



# Association of the working environment noise with occupational stress in industrial workers

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Received: 8 September 2020 / Accepted: 19 May 2021 / Published online: 22 June 2021

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## Abstract

**Aim** We aimed to investigate the association of the working environment noise with the psychosocial status and occupational stress level of the workers of an industrial company.

**Subject and methods** In this cross-sectional study, we enrolled all the employees at an industrial company. The Copenhagen Psychosocial Questionnaire was used to measure the workplace psychosocial factors and stress levels of the participants. Based on the sound level measurements, the company sections were divided into two areas: the areas with noise  $\geq 85$  dB (dB) A and the areas with noise  $< 85$  dB A. Then the participants were categorized into two groups based on the working area and the study variables were compared between the two groups.

**Results** We enrolled 401 workers from an industrial company. For 154 (38.4%) workers, the level of noise was equal to or above 85 dB A. According to the results of the Copenhagen Psychosocial Questionnaire, scores of the two groups were significantly different for scales related to cognitive, emotional, and sensory demands, possibilities for development, and predictability as well as workplace demand domain, which showed noise exposure level was significantly associated with perceived workplace demands ( $P = 0.002$ ).

**Conclusion** This study showed a slight association between the psychosocial status and the level of noise in the workplace environment.

**Keywords** Noise · Occupational stress · Psychosocial factors · Copenhagen psychosocial questionnaire

## Introduction

The workplace environment has been shown to have an influence on workers' health (Bergs 2002). Among the factors in the workplace, noise is an important factor that can influence the quality of life and health of the workers (Hunashal and Patil 2012). Noise pollution has been linked to many health problems, such as hypertension, metabolic syndrome,

cardiovascular disease, sleep disturbances, anxiety, hearing problems, and some other disorders (Alimohammadi et al. 2018; Jeong 2018; Kuehn 2018; Lee et al. 2017; Lewkowski et al. 2018; Shim and Han 2018; Tessier-Sherman et al. 2017). Moreover, current evidence shows that environmental noise can even act at the cell level and induce changes in the DNA methylation in the central nervous system (i.e., brain), and this can result in further complications (Guo et al. 2017). Therefore, noise pollution can create mood, cognitive, and behavioral problems in any individual. Current evidence has shown that noise has a role in developing stress in the workers of the polluted environment and exposure to noise and concomitant body vibration while doing cognitive works, which is usually seen in industrial workplaces, leads to an increased level of physiologic and psychological stress (Evans and Johnson 2000; Ljungberg and Neely 2007; Polajnar et al. 2012; Sjodin et al. 2012; Walinder et al. 2007). This can be due to both the unpleasant nature of noise and creating a tougher situation in the work environment (Sjodin et al. 2012). Following occupational stress, many other

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psychological and physiological problems such as depression or cardiovascular disease may develop (Kivimäki and Kawachi 2015; Oenning et al. 2018; Tennant 2001), which makes it an important issue in occupational health. On the other hand, those who work in places with less noise can have better concentration and less distraction and job psychosocial stress (Kjellberg et al. 1996; Leather et al. 2003). This stress leads to hormonal changes in the body, such as cortisol secretion which in turn causes fatigue, depression, insomnia, and burnout in the affected individual (Ahsberg 2000; Akerstedt 2006; Melamed et al. 2006). However, the data regarding the association of noise with the psychosocial status and occupational stress is limited.

The Copenhagen Psychosocial Questionnaire (COPSOQ) is a practical tool for the assessment and improvement of the psychosocial work environment that is widely used in occupational medicine setting (Kristensen et al. 2005a). This comprehensive questionnaire is provided in three versions—large, medium, and short size—and has high reliability and validity. The main domains of COPSOQ include job demands, interpersonal relations, leadership, person–work interface, health and well-being of the workers, and personality traits (Kristensen et al. 2005b). Few studies have used this instrument to assess the association of the psychosocial status of the employees with occupational noise exposure; however, more works are required on this topic.

Therefore, we aimed to investigate the psychosocial status and occupational stress level of the industrial workers and compare them between workers working in high and low noise level environments. We hypothesized that those who work in a low noise level environment are in a better situation regarding occupational stress and psychosocial status than their peers who work in a high noise level environment.

## Material and methods

In this cross-sectional study, we enrolled the employees at an industrial company in the southwest of Tehran in 2018. The inclusion criterion was working at the company for the past 1 year. The exclusion criteria were a congenital auditory problem, a history of hearing loss or ear conditions, a history of psychiatric disorders, and use of psychiatric or ototoxic medications.

For every individual participant, a demographic form was completed that included questions on age, marital status, level of education, job rank, type of working contract, years of affiliation to this company, and income. To assess the psychosocial status of the participants, the COPSOQ was completed by the workers (Kristensen et al. 2005a). We used the Persian validated and standardized medium-size version of the questionnaire consisting of 5 domains, 26 scales, and 95 questions (Pournik et al. 2015). COPSOQ assesses various dimensions

of psychosocial factors related to job, individual, organization, and person–work levels in the work environment. Five response categories on the Likert scale for intensity (from “to a very large extent” to “a very small extent”) or frequency (from “always” to “ever/hardly ever”) were available for most items. The direction of the scores followed the type of scale used. The computed indices were job demand, job content, interpersonal relationship, work–individual interface, and health and well-being. The level of noise was measured using a sound analyzer (TES1358C, TES electronic corp., Taiwan) in every section of the company. Based on these measurements, the company sections were divided into two areas: the areas with noise below 85 dB (dB) A and the areas with noise equal to or above 85 dB A. Then the participants were categorized into two groups based on the noise level of working area at a cut-off point of 85 dB, and the study variables as well as the COPSOQ scales and domain scores were compared between the two groups.

## Statistical analysis

The categorical variables were shown as frequency (percentage) and were compared between the two study groups by the chi-square test. The quantitative variables were shown as the mean (standard deviation) and were compared by student’s *t* test. For the COPSOQ, item responses score on Likert scales of 2 or 5 points on a 0–100 range. All scales were calculated as average scores. No-response items were considered as missing values. For assessing the combined effects of psychosocial work environment factors, we computed job demand index, job content index, interpersonal relationship index, work–individual interface index, and health and well-being index, by summing the values of scales within each domain after adjustment for the scoring direction. The result included scores from 0 to 200 for domains containing two scales (work individual interface), 0–500 for domains containing five scales (workplace demand, work organization, and job content), 0–600 for domains containing six scales (health and well-being), and 0–800 for domains with eight scales (interpersonal relations and leadership). A higher score of the domains indicates more adverse psychosocial conditions in the workplace (Kristensen et al. 2005a; Li et al. 2010). A linear regression model was performed to find the association of the study variables and each of the COPSOQ domains.  $P < 0.05$  was considered as the level for statistical significance. We used SPSS software version 24.0 for the data analysis.

## Results

From a total of 460 workers in the company, 401 workers completed the questionnaire and returned it

(response rate = 87%). All of the respondents were male and the mean age of the participants was  $38.5 \pm 7.8$  years (minimum 23, maximum 61 years). The range of the measured noise in the working sectors were 44 to 115 dB A. In 247 (61.6%) of the workers, the level of noise in the working environment was below 85 dB A and in 154 (38.4%) workers the level of noise was equal to or above 85 dB A. The age and years of work affiliation in the workers with noise level  $\geq 85$  dB A were significantly higher than the other group ( $P < 0.001$ ). The overall level of education was significantly higher in individuals who had exposure to noise levels less than 85 dB A ( $P < 0.001$ ). Moreover, all the office workers were working in areas with a noise level below 85 dB A and the number of operational workers who worked in an environment with a noise level  $\geq 85$  dB A was significantly higher ( $P < 0.001$ ). The details of the comparison of the baseline characteristics between the two study groups are shown in Table 1.

Based on the results of the COPSQ, the scores of the two groups were significantly different in scales 2, 3, 5, 7, and 11 (Table 2). Only workplace demand domain was significantly different between the two groups, which showed that the workers with a lower level of workplace noise had a better psychosocial status than the higher level noise workers ( $P = 0.002$ ) (Table 2).

In the linear regression model, the R squares for every domain as well as the association of the study variables were calculated (Table 3). The highest R square was for work–individual interface domain (R square = 0.281). Overall, there was a slight association between the workplace noise and the psychosocial status of the workers.

## Discussion

In this study, we found that there was a slight association between the level of noise and the psychosocial status of the workers in an industrial company.

Noise at the workplace has been linked to psychological stress. Consequently, noise and perceived stress were associated with job satisfaction and turnover (Applebaum et al. 2010). A study on preschool personnel showed that several subjective noise variables were related to annoyance and burn-out and the risk of stress and fatigue syndrome (Sjodin et al. 2012). Other studies on industrial employees concluded that exposure to occupational noise has a greater negative impact on job satisfaction over time among those performing complex jobs than who perform simple tasks (Melamed et al. 2001). Another study among the workers of a textile industry in Iran showed that noise sensitivity had a greater effect than noise exposure on increasing the occupational stress and job satisfaction (Abbasi et al. 2019). We similarly did not find any association between noise exposure and job satisfaction (scale 20 of COPSQ) in the present study. Interestingly the workers who are exposed to workplace noise above 85 dB did not report higher behavioral stress, somatic stress, and cognitive stress symptoms (scales of 24, 25 and 26 from COPSQ).

In a cross-sectional study on manufacturing workers that assessed the psychosocial aspects of stress by the short form COPSQ, noise failed to significantly predict the stress level, which is inconsistent with our findings. They found no significant association between work demand and stress level (Nuaim et al. 2015). Nevertheless, our study showed a statistically significant relation between noise level and work place demand that was

**Table 1** Baseline characteristics of the study population and comparison between the office and operational workers

Characteristic*	Total (n=401)	Workplace noise below 85 dB (n=247)	Workplace noise equal to or above 85 dB (n=154)	P value†
Age	38.5 (7.8)	37.1 (7.7)	40.5 (7.5)	<0.001
Marital status (married)	356 (88.8)	213 (86.2)	143 (92.9)	0.04
Type of working contract (formal)	228 (56.9)	141 (57.1)	87 (56.5)	0.91
Level of education				<0.001
High school diploma and below	190 (47.4)	94 (38.4)	96 (62.3)	
Above high school diploma	209 (52.1)	151 (61.6)	58 (37.7)	
Years of workplace affiliation	11.2 (8.5)	9.4 (8.3)	14.0 (8.1)	<0.001
Income <20 million Rials	193 (48.1)	116 (47.5)	77 (50.0)	0.63
Work type				<0.001
Operational	271 (67.6)	117 (47.4)	154 (100.0)	
Office	130 (32.4)	130 (52.6)	0 (0)	
Workplace noise level, dB	71.4 (16.4)	62.4 (15.1)	85.8 (1.7)	<0.001

\*Variables are shown as mean (standard deviation) of frequency (percentage) where appropriate

† $P < 0.05$  was considered as statistically significant

**Table 2** Results of the Copenhagen psychosocial test and its comparison between the study groups

Domains and scales*	Total (n=401)	Workplace noise below 85 dB (n=247)	Workplace noise equal to or above 85 dB (n=154)	P value†
D1: Type of production & tasks (work place demand)	<b>271.1 (58.7)</b>	<b>263.3 (60.7)</b>	<b>283.0 (53.5)</b>	<b>0.002</b>
S1: Quantitative demands	59.8 (16.4)	58.6 (16.6)	61.8 (16.0)	0.054
S2: Cognitive demands	63.8 (15.6)	61.5 (16.2)	67.9 (13.9)	<0.001
S3: Emotional demands	35.1 (20.2)	32.5 (19.8)	39.0 (20.1)	0.002
S4: Demands for hiding emotions	38.8 (22.3)	39.6 (22.8)	37.6 (21.6)	0.40
S5: Sensory demands	74.2 (18.1)	71.6 (17.8)	78.5 (17.9)	<0.001
D2: Work organization & job content	<b>223.3 (63.2)</b>	<b>225.8 (64.3)</b>	<b>219.2 (61.4)</b>	<b>0.33</b>
S6: Influence at work	48.1 (17.9)	48.2 (17.2)	48.0 (19.2)	0.93
S7: Possibilities for development	65.8 (20.7)	60.8 (21.2)	73.9 (17.2)	<0.001
S8: degree of freedom at work	31.2 (17.9)	32.1 (18.5)	29.6 (17.0)	0.18
S9: Meaning of work	72.6 (19.2)	73.0 (19.6)	71.9 (18.5)	0.56
S10: commitment to the workplace	58.7 (19.5)	59.8 (18.7)	56.9 (20.6)	0.15
D3: Interpersonal relations & leadership	<b>321.8 (104.7)</b>	<b>317.2 (102.1)</b>	<b>329.4 (108.9)</b>	<b>0.29</b>
S11: Predictability	55.2 (20.2)	56.8 (20.0)	52.6 (20.3)	0.04
S12: Role clarity	69.2 (16.3)	69.6 (16.6)	68.5 (15.9)	0.55
S13: Role conflicts	43.3 (18.8)	42.9 (19.5)	44.0 (17.8)	0.59
S14: Quality of leadership	61.3 (25.4)	62.4 (26.1)	59.5 (24.0)	0.28
S15: Social support	49.4 (20.7)	50.2 (19.9)	48.1 (22.0)	0.33
S16: Feedback at work	43.9 (22.6)	43.6 (20.9)	44.2 (25.2)	0.80
S17: Social relations	62.9 (20.0)	63.6 (19.5)	61.7 (21.0)	0.35
S18: Sense of community	78.5 (16.2)	78.2 (14.9)	78.9 (18.3)	0.69
D4: Work–individual interface	<b>83.6 (39.5)</b>	<b>82.5 (39.7)</b>	<b>85.5 (39.3)</b>	<b>0.46</b>
S19: Insecurity at work	41.1 (35.3)	41.2 (35.7)	40.9 (34.8)	0.92
S20: Job satisfaction	57.1 (19.5)	57.8 (20.2)	56.0 (18.5)	0.37
D5: Health & well-being	<b>144.2 (88.2)</b>	<b>143.8 (88.1)</b>	<b>188.8 (88.7)</b>	<b>0.91</b>
S21: General health	69.9 (17.5)	70.5 (17.2)	68.9 (18.0)	0.36
S22: Mental health	70.9 (16.9)	71.1 (16.9)	70.6 (17.1)	0.77
S23: Vitality	66.76 (18.2)	66.6 (18.2)	66.9 (18.4)	0.90
S24: Behavioral stress	21.3 (20.5)	21.6 (20.7)	20.8 (20.4)	0.69
S25: Somatic stress	12.7 (15.4)	12.3 (15.0)	13.2 (16.1)	0.61
S26: Cognitive stress	18.1 (19.8)	18.4 (20.0)	17.6 (19.7)	0.66

Values of the main domains of Copenhagen questionnaire are shown in bold

\*Variables are shown as mean (standard deviation)

† $P < 0.05$  was considered as statistically significant

measured by scales of cognitive demand, sensory demand, and emotional demand of COPSOQ, and this relation remained significant in the linear regression model. In the mentioned study, gender and interpersonal relationship were associated with stress at the workplace and according to the results of COPSOQ, the items of meaning of work, possibilities for development and commitment to the workplace had the highest score. Similarly, the respondents of our study reported higher level of meaning of work and sense of community at the work place. Moreover, they had a high score in scale of sensory demand, which means their job requires high precision. A recent study in Iran also showed that high level of noise in the work environment can increase the

incidence of tension and aggressive behavior in the workers, although this effect varied from person to person (Alimohammadi et al. 2018). Similar to our study, age and years of work affiliation were also related to the psychosocial stress in this study sample.

However, our study did not show a significant association between the level of noise and domains of COPSOQ, except for domain 1 (workplace demand), which means that the most influential effect of noise on psychosocial status of the workers comes from the workplace demand domain. In addition, we did not find more stress symptoms or less job satisfaction in exposed workers to workplace noise above 85 dB. One reason for this weak association may be the use of hearing

**Table 3** Results of the linear regression model for the associated factors with each of the psychosocial domains

Characteristic	Beta (regression coefficient)	P value*
D1: Type of production & tasks (workplace demand) (R square=0.12)		
Noise level	0.34	<0.001
Age	0.11	0.24
Work type	-0.3	0.01
Years of work affiliation	-0.24	0.77
Contract type	-0.74	0.42
Education level	-0.08	0.19
Income	-0.01	0.83
Marital status	0.13	0.04
D2: Work organization & job content (R square=0.06)		
Noise level	0.058	0.46
Age	-0.004	0.96
Work type	0.06	0.43
Years of work affiliation	-0.14	0.10
Contract type	0.05	0.63
Education level	0.02	0.72
Income	-0.13	0.17
Marital status	-0.03	0.66
D3: Interpersonal relations & leadership (R square=0.03)		
Noise level	0.06	0.46
Age	-0.05	0.60
Work type	0.13	0.11
Years of work affiliation	0.01	0.95
Contract type	0.03	0.78
Education level	0.07	0.28
Income	0.02	0.85
Marital status	0.06	0.38
D4: Work–individual interface (R square=0.28)		
Noise level	0.09	0.17
Age	-0.03	0.73
Work type	-0.06	0.36
Years of work affiliation	0.04	0.56
Contract type	-0.39	<0.001
Education level	-0.07	0.24
Income	-0.13	0.12
Marital status	-0.08	0.13
D5: Health & well-being (R square=0.08)		
Noise level	0.03	0.62
Age	0.09	0.34
Work type	-0.13	0.10
Years of work affiliation	0.111	0.19
Contract type	0.038	0.69
Education level	-0.08	0.22
Income	0.05	0.61
Marital status	-0.001	0.99

\*P < 0.05 was considered as statistically significant

protective devices and occupational health interventions in the studied company.

### Study limitations

Cross-sectional studies do not scientifically explain the cause-and-effect relationships, but comprehensive measurement of psychosocial hazards in the workplace by using a well-designed questionnaire (which measures psychosocial hazard dimensions related to modern work life) was the strength of this study. In addition, this study was conducted among workers of one industry and generalization of the results to the public and other working settings should be done with caution. Future studies with large sample size by recruiting participants from different industries over the country can provide higher external validity.

### Conclusion

This study showed a slight difference in the psychosocial status between different levels of noise at an industrial company, mostly in the workplace demand domain of the Copenhagen Psychosocial Questionnaire. Nonetheless, our findings do not rule out a possible association between occupational noise levels and the psychosocial status of the employees. Standardization of the working environment is beneficial in improving the psychosocial status of the workers. In this regard, we recommend organizational strategies and corrective actions to prevent stress in industrial workers.

**Acknowledgements** The authors sincerely thank the workers who participated in this study.

**Author contributions** Omid Aminian conceived and designed the experiments, contributed reagents, materials & data and involved in manuscript preparation and manuscript editing. Maryam Saraei conceived the experiments and was involved in manuscript preparation and manuscript editing. Mehdi Ahadi conceived the experiments, performed the experiments, and wrote the paper. Sahar Eftekhari conceived and designed the experiments, analyzed and interpreted the data, and was involved in manuscript preparation and manuscript editing.

**Data availability** The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

### Declarations

**Ethics approval** The study was conducted in accordance with the World Medical Association Declaration of Helsinki (revised in 2000). The study protocol was approved by the Ethics Committee of Tehran University of Medical Sciences.

**Consent to participate** A complete explanation about the purpose of the study was given to the participants and they all signed written informed consent.

**Competing interests** The authors declare that they have no competing interests.

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