Research Article

Relationship among Noise Exposure, Noise Annoyance, Emotional Intelligence, and Cognitive Emotional Regulation: A Generalized Structural Equation Modeling

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Highlights

- Noise exposure is directly related to noise annoyance
- Noise exposure has an indirect relationship with EI through noise annoyance
- Noise exposure has an indirect relationship with CER

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ABSTRACT

Background and Aim: There is evidence of associations between noise exposure and psychological outcomes from noise annoyance. This study aims to examine the mediating role of noise annoyance in the relationship of noise exposure with Emotional Intelligence (EI) and Cognitive Emotion Regulation (CER).

Methods: This is a cross-sectional study that was conducted on 58 male workers of a lead mine in Yazd, Iran. Noise exposure was determined based on ISO 9612:2009. Noise annoyance was assessed using the ISO/TS 15666:2003's numerical rating scale. The Schutte Self-Report Emotional Intelligence Test (modified version) and the Cognitive Emotion Regulation Questionnaire (CERQ) were used for data collection. Mann-Whitney U test, correlation test, and Generalized Structural Equation Modeling (GSEM) were used to analyze the data.

Results: The mean age of workers was 35.78±7.10 years. A significant relationship was found between noise annoyance and noise exposure, such that a unit increase in noise exposure had a multiplicative effect on the odds of experiencing more annoyance ($p<0.001$). Also, for every one-unit increase in noise annoyance, mean scores for EI and CER decreased by 0.192 and 0.172, respectively.

Conclusion: Noise exposure is directly related to noise annoyance and indirectly related to EI and CER. Further studies in this area are recommended to clarify the issue and the relationships between these variables.

Keywords: Noise; noise exposure; emotional intelligence; cognitive psychology

Introduction

Noise is one of the harmful physical factors in the workplace. Noise pollution has been considered a common harmful hazard in industrial settings. Some reports have indicated that about 600 million workers worldwide are exposed to occupational noise. In the USA and European countries, about 50–60 million people work in environments with dangerous noise [1]. Noise pollution has different effects on human health, including auditory and non-auditory effects. Auditory effects include hazards such as hearing loss. About 16% of hearing loss cases are due to occupational noise exposure. Other hearing impairments are tinnitus and impaired speech perception. Non-auditory effects include stress, anxiety, mental disorders, cognitive and mood disorders, sleep disorders, and cardiovascular dysfunction. These effects can have different consequences. For example, stress can lead to anger, mood swings, and lack of concentration. Noise pollution can also affect performance, attention, and efficiency [2]. One of the most important negative consequences of noise exposure is noise annoyance. The results of various studies have shown a significant relationship between noise exposure and noise annoyance. Some studies have reported that noise annoyance can affect mental health components. Noise annoyance is associated with aggression, depression, psychosis, self-reported morbidity, morbid fear, and anxiety [1].

In any organization, paying attention to the physical and mental health of employees is of special importance, since it affects job performance and productivity. One of the factors affecting personal, social, and work aspects is intelligence. There are different types of intelligence, one of which is Emotional Intelligence (EI). It refers to the ability to manage the emotions of self and others and pose the ability to solve problems and control environmental conditions. EI is related to the cognitive and psychological performance of individuals and is also associated with depression, anxiety, despair, stress-induced intuition, job burnout, subjective well-being, way of coping with problems, self-confidence, creativity, sensitivity, and self-awareness [3]. EI can improve performance such as decision-making and problem-solving skills [4]. Cognitive Emotion Regulation (CER) strategies can help a person regulate emotions in the face of threatening events. The CER refers to a set of cognitive processes that affect how we treat others or emotional situations. It can help make decisions and improve job performance. The CER strategies are associated with mental disorders such as anxiety and depression [5].

The EI and CER can be related to cognitive abilities. In a study, an EI test's dimension of understanding emotions was able to significantly predict the composite score of a cognitive ability test [6]. Ghanbari et al. suggested that the CER can positively and negatively affect people's cognitive performance. For this reason, it is necessary to pay attention to this factor in work-related situations with high cognitive demand [7]. Another cognitive ability that is very important in work-related situations is decision-making. High EI can reduce decision-making difficulties such as lack of readiness, lack of information, and inconsistent information [8]. In addition, EI is related to career decision-making self-efficacy components such as the gathering of career information, problem-solving, and planning for the future [9].

Some professions, such as the control room operators, require high attention, accuracy, and concentration. In fact, cognitive and mental function is of particular importance in these occupations. As mentioned above, harmful occupational factors such as noise pollution can affect physical, mental and cognitive health of employees. The cognitive, mental, and physiological effects of noise exposure have been studied in various studies, but its effect on the EI and CER have been less investigated. Due to the effect of these factors on physical and mental health and cognitive function, the present study aimed to assess the relationships of noise exposure with EI and CER.

Methods

Study design and participants

This cross-sectional study was conducted on male workers of a lead mine in Yazd, Iran aged 22–50 years and a work experience more than 6 months. Individuals with a history of drug use for mental health problems, family problems, and congenital hearing impairment

were excluded from the study. Ten samples are needed for each parameter in the conceptual model [10]. In this study, due to some limitations, 58 eligible male workers entered the study. All workers participated in the study voluntarily and with informed consent.

Measures

Information such as age, work experience, education level, work shift, and marital status were surveyed using a demographic form. The noise exposure was determined based on ISO 9612:2009 using the sound analyzer (TES-1358 model). Calibration was performed before the measurement. According to the standard ISO 9612:2009, the sound meter was placed at a height of 1.5 meters. In working environments where the sound fluctuation is less than 5 dB, the measurement is done for 15 minutes. In working environments where the noise fluctuation is more than 5 dB, the measurement time is equal to the working time in that place. In working environments where the measurement is for 15 minutes, the mean of three different measurements is considered. With respect to the noise exposure and duration of exposure at each area, the 8-hour equivalent continuous A-weighted sound pressure level (LAeq,8h) was calculated for each individual [11]. The ISO/TS 15666: 2003's numerical rating scale was used to measure noise annoyance. This scale is from 0 to 100. High numbers indicate more annoyance (Figure 1). The validity and reliability of the Persian version of this scale were confirmed by Golmohammadi et al. [12].

The Schutte Self-Report Emotional Intelligence Test (modified version) was used to measure the EI of workers. It was designed by Schutte et al. [13]. It has 41 items rated on a 5-point Likert scale. The total score ranges from 41 to 205. Items 6, 8, 17, 22, 28, 31, 36, 39 and 40 are for the appraisal of emotions. items 2, 12, 15, 18, 21, 29, 30, 35, 37 and 38 are for regulation of emotions. Items 4, 9, 10, 23, 25, 26, and 34 are for utilization of emotions. The validity of the Persian version of this questionnaire has been confirmed [4].

The Cognitive Emotion Regulation Questionnaire (CERQ) was used to measure CER strategies, designed by Garnefski et al. [14]. This questionnaire has 36 items and 9 subscales. Scoring is based on a 5-point Likert scale. The subscales include: Putting into perspective, positive refocusing, positive reappraisal, acceptance, and refocus on planning (adaptive CER strategies) and self-blame, other-blame, rumination, catastrophizing (maladaptive CER strategies). The validity and reliability of the Persian version of CERQ have been confirmed in the study by Khosravani et al. They reported a Cronbach's alpha of 0.82 [15].

Statistical analysis

Mean, standard deviation, and frequency were used to describe the data. To check the normality of data distribution, the Kolmogorov-Smirnov test was used. To describe non-normal data, median and Interquartile Range (IQR) were used. Mann-Whitney U test, correlation test, and the Generalized Structural Equation Modeling (GSEM) were used to analyze the data in SPSS v.17 and Stata v.14. With GSEM, we can check the direct and indirect relationships between variables.

Results

The means of work experience and age in participants were 10.87±5.23 and 35.78±7.10 years, respectively. It was reported that 82% had a diploma or lower than high school education; 82% were married and 67.2% had shift work. The median and IQR of EI score, CER score, noise annoyance level, and noise exposure level are presented in Table 1. The factors of marital status, age, and work experience had no significant relationship with EI and CER scores. The results of the Mann-Whitney U test showed the significant relationship of EI with educational level (p=0.004) and shift work (p=0.002). The CER also had a significant relationship with educational level (p=0.008) and shift work (p=0.038) (Table 2).

It was found out that there is a positive and significant relationship between noise exposure and noise annoyance (p<0.001, r=0.693). The data analysis

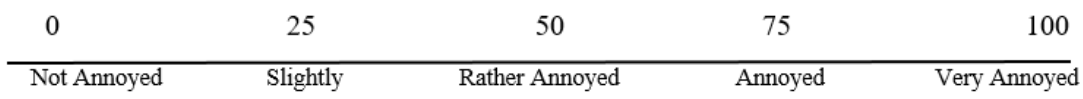


Figure 1. Noise annoyance scale (12)

Table 1. Median and interquartile range of emotional intelligence, emotional cognitive regulation, noise annoyance, and noise exposure

Variables	Median	IQR
EI	104.00	20.75
CER	105.50	34.25
Noise annoyance	75.00	50.00
Noise exposure	88.00	6.00

IQR; interquartile range, EI; emotional intelligence, CER; cognitive emotional regulation

Table 2. Relationship between emotional intelligence, emotional cognitive regulation with demographic variables

Demographic variables		EI			CER		
		Median	IQR	p	Median	IQR	p
Educational level	Diploma and lower	103.00	26.00	0.004	100.00	32.75	0.008
	Bachelor's degree	110.50	18.00		117.00	12.00	
Marital status	Married	104.00	19.25	0.928	105.50	35.00	0.727
	Single	105.00	33.50		106.00	22.00	
Shift work	No	109.00	19.00	0.002	116.00	14.00	0.038
	Yes	102.00	28.00		97.00	32.00	
Age (years)	≤37	103.50	16.25	0.871	103.00	34.00	0.416
	>37	106.00	29.00		113.00	37.00	
Work experience (years)	≤10	104.00	17.50	0.497	104.00	30.50	0.713
	>10	104.50	27.50		109.50	36.50	

EI; emotional intelligence, CER; cognitive emotional regulation, IQR; interquartile range

showed a significant relationship between EI and noise annoyance (p=0.009, r=–0.341) (Table 3). We also found a significant relationship between CER and noise annoyance (p=0.040, r=–0.270). Noise annoyance was associated with CERQ components of catastrophizing, other-blame, and acceptance (Table 4). To investigate the relationship among the study variables, GSEM was applied. Based on the findings, a significant relationship was observed between noise annoyance and noise exposure, such that, a unit increase in noise exposure had a multiplicative effect on experiencing noise annoyance (p<0.001). Furthermore, noise annoyance had a significant effect on EI (p=0.017) and CER (p=0.037). For every one-unit increase in noise annoyance, the mean score of EI and CER decreased by 0.192 and 0.172, respectively (Table 5). The GSEM model and the related path coefficients are shown in Figure 2. As can be seen, noise exposure is directly related to noise annoyance, while the noise exposure is indirectly related to EI and CER through noise annoyance.

Discussion

In most previous studies, the cognitive and mental effects of noise exposure were investigated. This study aimed to investigate the psychological effects of noise exposure and assess the mediating role of noise annoyance in the relationship of noise exposure with EI and CER. The results showed that increased noise annoyance in participants (workers of a lead mine) was associated with decreased EI and CER. Therefore, the research hypothesis that states noise annoyance affects EI and CER is confirmed.

Table 3. The relationship between noise annoyance with emotional intelligence and its components

Variables	Noise annoyance	
	Correlation coefficient	p
Appraisal of emotions	–0.473	<0.001
Regulation of emotions	–0.082	0.541
Utilization of emotion	–0.349	0.007
Total	–0.341	0.009

Table 4. The relationship between noise annoyance with cognitive emotional regulation and its components

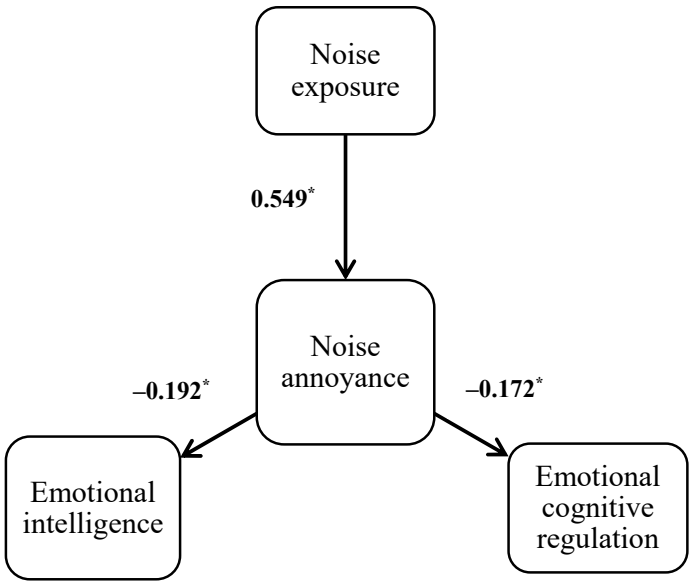
Variables	Noise annoyance	
	Correlation coefficient	p
Self-blame	–0.241	0.069
Rumination	–0.148	0.268
Catastrophizing	–0.452	<0.001
Other-blame	–0.419	0.001
Acceptance	–0.332	0.011
Positive refocusing	–0.118	0.376
Refocus on planning	0.038	0.775
Putting into perspective	–0.121	0.365
Positive reappraisal	–0.064	0.635
Total	–0.270	0.040

Table 5. Results of the generalized structural equation modeling in investigating the relation between noise exposure, noise annoyance, emotional intelligence, and emotional cognitive regulation

Path	Coefficient	Standard error	p
Noise exposure ->Noise annoyance	0.549	0.111	<0.001
Noise annoyance ->EI	–0.192	0.080	0.017
Noise annoyance ->CER	–0.172	0.082	0.037

EI; emotional intelligence, CER; cognitive emotional regulation

In this study, increased noise exposure was associated with increased noise annoyance. This finding is consistent with the results of Wang et al., who reported that increased noise was associated with increased annoyance in anesthesiologists [16]. In another study, living in noisy areas was significantly associated with annoyance [17]. Ali investigated the noise annoyance of workers in different industrial sites and found out that industrial noise level was associated with noise annoyance. He reported that with the increase of noise by 73–100 dB, the percentage of annoyed people highly increased [18]. Despite the differences in noise



* Significant path coefficients

Figure 2. Conceptual model of the study.

sources, the study population, and working conditions, our results regarding the relationship between noise exposure and annoyance are consistent with the results of these studies.

Our findings also showed that noise exposure affected EI and CER through noise annoyance. Studies have shown that noise annoyance predicts psychological consequences. This relationship was also confirmed in a longitudinal study [19]. Eze et al. found that aircraft and road traffic noise exposure caused depression in the general population through annoyance [20]. The results of a study by Stansfeld et al. showed that annoyance did not moderate the relationship between traffic noise exposure and heart disease [19]. The reason for the lack of relationship in their study can be due to the measurement of physiological consequences. Dzhambov et al. found that noise affects social cohesion and mental health through annoyance. In their study, higher noise annoyance was associated with lower social cohesion and poor mental health [21].

According to studies, the mental consequences of noise exposure can due to psychological changes in individuals. For example, studies have confirmed the negative effects of noise exposure on stress and anxiety [22]. On the other hand, Le Prell and Clavier reported that noise-induced hearing loss affects people's communication skills and reduces their interactions with others [23]. Decreased communication skills and social interaction affect people's stress and anxiety levels [24]. Erdem et al. found that social cohesion was associated with psychological distress such that higher social cohesion was associated with lower psychological distress [25]. In this regard, it can be said that communication skills are one of the mediators of the relationship between noise exposure and psychological disorders such as stress and mental distress. Neural changes caused by noise exposure can affect the occurrence of psychological disorders. Noise annoyance and negative emotions caused by noise exposure can affect the nervous system and Hypothalamic-Pituitary-Adrenal function and, thus, cause psychological disorders such as depression [26]. Noise exposure can also increase the secretion of stress hormone and lead to mental disorders [27].

In this study, the negative effect of noise exposure on EI and CER was confirmed. Partido and Owen found that higher EI level was effective in reducing stress and burnout in dental students. Their results also showed that the components of EI predicted stress [28]. In another study, a negative relationship was found between EI and empathic personal distress

[29]. In Lewis et al.'s study, higher EI in nurses was associated with higher psychological and physical well-being [30]. Moeller et al. found that improving EI in students is effective in reducing the perceived rejection and improving their well-being [31]. The relationship between emotion regulation and mental health was also confirmed in the study by Peh et al [32]. Easazadeh found a significant negative relationship between CER and burnout in nurses [33]. Amirifard et al. found that EI mediated anxiety and depression in cancer patients such that with the increase of EI, the depression and anxiety of patients decreased [34]. Psychological factors such as EI are not independent of difficult living and working conditions [35]. It is believed that emotional empowerment and adaptation to social challenges and problems can play an important role in mental health, social functioning, and general Health [34]. Thus, they act as mediators of the relationship between noise exposure and psychological consequences. Factors such as neurological and hormonal changes, personality traits, job satisfaction, family conditions, and work environment are expected to affect the auditory and non-auditory effects of noise exposure. Determining the role of mediators and their contribution level requires further studies.

In addition to mental health, EI is related to cognitive performance. In the study by Pardeller et al., a positive and significant relationship was found between the EI dimension of understanding emotions and the cognitive dimensions of verbal memory, verbal fluency, and symbol coding. Also, the EI dimension of understanding emotions was able to significantly predict the composite score of a cognitive ability test [6]. The results of Santos et al. showed a negative relationship between EI and decision-making difficulties [8]. The results of another study showed that EI was significantly related to career decision-making self-efficacy [9].

In our study, data analysis was performed using the generalized structural equation modeling. In some other studies, a simple regression analysis has been used and indirect paths have not been considered. Despite this advantage, the study had some limitations. The sample size was small and the participants were male workers from a lead mine in Yazd, Iran, which make use cautious to generalize the results. It is also difficult to infer causality in cross-sectional studies. No definite conclusions can be made about the mediating role of noise annoyance in the relationship of noise exposure with EI and CER, because these results may not be confirmed in a longitudinal study. Also, it should be mentioned that we had no knowledge of the noise exposure level of workers in their spare time at home.

Conclusion

Higher noise exposure is indirectly associated with lower Emotional Intelligence (EI) and Cognitive-Emotion Regulation (CER). Noise annoyance has a direct effect on EI and CER. Noise annoyance is also associated with noise exposure. In order to confirm and clarify the exact relationships between the variables, it is recommended that further studies with larger sample sizes be carried out in other industrial sites.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the ethics committee of Shahid Sadoughi University of Medical Sciences (code: IR.SSU.SPH.REC.1400.051).

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Authors' contributions

RFM: Study design, interpretation, writing; AA: Writing and data collection; RS: Data analysis and writing; FL and HB: Data collection and editing; MJN: Interpretation, writing, and supervision.

Conflict of interest

The authors declare no conflict of interest.

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