

SHIFT WORK AS A PREDICTOR OF HEARING PROTECTION DEVICES USE AMONG MANUFACTURING WORKERS IN SELANGOR, MALAYSIA

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ABSTRACT

Background: World Health Organization estimated hearing loss to reach top ten causes of burden of disease by 2030. Employers still prefer to choose hearing protection devices (HPDs) for prevention. Predictors for HPDs use were therefore crucial but only a few look into the effect of shift work. This study aimed to determine whether shift work is a predictor for HPDs use.

Materials and Methods: A cross-sectional study was conducted among 180 randomly selected participants from nine manufacturing companies in small medium enterprise who fulfilled inclusive criteria and information were gathered by self-administered questionnaires.

Result: Mean HPDs use was $38.13 \pm 31.84\%$ and mean HPDs use during high noise exposure was $39.19 \pm 30.99\%$. Shift workers had statistically significant higher HPDs use ($50.34 \pm 31.32\%$) than non-shift workers ($33.93 \pm 31.04\%$), $t(178) = 3.086$, $p = .002$. There was significant difference between HPDs use and sleep problem. There were weak but negative association between shift work and HPDs use during high noise exposure [$\chi(3) = 12.257$, $p = .007$]. Association between shift work and sleep problem was significant [$\chi(2) = 7.21$, $p = .027$] but weak, it was negatively associated.

Conclusion: Continuous rotation of shift work might lead to circadian rhythm alteration and affect sleep quality. Noise might worsen the situation hence further investigation is needed to examine if improper use of HPDs was related with sleep problems. Shift workers reported higher HPDs use and it might be due to less need of removing and putting on HPDs. Shift work may be a predictor for HPDs use among manufacturing workers.

Keywords: Hearing protection devices, HPDs use, noise, shift work, sleep problem

1.0 Introduction

By 2030, World Health Organization estimated hearing loss to reach top ten causes of burden of disease in high- and middle income countries, moving up at least three places in the rankings as compared to 2002 (Mathers & Loncar, 2006). Till now, employers still prefer to choose hearing protection devices (HPDs) for noise induced hearing loss (NIHL) prevention (Seixas et al., 2011). However, HPDs could not provide full protection from hearing disorders unless they are worn during entire noise exposure period, which means workers should wear HPDs all the time whenever they are working in high noise area more than 85dB (Jan & Hong, 2006).

Although HPDs should be used all the time, only 4.1% industrial workers (Maisarah, 1989) and 11.9% sawmill workers (Rus et al., 2008) in Malaysia use HPDs regularly in workplace. Therefore, it is important to access the period of use and non-use of HPDs by the workers (Costa & Arezes, 2014). Since NIHL is an irreversible, highly prevalent but preventable occupational disease (Hong et al., 2006) which potentially affect about 103,000 workers in Malaysia (Tahir et al., 2014), it is utmost important to study on predictors of HPDs use and investigates effective methods to improve worker's HPDs use.

The known predictors of HPDs use among workers included worker's risk perception, noise level, education level, age, perceived benefit and barriers, safety climate, perceived self-efficacy, gender, self-perceived susceptibility to NIHL, value of use of HPDs (Costa & Arezes, 2014; Lusk et al., 1999; Lusk et al., 1997; Mccullagh et al., 2010) but only a few look into the effect of shift work. Understanding the work pattern will provide further information on whether the time percentages of HPDs use would be different for shift workers compared to workers who perform their professional activity on normal eight working hours during day time, which are the regular workers.

International Labour Organization (ILO) define shift work as "a method of organization of working time in which workers succeed one another at the workplace so that the establishment can operate longer than the hours of work of individual workers" be it at day or night hours. Whereas the European Council Directive 93/104 (1993) stated that "concerning certain aspects of the organisation of working time, shiftwork shall mean any method of organising work in shifts whereby workers succeed each other at the same work stations according to a certain pattern. Shift worker shall mean any worker whose work schedule is part of shiftwork." Besides these formal definitions, researchers worldwide normally refer shift work as an arrangement of work schedule or a work-hour system which is different from the conventional eight-hour day time work (Harrington, 2001; Straif et al., 2007).

ILO divided shift work into fixed shift system and rotating shift system. Fixed shift system has two to three organized shifts either in the early, late or night shifts. On the other hand, rotating shift system has work shifts which vary regularly over time (International Labour Organization, 2004).

Hence, the main aim of this study was to obtain the relationship between shift work and mean HPDs use of workers. This study also aimed to find out factors associated with shift work and HPDs use, and the percentages time of HPDs use among manufacturing workers in Selangor. These data will ultimately allow for the establishment of whether shift work is a predictor for HPDs use.

2.0 Materials and Methods

2.1 Study design and respondents

This cross-sectional study used baseline data of a Solomon four-group study conducted to investigate the effectiveness of a hearing protection intervention for manufacturing workers in small medium enterprises. It involved nine manufacturing companies in Selangor, Malaysia. Data was collected in end of December 2013-February 2014. This study recruited 180 respondents who were 18 years old and above and exposed to noise level of 85dB and above in workplace. The respondents were randomly selected by the name list provided by management of the factories.

2.2 Questionnaire

Self-administered questionnaires were distributed and completed in a classroom setting by respondents with the presence of two researchers so that the respondents fully understand the questions. Apart from socio-demographics, questions regarding work duration, shift work, sleep problem, perceived stress and HPDs use were included.

Shift work. Respondents were asked to indicate if they were shift workers with one direct question. Shift workers referred to workers with work schedule other than normal eight hours day time work. Respondents who worked in the normal eight hours day time work schedule will be grouped as regular workers.

Sleep problem. Sleep quality was assessed with one question with three choices. Respondents were asked if they were having occasional, frequent or no sleep problem at all. Workers with occasional or frequent sleep problem will be classified as having sleep problem.

HPDs use. Mean HPDs use were obtained by the average of three questions measuring the percentage of time of self-reported HPDs use in the workplace during past week, past month and past 3 months. Questions were in the form of percentage of time (0-100%) transforming from the information provided in visual analog scale (0-100mm).

HPDs use during high noise exposure. Mean HPDs use were obtained by the average of three questions measuring the percentage of time of self-reported HPDs use during high noise exposure in the workplace during past week, past month and past 3 months. High noise was defined as "when you have to shout to be heard by a co-worker who is 3 feet or less away from you". Questions were in the form of percentage of time (0-100%) transforming from the information provided in visual analog scale (0-100mm).

2.3 Statistical analysis

Statistical Package for Social Sciences (SPSS) 21.0 was used for statistical analysis in this study. HPDs use was calculated by frequency plots. Differences of the variables were obtained by independent samples t-test and one-way analysis of variance (ANOVA). Pearson's chi-square test or the chi-square test of association is used to discover relationship between two categorical variables, which in this study referred to association of sleep problem and HPDs use, association of shift work with sleep problem and association of shift work with HPDs use during high noise exposure. Statistical significance was set at $p < 0.05$ level.

3.0 Result

3.1 Socio-demographics and HPDs use

The socio-demographics of the respondents in the present study are as illustrated in Table 1.

Table 1: Socio-demographic characteristics and PSS-10 scores of respondents ($N = 42$)

Variable	<i>M (SD)</i>	Frequency (%)	HPDs Use (%), <i>M(SD)</i>
Age (years)	32.91 (8.60)		38.13 (31.84)
Gender			
Male		129 (71.7)	43.71 (31.12)
Female		51 (28.3)	24.01 (29.45)
Race			
Malay		165	38.51 (32.48)
Chinese		10	26.17 (26.34)
Indian		3	48.00 (4.06)
Others		2	51.75 (7.19)
Marital status			
Single		65 (36.1)	41.98 (31.70)
Married		113 (62.8)	35.86 (32.07)
Divorced		2 (1.1)	40.67 (20.27)
Education level			
Primary School		2 (1.1)	46.50 (53.03)
Secondary School		135 (75.0)	38.93 (32.05)
Diploma		31 (17.2)	41.97 (31.35)
Undergraduate Degree		10 (5.6)	13.77 (15.24)
Doctorate Degree		2 (1.1)	38.00 (53.74)
Work position			
Operator/General worker		116 (64.4)	40.47 (30.73)
Supervisor		38 (21.1)	41.57 (34.36)
Executive		21 (11.7)	12.93 (22.13)
Others		5 (2.8)	63.53 (21.03)
Work Duration			
Normal		45 (25.0)	40.44 (35.07)
Overtime		135 (75.0)	37.36 (30.79)
Sleep Problem			
No		82 (45.6)	36.77 (32.60)
Yes		98 (54.4)	39.26 (31.32)

Mean age of the manufacturing workers studied was 32.91 ± 8.60 in the range of 19-61 years. Majority (71.7%) of the respondents was male and 62.8% of the respondents were married adults. The data showed that three quarter of the respondents was with secondary school educational level and more than half of the respondents were operator or general workers (64.4%). A total of 75% workers had to work overtime and a quarter of the total workers were shift workers, with 54.4% complaining sleep problem. Mean HPDs use among 180 manufacturing workers when working in the workplace was $38.13 \pm 31.84\%$ and mean HPDs use during high noise exposure was $39.19 \pm 30.99\%$.

3.2 Shift workers and regular workers

Table 2 showed that shift workers (28.50 ± 6.28 years old) were generally younger in age than regular workers (34.42 ± 8.78 years old). HPDs use in the workplace and HPDs use during high noise exposure of shift workers also higher than regular workers. Most of the shift workers were male (95.7%) and 84.8 % had education level of secondary school. Shift workers had statistically significant higher HPDs use ($50.34 \pm 31.32\%$) than non-shift workers ($33.93 \pm 31.04\%$), $t(178) = 3.086$, $p = .002$.

Table 2: Socio-demographics, HPDs use and HPDs use during high noise exposure among shift workers and regular workers

	Shift Worker (N=46)	Regular Worker (N=134)
	Mean (SD)	Mean (SD)
Age	28.50 (6.28)	34.42 (8.78)
HPDs use*	50.34 (31.32)	33.93 (31.04)
HPDs use during high noise exposure	44.51 (26.34)	37.36 (32.32)
	N (%)	N(%)
Gender		
Male	44 (95.7)	85 (63.4)
Female	2 (4.3)	49 (36.6)
Education		
Primary School	1 (2.2)	1 (0.7)
Secondary School	39 (84.8)	96 (71.6)
Diploma	6 (13.0)	25 (18.7)
Undergraduate Degree	-	10 (7.5)
Doctorate Degree	-	2 (1.5)
Work Position NEW		
Operator/General worker	38 (82.6)	78 (58.2)
Supervisor	8 (17.4)	30 (22.4)
Executive	0	21 (15.7)
Others	0	5 (3.7)
Sleep problem**		
No	16 (34.8)	66 (49.3)
Occasionally	27 (58.7)	67 (50.0)
Frequent	3 (6.5)	1 (0.7)

* Independent T-test, $p = .002$

** One-way ANOVA test (Welch's F test) for shift workers, $p < .001$

Among shift workers, significant difference was found between HPDs use and sleep problem. Sleep problem were categorized into no sleep problem, occasional sleep problem and frequent sleep problem. One-way ANOVA was performed to obtain the difference between mean HPDs use and sleep problem of shift workers. Welch's adjusted F ratio, $F(2,15.47) = 27.13$, $p < .000$ revealed that there was a statistically significant difference between groups of sleep problem. Welch's test was referred since levene's test of homogeneity of variances, $F(2, 43) = 4.051$, $p = .024$ reflected that the assumption of homogeneity of variance was not met for this data. Games-Howell post-hoc test indicated that workers with frequent sleep problems reported significant higher HPDs use ($92.0 \pm 7.13\%$) as compared to workers with no ($53.06 \pm 35.01\%$) and occasional ($44.10 \pm 27.23\%$) sleep problem.

3.3 Association of shift work with mean HPDs use during high noise exposure and sleep problem

Mean HPDs use during high noise exposure were categorized into four groups as stated in Table 3 for investigating the relationship between HPDs use during high noise exposure and shift work. There was an association discovered between shift work and HPDs use during high noise exposure as shown in Table 3. The association was significant at $p < 0.05$ [$\chi (3) = 12.257, p = .007$], with Kendall's tau-c correlation showing a weak, negative association between shift work and HPDs use during high noise exposure ($\tau_c = -.145, p = .029$).

Table 3: Association between shift work and HPDs use during high noise exposure

	HPDs use during high noise exposure				Total	Pearson's Chi-Square	Kendall's τ -c
	0-25	25.1-50	50.1-75	75.1-100			
Shift work							
Yes	9 (19.6)	19 (41.3)	9 (19.6)	9 (19.6)	46 (100.0)	12.257, $p = .007$	-.145, $p = .029$
No	61 (45.5)	27 (20.1)	21 (15.7)	25 (18.7)	134 (100.0)		

There was an association discovered between shift work and sleep problem of the respondents. The association was significant at $p < 0.05$ [$\chi (2) = 7.21, p = .027$], with Kendall's tau-c correlation showing a weak, negative association between shift work and sleep problem during high noise exposure ($\tau_c = -.132, p = .047$).

4.0 Discussion

Disregards of observational or experimental studies, noise exposure always related with annoyance, disturb sleep and causes daytime sleepiness (Basner et al., 2014). In this study, shift work was found to be associated with sleep problem. Since our respondents were working in manufacturing factories with noise exposure of 85dB or above, more than half of the respondents suffered from sleep problem. Respondents in our study were exposed to a variety of noise sources such as small or medium stamping machines, metal sheet cutting, hammering, grinding and other noises from repair works. Non-auditory effects of high noise exposure included sleep problem, elevated blood pressure, changes in brain chemistry, increased heart rate and other effects on the body (Lusk et al., 2002). Repetitive daily exposure to noise might lead to sleep disturbance. Moreover, the shift workers in this study were on rotating shift system such as 2 weeks of day shifts and 2 weeks of night shift in a month. Continuous rotation of shifts will lead to alteration of circadian rhythm and to a transitory increase of psychological interruption (Venuta et al., 1999; Zverev & Misiri, 2009). These rhythms are often influenced by environmental cues like daylight and noise (Spurgeon, 2003). However, the usage of HPDs was not high for our respondents, no matter whether it is during high noise ($39.19 \pm 30.99\%$) or when working in the workplace ($38.13 \pm 31.84\%$).

More analysis was done to dig a little deeper in order to investigate the relationship of HPDs use and sleep problem and discovered that among shift workers, respondents with frequent sleep problems reported significant higher HPDs use as compared to workers with no and occasional sleep problem. This phenomenon suggest that workers who was bombarded by

high noise exposure during daytime work tend to wear HPDs more, but the noise exposure still cause them to have sleep problem at night. Such situations leads to the consideration of the manufacturing workers might not fit the HPDs provided correctly into their ear canals. According to other study, 20.5% of hearing protection was badly fitted because workers inserted earplugs without following the manufacture's instruction (Kotarbińska & Rogowski, 2014). Manufacturing workers were vulnerable to an irritating sensation of ringing or buzzing noise in the ears called tinnitus, and it caused the sufferers experienced difficulty to rest and sleep when it happened (Hughson et al., 2002). Tinnitus was most noticeable when sufferers were in quiet environment. As a consequence, workers working in high noise areas did not protect their hearing well enough, and thus exposing to prolong hours of loud noise which eventually disturb their sleep quality (Abdel et al., 2014).

Through analysis, shift workers were found to have statistically significant higher HPDs use than non-shift workers. This is consistent with previous findings that shift work may have an influence in HPDs use of workers, where shift workers in textile industry reported 21.78% higher HPDs use than workers with normal working hours (Costa & Arezes, 2014). Shift workers were normally operators, general workers or supervisors at the production line of manufacturing industry. These groups of workers often exposed to high noise during daily routine work. Skilled workers or higher position workers have lower HPDs use than blue collar workers such as general workers or operators due to their movement actions to use and remove HPDs (Lusk et al., 1994). However, blue collar workers normally stay constantly in their work position without the need to step in and out of the production floor. They could just wear HPDs at the beginning of their work shift (Lusk et al., 1998). With the above findings as support, shift work was further analysed with mean HPDs use in workplace and HPDs use during high noise exposure. Association between shift work and percentage of time of HPDs use during high noise exposure gives a clear reasoning that even though shift work has a small effect on HPDs use, it should be considered as one of the predictors of HPDs use among workers. Shift work may have less impact in the behaviour of HPDs use among the work, but it cannot be denied that shift work indeed influenced the percentages of HPDs use. In fact, this study revealed that shift workers had higher HPDs use than regular workers, which were 16.41% higher in the workplace and 7.15% higher during high noise exposure.

A few limitations were arisen in this study. Since the information obtained via self-administered questionnaires, we cannot avoid information bias. Self-reported HPDs use might be varied with the actual HPDs use of the workers. This study might lack of generalization to other industry workers since only manufacturing workers were studied.

5.0 Conclusion and Recommendation

Continuous rotation of shift work might lead to alteration to body circadian rhythm, and affect sleep quality. Additional environmental cues such as high noise exposure might worsen the adverse effect of shift work, hence further investigation is needed to examine if improper use of HPDs was one of the contributing factors of sleep problems among manufacturing workers. Shift workers reported higher HPDs than regular workers, and it might be due to less need of removing and putting on HPDs. There was significant influence of shift work on HPDs use. Shift work may be a predictor for HPDs use among manufacturing workers.

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Declaration

Author(s) declare that there are no conflicts of interest.

Authors contribution

- a) Conception and design of the project: Sam Wei Yeng, Assoc. Prof. Dr. Anita Abd Rahman, Dr. Hayati Kadir @ Shahar, Assoc. Prof. Dr. Haslinda Abdullah
- b) Acquisition of data: Sam Wei Yeng,
- c) Writing of the manuscript: Sam Wei Yeng, Assoc. Prof. Dr. Anita Abd Rahman, Lim Chee Siang
- d) Statistical analysis: Sam Wei Yeng, Lim Chee Siang
- e) Critical review and significant revision of the manuscript: All authors

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