Work Stress and Cortisol Level among Shift Workers in a Tyre Manufacturing Factory in Selangor

Nasimah Md. Nasir, Zailina Hashim

[1] *Research Centre of Excellence for Environmental and Occupational Health, Department of Environmental and*

Occupational Health, Faculty of Medicine and Health Sciences,

Universiti Putra Malaysia, Malaysia

Corresponding author: Zailina Hashim; Department of Environmental and Occupational Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia. E-mail: zailina@upm.edu.my

ABSTRACT

Objective: A study was conducted to examine associations between work stress and cortisol hormone level among shift worker at a tyre manufacturing factory in Selangor.

Method: About 96 tyre manufacturing workers consisting of 56 shift and 40 non-shift workers were selected for this study. Majority of the workers were Malays (94.8%). Questionnaires were used to obtain their background information. Stress levels were determined using O'Donnel stress Questionnaire (Personal Stress Inventory). Other factors such as work, family and life events were also taken into consideration in evaluating the stress level of the shift worker. Saliva samples were collected from each respondent in the morning and after their shift work. Cortisol levels were determined using Salivary Cortisol Enzyme Immunoassay-Kit.

Result: No significant difference between stress scores related to family and work factors for both groups. However, there was a significant difference (z=0.454, p=0.01) in the morning cortisol hormone levels with that after work hours between the shift workers and the regular hours workers. Similar results were also found in the stress scores between the morning and night shift workers (t=6.75, p=0.071)**.** No significant correlations between stress level (health problem scores) and cortisol levels found. The shift workers' work activity and the nature of work significantly influenced the cortisol level (χ^2 =8.791, p=0.003).

Conclusion: Shift work and work rotations have increased work stress as indicated by the salivary cortisol levels of the shift workers. The saliva cortisol level was higher after the shift work and it was influenced by the work activities and working conditions.

Keywords: *Work Stress, Salivary Cortisol Hormone, Shift worker.*

1. Introduction

Stress refers to a condition of imbalanced in emotional, physical, and psychological state of a person. It is caused by a disturbing influence of many factors. Stress can be influenced by job tasks being performed in a workplace (Bashir & Ramay, 2010; Vischer, 2007). Stresses are usually being used as an indicator to look at the behavioral aspect of human being in enduring the work environment, personal relationship and responsibilities in life (Yang, Che, & Spector, 2008). Shift workers are frequently exposed to stress. There are several factors that lead to stress among workers such as physical work environment, social, organization or economic conditions (Noblet & Lamontagne, 2006). The contributing factor of stress at the work-

place were noise (Nuaim, et. al, 2015), apathy of unknown hazard and a congested working area (Melamed et al., 1999). Studies showed that shift workers have health problems due to high blood pressure (Attarchi, et al., 2012), altered circadian cycle, and high and active body hormone during their work activity within the twenty-four (24) hours period (Anjum et al., 2011).

Stress was said to be relate with the secretion of cortisol hormone by the adrenal glands. It is referred to the stress hormone merely due to its correlation of secretion when the human bodies react to the physical and psychological tension (Almeida, et al. 2009). The secretion of cortisol hormone is different with each individual. It is imperative that the measurement on the increase level of this hormone and the correlation with the stress be monitored and recorded for the shift work employees.

In Malaysia, the studies of cortisol hormone in relation to stress among shift workers are still limited. This study would determine the existence of stress level due several identified factor such as work environment, change of normal sleeping pattern due to shift cycle and other factors related to the workplace. The primary objective of this study was to determine the stress level using cortisol hormone and questionnaire interview as indicators and to determine the associations with shift work.

2. Materials and Method

This study was carried out in one of the largest tyre manufacturing factory located in Selangor. The study design was a cross-sectional comparative study. The respondents were made up of 56 shift workers and 40 normal work hours workers, from the same division in the factory. Workers' name list was provided by the Human Resource Department. The sampling was based on simple random sample from the list of shift and normal hour workers. The respondents selected had to fulfill the inclusive criteria such as male, age between 21-55 years, healthy, no hypertension, not on medication and have worked for at least one year with the company, otherwise he would be substituted with others. There were 3 shifts in the company such as the morning (7 am-3 pm), afternoon (3 pm - 11 pm) and night (11 pm -7 am) shift. The study samples were selected from the Truck Bus Radial (TBR) Division. This division was where the tire processing took place and the workers are highly exposed to the work risk such as stress, solvent, heat and noise.

2.1. Questionnaire

The study questionnaire included questions on the respondent's personal background, the socio-demographic,

health status, education level, income bracket and other relevant information. There were also questions related to the work hours, job scope and tasks, and exposure to hazard such as noise, dust and chemicals. The questionnaires on stress were based on the O'Donnell approach that encompasses and identifies personal stress inventory for shift workers. It measures the stress level by calculating the scores for each response. To each question, scores were assigned using Likert Scale with: 0 (never), 1 (once or twice occurrence), 2 (weekly occurrence) and 3 (almost every day occurrence). The total stress score that exceeded forty (40) indicated that the workers experience stress at the work place.

2.2 Salivary Cortisol Enzyme Immunoassay Kit

In order to measure the secretion of cortisol hormone in the saliva, containers were provided to the respondents. The saliva samples were taken twice, first samples were taken before workers started their work and the second samples were taken after the workers finish their work shift. These were carried out for both the shift workers and regular hours workers. Thorough briefings were conducted for both groups on the procedure of saliva sampling technique. Respondents were advised not to take heavy meals an hour before samples were collected, dairy base products should not be taken half-an-hour before sampling. No alcohol consumption within 24 hours period, and respondent were advised to rinse their mouth 10 minutes before collecting their saliva samples. Saliva samples were analysed using the *Salivary Cortisol Enzyme Immunoassay Kit.*

3. Results

3.1. Demographic and Socioeconomic Information

The TBR division comprised mainly Malay workers which constitute 96.4 % of the shift workers, while 92.5% were from the non-shift workers. While other ethnic group were Chinese, Indian and others constituted 11.1 % only. Their education levels are shown in Table 1. The information gathered on the sources of the stress were family/wife, neighbor/friends, life experience/event, did not significantly influence the shift or the regular hours workers (Table 2). The majority of the respondents were not ready to share their personal information.

3.2. Stress Factor

The results showed that the main factor influencing environmental work stress were the exposure to high noise level (80.2%), followed by job demand which need full attention (58.3%), exposure to dust (52.1%) (Table 3). Noise was the main source of stress for the shift workers merely because the work environment involved heavy

machineries. The automatic device which serve as the warning siren for a job completion as well as malfunction machines produced very loud audible signal which again added to the already high noise level. Stress factors in relation to work activity and family were identified from the questionnaires, in order to differentiate the work stress experienced by the 2 groups.

Table 1: Respondents' demographic and socioeconomic information

Variables	Frequency (%)	
	Shift workers (n = 56)	Non-shift workers (n = 40)
Age (years)		
21 - 27	39 (69.64)	13 (32.50)
28 - 34	12 (21.43)	16 (40)
35 - 41	5 (8.93)	3(7.50)
42 - 49	0 (0)	4 (10.00)
50 – 56	0 (0)	4 (10.00)
Ethnic		
Malay	54 (96.43)	37 (92.5)
Chinese	1 (1.79)	2(5.00)
Indian	0 (0)	1 (2.50)
Others	1 (1.79)	0 (0)
Religion		
Islam	55 (98.21)	37 (92.50)
Buddha	0 (0)	1 (2.50)
Hindu	1 (1.79)	1 (2.50)
Others	0 (0)	1 (2.50)
Marital Status		
Married	29 (51.79)	28 (70.00)
Single	27 (48.21)	11 (11.46)
Divorce	0 (0)	1 (2.50)
Education Level		
Secondary	3 (5.36)	2 (5.00)
Upper Secondary	30 (53.57)	23 (57.5)
Institution of higher learning	23 (41.07)	15 (37.5)

Table 2: Respondents' sources of stress (N = 96)

Variables		Frequency (%)	
		Shift workers (n = 56)	Non- shift workers (n = 40)
Family/ wife	Yes	7(12.5)	7(17.5)
	No	49(87.5)	33(82.5)
Neighbour/ Friend	Yes	7(12.5)	5(12.5)
	No	49(87.5)	35(87.5)
Work place environment	Yes	32(57.14)	22(50.0)
	No	24(24.9)	18(45.0)
Event in life	Yes	5(8.92)	4(10.0)
	No	51(91.1)	36(90.0)
Disease	Yes	4(7.14)	4(10.0)
	No	63(92.9)	36(90.0)

Table 3: Information on the respondent work activities

Variable	Shift workers (n = 56)		Non-shift workers (n = 40)	
	0	3	0	3
Unorganized job	18	16	15	18
Inadequate supervision	14	21	25	20
No job satisfaction	29	11	35	10
Job that involves extensive physical movement	11	48	23	45
Long sitting position	41	11	43	8
Long standing position	13	43	23	38
Frequent bending and kneeling	16	43	25	13
High angle reach	30	27	33	15
Job that needs extra or full alert and attention	7	59	8	58
Frequent Noise exposure	2	82	5	78
Frequent expose to vibration	45	18	13	35
Frequent expose to warm temperature	27	48	5	45
Exposed to temperature change	21	46	8	38
Expose to unhealthy air	20	54	5	48
Expose to smelly condition	25	25	8	28
Expose to dusty environment	27	52	0	53
Expose to smoke and steam	25	34	8	25
Sleep/wake disorder after shift cycle	21	45	40	23
Frequent expose to chemical hazard	27	18	30	18
Prone to accident during night shift	14	4	73	8
Accident due to insufficient rest	11	2	55	8
Health problem due to shift jobs	18	18	48	10

0 – No Occurance; 3 – Frequent Occurance

Table 4: Comparison on work stress scores between the groups (N = 96)

Variables	Median (IQR)		Z score	p value
	Shift worker (n = 56)	Regular hours workers (n = 40)		
Work-related factors	60.0 (28)	55.0 (25)	-1.499	0.134
Family related factors	19.0 (20)	17.0 (20)	-0.17	0.987

IQR = Inter Quartile Range, Statistical analysis – Mann-Whitney U-test

The Mann-Whitney U test was used for non-parametric data distribution. The results showed that there was no significant difference in the stress levels for both groups (Table 4).

3.2. Cortisol Level

Observations were made on the cortisol hormone levels for both groups before and after work. It was noted that there was a significant difference in the cortisol levels between the morning shift group with the regular hours workers (p = 0.001) (Table 5). While, Table 6 shows a similar significant difference of cortisol level at the end of their respective shift (p = 0.001), for the night shift as compared to the morning shift,. However, findings showed no significant relationship between cortisol level and health effect scores (Table 7).

Table 5: Comparison of cortisol levels between the groups

Cortisol level (µg/dL)	Median (IQR)		Z score	p value
	Shift workers (n = 56)	Non shift workers (n = 40)		
Before shift [a]	4.94(1.90)	3.67(1.00)	4.035	0.460
After shift [b]	2.98(1.65)	2.27(0.63)	4.544	<0.001 ***

***Significant at p < 0.001; IQR = Inter Quartile Range, Statistical analysis – Mann-Whitney U test, [a] 7 am; [b] 5 pm

Table 6: Comparison of cortisol levels between shift workers (n = 56)

Cortisol level (µg/dL)	Mean (SD)		t value	p value
	Morning shift	Night shift		
Before shift [a]	3.65(1.04)	1.51(0.95)	11.33	0.557
After shift [b]	2.27(0.62)	3.43(1.11)	-6.75	<0.001***

*** Significant at p < 0.001, Statistical analysis – Independent t-test, [a] 7 am for morning shift, 11 pm for night shift, [b] 3 pm for morning shift, 7 am for night shift

Table 7: Correlation of stress from health effect scores and cortisol levels

Cortisol Level (µg/dL)	Health Effect Scores			
	Shift workers (n = 40)		Non-shift workers (n = 56)	
	r value	p value	r value	p value
Morning Shift				
7 am	-0.074	0.587	0.195	0.229
5 pm	0.128	0.347	-0.020	0.989
Night Shift				
11 pm	-0.155	0.254	-	-
7 am	0.086	0.527	-	-

3.3. Stress Level and Work Related Activity

It was noted that stress scores and work related activities had a significant association, (χ^2 = 8.791, p = 0.003). The test was based on the percentile values of the stress scores from various health effect reported and percentile values of the work related activities (Table 8). However, no significant correlations between stress level (health problem scores) and cortisol levels was found.

Table 8: Association between stress from health effects scores reported and stress from work related activities among the workers (N = 96)

Health effect score	Work related activity n (%)		χ^2 value	p value
	Stress	No stress		
High	41 (65.0)	11 (33.0)	8.791	0.003**
Low	22 (35.0)	22 (67.0)		

** Significant at p < 0.01

4. Discussion

Stress can be generated in the work environment if workers are regularly exposed to repetitive or chronic hazardous conditions (Vischer, 2007). Based on the result, the study showed that the exposure to noise which was part of the working environment, was associated with stress. It was noted that there was no significant difference between the stress levesl of the shift workers and regular hours workers based on the parameter of work related activities and family factor in comparison to study by Boey, Chan, Ko, Goh & Lim (1997), the disparity resolution on the findings indicated that there was a direct correlation of stress level induced by work related activity and family conflict.

Results from this study showed that there was a significant difference (p<0.001) on the cortisol level between the morning shift employees with the non-shift workers and between the morning shift with the night shift workers. A systematic review by Niu et al. (2011), summarized that, cortisol secretion among night shift workers who slept during the day were higher than the regular workers who were night sleepers. The peak cortisol level of day shift workers, evening shift workers and night shift workers were observed at 6:00 a.m., 7:00 a.m., and 11:00 a.m. respectively (Niu et al., 2011).The cortisol levels showed significant difference (p<0.001) between the morning and night shift employees recorded after their working hours.

It was also noted that the cortisol hormone levels for the night shift was higher than the morning shift employees. Body cortisol secretions were high in the day and low at

night under normal secretion conditions among shift workers (Niu et al., 2011).

There was no significant association between health effect scores and cortisol levels of the respondent. The study conducted by Vreeburg et al. (2009) previously reported that health indicators such as smoking, physical activity, cardiovascular disease, weresignificantly correlated with cortisol. In view of the arising circumstances that limit data to be collected due the unsupportive attitude and memory recall of the respondents, the results turned out to the reverse.

The *O'Donnell Stress Questionnaire* (*Personal Stress Inventory*) measures the stress level based on the health effect score reported by respondents. Score that exceeded 50% indicated that the respondents experiencde stress in their work activities. In this study, a significant stress level related to the work activities were found (p = 0.003). Working life conditions such as job insecurity, demand and control at work, were related to level of burnout among working population in northern Sweden (Norlund et al., 2010). Besides that, physical work environment, for instance heat, noise and crowding, were also known as one of the domains of occupational stress (Byrne & Espnes, 2008).

The salivary cortisol test showed no significant association between the cortisol levels and work related activities. However, study by Zeier, Brauchli, & Joller-Jemelka, (1996) showed that the cortisol level has a significant correlation with work load and activities.

5. Conclusion

The results indicated that the shift workers especially the night shift workers in the Truck Bus Radial division experienced high stress as shown by the cortisol levels and questionnaire scores for stress levels. In addition, work related activities also influence the stress scores. The after shift cortisol levels among the shift workers were significantly higher than the normal workers showed that shift workers experienced stress due to the abnormal working hours which then influenced their biological system..

ACKNOWLEDGEMENT

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICAL ISSUES

The study was approved by the Medical and Ethics Research Committee of Faculty of Medicine and Health Sciences, Universiti Putra Malaysia.

REFERENCES

Almeida, D. M., McGonagle, K., & King, Heather. (2009). Assessing daily stress processes in social surveys by combining stressor exposure and salivary cortisol. *Biodermography and Social Biology*, *55*(2), 219-237.

Anjum, B., Verma, N. S., Tiwari, S., Singh, R., Mahdi, A. A., Singh, R. B., & Singh, R. K. (2011). Association of salivary cortisol with chronomics of 24 hours ambulatory blood pressure/ heart rate among night shift workers. *BioScience Trends*, *5*(4), 182-188.

Attarchi, M., Dehghan, Faezah, Safakhah, F., Nojomi, M., & Mohammadi, S. (2012). Effect of exposure to occupational noise and shift working on blood pressure in rubber manufacturing company workers. *Industrial Health*, *50*, 205-213.

Bashir, U., & Ramay, M. I. (2011). Impact of stress on employees job performance: a study on banking sector of Pakistan. *International Journal of Marketing Studies*, *2*(1), 122-126.

Byrne, D. G., & Espnes, G. A. (2008). Occupational stress and cardiovascular disease. *Stress and Health*, *24*, 231-238. doi: 10.1002/smi.1203

Melamed, S., Ugarten, U., Shirom, A., Kahana, L., Lerman, Y., & Froom, P. (1999). Chronic burnout, somatic arousal and elevated salivary cortisol levels. *Journal of Psychosomatic Research*, *46*, 591-598.

Niu, S. F., Chung, M. H., Chen, C. H., Hegney, D., O'Brien, A., & Chou, K. R. (2011). The effect of shift rotation on employee cortisol profile, sleep quality, fatigue, and attention level: a systematic review. *Journal of Nursing Research*, *18*(1), 68-81.

Noblet, A., & LaMontagne, A. D. (2006). The role of workplace health promotion in addressing job stress. *Health Promotion International*, *21*(4), 346-353.

Norlund, S., Reuterwall, C., Höög, J., Lindahl, B., Janlert, U., & Birgander, L. S. (2010). Burnout, working conditions and gender – results from the northern Sweden MONICA Study. *BMC Public Health*, *10*, 326. doi:10.1186/1471-2458-10-326

Nuaim, R., Irniza, R., Sharifah Norkhadijah, S. I., & Emilia, Z. A. (2015). The relationship between noise with stress and sleep disturbances among manufacturing workers. *Asia Pacific Environmental and Occupational Health Journal*, *1*(1), 9-14.

Vischer, J. C. (2007). The effects of the physical environment on job performance: towards a theoretical model of workspace stress. *Stress and Health*, *23*, 175-184.

Vreeburg, S. A., Kruijtzer, B. P., Pelt, J. V., Dyck, R. V., DeRijk, R. H., Hoogendijk, W. J. G., …, Penninx, B. W. J. H. (2009). Associations between sociodemograhic, sampling and health factors and various salivary cortisol indicators in a large sample without psychopathology. *Psychoneuroendo-crinology*, *34*, 1109-1120.

Yang, L. Q., Che, H., & Spector, P. E. (2008). Job stress and well being: an examination from the view of person-environment fit. *Journal of Occupational and Organization Psychology*, *81*, 567-587.

Zeier, H., Brauchli, P., & Joller-Jemelka, H. I. (1996). Effects of demands on immunoglobulin A and cortisol in air traffic controllers. *Biopsycology*, *42*, 413-423.