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Original Article

The Psychosocial Effects of Noise Level in Hydroelectric Power Plants on Employees

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Abstract

Background: This cross-sectional study was conducted to investigate the psychosocial effects of noise on employees in Hydroelectric Power Plants in Turkey.

Methods: The study was conducted in 2018, in operating Hydroelectric Power Plants located in the city of Artvin in Turkey with 110 employees. Data were collected by performing noise measurement, blood pressure measurement and using descriptive characteristics form and Depression, Anxiety and Stress Scale.

Results: The average personal noise of the sample was 72.3±0.8 dB(A). The blood pressure of the employees were within normal limits. There was no significant difference between the noise levels and the sub-dimensions of the scales used.

Conclusion: The measured mean noise of the sample was within normal limits as per the regulations regarding the protection of employees from noise. Measured BP means of employees during working and resting hours were within normal limits. DASS-42 subscale scores exhibited no difference depending on the noise level.

Keywords: Depression anxiety stress scale; Hydroelectric powerplant; Noisea

Introduction

Hydroelectric Power Plants (HPPs) have become one of the most preferred energy sources in recent years in terms of their renewability and as clean energy providers (1-3). To generate electricity, HPPs have been built on big dams as well as on small streams and brooks. When profit, loss and cost are calculated, the advantages of HPPs are seen (2,4).

HPPs usually assessed environmentally require a significant labor force during construction and operation (5,6). Therefore, HPPs pose some problems in terms of not only its environmental effects but also occupational health and safety (7).

Noise factor is also a very significant factor as a physical risk for HPPs (8). Noise has many harmful effects on health, the best known effect being its damage to hearing and auditory canals. Noise also has such effects as restlessness, insomnia, nervousness, loss of concentration on people. It decreases working efficiency, causes stress and anxiety and may impair thinking. It also increases the pulse, respiratory rate and BP and leads to disturbed sleep and decreased concentration. Sudden noise causes increased pulse and dilated pupils (8-10).

Noise in a working environment is the sounds that negatively affect the health of employees. According to the noise regulations, noise exposure limit is 87 dB(A), the highest exposure action value is 85dB(A) and the lowest exposure action value is 80 dB(A) (11). Lower levels of noise may not cause hearing loss but it may lead to other disorders in the employee (8-10). Noise occurs during the operation of turbines in HPPs in the production of electricity.

Psychosocial risks, one of the newly emerging threats in the world, are now discussed further. Many countries and organizations attempt to develop various methods and programs to determine the psychosocial risks (12-14). In our country, however, Occupational Health and Safety Act no. 6331 does not cover psychosocial risks (15). Article 4 of Regulation on Occupational Health and Safety Risk Assessment stipulates that employees must be protected and necessary precautions must be taken against the risks in workplaces. However, no explanation is provided regarding the identification of psychosocial risks, performance of risk assessments or precautions to be taken (14-16).

Insufficient information is available in the literature with regard to the noise level in HPPs and how employees are affected from the noise. Therefore, this study was conducted to determine the psychosocial effects of noise in HPPs on employees and to make a significant contribution to the literature.

Materials and Methods

This study was designed as a cross-sectional study to investigate the psychosocial problems experienced by employees due to noise in operating HPPs in the city in Turkey and to determine the effects of these problems on their lives.

Place and Time of Study

The study was conducted in 2018, in operating HPP located in the city of Artvin in Turkey and from which permission could be obtained. Autumn and spring are the seasons when the power plants operate in full capacity due to rain. Study data were collected within working hours of the day during the operation of at least two turbines, via a questionnaire, noise measurement, and blood pressure measurement using a manual sphygmomanometer during working and resting hours.

Study Universe and Sample

The study universe consists of employees from a total of 20 operating HPPs located in the city of the city that has significant and great HPP potential (17), and that sets an example in terms of the number of HPPs, electricity generation and number of employees. An average of 300 workers are employed in 20 HPPs to which we applied for permission to conduct the study and only 10 of which granted such permission. In calculating the study sample, G*Power 3.0.10 program was used. The study sample to accurately predict the psychosocial effects of high noise levels in HPPs on workers was determined to be minimum 109 under the conditions of effect size: 0.2, type 1, fault: 0.05, power: 0.90. 118 individuals working in the said 10 HPPs and agreeing to participate in the study were included in the study, however, the study sample consisted of 110 individuals as some of the participants failed to fill in the questionnaires in full.

Data Collection and Analysis

In data collection, special care was taken in HPPs to ensure that 2 turbines were operating. However, the types of turbines were not taken into consideration. Reliability of the noise measurements in the study was accredited by TÜRKAK (Turkish Accreditation Agency); task-based noise measurement was conducted by the measurement laboratory using a personal dosimeter in accordance with the standard/method TS-EN-ISO 9612. Five different working groups in HPPs [Machine control operators, business managers, internal services personnel, security staff, and technical staff] were taken as basis and task-based measurements were performed with personal dosimeters on employees from each group working on the day shift.

In addition, the researcher measured the BP of participants by using a manual sphygmomanometer during working and 5-minute resting breaks. Data was collected via face-to-face interviewing technique by using tools such as a Descriptive Characteristics Form prepared by the researcher in line with the literature and (DASS-42) (18).

Data obtained from the study were analyzed using SPSS 23 (IBM Corp., Armonk, NY, USA), number, mean, percentage, Mann-Whitney U test, Kruskal-Wallis H Pearson correlation analysis.

Data Collection Tools

Study data was collected as described below:

Descriptive Characteristics Form

It is a form prepared by the researcher through literature reviews that provides the necessary sociodemographic information regarding the participants.

DASS-42

Developed by Lovibond and Lovibond in 1995, the scale was developed (19). Turkish by Bilgel and Bayram in 2010 and assessed in terms of validity and reliability (20). The scale consists of 42 items and provides a four-point Likert-type evaluation (0=never, 1= sometimes, 2= very often, 3= always). The scale has depression, anxiety and stress subscales. In the original scale, normal range was determined as (0-9) for depression, (0-7) for anxiety and (0-14) for stress. In the Turkish version, on the other hand, cut-off points were calculated and normal range was determined as 10 for depression and 7 for anxiety. DASS-42 validity and reliability studies were conducted by Bilgel and Bayram and the psychometric characteristics study of the Turkish version was also performed. The reliability of the Turkish form was calculated using the internal consistence Cronbach's alpha coefficients which were 0.9 for depression, 0.86 for anxiety and 0.88 for stress (18, 20).

Noise measurements

Five different working groups in HPPs were taken as basis and noise measurements were performed with personal dosimeters worn by employees from each group working on the day shift and while 2 turbines were operating simultaneously in each HPPs. Measurements were evaluated based on the Articles 4 and 5 of the Regulation on Measurement of Noise Exposure of Employees in Workplaces related with the protection of workers from noise-induced risks and published in the Official Gazette dated 28.07.2013 and numbered 28721 (21).

Blood Pressure (BP)

BP measurement was performed by measuring the pressure of blood pumped from the heart on vein walls. The measurement was made on either arm and was repeated on both arms with 5-minute intervals in participants with above-normal values and the higher value was taken into consideration (22). Measurements were performed twice manually from upper arm and heart levels during working and following 5-minute resting times. Participants did not eat, smoke or consume tea or any caffeinated drinks half an hour before measurements including those during working. BP was assessed as <140 mmHg for systolic blood pressure (SBP) and <90 mmHg for diastolic blood pressure (DBP). The value accepted as normal is 120/80 mmHg (22, 23). This method was used in the study.

Ethical approval

Since the use of humans in studies requires the protection of individual rights, the 'informed consent' condition was adopted as the ethical principle and verbal consent of each employee was obtained. The study was approved by The University's Scientific Researches and Publications Ethics Committee with the resolution no.2017/1–2. Furthermore, permission was granted from the electricity generation companies under which the HPPs operated.

Results

Noise levels of the sample demonstrated that noise level ranged between 53.3 dB(A) and 92.6 dB(A) the sample mean was 72.3±0.8 dB(A). When the noise level (Fig. 1) was examined, the average measurement of individuals with typical noise levels was 69.2±0.5 dB(A). The group exposed to high levels of noise was determined as 87±1.040 dB(A). Mean noise exposure levels of the groups were different from each other, however, the difference was observed to be statistically insignificant (*P*>0.05). According to this finding, noise exposure levels of employees exhibited no significant difference depending on their jobs (Table 1).

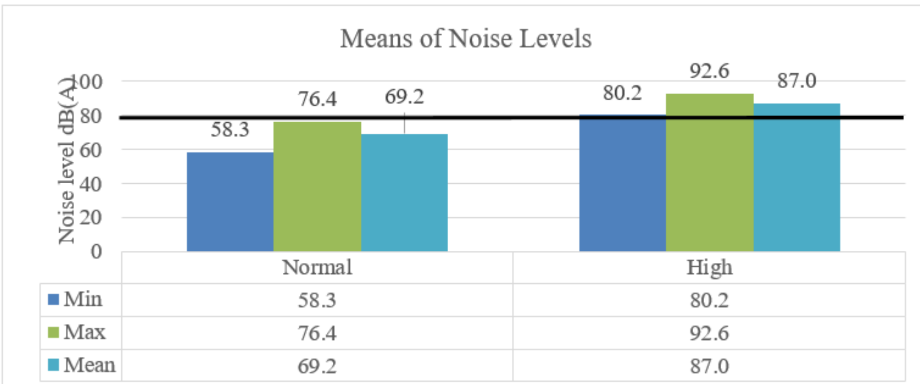

Fig. 1: Mean noise levels of individuals with normal and high noise levels

Table 1: Comparison of noise exposure levels of employees depending on their jobs

Variable		*N*	*X*	*SD*	*Significance*
Job	Manager	15	68.6	1.2	KW: 6.773
	Security staff	17	69.9	1.3	p:0.148
	Machine control operator	35	72.0	1.3	
	Internal services personnel	14	72.1	2.5	
	Technical staff	29	76.1	1.8	

Table 2: comparison of BP measurements of groups exposed to normal and high levels of noise

Measurements	*Noise Level*	*N*	*X*	*SD*	*Significance*
SBP during resting hours	Normal	91	115.2	1.3	MW-U:6o75.5
	High	19	119.5	2.1	p:0.124
DBP during resting hours	Normal	91	72.0	0.9	MW-U:600.5
	High	19	76.3	1.1	p:0.026
SBP during working hours	Normal	91	124.7	1.5	MW-U:750.0
	High	19	127.9	2.8	p:0.350
DBP during working hours	Normal	91	78.9	0.9	MW-U:744.0
	High	19	81.1	1.7	p:0.305

A comparison of the BP of groups exposed to normal and high levels of noise is presented in Table 2.

Mean DBP of the group exposed to normal levels of noise was 72.0±0.9 mm Hg while mean DBP of the group exposed to high levels of noise was76.3±1.1 mm Hg during resting hours and the difference between both groups was found to be statistically significant ($P<0.05$).

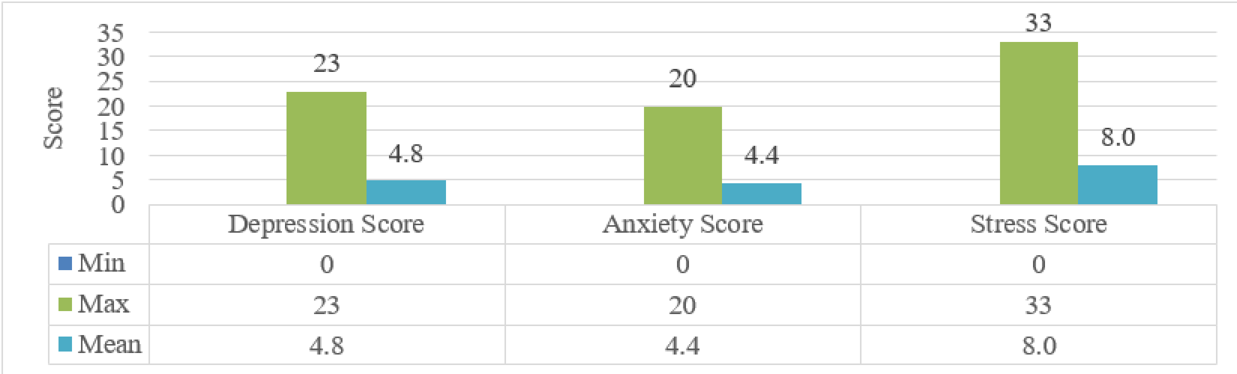

Fig. 2: Table of scores from DASS-42 Scale (n:110)

Table 3: Comparison of groups exposed to normal and high levels of noise according to DASS-42 subscales

DASS-42 Subscales	***Noise Level***	***n***	$\bar{X}$	***SD***	***Significance***
Depression subscale	Normal	91	3.3	0.6	MW-U:723.9
	High	19	5.1	0.7	p:0.260
Anxiety subscale	Normal	91	2.8	0.5	MW-U:679.5
	High	19	4.7	0.6	p:0.141
Stress subscale	Normal	91	6.6	0.7	MW-U:733.5
	High	19	8.2	1.3	p:0.299

DASS-42 scale results showed that the group exposed to normal levels of noise (Table 3) had the differences between the DASS-42 scale depression, anxiety, and stress sub-dimensions of the groups exposed to normal and high noise levels were found to be statistically insignificant ($P>0.05$).

Discussion

In this study, the noise level exposure of employees was calculated as minimum 53.3 dB(A), maximum 93.6 dB(A) and average 72.3 dB(A). In a study regarding the risk assessment in HPPs, personal noise measurement results were about 80.6 dB(A) and noise measurements of employees in work areas supported this study (24). No other study was found in the literature investigating the measurement of noise exposure of employees in HPPs. However, studies are available indicating the noise exposure of employees in other workplaces. Noise level was detected to be between 60-80 dB(A) even in hospitals, where noise must be minimized (35 dB(A)) (11), albeit changing in every department (25, 26). In noise measurements during construction works, noise level was observed to be much higher than 85 dB (A) which is the highest exposure action value (27). When the noise measurements made in different workplaces are examined, it is more than 85 dB(A) (28), in flour mills, more than 90 dB(A) (29), in textile knitting workshops, 90 dB(A) (30), in a manufacturing company, above 80 dB(A) in tea factories (31), minimum 86.3 dB(A) in carpet weaving factories (32).

For the sample in this study, a noise level under 80 dB(A) was described as normal, while a noise level above 80 dB(A) was described as high. These values were determined by considering the lowest exposure action values ($L_{EX,\ 8saat}$) = 80 dB(A) as specified in the Regulation on the Protection of Employees from Noise-Induced Risks (21).

The measured noise level of individuals exposed to normal noise level was 69.2±0.5 dB(A). The group mean of individuals exposed to high levels of noise was found to be 87±1.040 dB(A).

The managers were exposed to the least noise while the technical staff were exposed to the most noise. Furthermore, mean noise exposure levels of the groups were different from each other, however, the difference was observed to be statistically insignificant ($P>0.05$). According to this finding, noise exposure levels of employees exhibited no significant difference depending on their jobs. (Table 1). In a study conducted in HPPs, the highest ambient noise was detected to be beside the generator with 94 dB(A) (24). Normally, no employees work in this area. However, since entrance to the offices is usually through the corridors where turbines are located, all employees passing through these corridors are affected from the noise. In addition, the highest level of exposure was suffered by the technical staff with a noise level ranging between 62.7–92.6 dB(A) and a mean of 76.1 dB(A) because technical staff generally work in turbine corridors for such purposes as repair, check, maintenance while the turbines are operating. However, they keep this duration as short as possible. The technical staff is the group exposed to the most noise even if they use protective gears such as earphones, earplugs etc. during working. Similarly, the internal service personnel constantly use these corridors due to their works and thus are the second group exposed to the most noise. In this study, machine control operators were exposed to a noise level between 62-92.5 dB(A) and a mean noise of 72 dB(A). The noise level of the machine control room was detected to be 67.6 dB(A) (24). Since the rooms of managers who were exposed to the least noise were far away from the turbines, even the maximum noise level was 75.8 dB(A). The mean noise exposure was 68.6dB(A). The mangers were exposed to a mean noise of 69.1 dB(A) (24). Our results were similar with the results of this study. The second group exposed to the least noise 69.9 dB(A) in average was the security staff. Security cabins are usually outside the HPP premises. However, security staff are exposed to noise when they enter the premises for duty.

In this study, mean SBP of the group exposed to normal levels of noise was measured as 115.2 mmHg while mean DBP of the group exposed to high levels of noise was measured as 119.5 mmHg during resting hours and the difference between both groups was statistically insignificant ($P>0.05$). Mean DBP of the group exposed to normal levels of noise was 72 mmHg while mean DBP of the group exposed to high levels of noise was 76.3 mmHg during resting hours and the difference between both groups was found to be statistically significant ($P<0.05$).

The group exposed to normal levels of noise was found to have a statistically insignificant difference from the group exposed to high levels of noise ($P>0.05$). On the other hand, mean DBP of the group exposed to normal levels of noise during resting hours was detected to have a significantly lower mean DBP than the group exposed to high levels of noise (Table 2). In the study, the statistical significance of the mean DBP of employees in environments with normal and high levels of noise during resting hours was found to be insignificant because the value was within normal BP limits. A relationship was found between occupational noise and SBP and DBP, and DBP was found to be higher (33,34). In addition to these findings, the mean DBPs of the group exposed to normal levels of noise and the group exposed to high levels of noise during working hours and resting hours were similar (Table 2).

In a study with healthcare professionals, no significant correlation was found between noise level and hypertension (25). In another study on occupational noise exposure, noise increased DBP, but the relationship was not found to be significant (35). In another study conducted with those who were exposed to occupational noise, exposure to noise above at least 85 dB for a long time increases both SBP and DBP and is significant in terms of hypertension (36).

In the sample, DASS-42 scale data demonstrates that the depression subscale scores ranged be-

tween 0 and 23 and the sample mean was 4.8; the anxiety subscale scores ranged between 0 and 20 and the sample mean was calculated as 4.4 and the stress subscale scores ranged between 0 and 33 and the sample mean was 8.0 points (Fig. 2). A comparison of the scale's table of scores with the sample's table of scores showed that depression, anxiety and stress means were at normal levels (19).
All employees exposed to normal and high levels of noise had normal mean scores from the DASS-42 subscales. Even though there was a correlation between noise and psychological problems and some psychological problems (anxiety, stress, depression, and sleep disorders) were observed, there are a limited number of studies indicating that noise leads to psychological disorders and people who are sensitive to noise are exace1rbated by psychological problems (37). Because many factors other than noise may affect the psychological health of employees. The relationship between work stress and psychosocial risks caused by work environment, job satisfaction, etc. has been revealed and (38). In addition, noise has been shown to cause poor performance, fatigue, distraction and sleep disturbances (29).

Conclusion

The measured mean noise of the sample was within normal limits as per the regulations regarding the protection of employees from noise. The lowest to highest noise exposure mean scores of employees in HPPs were obtained by managers, security staff, machine control operators, internal services personnel and technical staff, respectively. Half of the employees were university graduates and the majority of them were trained on their jobs, which was shown to be an important factor in protection from noise. Almost all of the employees used personal protective gears to protect themselves from noise. Measured BP means of employees during working and resting hours were within normal limits. DASS-42 subscale scores exhibited no difference depending on the noise level.
Due to the lack of studies on the subject in HPPs, it is recommended to conduct repetitive studies addressing the noise exposures of employees.

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Conflicts of interest

All authors have no conflicts of interest to declare.

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