intervention ($P > 0.05$). The results revealed that the mean values of all dimensions of the HBM, except the dimension of perceived barriers, significantly increased in the intervention group after educational sessions ($P < 0.001$). However, there was not a significant difference in the control group ($P > 0.05$). **Conclusion:** Based on the results, the HBM could affect the use duration of hearing protection devices among refinery workers. Therefore, it is suggested that this model be applied to train employees exposed to high noise levels in various industries.

Keywords: Educational, health belief models, noise, occupational, personal, protective equipment

Introduction

Noise, as an unwanted and annoying sound, is one of the most common pollutants in the workplace.[1] The industrialization and development process in large industries has significantly increased the exposure to this harmful agent in the work environment.[2] In Iran, it has been estimated that higher than two million workers are exposed to noise above the permissible level (period 2009/2010).[3] In other countries, statistics show that nearly 14% of workers in the United States and 30% of them in Europe are exposed to noise levels >85 decibels (period 2000/2001).[4] The oil industry is one of the industries with loud noise.[5] Temporary and permanent hearing loss and sleep disturbance have been reported as important consequences due to chronic exposure to noise among oil industry employees.[6,7] To prevent these adverse consequences, control measures at the noise source, the emission path, and the receipt point are required. Because of some limitations, such as feasibility, safety, cost, and interference in the process, the combination of several control solutions must be applied.[8] One of these solutions is the use of personal protective equipment, such as an air plug or earmuff.[9] Use easiness, low cost, and availability are some advantages of hearing protection devices.[10] However, these devices have several disadvantages, including weak performance in high noise pressure levels, probability of infection transmission

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into the ear canal, and interference in some tasks.[11] In several studies, the positive effects associated with the use of hearing protection devices have been reported.[12] Based on the results of previous studies, the use of hearing protection devices is effective if workers use these devices continuously. Therefore, identification of the factors affecting the nonuse of hearing protection devices can be helpful. Ologe *et al*. observed that the most important reasons for the nonuse of hearing protection devices were insufficient training and poor motivation.[13] Therefore, an educational program is required to promote the proper use culture of these devices among employees. One of the most common educational intervention models is the health belief model (HBM), which was widely used since the early 1950s in the conceptual framework of behavioral health research to describe the change and continuity of health-related behaviors.[14] The basic concepts that exist in the HBM are perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and cues to action.[15] Based on this model, a person believes that exposure to loud noise can cause hearing loss, as an adverse health consequence. Furthermore, the individual perceives the depth of this danger and the seriousness of its consequences. Consequently, she/he performs safe behaviors, such as the use of hearing protection devices to decrease the risk of hearing loss. This model is applied to evaluate the behavior, determine the factors affecting a person's decisions, and plan for its change. In this model, employees' awareness firstly increases, and then, their attitudes alter toward the use of hearing protection equipment. Conceptual framework of HBM are shown in Figure 1.

This model has been used in various studies so far. Rani *et al*., in 2022, conducted a study entitled the acceptance rate of the COVID-19 vaccine based on the HBM.[16] Furthermore, in 2023, Huang *et al*. conducted a study with the title of Discovery of preventive behaviors of COVID-19 disease transmission among medical personnel.[17] As it was stated, noise exposure can cause many adverse health effects in exposed people, and according to the existing restrictions, in most cases, the use of personal protective equipment is the most important way to prevent the occurrence of these adverse effects. Regarding determining the effect of educational intervention using this model in improving the use of personal protective equipment in employees exposed to noise, it has not been done. This study aimed to investigate the effect of educational intervention on improving the use of hearing protection devices based on the HBM.

Materials and Methods

The present study is a semi-experimental and prospective interventional study. This study was conducted in an oil refinery located in the southwest of Iran. This refinery produces various products, such as gasoline, jet fuel, and fuel oil. Four thousand workers are working in this refinery in three shifts work. In this refinery, the noise pressure level is higher than 85 decibels in some units of this refinery, such as distillation and new transportation area (NTA).

Participants

The sample size in this study was determined similar to the studies conducted by Madvari *et al*.[18] The inclusion criteria included work experience of more than 1 year and noise exposure above 85 decibels. Failure to attend training classes and unwillingness to participate in the study were considered exclusion criteria. Finally, The 100 male workers exposed to noise participated in this study. They were randomly divided into intervention and control groups.

Tools

Data were collected using a questionnaire made by the researchers. This questionnaire had two main parts, including questions on demographic information and questions on the components of the HBM. Table 1 represents the dimensions

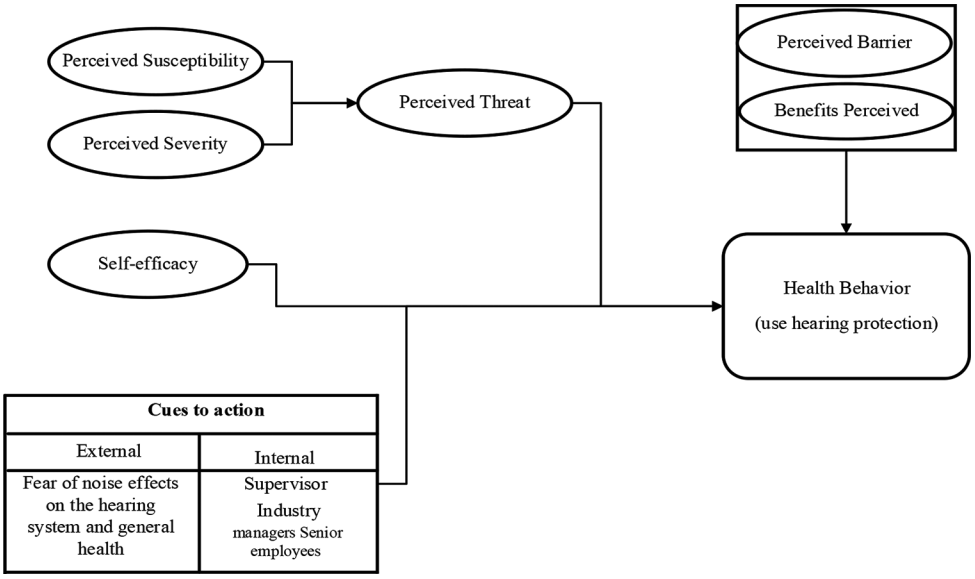

Figure 1: Conceptual framework of this study based on health belief model

Table 1: The dimensions of the developed questionnaire

Dimension	Number of questions (format)	Scoring (range)
Knowledge	11 items (true-false-don't know)	"Correct" response=2, "don't know" response=1, "incorrect" response=0 (0–22)
Perceived susceptibility	7 items/5-Point Likert Scale (strongly disagree to strongly agree)	Strongly disagree=1, disagree=2, no idea=3, agree=4, strongly agree=5 (7–35)
Perceived severity	5 items/5-Point Likert Scale (strongly disagree to strongly agree)	Strongly disagree=1, disagree=2, no idea=3, agree=4, strongly agree=5 (5–25)
Perceived benefits	6 items/5-Point Likert Scale (strongly disagree to strongly agree)	Strongly disagree=1, disagree=2, no idea=3, agree=4, strongly agree=5 (6–30)
Perceived barriers	5 items/5-Point Likert Scale (strongly disagree- strongly agree)	Strongly disagree=1, disagree=2, no idea=3, agree=4, strongly agree=5 (5–25)
Self-efficacy	5 items/5-Point Likert Scale (strongly disagree- strongly agree)	Strongly disagree=1, disagree=2, no idea=3, agree=4, strongly agree=5 (5–25)
Cues to action	6 items/5-Point Likert Scale (strongly disagree to strongly agree)	Strongly disagree=1, disagree=2, no idea=3, agree=4, strongly agree=5 (6–30)
Behavior	5 items/5-Point Likert Scale (Always to never)	Always=5, often=4, sometimes=3, rarely=2, never=1

of this questionnaire. The validity and reliability of this tool were evaluated in the present study.

Data collection before educational intervention

At this stage, workers in both intervention and control groups were asked to complete the designed questionnaire.

Educational intervention

Face-to-face interviews were performed with five professors working at the university and five safety experts working at the refinery. In these interviews, the challenges and effective solutions for the use of hearing protection devices were discussed. Finally, the topics of educational intervention were determined and approved. Educational interventions were conducted at 12 theoretical-practical sessions among the intervention group (40–60 min for each session and three times per week). The training was performed through the presentation of lectures, the distribution of educational pamphlets, the distribution of videos, and the exchange of personal opinions. In the first session, a brief description of the generalities and basic concepts were presented. In the second session, standards related to noise were explained. In the third session, noise-related diseases were described. In the fourth session, the principles and rules related to noise measurement were stated. In the fifth session, the identification methods of noise sources were discussed. In the sixth session, noise control strategies were introduced. In the seventh session, personal protective equipment, its advantages and disadvantages, and its use challenges were explained. In the eighth session, the information on the noise map of the workshop was presented. In the ninth session, the correct use of the earmuff and earplug was trained through an educational video. The 10th and 11th sessions were practically held in the work environment. The 12th session was also held for solving the problems and finalizing the course.

Data collection after educational intervention

After 3 months of educational intervention, the researcher-made questionnaire was completed by both intervention and control groups.

Statistical analysis

Data were entered into the IBM SPSS 25 software (IBM, Chicago, Illinois, USA) and analyzed by descriptive tests, analysis of covariance, and independent *t*-test (intergroup comparisons). The confidence and significance levels were 0.95 and 0.05, respectively.

Results

Table 2 reports the demographic information of workers in intervention and control groups. The mean ± standard deviation values of the age of workers in the intervention and control groups were 35 ± 1.3 and 31 ± 2.1, respectively.

The results of this study indicated that the developed questionnaire had proper validity and reliability. The alpha Cronbach coefficient of this questionnaire was equal to 0.910. The results in Table 3 showed that the dimensions of the HBM had no significant difference between the two groups before the intervention. The results revealed that the mean values of all dimensions of the HBM, except the dimension of perceived barriers, significantly increased in the intervention group after educational sessions.

Discussion

Based on the results, there is not a significant difference between the dimensions of the HBM in the two groups before the intervention. While, the mean values of all dimensions of the HBM, except the dimension of perceived barriers, significantly increased in the intervention group after educational sessions ($P < 0.05$). In the intervention group, the staff's knowledge on the effects due to noise exposure and the disadvantages and advantages of the use of hearing protection devices increased. Knowledge and awareness have been introduced as important factors affecting the use of personal protective equipment in previous studies. Monazzam *et al*. evaluated the effectiveness of the educational intervention on the use of hearing protection devices among employees of small workshops in Hamadan. They concluded that educational

intervention can play an important role in increasing the knowledge and attitude of individuals and the use duration of hearing protection devices.[19] Moreover, Madvari *et al*. observed that the educational intervention significantly impressed the use of earmuffs and earplugs among the workers of a tile company.[18]

Table 2: Demographic information of workers in intervention and control groups

Variables	Groups, frequent (%)		*P**
	Intervention	Control	
Marital status			
Married	38 (76)	32 (30)	0.712
Single	12 (24)	18 (36)	
Level of education			
Diploma	15 (30)	16 (32)	0.812
Associate degree	20 (40)	14 (28)	
Bachelor	10 (20)	8 (16)	
Master	8 (16)	12 (24)	
Work experience (years)			
Lower than 5	10 (20)	15 (30)	0.512
5–9	16 (32)	10 (20)	
10–14	20 (40)	15 (30)	
Higher than 15	4 (8)	10 (20)	
Employment status			
Official	15 (30)	20 (40)	0.361
Contractual	35 (70)	30 (60)	
Smoking			
Yes	35 (70)	38 (76)	0.612
No	15 (30)	12 (24)	
Job			
Welder	10 (20)	12 (24)	0.832
Mechanic	10 (20)	12 (24)	
Cutter	15 (30)	13 (26)	
Metalworker	10 (20)	7 (14)	
Pipe mechanic	5 (10)	6 (12)	

*Chi-square

The results of the present study also indicated that an increase in staff knowledge could improve the use of hearing protection devices. This finding is consistent with the results of a study performed by Raingruber. They concluded that the educational intervention based on the HBM could increase the mean score of staff knowledge in the intervention group.[20] Furthermore, Kein states that greater knowledge can influence safe behavior.[21] In the HBM, people always try to decrease their health risks. For this aim, they must perceive the risks. Fear of hearing loss, accidents, and injuries and fear of their high medical costs can convince employees to correctly use hearing protection devices.[22] The results of a study performed by Khan *et al*. showed that threat perception plays an important role in occurring safe behaviors among workers. The results of the present study revealed that the dimension of perceived obstacles had no significant difference before and after the educational intervention.[23] However, some obstacles, such as the lack of personal protective equipment, the distribution of substandard personal protective equipment, and the susceptibility of human ear to ear infections can decrease the use of personal protective equipment.[24] The present study was the first study that was conducted to investigate the effectiveness of educational intervention based on the HBM in improving the time of using personal protective equipment among employees exposed to noise above the permissible limit. The small size of the sample in the present study and the lack of a similar study to compare the results obtained from the health belief method are the limitations of this study. It is suggested that for future studies, the current study should be conducted with a larger sample size and in different industries whose workers are exposed to noise and the results should be compared with the current study.

Conclusion

Based on the results, the implementation of educational interventions with a focus on staff awareness and behaviors can be helpful to prevent health consequences due to noise

Table 3: Comparison of the mean score and standard deviation of the two groups before and after the intervention

Dimension	Groups	Status before intervention, mean±SD	Status after intervention, mean±SD	Mean difference	*P**
Knowledge	Intervention	15.32±3.55	21.32±1.62	6±1.93	<0.001
	Control	13.41±4.20	12.89±4.16	−0.52±0.04	
Perceived susceptibility	Intervention	17.32±3.60	20.11±3.10	2.79±05	<0.001
	Control	16.14±3.76	16.03±3.51	−0.11	
Perceived severity	Intervention	19.32±3.90	23.18±1.23	3.86±0.25	<0.001
	Control	18.13±3.46	18.11±3.20	−0.02±2.67	
Perceived benefits	Intervention	22.11±2.36	25.32±1.80	3.21±2.74	<0.001
	Control	20.19±2.87	20.10±2.60	−0.09±0.56	
Perceived barriers	Intervention	22.30±2.55	22.12±5.69	−0.18±0.14	0.9111
	Control	21.58±5.43	21.68±5.83	−0.10±0.45	
Self-efficacy	Intervention	20.36±4.63	23.32±2.93	2.96±2.30	<0.007
	Control	20.13±4.30	20.05±4.25	0.37±0.5	
Cues to action	Intervention	21.30±3.10	22.84±2.90	1.54±1.80	<0.001
	Control	20.76±3.06	20.15±3.01	−0.61±0.05	
Behavior	Intervention	14.30±1.78	16.80±1.20	2.5±0.58	<0.001
	Control	14.45±1.99	14.40±1.87	−0.05±0.12	

*ANCOVA. ANCOVA: Analysis of covariance, SD: Standard deviation

exposure, such as hearing loss. Knowledge and awareness in the industry have the greatest impact on improving the use of hearing protection devices. However, reducing perceived obstacles also plays a role in promoting the safe behavior of employees. Therefore, structures or factors such as awareness, perceived threats, and perceived barriers have an important role in the use of hearing protection devices and should be considered by safety experts and industry managers. Furthermore, the developed questionnaire in the present study can be helpful in collecting information on the dimensions of the HBM and evaluating the educational intervention for the use of hearing protection equipment in the next studies and industries.

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Ethics code

The study was approved by the ethics committee of Behbahan Faculty of Medical Sciences under code IR.BHN.REC.1397.021 informed consent has been signed by all participants. All methods were performed in accordance with relevant guidelines and regulations.

Conflicts of interest

There are no conflicts of interest.

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