June 2018, Vol 15, No1
ISSN 1675-5456
PP13199/12/2012 (032005)

Journal of Occupational Safety and Health

NIOSH
National Institute Of Occupational Safety And Health

National Institute of Occupational Safety and Health (NIOSH)
Ministry of Human Resources Malaysia

Journal of Occupational Safety and Health

The Journal

- Aims to serve as a forum for sharing research findings and information across broad areas in occupational safety and health
- Publishes original research reports, topical article reviews, book reviews, case reports, short communications, invited editorial and letter to editor.
- Welcomes articles in occupational safety and health related fields.

Journal of Occupational Safety and Health

June 2018 Vol. 15 No. 1

Contents

Introducing the Journal of Occupational Safety and Health

The National Institute of Occupational Safety and Health (NIOSH) is delighted to announce the publication of Journal of Occupational Safety and Health (JOSH).

JOSH is devoted to enhancing the knowledge and practice of occupational safety and health by widely disseminating research articles and applied studies of highest quality.

JOSH provides a solid base to bridge the issues and concerns related to occupational safety and health. JOSH offers scholarly, peer-reviewed articles, including correspondence, regular papers, articles and short reports, announcements and etc.

It is intended that this journal should serve the OSH community, practitioners, students and public while providing vital information for the promotion of workplace health and safety.

Apart from that JOSH aims:

- To promote debate and discussion on practical and theoretical aspects of OSH

- To encourage authors to comment critically on current OSH practices and discuss new concepts and emerging theories in OSH

- To inform OSH practitioners and students of current issues

JOSH is poised to become an essential resource in our efforts to promote and protect the safety and health of workers.

From the Editor-in-Chief

Workplace safety is a priority. Much needs to be done to encourage employees, employers and industries to put occupational safety and health at the top of their agenda. The most important thing is our commitment in taking action; our commitment to make the necessary changes to ensure that safety is at the forefront of everyone's thinking.

The Journal of Occupational Safety and Health (JOSH), the first to be published in Malaysia, aims to boost awareness on safety and health in the workplace.

It is no longer sufficient to simply identifying the hazards and assessing the risks. We aim to increase understanding on the OSH management system. We aim to strengthen commitment to workplace safety and better working conditions. We believe these aims can be achieved through participations and involvement from every industry.

We hope the contents of the journal will be read and reviewed by a wider audience hence it will have a broader academic base, and there should be an increased cumulative experience to draw on for debate and comment within the journal.

It is our hope that the journal will benefit all readers, as our purpose is to serve the interest of everybody from all industries. Prime focus will be on issues that are of direct relevance to our day-to-day practices.

I would personally like to take this opportunity to welcome all our readers and contributors to JOSH (Vol 15, No 1). I look forward to receive contributions from the OSH community in Malaysia and elsewhere for our next issues.

Ayop Bin Salleh
Editor-in-chief

Original Article

Dust Exposure and Respiratory Health of Workers in a Steel Mill in Terengganu, Malaysia

Nurul Ainun Hamzah,[a,]* Shamsul Bahri Mohd Tamrin,[b] Noor Hassim Ismail,[c]

[a] *Environmental and Occupational Health Programme, School of Health Sciences, Health Campus, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan. Malaysia*
[b] *Department of Environmental and Occupational Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia.*
[c] *Department of Community Health, Faculty of Medicine, Universiti Kebangsaan Malaysia, Jalan Ya'acob Latiff, Bandar Tun Razak, 56000 Cheras, Kuala Lumpur, Malaysia*

*Corresponding author: nurulainun@usm.my

ABSTRACT : *Air pollution in steel making operations would lead to adverse effect on respiratory health. This study aimed to measure the dust exposure and evaluate the respiratory health among steel workers. A cross sectional study was conducted among 402 male workers. Respiratory symptoms were assessed using British Medical Research Council (BMRC) Questionnaire while lung function was measured by spirometer. The airborne dust [$PM_{2.5}$, PM_{10}, and Total Particulate Matter (TPM)] were monitored by Handheld 3016 IAQ Particle Counter. All the parameters studied exceeded the limit of Malaysian guideline standard. Prevalence of chronic cough, chronic phlegm, chest of tightness, and shortness of breath were 35.8 %, 32.8 %, 23.4 %, and 22.4 %, respectively. There were significant differences between shortness of breath and work section (χ^2=9.236, p=0.026) and %FEV_1/FVC with work section [F (3, 3.98=3.194), p=0.025]. Smoking was associated with chronic cough (Adj OR =1.07, 95% CI: 1.04 - 1.10), chronic phlegm (Adj OR =1.05, 95% CI: 1.03 - 1.08), and shortness of breath (Adj OR = 1.05, 95% CI: 1.00 - 1.10) while past respiratory illnesses was associated with chest tightness (Adj OR = 2.24, 95% CI: 1.04 - 4.84) and shortness of breath (Adj OR = 4.16, 95% CI: 1.92 - 9.92). Duration of employment was associated with FEV_1 (β=-0.025, 95%CI:-0.030-0.020) while past respiratory illnesses was associated with %FEV_1/FVC (β =-1.784, 95% CI: -3.017 - 0.551). Steel workers are at risk of developing respiratory symptoms and lung function impairment.*

Keywords - *Dust Exposure, Lung Function, Occupational Respiratory Diseases, Respiratory Symptoms, Steel Workers*

1.0 INTRODUCTION

Various raw materials with different physical and chemical properties are used to produce steel. Seventy five percent of them have been developed in the last 20 years (Wilson & Anthony, 2001). Operations in the steel industry create major air pollution and have always been environmental and health hazards. As a consequence, steel workers are exposed to wide range of hazards or workplace activities that may cause incidents, death, illnesses or diseases (ILO, 1983). Pulmonary system (lungs) exposed to harmful agents either through acute effects or chronic effects may eventually develop lung diseases, such as pulmonary dysfunction and lung cancer (Cugell, 1992).

Occupational Respiratory Diseases (ORD) were observed among workers in iron and steel industry (Bogadi-Sare 1990; Lowe et al., 1970; Pham et al., 1979) Acute respiratory symptoms such as cough and phlegm were also observed and a high prevalence of chronic respiratory symptoms was found among steel production workers (Singh et al., 2011; Singh et al., 2013; Kayhan et al., 2013). Exposure to dust could cause airway obstruction (Abdel-Rasoul et al., 2009 & Johnson et al., 1985) and lung function impairment (Kuo et al., 1999, Low & Mithcelli 1985; Nemery et al., 1985). At the moment, the relationship between respirable dust with respiratory symptoms and lung function, as well as the additive effects of smoking and the frequency of mask usage during working hours has yet to be established.

In a steel manufacturing plant, the differences in work schedule, workplace, processes, and materials may lead to variations in intensity, frequency, and types of respirable dust exposure. As a result, workers engaged in different work section might suffer from different respiratory effects. The objective of this study was to assess respirable dust exposure, to determine the respiratory symptoms and lung function of steel workers, as well as to identify the contributing factors to respiratory health.

2.0 METHOD

2.1 Study Design and Population

A cross sectional study was conducted in a steel foundry in Terengganu, located at the eastern coast of Peninsular Malaysia. This 30-year old foundry is the only steel foundry operating in that region during the study period, employing 1675 workers with nearly 900 workers in the production section. A total of 424 workers were recruited by stratified random sampling based on these criteria; male, aged from 18 to 56 years old, and at least 1 year of employment (Table 1). Ninety four percent of them completed the questionnaire and spirometry. Subjects who were unable to produce acceptable spirograms meeting the American Thoracic Society (ATS, 1995) (N=20), those who were ill e.g. asthma (N=3) and had upper respiratory tract infection (URTI) (N=11) were excluded from statistical analysis. Therefore, the remaining 402 data were used in the final analysis.

Table 1: Distribution of Parts, Work Units, Number of Workers and the Samples Required of Steel Manufacturing Plant

Division and work Unit	Number of Workers	Number of Required Samples
1) Steel Making (SM) Plant		
- Furnace	70	34
- Ladle Furnace	29	14
- Ladle Handling	41	20
- Caster	99	48
- Scrap bay	31	15
Total	270	131
2) Direct Reduced (DR) Plant		
- Material Handling	62	30
- DR Operation	56	27
Total	118	57
3) Maintenance		
- Electrical and Instruments	86	40
- Mechanical	93	45
- Machining Facilities	14	7
- Refractory	41	20
- Fabrication	95	46
Total	326	158
4) Support Group		
- Crane operation	6	3
- Raw Material Handling	6	2
- Logistics	33	16
- Upstream Conveyer	19	9
	43	21
Total	161	78
Total Number	875	424

2.2 Dust Monitoring

Dust monitoring [(PM $_{2.5}$, PM $_{10}$, and Total Particulate Matter (TPM)] was done using Indoor Air Quality (Handheld 3016 IAQ, Model Lighthouse). The location of all sampling spot was recorded on the layout plan and instrument was run simultaneously according to Industry Code of Practice (ICOP) on Indoor Air Quality 2010 (DOSH, 2010). Instruments were located at the center of every sampling location and placed 75 cm above the ground. The numbers of sampling points were estimated based on the total volume of plant area in each building. The sampling points were determined based on the position of respondents and source of contaminants. The measurements of particulates were conducted five days a week continuously from 8 am to 5 pm and data were logged in every 10 minutes for the 8 hours. Fig. 1 represents the monitoring procedure implemented in gathering the data on-site. Partial period of consecutive sampling was performed three times (morning, noon, and evening) to obtain indoor air particles inside the plant throughout all day.

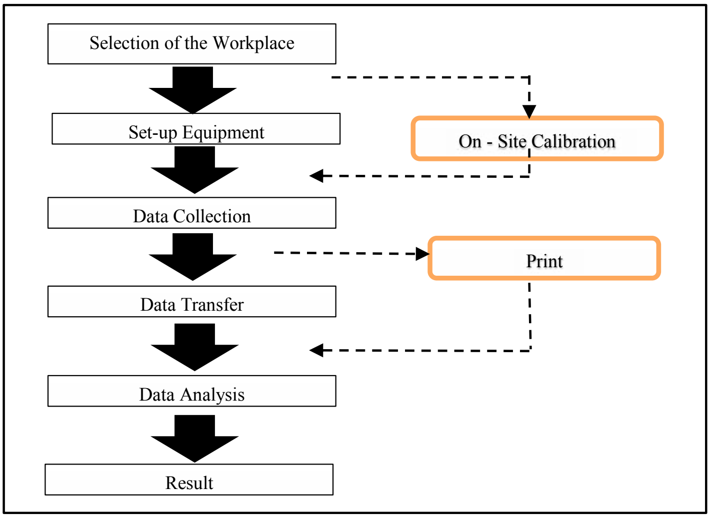

Figure 1: Sampling Procedure 1

Thirteen work areas were assessed within three month. The work sections monitored were: (i) Steel Making (SM) plant [furnace, ladle furnace, ladle handling, continuous casting machine, and crane operation], (ii) Direct Reduced (DR) plant [DR Shed and DR operation], and (iii) support group [raw material handling, refractory, and fabrication center (Fig. 2). The IAQ monitor was placed within the working area and the data were logged in every 10 minutes for 8 hours. Proper calibration was conducted on annual basis and on site just before measurements.

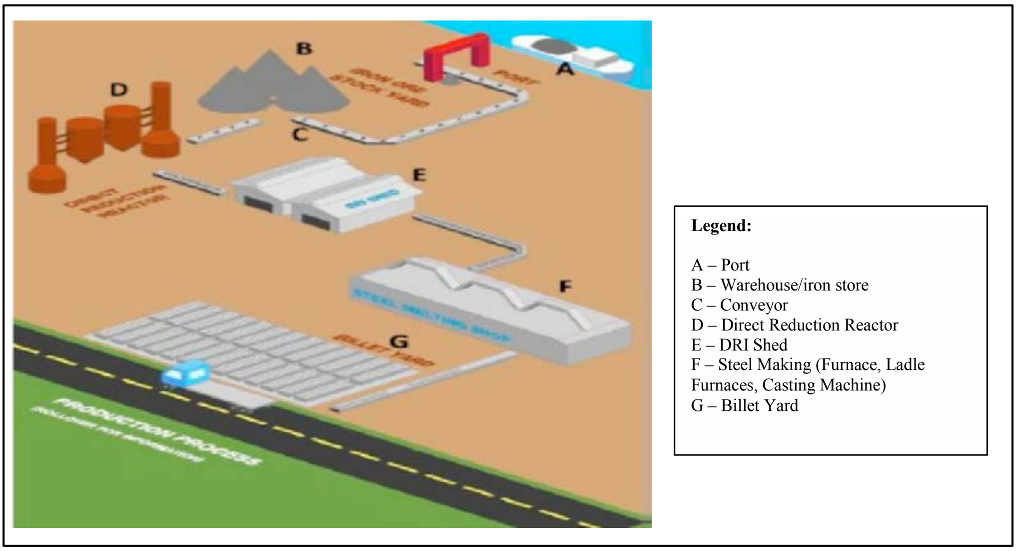

Figure 2: Layout Plan of Iron and Steel Plant

2.3 Measurement of Respiratory Health

A structured questionnaires of respiratory symptoms adopted from British Medical Respiratory Symptoms (BMRS) Questionnaire (BMRC, 1960) was pre tested, validated, and administered by the authors. The demographics, respiratory symptoms, current and past occupational history, subjective assessment regarding levels of dust in current job, smoking habits, past respiratory illnesses, and frequency of mask usage were covered in the questionnaires. The respiratory questionnaire responses also yielded subjective indicators of dust exposure i.e., subjective dustiness in current job corresponding to slight, moderate, and severe. Hours exposed to dust per day were also asked in the questionnaire and were divided into five levels corresponding to 0, 1-2, 3-4, 5-6, and 7-8 hours per day.

The following definitions of smoking were used: non-smokers were subjects who had never smoked of cigarette or tobacco in their lifetime: ex-smokers were those who had stopped smoking at least six months before the study was commenced, and everybody else were classified as current smokers. Lifetime cigarette consumption was coded and analyzed as a continuous variable-cigarette equivalent (packs per day multiplied by number of years smoked). The frequency of mask usage during the working period was divided into three levels corresponding to often, seldom, and always.

Lung function measurement was performed with Spiro lab (MIR) Model according to the American Thoracic Society 1995 (ATS, 1995) standard. Height and weight were measured beforehand. However, those who were unable to produce acceptable spirograms meeting the American Thoracic Society criteria (N=22) were excluded from the analysis to enhance the valid contrast. Daily instrument calibration was done before and after use. Each subject was given the opportunity to learn the technique while watching the others performed the lung function measurement. The subjects were measured in standing position with their nose clamped. The best forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) out of a minimum of three acceptable forced expirations were used as outcomes. Percentage of FEV_1/FVC was also calculated. As the spirometer is a flow-measuring devices, it was reasonable to neglect the body temperature pressure saturated (BTPS, temperature 37 ^oC, ambient pressure, saturated with water vapor at 37 ^oC) conversion under environmental conditions.

2.4 Definition of Respiratory Symptoms

Chronic cough refers to cough symptoms for at least three days a week for at least three months a year for two consecutive years or more. Chronic phlegm refers to phlegm production for at least three days a week for at least three months a year for two consecutive years or more. Chest tightness is defined as discomfort or pain anywhere along the front of body between the neck and upper abdomen and shortness of breath as breathlessness when hurrying on the level or walking up a slight incline. The respondents also must had reported the occurrence at least 1-3 days per week during the last four weeks and must had reported that the symptoms subsided when they were away from their workplace (Hodgson, 2002).

Past respiratory illnesses are defined as any history of respiratory diseases including bronchitis, pneumonia, chronic bronchitis, emphysema, asthma, pleurisies, pulmonary tuberculosis or any chest operation confirmed by medical doctors, and past occupational dust exposures for more than two years prior to joining the company.

2.5 Statistical Analysis

Data was analyzed using IBM SPSS version 21.0. Frequencies, percentages, mean, and standard deviations were calculated for appropriate variables. Chi Square test was used to compare percentages of respiratory symptoms according to work section. Analysis of variance (ANOVA) was used to evaluate differences between the means of lung function values according to work section. A Bonferroni test was used to explore the differences between groups if ANOVA showed a significant result.

Logistic regression analysis was used to determine the most important factors (predictors) to the presence of respiratory symptoms. The outcome variables analyzed were chronic cough, chronic phlegm, chest tightness, and shortness of breath. The exposure variables used were duration of employment and subjective dustiness in current job. The confounding variables controlled were age, duration of employment, cigarette equivalent, past dusty occupations, past respiratory illnesses, and frequency of using mask. Using the logistic model, adjusted odds ratios and confidence intervals of respiratory symptoms were calculated for any predictive variable.

Multiple linear regression was used to determine the contributing factors to lung function values. The outcome variables used were duration of employment and subjective dustiness in current job. The confounding variables controlled were age, Body Mass Index (BMI), cigarette equivalent, past dusty occupations, past respiratory illnesses, and frequency of mask usage. Ethnicity factor was abandoned because it did not significantly contribute to the model of lung function values as subjects were all Malays. Cigarette equivalent was not normally distributed and was therefore transformed logarithmically to yield log-normal distributions before the analysis commenced. An enter method was carried out as a mean of assessing the associations between multiple variables.

2.6 Ethical Considerations

All the procedures were explained to these workers and their willingness to participate was confirmed by their signatures on the consent form. The study was approved by the Research and Ethics Committee, Universiti Kebangsaan Malaysia (UKM) Medical Center (Reference number UKM 1.5.3.5/244/FF-055-2013 dated on 6th February 2013). All data were kept confidential throughout the study.

3.0 RESULTS

3.1 Background of the Subjects

Four hundred and two male Malay subjects were assessed. The mean age was 36.8 years ± 8.81 and the mean duration of employment was 12.2 years ± 8.23 years of work. Fifty percent of the workers were current smokers while 66.5% percent of them had been consuming for more than 10 years. Mean cigarette equivalent was 9.9 ± 9.71 packs per year. Prior to joining this company, 5.2% had been working in dusty occupations and 4.2% had a history of respiratory diseases. Majority of the workers (65.7%) did not wear mask frequently during the working period.

Various types of masks were available for all workers. One hundred and thirty eight (34.3%) workers used masks 'full time' during the working hours, 188 workers (46.8%) used masks 'most of the time', and 76 workers (18.9 %) were 'seldom' using masks. From the observation and walk-through survey, most of the workers used 'traditional methods' to protect themselves from the dust by using ordinary cloth, handkerchief, and T-shirt. (Table 2).

Table 2: Sociodemographic, Occupations, Smoking Characteristics and Frequency of Mask Usage

Demographic	Frequency, (%)	Mean ± SD	Average
Age (year)		36.8 ± 8.81	19 –56
Height (cm)		1.67 ± 0.06	150 –183
Weight (kg)		72.4 ± 13.89	44 –125
Body Mass Index (kg/ms^2)		26.00 ± 4.68	13.89 – 44.08
Duration of employment (years)		12.2 ± 8.23	1 – 30
Work Section			
- Steel Making (SM) Plant	108 (26.3)		
- Direct Reduced (DR) Plant	54 (13.2)		
- Scrap Bay	15 (3.7)		
- Raw Material Handling	16 (3.9)		
- Crane Operation	32 (7.8)		
- Fabrication	46 (11.2)		
- Refractory	20 (4.9)		
- Machining & Mechanical	52 (12.7)		
- Logistic & Workshop	9 (2.2)		
- Electrical & Instrumentation	37 (9.0)		
- Upstream Conveyor	21 (5.1)		
Pasty dusty occupations (Yes)	21 (5.2)		
Past respiratory illnesses (Yes)	17 (4.2)		
Subjective dustiness (Grades)			
- None	9 (2.2)		
- Slight	81 (20.1)		
- Moderate	119 (29.6)		
- Severe	193 (48.0)		
Smoking			
- Non Smoker	129 (31.7)		
- Ex Smoker (Quit since 12 months)	55 (13.7)		
- Current Smoker	218 (54.2)		
Year of Smoked (N=218)		15.1 ± 11.97	1 – 34
Number of cigarette (per day)		11.8 ± 6.78	1 – 40
Mean cigarette equivalent (pack/year)		9.9 ± 9.71	0.20 – 64.0
Frequency of mask usage			
- Full time	138 (34.3%)		
- Most of the time	188 (46.8)		
- Random	76 (18.9)		

3.2 Dust Concentrations

The distribution of mean particulate matters [(PM $_{2.5}$, PM $_{10}$, and Total Particulate Matter (TPM)] according to different section is presented in Table 3. In the Steel Making (SM) plant, the highest PM $_{2.5}$ showed a mean of 0.50 mg/m^3 in ladle handling section, and the range was within 0.01 – 0.11 mg/m^3. The mean concentration of PM$_{10}$ was 1.58 mg/m^3 within range 0.09 – 5.37 mg/m^3 while the mean concentration and the range of Total Particulate Matter (TPM) was 2.76 mg/m, and 0.13 – 11.18 mg/m^3 respectively. The proportion of PM $_{2.5}$ and PM $_{10}$ in TPM were found to be 18.11 % and 57.25 % which more inhalable than in other sections.

Table 3: Mean of Respirable Dust according to the Work Section

	Section	PM 2.5 (mg/m^3)	PM 10 (mg/m^3)	TPM (mg/m^3)	Proportion of PM 2.5 in TPM (%)	Proportion of PM 10 in TPM (%)
1	Steel Making (SM) Plant					
	Furnace	0.11 (0.03 – 0.29)	0.76 (0.10 – 3.73	0.97 (0.12 – 4.47)	11.34	78.35
	Ladle furnace	0.10 (0.02 – 0.16)	1.21 (0.03 – 7.27)	1.95 (0.04 – 12.59)	5.13	62.05
	Ladle handing	0.50 (0.01– 0.11)	1.58 (0.09 – 5.37)	2.76 (0.13 – 11.18)	18.11	57.25
	Continuous Casting Machine (CCM)					
	(I) MC5	0.35 (0.01 – 0.63)	0.18 (0.05 – 2.50)	1.24 (0.06 – 3.80)	12.10	75.00
	(II) Concast	0.25 (0.01 – 0.64)	0.38 (0.04 – 2.53)	1.55 (0.05 – 3.84)	9.68	69.10
	Crane operation	0.02 (0.01 – 0.08)	0.08 (0.02 – 0.50)	0.15 (0.08 – 0.70)	13.33	53.33
	Scrap bay	0.205 (0.05 –0.64)	1.28 (0.15 – 7.88)	2.14 (0.14 – 13.45)	16.35	59.81
2	Direct Reduced (DR) Plant					
	DR shed	0.08 (0.02 – 4.23)	1.48 (0.09 – 12.07)	2.06 (0.11 – 16.35)	3.88	76.70
	DR operation	0.02 (0.01 – 0.03)	0.10 (0.06 – 0.19)	0.12 (0.06 – 0.24)	16.67	83.33
3	Support Group					
	Fabrication Centre	0.04 (0.01 – 0.09)	0.21 (0.03 – 0.41)	0.25 (0.04 – 0.51)	16.00	84.00
	Refractory Centre	0.18 (0.01 – 0.50)	1.79 (0.07 – 9.13)	2.96 (0.10 – 17.95)	6.08	60.47
	Raw Material House (RMH)	0.02 (0.01 – 0.04)	0.18 (0.05 – 0.52)	0.25 (0.06 – 0.72)	8.00	72.00
	Machining & Mechanical Centre	0.02 (0.01 – 0.06)	0.10 (0.04 – 0.38)	0.12 (0.04 – 0.73)	16.67	83.33
	Electrical & Instrumentation	0.01 (0.01 – 0.06)	0.07 (0.02 – 0.40)	0.09 (0.02 – 0.46)	11.11	77.78

( ) range

In the Direct Reduced (DR) plant, the highest mean of PM$_{2.5}$ observed in the DR Shed section was 0.08 mg/m^3 within the range of 0.02-4.23 mg/m^3. The mean concentration of PM$_{10}$ was 1.58 mg/m^3 within the range of 0.09-12.07 mg/m^3, while the mean concentration and range of TPM was 2.06 mg/m^{3}m and 0.11-16.35 mg/m^3, respectively. The proportions of PM $_{2.5}$ and PM $_{10}$ in TPM were found to be 3.88 % and 76.70 %. The support group for both plants consisted of fabrication center, refractory, raw material handling, mechanical and machining center. The highest average of PM$_{2.5}$ was observed in refractory section was 0.18 mg/m^3 within the range of 0.01-0.50 mg/m^3. The mean PM $_{10}$ was 1.79 mg/m^3, within the range of 0.07 – 9.13 mg/m^3, while TPM was 2.96 mg/m^3 and 0.10-17.95 mg/m^3, respectively. The proportions of PM $_{2.5}$ and PM $_{10}$ in TPM were found to be 6.08 % and 60.47 %.

3.3 Respiratory Symptoms and Lung Function

Symptoms were grouped into four main categories namely chronic cough, chronic phlegm, chest tightness, and shortness of breath. These symptoms were based on workers' experience during the last 12 months. Chronic cough was the common symptoms (35.8 %) as claimed by the workers, followed by chronic phlegm (32.8 %), chest of tightness (23.4 %), and shortness of breath (22.4 %).

Respiratory symptoms of the workers were grouped according to four main work section namely SM Plant, DR plant, support plant group, and maintenance. The prevalence of chronic cough, chronic phlegm, chest tightness, and shortness of breath was the highest in the SM Plant. There was a significant difference of chronic cough with work section (χ^2= 9.236, p = 0.026). In contrast, no significant difference was found between chronic phlegm, chest tightness, and shortness of breath with work section (Table 4). Lung function factor was divided into four main work section namely SM Plant, DR plant, support plant group, and maintenance. There was a significant mean difference between %FEV_1/FVC with work section (p = 0.025). Furthermore, Bonferroni test showed a significance difference of FEV_1/FVC (%) for SM Plant and DR plant (p=0.014). However, no significance different was found between FEV_1 and FVC with work section (Table 5).

Table 4: Comparison of Respiratory Symptoms according to Work Section

Work section	Respiratory Symptoms (n, %)			
	Chronic Cough			
	Yes	No	χ^2 (df)	p-value
SM Plant	53 (43.8)	68 (56.2)	9.236	0.026*
DR plant	26 (29.5)	62 (70.5)		
Support plant group	41 (39.4)	63 (60.6)		
Maintenance	24 (27.0)	65 (73.0)		
	Chronic Phlegm			
	Yes	No	χ^2 (df)	p
SM Plant	44 (36.4)	77 (63.6)	2.177 (3)	0.536
DR plant	25 (28.4)	63 (71.6)		
Support plant group	37 (35.6)	67 (64.4)		
Maintenance	26 (29.2)	63 (70.8)		
	Chest of Tightness			
	Yes	No	χ^2 (df)	p
SM Plant	30 (24.8)	91 (75.2)	0.252 (3)	0.969
DR plant	20 (22.7)	68 (77.3)		
Support plant group	25 (24.0)	79 (76.0)		
Maintenance	19 (21.3)	70 (78.7)		
	Shortness of Breath (Dsypnea)			
	Yes	No	χ^2 (df)	p
SM Plant	30 (24.8)	91 (75.3)	1.952 (3)	0.583
DR plant	15 (17.0)	69 (83.0)		
Support plant group	25 (24.0)	79 (76.0)		
Maintenance	20 (22.5)	69 (77.5)		

χ^2 Chi Square Values
* Significant at p at 0.05 or less

Table 5: Comparison of Lung Function according to Work Section

Work section	n	Mean ± S.D	F stat (df) [a]	p-value
		FEV_1 (liter)		
SM Plant	121	2.88 ± 0.406	0.380	0.767
DR Plant	88	2.93 ± 0.443	(3; 398)	
Support Plant	104	2.89 ± 0.517		
Maintenance	89	2.94 ±0.050		
		FVC (liter)		
SM Plant	121	3.41 ± 0.445	0.410	0.746
DR Plant	88	3.48 ± 0.572	(3; 398)	
Support Plant group	104	3.44 ±0.544		
Maintenance	89	3.48 ± 0.533		
		FEV_1/FVC (%)		
SM Plant	121	82.99 ± 5.37	3.154	0.025[b]
DR Plant	88	84.47 ± 5.35	(3; 398)	
Support Plant group	104	84.23 ± 5.64		
Maintenance	89	85.35 ± 5.64		

[a] One Way ANOVA
[b] Bonferroni test showed significance differences of FEV_1/FVC (%) for SM Plant and DR Plant at p=0.014

3.4 Contributing Factors to Respiratory Symptoms and Lung Function

Each of respiratory symptom was further analyzed for any relationship with age, duration of employment, cigarette equivalent, past dusty occupations, past respiratory illnesses, subjective dustiness, and frequency of using mask. Smoking (cigarette equivalent) was associated with chronic cough (*Adj* OR =1.07, 95% CI: 1.04 - 1.10), chronic phlegm (*Adj* OR =1.05, 95% CI: 1.03 - 1.08), and shortness of breath (*Adj* OR = 1.05, 95% CI: 1.00 - 1.10) while past respiratory illnesses was associated with chest tightness (*Adj* OR = 2.24, 95% CI: 1.04 - 4.84) and shortness of breath (*Adj* OR = 4.16, 95% CI: 1.92 - 9.92) after controlling the confounding variables. In addition, duration of employment also found to be associated with reported shortness of breath (*Adj* OR = 1.05, 95% CI: 1.00 – 1.10). However, level of dustiness (subjective dustiness) and frequency of using mask had no relationship with all the reported symptoms (Table 6).

Table 6: Contributing Factors to the Presence of Respiratory Symptoms

Respiratory symptoms	Crude OR [a] (95% C.I.)	*p* -value	Adjusted OR (95% C.I.)	Wald stat (df)	*p*- value
Chronic cough					
Age (year)	1.02 (0.98, 1.06)	0.286	0.99 (0.91, 1.08)	0.029 (1)	0.865
Duration of employment (year)	1.01 (0.99, 1.04)	0.295	0.98 (0.92, 1.04)	0.516 (1)	0.473
Cigarette equivalent (packs/year)	1.05 (1.01, 1.09)	0.011*	1.07 (1.04, 1.10)	6.40 (1)	<0.001**
Past dusty occupations (Yes)	0.74 (0.13, 4.16)	0.731	1.58 (0.14, 8.35)	0.133 (1)	0.176
Past respiratory illnesses (Yes)	1.21 (0.36, 4.11)	0.763	1.60 (1.11, 3.27)	0.348 (1)	0.554
Subjective dustiness (Grades)	0.89 (0.66, 1.22)	0.478	0.83 (0.57, 1.22)	0.860 (1)	0.354
Frequency of using mask (Yes)	1.21 (0.48, 3.03)	0.689	1.49 (0.40, 5.51)	0.350 (1)	0.250
Nagekel R = 0.101					
Chronic phlegm					
Age (year)	1.03 (0.99, 1.07)	0.195	1.00 (0.91, 1.09)	0.501 (1)	0.997
Duration of employment (year)	1.02 (1.00, 1.05)	0.120	0.99 (0.94, 1.04)	0.116 (1)	0.733
Cigarette equivalent (packs/year)	1.06 (1.02, 1.10)	0.002*	1.05 (1.03, 1.08)	9.767 (1)	<0.001**
Past dusty occupations (Yes)	1.52 (0.27, 8.60)	0.634	2.38 (0.21, 16.47)	1.496 (1)	0.481
Past respiratory illnesses (Yes)	1.98 (0.61, 6.39)	0.250	1.00 (0.21, 4.62)	0.786 (1)	0.990
Subjective dustiness (Grades)	0.81 (0.60, 1.11)	0.193	0.87 (0.60. 1.27)	0.525 (1)	0.206
Frequency of using mask (Yes)	1.33 (0.51, 3.51)	0.560	1.61 (0.43, 6.03)	0.492 (1)	0.483
Nagekel R= 0.113					
Chest tightness					
Age (year)	1.02 (0.99, 1.05)	0.087	1.03 (0.98, 1.08)	1.339 (1)	0.247

Duration of employment (year)	1.02 (0.99, 1.040	0.148	0.94 (0.89, 0.99)	0.117 (1)	0.733
Cigarette equivalent (packs/year)	1.02 (0.99, 1.06)	0.196	1.01 (0.98, 1.04)	0.849 (1)	0.357
Past dusty occupations (Yes)	2.30 (0.45, 11.72)	0.318	2.29 (0.25, 20.71)	0.543 (1)	0.462
Past respiratory illnesses (Yes)	4.71 (2.21, 10.04)	<0.001**	2.24 (1.04, 4.84)	4.255 (1)	0.039*
Subjective dustiness (Grades)	0.83 (0.59, 1.16)	0.271	0.87 (0.59, 1.27)	0.525 (1)	0.469
Frequency of using mask (Yes)	1.00 (0.42, 2.35)	0.994	0.83 (0.453, 1.52)	0.361 (1)	0.548
Nagekel R = 0.23					
Shortness of breath					
Age (year)	1.01 (0.99, 1.04)	0.295	0.96 (0.91, 1.01)	2.275 (1)	0.131
Duration of employment (year)	1.02 (1.00, 1.05)	0.04*	1.05 (1.00, 1.10)	4.371(1)	0.037*
Cigarette equivalent (packs/year)	1.04 (1.01, 1.06)	0.004*	1.03 (1.00, 1.06)	6.376 (1)	0.012*
Past dusty occupations (Yes)	1.78 (0.11, 28.96)	0.679	2.13 (0.13, 36.57)	0.273(1)	0.601
Past respiratory illnesses (Yes)	4.05 (1.09, 8.62)	<0.001**	4.16 (1.92, 9.92)	13.05 (1)	<0.001**
Subjective dustiness (Grades)	0.90 (0.66, 1.22)	0.895	0.78 (0.57, 1.11)	1.800 (1)	0.180
Frequency of using mask (Yes)	1.26 (0.74, 2.15)	0.392	1.39 (0.79, 2.46)	1.303 (1)	0.254
Nagekel R = 0.25					

* Significant at p < 0.05, ** significant at p <0.001

The FEV_1, FVC and $\%FEV_1/FVC$ were further analyzed to find out the association with demographic and occupational exposure after controlled the confounding variables. As expected, age, BMI and smoking were the important determinants of lung function values. Duration of employment was found to be associated with FEV_1 (*Adj* OR = -0.025, 95% CI: -0.030 – 0.020) and past respiratory illnesses were significantly reduced the $\%FEV_1/FVC$ (*Adj* OR = -1.784, 95% CI: -3.017 – 0.551). However, no associations were found between the lung function values with subjective dustiness, smoking and frequency use of mask (Table 7).

Table 7: Predictors of Lung Functions Values in Simple and Multiple Linear Regression

Predictors	SLR[a]		MLR[b]		
	b (95% CI)	p value	*Adj b* (95% CI)	t-stat	p value
			FEV_1 (litre)		
Constant	-	-	2.974 (2.656 3.292)	18.541	<0.001**
Age (year)	-0.031 (-0.035, -0.026)	<0.001**	-0.027 (-0.038,-0.016)	-4.747	<0.001**
Duration of employment (year)	-0.027 (-0.032, -0.022)	<0.001**	-0.025 (-0.030, 0.020)	-4.721	0.004*
BMI (kg/ms^2)	-0.020 (-0.029, -0.010)	<0.001**	-0.010 (-0.020, 0.000)	-1.899	0.059
Cigarette equivalent (packs/year)[c]	-0.275 (-0.397, -0.154)	<0.001**	-0.166 (-0.371,0.039)	-1.606	0.112
Past dusty occupations (yes)	-0.565 (-1.212, 0.081)	0.086	-0.255 (-0.678.0.168)	-1.196	0.234
Past respiratory illness (yes)	-0.039 (-0.290,0.212)	0.760	-0.025 (-0.251, 0.201)	-0.219	0.827
Subjective dustiness (grades)	-0.091 (-0.257, 0.076)	0.286	-0.007 (-0.080, 0.067)	-0.180	0.857
Frequency of using mask (yes)	0.085 (-0.032, 0.201)	0.153	0.165 (-0.009, 0.340)	0.977	0.063
R^2					0.388
			FVC (litre)		
Constant	-	-	3.655 (2.148, 5.162)	4.558	<0.001**
Age (year)	-0.033 (-0.037, -0.028)	<0.001**	-0.028 (-0.041, - 0.015)	-4.154	<0.001*
Duration of employment (year)	-0.028 (-0.034, -0.023)	<0.001**	-0.001 (-0.014, 0.013)	-0.127	0.899
BMI (kg/ms^2)	-0.023 (-0.033, -0.012)	<0.001**	-0.014 (-0.026, -0.020	-2.333	0.021*
Cigarette equivalent (packs/year)[c]	-0.342 (-0.477, -0.206)	<0.001**	-0.046 (-0.187, 0.095)	-0.646	0.519
Past dusty occupations (yes)	-0.728 (-1.451, -0.005)	0.048*	-0.786 (-1.601, 0.030)	-1.899	0.059
Past respiratory illness (yes)	-0.173 (-0.359, 0.2012)	0.067	-0.149 (-0.338, 0.041)	-1.550	0.123
Subjective dustiness (grades)	-0.045 (-0.121, 0.032)	0.252	-0.073 (-0.159, 0.013)	-1.681	0.094
Frequency of using mask (yes)	0.111 (-0.019,0.241)	0.095	0.049 (-0.098, 0.196)	0.653	0.514
R^2					0.342
			FEV_1/FVC (%)		
Constant	-	-	106.87 (74.49, 139.25)	6.553	<0.001**
Age (year)	- 0.097 (-0.158, -0.036)	0.002*	-0.104 (-0.292, 0.084)	-1.088	0.278
Duration of employment (year)	-0.098 (-0.164, -0.032)	0.004*	-0.133 (-0.328, 0.062)	-1.345	0.180
BMI (kg/ms^2)	-0.023 (-0.140,0.094)	0.700	-0.052 (-0.221, 1.118)	-0.598	0.550
Cigarette equivalent (packs/year)[c]	-1.150 (-3.777, 1.477)	0.387	-1.709 (-3.736, 0.317)	-1.663	0.098
Past dusty occupations (yes)	-1.395 (-4.501,1.711	0.377	-2.847 (-14.554, 8.859)	-0.479	0.632
Past respiratory illness (yes)	-1.207 (-4.00, -2.018)	0.003*	-1.784 (-3.017, 0.551)	-2.854	0.005*
Subjective dustiness (grades)	-1.947 (-6.429, 2.535)	0.393	-0.177 (-2.897, 2.544)	-0.128	0.898
Frequency of using mask (yes)	0.186 (-2.003, 2.375	0.867	1.428 (-0.684, 3.539)	1.313	0.184
R^2					0.117

SLR- Simple linear regression, MLR -Multiple linear regression
[a] Crude regression coefficients, [b] Adjusted regression coefficients
[c] Logarithm transformation before analysis, * p <0.05, ** p < 0.01, # p < 0.001
** Significance at p or below than 0.05, ** Significance at p or below than 0.001
The model reasonably fits well. Model assumptions are met. There are no interaction between independent variables and no multicollinearity problem

Model of lung function among steel workers

FEV_1 (litre) = 2.974 – [0.027*age] – [0.025 * duration of employment]

FVC (litre) = 3.655 – [0.028 * age] – [0.014 * BMI]

FEV_1/FVC (%) = 106.87 – [1.784* past respiratory illnesses]

4.0 DISCUSSION

4.1 Dust Concentrations

In this study, measurement of dust in the working environment was done by using static sampling strategy. The instrument was placed in different workplaces throughout the shift to trap the dust. There was significantly higher $PM_{2.5}$, PM_{10} and TPM level indoor air (in most of SM plant, DR shed, Fabrication and Refractory center) as compared to the allowable limit of 0.15 mg/m^3 by Industry Code of Practice of Indoor Air Quality, 2010 by the Department of Occupational Safety and Health (DOSH), Malaysia.

Similarly, previous studies reported Steel Making (SM) plant had recorded higher occupational exposure to respirable dust which was consistent (Singh et al., 2013, Kayhan et al., 2013, Gomes et al., 2001). Substantial amount of dust was generated at many points in the steel manufacturing process (such as sintering, melting in furnaces, tapping, and slag removal process), and the warm dust clouds tended to rise upwards. In contrast to the physics concept of gas distribution that distributes equilibrium in an enclosed space, the higher the dimension size of the area the lower the concentration of $PM_{2.5}$ became as compared to the lesser dimension size of the area.

Air pollution in the steel plant cause health effects to cardio-respiratory fitness although at the exposure below than exposure standards (Nezhad & Siahkuhian, 2012). A study conducted by Singh et al. (2011) and Singh et al. (2013) in the Indian steel mills reported that exposure levels of respirable suspended particulate matter (RSPM) in the casting section was high, while the low dust concentrations was reported in the machining section. The RSPM level was also found to be above the limit of 5 mg/m^3 as prescribed by Indian Factory Act. Kayhan et al. (2013) also found that the dust concentrations in the core making and casting were more than 10 mg/m^3, while the smelting and after processing did not exceed 10 mg/m^3. Rafiei et al. (2009) stated that respirable particulate matter (RPM) in steel production was also higher as compared to Industry Code of Practice of Indoor Air Quality, 2010 by the Department of Occupational Safety and Health (DOSH), Malaysia.

The average dust concentrations in fabrication and refractory center were recorded higher than other support plant groups. Fabrication workers (fabricators and welders) exposed to high respirable dust as compared to ambient dust exposure in the workplace (Gomes et al., 2001). They were also exposed to high concentrations of metal dust during welding as compared to other groups. Most of support groups for both plants were exposed to high respirable dust while doing regular repairs as well as bi-annual maintenance.

Dust concentrations varied between work sections and types of work in each unit due to the efficiency of local exhaust ventilation (LEV) in removing the dust out of the plant. High ambient temperatures in smelting and casting also encouraged the accumulation of dust in such area. Therefore, the average dust concentration was higher in the upstream (smelting) and downstream (casting) as compared to other working groups in the Steel Making (SM) Plant. In general, airborne contaminants in the SM plant were well controlled through enclosed and Local Exhaust Ventilation (LEV) systems. Since PM_{10} particles were bigger, they moved at slower speed and shorter travelling distance in the air before settled to the ground. Therefore, the LEV would help in removing more PM_{10} particles out from the plant successfully. However, the result indicated that respirable dust exposure in the workplace still required more effective control to reduce the exposure as suggested by Andersson et al. (2009) and Cotton & Underwood (2009). Therefore, workers are required to wear mask or other respiratory protective equipment while doing work in order to reduce such exposure. However, the practice of using mask 'full time' was also relatively low. Most of the workers were observed to use traditional methods by using towel, handkerchief, and T-shirt to cover their nose and face to protect them from exposure to dust.

4.2 Comparison of Respiratory Symptoms and Lung Function According to Work Section

The prevalence rates of chronic cough, chronic phlegm, chest tightness, and shortness of breath were higher among workers in SM plant as compared to workers in other work section. Only chronic cough was significantly different with work section as reported in other studies in the developing counties. Some researchers reported that prevalence of cough, phlegm, chest tightness, and shortness of breath was more frequent among workers in casting (Singh et al., 2012, Kayhan et al., 2013, foundry (Gomes et al., 2001), and furnace (Low & Mithcelli 1985; Andersson et al., 2009) as compared to other work section. In contrast, Low & Mitchell (1985) reported no significant difference between chronic cough and shortness of breath among different working groups. However, the signs of acute respiratory such as sneezing and rhinorrhea were found to be more frequent among foundry and core making workers while cough and phlegm were high among casting workers.

High respiratory symptoms in the population studied showed the existence of chronic irritation to the respiratory tracts due to prolonged and repetitive exposure to airborne dust. The occurrence of respiratory symptoms may represent the earlier response to dust exposure followed by lung function changes. Early respiratory symptoms have been suggestive as risk factors to subsequent loss of pulmonary function in steel workers (Abdel-Rasoul et al., 2009; Kayhan et al., 2013; Singh et al., 2013). Respiratory symptoms reflecting airway inflammation resulting from dust, even occurring early and reversibly, have a 'lagged effect' on subsequent on pulmonary function (Nurul et al, 2015). The authors suggested that workers who develop respiratory symptoms at the early stage are more susceptible to subsequent pulmonary function loss.

The lung function values (FEV_1, FVC, and $\%FEV_1/FVC$) were to be found lower among workers in SM plant as compared to other work section. Only the $\%FEV_1/FVC$ had a significant difference with all of the work sections. It was apparent that the lowering of lung function values showed a combination of obstructive and restrictive pattern among the subjects. This might be due to some occupational asthma (OA) cases among the population studied but the description of the diseases has not been investigated in detail. Occupational asthma (OA) may cause symptoms of chest tightness, shortness of breath, and chronic cough. Despite this, wheezing which was an important symptom of asthma was not assessed. Therefore, the decline of the small airways should be investigated among those who may be experiencing an early symptom of asthma in order to examine the relationship between chronic bronchial obstructions with respiratory failure.

These findings were in agreement with several studies done elsewhere in the steel manufacturing. Prevalence of OA was higher among foundry workers as compared to other working section (Gomes et al., 2001). In addition, furnace and fabrication workers were also found to have lower of lung function values as compared to other working section (Low & Mitchelli 1985; Andersson et al., 2009). Besides, local study also found that workers in manufacturing section stated significant difference of FEV_1 and FVC between the working sections (Azlihanis et al., 2007).

4.3 Contributing Factors to Respiratory Symptoms and Lung Function

Smoking was found to be the predictor of chronic cough, chronic phlegm and shortness of breath while duration of employment and past respiratory illnesses as well as smoking was the predictors to shortness of breath. Those who smoked 1 cigarette pack per year had 1.07 times the risk of chronic cough, 1.05 times the risk of chronic phlegm, and 1.03 times of risk of shortness of breath. Those who had past respiratory illnesses had 2.24 times risk of chest tightness and 4.04 times of risk of shortness of breath. Furthermore, another year of employment putting the workers 1.05 times more likely to experience shortness of breath. Similar findings were reported by few researchers. Smoker had higher risk of morning cough and morning phlegm (Razlan et al., 2000). Those had been working for many years had higher risk of reporting shortness of breath, chest tightness, morning cough, and morning phlegm (Razlan et al., 2000;2002; Nurul et al., 2015). High smoking prevalence (54.2%) found in this study was also likely to explain the high prevalence of reported respiratory symptoms. Earlier studies documented that smoking prevalence among the steel workers were 67.7% (Nurul et al., 2005) and 65.0% (Azlihanis et al., 2006).

Some researchers reported that air pollution in the workplace was significantly associated with cough (Rafiei et al, 2009) and reduced respiratory function of the workers (Nezhad and Siahkuhian, 2012). In comparison, Chen at al. reported smoking, duration of employment, and subjective dustiness as predictors of cough, phlegm, and breathlessness while past respiratory illnesses as the only predictor of breathlessness (Chen et al. 2006). Likewise, a dose-response relationship between cigarette-years of smoking and chronic cough and chronic phlegm was also well documented (Hu et al., 2006). According to Mohammadien et al. (2013) the prevalence of respiratory symptoms increased with duration of employment while prevalence of respiratory disorders increased with both duration of employment and dust level.

This study failed to reveal the association of subjective dustiness with all the reported respiratory symptoms and lung function values. This might be due to the inadequate findings of dust indicator measurement whereas further protocol of personal respirable measurement based on the regulations stated are needed. Exposure assessment is important in all environmental/occupational-epidemiologic studies. Associations have been clarified by improved use of exposure assessment even where indirect methods have been used. Thus, causal relation between exposure to certain chemical agents and adverse health effect can be determined as well as to measure and characterize any cause relations (to assess the exposure-response relationship or dose-response relationship). The estimation of cumulative doses also an important component of many occupational-exposure studies, though such measures may not be valid even in occupational settings. Therefore, the exposure-dose relation should be examined for nonlinearity before cumulative estimates are calculated. The relation between cumulative exposure and peak exposure is known in many occupational-epidemiologic studies, particularly those involving hazardous- site exposures or exposures to episodic pollution (Hamzah et al. 2014; Hamzah et al., 2016; Qian et al, 2016).

Age and body mass index (BMI) were independent predictors to lung function, which is a well-documented fact (Leslie & Lunau 1992; Corn 1993). It should be noted that the subjective dustiness (grades in dust exposure based on job task) was also appeared to be an independent predictor of $\%FEV_1/FVC$. Furthermore, the duration of employment had negative association with all the parameters of pulmonary function and was an independent predictor of FEV_1. This study also failed to reveal a clear picture of obstructive and restrictive impairments and the relationship with duration of exposure as suggested in other studied. This might be due to the inadequate findings of lung function abnormalities as chest x-ray and radiological opacities were not examined. Large range of duration employment can provide significant results for both pattern of lung function.

Smoking was also negatively associated with lung function but it was not found to an independent predictor of lung function. The misclassification of smoking indices especially among ex-smokers in calculating packs/year might lead to zero value within each category. Separate analysis based on smoking category is warranted to better evaluate the effect of smoking. Past respiratory illnesses also increased the deterioration of lung function, where an association was found with $\%FEV_1/FVC$. One out of five cases of chronic obstructive pulmonary diseases (COPD) may be attributable to occupational exposures (Silvana & Afrim 2010). Therefore, physicians and health policy makers should address this potential causes and consequences of COPD as well as introducing an ambient air-safety protection at the workplace.

The current study showed that exposure to respirable dust in the steel making could lead to the development of respiratory symptoms and impairment of lung function. Therefore, preventive measures or control measures should be adopted (Corn 1993; Harrington et al., 1992; Vincent 1999; Williams & James 2000). Local exhaust ventilation (LEV) is required in the SM plant to remove out the pollution from the main source, while general ventilation is suitable for those working in the fabrication, refractory, machining and mechanical center as well as in the DR shed. In addition, protective respirable equipment such as air-purifying air respirator should be provided. Workers may also get benefit from the health surveillance and educational program. In fact, Malaysia mandates the annual health examinations, including lung functions test and chest X-ray for workers exposed in the dusty environments. Although smoking did not appear to be a significant predictor to lung function, its effect to lung by enhancing the toxicities of other occupational hazards by interfering the lung defense mechanism are well documented (Vincent 1999; Williams & James 2000). Therefore, anti-smoking campaigns are still desirable especially in the male working population.

No significance association was found between frequency of mask usage with the presence of respiratory symptoms and lung function values. This might be due to inappropriate (poor quality and not very effective) facemasks available to the workers in this study as compared to the respirator masks available in other studies (Ahmed & Abdullah 2002; Lee et al., 2005; Wu 2002). Furthermore, compliance of Personal Protective Equipment (PPE) especially usage of mask was low and being ignored, only 34.3% of the workers were frequently using mask during the working period. Similar percentages of mask usage were reported by other researchers. Sirajuddin et al. (2005) reported that 34.4% of steel workers wore masks all the time while Singh et al. (2013) found that 25.0% of casting workers used nose/mouth mask properly. Mwaiselage et al. also mentioned that 41.2% of highly exposed workers used face masks but not during the whole shift (Mwaiselage et al., 2006). Yasin et al., (2002) found that 21.7% of farmers wore oral-nasal masks during handling of pesticides. Providing a safe working environments can minimize exposure to harmful effect of dust and adopting safe work practices. There is strong evidence that working environments and unsafe practices are associated with adverse health effects outcomes in working population (Ahmed & Abdullah 2002; Yassin et al., 2002; Lee et al., 2005; Wu 2002; Mwaiselage et al., 2006).

4.4 Limitation of the Study.

Self-reporting could cause underestimation of respiratory symptoms among the workers. Some workers might have feared of losing jobs if they admitted to have health problems. This was probably reduced in the present study by the private setting of the interview, and the assurance of privacy of the information they provided.

Both personal dust exposure and the extent of radiological opacities were not well measured in this study. These factors might link to the respiratory symptoms and pulmonary function. The subjective dustiness and duration of employment were not good indicators for exposure as there were various categories of steel workers with different level of exposures. The composition of dust exposure also contributes primarily to the respiratory health effect other than particle size and concentration. This study also did not analyse the components of dust. Care should be taken in assessing the adequacy by applying the threshold limit values for nuisance particles.

Besides, this study was conducted among current employed workers. The possibility of Healthy Worker Effect (HWE) might have arisen from the subjects who had suffered less exposure as compared to those who already left their jobs. Some of the subjects might be due to the illness sustained from the occupational exposure. This would be typically result in underestimate of the association between exposure and respiratory health effects. Confounding from previous job exposures prior to joining this factory was not considered much. Most of the workers were of lower educational group. They joined the factory soon after leaving school, were trained to become semi-skilled workers, and satisfied with their salaries. Therefore, they stayed with the factory for the rest of their working lives.

5.0 CONCLUSION

It has been shown that workers engaged in steel manufacturing are at risk of developing respiratory symptoms and lung function impairment even though at low exposure level. Smoking has already been known to exert deleterious effect to respiratory health, while the additional exposures to respirable dusts exacerbate the symptoms even worse. Air Purifying Respirator and N95 should be provided and the workers should be encouraged to use them during working hours to reduce the dust exposure as low as reasonably practicable (ALARP).

ACKNOWLEDGEMENT

Thanks to the respondents who have participated in this study. Their willingness and contribution in research will ultimately help to improve the healthcare sector of environmental and occupational health field. A special thank goes to Dr Mohd Abd Rashid Hussin for his assistance throughout the study period. This research would not have been possible without financial assistance from the PPUKM research grant project number FF-055-2013.

Disclosures: The authors declare no conflict of interest regarding the publication of this paper. Part of this paper was presented at the 4th International Public Health Conference that was held on the 27-28 August 2014 in Putrajaya, Malaysia, but is not under consideration for publication in any journal.

REFERENCES

Abdel-Rasoul, G.M., Mahrous, O.A.E., Abou Salem, M.E., Al-Batanony, M.A., & llam, H.K. (2009). Auditory and respiratory health in an iron and steel factory. *Zagazig Journal of Occupational Health and Safety*, 2(1), 1-10.

Ahmed, H.O., & Abdullah, A.A. (2012). Dust exposure and respiratory symptoms among cement factory workers in the United Arab Emirates. Industrial Health, 50(3):214-22.

American Thoracic Society Standardization of spirometry 1994 update (1995). Am J Respir Crit Care Med,152 (3), 1107–36.

Andersson, L., Bryngelsson, I-L., Ohlson, C-G., Nayström, P., Lilja, B-G., & Westberg, H. (2009).Quartz and dust exposure in Swedish Iron Foundries. *Journal of Occupational and Environmental Hygiene*, 6(1), 9-18.

Azlihanis, A.H., Mazlan, A., Razlan, M., Nurul, A.H., Azwan, A., & Nasir, S. (2007). A respiratory health survey among male workers in an automotive manufacturing plant in Perak. *Malaysian Journal of Medical Sciences*, 14(Supp 1), 289.

Azlihanis, A.H., Mazlan, A., Razlan, M, & Nurul. A.H. (2006). The association of lung function and smoking among workers in a steel industry. *Malaysian Journal of Community Health*, 12 (Supplement 1) : 10.

Bogadi-Sare, A. (1990). Respiratory disorders in stainless steel workers. Arhiv Za Higijenu Rada i Toksikologiju, 41(3), 249-255.

British Medical Research Council (BMRC)(1960). Standardized questionnaire on respiratory symptoms. *British Medical Journal*, 2 :1665.

Chen, P-C., Doyle, P.E., & Wang, J-D. (2006). Respirable dust exposure and respiratory health in male Taiwanese steelworkers. Industrial Health, 44(1), 190-99.

Corn, M. (1993).*Handbook of Hazardous Materials*. San Diego Academic.

Cotton, R., & Underwood, R. (2009). Analysis of CTI foundry dataset. Derbyshire, Health and Safety Laboratory.

Cugell, D.W. (1992).The hard metal diseases. Clinics in Chest Medicine, 13(2), 269-279.

Department of Occupational Safety and Health (2010). Industrial Code of Practice on Indoor Air Quality.Ministry of Human Resource, Malaysia 2010.

Gomes, J., Lloyd, O.L., Norman, N.J., & Pahwa, P. (2001). Dust exposure and impairment of lung function at a small iron foundry in a rapidly developing country. *Occupational and Environmental Medicine*, 58 (10), 656-52.

Hamzah, N.A., Mohd Tamrin, S.B., & Ismail, N.H.(2014). Metal dust exposure and respiratory symptoms among steel workers: an dose-response relationship. *International Journal of Colaborative Research on Internal Medicine and Public Health*, 7(3), 24–39.

Hamzah, N.A., Mohd Tamrin, S.B., & Ismail, N.H.(2016). Metal dust exposure and lung function deterioration among steel workers: an exposure-response relationship. *International Journal of Occupational and Environmental Health*, 22:224–32. https://doi.org/10.1080/10773525. 2016.1207040.

Harrington, J.M., Gill, F.S., Aw, T.C.,Applebey, G., & Atwell, C.P. (1992) Personal protection of the worker. Occupational Health, 3rd edition. London. Backwell Scientific Publications; p. 282-88.

Hu, Y., Chen, B., Yin, Z., Jia, L., Zhou, Y., & Jin, T. (2006). Increased risk of chronic obstructive pulmonary diseases in coke oven workers: interaction between occupational exposure and smoking. Thorax, 61(4), 290-95.

International Labor Office (ILO).(1983). Occupational safety and health in the Iron and Steel Industry. Geneva. International Labor Organization.

Johnson, A., Moira, C.Y., MacLean, L., Atkins, E., Dybuncio, A., Cheng, F., & Enarson, D. (1985). Respiratory abnormalities among workers in an iron and steel foundry. Brit J Ind Med, 42 (2), 94–100.

Kayhan, S., Tutar, U., Cinarka, H., Gumus, A., & Koksal, N. (2013). Prevalence of occupational asthma and respiratory symptoms in foundry workers. *Pulmonary Medicine 2013*. Volume 2013: Article ID 370138: 4 pages.

Kuo, H-W., Chang, C-L., Liang, W-M., & Chung, B-C. (1999).Respiratory abnormalities among male foundry workers in central Taiwan. Occupational Medicine, 49(8), 499-505.

Lee, S.A., Adhikari, A., Grinshpun, S.A., McKay, R., Shukla, R., Zeigler, H.L., & Reponen, T. (2005). Respiratory protection provided by N95 filtering face piece respirators against airborne dust and microorganisms in agricultural farms. *Journal Occupational and Environmental Hygiene*, *2*(11), 577-85.

Leslie, G.B., & Lunau, F.W. (1992). Indoor Air Pollution: Problems and priorities. Cambridge University Press.

Low, I., & Mitchelli, C. (1985) Respiratory diseases in foundry workers. *British Journal of Industial Medicine*, 42(2), 101-5.

Lowe, C.R., Campbell, H., & Khosla, T. (1970). Bronchitis in two integrated steel works: III. Respiratory symptoms and ventilator capacity related to atmospheric pollution. *British Journal of Industial Medicine*, 27(2), 121-29.

Mohammadien, H.A., Hussein, M.T., & El-Sokkary, R.T. (2013). Effects of exposure to flour dust on respiratory symptoms and pulmonary function of mill workers. *Egyptian Journal of Chest Diseases and Tuberculosis*, 62(4), 745-53.

Mwaiselage, J., Moen, B., & Bråtveit, M. (2006). Acute respiratory health effects among cement factory workers in Tanzania: An evaluation of simple health surveillance tools. *International Achieves of Occupational and Environmental Health,* 79(1), 49-56.

Nemery, B., Van Leemputten, R., Goemaere, E., Veriter, C., & Brasseur, L. (1985). Lung function measurements over 21 days shift work in steelworkers from a strandcasting department. *British Journal of Industrial Medicine*, 42(9), 601-11.

Nezhad, M.H.M., & Siahkuhian, M. (2012). The effect of air pollution on cardio-respiratory fitness of steel plant co. workers. *Middle-East Journal of Scientific Research*, 11(2), 225-29.

Nurul, A.H., Shamsul, B.M.T., & Noor Hassim, I. (2015). Respiratory health of male steel workers in the eastern coast of Peninsular Malaysia. *American Journal of Applied Sciences*, 12(5): 321-28. doi:10.3844/ajassp.2015.321.328.

Nurul, A.H., Azlihanis, A.H., Mazlan, A., Aziah, A.M., Zainul, A.H., Razlan, M., Azwan, A., Rusli, N., Naing, L., Shamsul, B.M.T., & Krishna, G.R.& Nasir, S. (2005), The effect of smoking on lung function among workers in steel factory. *Malaysian Journal of Public Health Medicine*, 5(Supplement 3), 56.

Rafiei, M., Gadgil, A.S., Sore, S.D., Jaafarzadeh, N, & Mirkazemi, R. (2009). Assessment of air pollution and its effects on the health status of the workers in beam rolling mills factory (Iran National Steel Industrial Group from Ahvaz-Iran. *Indian Journal of Occupational and Environmental Medicine*, 13(1),20-22. doi:10.4103/0019-5278.50719.

Razlan , M., Naing, L., Zullkifli, A., & Kamarul, Y. (2000). Respiratory health of rice millers in Kelantan, Malaysia. *Southeast Asian Journal of Tropical Medicine and Public Health*, 31(3), 575-78. PMID:11289024.

Razlan , M., Naing, L., Zullkifli, A., & Rusli, N. (2002). Respiratory symptoms and pulmonary function among male quarry workers in Kelantan, Malaysia. *Malaysian Journal of Public Health Medicine*, 2(1), 54-7.

Qian, Q-Z., Cao, X-K., Qian, Q-Q., Shen, F-H., Wang, Q., Liu, H-Y., Tong, J-W. (2016). Relationship of cumulative dust exposure dose and cumulative abnormal rate of pulmonary function in coal mixture workers. *The Kaohsiung Journal of Medical Sciences*, 32(1), 44-9.

Silvana, B, & Afrim, T. (2010). Chronic obstructive pulmonary diseases in iron-steel and ferro-chrome Industry. *Central European Journal of Public Health*, 18(2), 93-8.

Singh, P.L., Bhardwaj, A., & Deepak, K.K. (2013). Occupational exposure to respirable suspended particulate matter and lung functions deterioration of steel workers: An exploratory study in India. ISRN Public Health. 2013. Vol 2013. Article ID 325410: 8 pages. http://dx.doi.org/10.1155/2013/325410.

Singh, P.L., Bhardwaj, A., & Deepak, K.K. (2011). Respirable suspended particulate matter (RSPM) and respiratory symptoms among casting industry workers : An exploratory study in Northern India. *International Journal of Advance Engineering and Technology*. II (1) Januari-Mac: 251-59.

Sirajuddin, H., Emilia, Z.A., Noor Hassim, I. (2005). Kajian komplian penggunaan alat perlindungan diri pekerja kilang keluli, Terengganu. *Malaysian Journal of Community*. Health. 2005; 11(1), 65-75.

Vincent JH. Particle-size Selective Sampling of Particulate Air Contaminants. (1999). ACGIH Press.

Williams, P.L., & James, R.C. (2000). Principles of Toxicity: Environmental and Industrial Applications. 2 edition. A Wiley-Interscience Press.

Wilson, Anthony. (2001). More effective use seen as key factor in future. American Metal Market Energy Special, 109:11.

Wu, M.T. (2002). Assessment of the effectiveness of respirator usage in coke oven workers. *American Industrial Hygiene Association Journal*, 63(1),72-5.

Yaasin, M.M., Abu Mourad, T.A., & Safi, J.M. (2002). Knowledge, attitude, practice, and toxicity symptoms associated with pesticide use among farm workers in the Gaza strip. *Occupational and Environmental Medicine*, 59(6), 387-93.

Original Article

Job Hazard Analyses (JHA) for Ergonomics Risk Factors in Malaysian Pineapple Plantation

Nur Fazrina Mohamad Salleh[a] and Ezrin Hani Sukadarin[a]

[a] *Occupational Safety and Health Program, Faculty of Engineering Technology, Universiti Malaysia Pahang, 26300 Gambang, Pahang, Malaysia*

Corresponding Author: ezrin@ump.edu.my

ABSTRACT : *The prevalence of Musculoskeletal Symptoms (MSS) rapidly increases and it is recognized as a significant health outcome in agricultural sector. Agricultural ergonomics risk factor is one of hazards constantly arising from all job task activities including awkward postures and heavy lifting. Job hazard analyses (JHA) were conducted to assess the exposure of ergonomics risk factors in Malaysia Pineapple Plantation. The analyses performed involved two steps. They were: 1) guidelines and manual book Malaysia Pineapple Plantation as references; and 2) conducting walkthrough observation based on checklist approaches at the plantation. The identified risk factors were prolonged exposure of standing, squatting, stooping and kneeling, highly repetitive motion on the lower limbs, deviation and twisting of wrist and lastly, heavy lifting. The analyses confirmed that the exposure to ergonomics risk factors in pineapple plantation is high. It would be desirable to reduce the risk factors by educating and training the pineapple workers to perform their task with strong consideration of occupational safety and health.*

Keywords – *Ergonomics Risk Factors, Job Hazard Analysis (JHA), Malaysia Pineapple Plantation, Musculoskeletal Symptoms (MSS),.*

1.0 INTRODUCTION

Agricultural sector is one of the main sources of income in Malaysia especially for the community in rural areas. It is known that agricultural works were associated with several occupational disorders among the farmers (Das & Gangopadhyay, 2011). Several epidemiological studies showed consistent occurrence of a great number of accidents and work related diseases among agricultural workers (Kirkhorn & Schenker, 2002; Earle-Richardson et al. 2003).

The most prominent risk factors were the ergonomics factors including combination of load and working postures (Heather & John, 2003), postural activities (Reid et al. 2010), awkward working postures (Scuffham et al. 2010) and heavy lifting (Andersen et al. 2007). The pineapple industry in Malaysia is escalating as Malaysia is one of the main pineapple producers in the world because of the well-known producing quality, golden-yellow fruit (Tamrin and Aumran, 2014).

Starting and growing pineapple plants is one of the most aggressive agricultural activities (Abrahão et al. 2013). During agricultural-based pineapple plantation activities, most farmers are exposed to several types of ergonomics risk factors such as prolonged and awkward postures (Tamrin & Aumran, 2014). Moreover, the workers also exposed to heavy lifting of materials (Abrahão et al. 2013). As pineapple tree is a short rotation crop that grows with the maximum height of 1.5 meter from the ground, workers were therefore required to bend their body in positions which were defined as awkward posture for many job tasks such as cultivating, weeding, harvesting and preparation which could lead to muscle pain the feeling discomfort (Tamrin et al. 2014).

According to the most current occupational musculoskeletal disorders statistics by the Social Security Organization (SOCSO) annual report in 2016, the total numbers of affected workers were steadily increasing from the year 2011 to 2016. There was an effort to characterize exposure to ergonomics risk factors in 2016 (Rani, et al. 2016). The distribution of one-year Musculoskeletal Symptoms (MSS) prevalence among the pineapple plantation workers showed that lower back, feet/ankles and knees were the most affected body parts. On the other hands, Guo et al. (1996) also reported that pineapple workers were exposed to direct sunlight leading to dermatitis and heavy manual work. Despite the big number of publications examining the risk of work-related musculoskeletal disorders in the agricultural field, research addressing occupational safety and health in pineapple sector is still limited, thus making it harder to provide information about ergonomics risks in the pineapple industry.

Occupational Safety and Health Administration of United States defines Job Hazard Analysis (JHA) as a technique that focuses on job tasks as a way to identify hazards before they occur (OSHA, 2002). In Malaysia, according to Department of Occupational Safety and Health (DOSH, 2008), to perform JHA, the tasks needed to be breakdown into specific steps. After that, each step for specific hazards needed to be analyzed. Next, safe work procedures to eliminate or reduce those hazards were developed and safe work procedures integrated into safety and health programs. It was a practical method of identifying, evaluating and controlling risks in industrial procedures (Chao & Henshaw, 2002).

This study aimed to document JHA which were conducted to identify the ergonomics risk factors of MSS in the process cycle of pineapple plantation and to suggest recommendations in reducing the risk factors identified. Malaysia pineapple agricultural activity involved four separated job sequences started with (1) land cultivation preparation, (2) planting, (3) maintaining crops and (4) harvesting. Each job process had its own subtask to be completed in order to ensure pineapple trees were planted with quality. JHA approaches required the subtasks to be critically analysed for hazard. JHA was conducted and documented for all four main processes to be completed with their subtasks.

2.0 METHOD

2.1 Job Hazard Analysis (JHA)

JHA method had proven to be effective in planning the safest way to perform a task. The process of JHA included three main stages (Chao et al. 2002) which were:

(i) The Identification

This stage involved choosing a specific job or activity and breaking it down into sequence of stages and identify all possible loss of control incident that might occurred during work task.

(ii) The Assessment

This stage involved evaluating the relative level of risk for all of the identified incidents.

(iii) The Action

The last stage was the action on controlling the risk by taking sufficient measures to reduce or eliminating it.

2.2 Analysis and recommendations

JHA were performed according to the guidelines by Occupational Safety and Health Administration (OSHA, 2002). It was conducted in a group of researchers by involving two steps. Step one was to refer to the manual guidebook of pineapple plantation which was published by the Malaysian Pineapple Industry Board (MPIB). This handbook contained all information and techniques from MPIB starting with the selection of soil and plant areas until the last stage which was collecting fruits. The actual purpose on establishing the manual guide book was to assist local pineapple farmers in order for them to perform the standard sequence pattern of work task. The handbook was used as a reference in JHA method for researchers to have deep understanding on the plantation processes. Step two included assessing workers exposure to Work-Related Musculoskeletal Disorders (WRMSDs) risk factors using walkthrough observation and checklist approaches at the plantation. This step was crucial in order to determine the actual activity or process during working cycle of pineapple plantation workers. Dynamic activities of workers were also recorded using video recording technique for detailed analyses on Personal Computer (PC). Four main processes with its subtasks were videotaped by using a video camera. Detailed posture analyses were undertaken for all main processes.

3.0 RESULTS & DISCUSSION

From the four cycles of pineapple plantation procession, it was shown from the analysis that ergonomics risk exposure was high among workers. The results from JHA analysis were shown in each process which was categorized in different tables. Each table discussed possible consequences of exposure and recommendations to control the exposure.

3.1 First process - Preparing cultivation land

Figure 1: The Area for Pineapple Cultivation

Fig. 1 shows the image of pineapple cultivation land. The first process in pineapple plantation work cycles was preparing the cultivation land. The area was selected according to the soil ability to support the growth of pineapple plants for plants' fertility. The area needed to be clear from all trees and well-drained. Cutting big trees was done by using machineries however, small trees and bushes needed to be managed manually by using grass sickle or chemical weed killers. Next, treating soil process was made using small hoe.

From JHA analysis, (Table 1) it shows that ergonomics risk factors involved were the forceful exertion of hand (gripping an unsupported object more than three hours per day) and prolonged stooping (more than four hours per day). The possible consequences from these two risk factors were shoulder and low back disorders. An investigation of ergonomics study conducted by (Fathallah, 2010) showed that forceful and repetitive of hand and stooping can cause hand/wrist pain and lower back disorder, while based on (Reid, McCauley Bush, Karwowski & Durrani, 2010) study, stooping posture affected most of lower extremity body parts.

Table 1: JHA for Land Cultivation Preparation

Main Process	Sub process	Ergonomics risk factors	Criterion	Possible consequences	References	Recommended controls
Preparing cultivation land	Cutting and cleaning bushes in cultivation areas	Forceful exertion of hand	Gripping an unsupported object weighing 4.5 kg or more per hand, or gripping with a force of 4.5 kg or more per hand more than 3 hours total per day	Shoulder disorders	Davis (2007); Osborne et al. (2010); (Fathallah, 2010)	Redesign tools or equipment to enable neutral postures
	Treating soil	Prolonged stooping	Constant bending of trunk more than 60° along working hours (more than 4 hour per day)	Low back disorders	Reid et al. (2010); Osborne et al. (2010); Steven et al. (2013)	Reduce exposure by changing job scheduling for more breaks to allow rest and recovery

3.2 Second process - Planting

Figure 2: Workers were Planting Pineapple Suckers on Crop Beds

Fig. 2 shows workers were doing pineapple planting. The insect and algae treatment on the pineapple suckers was done earlier by dipping them into pesticide and algae poison solution. Workers were then required to create cultivation holes on plant beds. A sharp-end wood was normally used to make the hole according to the right size. The depth of the hole should be between 10cm to 15cm or appropriately fit with the size of pineapple suckers. Next, the pineapple suckers were planted by using hands. JHA analysis showed that the ergonomics risk was the repetitive motion of hand and prolonged poor postures from planting the pineapple suckers which were stooping, kneeling and squatting. During squatting, high pressure was imposed on the knee joint of workers (Cooper et al. 1994). Meanwhile, in the study of Thambyah et al. (2005) it is shown that osteoarthritis and cartilage damage occurred in the knees as a result of frequent or high contact stress of knee surface area.

Stooping postures required a forward torso bend while keeping the legs and knees as close to neutral as possible. In an agricultural postural research by Meyer and Radwin (2007), the results portrayed that stooping postures entailing a high level of discomfort and fatigue on the body, while a squatting posture studied by Chung et al. (2003, 2005), severe knee flexion was considered as a higher level of discomfort compared to other postures, similar with Jin et al. (2009) which also concluded that in agricultural industry, when compared to kneeling and stooping, squatting was found to be the most causing lower extremity muscle fatigue and discomfort. Several studies showed repetitive task can cause muscle fatigue (Walker-Bone & Palmer, 2002; Rosecrance et al. 2006; Davis, 2007). On top of that, a study by Zadry et al. (2011) also proved that repetition task can also caused both muscles and mental fatigue. The JHA summary for planting activity can be seen in Table 2.

Table 2: JHA for Pineapple Suckers Planting

Main Process	Sub process	Ergonomics risk factors	Criterion	Possible consequences	References	Recommended controls
Planting	Seed is being dip into concentrated insect or algae poison.	Prolonged stooping	Constant bending of trunk more than 60° along working hours (more than 4 hour per day)	Low back disorders	Reid et al. (2010); Genaidy et al. (1994) Meyer and Radwin (2007)	Increase the number of workers to reduce individual workloads
	Create cultivation holes	High repetition motion	Repetitively hand motion in making hole using sharp-end wood more than 20 times per minute	Shoulder disorders Hand/wrists pain	Walker-Bone & Palmer (2002); Rosecrance et al. (2006); Davis (2007);	Establish system so workers are rotated away from tasks to minimize the duration of continual repetitive motions and awkward postures.

Planting pineapple suckers	Awkward kneeling/squatting	Kneeling and squatting more than three hours total per day	Hip and knee arthritis, Knee pain (including osteoarthritis)	Thambyah (2005); Maity et al.(2016); Reid et al. (2010); Chung et al. (2003,2005)	Rotate workers among different task to rest the various muscle groups of body, reduce repetition and ease mental demands

3.3 Third process - Maintaining crops

Figure 3: A worker is Doing Hormone, Fertilizing and Weed Controlling

Table 3: JHA for Maintaining Crops Process

Main Process	Sub process	Ergonomics risk factors	Criterion	Possible consequences	References	Recommended controls
Maintaining crops	Fertiliser and hormone	Prolonged standing and bending	Prolonged standing and bending alternately of trunk more than 60° along working hours (more than 4 hours per day)	Cramp legs Ankle/foot pain Low back pain	Balasu-bramanian et al. (2009) Ngomo et al. (2008)	Increase the number of workers to reduce individual workloads
		Deviation and twisting of wrist from neutral position repetitively	Repetitive motion of hand (more than 20 times per minutes)	Hand/wrist tendonitis such as carpal tunnel syndrome	Guo, (2002); Juul et al, (2005); (McKeown, 2008).	Change job scheduling for more breaks to allow rest and recovery
	Manual weed control	Highly repetitive motion in lower extremities	Repeating the same motion with the feet with little or no variation every few seconds more than 4 hours total per day	Cramp legs Ankle/foot pain	Walker-Bone & Palmer (2002); Osborne et al. (2010) (Reid et al. 2010)	Use more hard pad footwear to reduce direct contact with unstable terrain

Fig. 3 illustrates a worker who was doing maintaining crop task. This stage involved some phases namely fertilizing, hormone and weed controlling. The job task was manually done by the pineapple workers. The formulation and amount of fertilisers had been determined and there were two types of methods which were by spraying or spreading using hands. For fertilising and hormone, JHA showed that workers experienced prolonged standing and bending trunk with more than 60° throughout the working hours about more than four hours per day. They also repetitively were using their hands at least 20 times per minute. JHA analysis for manual weed control task revealed that workers repeated the same feet motion with little or no variation every few seconds more than four hours total per day. Prolonged standing can cause leg discomfort (Balasubramanian et al. 2009; Ngomoet al. 2008). A study by Messing et al. (2006) also observed that periods of prolonged standing with little movement to no movement can cause lower level of discomfort to the lower limbs. Repetitive, deviation and twisting of wrist can lead to repetitive motion injury (RMI) or cumulative trauma disorder (CTD). Typically these injuries were caused by repetitive motions, such as of a hand, and there was a cumulative effect so that RMI might develop after an extended period of time (McKeown, 2008). Table 3 shows the JHA for maintaining crops process for further understanding.

3.4 Fourth process – Harvesting

Figure 4: A Worker Using Sharp Object (Sickle or Machete) to Cut Pineapple Fruit from its Tree

Fig. 4 shows a worker was harvesting pineapple fruit by using sharp sickle or machete. Harvesting pineapples required the workers to use sharp objects to cut off the fruit from its tree. Therefore, it involved awkward posture of the trunk area and forceful exertion while performing task using shoulders, arms, wrists and hands. After cutting the fruit, workers then required to put them into a knapsack basket until the basket was full. The minimum weight of full knapsack basket with fruits was 50 kilograms and if modified, the basket could carry up to 70 kilogram per session and this would go for more than four hours in a day total up to 500 to 600 kg of fruits per day. Pineapples were planted on a hilly terrain peat soil, causing the workers to work on unstable base of land.

A study by Pope et al. (2003) revealed a correlation between workers whose jobs required lifting moving objects heavier than 23 kg with lower back discomfort along with hip discomfort. Also, study by Rani et al. (2016) found that harvesting pineapples was the task with the highest rating hazard as the knapsack basket was too heavy and exceeded the safe limit and ideal lifting load. Furthermore, an investigation of back pain among agricultural workers by Sukadarin et al. (2016) revealed that upper back and lower back discomfort usually happened due to repeated activities, twisting motion, poor posture and overuse of muscles or due to injuries received while engaging in heavy physical activities. Table 4 shows the JHA for the last process in pineapple plantation which is harvesting.

Table 4: JHA for Harvesting

Main Process	Sub process	Ergonomics risk factors	Criterion	Possible consequences	References	Recommended controls
Harvest	Cutting and collecting	High exertion force	Forceful exertions of shoulder, arm, wrist, and trunk	Shoulder disorders	NIOSH (1997); Rosecrance et al. (2006); Lee (2016)	Use adjustable and suitable tools to cut the fruit to shorten the reaching distances.
		Highly repetitive hand motion	Deviation and twisting of wrist from neutral position repetitively (more than 20 times per minute)	Hand/wrists pain Hand/wrist tendonitis	Sukadarin et al. (2014); Swangnetr et al. (2014); Buckle & Jason Devereux (2002)	Redesign tools or equipment to enable neutral postures
		Prolonged stooping	Excessive bending during unloading the pineapple to the ground (more than 60°)	Low back pain	Reid et al. (2010); Sukadarin et al. (2016)	Adapt neutral postures
	Transport to pack house	Heavy and awkward lifting	Carry heavy load during working hours (50 to 70 kilogram per session), total 500-600 kg in a day		Koltan (2009); (Govindu & Babski-reeves (2014); Kuta, Cież, & Młotek (2015)	Reduce the weight load to limit force exertion Cultivate teamwork skills to lift heavy objects Encourage proper body mechanics and use safety lifting techniques

4.0 CONCLUSION

Job hazard analysis was conducted to assess ergonomics risk factors in Malaysian pineapple plantation. The prominent part of body affected was at the lower extremities as working in a pineapple plantation demanded workers to constantly use their lower extremities. The eminent risk factors were poor postures and heavy lifting. Poor postures included were squatting, kneeling and stooping.

This study suggested that pineapple plantation workers were exposed to various ergonomics risks which could contribute in developing of MSS. The observation found that ergonomics risk was one of the main hazards in pineapple plantation regarding on the safety and health issue. Some of the highlighted risks during preliminary study were heavy lifting, highly repetitive motion in lower extremities, stooping, squatting, kneeling and bending. There were considerable high risks of poor and awkward posture as well as prolonged time exposure. The tasks which also were described as labour intensive and physically demanding present forceful exertion and heavy lifting.

Appropriate ergonomics programmes such as expert's support, training and education were necessary to reduce the prevalence and to prevent the risk of exposure to MSS among these workers. Besides, ergonomics intervention design should also take place in order to reduce the exposure. To achieve successful mechanization design of tools or equipment, the involvement of workers is essential. Their opinion and interpretation is crucial as most agricultural workers often play the primary role of identification, refinement and conformity on tools and equipment.

ACKNOWLEDGEMENT

Special gratitude is addressed for the participations in the whole JHA program which involved the management staff and aborigine workers of Ladang Bersepadu Nanas Rompin Pahang (Malaysian Pineapple Industry Board). This project is financially funded by the grant Ministry of High Education of Malaysia (Knowledge Transfer Programme) (Grant Number: RDU161002). A special appreciation also goes to Universiti Malaysia Pahang (www.ump.edu.my) for the support in term of facilities and expertise.

REFERENCES

Abrahao, R.F., Gonzaga, M.C., Frederico, R.C., Tereso, M.J.A, (2017). Personal Protective Equipment Design and Ergonomics Work Analysis : Protecting Farm Pineapple Growers. *Proceedings of The 2nd Asian Conference on Ergonomics and Design*, **53**, 552–555.

Andersen, J.H., Haahr, J.P., Frost, P., (2007). Risk factors for more severe regional musculoskeletal symptoms: A two-year prospective study of a general working population. *Arthritis Rheu,* **56** (4), 1355-1364.

Balasubramanian, V., Adalarasu, K. & Regulapati, R., (2009). Comparing dynamic and stationary standing postures in an assembly task. *International Journal of Industrial Ergonomics*, **39** (5), 649-654.

Buckle, P.W. and Jason Devereux, J., (2002). The nature of work-related neck and upper limb musculoskeletal disorders. *Applied Ergonomics*, **33**, 207–217.

Chao, E.L., Henshaw, J.L., (2002). Job Hazard Analysis. OSHA Publication 3071 (Revised). Occupational Safety and Health Administration, US Department of Labor, Washington.

Chung, M.K., Lee, I., Kee, D., (2003). Assessment of postural load for lower limb postures based on perceived discomfort. *International Journal of Industrial Ergonomics,* **31**, 17–32.

Chung, M.K., Lee, I., Kee, D., (2005). Quantitative postural load assessment for whole body manual tasks based on perceived discomfort. *Ergonomics* **48** (5), 492–505.

Cooper, C., McAlindon, T., Coggon, D., Egger, P., Dieppe, P., (1994). Occupational activity and osteoarthritis of the knee. *Ann Rheum Dis*, **53**(2):90–3.

Das, B. and Gangopadhyay, S., (2011). An ergonomics evaluation of posture related discomfort and occupational health problems among rice farmers. *Occupational Ergonomics*, **10** (1–2), 25–38.

Davis, K.G., Kotowski, S.E., (2007). Understanding the ergonomics risk for musculoskeletal disorders in the United States agricultural sector. *Am J Ind Med*, **50**, 501−511.

Department of Occupational Safety and Health Malaysia. (2008). *Guidelines for Hazard Identification, Risk Assessment and Risk Control*.

Earle-Richardson, G., Jenkins, P.L., Slingerland, D.T., Mason, C., Miles, M., May, J.J., (2003). Occupational injury and illness among migrant and seasonal farm workers. *Am. J. Ind. Med*, **44** (1), 37- 45.

Fathallah, F.A., (2010). Musculoskeletal disorders in labor-intensive agriculture. *Applied Ergonomics*, **41**(6), 738–743.

Genaidy, A.M., Al-Shedi, A.A., and Karwowski, W., (1994). Postural stress analysis in industry. *Applied Ergonomics*, **25**(2), 77–87.

Govindu, N. K., and Babski-reeves, K., (2014). International Journal of Industrial Ergonomics Effects of personal, psychosocial and occupational factors on low back pain severity in workers. *International Journal of Industrial Ergonomics*, **44** (2), 335–341.

Guo, Y., Wang, B., Lee, C., and Wang, J., (1996). Prevalence of dermatoses and skin sensitisation associated with use of pesticides in fruit farmers of southern Taiwan. *Occupational And Environmental Medicine*, **53**, 427–431.

Heather, L.B., and John, W.K., (2003).The effect of load and posture on load estimations during a simulated lifting task in female workers. *Int. J. Ind. Ergonomics,* **31**(5), 331-341.

Juul-Kristensen, B., and Jensen, C., (2005). Self- reported workplace related ergonomics conditions as prognostic factors for musculoskeletal symptoms: the "BIT" follow up study on office workers. *Occupational and Environmental Medicine*, **62** (3), 188-194.

Kirkhorn, S.R., and Schenker, M.B., (2002). Current health effects of agricultural work:respiratory disease, cancer, reproductive effects, musculoskeletal injuries, and pesticide-related illnesses. *J. Agric. Saf. Health*, **8** (2), 199-214.

Koltan, A., (2009). An ergonomics approach model to prevention of occupational musculoskeletal injuries. *International Journal of Occupational Safety and Ergonomics*, **15**, 113–124.

Kuta, Ł., Cieź, J., & Młotek, M., (2015). Musculoskeletal load assessment of farmers during selected agricultural works. *Procedia Manufacturing*, **3**, 1696–1703.

Lee, T., (2016). The effects of arm posture and holding time on holding capability and muscle activity. *International Journal of Occupational Safety and Ergonomics (JOSE)*, 1–5.

Maity, P., De, S., Pal, A., Dhara, P.C., (2016). An experimental study to evaluate musculoskeletal disorders and postural stress of female craftworkers adopting different sitting postures. *International Journal of Occupational Safety and Ergonomics*, **22**(2), 257–266.

McKeown, C., (2008). A Guide to Human Factors and Ergonomics. *Ergonomics*, **51**(6), 949-951

Meyer, R.H., Radwin, R.G., (2007). Comparison of stoop versus prone postures for a simulated agricultural harvesting task. *Applied Ergonomics,* **38**, 549–555.

Messing, K., Tissot, F., Stock, S.R., (2006). Lower Limb Pain, Standing, Sitting,Walking: The Importance of Freedom to Adjust One's Posture. The International Ergonomics Association, Maastricht, Netherlands.

National Institute of Occupational Safety and Health (NIOSH). (1997). Musculoskeletal disorders and work- place factors (Publication No. 97–141). Cincinnati, OH: Department of Health and Human Services.

Ngomo, S., Messing, K., Perrault, H., Comtois, A., (2008). Orthostatic symptoms, blood pressure and working postures of factory and service workers over an observed workday. *Applied Ergonomics* **39** (6), 729–736.

Occupational Safety and Health Administration (OSHA 3071), (2002) (Revised). Job hazard analysis. *US Department of Labor*, 1–46.

Osborne, A., Blake, C., Fullen, B.M., (2012). Prevalence of musculoskeletal disorders among farmers: A systematic review. *Am J Ind Med*, **55**, 143−58.

Pope, D.P., Hunt, J.M., Birrell, F.N., Silman, A.J., Macfarlane, G.J., (2003). Hip pain onset in relation to cumulative workplace and leisure time mechanical load: a pop- ulation based case-control study. *Annals of the Rheumatic Disease,* **62**, 322–326.

Rani, N.H., Abidin, E.Z., Ya'acob, N.A., Karuppiah, K., (2016). Musculoskeletal Symptoms Risk Factors and Postural Risk Analysis of Pineapple Plantation Workers in Johor. *Journal of Occupational Safety and Health*, **13**(1), 17–26.

Reid, C. R., Mc Cauley Bush, P., Karwowski, W., Durrani, S.K., (2010). Occupational postural activity and lower extremity discomfort: A review. *International Journal of Industrial Ergonomics*, **40**(3), 247–256.

Rosecrance, J., Rodgers, G., Merlino, L., (2006). Low back pain and musculoskeletal symptoms among Kansas farmers. *Am J Ind Med*, **49**, 547−56.

Scuffham, A.M., Legg, S.J., Firth, E.C., Stevenson, M.A., (2010). Prevalence and risk factors associated with musculoskeletal discomfort in New Zealand veterinarians. *Appl. Ergon*. **41**(3), 444-453.

Steven R. Kirkhorn, Giulia Earle-Richardson, R.J. Banks, C., (2013). Ergonomics Risks and Musculoskeletal Disorders in Production Agriculture : Recommendations for Effective Research to Practice, *Journal of Agromedicine*, **15**(3), 281-299

Sukadarin, E.H., Deros, B.M., Ghani, J.H., Ismail, A.R., (2014). A review of work related musculoskeletal problems in agricultural industry. *Aust. J. Basic & Appl. Sci.,* **8**(19), 56-59.

Sukadarin, E. H., Md Deros, B., Mohd Nawi, N. S., A. Ghani, J., Ismail, A. R., and Zakaria, J., (2016). Back Pain and the Observed Factors among Oil Palm Workers. *International Journal of Engineering Technology and Sciences,***5**, 70–78.

Swangnetr, M., Kaber, D. B., Puntumetakul, R., and Gross, M.T., (2014). Ergonomics-related risk identification and pain analysis for farmers involved in rice field preparation. *Work (Reading, Mass.)*, **49**(1), 63–71.

Tamrin, S.B.M., and Aumran, N., (2014). *A comparison of the hazards, the risks, and the types of control in three selected agricultural industries*. Occupational Safety and Health in Commodity Agriculture :Case Studies from Malaysian Agriculture Perspective , **1**, 93–146.

Thambyah, A., Goh, J.C.H., De, S.D., (2005). Contact stresses in the knee joint in deep flexion. *Medical Engineering and Physics*, **27**, 329–335.

Walker-Bone, K., Palmer, K.T., (2002). Musculoskeletal disorders in farmers and farm workers. *Occup Med*, **52**, 441−50.

Zadry, H.R., Dawal, S.Z.M., Taha, Z., (2011). The relation between upper limb muscle and brain activity in two precision levels of repetitive light tasks. *International Journal of Occupational Safety and Ergonomics*, **17**, 373–384.

Original Article

Knowledge, Attitude and Practice Regarding Motorcycle Helmet Usage among Secondary School Students in Kuantan, Malaysia

Suzilawati Mohamed Ariffin,[a,]* Mimi Nor Aliza Setapani,[b]

[a] *Department of Critical Care Nursing, Kulliyyah of Nursing,International Islamic University Malaysia, Jalan Hospital Campus, 25100 Kuantan, Pahang Darul Makmur.*
[b] *Kulliyyah of Nursing,International Islamic University Malaysia, Jalan Hospital Campus, 25100 Kuantan, Pahang Darul Makmur.*

* Corresponding author: suzilawatima@iium.edu.my

ABSTRACT*: Malaysia has the highest road fatality risk (per 100,000 populations) compared to other ASEAN nations and more than 50% of the road accident fatalities involving motorcyclists. Hence, this becomes the leading cause of death among young people, aged 15-29 years. The most common cause of fatalities involving motorcyclist is the head injury., This study aimed to evaluate the knowledge, attitude, and practice on motorcycle helmet usage among secondary school students in Kuantan, Malaysia. A descriptive cross-sectional design (two months of data collection) was used in this study. Questionnaires were distributed to 200 participants from two schools in Kuantan. The main finding of this study suggests that common reason for the participants to wear a helmet is that 'it can save a life'. Besides that, the poor practice regarding helmet usage was also found as only 4.5% of them wore the helmet all the time. However, the overall result showed that most of the participants have a good knowledge and positive attitude regarding utilization of helmet.*

Keywords – *Attitude, Head Injury, Helmet Usage, Knowledge, Practice*

1.0 INTRODUCTION

The motorcycle has become an important mode of transport among Malaysians yet currently, Malaysia ranks seventh place for motorcycle fatalities among ASEAN countries (Abdul Manan & Varhelyi, 2012). Serious head injury or traumatic brain injury (TBI) is the leading cause of the fatality and severity of motorcycle accident due to the lack of safety procedure compliance particularly by not wearing a head protector during a motorcycle ride (Olakulehin *et al.*, 2015). Surprisingly, 43.9% of the collisions between motorcycles involved students and 37.7% of those who sustained head injuries are in the 10-16 age groups (Oxley *et al.*, 2013). Road Safety Annual Report in Malaysia revealed that 63% of road deaths are among motorcyclists and the fatality rate increasing in trend between years 2000 to 2015 by 19% (ITF, 2017). Besides that, according to World Health Organization (2018), road traffic injuries are the leading cause of death among young people aged 15–29 years. An accident involving young people between 16-20 years was reported fluctuating in number from the year 2012 to 2015 which is 1032, 960, 1131, and 934 cases respectively (ITF, 2017).

Pahang state has 31.4% population of children under 18 years old which is about 1648000 (The Office of Chief Statistician Malaysia, 2017). According to Ministry of Transport Malaysia (2016), Pahang shown the highest incident rate for road accident (19635 cases) and death rate (532 cases) caused by road accident compare with other east coast regions in Malaysia. Students who withstand road traffic injuries (RTI) frequently require long-term care, depriving them of education and social advancement chances (Mohamed, Voon, Hashim & Othman, 2011). There is a study that has been conducted on knowledge, attitude, and practice regarding safety helmet usage among motorcyclist in Selangor (Ambak, Ismail, Rahmat & Shokri, 2011), however, the study did not specifically do among secondary school children especially in Kuantan. Therefore, this study is undertaken in order to evaluate the knowledge, attitude, and practice regarding motorcycle helmet usage among secondary school students in Kuantan. The hypotheses of this study are: 1) there is no significant relationship between demographic data with knowledge, attitude, and practices of helmet usage; and 2) there is no association between dependence variables (knowledge, attitude, practice) toward helmet usage.

2.0 METHOD

The location of this cross-sectional study was in Kuantan, Pahang. Two secondary schools out from 44 schools were selected from two different areas (Fig. 1). One of the schools represented an urban location, and another represented the suburban area. A purposive sampling method was used in this study where the participants must be within the range of 16-19 years old as 16 years old is the legal age to get a motorcycle license in Malaysia, and the participants must ride a motorcycle to school. A set of questionnaire adapted from a previous study (Bachani, Ismail, Rahmat & Shokri, 2011) was used as an instrument for this study. The sample size used in this study was 200 participants. The calculation was done using Roasoft software with a confidence level of 95%. The pilot study was done before distributing the questionnaire to the actual participants and the Cronbach alpha for each part: knowledge; 0.717, attitude; 0.700, and practice; 0.730.

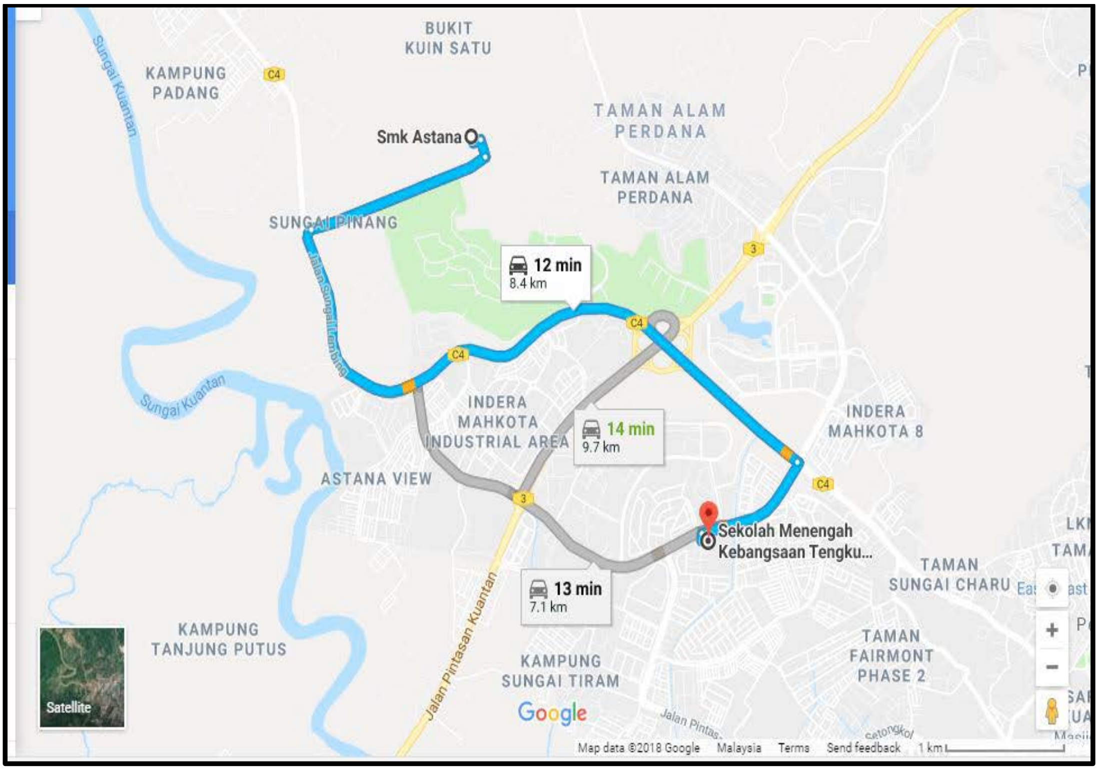

Figure 1: Location of the Schools

The 200 participants were successfully selected and willing to answer the questionnaire after the objectives and purposes of the study were explained to them. The questionnaire consisted of four parts, namely, Part A: social-demographic data, Part B: the participants' knowledge about helmet usage, Part C: the attitude of the participants about helmet usage, and Part D: their helmet usage practices. The completed questionnaires were collected by the researcher after 30 minutes of distribution.

Ethical approvals were obtained from Kulliyyah of Nursing Postgraduate and Research Committee (KNPGRC), IIUM Research Ethics Committee (IREC), Ministry of Education Malaysia (MOE), Jabatan Pendidikan Negeri Pahang (JPNP) and the principals of the selected schools. All the participants were provided with written consent. The identities of all participants were kept confidential in the study. The participants had the right to drop out of the study if they chose to do so.

Statistics

The Statistical Package for the Social Sciences (SPSS) version 19.0 was used to analyze the data of this study. Descriptive frequency and Chi-square were used to analyze the collected data.

3.0 RESULTS

3.1 Demographic data

Data collection was conducted from February 2017 – March 2017 and the total numbers of participants for this study were 200 students, comprising of 129 males (64.5%) and 71 females (35.5%). One hundred and twenty-three participants (61.5%) were aged 16 years old, and they formed the majority of the participants. A hundred participants were selected from each school. Out of 200 participants, 149 participants (74.5%) did not have a motorcycle license. Thirty-four or 66.7% of the participants had a license hold the license less than six months from the survey period, and 24 (47.1%) of them had a Learner's Driving License (LDL). Table 1 shows the demographic data of participants.

Table 1: Demographic Data of Participants

Characteristic	Frequency (N=200)	Percentage (%)
Gender		
Male	129	64.5
Female	71	35.5
Age		
16 years old	123	61.5
18 years old	63	31.5
19 years old	14	7.0
School		
School A (urban) School B	100	50
(sub-urban)	100	50
Having license		
Yes	51	25.5
No	149	74.5
Period of having a license		
≤ 6 months	34	66.7
6 months - 1 year	6	11.8
≥ 1 year	11	21.6
Type of license		
Learner Driving (LDL)	24	47.1
Probationary Driving	21	41.2
Competent Driving	6	11.8

3.2 Knowledge about safety helmet usage

Table 2 reveals that 131 participants (65.5%) from the whole populations state that by wearing a helmet can save their life. However, only 18.5% (37 participants) wore their helmet when traveling long distances.

Table 2: Knowledge of the Importance of Wearing a Helmet

Response	Frequency (N=200)	Percentage (%)
It can save my life	131	65.5
It protects against sunlight and dust	59	29.5
I travel long distances	37	18.5
I travel on a highway	60	30.0
To prevent the head injury	118	59.0

3.3 The attitude of secondary school students regarding helmet usage

Based on Table 3, 123 of participants (61.5%) do not wear a helmet because they only traveled a short distance. Only 27 out of 200 participants accounted for not wearing a helmet due to the price of the helmet.

Table 3: Reason for Not Wearing a Helmet

Response	Frequency	Percentage (%)
Messes up my hair	49	24.5
Only traveling a short distance	123	61.5
Traveling on the local road	75	37.5
Helmet price is expensive	27	13.5
No police/ laws enforcement in this community	59	29.5

3.4 The practice of helmet usage

As tabulated in Table 4, the highest result of the practice of helmet usage is accounted by 73 of participants (36.5%) who choose to wear their helmets ‘rarely’ while 58 participants (29%) wear them ‘sometimes’. On the other hand, only 4.5% (9 participants) wear the helmet ‘all the time’ when riding their motorcycles.

Table 4: Practicing on Wearing a Helmet in Past 30 Days

Responses	Frequency	Percentage (%)
All the time	9	4.5
Most of the time	32	16.0
Sometimes	58	29.0
Rarely	73	36.5
Never	28	14.0
Total	200	100

3.5 The relationship between the selected demographic status of the participants with the knowledge, attitude, and practices regarding helmet usage

From the results, it can be concluded that there is a significant relationship (p<0.05) between attitude on helmet usage with gender and location of the school (Table 6). The same result also found between gender and practice on helmet usage (Table 7). However, no significant relationships were found between knowledge on helmet usage with gender and location of the school (Table 5), and between locations of the school with practices on helmet usage (Table 7).

Table 5: Relationship between Knowledge of Helmet Usage against Gender and Location of the School

Variables		N	Knowledge Yes (%)	Knowledge No (%)	X^2 statistics	P value
Gender	Male	129	123 (95.3)	6 (4.7)	3.404 (1)	0.069
	Female	71	71 (100)	0 (0)		
Location	Urban	100	95 (95)	5 (5)	0.740 (1)	0.284
	Suburban	100	92 (92)	8 (8)		

Table 6: Relationship between the Attitude of Helmet Usage against Gender and Location of the School

Variables		N	Attitude Yes (%)	Attitude No (%)	X^2 Statistics	P value
Gender	Male	129	103(79.8)	26 (20.2)	4.668(1)	0.022
	Female	71	65(91.5)	6 (8.5)		
Location	Urban	100	92(92)	8 (8)	9.524(1)	0.002
	Suburban	100	76(76)	24 (24)		

Table 7: Relationship between Practices of Helmet Usage against Gender and Location of the School

Variables		N	Practice Yes (%)	Practice No (%)	X^2 Statistics	P value
Gender	Male	129	109(84.5)	20(15.5)	22.558(1)	0.0001
	Female	71	38(53.5)	33(46.5)		
Location	Urban	100	78(78)	22(22)	2.079(1)	0.100
	Suburban	100	69(69)	31(31)		

3.6 Association between dependence variables toward helmet usage

Tables 8, 9 and 10 show the association between knowledge with attitude, the association between knowledge with practice, and the association between attitudes with practice regarding helmet usage. Results from Chi-square tests suggested that the *p*-value for knowledge with attitude, knowledge with practice, and attitude with practice are 0.134, 0.281 and 0.321, respectively. Therefore, indicating that there was no association between all the dependent variables with helmet usage. The location of the schools which is quite near to each other (about 7 to 9 kilometers) might influence the result with the assumption that they need to follow the same law enforcement. Besides, the number of participants may also contribute to such result.

Table 8: Association between Knowledge and Attitude of Helmet Usage

Variable	N	Knowledge Yes (%)	Knowledge No (%)	X^2 Statistics (DF)	P value
Attitude (Yes)	168	159 (94.6)	9 (5.4)	2.257(1)	0.134
Attitude (No)	32	28(87.5)	4(12.5)		

Table 9: Association between Knowledge and Practice of Helmet Usage

Variable	N	Knowledge Yes (%)	Knowledge No (%)	X^2 Statistics (DF)	P value
Practice (Yes)	147	136(92.5)	11(7.5)	0.882(1)	0.281
Practice (No)	53	51(96.2)	2(3.8)		

Table 10: Association between Attitude and Practice of Helmet Usage

Variable	N	Attitude Yes (%)	Attitude No (%)	X^2 Statistics (DF)	P value
Practice (Yes)	147	125(85)	22(15)	0.441(1)	0.321
Practice (No)	53	43(81.1)	10(18.9)		

4.0 DISCUSSION

4.1 Demographic Data

In this study, the researcher found that 64.5% of the participant was males. This is similar to the findings of other studies. Even in the African culture, they also found more male than female motorcyclists (Olakulehin *et al*., 2015). As for the license status, the study revealed that only 25.5% (51 participants) had motorcycle license whereas the others 74.5% (149 participants) did not have any licenses. The same pattern also occurred in India where out of 158 (32.57%) students who rode motorcycles, only four of them had a driving license. Oxley *et al.* (2013) suggested few interventions that should be implemented in order to reduce the number of road fatality rate among younger-aged includes monitoring on unlicensed riders and encourage helmet wearing.

4.2 Knowledge about safety helmet usage

The most popular responses from the participants were 'it can save my life' and 'to prevent head injury' which accounted for 131 participants (65.5%) and 118 participants (59%) respectively. The same findings could be witnessed in a previous study which stated that 56% of the respondents strongly agreed that the correct use of a helmet might keep the head from being injured (Ambak, Ismail, Rahmat & Shokri, 2011). In another study, it was recorded that 99.2% of the respondents who always wear helmets claimed that wearing a head protector could save their head from injury (Wadhwaniya *et al.*, 2015).Participant in this study response that, 'I travel long distances' (18.5%) as the reason least to wear a helmet. Contrary, one study in Malaysia found that long distance travels (more than 5 km) are not solely the reason to wear a helmet as proven that one-third (33%) of the respondents disagreed that the helmet is only fit for long distance travels (Ambak, Ismail, Rahmat & Shokri, 2011). All the above result indicate that the young generation is still not fully aware or maybe not receive sufficient information on this issues.

4.3 The attitude of secondary school student regarding helmet usage

In this study, more than half of participants (61.5%) believe that the common reason for them to not wear a helmet was due to short distance travel. Other studies also revealed that the adolescents rarely wear helmets especially in short distance journey which are less than 2 kilometers (Ahmed, Ambak, Raqib & Sukor, 2013). It is because they believe that the possibility of any casualty and crash is remote if they only traveled in short distances (Jiwattanakulpaisarn *et al.*, 2013). However, this perception had been demonstrated to be wrong by the Trauma Registry information from the Khon Kaen Regional Hospital, which showed that the most motorcycle injuries happened because of street accidents occurring inside 1 km of their homes (Jiwattanakulpaisarn *et al.*, 2013). Fifty-nine of participants out of 200 (29.5%) from this study claimed that it was not necessary for them to wear a helmet all the time as there was no police/ laws enforcement in their community. This had been supported by a previous study which showed that 44% of the respondents agreed that the lack of enforcement made motorcyclist disobey the law about helmet wearing and 36% of the respondents agreed that RM100 compound is still considered inexpensive (Ambak, Ismail, Rahmat & Shokri, 2011). Because of this reason, it can be observed that still many of the riders chose not to wear a helmet.

4.4 The practice of helmet usage

ITF (2017) mentioned that wearing a helmet has been compulsory for motorcyclist since 1973, and highest fatality rate happens among young population (18-20 years old) and the senior population (above 65 years old) about 30 deaths per 100 000. In this study, it showed that the participant had a poor practice of helmet usage as only 4.5% (9 participants) wore the helmet 'all the time' and 16% (32 participants) wore it 'most of the time'. These results were different with the finding from a previous study done in Malaysia where it had a slightly positive outcome which was 36.3% (109) of the respondents admitted they often wore a helmet (Ambak, Ismail, Rahmat & Shokri, 2011). Rabihah et al. (2015) revealed that helmet wearing rate is high (94.40%) and the rate of proper helmet wearing is 77.05%. As mention by Mohamed Ghazali, Khairil and Mohd Pozi (2012), wearing a helmet properly is one of the precautions that can be practiced by motorcyclists in order to protect them from injury. It can be said that factor contributed to compliance on helmet wearing was due to a comprehensive knowledge of the life-saving action, laws enforcement, and also the education level (Bachani, Ismail, Rahmat & Shokri, 2011). Disappointedly, 29% of the participants in this study claimed that they had rarely worn a helmet during motorcycle rides, and this is higher compared to a previous study by Bachani, Ismail, Rahmat and Shokri (2011) which accounted only 1.7% (5) of respondents who have never used a helmet. An effective action should be considered into account in order to enhance practice on helmet wearing especially for the young population since the campaign alone seemed not really effective to give awareness on it.

4.5 The relationship between selected demographic status with knowledge, attitude, and practices of helmet usage

Both female and male participants showed similar knowledge level regarding helmet usage (100% and 95.3%, respectively). However, for attitude and practice, the result was differing between male and female participants. Male show 79.8% while female 91.5% for their attitude toward helmet usage. However, for the practice of helmet usage, the result showed the opposite result where 84.5% male revealed good practice on helmet usage, while female only 53.5%. In contrast, a study done in Thailand did not find any relationship between gender and deficiency of intention to use a helmet and non-helmet use (Siviroj, Peltzer, Pengpid & Morarit, 2012). As for the attitude, it was found that the female participants had a more positive attitude (91.5%) toward helmet usage compared to the male participants (79.8%). This had been proven by a similar result in Hyderabad that found men to be at a higher risk of not wearing helmets; but in terms of practice, the male participants (84.5%) were more likely to use helmet than female riders (53.5%) (Wadhwaniya *et al*., 2017). Such scenario happened may be because the male regularly rode motorcycles than the females. Conversely, Ambak, Ismail, Rahmat and Shokri (2011) stated that in Malaysia, female riders are more likely to use helmets compared to male riders.

Furthermore, this study revealed that the attitude regarding helmet usage was statistically significant (p=0.002) with the location of the school itself. A study conducted in Klang Valley found that the distribution of helmet use among the respondents in urban schools is higher than in non-urban (Hamzah, Ahmad, & Voon, 2009) and the same result noted in this study. Study byRabihah et al. (2015) mention that helmet wearing rate in primary roads in Malaysia is as high as 94.4%, but the rate is decreased when an aspect of properly wearing a helmet takes into account, and Pahang state showed 83.22% from population wearing a helmet. Although there was no significant difference in terms of knowledge (p=0.284) and practice (p=0.100) in this study, the finding showed a positive link between knowledge and practice as all of these elements were recorded as most of the participants had comprehensive knowledge, and practice as well as attitude regarding helmet usage.

4.6 Association between dependence variables toward helmet usage

The findings of the study illustrated that there were no associations between knowledge attitude, knowledge and practice, and also an association between attitude and practice toward helmet usage as represented by the p-values 0.134, 0.281 and 0.321 respectively. These contradict from the results of the previous study (Rezazadeh *et al*., 2015) which reported a significant relationship between knowledge and attitude and age, marital status, occupation, level of education, place of residence, and having driver's license. However, no significant relationship was found between knowledge and attitude with the history of the accident (Rezazadeh et al., 2015). This means that the association between knowledge and attitude also depend on others variables. Meanwhile, others found that knowledge and practice had a significant link as inconsistent helmet wearing was secondary to ineffective law enforcement of helmet usage and from this, it was suggested that that low level of helmet use may be partly attributed to the lack of knowledge of the protective benefits of helmets and low law enforcement is regarding helmet use (Mwakapasa & Outwater, 2012).

5.0 CONCLUSION

The objective of this study has been achieved when it was revealed that both males and females had good knowledge and attitude on helmet usage. However, in general, they had a poor practice on helmet usage as the majority of them rarely wearing the helmet. Participants also had positive knowledge, attitude and practice about helmet usage regardless the location of the school, whether it is urban or suburban. Unfortunately, the researcher believes that the finding is not significant as the environment of both locations were quite similar.

This study can be a baseline data for the school in promoting the awareness of helmet usage to their students. Besides that, it is hoped that this study will provide insight for healthcare providers in implementing helmet usage campaigns and programs with different strategies to increase awareness about it in order to decrease the severity and mortality rate among motorcyclists due to head injuries. In order to obtain a more accurate data, it is suggested that future studies conduct a study with different approaches such as interventional or observational study among secondary school children in Kuantan. Further study is also recommended to test the association of knowledge, attitude and practice to each other in order to identify another factor that may be related to them.

ACKNOWLEDGEMENT

Special thanks for those who involved and sincere thanks to International Islamic University Malaysia (IIUM) for funding this study (RIGS-16-281-0445).

REFERENCES

Abdul Manan, M. M., & Várhelyi, A. (2012). Motorcycle fatalities in Malaysia. *IATSS Research, 36*(1), 30–39.doi.org/10.1016/j.iatssr.2012.02.005

Ahmed, M. B., Ambak, K., Raqib, A., & Sukor, N. S. (2013). Helmet usage among adolescents in the rural road from the extended theory of planned behaviour. *Journal of Applied Sciences*, *13*(1), 161–166. doi.org/10.3923/jas.2013.161.166

Ambak, K., Ismail, R., Rahmat, R. A. O., & Shokri, F. (2011). Do Malaysian motorcyclists concern to safety helmet usage: A cross-sectional survey. *Journal of Applied Sciences*, *11*(3), 555–560. doi.org/10.3923/jas.2011.555.560

Bachani, A. M., Branching, C., Ear, C., Roehler, D. R., Parker, E. M., Tum, S., Ballesteros, M.F., & Hyder, A. A. (2013). *Trends in prevalence, knowledge, attitudes, and practices of helmet use in Cambodia: Results from a two- year study. Injury*, 44(SUPPL. 4), S31-7. doi.org/10.1016/S0020-1383(13)70210-9

Hamzah, A., Ahmad, Y., & Voon, W. S. (2009). *Child Helmet Efficacy for Motorcycle Use in Malaysia Child Helmet Efficacy for Motorcycle Use in Malaysia*. Malaysian Institute of Road Safety Research (MIROS) Review Report, MRev 04/2009. Retrieved from http://www.miros.gov.my

ITF (2017). *Malaysia, in Road Safety Annual Report 2017*, OECD Publishing, Paris. doi.org/10/1787/irtad-2017-en

Jiwattanakulpaisarn, P., Kanitpong, K., Ponboon, S., Boontob, N., Aniwattakulchai, P., & Samranjit, S. (2013). Does law enforcement awareness affect motorcycle helmet use? Evidence from urban cities in Thailand. *Global Health Promotion,* 20(3), 14–24. doi.org/10.1177/1757975913499030

Ministry of Transport Malaysia (2016). Transport Statistic Malaysia: Ministry of Transport Malaysia. ISSN: 0128-2778. Retrieved from www.mot.gov.my

Mohamad Ghazali, M., Khairil Anuar, M.I. & Mohd Pozi, M.T. 2010. *Children, Youth and Road Environment: Road Traffic Accident*. Asia Pacific International Conference on Environment-Behaviour Studies, Grand Margherita Hotel, Kuching, Sarawak, Malaysia. Procedia - Social and Behavioral Sciences 38 (2012) 213 – 218. doi: 10.1016/j.sbspro.2012.03.342

Mohamed, N., Voon, W. S., Hashim, H. H., & Othman, I. (2011). An Overview of Road Traffic Injuries among Children in Malaysia and Its Implication on Road Traffic Injury Prevention Strategy. *Malaysian Institute of Road Safety Research*. Issue: MRR 03/2011. Retrieved from http://www.miros.gov.my/c/document_library

Mwakapasa, E., & Outwater, A. (2012). Attitudes towards and practice of helmet use among commercial motorcyclists in Dar Es Salaam region, Tanzania. *Injury Prevention*, 18(Supplement 1), A194–A194. doi.org/10.1136/injuryprev-2012-040590s.16

Olakulehin, O. A., Adeomi, A. A., Oakanbi, O., Itie, C. J., Olanipekun, O. O., & Silori, O. (2015). Perception and Practice of Helmet Use among Motorcycle Riders in a Semi-Urban Community in Southwestern Nigeria. *IOSR Journal of Dental and Medical Sciences Ver. I, 14*(2), 2279–861. doi.org/10.9790/0853-14214120124

Oxley, J., Ravi, M. D., Yuen, J., Hoareau, E., & Hashim, H. H. (2013). Identifying contributing factors to fatal and serious injury motorcycle collisions involving children in Malaysia. Annals of Advances in Automotive Medicine. Association for the Advancement of Automotive Medicine. Annual Scientific Conference. 1 Jan 2013, 57: 329–36. Retrieved from http://europepmc.org/abstract/med/24406968

Rabihah, I., Abdullah, S., Nuur Sakinah, A., Nuura Addina, M., Mohd Firdaus, M.S. (2015). Helmet Wearing Rate: A Study in Malaysian Primary Roads. Proceeding of Conference of ASEAN Road Safety 2015. CARS-15-04-030. ISBN 978-967-5967-65-8

Rezazadeh, J., Rajabzadeh, R., Jabbari, S., Soliymani, A., Emami, O., & Hosseini, S. H. (2015). Knowledge Attitude, and Practice of the Motorcyclists of Bojnourd Regarding using Helmets. *Safety Promotion and Injury Prevention*, 2(4), 303–312.

Siviroj, P., Peltzer, K., Pengpid, S., & Morarit, S. (2012). Helmet use and associated factors among Thai motorcyclists during Songkran festival. *International Journal of Environmental Research and Public Health*, *9*(9), 3286–97. doi.org/10.3390/ijerph9093286

The Office of Chief Statistician Malaysia (2017). *Children Statistics, Malaysia. Press Release*. Retrieved from www.dosm.gov.my

Wadhwaniya, S., Gupta, S., Mitra, S., Tetali, S., Josyula, L. K., Gururaj, G., & Hyder, A. A. (2017). A comparison of observed and self - reported helmet use and associated factors among motorcyclists in Hyderabad city, India. *Public Health*, 144, S62–S69. doi.org/10.1016/j.puhe.2016.11.025

Wadhwaniya, S., Gupta, S., Tetali, S., Josyula, L. K., Gururaj, G., & Hyder, A. A. (2015). The validity of self-reported helmet-use among motorcyclists in India. *WHO South-East Asia Journal of Public Health* (Vol. 4).

World Health Organization (2018). *Road Traffic Injuries: Factsheets*. Retrieved from https://www.who.int/mediacentre

Original Article

Noise Exposure and Hearing Symptoms Among Laundry Workers and Mechanical Cutters in a Teaching Hospital

Asaritaminaziah binti Hisam[a, b] and *Siti Marwanis binti Anua[a]

[a]*Environmental and Occupational Health Programme, School of Health Sciences, Health Campus, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan.*
[b]*Clinical Trial Unit, School of Medical Health Sciences, Health Campus, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan.*

*Corresponding author: smarwanis@usm.my

ABSTRACT*:* *Workers who are exposed to high noise level were at risk of noise-induced hearing loss (NIHL). This cross-sectional study was conducted to investigate the noise exposure level and hearing symptoms among workers exposed to noise in a teaching hospital. Utilising convenience sampling method, 20 laundry workers and 17 mechanical cutters were recruited into this study. Noise exposure levels were measured using noise dosimeter for 8 hours and information on hearing symptoms were gathered using a modified questionnaire adopted from the American Speech Language Hearing Association (ASHA). A significantly higher mean noise level (85±2 dB(A)) was reported among mechanical cutters as compared to laundry workers (80±3 dB(A)), p=0.001 although the former had shorter duration of noise exposure (20±3 hours per week vs. 28±12 hours per week). Fourteen (70%) laundry workers and six (35%) mechanical cutters had reported having hearing problem in noisy background. Higher proportion of laundry workers (n=8, 57%) had reported hearing symptoms compared to mechanical cutters (n=6, 43%) and longer work years was found to be significantly associated with hearing symptoms (p=0.049). There is a need of appropriate education and training on noise exposure, NIHL and hearing protection devices usage in the workplaces.*

Keywords - *Hearing Symptoms, Laundry Workers, Mechanical Cutters, Noise Exposure*

1.0 INTRODUCTION

Noise-induced hearing loss (NIHL) is a public health concern and considered as the major preventable cause of hearing loss in the workplace (Basner et al., 2014). Workers engaged in heavy industries, factories, forge hammering, coal and ore mining, construction, cement plants, gas processing industries and mechanical engineering, mill and stationary machine device operators and workers at oil refineries are at risk of occupational NIHL (Azizi, 2010). In Malaysia, occupational noise-induced hearing disorders (which include NIHL, hearing impairment and Permanent Standard Threshold Shift) was the highest reported occupational disease compared to other diseases in the year 2016 with 2876 cases (74.5%) (DOSH, 2017).

Many factors have been suggested contributing to the NIHL such as age, smoking, gender, race, individual susceptibility, sound pressure level or noise intensity, the duration of noise, daily exposure period, total exposure period, existence of ear disease, working conditions, distance to noise source, direction of sound waves and the position of the ears and poor usage of hearing protection devices (Cruickshanks et al., 2003). The Malaysia Factories and Machinery (Noise Exposure) Regulation 1989 was introduced to protect the workers from excessive exposure to noise (FMA, 2015). Under this regulation, workers are protected from excessive noise exposure to reduce the risk of NIHL. The Act stated that employees shall not be exposed to noise level exceeding equivalent continuous A-weighted sound pressure level of 90 dB(A) nor to noise level exceeding 115 dB(A) at any time. Excessive exposure to the permissible limit should be prevented and the noise reduction plan must be initiated.

In this study, the potentially high risk noise-exposed groups of hospital workers identified were among workers at the laundry unit and mechanical department. The use of heavy machineries in the laundry unit such as washer and dryer machines may produce harmful noise level. Mechanical department workers in the hospital are involved with mechanical machines that produce high noise level which were used for maintenance activities such as grass, wood and metal cutting. It was believed that continuous exposure to high levels of sound pressure may bring about permanent changes in the workers' hearing threshold (Fontoura et al., 2014). Thus, in this current research, reported hearing loss symptoms related to noise exposure at workplace among laundry workers and mechanical cutters were studied. This study finding could be used to increase awareness to both parties and may lead to suggestions or appropriate intervention for preventing NIHL among workers at the studied workplaces.

2.0 METHOD

2.1 Study Design

This cross sectional study was conducted using convenience sampling method recruiting 20 laundry workers and 17 mechanical cutters such as grass, metal and wood cutters at a teaching hospital in measuring their noise exposure level and associated hearing symptoms. The study was approved by the Campus Director and Human Research Ethics Committee (reference: USM/JEPeM/16110504). All study participants were provided with research information and voluntarily signed the research and publication consent forms before data collection.

2.2 Questionnaire

All participants were requested to complete a self-administered questionnaire and work activity diary. The questionnaire comprised of four parts that include socio-demographic information (part A), medical history (part B), workplace noise exposure (part C) and hearing symptoms (part D). Part D was adapted and modified from the American Speech Language Hearing Association (ASHA) (ASHA, 2016). To ensure the validity and suitability of the questionnaires, it was piloted among 10% of the intended total population (among six supporting staff) that were not included in this study. Cronbach's alpha analysis was conducted to test the reliability of the questionnaire. The result obtained was 0.843 which was considered good and reliable as the acceptable value of alpha is between 0.70 to 0.95 (Tavakol & Dennick, 2011).

2.3 Walk through Survey and Personal Noise Monitoring

A walk through survey was conducted to identify the high noise level areas and job tasks at different job sections. The workers who agreed to participate in this study were requested to wear a personal noise dosimeter (Model: Spark 703, Larson Davis, Sweden) with the microphone clipped on to the collar of the worker near the hearing zone. Determination of the noise exposure level was accomplished using calibrated noise dosimeter for eight hours during working day. Pre-calibration and post-calibration of the dosimeter was performed following the manufacturer's instruction. The workers were ensured that they were comfortable wearing the device without disturbing their work routines.

2.4 Data Analysis

Blaze software (Larson Davis, Sweden) was used to analyse the noise exposure level data and the IBM SPSS software Version 22 was used to perform the statistical analyses. The statistical analysis with p value of less than 0.05 was set as significant. Normality was tested using the Shapiro-Wilk test and the result showed that data were normally distributed ($p>0.05$). Descriptive statistics were performed in presenting the sociodemographic characteristics and work descriptions of workers in frequencies, percentages, mean and standard deviation (SD). The independent t-test was performed to compare the mean noise exposure level between laundry workers and mechanical cutters. Meanwhile, Pearson Chi-Square test was utilised in establishing the association of hearing symptoms between the two groups.

3.0 RESULTS

3.1 Sociodemographic Characteristics and Work Description

The response rate of this study was 82% (N=37). All workers were Malaysian with an average (mean±standard deviation (SD)) age of 48±11 years old. Majority were males (81%, n=30) and more than half received education up to Sijil Pelajaran Malaysia (SPM) level (68%, n=25). Less than half (38%, n=14) of the workers reported a history of current smoking.

The laundry workers reported longer work employment duration (mean±SD) of 28±12 years compared to mechanical cutters, 20±3 years (p=0.127). When comparing the duration of noise exposure between laundry workers and mechanical cutters, the former had reported a significantly longer duration of noise exposure per week compared to the latter (28 hours per week vs. 20 hours per week), p=0.009. Only five workers (14%); two laundry workers and three mechanical cutters were found to have used hearing protection devices (Table 1).

Table 1: Sociodemographic and Work Characteristics of Workers

Variables	Laundry workers (n=20)	Mechanical cutters (n=17)	Total (N=37)
Mean age, years ± SD	45±12	51±8	48±11
Gender, frequency (%)			
Male	13 (65)	17 (100)	30 (81)
Female	7 (35)	0 (0)	7 (19)
Education level, frequency (%)			
SRP/PMR	2 (10)	10 (59)	12 (32)
SPM	18 (90)	7 (41)	25 (68)
Smoking status, frequency (%)			
Yes	6 (30)	8 (47)	14 (38)
No	14 (70)	9 (53)	23 (62)
Mean working years ± SD	18±13	23±10	20±12
Duration of noise exposure, hours per week			
Mean ± SD	28±12	20±3	25±10
Min	10	15	10
Max	39	24	39
Use of HPD			
Yes	2 (10)	3 (18)	5 (14)
No	18 (90)	14 (82)	32 (86)

SD - standard deviation; SRP - Sijil Rendah Pelajaran; PMR - Penilaian Menengah Rendah; SPM - Sijil Pelajaran Malaysia; HPD - Hearing protection devices

3.2 Walk through Survey and Noise Exposure Levels

Table 2 describes the work tasks and their average noise levels for laundry workers and mechanical cutters. Generally, laundry workers worked in five sections which are sorting and folding (15%), washing and drying (25%), ironing and folding (35%), sewing (10%) and supplying (15%). However, it is noteworthy that the workers work by rotation system according to job demand. Almost all the mechanical cutters recruited in this study involved in grass cutting (88%, n=15). However, they were usually involved in grass cutting activity in the morning (8.30 a.m. to 12.30 noon) and in the afternoon (2.00 p.m. to 5.00 p.m.), and also performed other duties such as sweeping and collecting garbage.

Table 2: Work Task Description and Average Noise Level among Laundry Workers and Mechanical Cutters

Work Task	Frequency	Percentage	Mean noise level L_{Aeq} ± SD (dB(A))
Laundry workers (n=20)			
Sorting and folding	3	15	82±4
Washing and drying	5	25	82±2
Ironing and folding	7	35	81±2
Sewing	2	10	76±2
Supplying and folding	3	15	76±1
Mechanical cutters (n=17)			
Hand grass cutting	13	77	85±2
Tractor grass cutting	2	12	86±3
Wood cutting	1	6	87
Metal cutting	1	6	85

dB(A) - Decibel (A); SD - Standard Deviation

There was one worker each at the sorting and folding section and at the washing and drying section who had noise exposure level of more than 85 dB(A), but on average both sections reported 82 dB(A). The highest level of noise exposure was recorded for a hand grass cutter (90 dB(A)), but on average their overall exposure was 85±2 dB(A) (Table 2). Whereas Table 3 shows the mean noise level measurement among mechanical cutters were significantly higher (L_{Aeq} = 85±2 dB(A)) compared to laundry workers (L_{Aeq} = 80±3 dB(A)), p=0.001. The work groups' noise exposures were further categorised based on the action level, of which majority of laundry workers (90%, n=18) were exposed to noise for <85 dB(A), while majority of mechanical cutters were exposed to noise for ≥85 dB(A) (59%, n=10), p=0.002.

Table 3: Comparison of Mean Noise Exposure Level between Laundry Workers and Mechanical Cutters

Variable	Laundry workers (n=20)	Mechanical cutters (n=17)	*p*-value
Mean L_{Aeq} ± SD (dB(A))	80±3	85±2	**0.001*[a]**
Noise exposure category, n (%)			
<85 dB(A)	18 (90)	7 (41)	**0.002*[b]**
≥85 dB(A)	2 (10)	10 (59)	

dB(A) - Decibel (A); [a]*p*-values were based on Independent t test; [b] *p*-values were based on Pearson Chi-Square *p<0.05

3.3 Reported Hearing Symptoms

Table 4 shows the perception of workers towards hearing symptoms due to noise exposure. Only one symptom (trouble hearing in a noisy background) showed significant association as majority, 70% (n=14) of laundry workers had reported such symptom compared to only 35% (n=6) among mechanical cutters. Similarly, more laundry workers reported problem of hearing in noisy restaurants (55%, n=11), although the difference was non-significant.

Table 4: Reported Hearing Symptoms among Laundry Workers and Mechanical Cutters

Variables	Frequency (%)		*p*-value
	Laundry workers (n=20)	Mechanical cutters (n=17)	
Hearing problem over the telephone	2 (10)	1 (6)	1.000[a]
Hear better through one ear than the other when on the telephone	5 (25)	3 (18)	0.701[a]
Trouble following the conversation with two or more people talking at the same time	6 (30)	3 (18)	0.462[a]
Being complained that has turned the TV volume up too high	3 (15)	2 (12)	1.000[a]
Having to strain to understand conversation	5 (25)	6 (35)	0.495[b]
Trouble hearing in a noisy background	14 (70)	6 (35)	0.035[b]*
Trouble hearing in restaurants	11 (55)	6 (35)	0.231[b]
Having dizziness, pain or ringing in the ears	1 (5)	4 (24)	0.159[a]
Asking people to repeat themselves	3 (15)	0 (0)	0.234[a]
Family members or co-workers remark about missing what has been said	2 (10)	0 (0)	0.489[a]
Many people seem to mumble (or not speak clearly)	2 (10)	2 (12)	1.000[a]
Misunderstand what others are saying and respond inappropriately	4 (20)	1 (6)	0.348[a]
Trouble in understanding the speech of women and children	2 (10)	2 (12)	1.000[a]
Having people getting annoyed because of misunderstand what they say	2 (10)	1 (6)	1.000[a]

[a]*p*-values were based on Fisher's Exact test; [b]*p*-values were based on Pearson Chi-Square test; *p<0.05

3.4 Association between Work Factors and ASHA's Category of Hearing Symptoms

The American Speech Language Hearing Association (ASHA) recommended that when there is presence of more than two hearing symptoms, the particular person is suggested to be evaluated by a certified audiologist. Table 5 shows that a higher proportion of laundry workers (57%, n=8) needed further evaluation by a certified audiologist as compared to mechanical cutters (43%, n=6). Majority of the workers were exposed to noise level below 85 dB(A), 71% (n=10), compared to only four workers (29%) were exposed to noise exceeding 85 dB (A) and reported having more than two hearing symptoms. Hence, no significant association was found between noise exposure categories and hearing symptoms. However, only working years was found to be associated with hearing symptoms (p=0.049). Majority of the workers, 64% (n=9) reporting more than two hearing symptoms had been working for 30 to 39 years. None of the sociodemographic characteristics were significantly associated with hearing symptoms based on ASHA's recommendation (results were not tabulated).

Table 5: Association between Work Factors and ASHA's Category of Hearing Symptoms

Characteristics	ASHA's category of workers reporting more than two hearing symptoms requiring further evaluation, n (%)		X^2	*p*-value[a]
	Yes (n=14)	No (n=23)		
Work groups				
Laundry workers	8 (57)	12 (52)	0.087	0.769
Mechanical cutters	6 (43)	11 (48)		
Noise exposure categories				
<85dB(A)	10 (71)	15 (65)	0.153	0.695
≥85 dB(A)	4 (29)	8 (35)		
Duration of working years				
< 9	4 (29)	3 (13)	7.840	**0.049***
10-19	1 (7)	10 (43)		
20-29	0 (0)	2 (9)		
30-39	9 (64)	8 (35)		

Statistical test - Pearson Chi-Square; *p<0.05

4.0 DISCUSSION

This study reported important findings with regards to noise exposure and hearing symptoms involving support group workers in a teaching hospital. The mean noise exposure level measured among laundry workers was found to be significantly lower than mechanical cutters (p=0.001). This finding contradicted with the findings from previous studies (Fontoura et al., 2014; Elias, Ijaduola and Sofola, 2003). Higher noise exposure levels were reported at the laundry unit of Public Federal Hospital in Brazil and Laundry Department of Lagos University Teaching Hospital (LUTH) in Nigeria, ranging from 77 to 99 dB(A) and 101 dB(A), respectively. This contradiction could also be due to the different environmental noise exposure. Although the intensity of noise exposure was lower among laundry workers compared to mechanical cutters, they were exposed to noise for longer duration per week compared to cutters. It is well known that intensity, frequency, exposure duration and type of noise play crucial influence on increasing the risk of health hazard (i.e. occupational hearing loss) (Ahmed et al., 2001).

The Factories and Machinery (Noise Exposure) Regulation 1989 stated that the permissible exposure limit of an equivalent continuous A-weighted sound pressure level shall not exceed 90 dB(A) (FMA, 2015). The criterion for action (action level) adopted is 85 dB(A) that necessitates the implementation of activities to reduce the risk of NIHL. This study found that there were 10 out of 17 (59%) mechanical cutters but only 2 out of 20 (10%) laundry workers who were exposed to noise of more than 85 dB(A) (p=0.002). Although the mean noise level among laundry workers were below the action level, a worker at the sorting and folding section and a worker at the washing and drying section had exceeded the action level for noise exposure. Similar scenario was observed among majority of mechanical cutters especially grass cutters, with the highest level of noise exposure recorded being 90 dB(A). Fontoura *et al.* (2014) also found that the noise exposure level at sorting, washing, drying and spinning area had exceeded the 85 dB(A) level which resulted in 18.9% of the workers diagnosed with NIHL. Similarly, they found that the folding area had slightly lower level (84 dB(A)) of noise exposure. The low level of noise at the folding area in the laundry unit may be due to its location which was farther away from the machineries (washer or dryer).

Similar to previous finding, the noise exposure level among mechanical cutters in this study was higher than action level maybe due to being in closer proximity to noisy equipment (Tengku Hanidza et al., 2013). They reported that grass cutters were exposed to an average noise level of 88 dB(A), ranging from 84 dB(A) to 92 dB(A). Although noise exposure levels between 80-85 dB(A) have only a small influence on hearing over the long term but in the high frequency range, these levels are capable of inducing measurable hearing threshold shifts in susceptible subjects (Plontke & Zenner, 2004). Normally, NIHL affects both sides of the ears due to noise exposure above 85 dB(A) (Ahmad Filza et al., 2013). Furthermore, the small number of noise induced hearing loss reported to the Social Security Organisation (SOCSO) may be due to underreporting or failure to capture workers' morbidities especially in the small and medium size enterprises (SME) in Malaysia (Hashim et al., 2005). Nonetheless, Berglund and Lindvall (1995) reported an estimated 15-20% of the working population in industrial countries affected by sound pressure levels of 75-85 dB(A). They also reported that to protect the majority of people from being moderately annoyed, the sound pressure level should not exceed 50 dB(A) during the daytime and 45 dB(A) during the night time (outdoors).

Based on ASHA's category of hearing symptoms, more laundry workers reported hearing symptoms compared to mechanical cutters, although it was not significant. However, there was significantly higher proportion of laundry workers reporting hearing problem in noisy background compared to mechanical cutters. Interestingly, even though more mechanical cutters were exposed to occupational noise exceeding the action level, the reported hearing problem among the laundry workers could be due to previous noise exposure at the old laundry building. Majority of the workers had been working in an enclosed building with potentially higher noise level before moving into the current building in 2013. Unfortunately, no previous noise measurement was conducted hence the suspicions could not be proven.

It was found that only 29% among all respondents with noise exposure of more than 85 dB(A) had hearing loss symptoms (Table 5). The small percentage may be due to homogenous level of exposure and small number of affected workers. In this study, all six (43%) mechanical cutters who reported more than two hearing symptoms were workers performing hand grass cutting. This might be contributed by high intensity of noise exposure and the proximity of the machine to the workers' ears, with the highest recorded noise exposure level being 90 dB(A). Tengku Hanidza et al. (2013) reported in their study that 28% (n=5) of grass cutters at Universiti Putra Malaysia experienced hearing impairment.

Increasing employment years was found to be significantly associated with hearing symptoms. The duration of employment may also reflect the cumulative duration of noise exposure. Higher year of employment may also relatively indicate higher age. A local study among airport workers showed that workers who are more than 40 years old had four times higher incidence of hearing impairment (Nasir & Rampal, 2012). However, this association was not found in the present study despites the mean age of workers were above 40 years. Nevertheless, this may indicate that hearing symptoms in this study were not due to older age but solely related to longer year of employment.

Although workers in this study were aware of occupational noise exposure, the usage of hearing protection devices (HPD) was below the targeted compliance rate of 100% as 86% of the workers did not use HPD during work. This was similar to a previous study where only 5% of factory workers regularly wore HPD despite 80.5% of them being provided with HPD (Maisarah & Said, 1993). Tengku Hanidza et al. (2013) also reported poor compliance in PPE usage among their respondents due to discomfort. In addition to discomfort, Daniel (2007) added other reasons such as safety concerns, design, lack of knowledge related to NIHL and peer pressure. Ahmed et al. (2001) reported that education level of the workers was positively related to the use of the ear protection (p=0.03). It is very important to take several preventive strategies such as using earplugs, reducing the duration of exposure and keeping a safe distance from the source in controlling the risk, thereby preventing NIHL (Manakandan & Jaafar, 2017).

5.0 CONCLUSION

Mechanical cutters have higher 8-hours noise exposure level with short duration of hours weekly exposure while laundry workers have lower noise exposure level but longer hours of weekly exposure. Laundry unit reported significantly higher proportion of workers with hearing symptoms associated with work employment. The use of HPD is also poor in both groups indicating the need for appropriate education and training on noise exposure and hearing effects as some workers were found to be exposed to excessive noise level. Although some of these workers showed evidence of tendencies to have impairment, there is no evidence to specifically indicate that it is caused by excessive noise exposure related to their work. It can only be speculated that they are at risk of acquiring NIHL because of their noise exposure at work exceeding the action level.

The hearing symptoms were self-reported hence may lead to data misreporting. Ideally, hearing loss should be measured using pure tone audiometric (PTA) test which is more accurate. The presence of hearing problem due to occupation may have been missed as it was based on self-reporting and no baseline PTA data was previously recorded during pre-employment stage. This may further limit us in establishing if the NIHL is due to current workplace or past workplace exposure. In 2015, Hearing Conservation Programme (HCP) was initiated and the PTA testing is still under progress hence not included in this paper due to incomplete data. Moreover, the Occupational Safety and Health Unit has made an effort by involving with the Systematic Occupational Health Enhancement Level Programme (SoHELP), establishing a partnership with the Department of Safety and Health (DOSH). Future research with longitudinal study design could show the trend of noise exposure and hearing effects among workers. Through continuous monitoring, researchers could study other factors and determine causal relationship between noise exposure at work and NIHL. It is noteworthy that even with the mentioned limitations, this study has achieved its objectives according to the limited time and resources.

ACKNOWLEDGEMENT

Special thanks are owed to all participants for their contribution to this study as well to the Occupational Safety and Health Unit, Universiti Sains Malaysia.

REFERENCES

Ahmad Filza, I. (2010). *Noise-Induced Hearing Loss among quarry workers in Kelantan*; Community Medicine Department, Universiti Sains Malaysia; degree of Master Community Medicine (Environmental Health).

Ahmed, H., Dennis, J., Badran, O., Ismail, M., Ballal, S., Ashoor, A. & Jerwood, D. (2001). Occupational noise exposure and hearing loss of workers in two plants in eastern Saudi Arabia. *Annals of Occupational Hygiene*, 45(5), 371-380.

American Speech-Language-Hearing Assocation (ASHA). (2016). *Self-Test for Hearing Loss*. http://www.asha.org/public/hearing/Self-Test-for-Hearing-Loss/ (Accessed 30 September 2016).

Azizi, M. H. (2010). Occupational noise-induced hearing loss. *The international journal of occupational and environmental medicine*, 1(3 July).

Basner, M., Babisch, W., Davis, A., Brink, M., Clark, C., Janssen, S. & Stansfeld, S. (2014). Auditory and non-auditory effects of noise on health. *The Lancet*, 383(9925), 1325-1332. doi: 10.1016/s0140-6736(13)61613-x

Berglund, B. & Lindvall, T. (1995). *Community noise: Center for Sensory Research*, Stockholm University and Karolinska Institute Stockholm.

Cruickshanks, K. J., Tweed, T. S., Wiley, T. L., Klein, B. E., Klein, R., Chappell, R., Nondahl, D. M. & Dalton, D. S. (2003). The 5-year incidence and progression of hearing loss: the epidemiology of hearing loss study. *Archives of Otolaryngology–Head & Neck Surgery*, 129(10), 1041-1046

Daniel, E. (2007). Noise and hearing loss: a review. *Journal of School Health*, 77(5), 225-231.

Department of Occupational Safety and Health (DOSH). (2017). *Occupational Diseases and Poisoning Investigation*. http://www.dosh.gov.my/index.php/en/occupational-diseases-and-poisoning-statistic (Accessed 29 January 2017).

Elias, S., Ijaduola, G. & Sofola, O. (2003). Noise-Induced Hearing Loss in laundry workers in Lagos. *Nigerian Medical Practitioner*, 44(1), 1-6.

Factory and Machinery Act (FMA). (2015). Factories and Machinery Act 1967 (Act 139), Regulation, Rules & Order. Selangor, Malaysia: International Law Book Services.

Fontoura, F. P., Gonçalves, C. G. d. O., Lacerda, A. B. M. d. & Coifman, H. (2014). *Noise effects on hospital laundry workers' hearing. Revista CEFAC,* 16(2), 395-404.

Hashim, S.B., Amin, F.B., Khalid, H.M. (2005). *Malaysia Country Report*, WHO/ILO Meeting on strengthening occupational health and safety, Kuala Lumpur, Malaysia.

Lie, A., Skogstad, M., Johannessen, H. A., Tynes, T., Mehlum, I. S., Nordby, K.-C., Engdahl, B. & Tambs, K. (2016). Occupational noise exposure and hearing: a systematic review. *International archives of occupational and environmental health*, 89(3), 351-372.

Maisarah, S. & Said, H. (1993). The noise exposed factory workers: the prevalence of sensori-neural hearing loss and their use of personal hearing protection devices. *Medical Journal of Malaysia*, 48, 280-280.

Manakandan, S. K. & Jaafar, M. H. (2017). Occupational hearing impairment and its related factors: A Review Article. *International Journal of Public Health and Clinical Sciences*, 4(1), 1-10.

Nasir, H. & Rampal, K. (2012). Hearing loss and contributing factors among airport workers in Malaysia. *The Medical journal of Malaysia,* 67(1), 81-86.

Plontke, S. & Zenner, H.P. (2004). Current aspects of hearing loss from occupational and leisure noise. In: Schultz-Coulon HJ, editors. *Environmental and Occupational Health Disorders*. Germany: Videel OHG. 233-325.

Tavakol, M. & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, 2, 53-55

Tengku Hanidza, T. I., Jan, A. A. M., Abdullah, R. & Ariff, M. (2013). *A preliminary study of noise exposure among grass cutting workers in Malaysia*. Procedia - Social and Behavioral Sciences, 91, 661-672. doi: 10.1016/j.sbspro.2013.08.467

June 2018, Vol. 15 No. 1

Original Article

The Behavioural-Based Safety System for Commuting Accident in Syarikat Bekalan Air Selangor Sdn. Bhd.

Mohamad Mahathir bin Mohamed Younos[a].

[a]*Razak School of Engineering & Advance Technology, University Technology Malaysia, City Campus Kuala Lumpur*

mohamad.mahathir84@gmail.com

ABSTRACT: *Motorcycle accidents are common among employees whose working nature is mostly outdoors. According to the statistics, the frequency of motorcycle accidents increases every year. In Syarikat Bekalan Air Selangor (SYABAS), a substantial number of motorcycle accidents occurred between the year 2009 and 2013. The increased number of accidents serves as a wake-up call to the company to come up with a behavioural-based safety system for commuting accident. The objective of this paper is to look into the effectiveness of behavioural-based system in a company. A total of one hundred and thirty (130) respondents participated in the data-collection session for this study. From this data-collection, along with accident data from the company, a number of criteria that contributes to commuting accidents in the company is obtained. At the end of this study, the behavioural-based safety system is applied, thus showing how its implementation assists in curbing the issue of commuting accidents in the company.*

Keywords - *Accident Data, Behavioural-Based Safety System, Commuting Accident, Motorcycle Accident, Number of Motorcycle*

1.0 INTRODUCTION

Syarikat Bekalan Air Selangor Sdn. Bhd. (SYABAS) was established on 8th July 1996 under the Malaysian Companies Act, 1965 to undertake the privatization of water in the state service supply Selangor and Wilayah Persekutuan Kuala Lumpur and Putrajaya. The company was granted for a period of thirty (30) years from the date of January 1, 2005 to take over the duties and functions of Selangor Water Governance Corporation Berhad (PUAS) in the field of water supply and distribution of water to consumers in the State of Selangor and the federal territories of Kuala Lumpur and Putrajaya involving more than 7.3 million residents and industrial and commercial users through 1.52 million accounts.

In SYABAS, the company's main revenue derives from the utilisation of water by consumers in the state of Selangor and Federal Territories. A large number of meter readers are employed to read water consumption meters at the customers' premises and produce water bill to the consumers. These meter readers use motorcycles to execute their daily works.

Although there are many other workers in SYABAS who utilise the motorcycle in their daily work, the meter readers have contributed a substantial increase of commuting accidents in SYABAS. During the first year, more than one hundred (100) motorcycles accidents have been recorded. Subsequently, an average of 20 cases are registered throughout SYABAS either at the district or head offices levels every year. This has caused a lot of problem to the management since it involves a number of subsequent activities such as requirements to carry out investigation, preparation of claims to SOCSO, Construction Industry Development Board Malaysia (CIDB) or the insurance company, and even the need to attend court hearing should the accident escalates to a court case.

In 2011, thirty-nine (39) accident cases involving motorcycle and six (6) cases involving other vehicles were recorded among SYABAS staff. Preventive measures have been taken by the management; however, the number of accident recorded is consistently increasing with a few records every year. In 2013, a percentage of 22.3%, 16.9%, and 10% accident cases are recorded for Hulu Langat, Klang and Kuala Lumpur. There is no consistent decrease in the number of commuting accidents recorded although the management of SYABAS with the cooperation from PERKESO and Malaysia Society

Occupational Safety Health (MSOSH) has conducted the defensive riding program commencing 2011 to 2012 which involves all staff who uses motorcycle in their daily work, and this includes those who are previously involved in motorcycle accidents.

Through this study, the behaviour aspects that may affect safety towards commuting accident rate is identified, the relationship between behaviour aspect identified and the number of motorcycle accident is investigated, and the behavioural-based safety system for improvement to the current safety systems as suitable countermeasures to reduce the commuting accidents among SYABAS staffs is recommended.

2.0 METHOD

This study begins by distributing questionnaires to a random one hundred (100) staff within the company's ten (10) districts in Selangor area with the intention of gaining information and data collection. These staff are those who frequently use motorcycles as primary transportation in daily work operations. Next, the processing and extraction of these data will be analysed according to the collection and recording of the evidence in the questionnaires through the Statistical Package for Social Sciences (SPSS) Version 17.0 software which includes Cronbach's Alpha Analysis, Mean and Pearson Correlation. Finally would be the publication of the result obtained and recommendation that can be given to improve the situation.

Quantitative data in the form of survey questionnaires is used in this research. Choices of three (3) answers are given to be selected in the form, as well as the Likert Scale is used. Apart from these questionnaires, data from organization sources are obtained. They are the Accident Statistics Report (2009 – 2013) and the Incident and Accident Investigation Report (2009 – 2013). Other outsourced data obtained are from Polis Di Raja Malaysia (PDRM), Malaysian Institute of Road Safety (MIROS) and Social Security Organization (SOCSO).

Table 1 shows the number of respondents who attended the data collection at their respective territories.

Table 1: Total Number of Respondents

No.	Location	Total Respondents
1	Gombak District	10
2	Kuala Langat District	10
3	Hulu Langat District	10
4	Klang District	10
5	Hulu Selangor District	10
6	Kuala Lumpur District	10
7	Kuala Selangor District	10
8	Petaling District	10
9	Sabak Bernam District	10
10	Sepang District	10

3.0 RESULTS

From the aspect of sociodemographic data, one hundred (100) random respondents throughout SYABAS who commute on the motorcycle on a daily basis who are involved in this study, fifty-one percent (51%) are meter readers. Seventy-one (71) of them are married and Malay respondents are the most since the company employs more Malays than the other races. In addition to that, fifty-four (54) respondents are SPM holders with forty (40) of them have served the company for more than six (6) years. Surprisingly, the employees who own a valid license for more than eight (8) years contribute to the largest number involved in commuting accident with sixty-five (65) cases. The accidents in SYABAS mostly happen in the evening when returning home from work, with sixty (60) cases. Nevertheless, lunch time can also be said as a critical time since there is also a number of staff who is still at work at this hour, especially those working on site.

From the socio-demographic data collected also, motorcycle type Yamaha LC has the highest numr for the type of motorcycle most involved in accidents in SYABAS with thirty-five (35) cases, more than other types of motorcycle. In second place is Honda EX5 with twenty-two (22) cases. Without realizing, the ability and strength of a motorcycle plays a vital role in influencing the mind or way of thinking, emotion and attitude of the staff. These two motorcycles are the most used by SYABAS staffs in their daily activities.

Finally, a total of sixty-one percent (61%) of the respondents are involved in an accident for at least one time, compared to those who were involved in an accident twice with thirty-two percent (32%), the thrice with three percent (3%). This shows staffs who use the motorcycle as their main transportation in their daily work are prone to be involved in an accident for the first time, as depicted in the percentage above.

From another part of the questionnaire, which is from the effectiveness of the attitude aspect towards motorcycle-riding responsibly by respondents, the record options average between 3 to 5 with the highest mean at 4.48 under the category of Scenery shows that the scenery plays an important role in affecting a rider's concentration. Besides that, under the respondent's assessment of skills theory, the data shows a highest mean of 4.49 for drugs and illegal driver which means that most respondents agree that drugs and riders who do not possess a valid driver license contribute to dangerous behaviour on the road. Apart from that, under the respondent's evaluation in terms of application of personal protective equipment (PPE), the data shows a highest mean of 4.44 for SIRIM, which means that they have the perception that a SIRIM approved helmet is important in ensuring the safety of a rider. Next, under the respondent's evaluation on motorcycle maintenance, the highest mean is 4.13 under condition which means that the respondents agree that the condition of the motorcycle is crucial to ensure safeness on the road. Finally, under the comparison between mean score and behavioural aspects, the answers given by the respondents from the evaluation are between the values of 3 to 5 which the majority of answers agree that behavioural aspects as a role an important part to reduce the motorcycle accident happen. It also shows that the behavioural aspects from the practical skills are the most strongly agree from the respondents through the highest score by the mean value of 4.37.

Table 2 below shows that the OSH Management System available is effective as a measure to reduce accidents. This is further reinforced by the results obtained through the questionnaire respondents showed absolutely agree that this system is effective in reducing accidents but there are problem lack of commuting safety management and element of road safety in OSH management system.

Table 2: Total Number of Motorcycle Accidents (By Year)

No.	Type of Years	Year	Number of case recorded
1	Year before OSH system	2009	37
2		2010	41
3		2011	45
4	Year after OSH system	2012	16
5		2013	14
	Total		153

4.0 DISCUSSION

4.1 The Behavioural-Based Safety System

From the data analysis and result obtained, several ways are identified to decrease the rising number of commuting accidents in SYABAS. They are to apply the Behaviour-Based Safety System through the seven key principles, to implement the HSE policy, to prepare a Critical Behaviour Checklist (CBC), to arrange consultant and communication, as well as to have safety intervention and intensive programs.

In the Behaviour-Based Safety System through the seven key principles, the following elements are emphasized. They are: 1. Focus intervention on observable behaviour 2. Look for external factors to understand and improve behaviour 3. Direct with activators and motivate with consequences 4. Focus on positive consequences to motivate behaviour 5. Apply the scientific method to improve intervention 6. Use theory to integrate information, not to limit possibilities 7. Design interventions with consideration of internal feelings and attitudes.

4.2 HSE Policy

It is the policy of SYABAS to conduct its business at the highest international standards, providing a healthy, safe and environmental friendly workplace for all employees, consumers, contractors, visitors and others, and promoting a positive health, safety and environment culture with proactive involvement by the management, employees and contractors. In order to achieve the above, SYABAS endeavours to: 1. Recognize health, safety and environment objectives as an integral part of its business performance 2. Implement a continually improved Health, Safety and Environment Management System 3. Periodically establish and review the health, safety and environmental objectives and targets 4. Comply with all applicable health, safety and environment legal and other requirements to which SYABAS subscribes 5. Provide sufficient information, instruction, training and supervision to enhance employee's health, safety and environment consciousness in ensuring works is performed safely 6. Minimize waste and continually prevent pollution in all activities 7. Continuously prevent injury and ill health at workplace 8. Investigate any incidents where the findings will be used to develop and continually improve the health, safety and environment conditions and performance.

The policy HSE will be reviewed yearly through the management review meeting which involves safety and health committee members from all levels including employer representative and employee representative to evaluate and discuss on continuous improvement. SYABAS is committed to periodically review this policy to ensure it is understood by all employees and is made available to all interested parties.

4.3 A Critical Behaviour Checklist (CBC)

A BBS checklist can be specific to a particular task, such as a critical behaviour checklist for motorcycle-riding to train the employees to develop safe riding habits, or at least to demonstrate to other employees the right way and how to ride safely. It is also to enhance the participation of employees to use the checklist as a guidance to encourage safe riding. In a water distribution organization like SYABAS, this type of behavioural checklist could be applied among staffs who commute on the motorcycle regularly as part of their daily work.

The BBS checklist for safe riding is a tool to facilitate employees towards the target behaviour through the action taken. There are two (2) observers for each activity of work which are through safe observation and risk observation. The use of the basic elements of riding can be vary such as behaviour identified, road direction if turn signal, intersection, speed limits, passing and two second rule.

4.4 Consultation and Communication

The responsibility and commitment of employees in health and safety issues and safety risks is communicated to and from employees as well as other interested parties.

The Head of Section shall communicate effectively to employees on matters related to the significant environmental impacts and safety risks, at least through departmental meetings, briefing or memos. Employees who receive information, feedback or complaint from any external interested parties shall forward the information to the Head of Section or the Head of Department directly. Interested parties can communicate through the website maintained by SYABAS and also through the hotline maintained by PUSPEL. PUSPEL will then channel the communication to the relevant department within SYABAS which will then decide on the actions to be taken.

The Head of Department will then, in consultation with the Safety and Health Committee decides on the actions to be taken and the reply to the interested parties. This information, feedback or complaint together with the decision and a copy of the reply would be maintained by the respective department/district. A Safety and Health Committee (SHC) has been established with members from the shop floor employees. Employees can channel their views through the SHC members for consideration by the management. All policies with regards to safety & health and environment are reviewed by the SHC before being approved. The SHC meets at least once in two months and the Secretary of the committee maintains minute of this meeting.

4.5 Safety Intervention

The Head of Department (HQ) / Head of Section (District) shall carry out the hazard and risks identification using the Hazard Identification, Risk Assessment and Determining Control Form (HRAR-HSE-01/01) and the aspect/impact identification using the Identification of Environmental Aspect and Impacts Form (HRAR-HSE-01/02) for all processes under their jurisdiction. If necessary, assistance from other relevant department/section, suppliers or consultant may be requested to complete the identification process.

The process of safety and health hazards/environmental aspects identification shall be conducted by taking into consideration of the following conditions: 1. Normal Condition - All process carried out under this condition are without any problems and are under control during normal operating hours. This does not include non-routine activities like maintenance 2. Abnormal Condition - This applies to process when the processes are functionally upset or functioning with abnormalities. E.g.: Machine functioning with abnormal sound or spillages of hazardous chemical on floor 3. Emergency Condition - This applies to processes where the processes cause a disaster unexpectedly. E.g.: Machine catch fire or large amounts of emissions to the atmosphere. It shall also include the non-routine activities like maintenance, repair and others.

4.6 Intensive Program

The success of the behavioural based safety system depends on how the process of managing and maintaining continuously improve from time to time and covers the entire area on OSH management system. Other than consultation and communication area, the employee needs to adopt the safety culture in workplaces or any changes and instruction of company about HSE as stated in section 24 (ii) which is the responsibility of employee according to Occupational Safety and Health Act 1994. To enhance the ways of working safely, programs such as motivational talks, social relationship programs and spiritual enhancement programs.

Social relationship programs are one of the BBS strategies to enhance the behaviour of employee in the workplace, construct and maintain relationships, communication networks and process, problem solving and communication skills. While the spiritual enhancement programs are important to employee to strengthened connection between the physical, emotional and spiritual for relaxing body pains and internal body parts or organs through natural way.

"It is the responsibility of the master (employer), to provide work for the employee, what made it easy. They should not be given a job that causes health is jeopardized." Hadith Riwayat Muslim Ibnu Majah.

"There can be a danger to yourself, and not be a danger to others." Riwayat Muslim.

5.0 CONCLUSION

This study shows that there are indeed significant relationships between the behaviour aspects and the number of accidents. It is proposed to improve the existing system with commuting safety management and road safety element in the OSH management system at workplace. Apart from SYABAS, the proposed improvements in OSH management system can be carried out by other organisations, particularly organisations involved with the use of motorcycles in daily operations. The studies previously cited the lack of provision of training leading to an increase in cases of accidents have always been a subject of dispute among each other.

Besides implementing the behavioural-based safety system, the result of the research also needs to be looked into. Demographic factors such as the group of staff, total years of service and level of education need to be taken into consideration before placing a staff in a job that requires the daily usage of motorcycle.

Furthermore, SYABAS needs to work together with the official authorities such as PDRM, JKR, MIROS and NIOSH in order to enforce strict ruling to ensure staffs comply with the road-safety requirements. The authorities need to oversee the matter and the condition of the roads under their coverage and responsibility.

REFERENCES

Bilangan Kemalangan Dilapor 2012-2016. (n.d). Retrieved on March 24, 2018, from Pertubuhan Keselamatan Sosial (PERKESO) website, https://www.perkeso.gov.my/index.php/ms/68-laporan/163-bilangan-kemalangan-2012-2016

Motorcycle Vol. 1 and Vol. 2, (n.d). Retrieved on March 24, 2018, from Malaysian Institute of Road Safety Research, Asean Road Safety Centre website, https://www.miros.gov.my/1/page.php?id=364

Royal Malaysian Police, *Statistical Report on Road Accidents in Peninsular Malaysia, 1975.*

Review Article

Development and Validation of Instruments for Measuring Principal Employer's Roles and Responsibilities in Occupational Safety and Health (OSH) Implementation in Malaysia

Mohd Esa Baruji,[a,*] Sham Zahary Sudin,[a] Siti Zainatul Arafah,[a] Nuraida Waslee,[a] Siti Nasyrah Ibrahim,[a] Nur Hidayana Abdullah,[a] Norasilah Latiff,[a] Ahmad Kamal Abdul Halim,[a] Mohd Khan Jamal Khan,[b] Zamalia Mahmud[c]

[a] *Consultation, Research and Development Department (CRD), National Institute of Occupational Safety and Health (NIOSH), Lot 1, Jalan 15/1, Section 15, 43650 Bandar Baru Bangi, Selangor, Malaysia*
[b] *Faculty of Safety and Health, Cyberjaya University College of Medical Sciences (CUCMS), No. 3410, Jalan Teknorat 3, Cyber 4, 63000 Cyberjaya, Selangor, Malaysia*
[c] *Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Malaysia.*

*Corresponding author: mohd.esa@niosh.com.my

ABSTRACT: *Roles of principal employer is very important in enhancing and empowering Occupational Safety and Health (OSH) implementation. This study have identified four elements (i.e., high commitment, effective communication, full compliance and good behavior) as among the crucial elements required to be possessed by the principal employers in three sectors, namely manufacturing, public services and construction. In relation to this, this paper describe the development and validation of instruments prior to the measurement of principal employers' roles and responsibilities in the implementation of OSH. Three assessment tools were developed, namely the Benchmarking Interview, Questionnaire and Workplace Inspection. Fifteen companies were selected for the benchmarking interview, 50 employers conveniently selected for the survey interview (covering three sectors) and 90 employers selected for the workplace inspection (30 respondents for each sector). The development of benchmarking interview and workplace inspection scores are briefly discussed while the main focus is on the validation of the survey constructs (or items). The reliability check on 53 items representing four elements (i.e., Commitment, Communication, Compliance, Behaviour) of employers' roles and responsibilities in the implementation of OSH showed that the Cronbach's Alpha coefficient is more than 0.90 which indicates that the internal consistency is extremely reliable. It also indicates that the set of items in each element are closely related and well understood by the respondents. Validity check on the items based on the Rasch measurement infit and outfit mean square statistics and standardized z-score found that nine items had misfitting values and finally corrected for further analysis. This study had shown that a valid and reliable instruments are important in ensuring that accurate and precise findings are obtained in measuring the roles and responsibilities of principal employer in the implementation of OSH.*

Keywords: *Behaviour, Commitment, Communication, Compliance, Employer, Occupational Safety and Health*

1.0 INTRODUCTION

This paper will focus on the development of the instruments used in this study and the validation process of the instruments. In order to ensure the quality of instrument to measure the element of leadership from employers in Occupational Safety and Health (OSH) aspect, validation test has to be done.

Under the Social Security Act 1969, the definition of a principal employer is the person who employ workers directly to work with them. Whereas the direct employer means a person who conducting a work by him or through a primary employer. Whereas, under the Occupational Safety and Health Act (OSHA) 1994, the principal employer means an industry or person with which an employee has contracted a service such as a manager, agent, or person in charge of payment of wages to a worker, occupier of a workplace, legal representative of the owner, any government department, local authority or statutory body. Meanwhile, direct employers mean employees who are employed by or through them. Principal employer means the owner of a workplace and who hire workers to work for them. In many cases, principal employer is grouped as the company top management team.

The roles of employer in Occupational Safety and Health (OSH) are stated clearly in Section 15, Occupational Safety and Health Act 1994 (OSHA 1994). An employer is responsible to ensure safety, health and welfare of every person at the place of work. This includes providing OSH instructions, OSH training, communicate hazards and practical hazards control measure. Clearly, an employer plays important role in implementing and sustaining OSH requirements. In reality, spoken with ethical conduct is simple rather than truly ethical treatment. There are challenges in delivering the call for responsibility in OSH as the employer has a big role attending other parts of organization needs. However, continuous improvement in OSH is vital towards empowerment of employers' responsibility. Leading by example is the key of being a good employer in order to gain trust from his employees and contractors as well as portraying positive leadership approach.

According to Wu, Tsung Chih (2010), involvement by employer or top management has a huge impact on OSH. Employer has three responsibilities, namely (a) ensuring the performance of OSH among middle management teams, (b) ensuring quality of OSH management, and (c) participate in each OSH activity. The concept of Wu, Tsung Chih (2010) in the OSH leadership by employers highlighted the three main elements which are Safety Caring, Safety Coaching and Safety Controlling. This is reinforced in the Reason (1997) study, which states that the individual's status is higher in an organization where all its actions have a greater impact. In detail, senior management should approve and disseminate the OSH policies, regularly review the OSH performance and create reasonable incentives for middle management involve in the implementation of OSH (Petersen, 1998).

In this study, the main element in OSH leadership of employers is measured based on their practice at the place of work. Apart from that, others issues such as factors hindering the employer to deliver their roles and responsibilities in OSH as well as most common hazards and control measures at the place of work are also being analyzed. Therefore, the right instrument used gives reliable and adequate findings. There are three instrument used in this study:

i. Benchmarking interview questionnaire
ii. Questionnaire form
iii. Workplace inspection checklist

Benchmarking interview questionnaire used to get the initial opinion regarding the issues related to study such as types of hazards and preferred control measures, common obstacles in delivering roles and responsibilities in OSH. The findings from interview session are use in developing the questionnaire for this study. Pilot test on the developed questionnaire were conducted before executing data collection. Along with data collection, workplace inspection were conducted using workplace inspection form to verify the OSH practice at place of work.

2.0 LITERATURE REVIEW

Management commitment, communication, compliance and behavior are among important elements to be studied related to the roles and responsibilities of principle employer. Commitment is referred to actions or responsibilities that the management should shoulder on regarding to the employees' OSH issues. It is particularly important to the employer in managing employees and to reduce the number of accidents at the workplace. Mohamed Taufek et. al (2016) states that the element of commitment has a strong relationship with the factors of workplace accidents.

Salleh, Hamid, Zakaria & Mutalib (2015) found that medium of communication is very important in providing useful information to employees. Use of appropriate, attractive and easily understood communications are recommended especially for foreign workers so that they can understand the overall aspects of OSH in the construction industry in Malaysia. The Malay language is commonly used as the intermediate language in Malaysia during information delivery and OSH Induction Course either in oral or written form. However, the use of Malay language is not understood by most of the foreign workers. The OSH information should be understood by foreign workers so that they aware the dangers at the construction sites. Effective communication is important since Kamar et al. (2014) had shown that 55.9% of respondents said that effective communication is very important to be practiced in any organizations.

Compliance with safety requirements enable work to be done both efficiently and safely. One very promising line of enquiry concerning the behavioral antecedents of accidents concerns the relationship among these procedural instructions governing work and the way in which work is done (Che Hassan et al., 2007). Previous study also found that any support or assistance received by Small and Medium Enterprises (SME) in implementing OSH will be able to encourage the industries (Lingard & Rowlinson, 2005). In the operation analysis report by Abdul Rahman (2007), 80% of the workplaces did not comply fully to the OSH regulations. Therefore, compliance issue should be intensively studied in order to identify the barriers in OSH implementation at place of work.

Several previous researches found the predictors towards developing safe working behavior at the workplaces. The predictors are namely management commitment, management safety practices, company's safety policy and procedures (Chinda, 2011; Vinod Kumar & Bhasi, 2010; Lu and Tsai 2008). Previous studies furthermore concluded that accident in workplaces could be reduced if the employees and employer were committed in having and maintaining good safety behavior (Makin & Suntherland, 1994; Christian et.al., 2009). Therefore, safety behavior must be seriously addressed and promptly monitored at the workplaces to prevent industrial accident cases.

3.0 METHOD

This section describes the development and validation of instruments for measuring the principal employer roles and responsibilities in OSH implementation in Malaysia. The instruments include Benchmarking Interview Form, Survey Questionnaire and Workplace Inspections checklist. For the Benchmarking Interview, an open-ended interview session was conducted to fifteen organizations that have been identified as recipients of the National Council of Occupational Safety and Health (NCOSH) CEO Excellence Award for the year 2010-2015. The intention is to obtain a benchmark for best practice in Occupational Safety and Health. The other reason is to gain insights and understanding regarding their opinion in measuring the employer's roles and responsibilities in OSH implementation in Malaysia. The benchmarking interview session was conducted face-to-face using a set of open-ended interview questions. For the survey questionnaire, it was developed based on an extensive discussions of subject matter with the industrial experts. The questionnaire had gone through several validation processes which include content, face and construct validation from the industrial and statistics experts. Comments and suggestions were obtained from the industrial experts on the OSH legislative contents and structure of the questionnaire.

Table 1: **Questionnaire for Development of OSH Improvement Plan to Empower the Role of Principle Employers on OSH Implementation in Malaysia**

Part	Elements	Questions / Statements (Items)	Reliability Index
A	Respondent Profile	11 Questions	nil
B	Company Profile	6 Questions	nil
C	Hazard At Workplace	5 items	nil
D	Control Of Hazard	6 items	nil
E	Factors That Prevents The Principal Employer In OSH Implementation	8 items	nil
F	Management Commitment	18 items	0.953
G	OSH Communication	9 items	0.935
H	OSH Compliance	18 items	0.964
I	Behaviour	8 items	0.938
J	Others: Accident Data & Respondent Opinion On Method/ Product	4 items	nil

For Part F, G, H and I, a 6-point numerical scales are used to measure the items in Fig. 1:

Scale	1	2	3	4	5	6
Strongly disagree	⟵			⟶	Strongly agree	

Figure 1: Numerical Scales

For measuring the construct reliability of the questionnaire, a pilot study was conducted on 50 employers from the target sectors of industry. The purpose is to assess the reliability of the measured items using Cronbach's Alpha (α), which is a measure of internal consistency. Table 1 shows four elements which have been identified as important in measuring the employer's roles and responsibilities in OSH implementation in Malaysia. These elements are Management Commitment, OSH Communication, OSH Compliance and Behavior. Each element is represented by a number of relevant items (or constructs) which have been subjected to a reliability check. The Cronbach's Alpha values for the four elements in Part F, G, H and I are shown in Table 1. The Cronbach's Alpha for all four elements are well above 0.90 which indicate that the set of items in each element are closely related and well understood by the respondents.

The selection of scales correspond to the respondent's true opinion relating to the statements. This study used Stratified Random Sampling in order to select the sample unit (i.e., employers). According to Vries (1986), this type of sampling technique is suitable since the population can be divided into heterogonous strata with sample size calculated proportionately according to the size of the sub-population (Lohr, 2010). This sampling technique is applicable in this study since the population can be divided into three sectors namely, manufacturing, construction and public services where each sector of industry or strata is further divided into sub-strata or sub-sector. Based on the calculation of sample size, the validated questionnaires were distributed to 380 employers across the three sectors. The criteria for the sampling element is a respondent at the managerial level or at par with the principle employer's position.

Validation of the items in Part F, Part G, Part H and Part I were further investigated using the infit/outfit mean square (MNSQ) statistics which was obtained based on the Rasch rating model in Equation 1.

$$P_{nik}\left(X/B_n, D_i, F_k\right) = \frac{e^{(B-[D_I+F_k])}}{1+e^{(B-[D_i+F_k])}} \qquad \text{(Eq. 1)}$$

Where P_{ni1} is the probability of person n choosing "disagree" (Category 1) over "strongly agree" (Category 0) on any item (i). In this equation, F_1 is the difficulty of the threshold, and this difficulty calibration is estimated only once for this threshold across the entire set of items in the rating scale. The threshold difficulty F_1 is added to the item difficulty D_i (i.e., $D_i + F_1$) to indicate the difficulty of Threshold *1* on item *i*. Given that $B_n - (D_i + F_1)$ has the same value as $B_n - D_i - F_1$, and helps to show more easily the shared bases of the Rasch models. Thus the general form of the rating scale model expresses the probability of any person choosing any given category on any item as a function of the agreeability of the Person n (B_n) Wright, B.D., & Masters, G.N. (1982). Rating scale analysis. Chicago: MESA Press.

Out of 53 items which was validated for misfit or inappropriate response, there are 9 items as shown in Table 2 which have been identified as misfit since these items does not fall within the acceptable range of the Rasch expected model, at standardized t-scale between -2.0 and +2.0 and/or infit/outfit range between 0.6 and 1.4 logit (Bond and Fox, 2011). These items are also validated in the Wright map as shown in Fig. 2.

Table 2: Item Statistics Misfit Order for 53 items

Items	Measure	Infit MNSQ	Infit ZSTD	Outfit MNSQ	Outside ZSTD
F16	.98	1.37	4.9	1.68	7.8
F17	-.06	1.50	5.7	1.64	6.8
F14	.15	1.43	5.1	1.56	6.2
H3	.34	1.39	4.8	1.46	5.3
F7	.36	1.29	3.6	1.44	5.1
I2	.76	1.24	3.2	1.44	5.2
F1	-1.13	1.32	3.9	1.44	2.3
F4	.34	1.28	3.5	1.23	3.3
F2	.07	1.20	2.5	1.27	2.7

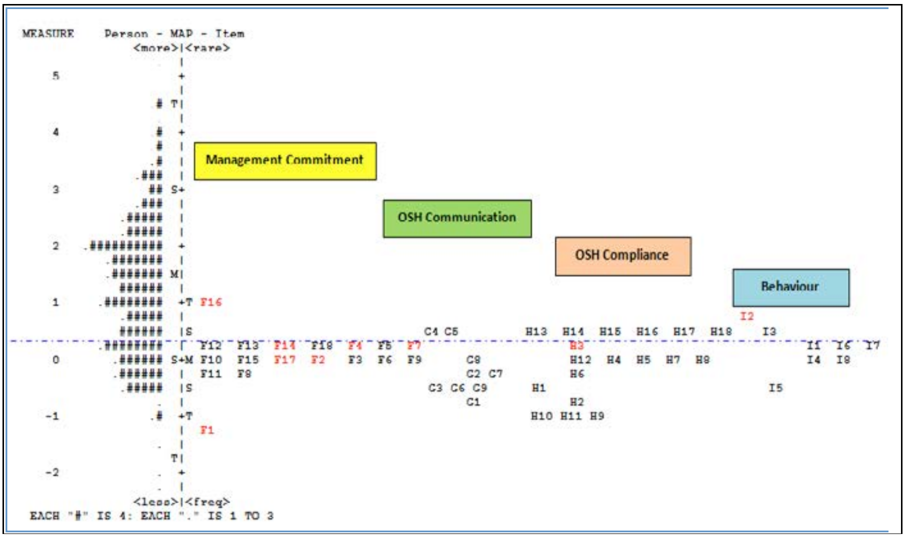

Figure 2: Wright Map of Statistics Misfit Order

The next instrument used which is the Workplace Inspection List was used to verify the company's OSH status based on on-site inspections conducted by OSH officers at selected workplaces. A total of 90 workplaces covering all related sub-sectors were inspected. The methods of inspection consist of workplace observation and OSH documentation review. The workplace inspection checklist has been validated by several experts and used by the National Institute of Occupational Safety and Health (NIOSH) Malaysia for standard workplace inspection. The workplace inspection checklist content is shown in Table 3. Marks obtained from the company inspection check list for Part 2 and 3 are categorized under the Compliance Level as "not satisfactory, satisfactory, good and excellent". The data collected was analyzed using the IBM SPSS Statistics 21 (IBM Corp., Armonk, N. Y., USA, 2017).

Table 3: Workplace Inspection Checklist & Score

Part	Elemen		Statement
1	Company Profile		11
2	OSH Documentation Review		21 (including 5 sub-elements)
3	Workplace Physical Inspection		12 (including 66 sub-statements)
		Marks Percentage (%)	**Compliance Level**
		75 to 100	Excellent
		50 to 74	Good
		25 to 49	Satisfactory
		0 to 24	Not satisfactory

4.0 RESULTS AND DISCUSSION

Results from the pilot study showed that Cronbach's Alpha coefficient (α) for all items/ statements in Sections D, F, G, H and I is 0.98 which indicate the an extremely high reliability on the items. The individual Cronbach's Alpha coefficients (α) for sections D, F, G, H and I are 0.83, 0.91, 0.91, 0.91 and 0.97, respectively which is generally above 0.9. DeVellis (2003) claims that Cronbach's alpha coefficient greater than 0.7 is reasonably reliable. When the value approaches 1, it indicates that the internal consistency is extremely reliable.

However, there are several research limitations are expected from this study. Researchers are likely to encounter difficulties in getting full cooperation from the principal employers, in obtaining information such as details of workers and number of accidents or occupational disease as it is classified as confidential. Other than that, researchers encounter problems in getting the accurate information of company such as their contact address, type of business and number of workers. This is due to the company's failure to update their records on time or misunderstood in supplying required information to DOSH and SOCSO. Workplace inspection might also requires verbal permission from the respective companies before it can be conducted. There might be a situation where not many work activities running while inspection is conducted making the Furthermore, few construction project were located far from office making the logistic arrangement were quite difficult and time consuming.

Respondent shares their commitment, communication, compliance and behavior in delivering their roles and responsibilities in OSH implementation. Furthermore, other information such as types of hazard and the control measure taken can be complied in a priority list to see the trend of most practical control. Other than that, limitation factors on delivering the roles and responsibilities of employers can be obtained from the complete questionnaire. All off these data can be considered as accurate due to strong validity and high reliability of the instrument used. It can be concluded that all the items/statements are reliable, consistent, has minimal error and statements are well understood by respondents.

ACKNOWLEDGEMENT

The research team is indebted to the technical support from National Institute of Occupational Safety and Health (NIOSH) and Department of Occupational Safety and Health (DOSH), Malaysia. In particular, the participation of volunteers in this study is gratefully acknowledged. The authors also wish to acknowledge the contributions of other team members in this study including officer from DOSH Negeri Sembilan (Hj. Izani Mohd Zain, Ir. Dr. Nor Halim Hassan, Syazwan Shah Zulkifly and Fatimah Abu Bakar). This project is funded by the Department of Occupational Safety and Health (DOSH), Government of Malaysia. The authors declare that they have no conflict of interest.

REFERENCES

Abdul Rahman, B. (2007, January 9). *Menangani risiko bahan kimia*. *Berita Harian*, p.11.

Che Hassan, C. R., Basha, O. J. & Wan Hanafi, W. H. (2007). Perception of building construction workers towards safety, health and environment. *Journal of Engineering Science and Technology, 2* (3), Pp. 271-279.

Christian, M. S., Wallace, J. C., Bradley, J. C. & Burke, M. J. (2009). Workplace safety: A meta-analysis of the roles of person and situation factors. *Journal of Applied Psychology, 9* (4), Pp. 1103-1127.

Chinda, T. (2011). Investigation of safe behaviours in small, medium, and large food companies in Thailand. In Proceedings of the International Conference on Engineering, Project, and Production Management (EPPM 2011), 20-21 September 2011, Singapore.

Construction Industry Development Board (2016). Ministry of Works. Construction Industry Transformation Program 2020. Retrieved December 12, 2017, from http://www.citp.my/

Department of Occupational Safety and Health (2016). Ministry of Human Resources. Occupational Safety and Health Master Plan 2020.

DeVellis, R. F. (2003). Scale development: Theory and applications, Second Edition. Thousand Oaks, CA: Sage Publications. Retrieved December, 4, 2017, from https://books.google.com.my/books?id=vmwBHYuchfAC&printsec=frontcover&dq=DeVellis,+R.F.+(2003)&hl=en&sa=X&ved=0ahUKEwiI-vfb0ZnXAhXCQo8KHSJSB0g Q6AEIJzAA#v=onepage&q=DeVellis% 2C%20R.F.%20(2003)&f=false

Lingard, H. & Rowlinson, S. (2005). Occupational health and safety in construction project management. Abingdon, Oxon: Spon Press.

Lohr, S. L. (2010). Sampling: Design and analysis, Second Edition. Cengage learning, Boston. Retrieved August 20, 2016 from https://books.google.com.my/books?id=VbsEAAAAQBAJ&printsec=frontcover&dq=inauthor:%22Sharon+L.+Lohr%22&hl=en&sa=X&ved=0ahUKEwjZ46D51pnXAhUKQo8KHZPxBB0Q6AEIJzAA#v=onepage&q&f=false

Makin, P.J., & Sutherland, V.J. (1994). Reducing accidents using a behavioural approach. *Journal of Leadership & Organization Development, 15,* Pp.5-10.

Malaysia (2000). Occupational Safety and Health Act 1994 (Act 514) Laws of Malaysia

Petersen, D. (1998). Techniques of safety management: A system approach, Fourth Edition.

Reason, J. (1997). *Managing the Risks of Organizational Accidents*. Aldershot: Ashgate. Retrieved November 23, 2017 from https://books.google.com.my/books?hl=en&lr=&id=UVCFCwAAQBAJ&oi=fnd&pg=PP1&dq=Reason,+J.+(1997).+Managing+the+Risks+of+Organizational+Accidents.+Aldershot:+Ashgate.&ots=3aXdQTtyKr&sig=EjYSDdrDsv00VlEXzK_FuuR7Vj4#v=onepage&q=Reason%2C%20J.%20(1997).%20Managing%20the%20Risks%20of%20Organizational%20Accidents.%20Aldershot%3A%20Ashgate.&f=false

Social Security Organisation. (2013-2015). Annual Report 2015. Retrieved June 2, 2015 from http://www.perkeso.gov.my/en/report/annual-reports.html

Vinodkumar, M. N., & Bashi, M. (2010). Safety management practices and safety behaviour: Assessing the mediating role of safety knowledge and motivation. *Journal of Accident Analysis and Prevention, 42* (10), Pp. 2082-2093.

Vries, P. G. (1986). Sampling theory for forest inventory: Stratified random sampling. Springer Science & Business Media. Retrieved July 14, 2017 from https://link.springer.com/chapter/10.1007/978-3-642-71581-5_2

Wu, T. C., Lin, C. H., & Shiau, S. Y. (2010). Predicting safety culture: The roles employers, operations manager and safety professional. *Journal of safety Research, 4* (5), Pp. 423-31.

GUIDELINES FOR CONTRIBUTORS (JOURNAL OF OCCUPATIONAL SAFETY AND HEALTH)

The Journal of Occupational Safety and Health is covers with areas of current information in occupational safety and health (OSH) issues in Malaysia and throughout the world. This includes Occupational Safety, Occupational Health, Ergonomics, Industrial Hygiene, Chemical Safety, OSH Management System and other related research title in OSH.

General Guidelines

Manuscripts should be email to the Secretariat, Journal of Occupational Safety and Health, NIOSH, Lot 1 Jalan 15/1, Section 15, 43650 Bandar Baru Bangi, Selangor, Malaysia (Fax: 6 03 - 8926 9842, Tel: 6 03 - 87692200 / 87692190, Email: journal@niosh.com.my. Please send softcopy of original submissions.

Prepare manuscripts in accordance with the guidelines given below:

(a) Manuscripts must be written using a template provided.

(b) Organisation of material for Original Article should follow standard reporting format - "Introduction", "Method", "Results" and "Discussion".

(c) For Review Articles, Short Communication and Case Report, appropriate headings should be inserted to provide a general outline of the material.

(d) Clarity of language and presentation are essential, and should avoid unnecessary technical terminology. The manuscript can be used either English or Malay. Manuscript in English must be consistent either UK or USA in the whole manuscript.

(e) Each author should complete a declaration form in JOSH Article Submission Form (NIOSH-A134-C)

(f) Define all abbreviations and acronyms used

(g) Permission to reproduce published material must be obtained in writing from the copyright holder and acknowledged in the manuscript.

(h) All material submitted for publication is assumed to be submitted exclusively to the journal unless otherwise stated.

(i) Copyright of all published materials belongs to NIOSH Malaysia.

(j) Once manuscript is accepted for publication, it may be reproduced with the consent, stored in the retrieval system or transmitted in any form or by any means, electronic, mechanical and photocopying with the consent and permission of the publisher. Application for permission should be addressed to: Secretariat, Journal of Occupational Safety and Health, NIOSH, Lot 1, Jalan 15/1 Section 15, 43650 Bandar Baru Bangi, Selangor Darul Ehsan, Malaysia. e-mail: journal@niosh.com.my

Kindly refer to Appendix A (Author's Checklist) and Appendix B (Template of the Paper) for more details/further information.

TYPE OF ARTICLE:

Original Article: Original Article is report on findings from original unpublished research. The article follows the format provided in the guide to authors. The content includes Abstract, Introduction, Materials and Methods, Results and Discussion, and Conclusion.

Review Article: Review Article summarise and describe new developments of interdisciplinary significance as well as proposing new future research directions based on their reviews. Reviews contain Abstract, Introduction that outlines the main theme, subheadings, and the Future Direction for resolving research questions. Conceptual Paper addresses a question that cannot be answered simply by getting more factual information. A purely conceptual question is one to which factual information is not even relevant.

Short Communication: Short Communication includes article of importance, preliminary observations, findings that extends previously published research, data that does not warrant publication as a full paper, small-scale clinical studies, and clinical audits. Short communications generally should not exceed 1,000 words and shall consist of a Summary and the Main Text.

Case Report*:* Case Report must follow these rules: Case reports generally should not exceed 1,000 words; with only maximum of one (1) table; two (2) photographs; and up to five (5) references. It shall consist of a Summary and the Main Text. The summary should be limited to 100 words and provided immediately after the title page.

STRUCTURE OF PAPER

Title Page: Submit a cover sheet including: article title, author(s) name(s), affiliation(s), and complete mailing address, phone, fax, and e-mail address of the corresponding author. If at any time during the review or publication process this contact information changes, please contact the secretariat with the updated information.

Abstract and Keywords: An abstract should accompany the manuscript. This should summarize the content of the paper and include Introduction, Method, Results and Discussion. It may not be necessary for all subheadings to be included, based on the nature of the manuscript. Authors must include up to five keywords or phrases in alphabetical order and separated by comma.

Introduction: The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper. Clearly state the purpose of the article. Summarize the rationale for the study or observation. Give only strictly pertinent references, and do not review the subject extensively.

Method: Method is proposal of new or an overviews of recent technical and methodological developments. Articles should present a new experimental, engineering, scientific or computational method, test or procedure. The method described may either be completely new, or may offer a better version of an existing method. Methods must be proven by its validation, its application to an important research question and results illustrating its performance in comparison to existing approaches. Articles should possess thorough assessments of methodological performance and comprehensive technical descriptions that facilitate immediate application by researchers in the field.

Results: Present your results in logical sequence in the text, tables and illustrations. Do not repeat in the text all the data in the tables or illustrations, or both: emphasise or summarise only important observations.

Discussion: Emphasise the new and important aspects of the study and conclusions that follow from them. Do not repeat in detail data given in the Results section. Include in the Discussion the implications of the findings and their limitations and relate the observations to other relevant studies.

Conclusion: Link the conclusions with the goals of the study but avoid unqualified statements and conclusions not completely supported by your data. Avoid claiming priority and alluding to work that has not been completed. Please state new hypothesis when warranted, and clearly label them as such. Recommendations, when appropriate, may be included.

Acknowledgements: Acknowledge grants awarded in aid of the study (state the number of the grant, name and location of the institution or organisation), as well as persons who have contributed significantly to the study. Authors are responsible for obtaining written permission from everyone acknowledged by name, as readers may infer their endorsement of the data.

References: All references must be formatted in accordance with the Publication Manual of the American Psychological Association (APA), Latest Edition.

Example References:

Journal Articles:

Smith, A.B., Adams, K.D., & Jones, L.J. (1992). The hazards of living in a volcano. Journal of Safety Research, 23(1),81-94.

Book:

Perez, A.K., Little, T.H., & Brown, Y.J. (1999). Safety in numbers. Itasca, IL: National Safety Council.

On-line Publication:

National Institute of Occupational Safety and Health. Sick Building Syndrome. www.niosh.com.my/safetytips.asp?safetyid=1 (accessed October 2004)

Government Publication:

Ministry of Health Malaysia & Academy of Medicine Malaysia (2003). Clinical Practise Guidelines on Management of Obesity 2003.

Tables: All tables should be kept simple and clear, and should be referred to in the text. They should be numbered, titled, and typed using double spacing on separate pages in the order of which they are referred to in the text. Title for table should be written above the table.

Illustrations: Illustrations including diagrams and graphs should be sharp and good contrast. They should accompany the manuscript on separate sheets and numbered consecutively in the same order as they are referred to in the text. Line drawings should be in black ink on a white background and lettering size must be large enough to permit legible reduction whenever necessary. All photographs submitted must be of good quality and printed on glossy paper. The author's name, short title of the paper and figure number must be written on the reverse side of each illustration submitted. Title for figures should be written below the figure.

Mathematical Notation and Equations: All equations must be clearly type, tripled-space and should be identified or numbered accordingly.

Contributor's copy: Each author will receive 1 copy of the journal.

Subscription Information: Journal of Occupational Safety and Health (ISSN 1675-5456) is published bi-annually by NIOSH, Malaysia. Subscriptions are available upon request from the publisher or from www.niosh.com.my. Issues are sent by standard mail. For orders, claims and product enquiries, please contact 6 03 - 8769 2200 / 2190 / 2191 or journal@niosh.com.my

Secretariat Address

Secretariat of JOSH,
National Institute of Occupational Safety and Health,
Lot 1, Jalan 15/1, Section 15,
43650 BANDAR BARU BANGI,
SELANGOR DARUL EHSAN,
MALAYSIA.
Tel: 6 03 - 8769 2200 / 2190 / 2191
Fax: 6 03 - 8926 9842

For more information please visit our website at *http://www.niosh.com.my/publication/niosh-journal*

Institut Keselamatan dan Kesihatan Pekerjaan Negara
National Institute of Occupational Safety and Health

Kementerian Sumber Manusia
Ministry of Human Resources

Lot 1, Jalan 15/1, Section 15, 43650 Bandar Baru Bangi, Selangor Darul Ehsan.
Tel : 03-8769 2100 Fax :03-8926 2900
www.niosh.com.my