

# The Relationship Between Harmful Noise and Cognitive Component

**Hadi Alimoradi**

Shahid Sadoughi University of Medical Sciences and Health Services: Shahid Sadoughi University of Medical Sciences and Health Services

**Rohollah Fallah Madaveri**

Shahid Beheshti University of Medical Sciences School of Public Health and Safety

**Mahsa Nazari** (✉ [nazarimahsa95@yahoo.com](mailto:nazarimahsa95@yahoo.com))

Shahid Sadoughi University of Medical Sciences and Health Services <https://orcid.org/0000-0003-3224-7051>

**Mohammad javad zare sakhvidi**

Shahid Sadoughi University of Medical Sciences and Health Services Yazd Research and Clinical Centre for Infertility

**Reza Jafari Nodoushan**

Shahid Sadoughi University of Medical Sciences and Health Services: Shahid Sadoughi University of Medical Sciences and Health Services

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## Research

**Keywords:** Measurement of noise, ISO9612, noise, anxiety, stress, depression

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## **The relationship between harmful noise and cognitive component**

### **Abstract**

Objective & Aim: People who are exposed to noise on a daily basis, exposure to this risk factor as a physical stressor can have immediate and delayed detrimental effects on concentration, attention, high blood pressure, and so on. Method: The present study examines a set of cognitive factors to assess negative emotional states in depression, anxiety, and stress in a noisy work environment. This case study was performed on 1000 workers of Isfahan Steel Industry. ISO9612 (2009) standard and K&B sound level meter were used to measure the noise pressure level. At the same time, the DASS questionnaire was used to measure the severity of the symptoms of depression, anxiety, and stress. results: Based on the findings of the study, the age factor on depression, the marital status factor on anxiety and the work shift factor showed a significant effect on employee stress ( $p < 0.05$ ). There was no significant difference in anxiety and depression variables between the case and control groups ( $p > 0.05$ ). Conclusion: Due to significant positive relationship between the level of intensity and stress in case it is necessary to effective preventive measures to prevent psychological trauma and protect the health of workers in this industry are necessary.

**Keywords: Measurement of noise, ISO9612, noise, anxiety, stress, depression**

## Introduction

Noise is one of the most important harmful physical factors in the workplace in developed and developing countries<sup>3</sup>. In other words, noise is an unwanted noise that is considered to be the most common source of environmental and occupational stress<sup>40</sup>. In fact, noise has been identified as one of the most important causes of occupational diseases and also the second leading cause of occupational injuries in the workplace<sup>18, 22</sup>. In recent years, noise pollution is one of the factors affecting the quality of life around the world<sup>14, 34</sup>. According to the World Health Organization (WHO), psychological disorders caused by noise have adverse effects on the quality of life associated with health. Today, noise pollution is one of the most important environmental and health aspects. From a health point of view, noise pollution, in addition to creating a variety of physiological effects, leads to psychiatric and psychological disorders<sup>8, 28</sup>. The physiological and psychological effects of noise exposure on humans often appear gradually and in the long run have negative psychological consequences, including aggressive behavior, physical-mental fatigue, stress, dizziness, headache, anger, distraction, sleep disturbance, and decreased productivity<sup>29, 38</sup>. There is no doubt that noise is one of the main problems in the industrial world, and a large number of people in the workplace are at risk from the harmful effects of it<sup>12, 25, 31</sup>. Nearly a third of people over the age of 65 suffer from hearing loss, and if left untreated, treatment is likely to increase in the coming years<sup>30</sup>. The hearing loss caused by noise in the world, for various reasons in the past two decades has increased from 120 to 466 million<sup>4</sup>. According to the statistics published by WHO, in 2018, the number of people with hearing loss will reach more than 900 million by 2050<sup>6, 13</sup>. The effects of noise in humans are not limited to hearing loss, but include physical and physiological stress, increased heart rate and respiration rate, overactive thyroid gland, premature fatigue, and decreased productivity<sup>7</sup>. The physiological and psychological effects of noise exposure on humans do not appear quickly and usually appear gradually, and in the long run can have negative psychological effects, including aggressive behavior, physical and mental fatigue, stress, dizziness, headache, anger, distraction, sleep disturbance, and increased sleep. Systolic and diastolic blood pressure determine the reduction in work efficiency<sup>19, 24</sup>. Noise also affects the components of cognitive function, and the slightest delay in a person's response to work can lead to accidents and irreparable risks<sup>5, 24</sup>. The major psychological disorders caused by noise include anxiety, stress, restlessness, sleep disturbances, and impaired mental function and information processing (stimulus identification, response selection, and response planning)<sup>1</sup>. Depression and anxiety are directly related to each other, and often these two disorders are experienced together for individuals<sup>15</sup>. But there is a significant difference between stress and anxiety because stress is a reaction to a threat, and anxiety is a response to stress<sup>36</sup>. Therefore, according to the above, if a person is exposed to noise above the permissible level (85dB) for a long time, he will most likely suffer from discomfort or depression in the work environment<sup>27</sup>.

One of the valid scales for measuring the main symptoms of depression, anxiety and stress is the DASS scale, which is a set of three self-reporting scales for assessing negative emotional states in depression, anxiety and stress<sup>11, 21, 32</sup>. Due to the nature of the work, the steel industry has a high level of noise, and according to studies conducted in third world countries, there is more concern about the severity of industrial noise and its consequences<sup>2</sup>.

In the steel industry of equipment and certain systems such as pumps, compressors, furnaces, engines, systems air blower and cooling towers, channels and valves for gas and steam, electric arc furnace, fans used for ventilation and other equipment as the most important sources of noise<sup>9</sup>. This study is a large collection of Iranian steel industries with the aim of investigating the effect of noise on depression, stress and anxiety in general and in one place. In this study, all aspects of the DASS questionnaire were examined; in general, all three scales were studied simultaneously.

## Methods

This case study was performed in one of the steel industries with an area of more than 200 square kilometers, which is about 40% of Isfahan province. The sample size was calculated and selected using Cochran's formula with a alpha coefficient of 0.5 and a beta of 0.8 thousand (Formula 1). In this study, in the case group, 500 people with a voice above the permissible level (standard 85 decibels) were confronted, and in the control group, there was the same number of encounters with a voice below the permissible level.

**Formula 1** 
$$n = \frac{\frac{z^2 pq}{d^2}}{1 + \frac{1}{N} \left[ \frac{z^2 pq}{d^2} \right]}$$

n = sample size

N = statistical population size (city, province, etc. population size)

t or z = Percentage of standard error of acceptable reliability

p = A ratio of a population without a certain adjective

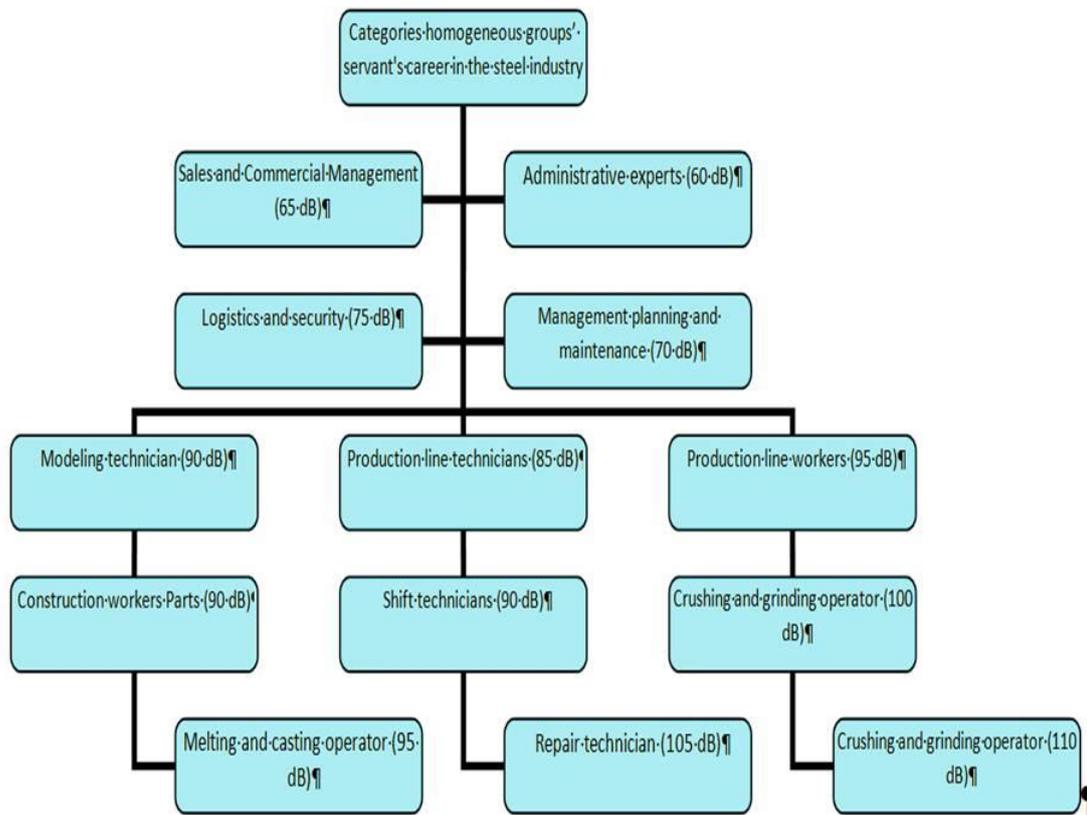
= q = 1-p A proportion of the population without a certain adjective

d = Optimal degree of certainty or accuracy

P and q usually consider to 5,0. Z value is usually 1.96. d can be 0.1 or 0.5.

To select and entry into the study criteria by the researcher were considered, including whether any of the people in terms of mental health and mental by a doctor factory be approved and in the case of examination of Occupational Medicine Annual person any neurological problems and There is no mental illness, including epilepsy, fainting, neurology, or ear hearing loss. In this case-control study matched data has been tried except for the difference between the two groups in terms of exposure to harmful noise is a significant difference between demographic variables ( $p > 0.05$ ) is not observed.

In this study, after selecting and screening individuals, to determine the harmful and normal noise using the standard method (2009) 9612, it is necessary to determine homogeneous occupational groups. Each member of the homogeneous job group must be exactly the same in terms of work hours, type of job, and intensity of noise pressure. After determining the homogeneous occupational groups according to the factory area as well as the points where the device is located, the points of measuring the sound pressure level with the hypothetical squares of 10 x 10 meters were determined. In the Noise Method (2009) iso9612, there are several methods for measuring noise and classifying job groups, such as task-based or job-based measurement, which are difficult to describe in this study because of job descriptions and work patterns. Job-based measurement methods have been used<sup>10, 20</sup>. Since the industrial complex of continuous noise and hoarseness due to down time so at any point measured at least three times the volume and the average of the three readings was recorded as noise in the desired station.



**Figure 1** shows the classification of homogeneous occupational groups based on exposure to the same sound pressure level as above. In the first four groups (control group), exposure to noise is in the range of 60 to 80 dB, and in all other homogeneous groups (case group), exposure to noise is in the range of 85 to 110 dB.

Measurement methods based jobs most useful method because a few of the tasks that the noise is very high. This strategy leads to a reduction in the time it takes to analyze the work is, of course, the definition of the jobs must be careful that exposure noise every worker in a specific job, the job is merely represent noise exposure. In the job-based measurement

method (2009) iso9612, the time required for measurements is time consuming, but less uncertainty is created in the results. , Information about the relative share of the various tasks of a job will not be estimated. In this study, to measure  $L_p, A, eqT$ , while using the identified jobs in homogeneous groups, the model's sound level measuring device was used<sup>17</sup>. Since the type of noise in this factory is continuous and uniform with small changes, noise measurement is done in network A and three numbers are read in the measuring station, and finally the average number as the final sound pressure level of that station in was considered. The microphone of the sound level measuring device was placed in the position of people's heads according to the (ISO9612) guidelines (2009), of course, without their presence, and the distance of the device's microphone to the ground was about 0.075 x 1.55 meters. Using the formula No. 2, the equivalent level of noise exposure caused by measuring the level of sound pressure in each of the homogeneous occupational groups has been estimated. Formula No. 3 was used to determine the amount of daily exposure to noise in the homogeneous occupational group and to estimate the level of sound pressure during the 8-hour work shift.

**Formula No. 2** determines the equivalent level of exposure to noise for homogeneous occupational groups<sup>37</sup>.

$$L_{p,A,eq,Te} = 10 \log \left( \frac{1}{N} \sum_{n=1}^N 10^{0.1 \times L_{p,A,eq,n}} \right) dB$$

$L_{p,A,eq,n}$  :Continuous noise pressure balance equivalent to network A for example n

$L_{p,A,eq,Te}$  :Continuous noise pressure balance equivalent to network A

$n$  :Job sample number

$N$  :The total number of employees affected by the measured noise pressure level.

Formula 3: The level of daily exposure to noise on the A (LEX.8h) network for workers in the homogeneous job group<sup>16</sup>

$$L_{EX,8h} = L_{p,A,eq,Te} + 10 \log \left( \frac{T_e}{T_0} \right) dB$$

$L_{EX,8h}$  The level of daily exposure to noise on the A network

$T_e$  Effective working day

$T_0$  The reference time is 8 working hours.

$n$  Job number

$N$  The total number of employees involved in calculating the daily noise level balance.

The DASS: Depression Anxiety Stress (DASS: Depression Anxiety Stress) questionnaire was used to assess the impact of head and voice on employee behavioral and cognitive

components. This questionnaire is a set of three reporting scales to assess the severity of negative emotional states in depression, anxiety, and Stress includes 21 questions with classification, stress (7 questions), anxiety (7 questions) and depression (7 questions)<sup>26</sup>. The validity and reliability of this questionnaire in Iran has been investigated by Samani (2007) and the validation test for depression, anxiety and stress scale is 0.80, 0.76 and 0.77, respectively, and Cronbach's alpha rate for scales. Depression, anxiety, and stress reported 0.81, 0.74, and 0.78, respectively<sup>33</sup>. All individuals were informed prior to completing the consent form. Data analysis and analysis in this study was performed using SPSS version 22 software and Fisher's exact test method, Kai-Square test and independent t-test. In all tests, the confidence level is 95% and the significance level is less than 0.05.

## Results

In this study, all individuals had the same gender, and in this respect, there is no difference between the male populations of the present study. The average age of people in the two groups of high and low noise was 85 decibels 4.41. 32.82 years. Individuals in the two groups did not have a significant difference in age ( $p = 1.00$ ), and the mean work experience of the two groups in terms of exposure to sound pressure level was  $9.32 \pm 2.26$  and  $9.26 \pm 2.26$  years, respectively, which was significantly different in terms of meaning. There were no statistics ( $p = 0.819$ ). In terms of academic levels between the two groups, most people had a diploma (36 to 56 percent). Also, a significant relationship was observed in the study between the two groups at the academic level ( $p = 0.001$ ). Most people were married at 85 decibels (75.4%) and 85 decibels (76.6%). (Table1)

**Table 1- Comparison of demographic characteristics, shift work, work experience and personality type in both case and control groups) data reported as (%) frequency(**

Variable	group		p-value
	Case (n=500)	Control (n=500)	
Level of Education	150(30%)	0(0%)	High school
	180(36%)	280 (56%)	Diploma
	100(20%)	160(32%)	Advanced Diploma
	70(14%)	60(12%)	Bachelor's degree and higher
material status	117(23.4%)	123(24.6%)	Single
	383(76.6%)	377(75.4%)	Married

Age (year) (standard deviation of average)(	37.82±4.68	35.82±4.41	1.00***
Work experience (year) (standard deviation ± average	10.26±6.26	11.32±4.25	1.00

**P-value <0.0001**

\* Fisher's exact test

\*\* Kai Square exam

\*\*\*Independent T-test

**Table 2 - Regression results of the relationship between demographic characteristics with depression, anxiety and stress\***

The dependent variable	Regression coefficient (β)	independent variable	p-value
Depression	0.069	Age	<b>0.023</b>
Anxiety	-0.556	marital status	<b>0.045</b>
Stress	0.493	Shift work	<b>&lt;0.001</b>

\*Among the demographic variables, the only significant independent variables in the table have been reported  
P-value <0.0001

Table 2 shows the results of simple regression to examine the relationship between the subscales of the DASS questionnaire (depression, anxiety and stress) in the role of the dependent variable with demographic variables, shift work and work experience in the role of independent variables. In this study, step-by-step regression method was used to select the independent variables affecting the model. Also, for every equation of all demographic variables entered in the regression model, the only significant variables in Table Gzarshshdhand. The results of this table show that among the mentioned factors, the age factor has a significant effect on depression, the marital status factor has an effect on anxiety and the work shift factor has a significant effect on employee stress ( $p < 0.05$ ). As you grow older, your depression will increase by an average of 0.049 points. Married people also experience lower levels of anxiety than single people. The level of anxiety experienced by a married person is 0.556 points lower than that of a single person. Also, people who work day and night shifts experience higher levels of stress than people who work during the day.

**Table 3: Statistical analysis of cognitive parameters in both case and control groups**

Variable	p-value	Degree of freedom	Test value t	95 %confidence interval	
				High limit	Low limit
<b>Depression</b>	0.001	97	3.46	2.72	0.738
<b>Anxiety</b>	0.062	96	1.88	1.96	-0.049
<b>Stress</b>	0.001	97	3.27	2.75	0.675
<b>sound Pressure Level(dB)</b>	0.001	98	14.99	17.98	13.77

P-value <0.0001

According to the results of Table 3, the subscales of depression and stress and the variable level of sound pressure were statistically significant ( $p < 0.05$ ), ie there is a difference between these parameters in the two groups of case and control. But the anxiety variable is not significant ( $p > 0.05$ ).

Table 4 compares the subscales of the DASS questionnaire (depression, anxiety, and stress) between the two case and control groups. The results of this study did not show a significant difference in the score of depression and anxiety between the two groups ( $p > 0.05$ ). But the stress score in the case group ( $14.40 \pm 1.86$ ) was significantly higher than the control group ( $12.89 \pm 1.59$ ) ( $p < 0.001$ ) and (Table 3 and Figure 1). This indicates the effect of noise intensity level on increasing workers' stress levels.

**Table 4 - Comparison of depression, anxiety and stress in both case and control groups**

p-value <sup>#</sup>	Groups		Variable
	Case (n=500)	Control (n=500)	
Depression	14.36±1.28	13.35±1.72	<b>&lt;0.001</b>
<b>Anxiety</b>	12.04±1.48	12.34±1.76	<b>0.015</b>
<b>Stress</b>	14.40±1.86	12.89±1.59	<b>&lt;0.001</b>

#Independent T-test

P-value <0.0001

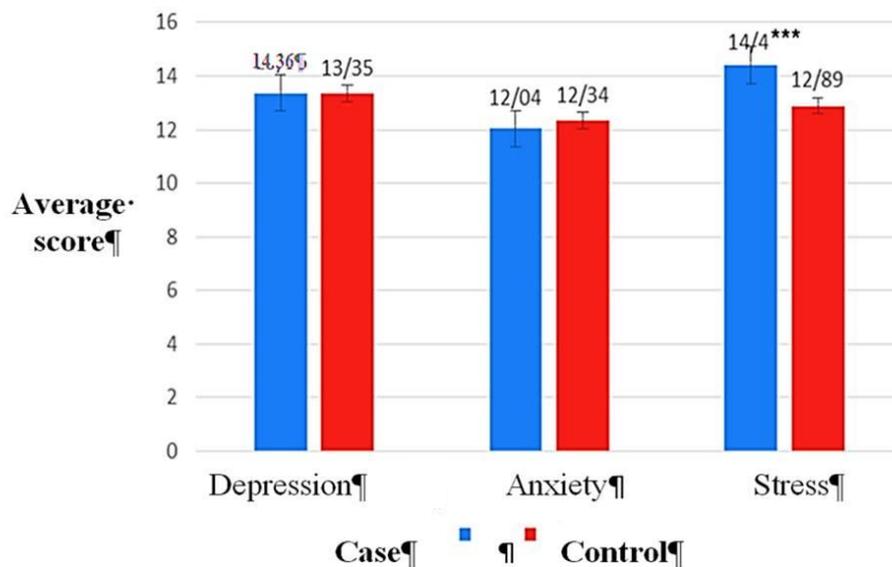


Figure 2. Comparison of stress, anxiety and depression between the two groups. The results were obtained through independent T-tests and reported as standard deviation  $\pm$  mean (n = 150 in each group) in Table 3. \*\*\* Shows a significant difference in  $p < 0.001$  level.

## Discussion

The findings of this study showed an increase in the level of noise pressure in the work environment, which increased the average stress score in the group. Of course, it is worth noting that in the present study, the discomfort caused by noise exposure in both age groups and the work experience of trained people is significant. Noise is known as one of the most important physical factors affecting people's health in the workplace of various industries<sup>39</sup>. In the steel industry, the diversity of jobs and the frequency of noise production are clearly seen and are considered as one of the most serious environmental hazards for workers<sup>35</sup>. The results of the present study showed that exposure to higher than permissible levels of noise affects depression, anxiety and stress. In this study, exposure to higher levels of voice is 85 dB with increasing prevalence of adverse mood conditions and increased risk of depression, anxiety. And stress comes with it. The mean stress index in the case group was  $2.06 \pm 2$  higher than the control group, which was statistically significant ( $p < 0.001$ ). In a study, Saadatian et al. examined the effects of sound and noise pollution on humans and determined that the physical effect of noise is related to its diffusion and transmission in the air and the psychological effect on the human soul and psyche and with the findings. The present study is consistent<sup>19</sup>.

In examining the internal and external validation of the DASS scale, Husain et al. Found that psychotic symptoms were common among patients with tinnitus, and that the DASS-21 BM scale was a reliable scale for assessing mental symptoms and was consistent with the

results of the present study<sup>36</sup> Kui Wang et al. Examined the intercultural validation of the DASS scale in China and showed that there was high depression and anxiety in the study group, but they did not have much stress compared to the control group, and the present study is consistent<sup>27</sup>. In their study, Kathleen and Fuller examined cognitive aging and auditory information processing with the help of signal-to-noise ratio (SNR) and showed that auditory processing problems over cognitive processing through perceptual stressors such as noise. Cognitive stressors, such as memory load, are effective and suggest therapeutic interventions during information processing, by changing behavior and physical environments to reduce stress on the body<sup>24</sup>. In Stanfel's study, high and low voice exposure and mental disorders examined a person's personality, and it was found that those with hypersensitivity and psychoactive problems were more likely to have psychological symptoms than those who did not<sup>5</sup>. In Saremi's review study, the non-auditory effects of environmental noise pollution and the mental performance of shift workers in both case and control groups were investigated and it was shown that in shift workers working in quiet environments, more hearing loss occurs. This decline is due to work tasks and is reflected in jobs with the need for awareness and information storage by increasing error and reducing sensory-motor activity, agility and speed of reaction. Mental and behavioral components stress and anxiety are not mentioned. It can be said that it does not correspond to the present study<sup>1</sup>. Also, in a meta-analysis study conducted by Techera, the factors influencing fatigue and stress were identified as one of the most important factors influencing the occurrence of these complications, and the inappropriate noise can affect people's stress. Effectively compatible with current study in the steel industry<sup>15</sup>. In Thomas Münzel's study, the effect of noisy noise on cardiovascular disease and stress in individuals was investigated and it was found that chronic noise levels, although low, can have effects such as dysfunction, sleep and communication. A number of emotional reactions, including discomfort and stress, occur in people exposed to noise, and this study is consistent with the present results<sup>23</sup>. Based on the results of the studies and the present study, it can be said that in performing tasks, noise above the permissible level increases stress and anxiety in employees and it is necessary to take the necessary control measures to maintain the health of employees.

## **Conclusion**

The results of this study show that exposure to noise above the allowable level can affect people's mood and can significantly affect the state of stress, anxiety and depression, so it is recommended to take action with the help of measures. Engineering, training workers, or using hearing aids can reduce the risk of adverse psychological conditions and prevent the progression of injury by periodically assessing the cognitive status of individuals on pre-employment examinations. Also, considering individual differences in the sense of depression, anxiety and stress, examining the sensitivity of people to noise to work in areas with high noise pollution can help improve working conditions and prevent serious injuries in susceptible individuals.

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### **Availability of data and materials**

The data that support the analysis of this study (Analysis codes and outputs) are available on request from the corresponding author (M.Nazari). The raw data are not publicly available due to institutional restrictions.

### **Authors' contributions**

HA participated in the study design, analysis, and wrote the manuscript. HA also conducted data collection. M.NZ also participated in the preparation of the draft of the paper, revised the draft of the manuscript, and supervised the project. M.NZ also conducted data analysis. All authors participated in the development of the manuscript and data interpretation. RF participated in the study design, interpretation of findings, and also wrote the manuscript. All authors read and approved the final manuscript.

### **Ethics approval and consent to participate**

The study was approved by the Ethics Committee of the Shahid Sadoughi University of Medical Sciences

### **Consent for publication**

Not applicable.

### **Competing interests**

The authors declare that they have no competing interests.

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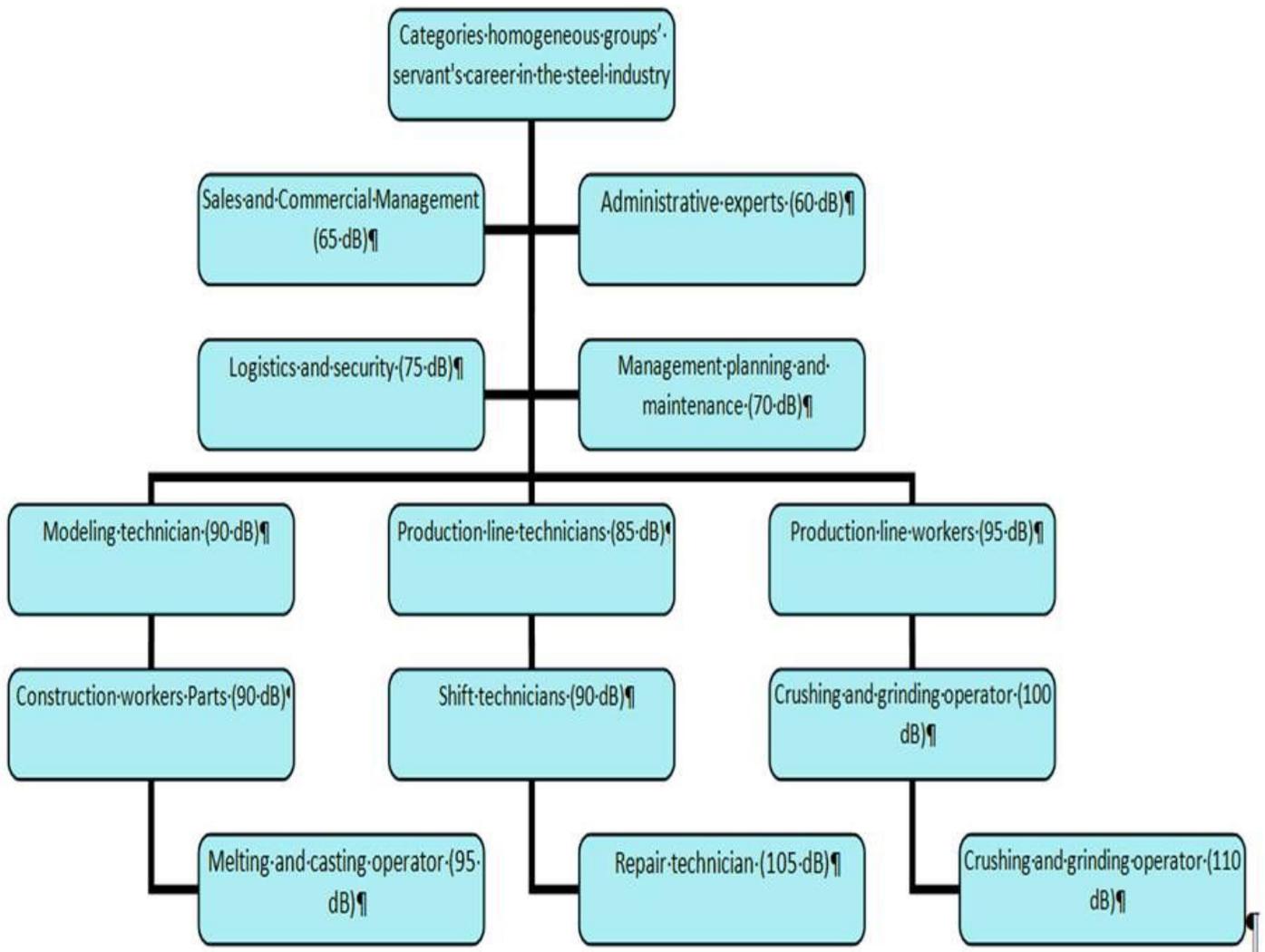
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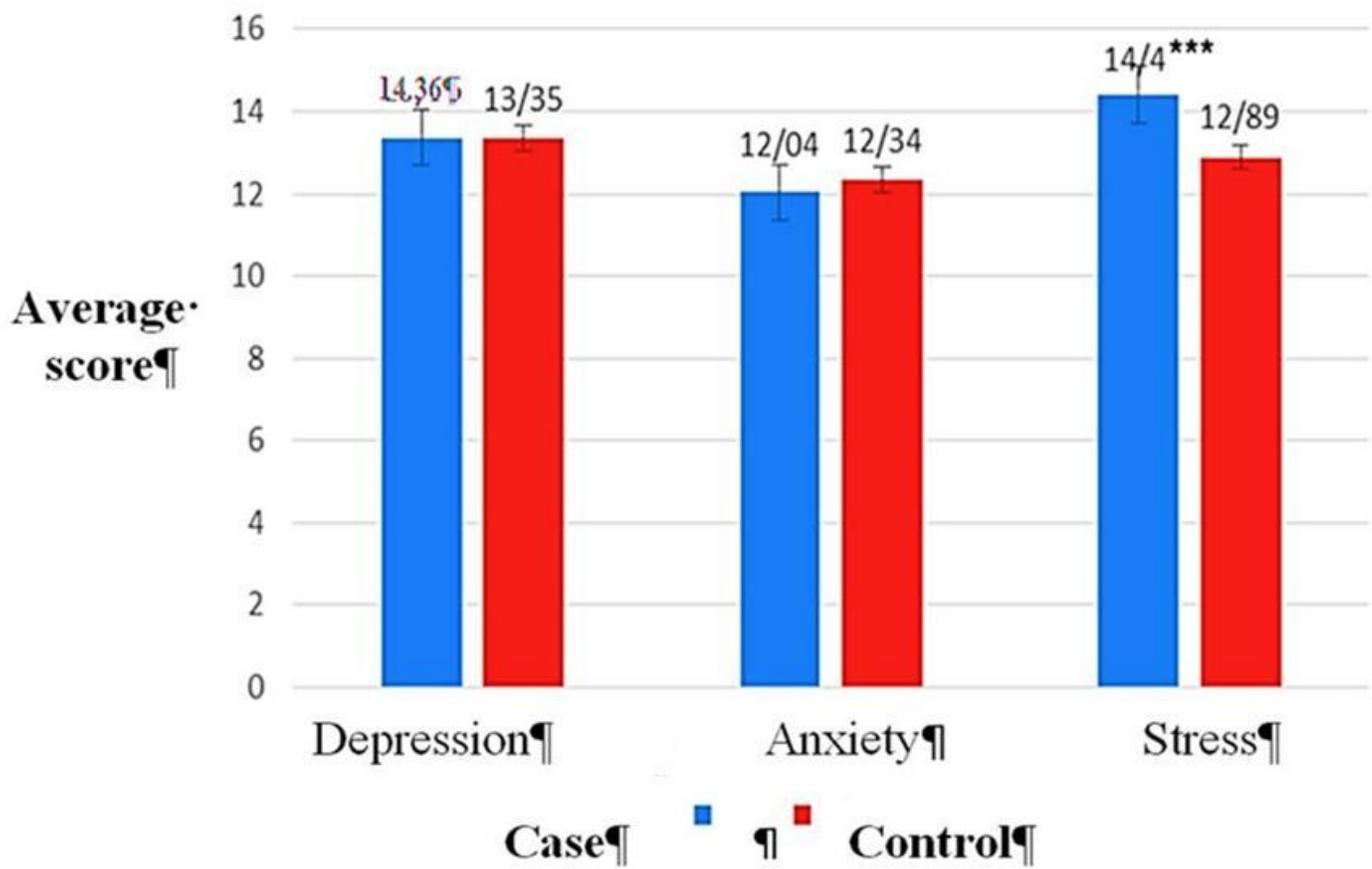
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# Figures



**Figure 1**

shows the classification of homogeneous occupational groups based on exposure to the same sound pressure level as above. In the first four groups (control group), exposure to noise is in the range of 60 to 80 dB, and in all other homogeneous groups (case group), exposure to noise is in the range of 85 to 110 dB.



**Figure 2**

Comparison of stress, anxiety and depression between the two groups. The results were obtained through independent T-tests and reported as standard deviation  $\pm$  mean (n = 150 in each group) in Table 3. \*\*\* Shows a significant difference in p < 0.001 level.