

## Relationship between noise and job stress at a private thread spinning company

Andi Mursali,<sup>\*a</sup> Endang Basuki,<sup>\*</sup> and Suryo Dharmono<sup>\*\*</sup>

### ABSTRACT

\*Department of Community  
Medicine, Faculty of Medicine,  
University of Indonesia, Jakarta

\*\*Department of Psychiatric,  
Faculty of Medicine,  
University of Indonesia/  
Central National General  
Hospital Dr. Cipto  
Mangunkusumo, Jakarta

#### Correspondence

<sup>a</sup>dr. Andi Mursali, M.Kes  
Department of Community  
Medicine, Faculty of Medicine,  
University of Indonesia, Jakarta  
Email:  
dr\_andimursali@yahoo.com

*Univ Med 2009; 28: 8-16*

Noise exposure is one of the major occupational hazards in many places, and has several health effects, including hearing loss and psychological effects such as sleep disturbances and mental stress. The objective of this research was to determine the relationship between noise and stress and other risk factors that affect job stress. A cross-sectional comparative design involved a total of 326 workers consisting of 220 workers in high noise conditions and 106 workers in low noise conditions. The data were collected directly from the respondents by filling out the questionnaire on worker characteristics, the stress diagnostic questionnaire, and the symptom checklist 90, through discussions with company management, and by measurement of noise levels. The job stress prevalence in workers in high noise conditions was 55% and in those in low noise conditions 24.5%. The results showed that risk factors such as gender of workers, noise conditions, habitual use of ear plugs, shift work, and work stressors had a significant relationship with job stress. Multivariate analysis indicated that the habit of using earplugs was a dominant risk factor causing job stress. The prevalence of job stress in high noise conditions was higher than that in workers in low noise conditions. Noise conditions have a significant relationship with job stress (OR=2.46; 95% CI 1.33 - 4.55). Workers in high noise conditions who did not always use or never had used ear plugs had a higher chance of experiencing stress than those in low noise conditions who did not need ear plugs (OR=21.76; 95% CI 8.09 - 58.52). This study supported that noise exerts its health effect via stress, since noise often raise stress in various ways.

**Keywords:** Noise, job stress, ear plugs, workers, thread spinning

### INTRODUCTION

Stress can be defined in several ways, and it is important to use an approach that covers the different concepts. One definition of stress

at work (job stress, work-related stress) is “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”.<sup>(1,2)</sup> Normally the worker should

make a successful adaptation to the work environment. The purpose of this adaptation is to minimize or eliminate discomfort caused by environmental stressors. Successful adaptation to a stressor will not cause problems, thus the resulting stress is an agreeable stress called eustress or positive stress. If the adaptation is incomplete or if the stressor is stronger than the defense mechanism of the individual, then the result will be disagreeable or uncomfortable stress. This condition is frequently called distress or negative stress.<sup>(3)</sup> Negative stress (in the following discussion to be referred to simply as 'stress') may influence health and cause numerous health problems, including anxiety, arthritis, cancer, depression, heart disease, high blood pressure, and insomnia. In severe cases of job stress occurring over a prolonged period of time, psychological problems and psychiatric disorders may develop.<sup>(1)</sup> Stress may occur in various types of occupation, and European studies have found that the prevalence of stress varies between different occupations. Professionals reported the highest level of stress (40%), as compared with 17% in elementary occupations.<sup>(4)</sup> Two British studies, one of head teachers and one of police officers, found the prevalence of self-reported work-related stress to be 43% and 41%, respectively.<sup>(5,6)</sup> The prevalence of job stress in the production section of a Japanese machinery factory was 57.7%.<sup>(7)</sup>

Noise is one of the intrinsic occupational factors that may cause job stress. Several studies indicate that occupational noise exposure is correlated with blood pressure changes and cardiovascular disease.<sup>(8,9)</sup> A cross-sectional study showed that there was no significant association between noise intensity and increased noise induced hearing loss.<sup>(10)</sup> Noise plays a substantial role in stress causation in workers. This is due to the fact that certain individuals are unduly sensitive to noise in comparison to others. Ivancevich is of the

opinion that repeated excessive noise (around 80dB) for a prolonged period of time may induce stress.<sup>(11)</sup> High-intensity noise may cause headaches, drowsiness, high blood pressure, occupational stress, muscle fatigue, and lack of concentration. Exposure to excessive noise may reduce the work ethos and result in increased absenteeism, thus decreasing work productivity.<sup>(12)</sup> Japanese studies in male workers aged 40 to 59 years indicate that around 35% experience noise-related stress.<sup>(13)</sup> Exposure to moderate levels of noise may also result in psychological disorders (gastrointestinal, sleep and psychosomatic disorders) and physical disorders (high blood pressure and raised levels of stress hormones).<sup>(14)</sup> Among a total of 2,368 company workers, female workers exposed to noise apparently suffered from somatic symptoms, anxiety, depression and irritability, whereas male workers presumably suffered only from irritability.<sup>(15)</sup> The use of ear muffers is one of the means for reducing the intensity of perceived noise.

If early stress symptoms are found in workers and the etiologic factors of these symptoms have been determined, then immediate steps have to be taken for managing early stress symptoms in those workers.<sup>(15)</sup> Stress is caused by multiple factors, thus no simple solution is available for application. Different cases of stress call for individualized solutions in stress management. One of the most ideal solutions is preventing the occurrence of early stress symptoms in workers. This may be attained by taking care of the core of the stress problem, this being the cause of stress itself. Studies on the relationship between noise caused by spinning machinery and job stress have been few in number. The aims of the study was to identify the risk factors of job stress at a private thread spinning company, where noise is presumably the principal risk factor of job stress.

## METHODS

### Research design

The present study uses a comparative cross-sectional design for determination of a relationship between noise and the occurrence of job stress, conducted from December 2007 until January 2008.

### Population and study subjects

The target population under study comprised the rank and file workers at a private spinning company in Citeureup, totalling 601 individuals. The minimal sample size needed was 326 persons, calculated using the following formula:<sup>(17)</sup>

$$\begin{aligned} n_1 &= \frac{Z_{\alpha}^2 \times p \times (1-p)}{d^2} \\ &= \frac{1.96^2 \times 0.26 \times 0.74}{0.05^2} \\ &= 296 \\ n_2 &= n_1 + 10\% n_1 \\ &= 296 + 30 \\ &= 326 \end{aligned}$$

The inclusion criteria in this study were: workers who had worked for at least 6 months with the company, and who were willing to participate in the study and sign a written consent. The exclusion criterion in this study was workers with severe hearing disorders. The study participants were recruited by proportional purposive sampling among workers in high and low noise conditions. For workers in high noise conditions ( $\geq 80$  dB) the sample size was 220, whilst for workers in low noise conditions ( $< 80$  dB) a sample size of 106 was obtained.

### Data collection

The variables investigated in this study consisted of dependent and independent

variables, where the dependent variable was job stress. The independent variables comprised personal characteristics (age, educational level, gender, marital status, length of employment, use of ear plugs), environmental factors (occupational stressors in the form of role conflicts, ambiguity of roles, work load, career development, work shift and the availability of ear plugs), and agent factor (noise). Data were collected by filling out of three types of questionnaire, namely the questionnaire on worker characteristics, the stress diagnostic survey questionnaire, and the symptoms checklist-90 (SCL 90). The questionnaire on worker characteristics collected data on workers, namely age, educational level, gender, marital status, length of employment, work shift, and the use of ear plugs. The stress diagnostic survey questionnaire consisted of 30 questions for measuring work stressor variables, namely ambiguity of roles, role conflicts, qualitatively excessive work load, quantitatively excessive work load, and career development. Stressors were negative (-) if the total score was 0–9, while stressors were positive (+) if the score was  $\geq 10$ . The SCL 90 questionnaire was used for measuring emotional mental disorders in workers, and consisted of 90 questions.<sup>(18)</sup> Mental or psychopathological disorders were positive (+) if the total score was  $\geq 61$  and negative (-) if the total score was  $\leq 60$ . Data on the use of ear plugs were obtained by discussions with the factory management.

### Measurements

Noise intensity data were obtained from the results of measurements performed by the investigators in the production section (high noise conditions) and in the non-production sections (low noise conditions). In both cases, noise level was determined using a Lutron sound level meter.

### Data analysis

Percentage analysis was performed to obtain stress prevalence, while simple logistic regression analysis was used to test various risk factors and stress events. To determine the dominant risk factor affecting the development of job stress, a multiple logistic regression analysis was conducted, and the risk factor affecting stress in the simple logistic regression analysis was included in the model. The level of significance of the bivariate analysis was  $p < 0.05$ . For the data analysis the SPSS 13 program was used.

## RESULTS

A total of 326 workers participated in this study, consisting of 55.8% (182/326) males and 44.2% (144/326) females. The mean age of the workers was 30.5 years. The number of workers in sections with low noise conditions was 32.5% (106/326), whilst the number of those employed in high noise conditions was 67.5% (220/326). The prevalence of job stress in high noise conditions was 55.0% whereas the prevalence of job stress in those in low noise conditions was 24.5%.

### Relationship between risk factors and job stress

The results of the relationship between several risk factors and job stress is shown in Table 1. Gender, use of earplugs and noise condition were risk factors of job stress among workers. The risk of job stress among workers who worked in a high noise condition were 3.76 higher than workers who worked in low noise condition (OR=3.76; 95% CI = 2.24-6.30).

### Dominant risk factor on occurrence of job stress

To obtain the dominant risk factor influencing the occurrence of job stress, a

multiple logistic regression analysis was performed. All significant variables in the simple logistic regression analysis were included in the model.

From Table 2 it is apparent that there were two significant risk factors, namely noise conditions and use of ear plugs. A correlation matrix, demonstrating a high correlation between noise conditions and use of ear plugs. This indicated the presence of colinearity between noise conditions and use of ear plugs.

From Table 3 it may be seen that noise condition was the dominant risk factor for occurrence of job stress (OR=2.46; 95% CI 1.33 - 4.55). From Table 4 it is apparent that the risk factor ear plug was a dominant risk factor for the occurrence of job stress, with (OR=21.76; 95% CI 8.09 - 58.52).

## DISCUSSION

In high noise conditions the prevalence of job stress was 55.0%, whereas the prevalence of job stress in low noise conditions was 24.5%. The prevalence of job stress of the production section in this study was lower than the value of 57.7% obtained in the study by Yoshio et al. in Japanese workers in the machinery section.<sup>(7)</sup> The difference may be due to differences in research design. The study by Yoshio used the cohort method based on observations made during a period of 2 years, whereas in the present study the cross-sectional method was employed, where study results were based on observations made at a given point in time.

In the present study gender had a significant correlation with occurrence of job stress. Female workers had a 1.57 fold greater chance for stress than their male counterparts. The available literature states that working females experience a higher level of stress in comparison with males workers.<sup>(3)</sup> A 6-year French cohort study on 8,847 male and 2,886

Table 1. Relationship between risk factors and job stress

Risk factors	Job stress						OR	P	95.0% C.I. for OR
	Absent n (%)	Present n (%)	Total n (%)						
<b>Noise condition</b>									
Low	80	75.5	26	24.5	106	100.0			
High	99	45.0	121	55.0	220	100.0	3.76	0.000*	2.24 - 6.30
<b>Age (yrs)</b>									
> 30	81	62.3	52	37.7	133	100.0			
< 30	98	50.7	95	49.3	193	100.0	1.51	0.072	0.96 - 2.36
<b>Education</b>									
≥ SMA	132	53.7	114	46.3	246	100.0			
< SMA	47	58.8	33	41.2	80	100.0	0.81	0.427	0.48 - 1.35
<b>Gender</b>									
Male	109	59.9	73	40.1	182	100.0			
Female	70	48.6	74	51.4	144	100.0	1.57	0.043*	1.01 - 2.45
<b>Marital Status</b>									
Married	138	57.5	102	42.5	240	100.0			
Single	41	47.7	45	52.3	86	100.0	1.48	0.117	0.90 - 2.43
<b>Length of employment</b>									
≤ 6 years	108	59.3	74	40.7	182	100.0			
> 6 years	71	49.3	73	50.7	144	100.0	1.50	0.071	0.96 - 2.33
<b>Use of ear plugs</b>									
Not needed	80	75.5	26	24.5	106	100.0			
Always used	91	63.2	53	36.8	144	100.0	1.79	0.040*	1.02 - 3.12
Not always/never used	8	10.5	68	89.5	76	100.0	26.15	0.000*	11.11 - 61.55
<b>Work Shift</b>									
No	84	65.6	44	34.4	128	100.0			
Yes	95	47.9	103	52.1	198	100.0	2.07	0.002*	1.30 - 3.27
<b>Ambiguity of roles</b>									
Absent	94	69.6	41	30.4	135	100.0			
Present	85	44.5	106	55.5	191	100.0	2.85	0.000*	1.79 - 4.55
<b>Role conflict</b>									
Absent	84	71.8	33	28.2	117	100.0			
Present	95	45.5	114	54.5	209	100.0	3.05	0.000*	1.87 - 4.96
<b>Quantitatively excessive load</b>									
Absent	70	73.7	25	26.3	95	100.0			
Present	109	47.2	122	52.8	231	100.0	3.13	0.000*	1.85 - 5.29
<b>Quantitatively excessive load</b>									
Absent	74	71.8	29	28.2	103	100.0			
Present	105	47.1	118	52.9	223	100.0	2.86	0.000*	1.73 - 4.74
<b>Career development</b>									
Absent	84	68.3	39	31.7	123	100.0			
Present	95	46.8	108	53.2	203	100.0	2.44	0.000*	1.53 - 3.91

Table 2. Dominant risk factor on occurrence of job stress

Risk factor	B	OR	95.0% C.I. for OR	
Noise conditions	3.080	21.76	8.09	58.52
Gender	0.359	1.	0.79	2.58
Use of ear plugs				
-Always used	2.902	0.55	0.02	0.13
Work shift	-0.227	1.25	0.65	2.40
Ambiguity of roles	0.140	1.15	0.57	2.31
Role conflict	0.596	1.81	0.88	3.73
Qualitatively excessive load	0.574	1.77	0.81	3.89
Quantitatively excessive load	0.551	1.73	0.79	3.80
Career development	0.422	1.52	0.81	2.85
Constant	-3.382	0.03		

Table 3. Multivariate analysis with inclusion of noise condition risk factor

Risk factors	B	OR	95.0% C.I. for OR	
Noise conditions	0.902	2.46	1.33	4.55
Gender	0.208	1.23	0.72	2.08
Work shift	-0.305	1.35	0.75	2.42
Ambiguity of roles	0.320	1.37	0.73	2.58
Role conflict	0.448	1.56	0.81	2.99
Qualitatively excessive load	0.521	1.68	0.83	3.39
Quantitatively excessive load	0.231	1.26	0.63	2.50
Career development	0.489	1.63	0.91	2.89
Constant	-3.429	0.03		

Table 4. Multivariate analysis with inclusion of ear plug risk factor

Risk factor	B	S.E.	Wald	Df	OR	95.0% C.I. for OR	
Gender	0.359	0.301	1.418	1	1.43	0.79	2.58
Work shift	0.227				1.25	0.65	2.46
Ambiguity of roles	0.140				1.15	0.57	2.34
Ear plug			44.344	2			
Plug(1)	0.179	0.342	0.273	1	1.19	0.61	2.33
Plug(2)	3.080	0.505	37.265	1	21.76	8.09	58.52
Role conflict	0.596				1.81	0.88	3.73
Qualitatively excessive load	0.574				1.77	0.81	3.89
Quantitatively excessive load	0.551				1.73	0.79	3.80
Career development	0.422				1.52	0.81	2.85
Constant	-3.382	0.655	26.629	1	0.03		

female workers reported that female workers experienced higher stress levels when compared with males.<sup>(19)</sup> Evans randomly assigned 40 experienced clerical workers (all female with a mean age of 37 years) to either a quiet office or one with low-intensity office noise (including speech) for three hours. The study showed that the workers in the noisy office experienced significantly higher levels of stress (as measured by urinary epinephrine).<sup>(20)</sup> A study of nurses yielded essentially similar results. Urinary cortisol, adrenaline and noradrenaline levels were all increased with age in both genders, with a greater difference in the younger age group compared with the older group. These hormones were lower in premenopausal women compared with male nurses of similar age.<sup>(21)</sup> A survey conducted in Japan found psychosomatic disorders in 88% of female workers and in only 80% of male workers.<sup>(22)</sup>

The habit of using ear plugs in the present study was significantly correlated with occurrence of job stress. Workers in high noise conditions who always used ear plugs had a 1.79 fold greater chance of stress than workers in low noise conditions who did not need ear plugs. On the other hand, workers in high noise conditions who never or not always had used ear plugs had a 26.15 fold greater chance of stress than workers in low noise conditions who did not need ear plugs. Use of ear plugs is one of the measures for reducing perceived noise intensity. Workers who always use ear plugs may still have a greater chance of experiencing stress compared with those not needing ear plugs. This may be due to the fact that use of ear plugs constitutes a stressor for the workers. The worker may not feel comfortable using the supplied ear plugs or they feel compelled to use ear plugs out of feelings of fear for the company. Another reason may be that although the workers always use ear plugs, they do not use them correctly.

The results of this study indicate that all work stressor variables were significantly correlated with occurrence of job stress. If the risk factors of ambiguity of roles, role conflicts, qualitatively excessive work load, quantitatively excessive work load and career development are present in the workers, these workers will have a greater chance of experiencing stress compared with those workers without above risk factors. Work shift also has a significant correlation with occurrence of job stress. This is consistent with studies conducted in Japan indicating that work shift is a main source of stress in factory workers.<sup>(23)</sup> According to Spurgeon, 10 out of 11 studies show that work shift is correlated with mental health disorders.<sup>(24)</sup>

The results of the present study reveal two significant risk factors for job stress, namely noise conditions and habitual use of ear plugs. This indicates the presence of colinearity between noise conditions and habitual use of ear plugs. After performing a multivariate analysis by exclusion of one of those factors, it was found that habitual use of ear plugs was the dominant risk factor of job stress, with OR=21.76 (95% CI 8.09-58.52). This signifies that workers in high noise conditions who did not always use or never had used ear plugs had a 21.76 fold greater chance of stress compared with workers in low noise conditions who did not need ear plugs. Use of ear plugs is one of the measures for reduction of perceived noise intensity levels. The study conducted by Melamed et al. showed that workers exposed to noise levels of >80 dB had substantially elevated cortisol levels.<sup>(25)</sup> After the use of earmuffs, which decreased the noise levels to 30dB, the cortisol levels were drastically lowered.<sup>(26)</sup>

Studies in the USA have indicated that the use of hearing protectors is increasing, but there is still much to be improved in this respect.

Many factors have been reported as influencing the use of hearing protectors, such as the perception of risk likelihood and comfort when using the hearing protectors.<sup>(27,28)</sup> There should be socialization on the use of ear plugs among the workers, control on use of ear plugs by the workers, and imposition of sanctions on those workers not using ear plugs.

## CONCLUSIONS

The prevalence of job stress in high noise conditions was 55.0%, and in workers in low noise conditions the prevalence was 24.5%. Use of ear plugs is a dominant risk factor for job stress. This signifies that workers in high noise conditions did not always use or never had used ear plugs.

## REFERENCES

1. Stress at work. Cincinnati OH. National Institute for Occupational Safety and Health; 1999. Available at: <http://www.athealth.com>. Accessed October 2, 2008.
2. Smith A. Perceptions of stress at work. *Human Resourc Manag J* 2001; 11: 74-86.
3. Leka S, Griffiths A, Cox T. Work organization & stress. Institute of Work, Health & Organization. Protecting Workers Health Series No 3. 2003
4. Paoli P, Merllié D. Third European survey on working conditions. Luxembourg: European foundation for the Improvement of Living and Working Conditions 2001.
5. Phillips S, Sen D, McNamee R. Prevalence and causes of self reported work-related stress in head teachers. *Occup Med* 2007; 57: 367-76.
6. Collins PA, Gibbs AC. Stress in police officers: a study of the origins, prevalence and severity of stress-related symptoms within a county police force. *Occup Med* 2003; 53: 256-64.
7. Mino Y, Shigemi J, Tsuda T, Yasuda N, Bebbington P. Perceived job stress and mental health in precision machine workers of Japan: a 2 year cohort study. *Occup Environ Med* 1999; 56: 41-5.
8. Babisch W, Ising H, Gallacher JE. Health status as a potential effect modifier of the relationship between noise annoyance and incidence of heart disease. *Occup Environ Med* 2003; 60: 739-45.
9. Davies HW, Teschke K, Kennedy SM, Hodgson MR, Hertzman C, Demers PA. Occupational exposure to noise and mortality from acute myocardial infarction. *Epidemiology* 2005; 16: 25-32.
10. Tana L, Halim FS, Ghani L, Delima. Hearing disturbance due to noise of workers in steel factory on Java island. *J Kedokteran Trisakti* 2002; 21: 84-90.
11. Ivancevich JM, Matteson MT. Stress at work. Glenview IL: Scot, Foresman Company; 1998.
12. Hartono. Pengaruh perbedaan intensitas kebisingan terhadap sindrom dyspepsia pada tenaga kerja PT. Kusumahadi Sentosa Karanganyar. (Tesis) Solo: Fakultas Kedokteran Universitas Sebelas Maret; 2007.
13. Fujino Y, Iso H, Tamakoshi A for the JACC study group. A prospective cohort study of perceived noise exposure at work and cerebrovascular diseases among male workers in Japan. *J Occup Health* 2007; 49: 382-8.
14. Melamed S, Y Fried, P Froom. The joint effect of noise, job complexity and gender on employee sickness absence: an exploratory study across 21 organizations the Cordis study. *J Occup Organ Psychol* 2004; 46: 1023-32.
15. Teenant C. Work related stress and depressive disorders. *J Psychosom Res* 2001; 51: 697-704.
16. Di Martino V. Safe work. Stress at work place. Programme on safety and health at work and the environment (Safe Work). 2000.
17. Sastroasmoro S. Dasar-dasar metodologi penelitian klinis. Edisi 2. Jakarta: CV Agung Seto; 2002.
18. Derogatis LR. Symptoms check listing (SCL-90). Pearson Assessment; 1983. Available at: <http://www.pearson.assessment.com/scl90.aspx>. Accessed September 2, 2008.
19. Melchior M, Krieger N, Kawachi I, Berkman LF, Niedhammer I, Goldberg M. Work factors and occupational class disparities in sickness absence: findings from the Gazel cohort study. *Am J Publ Health* 2005; 95: 1206-12.
20. Evans GW, Johnson D. Stress and open-office noise. *J Applied Psychology* 2000; 85: 779-83.
21. Deane R, Chummun H, Prashad D. Differences in urinary stress hormones in male and female nurses at different ages. *J Adv Nurs* 2002; 37: 304-10.
22. Reika K, Teruyo K, Ayumi M, Setsuko K. Work related reproductive, musculoskeletal and mental

- disorders among working women-history, current issues and future research directions. *Ind Health* 2002; 40: 101-12.
23. Fujino Y, Mizoue T, Izumi H, Kumashiro M, Hasegawa T, Yoshimura T. Job stress and mental health among permanent night workers. *J Occup Health* 2001; 43: 301-6.
  24. Spurgeon A. Working time: its impact on safety and health. International Labour Office Occupational Safety & Health Research Institute Korea Occupational Safety & Health Agency. International Labour Organization; 2003.
  25. Melamed S, Bruhis S. The effects of chronic industrial noise exposure on urinary cortisol, fatigue and irritability: a controlled field experiment. *J Occup Environ Med* 1996; 38: 252-6.
  26. Clemens K, Dirk H. Noise and stress salivary as a non invasive measure of allostatic load. *Noise Health Int J* 1999; 1: 57-69.
  27. Patel DS, Witte K, Zuckerman C, Murray-Johnson L, Orrego V, Maxfield AM, et al. Understanding barriers to preventive health actions for occupational noise induced hearing loss. *J Health Comm* 2001; 6: 155-68.
  28. Kerr MJ, Lusk SL, Ronis DL. Explaining Mexican American workers' hearing protection use with the health promotion model. *Nursing Res* 2002; 51: 100-9.