Research Paper

Noise Exposure and Job Stress – a Structural Equation Model in Textile Industries

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Noise exposure is one of the most important physical agents in the workplace which can induce job stress in several ways. The aim of this study was to model the interactions between independent and mediating variables and job stress using structural equation modeling. In this study, Weinstein's noise sensitivity scale, noise annoyance questionnaire, Health and Safety Executive (HSE) job stress questionnaire and job satisfaction scale were used. To assess worker's noise exposure, the 8-hours equivalent continuous A-weighted sound pressure level ($L_{\mathrm{Aeq,8\,h}}$), was measured based on ISO 9612 (2009). To achieve the aims of study, the structural equation model was run using R software 3.4.1 and Cytoscape software 3.6.0. Based on the results, while there was a direct positive correlation of noise exposure on total job stress, there were also indirect positive effects through job satisfaction and noise sensitivity as mediator variables. Using hearing protective devices negatively affected total job stress through a direct pathway and an indirect pathway when job satisfaction was a mediator variable. Regarding the total effect of noise exposure and using hearing protection devices on job stress subscales, it can be concluded that noise exposure and using hearing protection devices had greatest effect on colleagues support and demand, respectively. It can be concluded that noise exposure and lack of hearing protective devices have a significant positive effect on job stress among workers of a textile industry. In addition to the direct effect, this factor can induce job stress through noise sensitivity, job satisfaction and noise annoyance. Therefore, measures which can decrease any of the mentioned factors, also can alleviate job stress.

Keywords: noise exposure; noise annoyance; noise sensitivity; job stress; job satisfaction; hearing protective devices.

1. Introduction

Due to progress in technologies and work complexity, job stress has become one of most important problems in the workplace. Job stress can be defined as "the harmful physical and emotional responses that occur when the requirements of the job do not match the capabilities, resources, or needs of the worker. Job stress can lead to poor health and even injury" (HARADHAN, 2012). Stress is affected by the occupational conditions, in combination with daily-life elements and personal character (MARCHAND *et al.*, 2005). Workplace hazards including physical and psychosocial hazards can cause job stress (CLEGG, 2001) which can lead to negative personal and organizational concerns such as mental and behavioural problems, physical consequences, reduction in performance and work related satisfaction (BEHESHTIFAR *et al.*, 2011; POURSADEGHIYAN *et al.*, 2016). If stress continues, it can result in some deviations in immunological, autonomic and neuroendocrine functions and subsequently cause mental and physical outcomes such as anxiety, cardiovascular disorders and depression (COOPER, MARSHALL, 2013). Noise exposure is one of the most important physical agents of workplace related to job stress (LEATHER *et al.*, 2003; MICHIE, 2002). Noise is a risk factor for sleep disorder, hearing loss, and other adverse health effects (ABBASI *et al.*, 2015a; 2015b; 2019; MONAZZAM *et al.*, 2018; KHOSHAKHLAGH, GHASEMI, 2017; JEFFERY *et al.*, 2013; KROGH *et al.*, 2019). Noise exposure can adversely impact on psychological function such as concentration, attention, task performance, emotional response and annoyance (SUN *et al.*, 2018; SZYCHOWSKA *et al.*, 2018; VASSIE, RICHARDSON, 2017; ZHANG *et al.*, 2018; ABBASI *et al.*, 2015a). Other factors such as noise annoyance, hearing protective devices (HDP) and noise sensitivity, which are affiliated and related to noise, have an additional effect on job stress. MELAMED *et al.* (1994) stated that use of HPD is possibly an additional source of stress. It is revealed that noise annoyance acts as a mediator for the effects of noise exposure and it can intensify the stress responses (BABISCH *et al.*, 2013). Noise sensitivity is a specific individual feature that can change the severity of reaction to noise. There are many occupational and non-occupational factors that can affect job stress, but this study considered some of occupational factors related to noise exposure in the workplace. The aim of this study was to model the interactions between independent and mediating variables and job stress using structural equation modelling.

2. Material and methods

This cross-sectional study was conducted in 2018 among workers of the Savadkouh textile industry. All workers studied were volunteers. The workers were employed in four departments: office staff, technical, spinning and weaving. In this factory, based on the requirements of hearing protective program, all workers who are exposed to the noise exceeding occupational exposure limit of 85 dBA must use hearing protective devices. If the occupational exposure limit is not exceeded, workers decide whether to wear or not hearing protective devices. Based on this, workers were classified into two groups including workers using hearing protective devices and not using them. Workers who did not use hearing protective devices properly were categorized into the second group.

In this study, Weinstein's Noise Sensitivity Scale (WNSS), noise annoyance scale, job satisfaction scale and the HSE Job Stress Questionnaire were used to determine the individual's noise sensitivity, noise annoyance, job satisfaction and job stress respectively. The questionnaires were delivered to the workers in the middle of their work shift. In this study, workers with hearing disorders and hearing loss more than 25 dB, workers with history of anti-stress drug use, individuals with less than 1 year of experience and non-volunteers were excluded.

3. Weinstein's Noise Sensitivity Scale (WNSS)

Noise sensitivity is defined as; "the internal state of any individual which increases their degree of reactivity to noise in general" (JOB, 1999; EKEHAMMAR, DORNIC, 1990). Weinstein's Noise Sensitivity Scale (WNSS) was used to measure the workers' noise sensitivity. The WNSS contains twenty-one questions related to a number of topics such as attitude to noise control, interference with concentration, attitude to noise and acquiring a sensitivity to noise. Of these, eight questions used a 6-point scale from zero (strongly agree) to five (strongly disagree) and remaining 13 questions are scored in opposite direction (five (strongly agree) to zero (strongly disagree)). The total score of WNSS varies from 0 to 105. The higher scores indicate a higher sensitivity to noise. Based on earned scores, study participants were categorized into three groups including: no sensitivity (a score less than 25th percentile), moderate sensitivity (a score from 25th to 75th percentile) and high sensitivity (a score greater than 75th percentile). ALIMOHAMMADI *et al.* (2006) in their study of the Persian translation of the WNSS confirmed that this questionnaire is a reliable and valid tool for determination of sensitivity to noise in Persian people (The Cronbach alpha coefficient was 0.78).

4. Noise annoyance scale

The World Health Organization (WHO) defines noise as unwanted sound (BERGLUND *et al.*, 1995). While sound level meters can measure sound pressure level, unwanted sound is perceived by humans as

"noise". Noise-induced annoyance is defined as an individual's adverse reaction to noise such as disturbance, dissatisfaction, irritation and bother due to noise. For determination of noise annoyance, ISO/TS 15666:2003 *Acoustics – Assessment of noise annoyance by means of social and socio-acoustic surveys was used* (ISO/TS, 2003). In this 11-point numerical scale, individuals indicate their sense of noise induced annoyance from zero to 10 in a numerical scale. The higher the score, the higher the amount of perceived noise annoyance. Workers were asked to answer a direct rating question as "thinking about the last (12 months or so), what number from 0 to 10 best shows how much you are bothered, disturbed or annoyed by (source) noise?". Score of 0, 2, 4, 6, 8, and 10 were classified as not at all, slightly, moderately, very and extremely annoyed.

5. Persian version of Health and Safety Executive Stress Indicator Tool

To determine work-related stress, the Persian version of HSE's Management Standards Indicator Tool was used (Marcatto *et al.*, 2014). This questionnaire is an appropriate inventory and index for identifying job stressors. Seven subscales of this questionnaire include; changes, demands, control, colleague support, management support, relationships and role. Change deals with how organizational change is managed and communicated at work, demands subscales deals with issues such as workload, work patterns and the work environment, control reflects how much individuals have control over their work, colleague support evaluates peer encouragement and support at work, and management support refers to encouragement, sponsorship and resources delivered by the employer, relationships indicate the way of communicating with other colleagues, and role refers to how much a person perceived her/his role in the organization. This tool is a 5-option Likert scale from 1 (never) to 5 (always) and its score ranges from 35 to 175. Higher scores indicate a higher level of job-related stress. The reliability and validity of the Persian version of Health and Safety Executive Stress Indicator Tool was confirmed in a study by Azad and Gholami (2011) (The Cronbach alpha coefficient was 0.78).

6. Job satisfaction scale

To measure job satisfaction, an 11-point Likert scale was used, with the higher score the higher level of job satisfaction. In this study workers were asked to mark the continuous scale from zero (no satisfaction) to ten (extremely satisfied) based on their perceived satisfaction in workplace. The question regarding job satisfaction was expressed as follows:

Currently, how satisfied are you with your job overall? (Wanous *et al.*, 1997).

7. Noise measurement

To assess worker noise exposure, a noise measurement was conducted based on ISO 9612 (2009). To estimate the range of noise level, workstations were inspected and an initial measurement in all of the stations was done and a noise map drawn. In the next step, all individuals determined their workstation and duration of work at each place on prepared map. For each individual, noise measurements were conducted in all of the workstation using a TES, 1358 sound analyser. With regard to the noise exposure level and duration of exposure at each location, the 8-hour equivalent continuous A-weighted sound pressure level ($L_{\mathrm{Aeq,8\,h}}$) was calculated for each person. Based on ISO 9612 (2009) requirements, the calibrated sound level meter was placed at height of 1.5 meter and the measurement was conducted for 15 minutes at each designated workstation where the noise fluctuation was less than 5 dBA. In other designated locations where fluctuation of noise was greater than 5 dBA, duration of the noise measurement was equal to duration of working at those locations. At the locations where the noise measurement was conducted for 15 minutes, measurements were repeated 3 times and average of repeated measurements was considered as exposure level in that location.

8. Statistical analysis

Quantitative variables were described by mean and standard deviation (mean ±SD). In addition, the assumption of normality of quantitative variables were evaluated using the Shapiro-Wilks test. For checking mean differences of understudy variables among job groups, ANOVA was used. Mean differences of understudy variables among noise exposure groups, groups of using and not using HDP, the independent-sample *t*-test were used. Correlations of continuous variables were checked by Pearson test. Structural equation modelling as a multivariate statistical technique was used to analyse structural relationships between stress, its subscales and independent (noise exposure and using hearing protective devices (HPD)) or moderate variables (noise annoyance, job satisfaction and noise sensitivity). Some goodness of fit indexes including fraction of chi-squared and degree of freedom, root mean square error of approximation (RMSEA), normed-fit index (NFI), comparative fit index (CFI), and incremental fit index (IFI) were used to evaluate the fitness of models. The data was analysed using R software version 3.4.1 and Cytoscape software version 3.6.0. All *p*-values less than 0.05 were considered statistically significant. The process of statistical analysis is presented in Fig. 1.
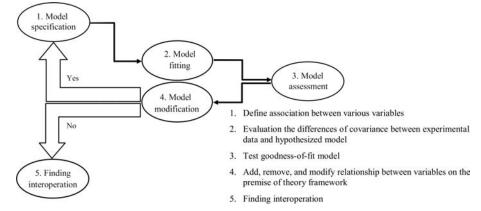
Fig. 1. Schematic view of process of statistical analysis.

9. Results

This cross-sectional study was conducted among 183 workers of a textile industry. The mean $\pm$ SD of individuals' age and work experience were 39.7 ± 6.4 and 14.8 ± 5.9, respectively. Also, 50 worker were no sensitive, 92 were moderately sensitive and 41 of them were highly sensitive to noise. The mean and standard deviation of sensitivity to noise for these three group were 54 ± 8.3, 71.3 ± 4.7 and 87.6 ± 5.9 respectively. In this study, 20.2% ($n = 37$) of participants were working as office staff, 21.9% ($n = 40$) were occupied as technician, 25.7% ($n = 47$) and 32.2% ($n = 59$) were working in the weaving section and 32.2% ($n = 59$) in the spinning department. These groups were exposed to 68.5 dB, 81.1 dB, 92.5 dB, and 94.5 dB of noise respectively. The frequency analysis of emitted noise in octave band is presented in Fig. 2.

Based on the frequency analysis it can be shown that at spinning and weaving department noise is dom-
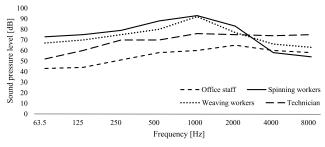

Fig. 2. Frequency analysis of emitted noise in octave band.

inant at the lower frequencies, but the trends of increasing noise level in accordance with increasing frequency is obvious at other departments.

The statistics of understudy quantitative variables in term of job groups and results of mean comparison of these variables using ANOVA are presented in Table 1.

Based on the results of ANOVA test, noise annoyance, noise exposure, noise sensitivity, role, colleagues support, control, demand, changes, total job stress

Table 1. Descriptive results of understudy quantitative variables in term of job groups.

	Office staff	Technician	Weaving workers	Spinning workers	p-value
Age [year]	39.9 ± 7.4	39.1 ± 7.0	40.2 ± 6.0	39.8 ± 5.8	0.88
Experience [year]	15.8 ± 6.9	14.9 ± 6.0	14.5 ± 5.7	14.3 ± 5.3	0.65
Noise annoyance	6.0 ± 2.8	6.1 ± 2.5	6.8 ± 2.2	7.6 ± 2.0	0.004^{**}
Noise exposure [dB]	68.5 ± 9.0	81.1 ± 6.1	92.5 ± 3.9	94.5 ± 5.6	0.001^{**}
Noise sensitivity	68.5 ± 13	66.5 ± 12.3	72.5 ± 15.6	73.6 ± 11.2	0.01^{*}
Role	21 ± 5.31	20.1 ± 4.6	21.4 ± 3.5	22.3 ± 2.4	0.04^{*}
Relationship	15.5 ± 3.7	14.5 ± 4.4	16.1 ± 3.2	15.7 ± 3.4	0.23
Management support	17.2 ± 5.1	16.7 ± 4.2	18.9 ± 4.0	18.1 ± 4.2	0.08
Colleagues support	13.9 ± 2.8	13.6 ± 3.8	15.5 ± 2.7	15.2 ± 2.6	0.009^{**}
Control	15.1 ± 4.0	16.1 ± 5.3	18.2 ± 4.1	17.0 ± 4.0	0.009^{**}
Demand	23.9 ± 5.3	22.2 ± 5.1	25.3 ± 4.9	23.4 ± 4.2	0.02^{*}
Changes	10.2 ± 3.5	9.1 ± 2.9	10.4 ± 3.0	11.2 ± 2.4	0.007^{**}
Total job stress	117.1 ± 20.5	112.3 ± 17.6	125.8 ± 12.3	123.1 ± 11.8	0.001^{**}
Job satisfaction	6.3 ± 2.2	$.7.0 \pm 2.4$	5.4 ± 1.4	5.8 ± 1.5	0.001^{**}

* Significant at the 0.05 level (2-tailed), ** significant at the 0.01 level (2-tailed).

and job satisfaction had a significant mean difference among job groups. More detailed results are presented in Table 1.

Based on the exposure level of the subjects to noise, 42.1% ($n = 77$) were exposed to noise less than the occupational exposure limit of 85 dB, and 57.9% ($n = 106$) were exposed to noise higher than 85 dB. In the first group, mean and standard deviation of nose exposure was 71.3 ± 7.6, and these values for second group were 93.3 ± 4.1. In this study 11.5% ($n = 21$) and 88.5% ($n = 162$) of workers were single and married, respectively. Sixty-five percent of participants used the hearing protective devices (HPD), but the remaining 35% did not use them.

For checking mean differences of understudy variables among noise exposure groups, and using and not using HDP, independent-sample t-test was used. Based on the results of this test, noise annoyance, role, relationship, management support, colleagues support, control, demand, changes, total job stress and job satisfaction had a significant mean difference between two noise exposure groups. The mean of age noise annoyance, role, relationship, management support, colleagues support, control, demand, changes, total job stress and job satisfaction were significantly different between two groups of using HDP and not using HDP.

Mean $\pm$ SD of individual's noise annoyance, sensitivity to noise and job satisfaction were 6.7 ± 2.4, 70.4 ± 13.4 and 6.0 ± 1.9, respectively. In Table 2, mean $\pm$ SD of understudy quantitative variables and the relationship between independent and moderate variables with dependent variables are presented.

The results obtained from Table 2 showed that total job stress, changes, control, colleagues support, management support, and role had a significant positive correlation with noise exposure. Also total job stress had a significant positive correlation with noise annoyance and sensitivity to noise but a significant negative correlation with job satisfaction. More detailed results are presented in Table 2.

In this study, effects of noise exposure and using HPD were evaluated using structural equations modelling (SEM). This multivariate statistical analysis technique can estimate the direct, indirect and total effects of noise exposure and using HPD on stress and its subscales. Separately, two models were fitted to compute the effects on total job stress and its subscales due to multi-collinearity of stress and its subscales.

Evaluating goodness of fit of model is one of the most important steps of structural equations modelling technique. In the current study, goodness of fit of both models was checked using several indices including chi-squared/degree of freedom, root mean square error of approximation (RMSEA), normed-fit index (NFI), comparative fit index (CFI), and incremental fit index (IFI). The values of these indices in Table 3 indicated that the estimated models fit the structural connection between variables correctly. In other words, the indices were confirmed regarding the "goodness of fit" of both models.

In the first model, the structure of connections between noise exposure, HPD, noise annoyance, noise sensitivity, job satisfaction, and total job stress was modelled.

Figure 3 shows the standardized estimates of direct effects and the connections between factors.

Table 2. Descriptive results and correlations between independent and moderate variables with dependent.

	Mean $\pm$ SD	Noise exposure [dB]	Noise annoyance	Noise sensitivity	Job satisfaction
		85.9 ± 11.8	6.7 ± 2.4	70.4 ± 13.4	6.0 ± 1.9
Total job stress	120.2 ± 16.0	$p = 0.001^{**}$ $r = 0.23$	$p = 0.001^{**}$ $r = 0.45$	$p = 0.001^{**}$ $r = 0.41$	$p = 0.001^{**}$ $r = -0.86$
Changes	10.3 ± 3.0	$p = 0.02^{**}$ $r = 0.17$	$p = 0.001^{**}$ $r = 0.32$	$p = 0.001^{**}$ $r = 0.37$	$p = 0.001^{**}$ $r = -0.34$
Demand	23.7 ± 4.9	$p = 0.12$ $r = 0.09$	$p = 0.28$ $r = 0.09$	$p = 0.66$ $r = -0.03$	$p = 0.001^{**}$ $r = -0.34$
Control	16.7 ± 4.5	$p = 0.003^{**}$ $r = 0.21$	$p = 0.001^{**}$ $r = 0.22$	$p = 0.09$ $r = 0.12$	$p = 0.001^{**}$ $r = -0.48$
Colleagues support	14.7 ± 3.5	$p = 0.001^{**}$ $r = 0.30$	$p = 0.001^{**}$ $r = 0.30$	$p = 0.001^{**}$ $r = 0.34$	$p = 0.001^{**}$ $r = -0.69$
Management support	17.8 ± 4.4	$p = 0.01^{**}$ $r = 0.17$	$p = 0.001^{**}$ $r = 0.17$	$p = 0.001^{**}$ $r = 0.39$	$p = 0.001^{**}$ $r = -0.57$
Relationship	15.5 ± 3.7	$p = 0.09$ $r = 0.13$	$p = 0.008^{**}$ $r = 0.12$	$p = 0.12$ $r = 0.12$	$p = 0.001^{**}$ $r = 0.12$
Role	21.3 ± 3.0	$p = 0.02^{*}$ $r = 0.17$	$p = 0.001^{**}$ $r = 0.17$	$p = 0.001^{**}$ $r = 0.45$	$p = 0.001^{**}$ $r = -0.37$

* Correlation is significant at the 0.05 level (2-tailed), ** correlation is significant at the 0.01 level (2-tailed).

Table 3. Goodness-of-fit indices.

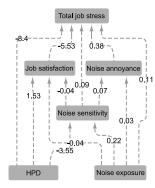| Goodness of Fit Index	Measured		Threshold
	Model of total job stress	Model of subscales of job stress	
Chi-squared/degree of freedom	2.57	0.70	<5
Root mean square error of approximation (RMSEA)	0.043	<0.001	<0.05
Normed-fit index (NFI)	0.994	0.990	>0.9
Comparative fit index (CFI)	0.996	1	>0.9
Incremental fit index (IFI)	0.996	1	>0.9

Fig. 3. Effect of noise exposure and using HPD on total job stress (explanation: the dash shows the direct effect of a variable on the dependant variables, and the number upon the dash shows effect size).

There was not only a positive and direct effect of noise exposure on total job stress (unstandardized effect = 0.11, p-value = 0.021), but also there were additional indirect effects using job satisfaction as a mediator variable (unstandardized effect = 0.205, p-value < 0.001). Noise exposure had an indirect borderline effect on total job stress when noise sensitivity was as a mediator variable (unstandardized effect = 0.020, p−value = 0.049). Additionally, there was no direct and indirect relation among noise annoyance and total job stress (unstandardized effect = 0.381, p-value = 0.144). In brief, direct, indirect, and total effects of noise exposure on total job stress were statistically significant. Details of results are shown in model I part of Table 4.

Importantly, the results of HPD, in this model, were the same as noise exposure. HPD affected total job stress with a direct pathway and another indirect pathway when job satisfaction was a mediator variable (unstandardized effects = −8.4, −8.43 respectively, both p-value < 0.001). Again, total job stress was not affected indirectly by HPD when noise sensitivity was as a mediator variable (unstandardized effect = −0.323, p-value = 0.119). According to Table 4, direct, indirect, and total effects of HPD on total job stress were inversely significant (p-value < 0.05).

The second model estimated direct, indirect and total effects of independent and moderate variables on subscales of stress. The main results are shown in Table 4 and Fig. 4.
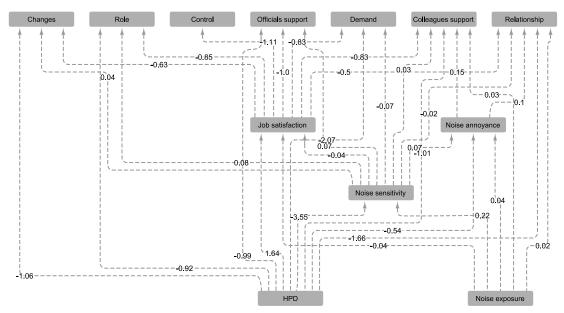

Fig. 4. Effect of understudy variables on job stress subscale (explanation: the dash shows the direct effect of a variable on the dependant variables, and the number upon the dash shows effect size).

Table 4. Evaluating the unstandardized direct, indirect, and total effects of hearing protective devices and noise exposure on job stress and its subscales.

| | Using hearing protective devices | | | | | | Noise exposure [dB] | | | | | |
	Direct	p-value	Indirect	p-value	Total	p-value	Direct	p-value	Indirect	p-value	Total	p-value
Total job stress	−8.4 (−10.9, −5.9)	0.001**	−8.76 (−11.52, −6)	0.001**	−17.16 (−20.5, −13.8)	0.001**	0.11 (0.02, 0.21)	0.021*	0.22 (0.11, 0.34)	0.001**	0.34 (0.19, 0.48)	0.001**
Role	−0.92 (−1.97, 0.12)	0.084	−1.81 (−2.6, −1.1)	0.001**	−2.73 (−3.9, −1.6)	0.001**	0	–	0.05 (0.03, 0.07)	0.001**	0.05 (0.03, 0.07)	0.001**
Officials support	−0.99 (−2.17, 0.19)	0.100	−2.04 (−2.87, −1.2)	0.001**	−3.03 (−4.27, −1.78)	0.001**	0	–	0.06 (0.03, 0.09)	0.001**	0.06 (0.03, 0.09)	0.001**
Control	0	–	−1.83 (−2.5, −1.11)	0.001**	−1.83 (−2.54, −1.11)	0.001**	0	–	0.04 (0.02, 0.07)	0.001**	0.04 (0.02, 0.07)	0.001**
Demand	−2.07 (−3.56, −0.6)	0.007**	−1.1 (−1.9, −0.32)	0.006**	−3.17 (−4.59, −1.74)	0.001**	0	–	0.02 (0, 0.05)	0.067	0.02 (0, 0.05)	0.067
Changes	−1.06 (−1.9, −0.26)	0.009**	−1.18 (−1.7, −0.71)	0.001**	−2.24 (−3.04, −1.45)	0.001**	0	–	0.04 (0.02, 0.06)	0.001**	0.04 (0.02, 0.06)	0.001**
Colleagues support	−1.01 (−1.8, −0.24)	0.010*	−1.71 (−2.3, −1.08)	0.001**	−2.72 (−3.59, −1.86)	0.001**	0.03 (0.01, 0.06)	0.018*	0.05 (0.03, 0.08)	0.001**	0.08 (0.05, 0.12)	0.001**
Relationship	−1.66 (−2.8, −0.54)	0.004**	−0.9 (−1.5, −0.32)	0.002**	−2.57 (−3.6, −1.53)	0.001**	0.02 (−0.02, 0.06)	0.428	−0.08 (−0.18, 0.02)	0.103	−0.06 (−0.17, 0.04)	0.244

Values in the parenthesis refer to 95% confidence interval.

* Correlation is significant at the 0.05 level (2-tailed), ** correlation is significant at the 0.01 level (2-tailed).

Explanation: direct effect means that independent variables can increase or decrease job stress or its subscales in accordance with the positive and negative sign of effect size. The indirect effect refers to the effects that independent variables can have on job stress or its subscales through the mediator variables. The total effect is sum of direct and indirect effects.

While there were no direct effects on role, management support, control, demand, and changes by noise exposure, these subscales were affected indirectly. As a result, the total effect of noise exposure on these variables was equal to the indirect effect. It should be noted that the significance level of indirect effect of noise exposure on demand was a borderline. Subscales colleagues support and relationship were affected both directly and indirectly by noise exposure. HPD affected role subscale indirectly but not affected directly; however, its *p*-value was a borderline. According to statistical significance, results of management support were the same as role subscale. In other words, HPD indirectly had significant negative effects on management support and role; however based on the degree of the effect, management support was more affected than role. There was a significant indirect effect of HPD on control but there was no significant direct effect. Demand, change, colleagues support, and relationship were not only affected directly by HPD but also affected indirectly. Interestingly, HPD had negative total effects (sum of direct and indirect effects) on the all subscales of stress. According to results in Table 4, demand and management support were more affected than others by HPD. Details of results are shown in model I part of Table 4.

10. Discussion

This study was conducted among workers of a textile industry to assess the effect of noise exposure and some related factors on job stress, and to model the interactions between independent, mediator and dependent variables. The main finding of this study is the effect of noise exposure on job stress. This result is consistent with the previous studies (MURSALI *et al.*, 2016; LEATHER *et al.*, 2003; EVANS, JOHNSON, 2000; WAYE *et al.*, 2002). MURSALI *et al.* (2016) indicated that there are two significant risk factors for work related stress in workers in the textile industry, namely noise exposure and use of hearing protective devices. The present study found similar results.

Based on the results presented in Table 2, noise exposure and job stress had a direct correlation with a coefficient of 0.23. In Fig. 3, the direct and indirect effect of noise exposure on stress was modelled. The results indicate that noise has direct and indirect effect on job stress. It can be seen from the results in Table 4 that indirect effects are 2 fold greater than direct effects. Based on findings in the previous studies, noise can directly induce occupational stress by increasing the release of stress hormones such as cortisol, noradrenaline and adrenaline (MASCHKE *et al.*, 2002; BABISCH, 2003). The indirect effect of noise exposure on work-related job stress is somewhat ambiguous, complex and multifactorial. Results of this study (Fig. 3 and first row of Table 4) indicate that the indi-

rect effect of noise on worker's stress (0.22(0.11, 0.34)) is 2 fold greater than its direct effect (0.11(0.02, 0.21)). Noise exerts its indirect effect via noise sensitivity and job satisfaction. The indirect effect via job satisfaction (0.04 · 5.53 = 22) is greater than that of noise sensitivity (0.09 · 0.22 = 0.2). The findings of the present study confirmed the results of a study conducted by LEE *et al.* (2016) which investigated the impact of noise on self-rated job satisfaction in open-plan offices. LEE *et al.* (2016) found that occupational noise exposure could decrease job satisfaction. FAIRBROTHER and WARN (2003) found that job satisfaction can negatively affect job stress. These studies support the hypothesis that noise can indirectly affect job stress via job satisfaction. The authors of this study have shown that exposure to high levels of noise adversely influences job satisfaction, and subsequently has a negative effect on job stress. Based on the results obtained in this study, it can be stated that noise exposure can increase job stress through the reduction of job satisfaction.

Noise sensitivity was another mediator for the effect of noise exposure on job stress. In this study, a weak relationship between noise exposure and noise sensitivity was observed which is consistent with the study by JOB (JOB, 1988; ABBASI *et al.*, 2020). In other words, noise exposure indirectly influenced job stress through increased noise sensitivity, which in turn led to an increase in occupational stress.

Results indicate that noise exposure had a significant direct effect on job stress. Also, a noise sensitivity had a direct and an indirect impact on job stress. These results are consistent with the literature (ZIJLEMA *et al.*, 2015; HILL *et al.*, 2014). Studies by ZIJLEMAA *et al.* (2015) and HILL *et al.* (2014) found that noise sensitive persons were vulnerable to stress. In addition, noise sensitivity has a strong relationship with impaired mental performance (LJUNGBERG, NEELY, 2007) and diminished mental health (KISHIKAWA *et al.*, 2009). Regarding the indirect effect of noise sensitivity on work-related job stress, noise sensitivity can increase job stress by adversely influencing both noise annoyance and job satisfaction. This result is confirmed by MONAZZAM *et al.* (2018) where noise sensitivity was found to be a main risk factor for increasing of noise annoyance in workers. The results shown in Fig. 3 also indicate that noise sensitivity has an effect on job satisfaction. A noise sensitive person is more vulnerable to noise and susceptible to its adverse health effects. For this reason, it is expected that noise sensitive people who are exposed to noise expressed more job dissatisfaction. However, in a quiet environment without a noise stimulus, it is reasonable that job satisfaction does not change in a noise sensitive person. As indicated by NAM *et al.* (2016), job dissatisfaction has a negative correlation with job stress.

In addition to the impact of the noise exposure on job stress, Fig. 3 indicates that noise exposure has an additional indirect pathway to a detrimental effect on job stress via the job satisfaction. This result is consistent with the Lee *et al.* (2016) finding that the implied duration of annoying sound had a significant impact on job satisfaction. It is clear that noise can affect job satisfaction directly and indirectly through noise sensitivity.

Although noise exposure has a significant effect on job satisfaction, other intrinsic elements to a job such as: role in organization, career development, relationship at work and organizational structure and climate can influence job satisfaction. These elements are outside the scope of the present study (Michie, 2002). Job satisfaction that is reduced by noise exposure can adversely affect job stress. The result of this current study is consistent with other studies stating that there is a negative and significant bilateral relationship between work related stress and job satisfaction (Michie, 2002; Nam *et al.*, 2016; Fairbrother, Warn, 2003).

Another main finding of the present study is the effect of the use of HPD on job stress. Based on this study's findings appropriate use of HPD had a significant inverse relationship with job stress. This result is consistent with the findings of Mursali *et al.* (2016) which revealed that the habit of not applying HPD was a prevailing risk factor causing work related stress. Mursali *et al.* (2016) stated that employees in a noisy workplace who did not continuously apply or had never applied HPD had a higher perception of stress than workers in low-level noise conditions who did not use HPD. The usage of HPD is one of the practical ways for decreasing the intensity of perceived sound and subsequently decreasing the experienced job stress.

As shown in Fig. 3, HPD indirectly affected job stress via job satisfaction. With a similar analogy, when workers wear HPD, they perceive their workplace as quieter; therefore their jobs seem more satisfying. While incorrect usage of HPD may decrease the efficiency of these devices, wearing HPD may constitute a feeling of being safe against the adverse health effects of noise. As a result, compliance with the requirements of the labour law may lead to a sense of job satisfaction and reduction of job stress.

The results in Fig. 4 and some parts of Table 4 show that some subscales of job stress including demand and colleague support are more directly affected by hearing protective devices and noise exposure respectively. The indirect effect of noise exposure and HPD on relationship and management support subscales was stronger. Regarding the total effect of noise exposure and HPD on job stress subscales, it can be concluded from Table 4 that colleagues support and demands were the most affected subscales of job stress.

There were a several limitations in the present study. This study was cross-sectional which can be a source of bias. In this study, only a number of variable which were related to occupational noise were studied. The effects of organizational and other personal and environmental affective factors were not included.

11. Conclusion

It can be concluded that noise exposure and use of hearing protective devices have a significant effect on job stress among workers of a textile industry. That means, reducing noise exposure and using hearing protective devices can lead to reduced job stress induced from noise exposure. In addition to the direct effect, this factor can induce job stress through the noise sensitivity, job satisfaction and noise annoyance pathway. Considering these, it can be stated that decreasing noise exposure through administrative and engineering control measures, especially the proper use of hearing protective devices can alleviate job stress directly. As well as, measures such as educational interventions regarding making a positive attitude toward noise or educational interventions aiming reducing annoyance due to noise exposure, can decrease noise-induced job stress, indirectly.

Disclosure of conflicting interests

The authors declare that there is no conflict of interest to disclose.

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