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Journal of Occupational Safety and Health

The Journal

- Aims to serve as a forum for the sharing of 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 letters to editor.
- Welcomes articles in Occupational Safety and Health related fields.

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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 the first issue of the journal. I look forward to receive contributions from the OSH community in Malaysia and elsewhere for our next issues.

Ir. Hj. Rosli Bin Husin
Editor-in-chief

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Reassessing Medical Emergency Preparedness in an office-BASF Hong Kong's experience in 2012

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Abstract

Medical Emergency Preparedness is important to ensure timely and correct response during medical incidents. It is also important that medical drills are evaluated and effective action plans are developed. In 2011, we conducted our first medical drill in large office with 650 employees in Hong Kong. Based on the gaps identified we developed a remedial action plan and implemented it. In 2012, we conducted a follow up medical drill. This paper shares our experience in conducting this drill and also compares it with the medical emergency response in 2011. Seventy eight percent of the certified first aiders were at their desk on the day of drill. Seventy two percent of appointed first aiders had received their certification training. The response time was between 1 to 6 minutes. Most of the certified First aiders were able to recall the important first aid action. Twenty one percent had to be reminded to ask for an Automated External Defibrillator (AED), 14% to check responsiveness, 14% to get help from other first aiders, 14% to give two rescue breaths, 7 % did not bring their first aid pouch and 7% were unsure about number of rescue breaths even after reminder. Compared to the medical drill in 2011 there was an overall improved medical response. Aspects which improved significantly were arriving with First Aid Pouch (20%), getting help from other first aiders (22%), and remembering that CPR involved thirty chest compressions (45%) and two rescue breaths (61%). Conducting medical drills, evaluating it, developing effective remedial action plans and implementing it improves medical emergency preparedness and response.

Key words: Medical Emergency Preparedness, Medical drill, First Aid, Follow-up, office.

Introduction

Medical emergency preparedness at workplaces is important. Government agencies responsible for workplaces have produced guidelines on First Aid provision at the workplace. Examples of such documents are Hints on First Aid[1] in Hong Kong and Guidelines on First Aid in the Workplace[2] in Malaysia.

BASF is a German chemical company with global operations employing around 110,000 employees. The BASF regional headquarters for Asia Pacific is in Hong Kong, with 650 employees. These employees occupy 6 floors (floor A-F) in Jardine House which is a 48 floor building located in Central Hong Kong and 1 floor (floor G) in One Exchange Square which is a 51 floor building and located about 20 metres from Jardine House.

The BASF Occupational Medicine and Health Protection (OMHP) Directive[3] defines the global Occupational Health requirements in the company. This directive covers goals, scope, definitions, responsibilities, performance standards, audits and communication. There are eight performance standards, one of which is Medical Emergency Preparedness. This standard states the need for sites to ensure that medical drills are carried out at least once a year, five percent of the office workers are trained in first aid and immediate medical attention is guaranteed at all times. Further guidance is provided in the BASF First Aid Manual [4] and Medical Emergency Preparedness and Emergency Response Manual [5]. For First Aid Response, BASF recommends the use of the European Resuscitation Council Guidelines for Resuscitation 2010[6].

In 2011, BASF Hong Kong conducted its first Medical Drill and detected gaps in medical emergency response. In this medical drill all appointed first aiders including those who had no completed first aid certification were involved in the medical drill. Among the important findings of this drill was: 68% of first aiders were at their desk and able to respond, 85% of responding first aiders

had a valid first aider certificate, 38% of first aiders were unable to confirm the need to get an Automated External Defibrillator (AED) on-site, 54% were unable to confirm the correct number of chest compressions and 77% were unable to confirm the correct number of rescue breaths to be given. Based on these findings a remedial action plan was developed and it included: establish a system to ensure that first aiders have valid certification, ensure adequate first aiders on every floor, reemphasise the need to get an AED when victim is unresponsive, conduct regular first aider meetings and refresher training and develop pocket first aider checklist [7].

During the first aider meetings which were conducted three times a year, first aiders were reminded of the appropriate action to take during a medical emergency. We later decided to also develop a first aider pouch which contained: a pouch content list card, gloves (2 sets), face shields (2 sets), gauze (4"x4" 2 pieces), contact numbers, First Aid action flow card, AED algorithm card, treatment record and incident record. Each first aider was given a pouch and told to bring it with them whenever responding to a request for medical support.

The First Aid action flow card and AED algorithm card (based on the European Resuscitation Council AED Algorithm[6]) replaced the initially proposed first aider checklist. We thought these cards would be even more useful and user-friendly than the checklist. The First Aid action flow provided a step by step guide on what or first aiders needed to do when responding to different situations, i.e. non-life threatening, life-threatening but conscious and unconscious victim at our site. The AED Algorithm provided a step by step guide on how to manage a patient who was unconscious. Since these cards were in the pouch, which first aider would need to have with them when responding, they could easily refer to it to remind them of appropriate actions.

In 2012, we conducted a follow up medical drill to evaluate the latest performance and effectiveness of remedial action measures from the previous medical drill. This paper shares the findings of the follow up drill, compares it with performance in 2011 and recommends new remedial measures.

Methodology

The method used to evaluate performance in this medical drill was similar to that used in the previous medical drill in 2011 [7]. However, there were two differences. Firstly unlike the medical drill in 2011, in this drill only appointed first aiders who had completed first aid certification were included. Secondly in the 2011 medical drill, first aiders were expected to collect a first box from the pantry and bring it to the location of response. In 2012, first aiders were no longer expected to bring the first aid box but to bring their first aid pouch

First aiders were informed over the phone that a medical drill was being conducted and requested to come immediately to a designated room in Jardine House or at One Exchange Square, to the reception area. When they arrived they were asked what they needed to do for an unresponsive and non-breathing victim. A form was used to document the name of first aider who answered call, time of call and time of response, possession of valid first aid certification and ability to recall 10 important actions. The 10 important actions were: bring First Aid Pouch, check responsiveness, open airway and check breathing, call for help, get help from other First aiders, Get help to call ambulance, get help to bring Automated External Defibrillator (AED), start cardiopulmonary resuscitation (CPR), give thirty chest compressions and two rescue breaths.

The quality of response was categorized as: 'spontaneous' which was good, 'reminded' which was moderate and 'unaware' which was poor. If the first aider was able to offer answer spontaneously or recall when asked have you forgotten any action, their response was categorized as 'spontaneous'. If after a reminder of correct action, the first aider is able to confirm it is correct, their response was categorized as 'reminded'. If after a reminder of correct action, the first aider is unable to confirm it is correct, their response was categorized as 'unaware'. If the first aider said that they remembered that they needed to bring a first aid pouch when responding but did not do so, the response was categorized as 'unaware'.

Table 1: Response and time

Floor	Number of appointed First aiders	Number of certified First aiders	Number of certified First aiders available	Response Time
A	1	1	1	6mins
B	4	4	4	2-4mins
C	5	3	2	2mins
D	5	3	3	1-4mins
E	5	2	2	3mins
F	3	3	1	5mins
G	2	2	1	2mins
Overall	25	18	14	1-6mins

Findings

There were 25 appointed First aiders covering the locations during the drill period. Eighteen (72%) of appointed first aiders had completed their First Aid certificate training. Fourteen (78%) out of the 18 certified First aiders were at their desk and able to participate in the medical drill. There was at least one certified First aider available at each floor during the drill. The response time was between 1 to 6 minutes (Table 1)

First aiders were able to recall most of the appropriate First Aid action. One (7%) first aider did not bring her first aid pouch with her when responding. Two (14%) first aiders had to be reminded to check responsiveness of an unconscious patient. One (7%) first aider needed to be reminded to open airway and check breathing. Two (14%) first aiders needed to be reminded to get help from other first aiders. Three (21%) first aiders needed to be reminded to ask for an AED. Two (14%) first aiders needed to be reminded to give two rescue breaths and one (7%) first aider was unsure even after being reminded (Table 2)

Discussion

It is common for employees to change their work location or jobs and hence the need to appoint new first aiders. It is sometimes difficult to find a suitable first aid certificate training date, which results in delay of appointed first aider being certified. In this drill only 72% of the appointed First aiders had completed their first aid certificate training. Although in this drill at least one certified first aider was available on the day of drill on every floor, it would be better if all the appointed first aiders on each floor were certified. In general, a response time of less than 4 minutes is expected from first aider being called to arriving on scene. In the this drill the 'patient' was located at floor C (for floor A-F) and floor G (for floor G). The response time from first aiders on the same floor was 2 minutes, which was acceptable. The response time for first aider who came from different floors i.e. A,B,D,E and F was between 1-6 minutes. This was acceptable since they were only expected to be a backup for the first aiders located on the same floor as the 'patient'.

Table 2: Recall of appropriate action

Action	Spontaneous	Reminder	Unaware	Total
Arrive with First Aid Pouch	13 (93%)	0 (0%)	1 (7%)	14
Check responsiveness	12 (86%)	2 (14%)	0 (0%)	14
Open Airway & check breathing	13 (93%)	1 (7%)	0 (0%)	14
Call for help	14 (100%)	0 (0%)	0 (0%)	14
Get help from other First aider	12 (86%)	2 (14%)	0 (0%)	14
Get help to call ambulance	14 (100%)	0 (0%)	0 (0%)	14
Get help to get AED	11 (79%)	3 (21%)	0 (0%)	14
Start CPR	14 (100%)	0 (0%)	0 (0%)	14
Thirty compressions	14 (100%)	0 (0%)	0 (0%)	14
Two rescue breaths	11 (79%)	2 (14%)	1 (7%)	14

The medical drill in 2012 showed an overall improved performance compared to the medical drill in 2011. There were significant improvements in arriving with First Aid Pouch (20%), getting help from other first aiders (22 %), and remembering that CPR involved thirty chest compressions (45%) and two rescue breaths (61%). There were no significant differences in action check responsiveness (-5%), open airway and check breathing (-7%), call for help(9%) , get help to call ambulance(0%) and start CPR(0%) (Table 3).

Table 3: Comparison of findings in Medical Drill 2012 and 2011

Action	Spontaneous 2012	Spontaneous 2011*	Difference
Arrive with First Aid Box/Pouch	93% (13/14)	73% (8/11)	+20%
Check responsiveness	86% (12/14)	91% (10/11)	-5%
Open Airway & check breathing	93% (13/14)	100% (11/11)	-7%
Call for help	100% (14/14)	91% (10/11)	+9%
Get help from other First aider	86% (12/14)	64% (7/11)	+22%
Get help to call ambulance	100% (14/14)	100% (11/11)	0%
Get help to get AED	79% (11/14)	0% (0/11)	+79%
Start CPR	100% (14/14)	100% (11/11)	0%
Thirty compressions	100% (14/14)	55% (6/11)	+45%
Two rescue breaths	79% (11/14)	18% (2/11)	+61%

**To be consistent, two participants who had participated in medical drill in 2011 but were not certified were excluded from these figures.*

These improvements were somewhat expected considering the measures taken to address gaps identified in the after the previous medical drill.

Conclusion

Sites that conduct medical drills are able to identify gaps and develop remedial action plans. When sites develop effective remedial action plans and implement it, the follow up medical drill will demonstrate improvements in medical response. The follow up medical drills will also enable sites to identify new gaps and develop new remedial action measures. Good medical emergency preparedness is not only about having a medical emergency plan but in having it continuously tested and enhanced.

Acknowledgements

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Manual Work and Lung Cancer Risk in High-Risk Populations

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Abstract

Manual work is associated with increased lung cancer risk possibly because of increased exposure to occupational and other carcinogens, reduced use of health care services and/or a less healthy lifestyle. The aim of this study was to examine whether the association between manual work and lung cancer risk has changed over time. Three separate retrospective studies were carried out over a 10-year period (1996-1997, 1998-2000 and 2003-2005) in patients attending a bronchoscopy clinic to investigate lung cancer risk in an area of Manchester characterised by high deprivation and unemployment. Cases (n=321) were patients newly diagnosed with a tumour of the lung, trachea or bronchus and controls (n=542) were patients free of tumours at the time of, and prior to, examination. Patients were interviewed using the same structured questionnaire for associations between risk factors and lung cancer examined. The study population in all three studies was similar with little difference in smoking history. In each study smoking was associated with lung cancer risk. Lung cancer risk was higher in manual workers (compared to managers and other professionals) in the first (OR 2.50, 95% CI 1.20 – 5.05) and second study (OR 2.73, 95% CI 0.97 – 7.70) but not the third (OR 0.97, 95% CI 0.58 – 1.61). However, the summary odds ratio (meta-OR) for lung cancer in manual worker was 1.81 (95% 1.75 – 1.87) after controlling for sex, age and smoking. This study suggested that even after taking into account known occupational and environmental causes of cancer, there was a residual cancer risk associated with manual work, high risk working populations of lung cancer. However this appears to have attenuated recently for as yet unknown reasons.

Keywords: Occupational exposure; manual work; lung cancer risk.

Introduction

Lung cancer is the most common cancer in the world with an estimated 1.61 million new cases (12.7% of all new cancers)[1]. It is the second ranked cancer after bladder cancer amongst all occupational cancers worldwide[2].

Lung cancer is clinically silent for the majority of time. About 10% of lung cancer cases are discovered in the asymptomatic stage. Initial presenting symptoms in patients with lung cancer may be respiratory related, but are often constitutional and attributable to metastatic disease. There is a large variation in incidence between different regions of the world. The highest rates in men are found in Europe and for women in USA and northern Europe. The lowest lung cancer incidence rates are found in African and Asian countries for both men and women[2].

Although smoking is the most important cause of lung cancer, occupational risk factors play an important role. It has been estimated worldwide that 10% of lung cancer deaths in men (88,000 deaths) and 5% in women (14,300 deaths) were attributable to occupational carcinogens' exposure; the corresponding numbers of years lost due to morbidity or premature mortality (disability-adjusted life years, DALYs) were 825,000 (men) and 144,000 (women)[3]. These carcinogens include several occupations (*e.g.* painters, welders) and occupational exposures such as asbestos, cadmium, chromium, nickel, coke and crystalline silica[4]. In the United Kingdom (UK), the proportion of lung cancer deaths attributed to occupation was 21% in men and 5% in women[5].

A number of occupations or occupational exposures are established or suspected risk factors for lung cancer. The literatures from relevant studies have been identified based on a number of occupations or occupational exposures listed by IARC[4]; which are associated with human lung cancer. A number of recent studies were reviewed (the past five years), but there were also some references which had been reviewed in earlier years based on their significant findings. The IARC has identified several occupations (*e.g.* painters, welders) and occupational exposures as being carcinogenic to the human lung. These include asbestos, cadmium, chromium, nickel, coke and coal gasification fumes, solvents, crystalline silica, and other agents[4]. Manual

work has been associated with an increased lung cancer risk[6,7] possibly because of increased exposure to occupational and other carcinogens, reduced use of health care services and/or a less healthy lifestyle. It is also related to the variability of working environments among those workers which appears to have attenuated due to some reasons which includes wide variety of chemical mixtures, substitution of newer chemicals and the role of other substances in increasing risk of lung cancer[8]. Manual workers often underestimate the dangers or complexity of hazardous material in the workplace due to low education level and lack of training[9].

Wythenshawe (the southernmost district in Manchester, UK), is an area characterised by high deprivation and unemployment. In Wythenshawe, smoking prevalence is high (30.3%)[10] and hence the lung cancer rate is also high. However little is known about the importance (if any) of other risk factors in this population.

The aim of this study was to examine the trend of occupational exposures and type of occupation and lung cancer risk in three separate studies over a 10-years period in Wythenshawe.

Methodology

Study design and sampled population

Three separate retrospective studies over a 10-year period were carried out in Wythenshawe (in 1996-1997[12], 1998-2000[11] and 2003-2005[13]). Participants in all studies were recruited from the same bronchoscopy clinic at the North West Lung Centre, Wythenshawe Hospital. Cases were patients newly diagnosed with a tumour of the lung, trachea or bronchus. Controls were patients free of tumours at the time of, and prior to examination. Collected data were analyzed from the self-reported occupational histories and exposures which have not been examined previously.

Occupational Exposure Analysis

This study was a secondary analysis of existing data. Collected data on occupational histories and exposures were analyzed from the completed questionnaires which had not been examined previously. The information on job title and number of years working in each occupation were obtained in chronological order, beginning with the first job undertaken on leaving school, together with the occupational exposure whether they were exposed to smoke, dust, fumes or asbestos. Type of industry was coded according to the UK Standard Industrial Classification (2003) and occupation was coded according to the Standard Occupational Classification (2000), both from the UK Office for National Statistics (ONS)[14].

Manual work is defined as work done by people, literally with their hands, involved with the work process and directly exposed to the substance used in the workplace. In this study, the working definition for manual work is based on the Standard Occupational Classification (SOC), 2000 which includes, skilled workers, (such as farmers, welders, plumbers), process, plant and machine operations (such as quarry worker, assemblers) and elementary occupations (such as laboratory, cleaners)[14].

Statistical Analysis

Frequencies were presented for categorical data and means with standard deviations for continuous data. All statistical analysis was carried out using SPSS (version 15.0). Comparisons were made between two groups (*e.g.* cases and controls) to determine the association with lung cancer. Chi-square (χ^2)-test was used for 2 X 2 table and binary logistic regression was used for variable with two or more categorical groups. Odds Ratio (OR) and its 95% confidence interval (95% CI) were determined to assess the association between lung cancer and occupational and other factors (smoking, alcohol consumption and family history of lung cancer). The variables were further adjusted for sex, age and smoking status and the adjusted odds ratio calculated (aOR).

For combining results from three separate studies, meta-analysis was manually undertaken by calculating a common measure of effect size which gave a thorough summary of those separate studies. The independent set of odds ratio (effect size, ES) with their inverse variance (w) were analysed to get the summary odds ratio (meta-OR). Homogeneity statistic (Q) was calculated to test for homogeneity assumption across the three studies in the same population [15, 16].

Results

Sociodemographic and Smoking Status of Study Subjects

There were a total of 863 subjects in these studies (321 cases, 542 controls), with 361 recruited in study one (1996-1997), 121 in study two (1998-2000) and 381 in study three (2003-2005). The majority of them were men (62.5%) and the mean age of total study population was 64.4 $\pm$ 11.8 years old. There were no significant differences between cases and controls in between three different studies carried out over a 10-year period in terms of gender and age group, except among male gender (Table 1)

The vast majority of the lung cancer patients were ever smokers (86.3%). There was no difference in the estimated mean for age smoking began in the three studies. However, the case group was found to have smoke more compared with the controls; 51.2 $\pm$ 37.7 *vs.* 38.2 $\pm$ 27.4 packed years respectively in the first study (p=0.0002); 52.8 $\pm$ 34.13 *vs*. 3.8 $\pm$ 22.9 packed years in the second study (p=0.003), but not in the third study, 53.4 $\pm$ 27.8 *vs*. 53.4 $\pm$ 37.5 (Table 2).

Table 1. Age and gender of cases and controls

Variable	Study 1 (1996-1997) (Cases, n=118) (Control, n=243)	Study 2 (1998-2000) (Cases, n=39) (Controls, n=82)	Study 3 (2003-2005) (Cases, n=164) (Control, =217)	*p*-value
Gender				
Male				
Cases	74 (62.7)	29 (74.4)	111 (67.7)	0.03*
Controls	133 (54.7)	45 (54.9)	131 (60.6)	
Female				
Cases	44 (37.3)	10 (25.6)	53 (32.3)	0.09
Controls	110 (45.3)	37 (45.1)	86 (39.4)	
Age group (years)				
< 55				
Cases	20 (16.9)	6 (17.1)	15 (9.1)	0.39
Controls	79 (32.5)	32 (40.5)	39 (18.0)	
55 – 64				
Cases	24 (20.3)	10 (28.6)	37 (22.6)	0.08
Controls	69 (28.4)	15 (19.0)	60 (27.6)	
65 – 74				
Cases	46 (39.0)	14 (40.0)	55 (33.5)	0.78
Controls	61 (25.1)	18 (22.8)	77 (35.5)	
≥ 75				
Cases	28 (23.7)	5 (14.3)	57 (34.8)	0.09
Controls	34 (14.0)	14 (17.7)	41 (18.9)	

**significant difference p<0.05. It was calculated to look at the difference between cases and controls between three different studies*

After adjusting for covariates of gender and age, there was little difference in smoking history across the three studies. In each study ever smoking was associated with lung cancer. Smoking status was significantly associated with lung cancer in all studies: the adjusted odds ratio (aOR) of having lung cancer in ever smokers (vs. never smokers) were 5.88 (95% CI: 2.80 – 15.90) in the first study, 5.31 (95% CI: 1.12 – 25.15) in the second and 3.39 (95% CI: 1.31 – 8.81) in the third. (Figure 1).

Variable	Study 1 (1996-1997) (Cases, n=118) (Control, n=243)	Study 2 (1998-2000) (Cases, n=39) (Controls, n=82)	Study 3 (2003-2005) (Cases, n=164) (Control, n=217)	*p*-value
Ever smoking				
Yes				
Cases	112 (94.9)	35 (89.7)	158 (96.3)	0.10
Controls	179 (73.7)	60 (73.2)	195 (89.9)	
No				
Cases	6 (5.1)	4 (10.3)	6 (3.7)	0.11
Controls	64 (26.3)	22 (26.8)	22 (10.1)	

Variable	Study 1 (1996-1997) (Cases, n=118) (Control, n=243)	Study 2 (1998-2000) (Cases, n=39) (Controls, n=82)	Study 3 (2003-2005) (Cases, n=164) (Control, n=217)	*p*-value
Age smoking began (years) mean ± SD				
Cases	17.2 ± 14.2	15.2 ± 2.9	16.0 ± 4.4	0.49
Controls	17.2 ± 4.5	16.4 ± 3.3	16.8 ± 4.2	
Packed Years mean ± SD				
Cases	51.2 ± 37.7	52.8 ± 34.1	53.4 ± 27.8	
Controls	38.2 ± 27.4	33.8 ± 22.9	53.4 ± 37.5	<0.01*

**significant difference p<0.05. It was calculated to look at the difference between cases and controls between three different studies*

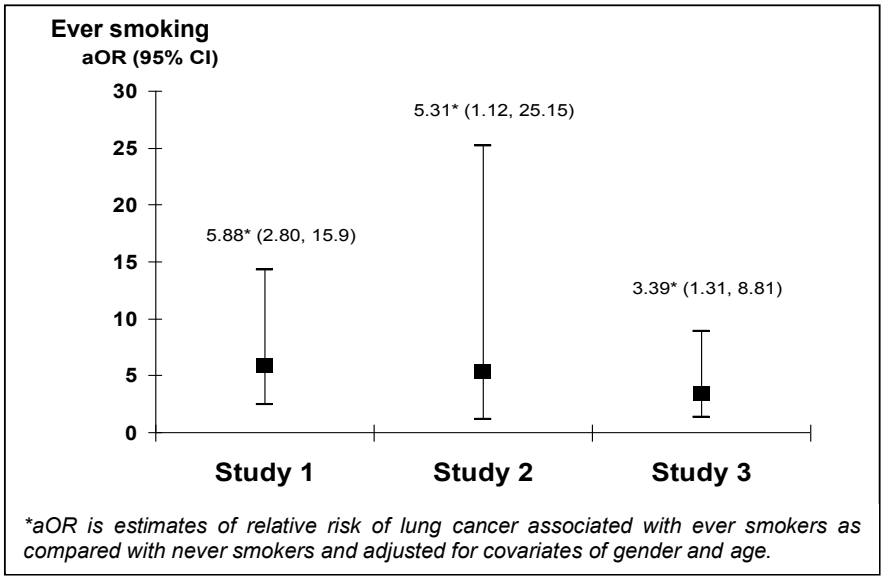

Figure 1: Ever smoking and lung cancer risk

Pack years smoked was associated with lung cancer in the first and second study but not the third. The adjusted odds ratio in patients who had smoked 60 or more pack years (*vs.* patients smoked less than 20 pack years) was 2.53 (95% CI: 1.13 – 5.67) in the first study, 9.02 (95% CI: 1.43 – 56.5) in the second, and 1.45 (95% CI: 0.79 – 2.65) in the third study (Table 3)

Table 3. Associations between pack years smoked and lung cancer

Variable	Cases n (%)	Controls n (%)	Crude Odds Ratio (95% CI)[a]	Adjusted Odds Ratio (95% CI)[c]
Study 1				
Pack years smoked				
<20[b]	14 (13.1)	49 (28.2)	1*	1*
20 - 39	30 (28.0)	49 (28.2)	2.14 (1.01 - 4.53)	2.00 (0.93 - 4.25)
40 - 59	35 (32.7)	45 (25.9)	2.72 (1.30 - 5.71)	2.31 (1.09 - 4.92)
≥ 60	28 (26.2)	31 (17.8)	3.16 (1.44 - 6.92)	2.53 (1.13 - 5.67)

Variable	Cases n (%)	Controls n (%)	Crude Odds Ratio (95% CI)[a]	Adjusted Odds Ratio (95% CI)[c]
Study 2				
Pack years smoked				
<20[b]	2 (5.9)	15 (29.4)	1*	1*
20 - 39	10 (29.4)	19 (37.3)	3.95 (0.75 - 20.8)	3.16 (0.58 - 17.2)
40 - 59	13 (38.2)	11 (21.6)	8.86 (1.65 - 47.5)	10.6 (1.87 - 59.8)
≥ 60	9 (26.5)	6 (11.8)	11.2 (1.86 - 68.1)	9.02 (1.43 - 56.5)
Study 3				
Pack years smoked				
<20[b]	31 (19.5)	49 (22.9)	1	1
20 - 39	45 (28.3)	46 (21.5)	1.54 (0.84 - 2.84)	1.79 (0.95 - 3.36)
40 - 59	33 (20.8)	62 (29.0)	0.84 (0.45 - 1.56)	0.92 (0.49 - 1.73)
≥ 60	50 (31.4)	57 (26.6)	1.38 (0.77 - 2.49)	1.45 (0.79 - 2.65)

*[a]*Crude Odds Ratio is estimates of relative risk of lung cancer in each group versus in patients in group[b]. Adjusted Odds Ratio is estimates of relative risk of lung cancer associated with patients who had smoked 60 or more pack years compared with patients smoked less than 20 pack years and adjusted for covariates of gender and age.*

Type of Occupation and Exposure to Carcinogen and Lung Cancer Risk

The majority of the study subjects were not employed, as most of them had retired, and there were no significant differences between three different studies. (Table 4)

Job category was found to be significantly associated with lung cancer in the first study but not the second and third study. Lung cancer risk was higher in manual workers (compared to managers and other professionals) in the first (OR 2.50, 95% CI 1.20 – 5.05) and second study (OR 2.73, 95% CI 0.97 – 7.70) but not the third (OR 0.97, 95% CI 0.58 – 1.61). The majority of cases in the second (n=30; 76%) and third study (n=117; 71.3%) have been exposed to carcinogen but not in the first (n=32; 28.8%) (Table 5)

Table 4. Employment status of cases and controls

Employment status	Study 1 (1996-1997) (Cases, n=118) (Control, n=243)	Study 2 (1998-2000) (Cases, n=39) (Controls, n=82)	Study 3 (2003-2005) (Cases, n=164) (Control, n=217)	*p*-value
Employed				
Cases	17 (14.7)	5 (12.8)	35 (21.3)	0.02*
Controls	68 (28.2)	27 (31.7)	63 (20.5)	
Not employed				
Cases	99 (85.3)	34 (87.2)	129 (78.7)	0.59
Controls	173 (71.8)	55 (68.3)	244 (79.5)	

**significant difference p<0.05. It was calculated to look at the difference between cases and controls between three different studies*

Table 5. Associations between type of occupation and exposure to carcinogen and lung cancer

Variable	Cases n (%)	Controls n (%)	Crude Odds Ratio(95% CI)[a]	Adjusted Odds Ratio (95% CI)[c]
Study 1				
Type of Occupation				
Management, professional & associate professional[b]	12 (11.1)	46 (19.9)	1*	1*
Clerical and secretarial	18 (16.7)	35 (15.2)	1.97 (0.84 - 4.62)	1.81 (0.75 - 4.37)
Sales & service	11 (10.1)	47 (20.3)	1.06 (0.44 - 2.57)	1.15 (0.46 - 2.86)
Manual	67 (62.0)	103 (44.6)	2.50 (1.20 - 5.05)	2.43 (1.17 - 5.01)
Exposure to carcinogen				
No[b]	79 (71.2)	166 (71.9)	1	1
Yes	32 (28.8)	65 (28.1)	1.03 (0.63 - 1.71)	0.93 (0.54 - 1.60)
Study 2				
Type of Occupation				
Management, professional & associate professional[b]	8 (20.5)	26 (32.1)	1	1
Clerical and secretarial	7 (17.9)	12 (14.8)	1.90 (0.56 - 6.44)	2.31 (0.59 - 9.04)
Sales & service	8 (20.5)	24 (29.6)	1.08 (0.34 - 3.34)	1.49 (0.40 - 5.61)
Manual	16 (41.0)	19 (23.4)	2.73 (0.97 - 7.70)	2.85 (0.94 - 8.62)
Exposure to carcinogen				
No[b]	9 (23.1)	36 (43.9)	1*	1
Yes	30 (76.9)	46 (56.1)	2.61 (1.10 - 6.18)	2.04 (0.80 - 5.21)
Study 3				
Type of Occupation				
Management, professional & associate professional[b]	37 (22.8)	46 (21.3)	1	1
Clerical and secretarial	18 (11.0)	22 (10.2)	1.04 (0.49 - 2.22)	1.14 (0.52 - 1.51)
Sales & service	18 (11.0)	28 (13.0)	0.79 (0.38 - 1.63)	0.94 (0.44 - 2.00)
Manual	90 (55.2)	90 (55.5)	0.97 (0.58 - 1.61)	0.89 (0.53 - 1.51)
Exposure to carcinogen				
No[b]	47 (28.7)	60 (27.6)	1	1
Yes	117 (71.3)	157 (72.4)	0.95 (0.61 - 1.49)	0.84 (0.52 - 1.36)

*[a]*Crude Odds Ratio is estimates of relative risk of lung cancer in each group versus in patients in group[b]. Adjusted Odds Ratio is estimates of relative risk of lung cancer adjusted for covariates of gender and age.*

Exposure to carcinogens was found to be associated with lung cancer risk in the second study but not the first and third study. The adjusted odds ratio of having lung cancer for ever exposure (*vs.* never exposed) was 2.04 (95%CI: 0.80 – 5.23) in the second study (Table 5). However, the summary odds ratio (meta-OR) for lung cancer in manual worker was 1.81 (95% 1.75 – 1.87) after controlling for sex, age and smoking (Figure 2).

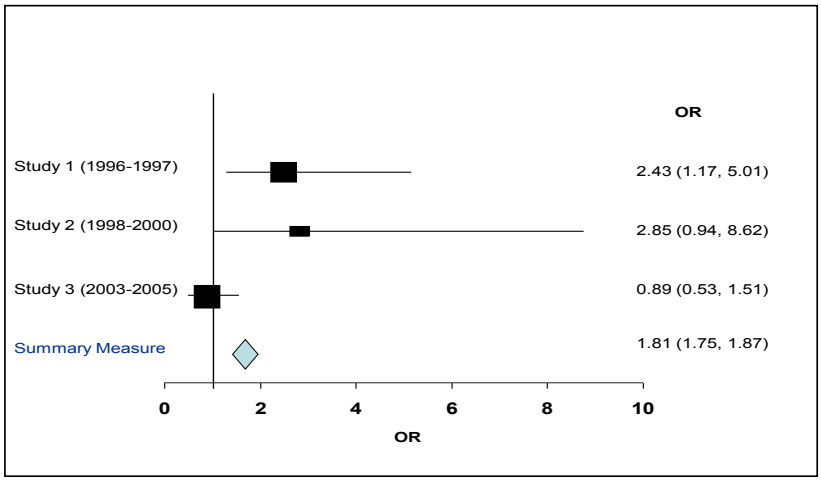

Figure 2. Forrest plot of lung cancer risk among manual worker from meta-analysis

Discussion

Smoking status was significantly associated with lung cancer risk and also associated with the duration of years smoked. The findings were consistent with the other studies[17, 18] which indicating the duration of smoking as one of the strongest determinants of lung cancer risk in smokers. The risk increases with the pack years smoked[18].

This study suggests that even after taking into account smoking as the main cause of lung cancer, there is a residual cancer risk associated with manual work. Manual work has been associated with an increased lung cancer risk[19, 8], possibly because of increased exposure to occupational and other carcinogens, reduced use of health care services and/or a less healthy lifestyle.

Studies showed that socioeconomic factors act as contributors to lung cancer risk. Smoking rates are higher in manual workers group[20]. The findings showed that the majority of lung cancer patients who were manual smokers were ever smokers. It is consistent with a study reported that there was a difference in lung cancer risk between social classes, in addition to the effect of smoking[21]. Manual workers are also more likely to become a passive smoker, as reported that 49% of non-smokers exposed to passive smoke where 66% of them were manual workers[22].

Health inequalities and reduced use of health services were found to be one possible cause of increased lung cancer risk among manual workers. It is a possibility of those workers went to seek medical treatment in the later stage of illness or lack of awareness of their safety and health particularly on exposure to occupational hazards[9].

Different job category having different types of exposure to occupational hazards particularly occupational carcinogens. Exposure to occupational carcinogens was associated with an elevated lung cancer risk. In this study, unskilled manual job workers had a higher lung cancer risk compared with other categories, such as management, professional & associate professional. It is suggested that those who worked in the unskilled manual workers are more prone to be exposed to different kind of occupational carcinogens.

Manual work is associated with an increased lung cancer risk is also related to the variability of working environments among those workers which appears to have attenuated due to some reasons which includes wide variety of chemical mixtures, substitution of newer chemicals and role of other substances in increasing risk of lung cancer[8]. Manual workers often underestimate the dangers or complexity of hazardous material in the workplace due to low education level and lack of training[9].

As previously reported, manual workers found to be more exposed to lung carcinogens which have been identified by the IARC as being carcinogenic to the human lung[4]. Our findings also showed workers who exposed to carcinogen were found to be associated to lung cancer risk and it supports similar study which reported the occupational risk factors for lung cancer was higher among manual workers[19].

Strategies on risk reduction should be focused on those manual workers where such exposures still exist, such as the occupational safety and health best practices, awareness on the importance of proper usage of the protective gears (*eg.* respiratory protective equipments), health education particularly on possible illness and

health adverse effects of occupational hazards exposed. Further research is required to examine in more detail on the lung cancer risk and occupational exposures, specifically looking at the job characteristics and cumulative exposure to those carcinogens in terms of intensity, frequency and duration.

Conclusion

The findings in this study showed the evidence that occupational exposures may be an important factor associated with lung cancer risk. This study suggested that even after taking into account known occupational and environmental causes of cancer, there was a residual cancer risk associated with manual work. However this appeared to have attenuated recently for as yet unknown reasons.

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Occupational Lead Exposure And Homocysteine Level Among Automotive Component Manufacturing Factory Workers

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Abstract

Homocysteine could be a mechanism that underlies the effects of lead on cardiovascular system. This study aims to identify the relationship between lead exposure and homocysteine levels among workers. A comparative cross-sectional study was carried out on 80 workers of an automotive components manufacturing factory; that comprised of 40 exposed workers and 40 non-exposed workers. Blood samples of respondents were taken by finger-prick. The blood samples were analyzed for blood lead concentration by using Atomic Absorption Spectrometry Graphite Furnace Model GBC 908AA. Besides that, ELISA Kit was used to show the homocysteine level among the respondents. Questionnaires were used to obtain demography information of respondents. Results from the statistical analysis showed that the mean blood lead concentration for exposed respondents was 5.53±4.74 µg/dL and 3.53±2.81 µg/dL for the comparative respondents. Mann-Whitney U test showed that there was no significance difference between the mean blood lead concentration of the exposed and comparative group (z=-1.178; p=0.075). The blood lead concentration ranged 0.68-17.95 among the exposed group and with a range of 0.084-11.96 for the comparative group. The mean homocysteine level (µmol/L) was 32.48±2.481µmol/L for the exposed group and 16.50±4.0960 µmol/L for the comparative group. There was a significant difference in homocysteine level (µmol/L) between the exposed (32.48±2.481) and comparative (16.50±4.0959) groups (z = -7.699, p<0.001). The range of homocysteine level among exposed group was 28.64 to 38.54 and for comparative group was 7.58 to 22.41. The lead exposure among exposed group (r=0.049;p=0.764) and comparative group (r=-0.053; p=0.743) was not significantly correlated with the concentration of homocysteine. The occupational lead exposure has no correlation with homocysteine level among workers at automotive component manufacturing factory.

Keywords: blood lead, homocyteine, automotive component manufacturing factory.

Introduction

Lead is a well-recognized industrial and environmental toxin, with a wide range of acute and chronic toxic effects (Vaziri, 2002). Chronic exposure to low levels of lead has been shown to increase arterial blood pressure in humans and in experimental animals (Sharp et al. 1988; Harlan, 1988). Anemia with elevated erythrocyte protoporphyrin is evident at blood lead levels around 1.92 mol/L and a clinical effect on peripheral nerve conduction can be detected at 0.96 mol/L (CDC, 1985). The automotive industry probably accounts for the largest proportion of lead used, and also for the sheathing of telegraph, telephone and power cables. Lead-tin-antimony alloys are used in the production of printing metals. These alloys are used as they melt completely to form a free–flowing liquid which easily fills all the intricate patterns in the moulds and then, on solidifying, are hard-wearing. Based on ATSDR, 2000, the standard permissible exposure limit for lead in atmosphere is 1.5µg/m^3.

Recent findings suggest that lead may play an essential role in human essential hypertension (Kopp et al. 1988). However, the epidemiologic data relating lead exposure to hypertension are insufficient and conflicting. Although two retrospective cohort studies have suggested a relationship between lead exposure and both “other hypertension diseases mortality” (Copper and Galley, 1975) and cerebrovascular disease deaths (Dingwell and Lane, 1963), other investigations in lead-exposed workers have not confirmed these results (Robinson, 1976; Cramer and Dahlberg, 1966).

Lead acts primarily on sulphydryl-containing enzymes and generally inhibits their biological activity. Homocysteine itself has a sulfhydryl group. Such sulfhydryl binding by lead could be one mechanism

that could account for the observed lead-homocysteine relation. Lead and homocysteine are both associated with cardiovascular disease and cognitive dysfunction (Schafer et al., 2005). The degree of cardiac impairment from lead intoxication appears to depend on both exposure level and duration. Less certain are the effects of low lead exposures on the cardiovascular system (Kopp et al. 1988).

Cardiovascular diseases (CVD), especially coronary heart disease (CHD), are the most important causes of death in industrialized countries. Increased concentrations of total plasma homocysteine (tHcy) have been associated with an increased risk of CHD (Boushey, 1995). Homocysteine is an intermediate amino acid resulting from the metabolism of methionine and is known to be toxic to vascular endothelium. Epidemiology studies show a significant correlation between homocysteine levels of 11-16 mol/L and cardiovascular disease.

Schafer et al. 2005, stated that the data obtained from his study was the first data which reveal the association between blood lead and homocysteine. It was also mentioned that the key remaining problems of lead toxicity is that the mechanisms for health effects are not well understood. Hence, it is very important to study on the relationship between lead exposure and homocysteine among the workers. The main objective of this study was to identify the relationship between lead exposure and homocysteine levels among workers at automotive component manufacturing factory.

Methodology

This study was conducted at an automotive component manufacturing factory. The factory's final products include deep groove ball bearing and spherical roller bearings for use in motors, cars, elevators, excavators, and industrial fans. The processes of melting bearings include grinding, honing, heat treatment, washing, cutting and turning which may be the exposure route to the workers doing the task. Those who were in the production department were selected as the exposed group; while those who worked at office and not exposed to any occupational lead as the comparative group. Matched sampling was conducted of 40 exposed technicians and another 40 comparative office workers. A brief description of the study with a consent form was distributed to all respondents to read and sign to consent form as a willingness to take part in this study. Questionnaire was distributed to the respondents to obtain respondents background information such as age and working history.

One hundred µL of blood samples were taken from the respondents by finger-prick following standard operating procedure. The blood was then inserted in a microtainer containing 500µl matrix modifier. Blood samples were stored in the refrigerator at 2^0C -8^0C until analysis. Atomic Absorption Spectrophotometer Graphite Furnace Model GBC 908AA was used to determine the blood lead concentration.

The homocysteine analysis was done by following the standard operating procedure provided by the manufacturer of homocystine analytical kits. The blood samples obtained were analyzed for homocysteine concentrations by using the ELISA kit. The OD was observed by the ELISA Reader and then the K.C. Junior Software was used to calculate the homocysteine level (µmol/L) of all the samples. EDTA-plasma or serum was used with the homocysteine ELISA kit (Ubbink et al. 1992).

Data obtained from this study was analyzed using statistical analysis software SPSS. Correlation between blood lead concentration and homocysteine were studied by using Spearman's rho. It was also used to correlate blood lead concentration with age, education level and work experience of the respondents. Pre-test was performed on 10% of the sample size to verify reliability of the questionnaire. Standard operating and sampling procedures were followed throughout the sample collection to prevent contamination.

Results

In this study, the study group was not restricted to only one sex or ethnic group. All of the workers selected are in the age range of 20-45 years old and of both sex, male and female. The mean age of the exposed group was 34.48 years while the comparative group with a mean age of 36.78 years. This shows that there was no significant difference for the age (z=-1.323; p=0.186), education levels (z=-1.888; p=0.059) and work experience (z=-0.462; p=0.644) between the two study groups (Table 1).

The distribution of blood lead concentration for both the exposed and comparative groups was not normal as shown in Figure 1 and Figure 2. The normal distributions of $\log_{10}$ blood lead concentration for both of the groups are displayed as Figure 3 and Figure 4. A comparison of the blood lead concentration between exposed and comparative groups was shown in Table 2. The mean blood lead concentration for exposed respondents was 5.53±4.74 µg/dL and 3.53±2.81µg/dL for the comparative respondents. Mann-Whitney U test showed that the mean blood lead concentration between the exposed and comparative group have a significance difference (z=-1.178; p=0.035). The blood lead concentration ranged 0.68-17.95 among the exposed group and ranged 0.084-11.96 for the comparative group. There also was a significant difference in homocysteine level (µmol/L) between the exposed and comparative group (z=-7.699; p<0.01). The mean of homocysteine concentration (µmol/L) were higher in exposed group compared to comparative group, respectively

32.5±2.48µmol/L and 16.5±4.096µmol/L. A summary of the results are presented in Table 2. The range of homocysteine level among exposed group was 28.64 to 38.54 and for comparative group was 7.58 to 22.41.

Spearman-rho correlation was performed to determine the relationship between the exposure of lead and homocysteine level of the respondents. From the statistical analysis, it showed that there was no significant correlation between blood lead concentration with homocysteine level among exposed group (r=0.049; p=0.764) and also for the comparative group (r=-0.053; p=0.743), as shown in Table 3.

Discussion

In the results (Table 1), we know that there was not a significant difference between the exposed and comparative groups for the variables including age, education level and work experience. This shows that the respondents in this study were matched well with similar characteristic. The matching of respondents is essential in assisting the researcher to identify the relationship of blood lead and homocysteine concentration. The blood lead concentration reflects the absorbed dose. Over 95% of blood lead is contained within erythrocytes and it represents the relatively short-term exposure (Mushak and Crocetti, 1989).

The blood lead concentrations of exposed and comparative group appear to be very low with the range of blood lead concentration 0.68 to 17.95 µg/dL for exposed and 0.08 to 11.96 µg/dL for comparative group. This is far lower if we refer to the OSHA and ACGIH standard, with limits for blood lead concentration at 50µg/dL and 30µg/dL respectively. In addition, that was a significant differences blood lead concentrations between the exposed and comparative group (z= -1.178; p=0.035). This suggested that the occupational lead exposure will influence the level of blood lead concentrations among automotive component factory workers.

The range of homocysteine level among exposed group was 28.64 to 38.54 µmol/L and for comparative group was 7.58 to 22.41 µmol/L. The total homocysteine concentration in plasma of healthy individuals varies with age, gender, geographical area and genetic factors. Scientific literature reports reference values for adult male and females between 5 and 15 µmol/L (Ueland, 1993). Result showed, there was a significant differences in homocysteine level between the exposed and comparative groups. Despite the low blood lead concentrations, we could observe a high homocysteine concentration especially among the exposed group. Hence, the results imply that the exposed group has a higher risk of getting cardiovascular diseases. In previous study by Veerula and Noah (1990), it stated that there is a spectrum of sub-acute and chronic lead toxicity which expanded to nephropathy and hypertension. The homocysteine concentration was higher among the exposed group compared with the comparative group.

Lead and homocysteine are both associated with cardiovascular disease and cognitive dysfunction (Schafer et al. 2005). In occupational and general population samples, low blood lead levels had been associated with increased circulatory and cardiovascular mortality. In addition, according to ATSDR, hypertension may begin to occur even at blood lead concentrations of 10 µg/dL. As discussed in most of the previous researches, there should have a positive correlation. But there is one study done by Mimala (2002), in Malaysia which showed an inverse relation between the blood lead concentration and blood pressure. Besides that, in another study (Wu et al. 1996) on occupational lead exposure and blood pressure, it showed a poor correlation between the blood lead concentration and blood pressure as well. In this study there was no significant correlation between blood lead concentration and homocysteine level among exposed group (r=0.049; p=0.764) as well as the comparative group (r=-0.053 and p=0.743).

Conclusion

This study found that the lead exposure as shown by the mean value of blood lead concentration for both exposed group and the comparative group was not significant and extremely low. The concentration of homocysteine concentration was significantly higher among the exposed group compared to the comparative group. There was no significant correlation between blood lead concentration and homocysteine level among both the exposed group the comparative group. Anyways, there are other factors which may contribute to the increase of homocysteine concentration in blood need to be considered.

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Table 1: Background of respondents

Variable	Median(IQR)		z value	p value
	Exposed (n=40)	Comparative (n=40)		
Age (years)	34.50(5.00)	35.00(8.00)	-1.323	0.186
Education (years)	13.00(0.00)	13.00(1.00)	-1.888	0.059
Work experience (years)	11.10(3.03)	11.00(3.38)	-0.462	0.644

N=80
Mann-Whitney U

Table 2: The comparison of blood lead between the exposed and comparative group

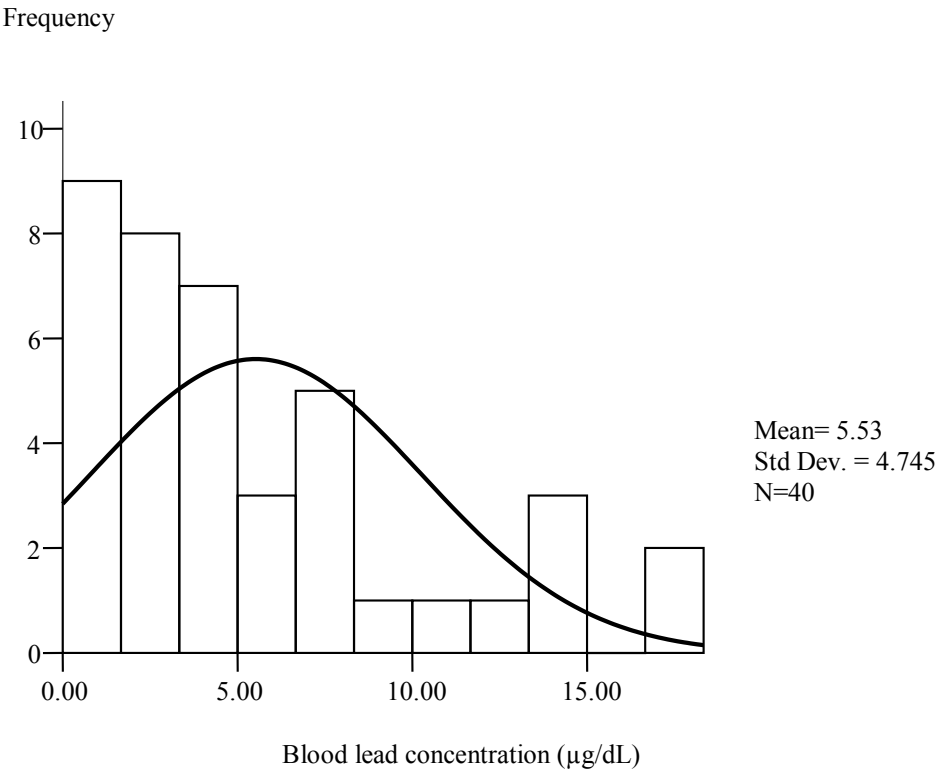
Variable	Exposed (n=40)		Comparative (n=40)		z value	p value
	Median (IQR)	Range	Median (IQR)	Range		
blood lead (µg/dL)	3.82 (5.92)	0.68 to 17.95	2.98 (4.21)	0.08 to 11.96	-1.178	0.035*
homocysteine level (µmol/L)	31.89 (4.13)	28.64 to 38.54	16.77 (5.86)	7.58 to 22.41	-7.699	0.001**

N = 80
** Significant at $p<0.01$
* Significant at $p<0.05$

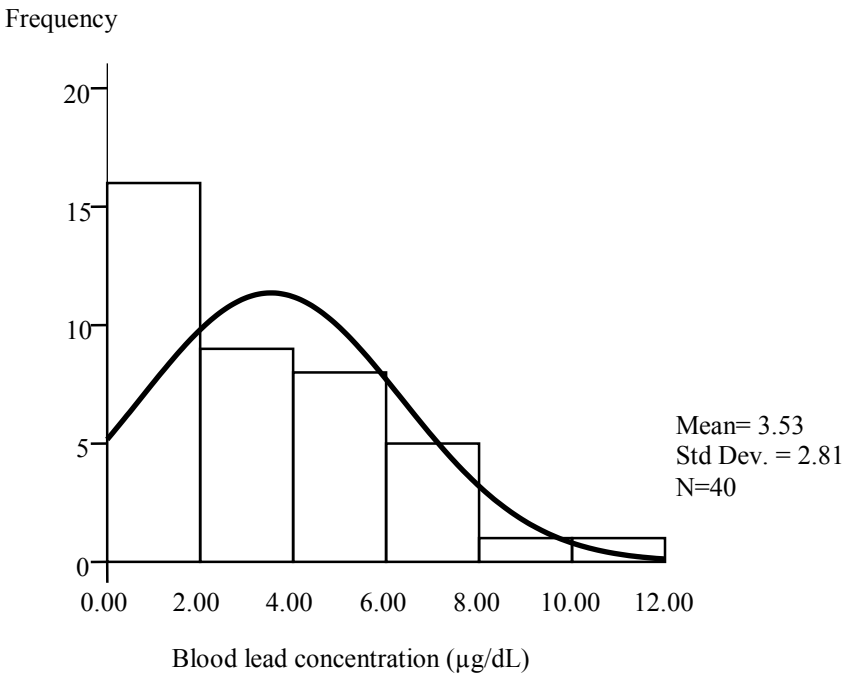
Table 3: Spearman's Correlation between blood lead and homocysteine level.

Variable	Exposed (n=40)		Comparative (n=40)	
	r value	p value	r value	p value
Pb Blood (µg/dL) vs Homocysteine level (µmol/L)	0.049	0.764	-0.053	0.743

N=80



Figures 1: Distribution of blood lead concentrations for exposed group



Figures 2: Distribution of blood lead concentrations for comparative group

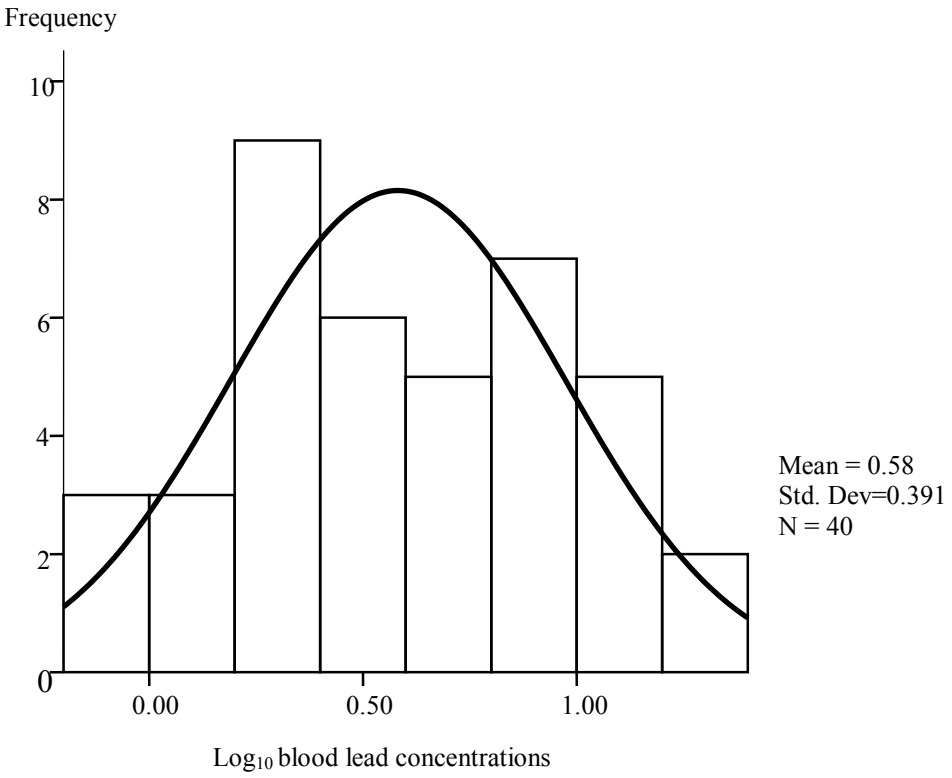


Figure 3: Distribution of log_{10} blood lead concentrations for exposed group

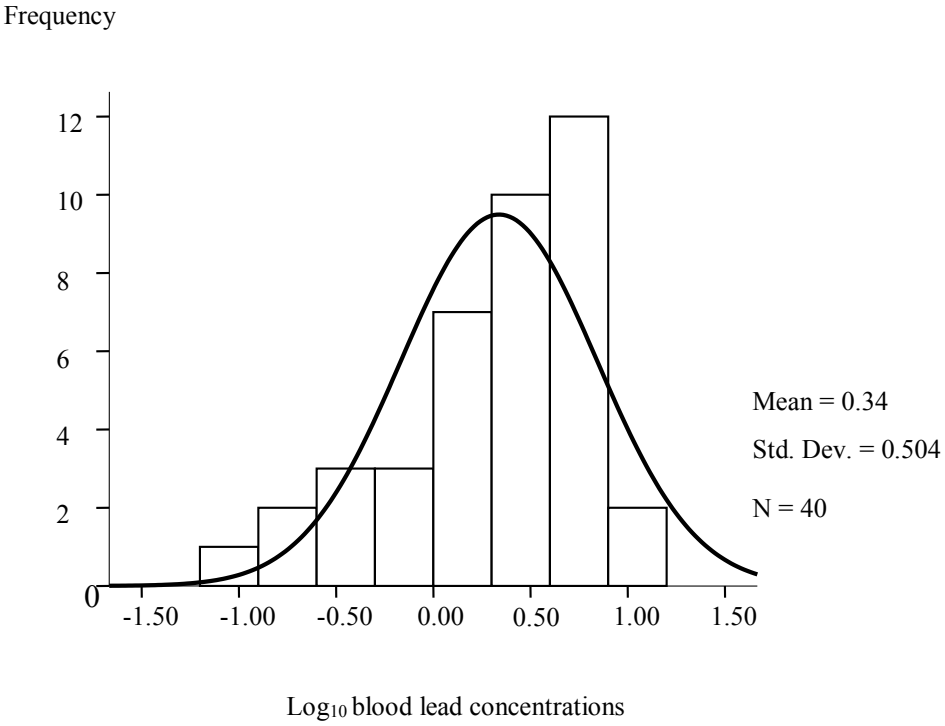


Figure 4: Distribution of log_{10} blood lead concentrations for comparative group

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Association Between Respirable Hexavalent Chromium (Cr-VI) Compounds with Urinary β2-Microglobulin Level of Welders in an Automotive Components Manufacturing Plant

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Abstract

The main objective of this study is to determine the association between respirable hexavalent chromium compounds with urinary β2-microglobulin levels among welders in an automotive components manufacturing plant. 49 welders and 39 workers involved in stamping process were selected as the exposed and the comparative group. β2-microglobulin is a protein renal tubular dysfunction marker that can indicate renal dysfunction caused by heavy metal. Air samples of worker's breathing zone were collected using personal air sampling pump and filter papers. Filter papers were then diluted and analysed with Atomic Absorption Spectrophotometry (AAS). Workers' urine samples were collected at the end of 8-hour work shift and analysed with β2-microglobulin ELISA Kit (IBL-Hamburg) and a microtiter reader. Meanwhile, creatinine levels were analysed with creatinine test strips and Reflotron®. A mean concentration of respirable hexavalent chromium compounds in air for the exposed group was 0.135 ± 0.043µg/m^3 while for the non-exposed group was 0.124 ± 0.029µg/m^3. The mean level of urinary β2-microglobulin per creatinine for the exposed group was 84.996 ± 39.246µg/g while that of the comparative group was 61.365 ± 21.609µg/g. The concentrations of respirable hexavalent chromium compounds were higher in the exposed group compared to the comparative group (Z=-2.444, p=0.015). β2-microglobulin level was also higher in the exposed group compared to the non-exposed group (t=3.821, p=<0.001). However, there was no significant correlation between respirable hexavalent chromium compounds with urinary β2-microglobulin levels (r=0.080, p=0.457) among the respondents. A multiple stepwise regression analysis showed that the most influence variable or confounding factor to β2-microglobulin level was the education year (β =-0.020, p=0.010). All respondents were exposed to concentrations of chromium below regulated limit. Years of education seemed to be a secondary factor that influenced β2-microglobulin level.

Keywords : Respirable hexavalent chromium compounds, urinary β2-microglobulin, welders, automotive components.

Introduction

Metallic chromium (Cr), trivalent chromium (Cr^{3+}) and hexavalent chromium (Cr^{6+}) are the most common structure of chromium compounds. Metallic chromium is a grey colour metal with high boiling point and use to produce steel and other type of alloy. Chromium can easily cross the biological membrane. It can stay in body cell and interact with nucleic acid and protein (ATSDR, 2000). From previous studies on chromium compounds, the results found that chromium have a large impact to health from occupational and environmental exposure because of the high toxicity and its ability to cross cell membrane (Berndt, 1993).

β-2-microglobulin is a protein found on the surface of many cells. At the time of diagnosis, the β-2-microglobulin levels reflect how advanced the disease is and the likely prognosis for that person. When kidney disease is suspected, comparing blood and urine levels helps identify whether the kidney is damaged. β-2-microglobulin normally is filtered out of the blood by the kidney's glomeruli (a round mass of capillary loops leading to each kidney tubule), only to be partially reabsorbed back into the blood when it reaches the kidney's tubules. In glomerular kidney disease, the glomeruli cannot filter it out of the blood, so levels increase in the blood and decrease in the urine. Tubular kidney disease is disease of the kidney that affects the tubules, the part of the kidney that allows certain substances to be reabsorbed back into the blood. Increased urinary levels of β-2-microglobulin are found in people with renal dysfunction caused by high exposure to the heavy metals (Bonde and Vittinghus, 1996).

Welding is an important occupational activity, in part because about 0.2 to 2.0% of the working population in industrialized countries had been reported to be engaged in welding. According to Cunat (2002), fume particles

from the welding of stainless steel may contain trivalent chromium [Cr (III)] and hexavalent chromium [Cr (IV)] compounds. Welding designates a joining operation that ensures the continuity of the metallic state between two pieces to be joined. Most arc welding processes can produce a small fraction of the filler metal as vaporized-condensed (oxidized) or vaporized-(oxidized)-condensed creating a fume consisting of small particles containing chromium which is mainly in the trivalent form [Cr (III)]. Hexavalent chromium [Cr (VI)] is only present in small proportion.

Effects of chromium to human such as renal dysfunction, respiratory cancer, allergy and ulcer to the nose septum and skin are well established by previous study. Chromium effects on kidney include renal dysfunction, protein excretion and high glucose in urine and also renal necrosis at S2 segment on proximal tubule (Foa et al. 1988). The study of exposure to chromium and renal dysfunction are more accurate by using kidney damage marker such as β-2-microglobulin, retinol binding protein and renal BB-50 antigen (Wang et al. 1994; Foa et al. 1988; Mutti et al. 1979).

Study on occupational renal disease or dysfunction is important because they are preventable. Studies on welders and chromium platters have found that workers with higher levels of exposure to airborne chromium (>20 $\mu g/m^3$) show damage to renal tubules. Renal dysfunction has been reported in humans after inhalation, ingestion, and dermal exposure to chromium. Elevated urinary ß-2-microglobulin levels (an indicator of renal tubular damage) have been found in chrome platters, and higher levels have generally been observed in younger persons exposed to higher chromium concentrations (Pellerin and Booker, 2000).

Material And Methods

This cross-sectional study used a purposive sampling, which focused on 49 welders in a metal-based automotive component manufacturing plant as the exposed group, with 39 workers in stamping department as the non-exposed group. The plant was selected due to the assumption of high level of welding fumes produced during the welding processes. Welding activities are carried out in a large scale at the assembly area. Types of welding involved include spot welding, nut welding, bold welding, arc welding, TIG welding, MIG welding and CO_2 welding. The selection criteria of the exposed group were male welders who were involved in welding processes not less than a year, aged between 20 to 40 years old and not having any disease related to kidney or other chronic diseases; while the comparative group matched the criteria of exposed group except that they were not involved in any welding process before. Questionnaire has been used to obtain respondent's background information such as socio-economic and socio-demographic status, health status, and others.

Samples of suspended chromium compounds were collected with Personal Air Sampling Pump (PASP) and filter papers. 5 samples were collected each day for 18 days at the end of 8-hour work shift. PASP flow rate were set at 1.7L/min. Exposure and contacts with the filter paper were minimized to avoid any contamination. Forceps with end covered with tape was used to hold the filter paper. 3-pieces cassette, consists of three plastic pieces were used for collection of suspended chromium compounds. Each PASP was connected to a numbered cassette holder by plastic tubing. PASP was clipped to worker's belt, and then cassette was placed in the worker's breathing zone using a clipper. The tube was snugly and neatly tucked inside the smock suit to avoid entanglement during work activities. After everything was correctly placed, the blue cap on the inlet of cassette was taken off and the pump turned on. The sampling pump was stopped during lunchtime and re-capped. After lunchtime, the PASP was turned on again to resume sampling. At the end of work shift, the pump was turned off and the sampling of respondents was completed. The cassette was then removed from the tubing and the blue cap that was previously placed on inlet hole was then placed as outlet and the red cap was placed as the inlet. It was then, placed into a sealed plastic bag and kept in an airtight container to avoid contamination. Filter papers were digested and analysed with Atomic Absorption Spectrophotometry (AAS) based on NIOSH Analytical Method (NIOSH, 1994). All filter papers digestion was done under a fume hood, because the procedure involved heating of hydrochloric acid (HCl) and also nitric acid (HNO_3).

Urine samples of respondent who wore the PASP during the day were collected at the end of their work shift in polyethylene bottles. The samples were stored at temperature below 4°C. Urine was centrifuged for 10 minutes with 1500rpm, and then analysed with β-2-microglobulin Enzyme Immunoassay Kit (ELISA kit) for determination of urinary β-2-microglobulin level. This kit consisted of microtiter strips, standard solution from A to G, control solution, conjugate dilution buffer, sample diluent, enzyme conjugate TMB-Substrate Solution, TMB-stop solution, concentrate wash buffer and Sodium Chloride (NaCl) solution (IBL, 2001). By using a microtiter plate reader, the optical density was read at 450nm immediately after stopping. On a graph paper, the concentrations of the standard are plotted against their corresponding optical density. The concentrations of the samples can be read directly from the standard curve by using their optical density.

Results

Table 1 shows the descriptive analysis of respondent's background. 88 workers that fulfilled the inclusive criteria were selected as respondents, where out of 88 respondents, 49 were in the exposed group and the remaining 39 in the non-exposed group.

Respondents, who took part in this study, consisted of mainly Malay and 'Others' ethnic groups. 'Others' category comprised of Bugis, Kadazan and Bajau ethnic. In the exposed group, there were 83.7% Malays and the other 16.3% were categorized as 'Others' ethnic. As for the non-exposed group, there were 92.3 Malays and the other 7.7% were also categorized as 'Others' ethnic. As such, the total number of Malays and Others ethnic in this study was 87.5% and 12.5% respectively. From 49 respondents in the exposed group, 44.9% of exposed respondents were smokers while the rest were non-smokers. As for the non-exposed group, from the 39 respondents, 53.8% were smokers and the other 46.2% of non-exposed respondents were non-smokers.

Descriptive analysis of suspended chromium concentrations was summarized in Table 2. The result of Kolmogorov-Smirnov test for air chromium concentrations produced a p-value of 0.05, which differs significantly from a normal distribution. The chromium concentrations were then converted to $\log_{10}$ values and the normality test was conducted on the $\log_{10}$ data. The test was once again conducted on $\log_{10}$ chromium compounds data, and the test yielded p value of lower than 0.01, which was still different from a normal distribution curve. Therefore, the original data were used in further data analysis. Figure 1 shows a histogram with normal curve of chromium concentrations for all respondents. Mann-Whitney U test was then used to compare the median of suspended chromium concentrations between the exposed and the non-exposed group. From the statistical test, p-value of 0.015 with a corresponding Z value of -2.444 (Table 3) was obtained. Table 3 summarized the findings for comparison of suspended chromium concentrations among respondents.

Kolmogorov-Smirnov test was also conducted for β-2-microglobulin data. The distribution of urinary β-2-microglobulin levels was different from a normal distribution curve ($p<0.001$). When the β-2-microglobulin levels computed into $\log_{10}$ value, the same normality test yielded a p-value of 0.56, which means that the $\log_{10}$ distribution has a normal distribution. It is statistically sound that the $\log_{10}$ data must be used for further analysis. Figure 2 shows a histogram with normal curve of $\log_{10}$ urinary β-2-microglobulin levels for all respondents, while Table 4 summarized the descriptive analysis of urinary β-2-microglobulin levels. Student-T test was used for comparison of means of β-2-microglobulin levels between the exposed and the non-exposed group and summarized in Table 5.

The Spearman Rho test was used to determine the relationship between suspended chromium concentrations and urinary β-2-microglobulin levels. From this test, it is statistically concluded that there is no significant relationship between suspended chromium concentrations in air and urinary β-2-microglobulin levels among respondents ($r=0.080$, $p=0.457$). The mean, range and standard deviation of urinary β-2-microglobulin levels for the exposed group was slightly higher compared to the non-exposed group. Table 6 shows the result of this statistical test for the exposed group, non-exposed group and all respondents.

Some factors or variables might also influence the urinary β-2-microglobulin levels. For this, multiple regressions analysis was done on selected data or variables. Enter method was done to include all selected variables. Variables that had been chosen were age, concentrations of suspended chromium compounds, education years, monthly salary, and household monthly salary, working hours in a day, working years, and body mass index (BMI). Those variables were set as the independent variable, while levels of urinary β-2-microglobulin as the dependent variable. After multiple regression with stepwise method were done on those factors, the result shows that the most influenced variable to urinary β-2-microglobulin levels were not suspended chromium concentrations but the education years ($\beta=-0.020$, $p=0.010$). The Adjusted R^2 value was 0.115 while F value was 7.247 (Table 7).

Discussion

From the Mann-Whitney U test, it was concluded that there is significant different of suspended chromium concentrations between the exposed and the non-exposed group ($p<0.05$). The mean and range of suspended chromium concentrations for the exposed group was higher compared to the non-exposed group, but still below the regulated limit of 0.5mg/m^3 (NIOSH, 1994). From observation of the plant, obtained result might be because welding fumes were cleared by the used of the Local Exhaust Ventilation System (LEV) installed at some of the workstation. Fans were also installed at each spot welding station. The fans removed generated fumes from the breathing zone of the welders. All respondents in this study were exposed to less than 0.5 mg/m^3 of suspended chromium compounds. The result corresponds with a study done by Foa et al. (1988) on 236 workers (142 employed in production department, 33 office workers and 61 sub-contractor employees). The researcher found that environmental hygiene measurements showed a relatively low value of total chromium in air (always lower than 0.16mg/m^3), although ferro-chromium was known to produce very high chromium concentrations compared to others type of workplace exposure. From the questionnaire, the result also found that majority of the exposed group (63.3%) was having not less than one of these symptoms, which were nausea, headache, eye irritation and dermatitis. According to ATSDR (2000), these symptoms may occur as acute effects after exposure to chromium compounds. This concluded that even though the concentrations of suspended chromium compounds was very low, workers still had some irritation, due to chromium compounds exposures.

The mean, range and standard deviation of urinary β-2-microglobulin levels for the exposed group was slightly higher compared to the non-exposed group. The p-value ad t-value, concluded statistically that there was a significant different in urinary β-2-microglobulin levels between the exposed and the non-exposed group. The result corresponds with a study done by Bonde and Vittingus (1996). From the study, they found that the urinary of β-2-microglobulin levels of the exposed group was 1.5 to 3.0 times higher compared to the non-exposed group. A person was diagnosed as having a tubular renal dysfunction if their urinary β-2-microglobulin level exceeds 200 µg/g creatinine (Yeol Jung et al. 1998). In this study, 2 respondents of the exposed group were diagnosed as having early tubular renal dysfunction, with their urinary β2-microglobulin level exceeds 200 µg/g.

The Spearman Rho correlation test between suspended chromium concentrations and urinary β-2-microglobulin levels shows that there was no significant correlation between the concentrations of chromium compounds in air and urinary β-2-microglobulin levels among respondents. (r=0.080, p=0.457). This finding might be because of the exposure duration to welding fumes was not long enough, where the average working years was only 3.16 years. The result corresponds with a research done by Wang et al. (1994) on 84 male and 38 female ferrochromium-producing workers who work more than 10 years. The researcher concluded that there were no clear relationships nor time effect relationship was found, although there were a significant different between urinary chromium level of the exposed and the non-exposed group. A study by Stern (1982) on welders, who exposed to chromium, indicates that the apparent effect of welding on renal tubular function may at least be partially reversible. According to Foa et al. (1988), the tubular epithelium is capable of repairing any damage suffered, by means of regeneration mechanisms, thus making it difficult to detect effects of low-level exposure.

Urinary β-2-microglobulin levels had a relationship with total years of education. The lower the education year, the higher β-2-microglobulin levels will be. Furthermore, from the multiple regression analysis, to other independent variables or confounding factors such as age, monthly salary, household monthly salary, working hours in a day, years of employment, number of cigarettes per day and body mass index (BMI), it is statistically found that β-2-microglobulin level has no significant relationship with those factors. The low p-value (p=0.010) shows a higher significance of the studied variable. In other words, years of education was the most influenced confounding variable. No study on the correlation of education years with β-2-microglobulin level was done before. There might be an indirect relationship of education years to β-2-microglobulin levels (as the secondary factor). Education can minimized exposure, might be because educated workers will have better understanding on the importance of good health and preventive measures. Adjusted R^2 for all selected variables is 0.115, which means those factors influenced the level of urinary β-2-microglobulin with 11.5% strength.

Conclusion

Statistical analysis shows that there was significance in difference for suspended chromium concentrations and also for urinary β-2-microglobulin levels. The correlation between chromium concentrations and urinary β-2-microglobulin levels was failed to be proven. It means that there were no significance in correlation between chromium concentrations and urinary β-2-microglobulin levels. Finally, the education years were the most influence confounding factor to β-2-microglobulin levels.

Chromium compounds were largely produced by industrial activities. Even though chromium is essential to human, a higher level of chromium ingested or inhaled will cause various acute and chronic health effects. The management should ensure that all employees are well protected from hazardous exposure to chromium. Nevertheless, some information and education on the importance of personal hygiene must be given to all workers. Development of welding process will introduce more sophisticated processes and hazards. Work pieces of stainless steel and consumables with chromium are used with increasingly complex semi-manual or automated systems involving variety of fluxes or gases. Controls should be integral at the design stage, otherwise substantive detriments and later costs can ensue.

Exposure to suspended chromium compounds in the automotive components manufacturing plant was still low (< 20ug/m^3). This might be due to some steps taken by the management such as installation of Local Exhaust Ventilation Systems (LEV) and fans. As such, those workers in the plant are well protected from exposure to chromium compounds. LEV must be inspected on a regular basis to determine its effectiveness and conformance with design criteria. Monthly internal inspections using a Velometer are recommended. However annual LEV inspections have to be conducted by a registered Industrial Hygiene Technician as stipulated by Use and Standard of Exposure of Chemicals Hazardous to Health Regulations (USECHH), 2000 (DOSH, 2004).

Although fume emission may be minimized by selection of an appropriate welding process, the choice is usually restricted by technical and economic factors. It is therefore necessary to control by reducing exposure to fume: often this is achieved by general ventilation of the workplace but Local Exhaust Ventilation System that remove fume near its source are more effective and desirable. In this approach, contaminated air is exhausted by fixed or movable extraction units and may

be filtered before emission to atmosphere or returned to the workshop. Although the suspended chromium concentrations were very low, workers still can have some acute irritation due chromium compounds exposures.

It is recommended that more study on chromium compounds to be carried out, with a larger sample size. Further retrospective or prospective study in order to get a more accurate data and understanding of renal dysfunction, especially tubular dysfunction that were induced by heavy metal exposure should be reinforced. Understanding of the mechanism of action of nephrotoxicants will be helpful in the prevention and clinical management of unwanted renal effects, and may help in predicting the nephrotoxic potential for heavy metal, chemicals and also new drugs.

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Table 1: Respondents background

Variables	Range		Mean ± S.D	
	Exposed Group n=49		Non-exposed Group n=39	
Age (year)	20 – 35	25.45 ± 3.57	22 – 38	28.21 ± 3.98
Formal study (year)	0 – 12	7.96 ± 3.24	0 – 12	8.33 ± 3.62
Employment (year)	1.0 – 9.0	3.16 ± 2.20	1.0 – 12	3.56 ± 3.03
Working duration (hour)	8.5 – 12	8.79 ± 0.75	8.5 – 12.5	9.19 ± 1.25
Body mass index (kg/m^2)	15.92 – 32.04	21.76 ± 3.71	15.23 – 36.93	21.51 ± 3.71
Salary (RM)	750 – 1400	934.10 ± 139.24	600 – 1500	1019.26 ± 224.65
Household salary (RM)	750 – 3000	1066.76 ± 429.99	600 – 2500	1144.90 ± 415.59

N = 88

Table 2: Air chromium concentration

Variables	Air Chromium Concentration (ug/m^3)	
	Range	Mean ± S.D
Exposed group (n = 49)	0.033 - 0.208	0.135 ± 0.043
Non-exposed group (n = 39)	0.018 - 0.175	0.124 ± 0.029
All respondent (N = 88)	0.018 - 0.208	0.130 ± 0.038

Table 3: Comparison of median for Air chromium concentrations

Variables	Air Chromium Concentration (ug/m^3)		
	Median ± S.D	z-value	p-value
Exposed group (n = 49)	0.135 ± 0.043		
Non-exposed group (n = 39)	0.124 ± 0.029		
All respondents (N = 88)	0.130 ± 0.038	- 2.444	0.015*

**Significant at $p \leq 0.05$*
Statistical Test: Mann-Whitney U

Table 4: Urinary β-2-microglobulin levels

Variables	Urinary β-2-microglobulin Level (μg/g)	
	Range	Mean ± S.D
β -2-microglobulin Level		
- Exposed group (n = 49)	33.747 – 220.639	84.996 ± 39.246
- Non-exposed group (n = 39)	32.758 – 124.795	61.365 ± 21.609
- All respondent (N = 88)	32.758 – 220.639	74.523 ± 34.542
Log_{10} β -2-microglobulin Level		
- Exposed group (n = 49)	1.528 – 2.344	1.893 ± 0.174
- Non-exposed group (n = 39)	1.515 – 2.096	1.765 ± 0.138
- All respondent (N = 88)	1.515 – 2.344	1.836 ± 0.171

Table 5: Comparison of means for log_{10} β-2-microglobulin level between the exposed and the non-exposed group

Variables	β -2-microglobulin level (μg/g)		
	Mean ± S.D	t-value	p-value
Exposed group (n = 49)	1.893 ± 0.174		
Non-exposed group (n = 39)	1.765 ± 0.138		
All respondent (N = 88)	1.836 ± 0.171	3.821	< 0.001**

***Significant at $p \leq 0.001$*
Statistical Test: T-Test

Table 6: Relationship between suspended chromium concentrations with β-2-microglobulin levels

Study Group	r-value	p-value
Exposed group (n = 49)	- 0.015	0.918
Non-exposed group (n = 39)	- 0.077	0.640
All respondent (N = 88)	0.080	0.457

Statistical Test: Spearman's Rho Correlation

Table 7: Multiple regressions

Independent Variables	β Regression Coefficient	t-value	p-value
Constant	2.049	32.694	<0.001**
Education (year)	- 0.020	-2.692	0.010

F value = 7.247
Adjusted R^2 = 0.115
N = 49
*** significant at p ≤ 0.01*
Regression type : Stepwise

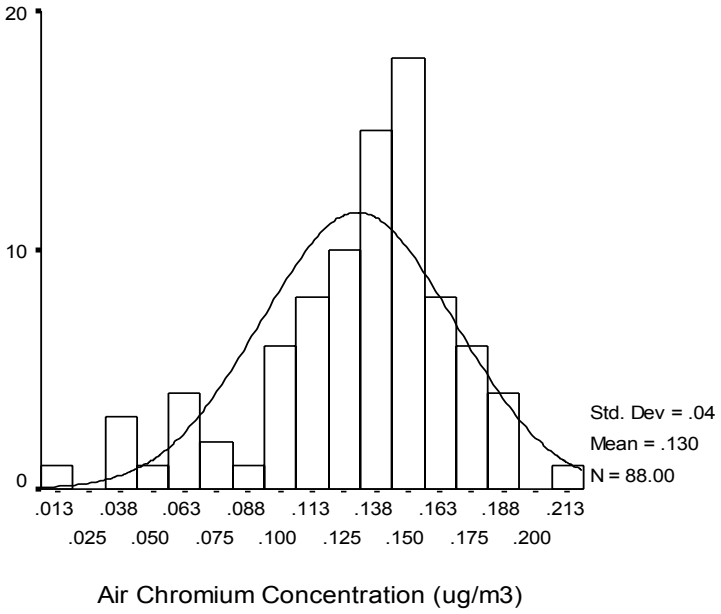

Figure 1: Concentrations of suspended chromium compounds for all respondents

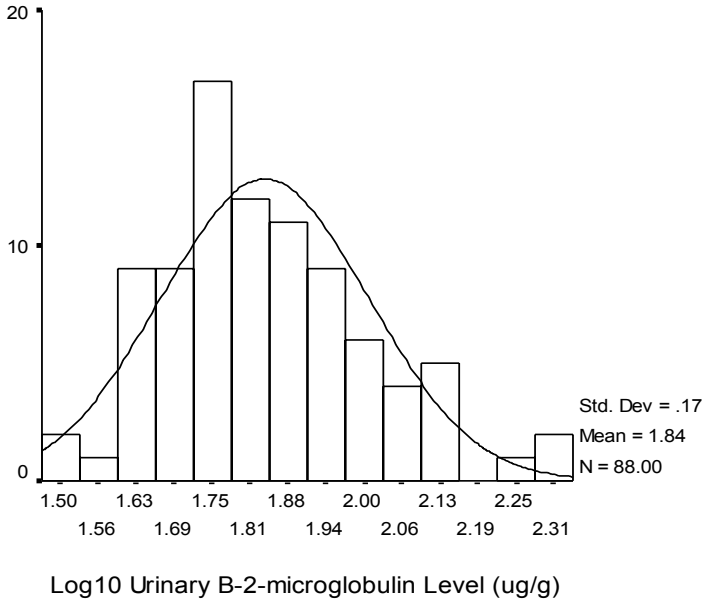

Figure 2: Log_{10} levels of urinary β-2-microglobulin for all respondents

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Work-related Musculoskeletal Disorders among Assembly Workers in Malaysia

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Abstract.

Studies have identified working postures as a major risk factors associated with Work-related musculoskeletal disorders (WMSD) in industries. This study investigated the prevalence of WMSD among assembly workers in Malaysia and how psychosocial factors such as personal values and workers relationship with family and superior are associated with discomfort and pain. A survey was conducted among 127 workers at assembly process in the manufacturing industry. The workers were aged 28.74±6.74 years and 64.6% of them were males. Analysis of Variance (ANOVA) was used to determine the effect of workplace factors on WMSD at different body regions. Spearman's rank correlation was used to investigate association between psychosocial factors and occurrence of discomfort and pain. Only occupation and job activities revealed any significant different with WMSD in the major body regions while there was no significant difference in gender, age and work duration classifications. Shoulder pain is the most prevalent in terms of frequency and intensity of occurrence. Psychosocial issues that have to do with person values, effect of job on family relationship and workers rapport with superiors are all found to be associated with the discomfort and pain among the occupational group. Employers and concerned government agencies need to take more proactive steps in tackling the problem as the occurrence of WMSD will have a significant effect on the overall well-being of the working population.

Keywords : Musculoskeletal Disorder (MSDs), standing, sitting, assembly workers,

Introduction

Standing and sitting are common work postures. Usually, manufacturing industry prefer standing posture due to mobility of legs and large degree of freedom [1]. Tissot et al. [1] stated that working posture is a determinant of musculoskeletal and vascular health and Winkel et al. [2] also stated that occupational musculoskeletal disorders may be caused by mechanical (physical) exposure at work while psychosocial factors at work may in themselves cause pain or modify the perceived pain level caused by the mechanical exposure. There are findings in scientific research that identified physical, psychosocial, organizational and individual occupational risk factors as contributing towards development of musculoskeletal disorders (WMSDs) [3,4]. Their findings buttressed Baker et al. [5] claim of the complexity of WMSD because it involves the interplay among multiple factors. This might be responsible for the continuous annual increment in the number of WMSD cases as reported by [6]. In industrialized countries, about one-third of all health-related absences from work are due to musculoskeletal Disorders (MSDs) of which pain in lower back, neck, shoulder and knee regions accounted for the largest proportion of the problem [7]. The financial implication of the problem is enormous as countries are spending tens in billions of dollars on claims associated with the problem [8]. The direct effect on productivity of the workers is obvious based on reported symptoms such as fatigue, numbness, pain, tingling, stiffness and swellings which will lead to discomfort or other psychological illness. Social Security Organization (SOCSO) Malaysia reported that WMSDs have increased from 15 to 161 cases from 2006 to 2009 and to 268 cases in 2011 and the most significant industry is manufacturing [5]. This paper therefore aims at identifying the prevalence of WMSD among assembly workers in Malaysia and how psychosocial factors such as personal values and workers relationship with family and superior are associated with discomfort and pain. Emphasises will be on investigating the role of workers standing and sitting posture in the occurrence of WMSD among workers at assembly process in the manufacturing industry.

Method

This study is part of an on-going study to investigate the relationship between WMSDs and psychosocial factors in the electronics industry. After obtaining approval from the management of two electronic

companies in Johor, Malaysia, questionnaires were distributed to 127 workers, who gave their consent to partake in the studies. The participants were selected from workers who were involved in assembly process at the organisations' factories. The questionnaires consist of three sections: the first section was associated with the participants' demography such as age, gender, period of working hours, work culture and other general job characteristics; the second section consists of items associated with personal pain/discomfort experiences, and the workers were also expected to indicate the frequency and intensity of such pains at different body regions on a body map; and the third section relates to psychosocial factors associated with their working environment. All questions were designed using 5 point Likert scale and the response rate was 100%. Descriptive analysis of the variables was carried out and Non parametric Spearman's correlation was used to investigate association among the variables. Analysis of Variance (ANOVA) was used to find out if there was significant difference in pain occurrence within the various classifications. All statistical analysis was conducted in SPSS 16 with significance level at 0.05.

Results

Table 1 shows the distribution of the participants' demographic variables. About 90% of them are aged between 20 and 40 years. The mode, median and mean age all lied within the 20-29 age group. About 60% of the participants were male and most of them were also general factory workers, with about 65% of them having been working for between 1 and 5 years. The modal working time is 12 hours and about 82% of the participants carrying out their duties while standing.

Table 2 shows the average ratings of the frequency and intensity of WMSD by the participants in descending order. The highest prevalence of WMSD occurs at the shoulder, feet, lower leg and lower back. The ANOVA table in Table 3 shows the few factors significantly associated with the frequency and intensity of WMSDs at the different body regions. It shows that occupation and job activities exhibited significant difference within their classification at the shoulder, neck and lower leg. The post hoc analysis of the ANOVA reveals that the differences in the rate of pain in these regions were mainly between leaders and technicians.

Table 4 shows the interaction between workers reported personal relationship with commitment to work, and their reported WMSD. The workers' conflict with personal values is significantly associated with rate of physical exhaustion ($r=0.255$, $p=0.004$) and their physical endurance ($r=0.322$, $p<0.001$). Both Occurrence of discomfort and job interference were also

Table 1: Descriptive summary of General characteristics of the study population

General Characteristics	Numbers	Percentage	General Characteristics	Numbers	Percentage
Age			*Contract Worker*		
Less than 20	5	3.9	Yes	46	36.2
20-29	79	62.2	No	80	63.8
30-39	36	28.3	*Working Hours*		
40-49	7	5.5	8	2	1.6
Gender			12	115	90.6
Male	82	64.6	More than 12	10	7.9
Female	44	34.6	*Dominant hand*		
Occupation			Right	79	62.2
General Worker	108	85.0	Left	5	3.9
Technician	8	6.3	Either	43	33.9
Supervisor	3	2.4	*Job Activities*		
Leader	8	6.3	Standing	104	81.9
Duration			Sitting	8	6.3
Less than 3 months	12	9.4	Either	15	11.8
3 months to 1 year	30	23.6			
1-5 years	80	63.0			
5-10 years	5	3.9			

Table 2: Mean and Standard deviation of frequency and Intensity of WMSD in different body segment for the 127 assembly workers.

Frequency of WMSD	Mean	Standard Deviation	Intensity of WMSD	Mean	Standard Deviation
Shoulder	3.24	1.027	Feet	3.30	1.041
Feet	3.20	0.976	Shoulder	3.22	1.126
Lower leg	3.17	0.918	Lower leg	3.20	0.968
Lower Back	2.84	1.087	Lower Back	2.97	1.091
Thigh	2.75	0.926	Thigh	2.73	0.921
Knees	2.67	0.984	Upper back	2.66	0.919
Neck	2.63	0.900	Wrist	2.65	1.026
Wrist	2.61	0.873	Knees	2.63	0.898
Upper back	2.58	0.801	Neck	2.60	0.937
Elbow	2.48	0.898	Elbow	2.53	0.916
Forearm	2.46	0.853	Forearm	2.49	0.890
Hips	2.35	0.791	Hips	2.34	0.838

Table 3: Summary of factors and risk factors which significant different during ANOVA

Factor	Variable		ss	Df	ms	F	sig
Occupation	Frequency of shoulder pain	Bet Groups Within Total	8.955 123.958 132.913	3 123 126	2.985 1.008	2.962	0.035
Occupation	Intensity of pain in lower leg	Bet Groups Within Total	8.162 109.917 118.079	3 123 126	2.721 0.894	3.045	0.031
Job Activities	Intensity of pain in neck	Bet Groups Within Total	13.027 97.493 110.52	2 124 126	6.513 0.786	8.284	0.000
Job Activities	Frequency of shoulder pain	Bet Groups Within Total	7.065 125.849 132.913	2 124 126	3.532 1.015	3.48	0.034
Job Activities	Intensity of shoulder pain	Bet Groups Within Total	14.023 145.804 159.827	2 124 126	7.011 1.176	5.963	0.003

significantly associated with relationship with family. People's satisfaction with overtime was also negatively correlated with time spent with family (r=-0.224, p=0.011). There is also significant association between the level of worker-supervisor rapport and the occurrence of discomfort and pain among the workers. The role of supervisor (r=-0.245, p=0.005) and other encouragement and moral support (-0.262, p=0.003) were also found to be beneficial, because they are negatively correlated with discomfort and pain.

Discussion

The study shows that apart from the shoulder, the lower limb region accounted for the highest prevalence of WMSDs among the participants. The higher prevalence of shoulder pain observed in this study is contrary to other international and national findings, which identified lower back pain as having the highest prevalence among the different body region. [6,7]. The prevalence rate in different body regions could be associated with occupation groups as Neck/ shoulder region have also been reported to have the highest prevalence among VDT workers [4] and teachers [8] while it lower back and neck region among dentist [9]. The higher occurrence in these body regions among assembly workers is as a result of the standing posture by greater percentage (81.9%) of the workers. Pain in the neck/shoulder and lower back region has been found to be associated with work posture [10,11]. The degree of physical commitment must have also contributed to the high prevalence as most of the workers are general workers of which about 70% reported to be often and always involve in manual labour, although manual labour was not found to be associated with job activities in this study (r=-0.129, p=0.148). Though the workers complained more of shoulder pain, pain on the feet was more intense than in any other part of the body. This should be expected in a standing population because the body weight rest on the feet and the additional burden on wearing protective shoes for as long as 12 hours every day. This intensify the need for a more proactive design of factory shoes in terms of comfort and protection as only 28% of the workers are satisfied with their shoe design.

ANOVA for the major body regions with the highest prevalence (shoulder, lower back, lower and feet) shows that there are no significant differences in gender, age and work duration classifications. Lack of association of age is similar to findings in other studies [8,12], but the none significant effect of gender is contrary to the general trend observed in many studies [7, 8,12]. The difference in the gender finding may be associated with different occupational group involve in each study, because development of WMSD is related to work exposure [7]. Also, the difference in shoulder pain intensity among the general workers may be due to the task difference between them. While leaders are mainly supervising and are not engaged in physical task, technicians are expected to be more exposed to handling activities and working in awkward posture during maintenance. The intensity of pain in lower leg is also significant among general workers and technicians. Most general workers in an assembly plant are constraint to a limited work space consistently every day, while technicians move more free within an organisation. The difference in the intensity of neck pain is significant among workers exposed to the three postures during job activities. The same applies to the intensity of shoulder pain among the workers postures during job activities, as there were significant differences among the three postures. However the difference lies between standing and sitting in the frequency of shoulder pain occurrence.

Psychosocial factors associated with the interplay between the mind and the body with relation to the social and cultural climate is believed to play significant role towards job satisfaction and occurrence of WMSD [5]. Table 4 shows that there is significant association between the reported workers family interaction with commitment to work and their reported WMSD. There is an association between how the workers perceived their job conflicted with their personal values. Conflict with personal values could have a direct effect on workers individual motivation as it is strongly associated with rate of physical exhaustion ($r=0.255$, $p=0.004$) and their physical endurance ($r=0.322$, $p<0.001$). Such conflict falls into the psychosocial categories the European regulators identify as state of stress in workplaces, and is associated with the state of health of workers [13]. As highlighted by Ferrand et al.[13], that a single variable may not be sufficient to make conclusion in cross sectional studies, the non-significant association between complaint of pain and frequency of over-time/ time spend with the family cannot be independent interpreted because of the financial benefits accruable from it. As in the studies with health workers in [13], people's satisfaction with overtime, which is negatively associated with time spent with family in this study ($r=-0.224$, $p=0.011$) doesn't not deny the presence of stress or stain which is not beneficial in the long run. In fact, Table 4 shows that there is association between job interference with family and frequency of overtime and also job interference with family and time spend with the family. The findings in Table 4 also find association between the level of worker-supervisor rapport and the occurrence of discomfort and pain among the workers. Workers that are regularly encouraged and given moral support reported lower level of discomfort and pain ($r=-0.262$, $p=0.003$). The same applies to workers that supervisor always encourage to participate in activities as they reported lower level of pain ($r=-0.245$, $p=0.005$). These findings reflect the effect of cordial atmosphere towards general wellbeing of workers, as similar study carried out among bricklayers and construction supervisors, where low social support of direct supervisor was found to be associated with symptoms of depression [14].

Conclusion

The study reveals the prevalence of WMSD among active work age group. WMSDS was more prevalent at lower limb region and the shoulder of the participants. The findings can be more suitable for workers that stand for greater proportion of their working time, since they constitute the large percentage of the participants in this study. The study also highlighted the significant role played by the psychosocial variables in the occurrence of WMSDs. It is therefore important for organisations to promote cordial relationship between supervisors and the general workers, because such relationship affects the general wellbeing and the productivity of the workers. Organisations should also provide working environments that does not conflict with the workers belief and personal relationship.

Table 4: Association between Personal factors and perceived discomfort and pain among industrial workers.

		Conflict with person values	Interfere with your relationship with family	Time spent with Family	Frequency of Overtime	Encouraging and moral support	immediate superior encourage you to participate
Discomfort and Pain	Coefficient significant	0.198 0.026	0.181 0.042	-0.014 0.879	-0.02 0.822	-0.262 0.003	-0.245 0.005
Interference with family relation	Coefficient significant	0.80 0.371	1.000	0.384 0.0001	-0.295 0.001	-0.042 0.641	-0.044 0.621

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Questionnaires Results For Data Consolidation On Occupational Safety And Health Management System Among Gas Contractor In Peninsular Malaysia

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Abstract

There is a need to develop an Occupational Safety and Health Management System (OSHMS) Critical Success Factors (CSF) Monitoring among gas contractor in Malaysia. Critical Success Factors (CSF) can be used for future implementation, adaptation and practice for gas contractor work for both by clients and contractors in Malaysia. The main purpose of CSF implementation is to reduce the number of accident related with Occupational Safety and Health (OSH). The need for CSF is due to the requirement by law and standard that require companies to establish an arrangement related to the identified OSH risks. The objective of this study is to assess the established of OSHMS among gas contractor in Peninsular Malaysia and to identify the CSF imposed by these industries. A cross sectional study for eighty gas contractor companies using established questionnaire has been done. All data consolidated in order to determine the OSHMS and it CSF among gas contractor in Peninsular Malaysia that has registered with Department of Occupational Safety and Health. Established questionnaire are based on OSHMS MS 1722:2011 elements requirement No 1: Policy, No 2: Organizing, No 3: Planning and Implementation, No 4: Evaluation and No 5: Action for Improvement as parameters to come out with organization means and Z-scores. Descriptive statistic showed that element mean (standard deviation) score for policy is 75(6.6), for Organizing is 63(5.2), for Planning and Implementation is 59(9.4), for Evaluation is 66(5.1) and Action for Improvement is 63(1.3). Percentage of company that complies with the main element for Policy is 15%, for Organizing is 8.8%, for Planning and Implementation is 11.3%, for evaluation is 11.3% and for Action for improvement is 13.8%. Percentage of companies that partially comply with Policy element is distributed between 61.0% to 85.0% which is 76.3 %, for Organizing score is mainly distributed between 46.0% to 60.0% which is 62.5%, for planning and Implementation score for 80 companies distributed mainly in group score between 46.0 to 60.0% which is 56.3 %, for Evaluation the partially comply score is distributed in group score between 61.0% to 85.5% which is 41 % and for Action for Improvement partially comply score, the distribution is mainly distribute in range of 61.0% to 85.0% which is 62.5 %. Z-score for element policy is five points from policy mean, for organizing Z-score is three points from Organizing mean, for Planning and Implementation the Z-score is three points from Planning and Implementation mean, for Evaluation the Z-score is three points from evaluation mean and for Action for improvement Z-score is two to three points from Action for Improvement mean. Percentage of compliance with OSHMS MS 1722:2011 elements by gas contractors in almost main element and sub element are still low and can be further improved by focusing on all company element score for continual improvement of OSH elements compliances.

Keywords : Occupational Safety and Health Management System (OSHMS), Critical Success Factors (CSF) and Z-score

Introduction:

In Malaysia, research related with the Development of Monitoring Tools for Occupational Safety and Health management System (OSHMS) Critical Success Factors (CSF) has yet to exist. Occupational Safety and Health (OSH) standards are mandatory rules and standards, set and enforced to eliminate or reduce OSH hazards in the workplace. Safety is an important issue, but many employers do not feel it is vital to the success of companies (1). OSH standards aim to provide at least the minimum acceptable degree of protection that must be afforded to every worker in relation to the working conditions and dangers of injuries, sickness or death that may arise due to work task. For decades, industries have embraced many systems to minimize workplace related accidents and injuries. Yet despite the best intentions, there has been little reduction in the rate at which people are killed or injured at work. Of all the major factors or accidents, the main reason still owes to the attention of daily signals and warnings that people choose not to adhere to. An effective implementation of the OSH practices could reduce accidents thus decreasing compensation paid. Studies (2) have found that safety measures taken in the workplace can lead to better safety performance and study by Laukkanen also emphasized on safety as being part of a skillful job performance (3). In order to generate higher returns by reducing cost incurred to pay out to compensation (2). From the study that was done, it shows that most of the companies still not fully comply with OSHMS standard requirement.

Critical success factor (CSF) is a term for an element that is necessary for an organization or project to achieve its mission. It is also referring as a critical factor or activity required for ensuring the success of a company or an organization. The term was initially used in the world of data analysis and business analysis. CSF is those few things that must go well to ensure success for a manager or an organization. Therefore, it represent those managerial or enterprise area, that must be given special and continual attention to bring about high performance. The concept of 'success factor' was developed in 1961, then it was refined into 'critical success' between 1979 and 1981 (4). The concept has been used worldwide not just by the business companies but in implemented OSHMS as well in order to perform well in organizations. There are 5 main elements that can contribute to critical Success Factor (CSF) namely Policy, Organizing, Planning and Implementation, Evaluation and Action for improvement. CSF is defined as the necessary element that needs to be achieved by companies in order to ensure the success of OSH implementation in the company. There are five main elements that can be contributed to CSF namely Policy, Organizing, Planning and Implementation, Evaluation and Action for Improvement.

OSHMS is best viewed as an organizing framework that provides direction for compliance with the OSH requirements pursuant to national law and regulation. The effective, suitable and adequate established document, implement, maintain and continuously improve the OSHMS should be able to assist and guide the management in minimizing incident related with routine, non-routine and abnormal activity in the organization.

Methodology:

The questionnaire was developed according to Malaysian Standard requirement for the establishment of Occupational Safety and Health Management System (MS 1722:2011) and divided into five main parts which are Policy, Organizing, Planning and Implementation, Evaluation and Action for Improvement (5). Each main part consists of questions derived from sub element that are required by standard to be documented and implemented by the organization as an essential activity for the establishment of OSHMS.

Eighty gas contractor companies in peninsular Malaysia that have registered with Department of Occupational Safety and Health (DOSH) were selected (6). Safety representatives from the company were selected to answer the questionnaire. The cumulative score from the questionnaire was grouped according to "not comply", "partially comply" and "comply". For "not-comply" group, the score was set at zero, for "partially comply" group, the score was set from one to ninety nine and for "comply" the score was set at hundred. Partially comply range scores was set between range of 1 to 99. Partially comply then divided into two parts which are Critical Success Factor and Opportunity for Improvement. Scores 1 to 60 fall into Critical Success Factor, while scores 61 to 99 classify as Opportunity for Improvement with objectives to identify priority need in meeting the OSH requirements. However, these both division still in non-comply result. From the mean score of the overall 80 companies, CSF for each element was known using Z-score. Z–score is a statistical measurement of a score's relationship to the mean in a group of score. Positive value of Z-score indicate the element score is better compared to the standard set by the all other gas contractor companies in Peninsular Malaysia since it shows the score that individual company achieved is above the overall company mean score. Negative value of Z-score show the score is less compared to standard set by all other companies around Peninsular Malaysia since it shows the score that individual company achieves is below the overall company mean score. The important outcome of this study is the establishment of monitoring tools for CSF in Managing OSH for gas contractors works in Peninsular Malaysia.

First and foremost important step in this study is to have a listing on gas contractors registered with Department of Occupational Safety and Health (DOSH)

and identify all occupational safety and health critical success factors facing by an organization in comparing with the MS 1722:2011 requirements on Occupational safety and health management system elements. In this study the questionnaire that was developed was based from MS1722:2011 standard and the Z-score from the individual company will be compared to cumulative mean score from the total eighty companies. Statistical formula for Z-score is shown below.

$$\text{Z-score} = \frac{X - X_{min}}{\sigma} \qquad (1)$$

Data Analysis:

Data from questionnaire was analyzed using Microsoft excel and SPSS Version 21 to identify the distribution of company scores. The frequency and cumulative percent of individual company score in "comply groups", "partially comply groups" and "not comply groups" was known from statistical test. The overall cumulative mean for eighty companies was known from excel analysis. The Z-score was obtained based on formula stated above (1) and data was presented in line Chart. The CSF in managing OSH for gas contractor works in Peninsular Malaysia was known from the Z-score value of individual company compare to the cumulative mean score of 80 companies.

Result:

A total of 80 companies were involved in this study, out of these the main element mean score for policy for eighty companies is 75%, for Organizing is 63%, for Planning and Implementation is 59%, for Evaluation is 66% and Action for Improvement is 63%. Percentage of company that complies with the main element for Policy is 15%, for Organizing is 8.8%, for Planning and Implementation is 11.3%, for evaluation is 11.3% and for Action for improvement is 13.8%. Figures 1, shows the mean scores of eighty companies' main elements and sub-elements scores for the questionnaire that was answered by the safety representative of the companies.

Table 1 and Table 2 show the distribution of the percentage of the score distribution obtained by the 80

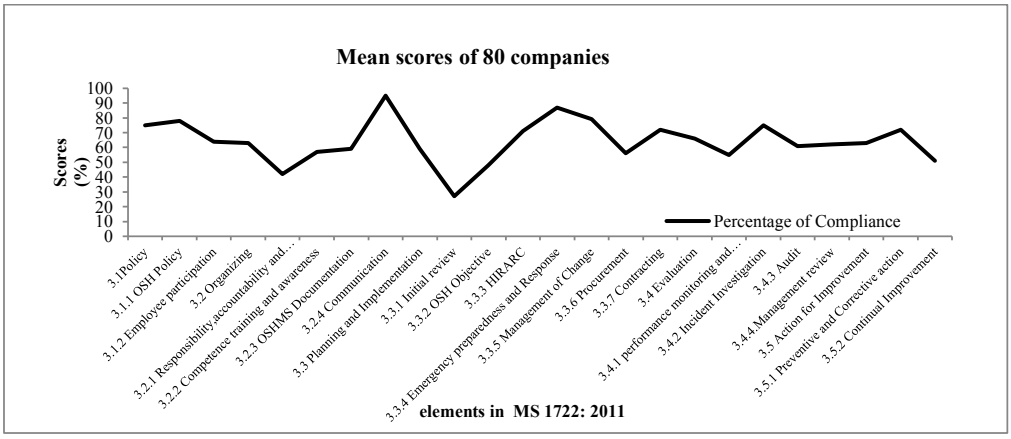

Figure 1: Mean score for eighty companies main element and sub element

Table 1: Frequency table of compliance for main element

Element	Policy		Organizing		Planning And Implementation		Evaluation		Action for Improvement	
	Comply	Partially Comply	Comply	Partially Comply	Comply	Partially Comply	Comply	Partially Comply	Comply	Partially Comply
Percent (%)	15	85	8.8	91.2	11.3	88.7	11.3	88.7	13.8	86.3
Frequency	12	68	7	73	9	71	9	71	11	69

Table 2 Frequency table of partially comply distribution for main element

Element / Score for partially comply (%)	Policy	Organizing	Planning and Implementation	Evaluation	Action for improvement
	Frequency				
1-15	0	0	0	0	1
16-30	0	1	0	2	4
31-45	0	1	5	2	4
46-60	1	50	45	28	9
61-85	61	18	19	33	50
86-99	6	3	2	6	1

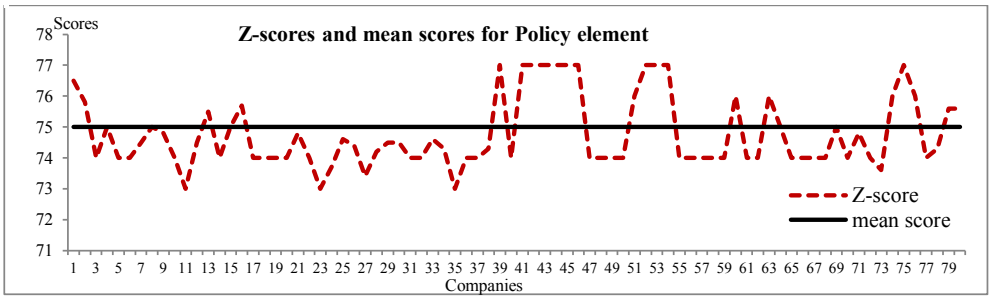

Figure 2: Z-Score and Mean Score of 80 companies for Policy element

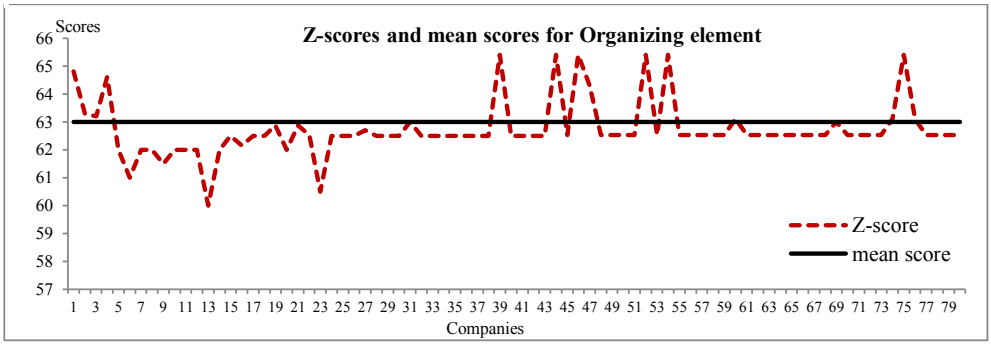

Figure 3: Z-Score and Mean Score of 80 companies for organizing element

companies. From the data, the frequency of compliance for main element policy is higher as compare to other main element which is 15% or about 12 companies that comply with the element policy. The lowest is organizing which is 8.8% comply or equivalent to 7 companies from the 80 respondent companies. Table 2 shows the partial distribution score obtained by 80 companies for each main element.

Figures 2, 3, 4, 5 and 6 below shows the Gas Contractors in Peninsular Malaysia Z-scores and means scores for the main elements of Policy, Organizing, Planning and Implementation, Evaluation and Action for Improvement accordingly.

From the results of Figure 2, it shows that the policy mean for eighty companies is 75. Most companies' average score are near the mean score. From the result of Z-score for each company, the individual company score shows the implementation of policy in gas contractor companies does not vary that much from 5 points above and below mean score.

Results in figure 3, the organizing mean score for 80 companies is 63, which shows that most of the companies get lower score indicating lack of compliances. From the Z-score, the individual score of the company was in a range of 3 points above and below mean score which mean that the score for organizing element in gas contractor companies did not vary when compared to the others.

The mean score for eighty companies for Planning and Implementation element in figure 4 is 59. The mean score shows that most of the companies partially comply with this element and mostly obtained score below 60. The Z -score for individual company show that the range of the score from overall mean score is about 3 points below and above.

From the results in figure 5, it shows that the Evaluation means score for 80 companies is 66 and the Z-score for the individual companies for Evaluation element range are between 63 to 68 which indicates most of the companies partially comply in Evaluation element.

Action for Improvement mean in figure 6 for 80 companies is 63. From the Z-score of individual companies for Action for Improvement score shows that most of the companies varies from 2 to 3 points from the overall mean score. This result shows that the score for each company did not vary when compared to other companies.

Discussion:

This study was performed to identify the CSF for 80 gas contractor companies in Peninsular Malaysia. From the results, it has been shown that most of the companies have the same barrier in establishing and implementing the OSHMS according to the result of Z-score obtained. The overall implementation of Occupational Safety and Health Management System among gas contractor in peninsular Malaysia is still low.

This study involved various gas contractor companies that operates in Peninsular Malaysia, hence the data that was obtained represented the current OSHMS

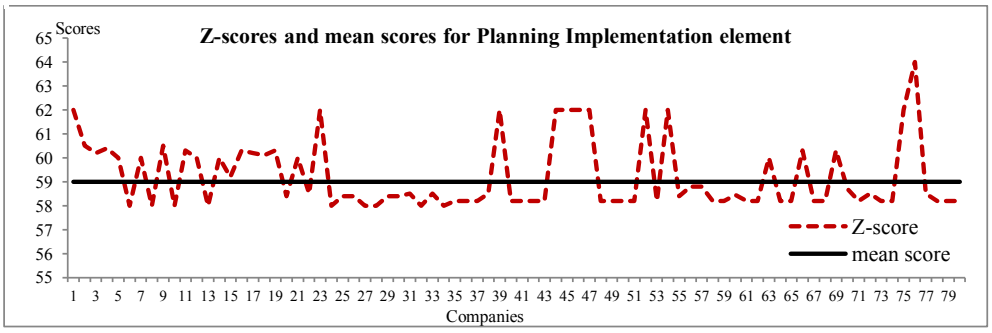

Figure 4: Z-Score and Mean Score of 80 companies for Planning Implementation element

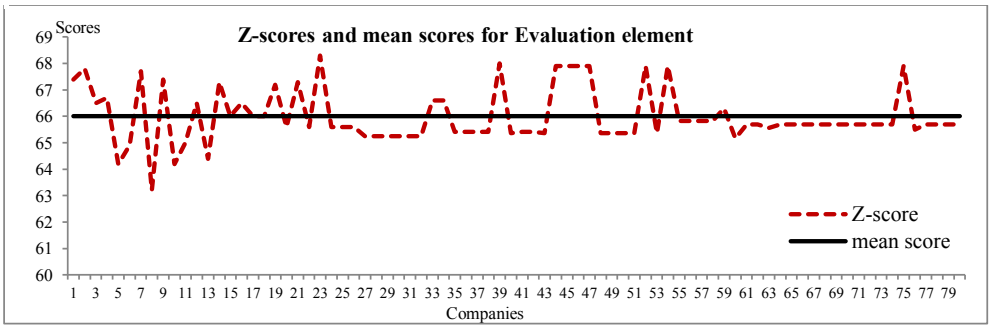

Figure 5: Z-Score and Mean Score of 80 companies for Evaluation element

implementation for this sector, but because the study focus on the establishment of OSHMS in the companies through used of questionnaires and interviews method related to the OSHMS requirement, the implementation of the system at site are still blurred. Suggestion for future studies is to involve inspection at site to see the implementation related to OSHMS and can strengthen the data that was obtained.

From the result obtained, the main significant finding was most of the companies lacked scores in the Planning and Implementation element. The companies mostly do not have procurement and contracting arrangement related to safety and health. Initial review that is a part of OSHMS requirement was also not established by the companies.

From the result shows that the main elements mean score that obtained high score is Policy element which was 75. The Policy element consists of OSH policy and employee participation sub-element. From the results, it showed that the commitment from the top management in Occupational Safety and Health management system in eighty companies are good. The higher score from policy was explained due to Occupational Safety and Health Act 1994 and its regulation's requirement on Policy statement.

The Z-score indicates that most of the company Policy element score for eighty companies did not largely vary among each other. The results also showed that the Policy element implementation among gas contractors in Peninsular Malaysia is partially complied. The Organizing main element, mean score is 63%. The organizing sub-elements consist of Responsibility, Accountability, and Authority sub element, Competence, Training and Awareness sub element, OSHMS Documentation sub element and Communication sub element. From the mean score result of 80 companies show that the gas contractor companies was lacking in implementation of Organizing sub element. Most of the companies partially complied with sub element in the Organizing element.

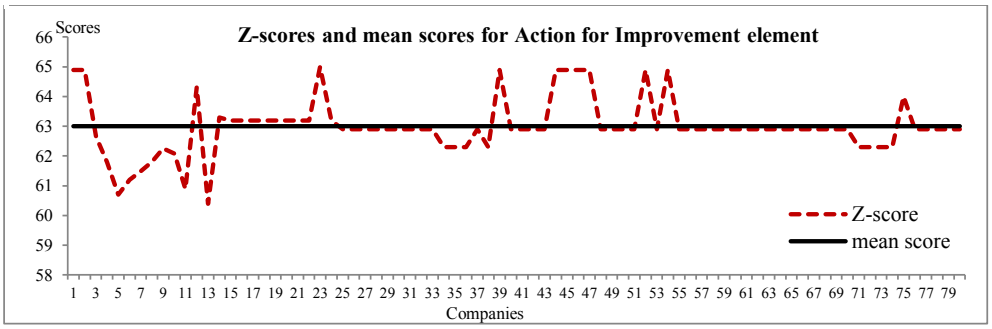

Figure 6: Z-Score and Mean Score of 80 companies for Action for Improvement element

For one reason or other reason, some of the companies were still using the previous standard requirement MS 1722:2005 which was not updated and maintained in accordance to MS 1722:2011 latest standard that have been recently approved by Standard Malaysia.

The Z-score of the individual companies showed that most of the companies organizing main element scores were similar from each other which indicate that the gas contractor companies have the same problem in implementing the Organizing main element.

For Planning and Implementation element, the mean score for 80 companies is 59.The sub-elements in this element consist of Initial Review sub element, OSH Objective sub element Hazard Identification Risk Assessment and Risk Control (HIRARC) sub element, Emergency Prevention, Preparedness and Response sub element, Management of Change sub element, Procurement sub element and Contracting sub element. Most of the companies did not comply with Initial Review sub element and Procurement sub element. This was due to the lack of knowledge that the initial review should be done on the existing OSHMS and relevant arrangement shall be evaluated by an initial review and be documented for the basis making decision regarding the implementation of the OSHMS MS 1722:2011 and procurement procedures that shall be established and maintained to ensure safety and health requirements for the organization is identified, evaluated and incorporated into purchasing and leasing specification. The Z-score of this element is in the range between 3 points above and below Organizing mean element score. The results also showed that most of the companies partially complied with the standard requirement such as need of emergency prevention, preparedness and response procedures that shall be established and maintained for identifying the potential for accident and emergency situation, and address the prevention of OSH risks associated with them,, HIRARC procedures that shall be made to identify hazards, assess and control risks and procurement procedures.

The Evaluation result showed that most of the gas contractor companies also partially complied with the standard requirement. The mean evaluation score for 80 companies is 66 and the Z-score for individual companies ranged between 3 points above and below Evaluation means score. The Evaluation sub elements consist of Performance Monitoring and Measurement sub-element on arrangement to monitor, measure and record organization's OSH performance on a regular basis shall be developed, established, and periodically reviewed, Incident Investigation sub-element and Management Review sub element. Most of the companies partially complied with the Evaluation sub element. The highest contribution to the non-compliance of this element was Incident Investigation procedures that shall be established, implemented and maintained which will identify any failure in the OSHMS were not in place and audit arrangements including documented procedures were not established to conduct periodic audit in order to determine whether the OSHMS and its elements are in place, adequate and effective in protecting the safety and health of employees and preventing accidents.

For Action for Improvement, the mean score for overall company is 63 and consisted of preventive and corrective actions sub element and continual improvement sub element. The Z-score range for main element mean score is 2 points below and above the Action for Improvement mean score. This show that Action for Improvement among gas contractor companies in peninsular Malaysia is still low for preventive and corrective action(s) resulting from OSHMS performance monitoring and measurement, OSHMS audits and management reviews.

In planning and implementation most of the companies have good individual companies score for Emergency Prevention Preparedness and Response due to requirement from client that have strict requirement pertaining to the Emergency Prevention Preparedness and Response. The interview result also indicate that, most of the company that obtained higher score in Planning and Implementation element is the company that deals with well-established company that have their own specification and standard related to safety and health.

Management review is a part of the CSF in Evaluation main element since most of the companies get lower score due to action taken for continual improvement did not obtained commitment from various level that were responsible for the matter which were addressed. The result that was obtained also can be used to identify the part that mostly being contravened with law and regulation. Incident Investigation has lower score due to companies fail to notify accident or near misses that have occurred to the respected authorities.

This study shows that the implementation of OSHMS among the gas contractor in Malaysia is still low. From the sub elements that obtained the lowest score indicate that the companies has difficulties to comply with the standard requirement. Hence from that, the responsible party can used this study to overcome the problem to assists industries to fulfill the requirement and increase the OSH level among gas contractor companies.

Conclusion:

This study shows the current status of compliance among gas contractor on OSHMS elements requirements need further improvement. The mean score for almost all of main element is below 70 except Policy mean score is 75 and from the Z-score indicates that the individual company's compliances did not differ from each other.

Ethical consideration:

Ethical consideration has been given with clearance reference letter UPM/FPSK/PADS/T7-MJKEtikaPer/F01(JKK-Jun(09)09) dated 23 February 2010.

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