

Original Article



Association between noise exposure and noise annoyance with communication skills and cognitive triad among mine workers, Iran

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Abstract

Background and aims: Noise has many psychological effects. Although different studies have so far focused on various psychological effects, they have not evaluated communication skills and cognitive triad. Thus, this study was conducted to investigate the effect of noise exposure and noise annoyance on communication skills and cognitive triad.

Methods: This cross-sectional study was conducted on 65 workers in 2021. The equivalent sound level (LeqA) was determined using dosimetry. Based on LeqA, noise exposure was divided into permissible and impermissible types. Noise annoyance was measured by the numerical rating scale recommended by ISO/TS 15666:2003. The Communication Skills Questionnaire and Cognitive Triad Inventory were used for data collection. Finally, the obtained data were analyzed by SPSS 24 using an independent samples *t* test and Spearman correlation test.

Results: The mean (\pm standard deviation) age of workers was equal to 33.87 (\pm 5.95) years. The results of the correlation test showed a positive and significant relationship between LeqA and noise annoyance ($P < 0.001$, $r = 0.82$). Based on the results of the independent samples *t* test, there was no significant difference in the scores of communication skills ($P = 0.11$) and cognitive triad ($P = 0.93$) in the two groups.

Conclusion: In this study, a positive and significant relationship was found between noise exposure and noise annoyance. In addition, communication and cognitive skills were not significantly different in the two study groups. To accurately determine the relationships of variables, it is recommended to conduct similar studies with larger sample sizes while considering variables such as personality traits and social intelligence.

Keywords: Noise, Psychological characteristics, Workers, Mining

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Introduction

Noise pollution has been considered by researchers as a common harmful factor in industry and the environment. Approximately 10 million workers in China are exposed to impermissible noise (1). Statistics indicated that about 2 million workers in Iran are exposed to impermissible noise (2).

Noise has auditory and non-auditory effects. Noise may exert its effects directly through synaptic interactions or indirectly through emotional, cognitive, and perceptual impacts. The adverse effects of noise are sleep disorders, cardiovascular dysfunction, stress, gastrointestinal diseases, cognitive and mood disorders, as well as mental and physiological disorders (3). Cognitive function and

proper information processing play a highly important role in many job tasks (4). Cognitive functions include memory, concentration, reaction, problem-solving, and awareness of time and place. The results of various studies show that noise exposure and noise annoyance reduce the level of attention and concentration, and thus increase the level of errors (5,6). The slightest delay in the reaction of people in sensitive jobs can lead to increased accidents and irreparable risks (7).

Noise annoyance or the feeling of annoyance caused by sound is one of the most important mental responses to noise (8). The results of studies represent that noise annoyance is associated with various psychological effects. Noise annoyance can cause sleep disorders and increase

anxiety (9). Hammersen et al found that noise annoyance from various noise sources could have a negative effect on the mental health of German adults (10).

As mentioned earlier, noise has different psychological effects such as stress. The results of Abbasi et al demonstrated that occupational exposure to noise has a positive and significant effect on the stress of textile industry workers (11). Among the consequences of stress are mood swings, lack of concentration, and anger (12). Further, the results of various studies revealed that communication skills are inversely related to stress. Noise is known as a stressor in the workplace, thus exposure to unauthorized noise can lead to decreased communication skills (13). Communication skills are a set of abilities that can be used to achieve acceptable and informative behavior to reach a level of emotional relationship (14). Communication is one of the most important factors in improving productivity and job satisfaction. Previous evidence suggests that poor communication between people in the workplace can increase errors (15). In addition, as previously mentioned, noise can cause mental disorders and depression. Beutel et al reported that there is a significant relationship between noise annoyance and anxiety and depression in the general population (16). An important component of depression is a set of negative cognitions about the self, the world, and the future. This dysfunctional view of self, the world, and the future is called a cognitive triad. A negative cognitive triad arises from the interaction with negative environmental events (17). Furthermore, some studies indicated that cognitive triad is associated with mental health (18,19).

So far, several studies have investigated the effect of noise on mental health components such as stress and depression. Moreover, various studies have confirmed the relationship between mental health components and communication skills and cognitive triad. However, no study, to the best of our knowledge, has investigated the effect of noise on communication skills and cognitive triad. According to the results of previous studies, it is predicted that noise exposure and noise annoyance have a significant effect on communication and cognitive skills. Therefore, the current study sought to evaluate the relationship between noise exposure and noise annoyance with communication skills and cognitive triad.

Materials and Methods

The present cross-sectional study was performed in 2021. The participants were workers from a lead mine in Yazd province. No sampling technique was used in this study, and all workers were surveyed for participation in the study. Finally, 65 qualified workers were included in the study. The inclusion criteria included the age range of < 50 years (due to the removal of age-related confounders) and a work experience of at least 6 months (due to the presence of a worker in the workplace for a significant period of time). However, workers with a history of psychiatric medications, family problems, and congenital hearing loss

were excluded from the study. In this study, workers were divided into noise permissible and impermissible groups. The first group (noise permissible) consisted of workers whose noise exposure was lower than the allowable level according to the ACGIH standard (85 dBA). The second group (noise impermissible) included workers whose noise exposure was equal to or higher than the allowable limit. After explaining the details of the study, orally and in written form, and completing and confirming the informed consent by each individual, the questionnaires were provided to them. Individuals were also assured that their information and details would remain confidential.

Data collection tools

Demographic information questionnaire

This questionnaire was designed to obtain personal information such as age, gender, marital status, and educational level.

Noise exposure

Initially, the necessary information was collected in the workplace and how workers were exposed to noise. In this study, noise exposure was measured using a calibrated dosimeter (model 1354 -TES, Taiwan). Prior to measurement, the device was calibrated by a Tes-1356 calibrator (Taiwan) to obtain accurate results. Then, noise exposure was measured in accordance with the ISO 9612:2009 standard in different sections (20). According to the standard, the microphone of the device was installed at a distance of 10-30 cm from the external ear canal. Workers were requested to bring the device with them until the end of the shift work (eight hours). Finally, the equivalent sound level was calculated using formula 1.

$$Leq_{8hr} = 10 \log \left(\frac{D \times T}{100 \times t} \right) + SPL \quad (1)$$

which D=Noise dose; T=Duration of work shift=8 hours; t=Exposure time=8 hours and SPL=Standard sound pressure level=85 dBA.

Noise annoyance questionnaire

The noise annoyance was assessed based on the Acoustic Questionnaire (assessment of noise annoyance using social and socio-acoustic auditing) which was also a self-report. The question relating to annoyance was recommended by the international standard ISO/TS-15666: 2003. This scale is numerical and includes 11 classes from 0 to 10, indicating no annoyance and extremely annoyed, respectively (Figure 1). Participants should choose their level of annoyance from 0 to 10 (21). The validity and reliability of the questionnaire were evaluated according to Alimohammadi et al (22).

Communication skills questionnaire

This questionnaire was developed by Queen Dam (2004) to assess adult communication skills. This questionnaire has 34 questions which are scored on a 5-point Likert-type

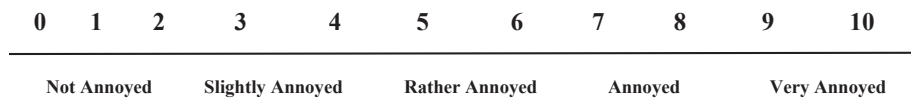


Figure 1. Noise annoyance scale. Source: Beheshti et al (23)

scale ranging from 1 = Never to 5 = Always. The range of scores is from a minimum of 34 to a maximum of 170, and higher scores indicate better communication skills. The final score of this questionnaire is classified into low (< 34), medium (score between 34 and 102), and high (> 102) groups. This questionnaire has five sub-components, including listening skill, understanding verbal and nonverbal messages, insight into the communication process, emotional regulation, and assertiveness (24). In Iran, the validity of this questionnaire was confirmed using confirmatory factor analysis (25). In the study of Shekhaleslami et al, the reliability of this questionnaire was calculated at 0.79 using Cronbach's alpha coefficient (26).

Cognitive triad inventory

This questionnaire was developed by Beckham et al to measure cognitive triad. It has 36 questions which are scored on a 7-point Likert-type scale ranging from 1 = Strongly agree to 7 = Strongly disagree. The higher and lower scores indicate a negative and a positive outlook, respectively. This questionnaire has three subscales, including people's views on the world, self, and future (27). In the study of Cheshmeh Morvari et al, the reliability of this questionnaire was 0.93 using Cronbach's alpha coefficient. In this study, exploratory factor analysis and confirmatory factor analysis were used to check the validity of the questionnaire (28).

Statistical analysis

In the present study, frequency, percentage frequency, mean and standard deviation (SD) were employed to describe the information. In addition, an independent samples *t* test and Spearman correlation test were applied for statistical analysis. The Kolmogorov-Smirnov test was also utilized to check the normality of the data. Moreover, median and interquartile range were used to describe non-normal data. Data were analyzed by SPSS software (version 24), and a significant level was considered as 5%.

Results

All the qualified workers participated in the study. A total of 29 and 36 workers were in the first (an exposure rate less than the allowable limit) and the second (noise exposure exceeded the allowable limit) groups, respectively. The mean (\pm SD) age and work experience of workers were 33.87 (5.95) and 9.71 (4.90) years, respectively. Additionally, the minimum and maximum age of the workers were 23 and 50 years, respectively, and the median of the equivalent sound level was equal to 87

(7). Table 1 provides the results of demographic variables.

Based on data in Table 1, 14 workers (21.5%) were on one shift and 51 (78.5%) of them had shift work. Furthermore, 20 workers (31.74%) had more than 10 years of work experience. In this study, the mean (\pm SD) of communication skills was 101.29 (13.26). In this study, 50.8% of people reported high communication skills and 49.2% reported moderate communication skills. Further, the mean (\pm SD) of the cognitive triad was 138.08 (22.02). Table 2 presents the results of the study on the relationship between demographic variables and communication skills and cognitive triad.

The results of the independent sample *t*-test demonstrated that there was a significant relationship between age ($P=0.03$) and work shift ($P=0.002$) with the cognitive triad. The workers of shift work reported significantly higher scores in the three cognitive domains. Based on the findings, no significant relationship was found between demographic variables and communication skills.

In this study, the median of noise annoyance was equal to 7 (3). The Spearman correlation test was used to investigate the relationship between equivalent sound level and noise annoyance. The results of this test showed a significant relationship between equivalent sound level and annoyance ($P<0.001$, $r=0.82$). According to the results of the Spearman correlation test, no significant relationship was observed between noise annoyance with communication skills ($P=0.41$, $r=0.10$) and cognitive triad ($P=0.65$, $r=-0.05$).

In this study, the independent sample *t*-test was employed to compare communication skill and cognitive triad scores in the two groups. Tables 3 and 4 summarize the results of communication skills and cognitive triad in

Table 1. Frequency distribution of demographic variables (N=65)

Variable	Grouping	Frequency	Percent
Education status	Diploma	62	95.4
	Above the diploma	3	4.6
Marital status	Single	12	18.5
	Married	53	81.5
Age (years)	≤ 37	46	70.76
	> 37	19	29.24
Work experience (years)	≤ 10	43	68.26
	> 10	20	31.74
Shift work	One-shift	14	21.5
	Shift work'	51	78.5

Note. ' Morning-night.

Table 2. Investigating the relationship between communication skills and cognitive triad with demographic variables

Demographic variables		Communication skills		Cognitive triad	
		Mean \pm SD	P value	Mean \pm SD	P value
Marital status	Single	97.58 \pm 13.36	0.28	129.08 \pm 22.15	0.11
	Married	102.13 \pm 13.21		140.11 \pm 21.68	
Shift work	One-shift	98.79 \pm 10.70	0.07	122.64 \pm 22.02	0.002
	Shift work	102.80 \pm 13.58		142.31 \pm 20.24	
Work experience	\leq 10	100.26 \pm 13.43	0.18	138.44 \pm 21.87	0.70
	$>$ 10	105 \pm 12.33		136.25 \pm 20.33	
Age	\leq 37	100.30 \pm 13.64	0.33	141.70 \pm 21.67	0.03
	$>$ 37	103.68 \pm 12.29		129.32 \pm 20.87	

Table 3. Comparison of the communication skill score in the two groups

Variables	Noise permissible (n=29)	Noise impermissible (n=36)	P value
	Mean (\pm SD)	Mean (\pm SD)	
Listening skills	17.28 \pm 3.90	17.42 \pm 3.13	0.87
Understanding verbal and nonverbal messages	28.28 \pm 4.87	28.86 \pm 4.54	0.35
Insight to the communication process	14.69 \pm 3.23	15.75 \pm 2.29	0.17
Emotional regulations	24.76 \pm 5.36	24.94 \pm 3.62	0.06
Assertiveness	13.28 \pm 3.5	14.75 \pm 2.78	0.06
Total (communication skills)	98.28 \pm 16.17	103.72 \pm 9.92	0.11

Note. SD: Standard deviation.

Table 4. Comparison of the cognitive triad score in the two groups

Variables	Noise permissible (n=29)	Noise impermissible (n=36)	P value
	Mean (\pm SD)	Mean (\pm SD)	
View to the self	48.14 \pm 8.69	48.86 \pm 10.26	0.71
View to the world	40.14 \pm 5.89	42.14 \pm 6.36	0.19
View to the future	49.55 \pm 10.67	47.28 \pm 11.19	0.40
Total (cognitive triad)	137.83 \pm 21.66	131.28 \pm 22.61	0.93

Note. SD: Standard deviation.

the two groups.

The mean score of communication skills in the second group (noise impermissible) was slightly higher than in the first group (noise permissible); however, this difference was not significant. Additionally, the mean of the cognitive triad score in the first group (noise permissible) was slightly higher than the second group (noise impermissible), but this difference was not significant.

Discussion

So far, the auditory and cognitive effects of noise have been studied in various studies; nonetheless, no study has evaluated the effects of psychology. Therefore, the present study investigated the effect of noise exposure on communication and cognitive skills. In this study, the mean communication skills of workers were 101.29, indicating a medium situation. A significant and positive relationship was observed between noise exposure and noise annoyance. Communication skills and cognitive triad were not significantly different between the two groups.

In the study of Ebrahimnia et al, the mean communication skill among medical imaging unit personnel was 111.20 (29), which is slightly more than that of the present study. In another study by Norouzinia et al, the mean communication skill of academic members was calculated to be 123.93 (30). In this study, no significant relationship was found between communication skills and demographic variables. In the study of Banaee et al, there was no significant relationship between communication skills with age and marriage (31), which is consistent with the results of the present study. The results of Norouzinia et al showed no significant relationship between work experience and communication skills in academic members (30), which is in line with the results of the present study. However, Khedmatinejad et al reported a significant relationship between communication skills and work experience (32), which contradicts the results of the present study. It is predicted that contradictions in the results of different studies may be due to differences in the population. In this study, the workers of shift work, compared to those of one-shift work, had a more negative view of the self, world, and future. The results of Booker et

al demonstrated that shift work has a strong relationship with depression so that shift work is one of the important predictors of depression (33). Additionally, another study confirmed the relationship between depression and cognitive triad (34).

Based on the results of Monazzam Esmailpour et al, there was a significant relationship between noise exposure and noise annoyance (35), which corroborates the findings of the present study. Similarly, Ali found a significant and positive relationship between noise exposure and noise annoyance among workers in different jobs (36). Likewise, Paiva et al concluded that living in noisy areas was associated with a higher sense of annoyance (37). Despite the differences in the study population and noise type, this relationship has been confirmed by various studies.

In a study conducted in one of the mines, a significant relationship was observed between the level of noise exposure and the communication skills of workers (15), which does not match the results of the present study. Job stress is one of the factors that occurs as a result of noise exposure in the workplace and can affect communication skills (38). According to Le Prell, the communication of people, who lose their hearing due to noise exposure, with others decreases, leading to a decrease in communication skills (39). The results of Ghazavi et al showed a significant relationship between communication skills and stress and anxiety (40). The results of another study revealed that the effects of noise exposure were significantly related to sound frequency (41). Other variables affecting the consequence of noise exposure are personality traits and noise sensitivity. In addition, it was reported that noise sensitivity has the greatest effect on job stress (42). Moradi et al also reported that noise improves selective attention in extrovert students compared to introverts (43). In another study, the use of personal protective equipment directly affected workers' job stress (11). In general, evidence revealed that the characteristics of noise and the personality of people are effective in the consequences of noise exposure. Contradictory results can be due to the type of studied jobs, different noise sources, and various working conditions.

The worst and best views of workers were toward the future and the world, respectively. The results of Rostami et al demonstrated that the mean view of self, world, and future in the mothers of students in a school was 32.9, 41.26, and 34.84, respectively, representing a better perspective compared to the current study. In their study, the worst view was toward the world (44), which contradicts the results of the present study. Exposure to harmful factors in the workplace (e.g., noise) can upset the physical and mental balance of the person. In fact, the stress of the workplace can affect the quality of life and psychological factors (45). Considering the lack of similar work with psychology variables in the field of employees and workers, it was impossible to compare our results with those of similar studies.

To the best of our knowledge, this study is one of the first studies to investigate psychological variables in workers. Moreover, it also evaluated the impact of one of the most important harmful factors in the workplace. The current study has some limitations that may have affected the results, including the inability to examine changes in a cross-sectional study and non-investigate gender differences. This study was performed on workers in a mine in Yazd province. Therefore, to determine the subject, it is necessary to conduct more studies on different occupations with a larger sample size.

Conclusion

In this study, a positive and significant relationship was found between noise exposure and noise annoyance. Due to the significant effect of noise exposure on the feeling of annoyance, it is recommended to implement a hearing protection program in the workplace. Communication and cognitive skills were not significantly different in the two groups of the study. Given the lack of psychological studies on industrial and mining workers, it is suggested that a similar study be performed on other workers and its results be compared with those of the present study. Researchers in the future can conduct similar studies with larger sample sizes, taking into account variables such as personality traits and social intelligence. Considering that the psychological characteristics of individuals are affected by various factors, it is recommended that the role of various occupational factors such as lighting, heat stress, and job satisfaction be investigated in future studies. Finally, it is suggested that a study be conducted to evaluate the effect of ambient noises such as traffic noise on the general population.

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Authors' Contribution

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Supervision: Rohollah Fallah Madvari.

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Conflict of Interests

None.

Ethical Approval

The study protocol was approved by the Ethics Committee of Shahid Sadoughi University of Medical Sciences (IR.SSU.REC.1400.115). The conditions and objectives of the study were explained to the

workers, and all workers completed informed consent.

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