The Analysis of Harmful Factors Affecting on Mental Health and Cognitive Function Among Workers of Steel Industry (Using the ISO9612 Approach)

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Abstract

Background: In most industrial environments, workers are exposed to noise on a daily basis. The present study dealt with a set of cognitive factors to evaluate the negative emotional states in depression, anxiety, and stress in a noisy work environment.

Methods: The research was a case-study that examined in 1000 male workers of steel industry. The sampling method was random sampling. The workers filled out questionnaire about, Depression, Anxiety, Stress (DASS), Cognitive Processing Inventory (CPI), and personality type tests in the study, and the ISO 9612:2009 standards was used to obtain external noise. Data was collected and analyzed using SPSS version 22 and exact test with 0.05 significant levels.

Results: According to the results, age showed a significant effect on depression, marital status on anxiety, and the shift on employee stress (p <0.05).

Conclusion: Finally one can conclude that given the positive and significant relationship between noise pressure level and cognitive and subjective components in the case group, it is necessary to take effective preventive measures to prevent psychological damage and to maintain workers' health in the industry.

Trial registration: There is no clinical trials code in this article and only have an ethical code.

Background

As an environmental pollutant, noise is created due to different human activities and the mandatory communication between humans and the world around them (Hammer et al., 2014). Noise waves are considered as necessary factors in daily life and occupational activities, yet in some cases and under certain conditions, hearing these waves is unpleasant. Those noise waves unwittingly emitted into the environment and are annoying to hear are called noise or noise pollution (Brown, 2010, Hammer et al., 2014). Occupational noise is a kind of noise pollution we face in the workplace that is beyond the control and management of the employer and employees. Strong proofs show that industrial noise pollution is an undesirable risk factor for human health (Cantley et al., 2019, Sayler et al., 2019). Indeed, the noise has been introduced as one of the most significant causes of occupational diseases and the second leading cause of occupational injuries in the workplace, as due to the presence of high-speed machines and high-speed mechanical movements, the harmful effects of noise have become more intense in manufacturing industries (Müller and Janssen, 2008). Globally, hearing loss (more than 40 decibels) has risen from 120 to 466 million in the last two decades from 1995 to 2018 because of different causes (Ramsey et al., 2018) with approximately one-third of people over 65 suffering from hearing loss and the number of people with hearing loss will probably increase in the coming years in case of lack of timely care and treatment (Ramos, 2018). According to statistics released in 2018 by World Health Organization (WHO), about 466 million people worldwide suffer from disabling hearing loss (6.1% of the world population), of whom about 432 million (93%) are adults and (7%) are children. According to the estimates made by the Occupational Safety & Health Administration, 17% of manufacturing workers have a hearing
impairment (Organization, 2018). Hearing loss due to exposure to workplace noise is of the most significant diseases that can affect the safety and effectiveness of the individual, but its importance is usually neglected (Feder et al., 2017). According to the estimates of WHO, the number of people with hearing loss will reach 630 million by 2030, and this population may even reach more than 900 million by 2050 (Laxmi et al., 2019, Punch et al., 2019). The cost of hearing loss due to noise exposure higher than threshold limit value (TLV) is high; for instance, in a country like America, this cost is over hundreds of millions of dollars (BakhshianShahrbabaki et al., 2018). These statistics show the high number of people exposed to noise and the significance of this issue. Undoubtedly, one can state that noise is one of the fundamental problems of the industrial world and the working class, with many people at risk from its adverse effects in the workplace (TAJIK et al., 2009). Noise exposure has always had a devastating impact on human health, which has been recognized for more than 2,500 years (Raja et al., 2019, Basner, 2019). Problems due to the exposure noise do not end with hearing loss. For example, people exposed to more noise than the limit have twice as many family problems as healthy people (Joynes, 2019).

Moreover, the body's response to noise is so similar to the state when the body responds to stress, which over time can impair health (Wendt et al., 2017). Prolonged exposure to noise can lead to hearing loss (Kurabi et al., 2017). There is now evidence claiming that stress-related noise leads to a wide range of mental, psychological, and physiological problems (from allergies to heart disease). Meanwhile, the number of people affected by the environment noise is increasing daily (Sadeghi et al., 2007, Mbuligwe, 2004). Noise exposure can affect a person's ability to work, especially the mental work (Fausti et al., 2019). Moreover, like a warning signal sudden, noise can affect the brain in several ways that trigger the response to stress (Jafari et al., 2018). Noise-related health effects are bad mood, lack of concentration, weakness and fatigue, and poor performance (Shan and Neis, 2020), impaired speech and verbal communication, hearing loss, sleep disorder, cardiovascular effects, changes in physiological-psychological and cardiovascular levels, changes in stress hormone levels, blood magnesium levels, changes in the functioning of the body's immune system, gastrointestinal tract, decreased productivity, increased incidents, the effect on social behavior, increased aggressive behaviors, mental states, helplessness and confusion that occurs in individuals depending on the job conditions (Organization, 2019). The physiological and psychological effects of exposure to noise on humans usually appear gradually with negative psychological consequences in the long run (Jafari et al., 2019a, Mohammadi et al., 2019). Among the individual differences relative to noise, one can state that noise is more annoying for some people than the others. The performance of people with an anxious personality type is more than the performance of those with a non-anxious personality type (Ljungberg and Neely, 2007). Personality traits are the first guides for determining the cognitive and emotional status of individuals and affect emotional-social maps and interpersonal or occupational behaviors of individuals (Marinova et al., 2019). To Eysenck, the main reason for the difference between extroverts and introverts is their level of cerebral arousal (Netter et al., 2020). In other words, introverts and extroverts differ in a part of their brain functions (Revelle, 2016). Another effect of noise as a stressor is an occupational cognitive impairment (reaction time, attention, comprehension of warning signs, and so on), as the slightest delay in reaction of the individuals in sensitive occupations can increase the likelihood of an accident and the
risk of irreversible incidents (Zare et al., 2017). Depression and anxiety are strongly interrelated, and usually, these two disorders are experienced side by side (Januzzi et al., 2000). There is a difference between stress and anxiety in terms of mental health, stress is a reaction to a threat, and anxiety response to stress is a threat (Moussa et al., 2017), and if people are exposed to stress for a long time, they may experience discomfort or depression (Beutel et al., 2016). Among the valid scales for examining the physiological and psychological effects of noise in the areas of cognitive processing and stress and anxiety, respectively, are Cognitive Processing Inventory (CPI) and Depression, Anxiety, Stress, Scale (DASS) (Monroe and Simons, 1991). Measuring the severity of the main symptoms of depression, anxiety, stress, and disorder in employee information processing exposed to harmful noise is done using the psychological and mental scales of CPI and DASS (Habibi et al., 2017, Sahebi et al., 2005). Mood and emotional states affect cognitive processes as well. Many of our cognitive processes like attention, learning, memory, judgment, inference, and interpretation are affected by our moods (Canter et al., 2016). The effect of moods on the processing pattern is that in different mood states, information is processed in different ways (Forgas et al., 2012). When someone is in a particular mood, one pays more attention to the stimuli, subjects, images, and situations emotionally compatible with one's emotional state, thus processing them better and learning better (Christianson, 2014).

Noise is present in almost all occupational activities, yet certain types of material produce noise more strong intensity in some activities. Those working in the manufacturing, transportation, mining, construction, agriculture, and military industries have the highest risk of hearing loss as a result of noise (Berger, 2000, Goelzer et al., 2001). Given the special equipment and systems like pumps, compressors, furnaces, motors, air blower systems and cooling towers, ducts and gas and steam valves, arc furnaces, rolling units, and the fans used for ventilation in the steel industry, high nose threatens the health of the employees (Golmohamadi et al., 2013).

The existence of extensive studies on the effects of noise shows that this detrimental factor can affect the health of employees and their mental health components. Studies in Iranian literatures show that little examine the impact of noise and cognitive effects in industrials. Therefore, in the one of Iranian steel industrial the simultaneous effect of harmful noise on the nine psychological components and mental processing of individuals is done.

**Methods**

**Sampling and sample**

The Cross-sectional study location was one of the steel industries of Iran located in the center of the country (Isfahan). The population of the case group was all the employees with more than 10 years of work experience, and their workplace had noise generating resources that were 500 people. The population of the control group was the employees of administrative units who had more than ten years of work experience and were not exposed to noise in their workplace that were 500 people. The case group and the control group were selected to match all characteristics (except sound exposure). The
current way of protecting employees against noise is mainly personal protective equipment, including protective earphones. The reason for selecting the workers with more than ten years of experience was that most occupational diseases occur after ten years of exposure (Peplońska and Szeszenia-Dąbrowska, 2002). In the studies of examining noise-induced hearing loss, the minimum of 10 years is considered when a significant hearing loss takes place (Themann and Masterson, 2019, Gopal et al., 2019).

The study excluded those with a history of head trauma, vocal trauma, epilepsy, neurological disease, and auditory diseases of the ear like neurological, conductive, and mixed ones. The study considered the ethical issues and informed consent was received from all the individuals to participate in the study.

Cochran's formula was used in Formula 1 with an alpha confidence factor of 0.5 and beta of 0.8 to determine the number of study samples.

We used written consent and placed the example of that in Appendix. The Ethics Committee approval number: IR.SSU.SPH.REC.1398.060 was approved by Ethics Committee of the Shahid Sadoughi University of Medical Sciences.

1. Measuring the noise pressure level in the workplace:

In the first study phase, homogeneous groups were identified in terms of noise exposure, and given the identification of significant places for noise production in each job, the continuous noise pressure level was measured according to ISO\(^1\) 9612(2009)\(^2\) (DIN, 2009), thus the noise components L\(p\), A, and eq\(T\) in each occupational group. In defining jobs, it should be noted that the vocal exposure of each worker in a given job shows the vocal exposure for all homogeneous individuals in that similar occupational group (Costa and Arezes, 2012). This method is time-consuming but produces less uncertainty in the results (Arezes et al., 2012). As the noise changes in this industry are very low over time and fall into the category of continuous noise, the CEL-440 sound level meter, calibrated according to the manufacturer instructions using the CEL-282 calibrator, was used to measure the sound level meter. Equal squares (10 meters in 10 meters) were identified and in the center of these squares, the points for measuring the sound level meter were determined based on homogeneous occupational groups to divide the different halls. Measurement of noise should be done at least three times at each point of measurement, and finally the final number of each station should be determined by the average measurement.

During noise evaluation, the sound level meter microphone was at least one meter away from reflective surfaces like walls or machines, and its distance from the ground was 5 feet or 1.5 meters. Moreover, the sound level meter microphone was as far away from the operator body as the arm and placed at a 90-degree angle to the noise source. An error of up to 6 decibels may happen while using the sound level meter, mainly due to the operator exposure to the noise source (Müller and Möser, 2012). Furthermore, the mean sound level meter of each unit was compared with SPSS software with a national permissible noise limit of 85 decibels.
2. The questionnaire

Noise-induced disorders and discomfort were evaluated based on the following three series of tests. All eligible participants in the study participated in three series of tests. The mental function tests used in the study were standardized (psychologically) stress-anxiety tests (DASS), CPI mental processing, and Eysenck's personality type. Each mental performance test was performed while the individuals were exposed to noises higher than 85 dB in the case group and less than the allowable level in the control group and the other demographic information of employees in was collected in a separate questionnaire (containing demographic information age, gender, work shift, work history, education, marital status and place of residence.

The validity and reliability DASS questionnaire in Iran has been examined by Samani and Jokar (2007). Its test-retest reliability for depression, anxiety and stress have been 0.80, 0.76 and 0.77, respectively, and its Cronbach's alpha for depression, anxiety and stress 0.81, 0.74, and 0.78, respectively (Samani and Jokar, 2001).

The reliability of CPI test was reported 0.92 using test-retest and from 0.80 to 0.92 using split-half test. CPI validity through correlation with Global Processing Index (GPI) is from 0.92 and 0.95. Predictive validity was reported 0.78 with 12% positive prediction and 10% negative prediction errors. This information confirms that the test has a very strong validity and reliability (12). Eysenck Personality Inventory (EPI) is composed of 48 questions with two-option yes and no. After administering the test, the collected responses are compared with three keys E, N and L and a score is assigned to each answer that looks like a key. In the present study, the reliability of this tool was 0.86 using Cronbach's alpha coefficient (Abdel-Khalek, 2012, Eysenck et al., 2020).

3. Statistical analyses:

The data was extracted according to the results of the completed questionnaires, the level of the measured noises, and the audiometry results mental function test results (individuals and data according to each test). For the analyses, it was coded with the instructions of each test. Depression was selected as the dependent variable. Participants’ data were, therefore, only included in the final analyses if a response was provided for each of the ten items used to calculate optimal Depression logistic regression analysis was used to determine associations between both demographic factors and lifestyle behaviors and cognitive function (IBM SPSS Statistics version 22 for Windows). Crude, partially adjusted (adjusted for age, gender, Literacy status, and marital status), and fully adjusted (adjusted for all socio-demographic and cognitive component variables concurrently) odds ratios were calculated. Bootstrapped 95% confidence intervals (CI) were calculated using 1000 samples. The alpha was set at 0.05 to determine statistical significance. Missing data for lifestyle behaviors and socio-demographic variables were excluded pairwise.

1International Organization for Standardization.
Species an engineering method for measuring workers' exposure to noise in a working environment and calculating the noise exposure level.

Results

One thousand workers of Iran steel industry participated in the study: 500 assigned to the case and 500 to the control groups. The mean age of the participating workers was 37.82 ± 4.68 and their mean work experience was 10.26 ± 6.26 years. In this study, 24.6% (n = 123) of the sample were single and 75.4% (n = 377) were married. As Table 1 shows, there were no significant differences between the two groups in terms of age, work experience and marital status (p > 0.05). This shows that the distribution of these variables in both groups is the same and does not have a disrupting role in the final results. Moreover, over 90% of the participants in the sample were males and the number of females in the case group was significantly higher than the control group (p < 0.05). Additionally, 20% (n = 100) worked in day shifts, 20% (n = 100) night shifts and 60% (300 people) worked in rotation. As Table 1 shows, the distribution of education and shift in the case and control group is not the same (p < 0.05). Personnel personality type shows a high degree of extroversion in the case group, the reverse of which is seen in the control group (p < 0.05).
Table 1
Comparison of demographic characteristics, shift, work experience and personality type in case and control groups (data reported as (%) frequency)

| Variable          | Group          | Case (n = 500) | Control (n = 500) | p-value |
|-------------------|----------------|----------------|-------------------|---------|
| Gender            | Male           | 450(90%)       | 500(100%)         | 0.005*  |
|                   | Female         | 50(10%)        | 0(0%)             |         |
| Education         | Sub-diploma    | 0(0%)          | 180(36%)          | 0.001   |
|                   | Diploma        | 60(12%)        | 150(30%)          |         |
|                   | Associate's degree | 160(32%) | 100(20%)          |         |
|                   | Bachelor and higher | 280(56%) | 70(14%)           |         |
| Marital status    | Single         | 123(24.6%)     | 117(23.4%)        | 0.308** |
|                   | Married        | 377(75.4%)     | 383(76.6%)        |         |
| Shift             | Day            | 430 (86%)      | 100(20%)          | < 0.001*|
|                   | Night          | 5(1%)          | 100(20%)          |         |
|                   | Rotation       | 65(13%)        | 300(60%)          |         |
| Personality type  | Introvert      | 260(52%)       | 180(36%)          | < 0.001 |
|                   | Extrovert      | 240(48%)       | 320(64%)          |         |
| Age (year) (std dev ± mean) | 35.82 ± 4.41 | 37.82 ± 4.68 | 1.00*** |
| Work experience (year) (std dev ± mean) | 11.32 ± 4.25 | 10.26 ± 6.26 | 1.00   |

P-value < 0.0001

* Fisher’s exact test

** Chi square test

*** Independent T-test

The results obtained from measuring and comparing the mean hearing threshold of employees exposed to noise and control samples are presented in Table 2. Comparing the mean hearing threshold of the control samples and those exposed to noise at different frequencies shows that except 250 Hz frequency, where there are no significant differences between the mean hearing threshold of control and case groups, in all other frequencies the mean hearing threshold of the samples exposed to noise is larger than the control samples. Moreover, 43.6% of the subjects in the case group and 10% of the control group in
the low frequencies have hearing loss, which is statistically significant ($P < 0.001$). On the other hand, 72.2% of the subjects in the case group and 37.8% in the control have hearing loss in the high frequencies, which is again statistically significant ($P < 0.001$).

Table 2  
Comparison of the employees’ mean left ear hearing threshold in case and control groups

| Noise frequency (Hz) | Mean hearing threshold (dB) | P value |
|----------------------|----------------------------|---------|
| 250                  | Case 17.5 ± 8.9             | 0.12    |
|                      | Control 15.9 ± 8.5          |         |
| 500                  | Case 22 ± 9                 | 0.005   |
|                      | Control 15.7 ± 6.3          |         |
| 1000                 | Case 19.5 ± 10.5            | 0.02    |
|                      | Control 16.2 ± 6.7          |         |
| 2000                 | Case 26.7 ± 10.9            | < 0.001 |
|                      | Control 14.7 ± 7.7          |         |
| 3000                 | Case 29.8 ± 6.8             | < 0.001 |
|                      | Control 20.5 ± 7.8          |         |
| 4000                 | Case 34.3 ± 7.5             | < 0.001 |
|                      | Control 24.5 ± 6.9          |         |
| 6000                 | Case 30.5 ± 12.5            | 0.01    |
|                      | Control 25 ± 7.7            |         |
| 8000                 | Case 30.8 ± 14.4            | < 0.001 |
|                      | Control 20.7 ± 9.8          |         |

Table 3 shows the results of simple regression to examine the relationship between the subscales of the DASS questionnaire (depression, anxiety and stress) and CPI (cognitive processing) as the dependent variable with demographic variables, shift and personality type as independent variables. In this study, stepwise regression was used to select the independent variables affecting the model. Furthermore, of all the demographic variables entered in the regression model for each equation, only significant variables were reported in the table. The table results show that from among the mentioned factors, age has a significant effect on depression, vision and hearing, marital status on anxiety, work shift on stress and sequential and logical processing of employees and finally personality type on processing speed and
attention ($p < 0.05$). For instance, as one grows older, his depression increases by an average of 0.049 points. Additionally, married people experience less anxiety than single people, and the level of anxiety experienced by a married person is 0.556 less than that of a single person. Those working rotationally and during night shifts experience more stress levels than those working during the day, and this affect the rate of processing and attention to information when necessary and in alert. Introverted personality types are less sensitive to processing rate changes in the case group ($p < 0.05$).

Table 3
Regression results of examining the relationship between demographic characteristics and mood states of mental processing

| Dependent variable                  | Independent variable | Regression coefficient ($\beta$) | $p$-value |
|-------------------------------------|----------------------|---------------------------------|-----------|
| Depression                          | Age                  | 0.049                           | 0.023     |
| Anxiety                             | marital status       | 0.556                           | < 0.001   |
| Stress                              | Work shift           | 0.493                           | < 0.001   |
| Vision                              | Age                  | 0.391                           | 0.037     |
| Hearing                             | Age                  | 0.351                           | 0.059     |
| Sequential / logical processing     | Work shift           | 0.455                           | < 0.001   |
| Conceptual / abstract               | Work shift           | 0.561                           | < 0.042   |
| Processing speed                    | Personality type     | 0.522                           | < 0.001   |
| Attention                           | Personality type     | 0.485                           | < 0.001   |

$P$-value < 0.0001

*Among the demographic variables, only significant independent variables have been reported in the table.*

Table 4 shows the comparison of the subscales of the DASS and CPI between the case and control groups. The results of the study do not show a significant difference in the scores of depression, anxiety, vision, hearing, and conceptual processing between the two groups ($p > 0.05$). However, the scores of stress, sequential processing, processing rate, and attention in the case group were significantly higher than the control group ($p < 0.001$) (Table 4). This shows the effect of noise intensity level on increasing stress, sequential processing, processing rate and attention of employees exposed to noise above the allowable level. Providing control measures for employees exposed to noise to reduce physical and psychological damage is necessary.
### Table 4
Comparison of DASS and CPI test components in case and control groups

| Variable                        | Group                  | p-value# |
|---------------------------------|------------------------|----------|
|                                 | Control (n = 500)      | Case (n = 500) |
| Anxiety                         | 13.35 ± 1.72           | 17.36 ± 1.88 | < 0.225 |
| Stress                          | 14.34 ± 2.11           | 16.56 ± 1.65 | 0.120   |
| Vision                          | 12.89 ± 1.59           | 14.40 ± 1.71 | < 0.001 |
| Hearing                         | 15.35 ± 1.88           | 13.36 ± 1.27 | 0.445   |
| Sequential / logical processing | 14.34 ± 1.65           | 12.56 ± 1.15 | 0.955   |
| Conceptual                      | 12.89 ± 1.59           | 16.40 ± 1.71 | < 0.001 |
| Processing speed                | 15.35 ± 1.91           | 18.36 ± 1.61 | 0.556   |
| Attention                       | 12.34 ± 1.20           | 17.56 ± 1.65 | < 0.001 |

*P*-value < 0.0001

# Independent T-test

### Discussion

This study aimed at investigating the effect of noise on Cognitive and mental components among workers in a steel industry and industrial firm during various exposure times. Based on studies regarding the harmful physical factors harmful to workers in the workplace, the noise has been proven as a risky job factor that affects millions of workers around the world (Dehaghi et al., 2014). Noise has different effects, of which physiological and psychological disorders caused by physical stressors in the body can be cited. noise-induced psychological disorders are anxiety, stress, depression, sleep disorders, and impaired mental function and information processing (stimulus identification, response selection, and response planning) (Alimohammadi et al., 2015). In a study, Alexander F. Lubitz in a sample of 734 healthy participants examined mental cognitive problems in various cognitive domains. Differences in types of cognitive problems with multivariate analysis of variance was evaluated. The results indicate the general level of cognitive problems that are greatly affected by depression in individuals and young people have more cognitive problems and in this regard is consistent with the present study (Lubitz et al., 2018).

The results of HAINES ‘study, cognitive function and health of 340 children aged 8 to 11 years were performed in noisy areas on London airport. noise of aircraft and noise of outside the home compared with. Cognitive tests were performed for children. The results showed that exposure to aircraft noise was associated with higher levels of annoyance. Chronic exposure to aircraft noise disturbances, including
loss of comprehension and increase discomfort and annoyance associated with orientation similar to the current study's results (Haines et al., 2001). The results of Techera, conducted to identify the factors affecting job fatigue, showed that sleep deprivation and environmental factors like noise, vibration and temperature are the most essential elements in causing mental and psychological disorders in people, which is consistent with the present study in that noise affects mental disorders (Foreman, 2012). Moreover, Stanfel examined high and low noise in various places and the occurrence of mental disorders, stating that the level of noise pressure is not significantly related to individuals' stress and anxiety, but there is a significant relationship between the level of depression and the level of noise pressure, in line with the results of the present study (Pugh et al., 2007). In another study, By Phil Leather, the effects of job noise on job-psychological-social stress were examined, and the results showed that job noise, even at low levels, would have negative effects on various aspects of job stress. Working with it has shown that the direct effect of noise on stress is consistent with the present study (Leather et al., 2003). A study by Jafari looked at the negative effects of various paradigms of exposure to noise on the nervous system and endocrine glands, hippocampal and neocortical structures, cognitive functions and the development of Alzheimer's-like neurological diseases in the brains of laboratory animals. And it has been shown that exposure to chronic noise disrupts the nervous system and endocrine glands, leading to hyperactivity of the sympathetic parts of the autonomic nervous system (ie, hypothalamus-pituitary-adrenal) and stress hormones. Increases brain and behavioral impact, so it can be said to be consistent with the present study (Jafari et al., 2019b). The results of this study in relation to hearing loss confirm the results of Chen and Morata in industry (Morata et al., 1997, Chen and Tsai, 2003). In Kui Wang entitled “Intercultural validation of DASS scale in China,” which is consistent with the present study in terms of the type and method of study, the findings of the present study show that the level of anxiety and stress in the case group is at a high level. In other words, one can state that depressed people have a higher level of anxiety than the control group (Arnsten and Goldman-Rakic, 1998). In another study of Di Blasio associated noise of everyday conversations loud or slow the discomfort, mental health, performance was assessed and it was shown that in speaking slowly increase the discomfort of noise, low efficiency of labor and increasing signs It is more related to mental health and is not consistent with the present study (Di Blasio et al., 2019). Another study by Abbasi, the relationship between noise and distress, job satisfaction and job stress in a textile industry was examined, and the results showed that among the average job satisfaction, job stress, noise sensitivity and discomfort between the groups And there is a significant difference in control. Also, noise sensitivity has the greatest effect on increasing job stress and job satisfaction in people in the group, and the results are in line with the current study (Abbasi et al., 2019).

A limitation of the study was the problems that the researchers encountered to convince the stakeholders in the industry to participate in the study. In particular, some workers were reluctant to complete questionnaires at different times during their work. The results indicated a significant and positive relationship between noise above the allowable limit with mood and mental processing showing that noise in working group employees who are extroverted affects cognitive and mental components more than the control group and affects the balance of the variables of this test. Thus, it is necessary that managers of organizations when conducting recruitment tests in pre-employment interviews consider the
personality traits of individuals and people to improve and control mood and mental processing and are recruit those to the organization that can show higher job health in the organization.

**Conclusion**

In this study, three research fields—Depression Anxiety Stress and mental processing with personality type—have been integrated to examine the relationship between harmful noise exposure and Cognitive and mental health components. The current study contributes to the limited Cognitive and mental health research in workers of IRAN to show almost a half of a large and demographically diverse sample of steel workers are not meeting the criteria for optimal Cognitive and mental health. This study also extends current international knowledge to show every harmful Work-related risk factor is associated with a broader, more complex notion of Cognitive and mental health components. It is likely this relationship between Cognitive and mental health components and harmful noise is bidirectional giving rise to the debate that holistic approaches are needed to promote cognitive health in workplace. The results suggest that changing employee attitudes toward stressors and reducing stressors, including administrative/organizational pressures and lack of support, may lead to decreased performance and mental processing. The limitations of the present study are taken into account when interpreting our results. In the first stage, a cross-sectional design (case-control) design prevents any causal effects of stress on performance and mental processing. Second, a relatively small population worked night shifts and reduced statistical power to detect real psychological effects. Third, the noise of people’s daily conversations may be the cause of measurement errors. However, stressful events were limited to the occurrence of the past year to minimize the call for prejudice. Future studies using biological markers of stress such as cortisol and sleep measurement are objectively necessary.

**Abbreviations**

**WHO:** World Health Organization

**CPI:** The California Psychological Inventory

**DASS:** Depression, Anxiety and Stress

**ISO:** International Organization for Standardization

**ISO 9612(2009):** specifies an engineering method for measuring workers' exposure to noise in a working environment and calculating the noise exposure level.

**Declaration Of Conflict & Interest**

Ethics approval and consent to participate
In this research, all ethical considerations such as informed consent, preservation of anonymity and secrecy, voluntary participation in the interview were observed. The project was approved by the Ethics Committee of the Shahid Sadoughi University of Medical Sciences. (Ethics Committee approval number: IR.SSU.SPH.REC.1398.060).

Consent for publication

Not applicable.

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.

Competing interests

The authors stated that they had no known financial interests or competitive personal relationships that may appear to affect the work reported in this article.

There is no conflict of material or spiritual interest between the paper authors

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Authors’ contributions

H.A participated in the study design, analysis, and wrote the manuscript. H.A & A.A 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. R.F & MJ.Z & R.J participated in the study design, interpretation of findings, and also wrote the manuscript. All authors read and approved the final manuscript.

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Figures

![Figure 1]
Kinds of jobs in the steel industry. Figure: shows the types of jobs in the steel industry based on the level of exposure to sound pressure levels. From left to right, the control group, facing the allowed level noise (less than 85 dB), is divided into three primary and homogeneous groups (the range of noise in this group is from 60 to 80 dB). The last 4 groups on the right show the case groups exposed to noise above 85 dB and unfavorable noise conditions (the range of noise in this group is from 85 to 110 dB).

Figure 2

Cognitive components affected by noise. Figure: Cognitive components affected by physical detrimental factors in the workplace (noise). Cognitive indicators (DASS, CPI, personality type) were applied to study the effect of noise on cognitive performance and showed in the above figure.