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Investigating the Relationship between Exposure Level to Sound Pressure Level (SPL) and Light Intensity with Occupational Burnout in an Automotive Parts Industry

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Abstract

Background and aim: noise pollution and poor lighting in workplaces can have detrimental effects on workers' health. The present study aimed to investigate the relationship between Exposure Level to Sound Pressure Level (SPL) and Light Intensity with Occupational Burnout in an Automotive Parts Industry. Methods: This descriptive-analytical study was conducted in 2018 during three consecutive seasons on 50 staff in the administrative section and 50 workers in the assembly section of an automotive parts industry. To collect data in the first stage, Geldard Burnout Inventory (1989) was employed. Data were analyzed by Pearson test, independent T-test, ANOVA and SPSS-22 software. Findings: The mean score of local lighting and equivalent sound pressure level in the exposure group were 274.62 lux and 78.46 dB, respectively. However, the mean scores of local lighting and equivalent sound pressure level in the control group were 396.38 lux and 53.24 dB, respectively. The mean scores of occupational burnout was 141.66 for the exposure group and 62.98 for the control group. The results of statistical analysis showed that there is a significant positive correlation between the mean scores of occupational burnout and the of equivalent sound pressure level ($p<0.05$). However, no significant correlation was found between mean scores of occupational burnout and age and education ($p> 0.05$). Conclusion: as the results show, it can be concluded that the study of noise and ambient environment may be important in occupational burnout. So, it is advisable to conduct more research on a larger sample and other workplace harmful factors.

Key words: Light Intensity, Sound Pressure Level, Occupational Burnout, Automotive Parts Industry

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Introduction

Nowadays technological advancement has spread to all industrial fields in such a way that it has resulted in the widespread use of various tools, equipment, and machinery. (Baesmat *et al.*, 2017; Szirmai, 2012) This advancement has made human beings be affected by unpleasant disturbances in their daily lives as well as in their workplaces more than ever. (Zamanian *et al.*, 2016) Occupational burnout has become widespread in contemporary human societies, encompassing all aspects of their lives. (Grunfeld *et al.*, 2000) Occupational burnout can be one of the inevitable consequences of job stress. (Fried and Fisher, 2016) This phenomenon is one of the occupational hazards receiving special attentions in recent years. In addition to the adverse physical effects, this problem has many psychological consequences especially in high-risk industrial jobs due to the stressful nature of these occupations. (Moshtagh Eshgh *et al.*, 2014; Torkaman *et al.*, 2017)

Occupational burnout has been implicated in mental illness, hypertension, and gastrointestinal problems. It is currently being studied by researchers because it is increasingly expanding. (Abazari *et al.*, 2017; Rafahi *et al.*, n.d.) Various factors such as lack of social support, conflict and confusion about role, type of management, overwork pressure, inappropriate work conditions, type of job and its detrimental factors are effective on occupational burnout. (Grunfeld *et al.*, 2000; Maslach and Leiter, 2008) Research has shown that occupational burnout has caused 300 million working days in the United States to be lost. Its imposed cost was estimated as $ 300 million in 2001. (Hanifi, 2007; Lăzăroiu, 2015) Numerous studies in Iran have examined occupational burnout among different occupations at education and healthcare centers such as nursing, midwifery, medical emergencies, and training health care providers. (Torkaman *et al.*, 2017; González-Morales *et al.*, 2012; Arab *et al.*, 2012 Najafi *et al.*, 2013) But, there are very few studies done on occupational burnout among industry workers. (Salahian *et al.*, 2015; Aslan and Ünal, 2010) Occupational burnout imposes many costs on organizations and staff, such as frequent shifts in jobs and workplaces (increases in job transfers), high degree of absenteeism and plenty of vacations, decrease in quality and quantity of work, affectedness of mental health, decrease in quality of services provided to clients, and recession and delays in the chain of specialized and administrative tasks. (Ahola *et al.*, 2010; Nahrgang *et al.*, 2011) There are many damaging risks in the industry, threatening workers' physical and mental health. (Mohebian *et al.*, 2018) Among these risks, sound level and light intensity are of high significance. (Mehri *et al.*, 2017) Noise can be defined as the unwanted and undesirable sound that one is exposed to. The distinction between desirable and undesirable sound can depend on various factors such as duration of call and frequency of sound. Workplace noise is also one of the most important problems in the industry. Ambient noise level, if permitted, can cause achievement of maximum system efficiency. (Farhang Dehghan *et al.*, 2013)

Doubtlessly our most important sense is vision. As a result, lighting is so important in workplaces. Lighting is an essential element for workers' safety and health of at work because it can make determination of the size, shape, color of tools and apparatuses more feasible, cause workers' attentiveness to increase, and ultimately prevent visual errors and workplace accidents. (Ganbari Head Tang *et al.*, 2016) An adult uses his/her eyes for about 16 hours a day, so the light intensity should be provided depending on the nature and type of tasks required to perform the job in the best workplace conditions. (Zamanian *et al.*, n.d.)

High noise and light levels can be identified as common workplace stressors. One of the occupational groups affected by these stressors are the workers in the automotive parts industry. Since labor forces are the largest and most valuable assets of the Iranian manufacturing industry, so this study is the first to investigate the relationship between exposure to sound pressure level and light intensity with occupational burnout which may be created and intensified by stressors. This issue was studied on two exposure and control groups in the period of three consecutive seasons. Occupational burnout in the industry can lead to a decline in the quality of service delivery along with a variety of stressors and job stresses.

Methodology

This descriptive-analytical study was conducted in 2018 in one of the manufacturing industries affiliated to IKCO. Initially, a preliminary review of the industry was carried out to select the sound-exposed sections. Then, volunteers of participating in the study were explained about the significance of the research subject. Then they signed informed consent forms. In this study, 50 employees were selected from the administrative section (as the control group) and 50 workers from the assembly section (as the exposure group). All participants were male with at least 6 months of work experience and under 50 years of age. Other interfering factors, such as suffering from hearing ailments and consuming some medications were also considered. After completing the questionnaire, those with congenital hearing impairment, consumption of antidepressants, and a second job were excluded from the study. After selecting the subjects, the sound pressure level and light intensity were investigated in the two exposure group (assembly workers) and the unexposed or control group (the staff).

Measuring individual exposure to workplace noise

A TES-1355 was employed for measurement of individual exposure to workplace noise. The noise dose level was calculated through Equation 1, and the 8-hr Time-Weighted Average (TWA) noise level was measured using Equation 2. (Nassiri *et al.*, 2013)

Equation 1

TWA = 10 log (Noise Dose daily noise exposure (D)/ 100*exposure time) + Standard sound pressure level*

Equation 2

$$leq_{8h} = 10log\left[\frac{1}{8}\sum_{i=1}^{n} 10^{lp_i/_{10}} \times t_i\right]$$

Daily Working Time (8 hours of exposure): 4 hours of standard sound pressure level: 85 dB (for the exposure group); and standard sound pressure level: 65 dB (for the control group)

Lp_i is the measured equivalent sound level, and t_i is the corresponding exposure time (hr).

All measurements were done in the morning shift at 25 ° C and humidity as 34%.

Measurement of local lighting

Light intensity was measured locally at the workstation of the participants. According to the recommendation of the Iranian Technical Committee of Occupational Health (ITCOH) there are enough stations to measure the local lighting. These three stations must be measured at work surface, including the maximum visibility timeout and two stations on its either side are in the visibility limit. None of the read numbers should be lower than the recommended limit. In this study, three points were measured on the work surface and the mean of those numbers was considered as the light intensity at that point. The Lutron Lx-110 (made in Taiwan) was used to measure the light intensity. In each station, the light intensity measured on the surface horizon indicates the distribution of light intensity on the surface.

Occupational burnout

Geldard Burnout Inventory (1989) was used to assess occupational burnout. This questionnaire was originally developed to measure counselors' job burnout and is currently used to measure work-related burnout. The questionnaire contains 40 items that show individuals' feelings to their jobs and to what extent they are at risk of occupational burnout. Each item of this questionnaire scores from 1 to 7. According to the norm of Geldard Burnout Inventory, participants who have completed the questionnaire are divided into 4 groups (Aziznezhad and Hosseini, 2006):

1. Individuals who are very active (burnout score below 81);
2. Individuals who do their job well (score between 81 and 120);
3. Individuals who are not in good occupational conditions (burnout score from 121 to 200); and
4. Individuals in need of urgent measures (burnout score above 200).

Khakpour and Birashk obtained its Cronbach's alpha coefficient as 86%, and Esfandiari as 73% using the test-retest method. (Khakpour and Birashk, 1999; Esfandiari, 2001)

Statistical analysis

Data analysis was done by SPSS-22 software. Descriptive statistics such as percentage, minimum, maximum, median and standard deviation were employed for presenting the demographic data, environmental monitoring, and burnout results. The Kolmogorov-Smirnov (K-S) test was used to determine the normality of the data distribution. The data was found to be normally distributed. Then, Pearson test was used to investigate the relationship between age, work experience and burnout and also significant difference between individuals' noise exposure and light intensity with occupational burnout scores. Independent t-test and ANOVA were employed to examine the relationship of smoking and education level with occupational burnout, respectively. P<0.05 was considered as the significance level.

Findings

Results indicated that mean age and work experience of the exposure group were 34.48 years old, 7.58 years, while those of the control group were 32.36 years old and 6.76 years, respectively. Table 1 illustrates the participants' demographic characteristics, including age, height, weight, smoking status in the two exposure (n = 50) and control (n = 50) groups.

Table 1 – participants' demographic characteristics of in two exposure (n = 73) and control (n = 27) groups

Variable	Exposure group	Control group
Age (years old)	34.48 (6.73)	32.36 (6.23)
Height (cm)	176.60 (9.13)	178.44 (9.58)
Weight (kg)	81.08 (10.97)	83.26 (10.51)

Smoking state	Yes	7 (14%)	-
	No	43 (86%)	50 (100%)

* P < 0.05 considered to be statistically significant.

The results of equivalent sound pressure level and local light intensity of 100 stations in two assembly and administrative sections showed 84% of local lighting measured in the assembly section to be between 200-300 lux, and 96% of measured local lighting in administrative section to be between 300-500 lux. 82% of equivalent sound pressure level obtained in the assembly section was below 85 dB A and 2% of equivalent sound pressure level achieved above 65 dB A. Also the mean scores of the equivalent sound pressure level and local light intensity of the exposure group was higher than the control group's (Table 2).

Table 2. Mean scores of the equivalent sound pressure level and local light intensity in the exposure and control groups

p-value*	Autumn		Variable
	Mean SD		
	Control group	Exposure group	
0.00*	396.38 (61.84)	274.62 (31.32)	Local light intensity (lux)
0.00*	53.24 (6.75)	78.46 (12.74)	equivalent sound pressure level (dB) (8-hr TWA)

The mean scores of occupational burnout were obtained as 141.66 ±56.54 for the exposure group and 62.08 ± 23.21 for the control group. The results also showed that in the exposed group, the occupational burnout score was below 81, 81 to 120, and 121 to 200 are 20%, 24% and 56%, respectively. The results of occupational burnout assessment of participants in the two exposed and control groups are shown in diagram 1.

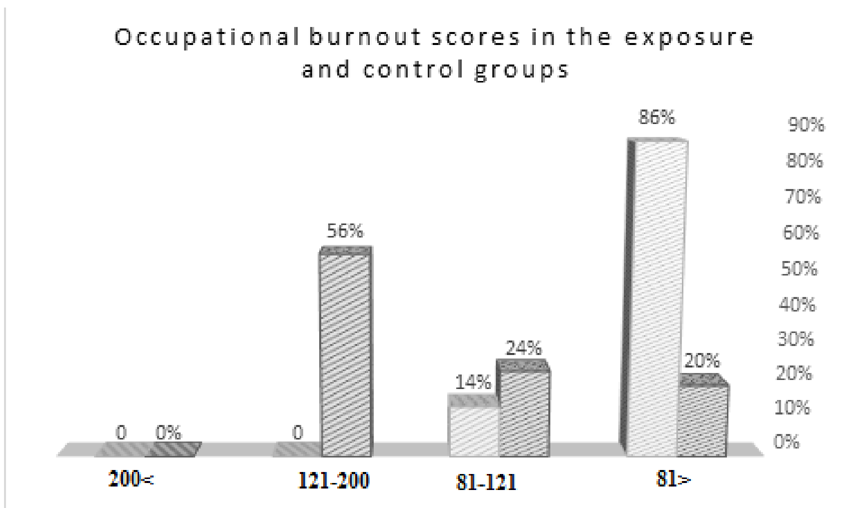

Diagram 1- relative frequency distribution of occupational burnout scores among participants

According to the findings of Table 3, there is a significant positive correlation of occupational burnout with local light intensity and equivalent sound pressure level, that is to say, the more these criteria increase, the higher the occupational burnout score is (P> 0.05).

Table 3. Relationship of demographic variables and measured environmental parameters with occupational burnout scores in the exposure group (n = 100)

Pearson correlation coefficient	p-value	Variable
0.104	0.33	Age
0.019	0.848	Work experience
0.687**	0.000	8-hr TWA
-0.550**	0.000	Local light intensity

The data analysis results displayed that there was no significant correlation between occupational burnout and smoking status of the study population (p> 0.05), (t = 1.85). The results also showed that there is no significant correlation between occupational burnout and marital status of the study population (p> 0.05).

Discussion and Conclusion

This study was conducted in an automotive parts industry affiliated with IKCO to investigate the relationship of the noise exposure level and light intensity with occupational burnout. Noise can cause nerve irritation, mental and physical exhaustion, dizziness, headache, anger, aggressive behaviors, distraction, and sleep disturbance. It can also increase the heart rate, blood pressure, oxygen consumption, and high respiratory rate. Various articles have also offered that noise causes stress in individuals, which is itself a factor that causes occupational burnout. Consequently, research indicates the significance of noise in workplaces in the occurrence of occupational burnout (4, 5).

The sound measurement results in 50 stations in the assembly section showed that about 9 stations were at risk (with noise above 85 dB), while the survey of 50 stations in the administrative section showed that some 2 stations were at risk (with noise above 65 dB). The research results also showed that there is a significant positive correlation between burnout with local lighting and equivalent sound pressure level (p <0.05), that is to say if these indices increase in the workplace, the occupational burnout score increases. Moreover, the results indicated that the control group (working in the administrative section), the staff were in a good condition in terms of individual exposure to sound pressure level and light intensity the workplace. The results showed that this group had an inappropriate situation in terms of personal exposure to noise level and light intensity in the workplace and the occupational burnout score was higher in this group. The results of workplace noise assessment displayed that the major portion of the hazard area is related to profile saws, milling machines, tissue casing, and mangles, which can be identified as the main source of noise.

The reasons for unfavorable lighting can also be attributed to inappropriate work surface layout, inappropriate lighting arrangement, and simultaneous use natural and artificial lighting sources. As a result, by revision and redesign of the existing systems can be achieved by using sufficient number of lights and the correct layout pattern and light intensity for locations less than the limit and more than the limit. Low light levels in the workplace can lead to intraocular pressure, headache, dizziness, fatigue, and musculoskeletal disorders. Excessive levels of light in the workplace can cause headaches, fatigue, stress, eye irritation, and anxiety. (Golmohamadi, 2003) Therefore, the amount of light needed in the industry should be examined and, if not permitted, it should be modified.

Since occupational burnout can be introduced as one of the inevitable consequences of job stress, (Fried and Fisher, 2016) it is therefore important to examine occupational stress and its factors in a workplace. Workplace stress remains a very pervasive issue having direct negative effects on people exposed to it. It also indirectly affects industries by imposing costs. Job stress refers to harmful physical and emotional responses that occur in workplaces when the requirements of the job do not match the capabilities, resources, or needs of the worker. Job stress matters to our health and our work. One of the factors causing stress at work can be inappropriate working conditions such as noise and inadequate lighting. Thus, industries must be able to eliminate stressors and work-related factors and be able to identify and differentiate environmental factors and potential sources causing stress.

Nowadays it has been found that occupational stress can be linked to many physical, mental, behavioral, organizational diseases and disorders. Physical complications include cardiovascular disease, gastrointestinal, musculoskeletal disorders, immune system disorders, and cancers. There are a wide variety of diseases with mild to severe symptoms. Mild symptoms can be loss of appetite, insomnia, nerve impulse, headache, malnutrition, nail chewing, and decreased concentration. In more severe conditions and in burnout, anxiety disorders, psychogenic pain, and somatoform pain disorder occur in individuals. Behavioral consequences can be noted as absenteeism, smoking, sleep disturbances, drug abuse, alcoholism, and addiction. (Vosooghi Nairi *et al.*, n.d.)

Zamanian *et al.* examined the relationship of noise level and local lighting with occupational stress. They found that there is a direct and statistically significant correlation between workplace noise and occupational stress (p = 0.007). They also found out that the correlation between age and job stress was inverse and statistically significant (p = 0.01), these results are consistent with those of the present study. However, other results of their study showed that there was a significant correlation between work experience (p = 0.2) and job stress, that is inconsistent with those of the present study. (Zamanian *et al.*, n.d.)

A study by Khani Jazani *et al.* (2015) was conducted to study the relationship between job stress and adverse factors in a cement industry. The results showed that the mean scores of occupational stress in the study population was 45.01%, and there was a statistically significant correlation between noise factors and occupational stress (p <0/01). But there is no correlation between job stress and light intensity, which is inconsistent with the results of the present study. (Khani Jazani *et al.*, 2016)

As the results offered, it can be stated that workplace physical factors are important in occupational burnout and further research should be done in this area. Also, identifying the industrial workers' degree of occupational burnout and physical factors such as noise and light cause activities to reduce the effects of burnout and improve workers' productivity and quality of life. Furthermore, occupational burnout is a consequence of job stress that is important in the two areas. Occupational burnout affects individuals' physical and mental health and reduces the quality and quantity of services and production. Finally, it may be suggested that managers, employers, and workers be more familiar with the symptoms of occupational burnout and ways to deal with it. Relevant training classes to reduce occupational stress can be useful for workers entering the factory or having more than 5 years of experience. It also recommended that periodic analysis of the physical factors of the work environment be done.

Control of the physical factors causes dissatisfaction in a workplace with the design of general lighting system because the local method is less likely to cause shadowing and dazzling. It is better to use less lamp variety in the workplace, burnt lamps should be replaced as soon as possible, and appropriate arrangement of the work surface should be considered in accordance with workers' work intensity. Also acoustic tile should be applied for covering the workplace's ceiling and controlling workplace noise. Timely and appropriate maintenance of electronic equipment such as appliances, ventilation, etc. should be done. Finally, workers should use personal protective equipment if workplaces are not modified in terms of noise.

As the results show, it can be concluded that the study of workplace noise may be important in occupational burnout. So, it is advisable to conduct further research to clarify the subject with other harmful factors other than noise. Determining the risk level of physical harmful factors such as noise in a workplace can be a measure to reduce the effects of workers' occupational burnout and increase their productivity and quality of life.

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