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Original Article

The Relationship Between Noise Sensitivity, Noise Annoyance, and Resilience Among Employees Working in Open-Plan Offices of State Banks in Birjand, Iran

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Abstract

Background: Noise pollution is one of the most significant hazards in occupational environments, affecting not only auditory health but also mental well-being and overall quality of life. This study aimed to examine the relationship between noise sensitivity, perceived noise annoyance, and resilience among employees working in open-plan office settings of state-owned banks in Birjand, Iran.

Methods: This descriptive-analytical cross-sectional study was conducted in branches of state banks in Birjand. Participants were selected through convenience sampling. The equivalent continuous sound level was measured in accordance with ISO 9612 using a CEL 450 device, and frequency analysis was performed to calculate the preferred noise index and speech interference level. Data from 96 employees were collected using demographic questionnaires, the Noise Sensitivity Scale, the Resilience Scale, and the ISO 15666 Noise Annoyance Scale. The collected data were analyzed using SPSS-19 software.

Results: The mean indoor exposure noise level was 61.45 ± 2.98 dBA, and the mean outdoor noise level was 65 ± 6.28 dBA. Based on frequency analysis, the dominant frequency in the work environment was identified as 500 Hz. The speech interference level during bank operating hours was calculated at 57.77 dBA. The mean noise sensitivity score was 64.04 ± 12.73, and the mean resilience score was 69.79 ± 12.58. A total of 91 participants (94.8%) were classified as having "resilience." A significant inverse correlation was found between resilience and noise sensitivity (r = –0.287, P = 0.025), as well as between resilience and noise annoyance (r = –0.277, P = 0.028).

Conclusion: The findings suggest that noise sensitivity may be a contributing factor in reducing psychological resilience and that experiencing noise annoyance further exacerbates this sensitivity. These associations underscore the importance of considering environmental factors in promoting mental health. The lack of correlation with demographic characteristics highlights the independent role of these variables.

Keywords: Open-plan offices, Equivalent noise level, Noise sensitivity and annoyance, Resilience

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Introduction

Noise pollution is widely recognized today as one of the major factors affecting human quality of life across the globe (1). Exposure to noise levels exceeding 85 dB can lead to biochemical, biological, and psychological effects on the human body (2). These effects include cardiovascular diseases, respiratory disorders, elevated blood pressure, stimulation of gastrointestinal activity, speech disturbances, sensations of pressure in the head and eyelids, and tinnitus. Moreover, psychological and behavioral consequences, such as irritability and distress, annoyance, stress, cognitive impairment, fatigue, difficulty concentrating, and feelings of loneliness, are well-documented outcomes of noise exposure (3–9).

Noise sensitivity is a stable personality trait that can play an important role in individuals' resilience when exposed to noise pollution (10, 11). Research has shown that personality characteristics influence resilience levels, and resilience is associated with a reduction in psychological problems such as anxiety and depression, as well as an

increase in psychological well-being (12). Furthermore, modernization and distancing from traditional lifestyles, together with declining tolerance for challenging conditions, have led to decreased hope and increased psychological issues, including anxiety and depression. In this context, resilience, defined as the ability to positively adapt to life's adversities and stressors, plays a vital role in maintaining mental health and coping with environmental pressures (13).

Noise sensitivity tends to remain stable across various levels of exposure and is widely regarded as a strong predictor of noise annoyance (14, 15). Findings from a 2010 study by Shepherd et al demonstrated that individuals differ in their sensitivity to noise, and that higher noise sensitivity is associated with poorer physical health, reduced quality of life, greater annoyance, and increased sleep disturbances (16).

Banks, as key components of a nation's economic system, play a critical role in driving economic development or contributing to economic stagnation. Optimal performance by bank employees is essential to achieving organizational goals and improving the country's economic conditions (17). Banking environments are typically designed as open-plan offices, where employee-customer interactions occur face-to-face and through verbal communication (18). Providing financial services requires high levels of cognitive activity and sustained concentration, yet bank employees are simultaneously exposed to noise pollution originating from both internal and external sources. Such exposure can disrupt cognitive processes and ultimately reduce job productivity (19, 20).

Assessing resilience and identifying its components, especially through evaluating individuals' stability in the face of harmful or threat-inducing conditions, can play an important role in improving performance and enhancing bank employees' adaptive capacity when confronting occupational challenges and crises (17, 21). In a study by Nezami et al the primary sources of noise in bank environments were identified as conversations between employees and customers, queue announcement loudspeakers, heating and cooling systems, and traffic noise outside the building (19).

Given the nature of banking occupations, characterized by high workload, the need for substantial accuracy and concentration, and continuous exposure to noise pollution, examining the potential effects of these exposures and the role of noise sensitivity on employees' resilience is of particular importance. Accordingly, the present study sought to examine the role of noise sensitivity in the resilience of employees working in open-plan offices in state-owned banks in Birjand.

Materials and Methods

Study Design

This descriptive-analytical, cross-sectional study was conducted in 2018 among employees of state-owned banks in Birjand. The study population consisted of all staff working in the state-owned banks of the city. The sample size, calculated using the formula for estimating means and based on a similar study (19), was determined to be 96 participants. Convenience sampling was employed. Inclusion criteria consisted of full-time employment at one of the state-owned bank branches in Birjand at the time of the study, and having at least one year of work experience in the banking system. Individuals who were unwilling to participate or had less than one year of work experience were excluded from the study.

For data collection, the researcher visited various branches of state-owned banks in person and invited employees who met the inclusion criteria and expressed willingness to participate. To minimize bias inherent in convenience sampling, efforts were made to include branches from different urban areas and to ensure demographic diversity in terms of age, gender, and work experience to the extent possible.

In this study, the main dependent variable was *resilience*, defined as an individual's ability to cope with psychological stress, adapt to challenging circumstances, and return to previous or higher levels of functioning following a crisis. This construct was defined based on the perspectives of Connor and Davidson and measured using the Connor-Davidson Resilience Scale (CD-RISC).

The main independent variables were noise sensitivity and noise annoyance. Noise sensitivity was defined as the degree of an individual's mental and emotional reactivity to environmental sounds, whereas noise annoyance referred to the level of unpleasantness and discomfort experienced in response to environmental noise. Besides, demographic variables such as age (years), gender (male/female), marital status (single/married/other), education level (high school diploma/associate's, bachelor's, above bachelor's), work experience (years), and sound level (in decibels) were considered independent variables in the statistical analyses.

Measures

The first phase of this study involved measuring and evaluating the noise level in the selected banks and conducting a frequency analysis of the environment in accordance with ISO 9612. Noise measurements were performed using the advanced sound level meter CEL-450. Based on preliminary environmental assessments, the duration of each measurement was set at 30 minutes, and measurements were conducted between 10:00 and 12:00 a.m., corresponding to peak customer traffic hours.

Noise exposure was calculated using the Equivalent Noise Level (L_{eq}). Before each measurement session, the sound level meter was calibrated using a standard acoustic calibrator to ensure the accuracy of the readings.

Subsequently, the Speech Interference Level (SIL) was

calculated based on the average sound pressure level within the critical speech frequency bands (500, 1000, 2000, and 4000 Hz) using the following formula:

$$SIL = \frac{(L_{500} + L_{1000} + L_{2000} + L_{4000})}{4}$$

This index is used to assess the extent to which environmental noise interferes with speech perception in workspaces and public environments (22).

In the second phase of the study, following the completion of noise measurements (10:00–12:00), the employees were asked between 12:00 and 14:00, after ensuring confidentiality and obtaining informed consent, to complete standardized questionnaires on demographic characteristics, noise sensitivity, and resilience.

The Weinstein Noise Sensitivity Scale consists of 21 items across four subscales: sensitivity to noise (10 items), disruption of concentration (6 items), attitudes toward noise in the living environment (5 items), and attitudes toward noise control (6 items). Responses were recorded through a six-point Likert scale ranging from "strongly agree" to "strongly disagree," using self-report. Scoring ranged from 0 to 5, and several items were reverse-scored. The total score, ranging from 0 to 105, reflects overall noise sensitivity with higher scores indicating greater sensitivity to noise. The validity and reliability of this instrument were confirmed in a study by Alimohammadi et al with a reported Cronbach's alpha of 0.78 (23).

Noise annoyance was assessed based on the Acoustic Annoyance Assessment Scale (social–acoustic survey) in accordance with ISO 15666 (24). This scale ranges from 0 to 10, where 0 indicates no annoyance and 10 indicates extreme annoyance. Employee responses within the ranges 0–2, 2–4, 4–6, 6–8, and 8–10 correspond to no annoyance, mild annoyance, moderate annoyance, high annoyance, and extreme annoyance, respectively.

Resilience was measured using the Connor–Davidson Resilience Scale (CD-RISC). This 25-item instrument assesses the construct of resilience on a five-point Likert scale ranging from 0 (not true at all) to 4 (always true). The total score ranges from 0 to 100, with higher scores representing greater resilience. Using the cutoff point of 50, scores above 50 indicate resilient individuals. The scale was standardized and its reliability confirmed in Iran by Mohammadi (25).

Data Analysis

The collected data were entered into SPSS software version 19. In the first stage, descriptive statistics, including mean, standard deviation, frequency, and percentage, were calculated to describe demographic characteristics and the main research variables. To assess the normality of data distribution, the Kolmogorov–Smirnov test was employed. If the data demonstrated a normal distribution, statistical analyses of the relationships between variables were performed using one-way analysis of variance (ANOVA), the independent samples t-test, and the Pearson correlation coefficient.

Ethical Considerations

This study was conducted after obtaining approval from the Student Research Committee of Birjand University of Medical Sciences under the ethics code IR.BUMS.REC.1398.279. All participants were provided with full information regarding the study objectives, confidentiality of data, and their right to withdraw at any stage. Participation proceeded only after obtaining written informed consent.

Results

Demographic Characteristics of Participants

This study was conducted on bank employees in Birjand, with a mean age of 39.69 ± 6.45 years. Of all participants, 80 individuals (83.3%) were male, and 16 (16.7%) were female. In addition, 93 participants (96.9%) were married, and 44 individuals (45.8%) held a bachelor's degree (Table 1).

Environmental Acoustic Indicators

The mean indoor noise level measured inside the banks was 61.45 ± 2.98 dBA, while the mean outdoor noise level was 65 ± 6.28 dBA. The maximum and minimum noise levels inside the sampled banks were 72.74 dBA and 52.07 dBA, respectively. The noise levels, both indoors and outdoors, exceeded the permissible standard limits (40 dBA indoors and 60 dBA outdoors) (19, 20). The dominant frequency in the work environment was 500 Hz, and the Speech Interference Level (SIL) was determined to be 57.77 dBA (Table 2).

Noise Sensitivity and Noise Annoyance

The mean score of noise sensitivity (range 0–105) among the participants was 64.04 ± 12.73. The mean overall noise annoyance score in this study was 4.51 ± 1.69. Based on these findings, only 8.3% of individuals reported no noise annoyance. The level of noise annoyance was moderate among the majority of participants (46.0%), while 12.5% reported high annoyance and 1.4% reported extreme annoyance (Table 1). Analytical results showed that the mean noise annoyance score was significantly higher among individuals with lower income. Gender, marital status, education level, and residential status were not associated with noise annoyance (Table 3).

Environmental noise indicators, including SIL and L_{eq}, showed no significant association with noise sensitivity. However, SIL demonstrated a significant inverse correlation with noise annoyance ($r = -0.254$, $P = 0.014$). Moreover, a significant direct correlation was observed between noise sensitivity and noise annoyance (Table 4).

Table 1. Demographic Characteristics of Bank Employees

Variable	Categories	Value / Frequency (%)
Total number of participants		96 (100)
Gender	Male	80 (83.3)
	Female	16 (16.7)
Work experience (years) – Mean ± SD		16.90 ± 2.82
Age – Mean ± SD		39.69 ± 6.45
Education level	High school diploma	17 (17.7)
	Associate's degree	9 (9.4)
	Bachelor's degree	44 (45.8)
	Master's degree	26 (27.1)
Marital status	Married	93 (96.9)
	Single	3 (3.1)
Housing status	Owner-occupied	84 (87.5)
	Rented	12 (4.6)
Income (million tomans/month)	<2	4 (4.16)
	2–5	10 (10.43)
	>5	82 (85.41)
Sleep quality	Very good	8 (8.3)
	Good	39 (40.06)
	Average	36 (37.5)
	Poor	12 (12.5)
	Very poor	1 (1.0)
Feeling of fatigue	Yes	53 (55.21)
	No	43 (44.79)
Noise sensitivity – Mean ± SD		64.04 ± 12.73
Resilience – Mean ± SD		69.79 ± 12.58
Noise annoyance – Mean ± SD		4.51 ± 1.69
Individuals classified as resilient	Yes	91 (94.8)
	No	5 (5.2)
Noise annoyance level	No annoyance	8 (8.3)
	Mild annoyance	28 (29.1)
	Moderate annoyance	44 (46.0)
	High annoyance	12 (12.5)
	Extreme annoyance	4 (4.1)

Table 2. Environmental Acoustic Indicators Measured in Open-Plan Bank Offices

Variable	Mean ± SD	MAX	MIN
Indoor noise level (dBA)	61.45 ± 2.98	72.74	52.07
Outdoor noise level (dBA)	65.00 ± 6.28	–	–
Dominant frequency	500 Hz	–	–
Speech Interference Level (SIL)	57.77 dBA	–	–

Table 3. Comparison of Mean Psychophysiological Non-Auditory Effect (Noise Annoyance) by Demographic Variables

	Demographic Variable	Noise Annoyance (Mean ± SD)	Sig.
Gender	Male	4.41 ± 1.65	0.198
	Female	5.00 ± 1.59	
Marital status	Married	4.53 ± 1.70	0.396
	Single	3.67 ± 1.15	
Education level	High school diploma	5.06 ± 1.84	0.419
	Associate's degree	4.50 ± 0.926	
	Bachelor's degree	4.51 ± 1.69	
	Master's degree	4.15 ± 1.75	
Income (million tomans/month)	<2	6.50 ± 1.91	0.048*
	2–5	4.42 ± 1.66	
	>5	4.22 ± 1.48	
Housing status	Owner-occupied	4.56 ± 1.70	0.390
	Rented	4.09 ± 1.64	
Sleep quality	Very good	5.38 ± 1.06	0.155
	Good	4.39 ± 1.71	
	Average	4.56 ± 1.65	
	Poor	4.42 ± 1.83	
Feeling of fatigue	Yes	4.55 ± 1.65	0.786
	No	4.45 ± 1.75	
	Total	4.51 ± 1.69	

*Statistically significant at $P < 0.05$

Resilience

Data revealed that the mean resilience score of bank employees in Birjand was 69.79 ± 12.58, and 91 participants (94.8%) were classified as "resilient" (Table 1). None of the demographic variables showed a significant association with resilience (Table 5). A significant inverse correlation was found between resilience and noise sensitivity (r = –0.287, $P = 0.025$), as well as between resilience and noise annoyance (r = –0.277, $P = 0.028$) (Table 4).

Discussion

The present study was conducted in state bank offices in Birjand. Data collected from 96 bank employees indicated that the mean scores for noise sensitivity and resilience were 64.04 ± 12.73 and 69.79 ± 12.58, respectively. More than 94% of participants, based on standard criteria, were classified as "resilient." Measurements of noise levels inside and outside the banks showed that the sound levels exceeded the recommended standards. However, equivalent noise levels did not show a significant association with either noise sensitivity or resilience. Statistical analyses indicated that noise annoyance was significantly associated with monthly income. Furthermore, a significant inverse relationship was observed between noise sensitivity and resilience, such that individuals with lower noise sensitivity exhibited higher resilience. Noise annoyance also showed significant associations with both noise sensitivity and resilience.

The results of this study revealed that indoor noise exposure in banks exceeded the recommended threshold of 40 dBA, a finding consistent with the results of the study by Gholami et al (20) and Nezami et al (19) in banks

Table 4. Correlation between Noise Annoyance, Noise Sensitivity, Psychological Resilience, and Environmental Acoustic Indicators (L_{eq} and SIL)

Variable	Noise Annoyance	Noise Sensitivity	Resilience
Noise Annoyance	1	–	–
Noise Sensitivity	r = 0.364, P = 0.001*	1	–
Resilience	r = –0.277, P = 0.028*	r = –0.287, P = 0.025*	1
Noise level (L_{eq})	r = –0.058, P = 0.581	r = –0.048, P = 0.977	r = 0.010, P = 0.920
SIL	r = –0.254, P = 0.014*	r = –0.052, P = 0.613	r = –0.009, P = 0.931

*Significant at $P < 0.05$

Table 5. Comparison of Mean and Standard Deviation of Resilience Scores by Demographic Variables (ANOVA / t-test)

Demographic Variable		Resilience (Mean ± SD)	Sig.
Gender	Male	70.81 ± 12.11	0.075
	Female	64.68 ± 13.98	
Marital status	Married	69.69 ± 12.7	0.690
	Single	72.66 ± 9.07	
Educational level	High school diploma	72.58 ± 12.67	0.766
	Associate's degree	69.10 ± 10.23	
	Bachelor's degree	68.77 ± 12.94	
	Master's degree	69.96 ± 13.01	
Employment type	Permanent	70.87 ± 12.66	0.156
	Contractual	58.00 ± 11.53	
	Temporary	64.75 ± 10.60	
	Company-based	62.50 ± 0.70	
Monthly income (million tomans)	< 2	60.25 ± 6.89	0.282
	2–5	70.09 ± 13.26	
	> 5	71.77 ± 7.22	
Housing status	Owner-occupied	69.45 ± 12.52	0.487
	Rented	72.16 ± 13.29	
Total		69.79 ± 12.58	

in Hamedan. Moreover, the equivalent noise level outside the banks exceeded the permissible limit of 60 dBA, which is also in agreement with the findings reported by Gholami et al (20). Besides, Takaykhah, in his study in Sanandaj, reported an average equivalent noise level of 71.6 dBA across all measurement stations, exceeding the permissible limit (26).

Comparison of mean noise sensitivity scores across demographic variables did not reveal statistically significant differences, although the mean score was slightly higher among women. In contrast, a study by Derakhshan et al reported that women were more affected by low-frequency noise than men (27). Similarly, Aniansson et al found that women exhibited higher noise sensitivity compared to men (28), which is inconsistent with the present findings. Education level also did not show a significant effect on noise sensitivity among the participants. This contrasts with a study by Abolhasannejad et al reporting a significant association between individuals' attitudes toward noise control and their education level (29). The discrepancy may be attributed to differences in the study populations and the range of education levels in the two studies.

The results of the present study showed that 94.8% of employees exhibited optimal resilience. Although men displayed slightly higher resilience than women, no statistically significant difference was observed between genders. This finding aligns with the results of studies by Moumeni and Hartman (30, 31). However, in a study by Aldora, men demonstrated higher adaptability and resilience compared to women (32). Resilience scores were not significantly associated with employees' employment type. In contrast, Modabernezhad et al's study on employed personnel reported higher resilience among permanent employees, which was attributed to greater job security and available resources (33).

The analysis revealed a significant relationship between noise sensitivity and resilience, indicating that individuals with higher noise sensitivity demonstrated lower tolerance and resilience. Similarly, Cao et al reported a negative correlation between noise sensitivity and psychological resilience (34), consistent with the present findings.

The findings of the present study also indicated that noise levels were not significantly associated with noise annoyance. This contrasts with the results reported by Fallah Madvari et al (35). Such discrepancies may be due to differences in individual personality traits, which influence subjective responses such as perceived annoyance and the psychological perception of sound intensity (35).

Furthermore, the findings indicated a significant relationship between noise annoyance and noise sensitivity. This result is expected, as individuals with higher sensitivity tend to perceive environmental sounds as more disturbing. Similarly, the study by Öhrström et al reported an association between noise annoyance and noise sensitivity (36). Based on the findings of the present study, it can be concluded that in noisy work environments such as banks, human resource management should consider not only the control of noise levels but also the individual characteristics of employees. In particular, during recruitment or retention processes, assessing noise sensitivity and resilience may serve as a useful tool to prevent long-term declines in productivity and psychological problems. Furthermore, interventions such as soundproofing, stress-coping skills training, and resilience-enhancement programs may play a crucial

role in mitigating the psychological consequences of noise exposure.

Considering that every study has limitations, the present study is no exception. Some psychological factors influencing resilience, such as occupational stress, job satisfaction, and social support, were not examined. Since these variables may act as mediators in the relationship between noise sensitivity and resilience, future studies should adopt a more comprehensive approach and incorporate these factors into the research design. Such studies could provide a more complete understanding of the psychological mechanisms related to noise exposure and facilitate the development of more effective strategies for promoting mental health in noisy work environments.

Conclusion

The results of this study demonstrated that the noise levels inside and outside banks are substantially higher than the recommended standards, placing employees in these occupations at risk of exposure to excessive noise. Based on these findings, it is recommended that in selecting personnel for positions in banks and open-plan administrative environments, both noise sensitivity and resilience to noise exposure be considered. Moreover, implementing measures such as soundproofing, reducing environmental noise, assessing noise sensitivity during recruitment, and providing training programs can play a significant role in improving workplace quality, enhancing job satisfaction, and increasing productivity.

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Competing Interests

The authors declared no conflicts of interest in this study.

Ethical Approval

This study was derived from a registered student research project (Ethics Code: IR.BUMS.REC.1398.279) approved by the Deputy for Research and Technology of Birjand University of Medical Sciences. All ethical considerations in conducting this research were fully observed.

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