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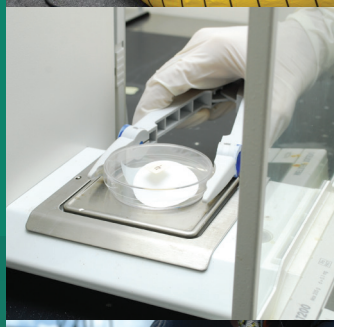

National Institute of Occupational Safety and Health (NIOSH)
Ministry of Human Resources Malaysia

Journal of Occupational Safety and Health

The Journal

- Aims to serve as a forum for 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.

Hj. Zahrim Bin Osman
Editor-in-chief

June 2016, vol 13, No. 1 : 1-10

Prevalence And Factors Associated With Low Back Pain Among Tea Plantation Workers In Cameron Highlands, Malaysia

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Abstract: *A cross sectional study was conducted among tea plantation workers in Cameron Highlands from July to December 2006 to study the prevalence of low back pain and factors associated with it. One hundred and six tea plantation field workers participated in the study. Data was collected using self-administered questionnaire. Time motion studies were also conducted for 3 different job categories. The prevalence of back pain experienced throughout their work in the plantation was 81.1% and the prevalence of low back pain experienced in the past 12 months was 64.2%. Feeling the need to work as fast as possible was a significant predictor of low back pain and increased the risk by 3.5 times, therefore it is suggested that both the management and workers give serious attention to this particular aspect to reduce the incidence of low back pain.*

Keywords: *Low back pain, plantation workers, postures, manual handling, tea plantation, Malaysia.*

Introduction

Low back pain is one of the most common health problems faced by working adults. It can affect workers of all age groups and is most prevalent between the ages of 35 to 55 years. It was estimated that about 60 to 80% will experience low back pain at any time in their life[1]. It can be acute, recur many times or become chronic. Low back pain includes pain that occurs between the lowest rib bones and the gluteal folds and that can radiate toward the thighs and below the knees.

Many studies in the past have found the association between low back pain and factors such as working environment, exposure to physical hazards[2]; ergonomic hazards such as awkward posture, forceful activities[3] and psychosocial factors such as low job satisfaction and poor work control[4,5]. Many workers who are suffering from low back pain usually continue to do their same job and use the same techniques. This causes the pain to recur and results in prolonged sick leave and condition becoming chronic.

Low back pain is an important health problem because it involves workers of all age and in all industries. With the findings of associated risk factors from previous studies, many recommendations have been put forward to manage low back pain such as specific health education, regular exercise to keep fit and healthy, back exercise, achieve ideal body weight and to reduce personal and work stress. The introduction and implementation of good work practice in manual materials handling and ergonomic approaches are also important in managing low back pain.

Despite the high prevalence of low back pain, there are very few studies on low back pain among plantation workers in Malaysia. No study has been done among tea plantation workers. This study was conducted to study the prevalence of low back pain and associated factors among tea plantation workers.

Materials and methods

A cross sectional study was conducted at a tea plantation in Cameron Highlands, Pahang. The study sample included all tea leaves pluckers and field workers in this tea plantation which were 128 workers. The sample population were permanent workers who had been working for at least 12 months in this plantation. Consent to be included in the study was obtained from the respondents. A pre-tested self administered questionnaire in Bahasa Malaysia was used to collect information. Respondents were grouped together (about 10 to 20 people per group) in selected halls or office rooms. Translators among senior workers were provided for those who were illiterate or did not understand Bahasa Malaysia. Completed questionnaires were collected at the end of every session.

The questionnaires included sections on respondents' personal data (sociodemographic data, smoking habit, occupational history), back pain and also physical (posture, working environment, manual materials handling) and psychosocial factors. Low back pain was assessed using the modified Nordic Musculoskeletal Questionnaire (only low back pain questionnaire were included in this study, neck and shoulder questionnaire were omitted). This questionnaire has been widely used to study musculoskeletal problems. A similar questionnaire was used by Nizam J.[6] in his study of back pain and associated factors among oil palm plantation workers in

Selangor. The operational definition for low back pain used in this study was low back pain experienced in the past 12 months in this tea plantation.

Time motion study was also conducted on 15 randomly selected workers performing 3 different job activities (5 workers for each activity). This includes activities in tea leaf plucking using machine, tea leaf plucking using shear and weighing of tea leaves.

Data was analyzed using Statistical Package for Social Sciences (SPSS) version 12.0. Bivariate analysis (chi-square and independent t-test) and multivariate analysis (logistic regression) were used to study the association of low back pain with individual, physical and psychosocial factors.

Results

There were 128 tea leaf pluckers and field workers in this tea plantation. However only 106 workers met the study selection criteria, twenty two workers were excluded because the period of work for 9 of them was less than 12 months and the other 13 were part time workers. The mean age for the workers was 37.6 ± 6.9 years. All tea leaf pluckers and field workers were male (100.0%). The majority of the workers were Nepalese (59.4%) and the majority had received primary school education (47.2%). The mean monthly salary was RM 653.60 ± 134.70 (Table 1). There were more workers plucking leaves using machines (68.9%) than those plucking leaves using shears (31.1%). The median work duration in this tea plantation was 4 years.

The prevalence of back pain experienced throughout their work in the plantation was 81.1%, whereas the prevalence of low back pain in the past 12 months was 64.2% (Table 2). Characteristics of low back pain that occurred in the last 12 months were studied in detail. The majority of the cases suffered between 1 to 5 episodes of low back pain (54.4%), low back pain was localized in nature in 72% of them, 50% did not require any treatment and 95.6% did not need medical leave (Table 3). It was also noted that none of the workers had to change their work due to low back pain.

Bivariate analysis (chi square and independent t-test) showed significant association between these factors with low back pain in the last 12 months: ethnicity, educational level, category of work, frequency (low or high) of bending forward, body twisting, bending sideways, duration (short or long) of standing, walking and exposure to whole body vibration, heaviest weight carried, frequently need to work fast and failure to get support and help from colleagues and employer. After adjusting for possible confounders by the multivariate analysis, frequently feel the need to work as fast as possible was the only predictor increasing the risk of low back pain by 3.5 times (Table 4).

From time motion analysis, walking (34.9%), standing (27.3%) and bending forward (24.6%) were the main postures adopted during plucking tea leaves using machine. While standing (32.8%), bending forward (32.2%) and walking (20.4%) were the main postures adopted during plucking tea leaves using shear. During weighing activity bending forward (42.3%) and standing (41.3%) were the main postures adopted by the workers (Table 5).

Discussion

The results of this study showed a high prevalence of low back pain among tea plantation workers, which was 64.2% in the last 12 months duration. A study by Nizam J.[6] among oil palm plantation workers in Selangor showed prevalence rate of 82.6%. The prevalence found in this study is also consistent with study by Muruka[7] among tea plantation workers in Kenya which showed the prevalence of low back pain of 64.0%. In other industries, a study by Muhamad[8] among taxi driver showed prevalence rate of 67.9% and a study by Ahmad Munir[9] among international airport cargo handlers showed prevalence rate of 75.0% and a study by Abherhame[10] among semiconductor workers showed prevalence of 28.5%. However it is difficult to compare the results with these studies due to various differences in the type of industry, task involved, existing risk factors and methodological differences[11].

The high prevalence of low back pain among tea plantation workers in this study could be associated with their daily work activities that exposed them to many ergonomic risk factors such as awkward body postures, force required to perform tasks, lack of rest, frequent body movement and frequent manual materials handling[12]. High exposure to physical activities can cause lower back muscle, ligaments and adjacent area to sustain compression. This is especially true for those workers because they have to carry a big sack containing tea leaves weighing 50kg or more every day. Findings from this study also revealed low back pain commonly occurred among those in the younger age group (37.5 ± 6.8). However it was not statistically significant. This is inconsistent with many studies in the past which showed a higher prevalence of low back pain in the older age group. One explanation for this is that the majority of the employees in this study are foreign workers employed on contract basis. Once their contract expired, they are sent back to their country of origin and employer will hire a new batch of young group of workers. This may have affected the findings of this study.

Even though the prevalence of low back pain was high, this study showed that the medical sick leave recorded among the workers was low. In the past 12 months only 1 respondent took medical sick leave for more than 3 days due to his low back pain. This is consistent with the finding from a study by Holmberg et al.[13] which showed that farm workers in Sweden were less

likely to take medical sick leave or seek treatment when compared to workers from other industries, this is also true for those self employed persons. The reason for this could be due to daily payment scheme, all field workers in this plantation were paid according to the weight of tea leaves they plucked everyday, thus if they do not work they would get less. Therefore there was tendency for workers to continue working and avoid taking medical sick leave although they may have been sick.

Lower level of education was significantly associated with low back pain. This study showed a higher prevalence of back pain (75.0%) among respondents who had never received any formal education compared to respondents who attended school (56.9%). This is consistent with the finding from a study by Nachemson and Jonsson11. Ethnicity was another individual factors that was significantly associated with low back pain. Chi square analysis for Indian ethnic against others showed significant association with p value less than 0.05. However small sample size may have affected this finding as only 6 Indonesian, 18 Bangladeshi and 19 Indians participated in this study.

Time motion study showed that in all 3 job categories (plucking tea leave using machines, plucking tea leave using shears and weighing tea leaves), bending forward was the main posture adopted while performing their tasks. Bending forward was found to be associated with low back pain in previous studies[14]. Awkward posture is known to be a risk factor for low back pain since this will increase the compression on the spine, particularly at the lumbar segment[15]. Adopting asymmetrical posture, causes unequal pressure by the muscle action adjacent to the spine resulting in increase of disc prolapse[16]. This study also showed significant association between exposures to whole body vibration and low back pain with a prevalence of 78.8%. This is consistent with many studies in the past[17,18].

Field workers in this plantation are frequently exposed to manual materials handling. It is important for them to handle big, heavy sacks of tea leaves correctly. Many studies have demonstrated the importance of correct manual materials handling to prevent low back pain[19.20]. This is because by adopting the correct technique the weight will be distributed to the pelvic and thigh muscle and not to the lower back area and this usually prevents low back pain. This study showed that respondents suffering from low back pain carried heavier weight ie. 52.6 kg as compared to 49.5 kg among non-sufferers and this is statistically significant with $p < 0.05$. Higher prevalence of low back pain was also seen among respondents who handle heavy sacks on their own (67.9%), who think sacks were too heavy (65.5%), who think sacks were difficult to handle (68.9%) and used wrong techniques to transfer heavy sacks (66.3%). However statistical analysis did not show significant association for these factors ($p>0.05$).

Studies in the past have shown an association between low back pain and psychosocial factors such as low job satisfaction, low social support from colleagues, and from employer[13,17,21,22]. This study showed higher prevalence among respondents who frequently felt the need to work fast (77.4%); frequently failed to get support from colleagues (90.5%) and frequently failed to get support from employer (90.0%). Statistical analysis showed significant associations ($p<0.05$) between low back pain and these three psychosocial factors. On further analysis by multivariate logistic regression to control the possible effect of other confounders, this study showed that the psychosocial factor frequently feeling the need to work fast was a significant predictor increasing the risk of low back pain by 3.5 times.

This study has a few important limitations. Language barrier was one of the aspects that could interfere with the results since the majority of respondents were from Nepal. This was minimized by providing Nepalese translators from senior workers or from the administration unit who were able to communicate in Bahasa Malaysia. This however might have influenced the answers provided by the respondents. No gender comparison could be made since there were no female field workers in this tea plantation. Further study is suggested with a larger sample size and reviewing respondents' medical record and performing physical examination and/or objective measurements to improve the validity of the results.

Conclusion

The results of this study showed a high prevalence of low back pain among tea plantation workers. This could be due to their daily work activities that exposed them to ergonomic risk factors involving frequent manual material handling. Frequently feeling the need to work as fast as possible was a significant predictor of low back pain and this increased the risk by 3.5 times, therefore it is suggested that both the management and workers give serious attention to this particular aspect to reduce the incidence of low back pain.

Acknowledgement

We would like to thank Hospital and Medical Faculty, Universiti Kebangsaan Malaysia for providing financial support for this research.

Table 1: Sociodemographic characteristics of the study population

	Frequency	**% or Mean ± S.D**
Age (years)		37.6 ± 6.9
Sex		
Male	106	100.0%
Ethnic		
Bangladesh	19	17.9%
Indian	18	17.0%
Nepalese	63	59.4%
Indonesian	6	5.7%
Education		
Nil	41	38.7%
Primary school	50	47.2%
Lower secondary	10	9.4%
Upper secondary	5	4.7%
Monthly Salary		653.60 ± 134.70
Total	106	100.0%

S.D = Standard Deviation

Table 2: Prevalence of back pain and low back pain among respondents

	Frequency (%)	**Percentage (%)**
Having back pain throughout working experience	86/106	81.1%
Upper back	57/86	66.3%
Middle back	58/86	67.4%
Lower back	68/86	79.1%
Having low back pain in the last 12 months	68/106	64.2%

Table 3: Characteristics of low back pain among respondents

	Frequency (%)	Percentage (%)
Back pain episodes		
1-5 times	37	54.4
> 5 times	31	45.6
Pain character		
Localized pain	49	72.0
Referred pain above knee	11	16.2
Referred pain below knee	3	4.4
Nervous system involvement	5	7.4
Type of treatment		
No treatment	34	50.0
Traditional treatment	23	33.8
Medicine without prescription	7	10.3
Treated by doctor in clinic	4	5.9
Admitted to hospital	0	0.0
Medical leave (days)		
0	65	95.6
1- 3	2	2.9
> 3	1	1.5
Had to change work due to low back pain		
No	68	100.0
Total	68	100.0

Table 4. Multivariate analysis on factors associated with low back pain

	ß	OR (95%CI)	p
Individual Factors			
Ethnic	0.55	1.7 (0.5 - 5.5)	0.352
Education level	-0.58	0.6 (0.2 - 1.8)	0.332
Job category	0.22	1.2 (0.7 - 20.9)	0.880
Duration working	-0.04	0.9 (0.8 - 1.0)	0.375
Physical Factors			
Twisting	-0.50	0.6 (0.0 - 8.3)	0.708
Heaviest weight carried	0.02	1.0 (0.9 - 1.1)	0.746
Psychosocial factors			
Need to work fast	1.26	3.5 (1.0 - 12.2)	0.047*
Constant	-0.55	0.6	0.835

*Significant at $p<0.05$

Table 5: Time Motion Study

	Percentage of time in adopted postures (%)					
	Bending forward	Bending sideways	Twisting	Standing	Walking	Sitting
Pluck using machines	24.6	5.5	5.3	27.3	34.9	2.4
Pluck using shears	32.2	8.9	4.3	32.8	20.4	1.4
Weighing tea leaves	42.3	1.8	2.1	41.3	3.3	9.2

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Musculoskeletal Symptoms Among Employees In A Shared Service Center In Kuala Lumpur

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Abstract: *Computer work is common at shared service centres and employees are exposed to risk of musculoskeletal symptoms. Although employees at this service centre had already been advised to complete an ergonomics self assessment using a checklist and consult an occupational health doctor if symptomatic, almost half participants responded they were either unaware or unsure of the company's ergonomics self assessment checklist and all did not mention consulting an occupational health doctor if symptomatic.Most participants had at least one musculoskeletal symptom. The main location of musculoskeletal symptom reported was shoulder, neck and lower back. This was consistent with main location of musculoskeletal symptoms reported due to work which were shoulder, neck and lower back. Most of the musculoskeletal symptoms affected wellbeing at work and almost half were at least moderately severe. The incorrect posture often observed were: upper arm not close to body, shoulder not relaxed and hand not in-line with forearm.. The musculoskeletal symptoms reported were consistent with observation of incorrect posture. There is an urgent need to enhance the effectiveness of the ergonomics program at this service centre.*

Keywords: *ergonomics,musculoskeletal symptoms, shared service centre*

Introduction

Currently there are more than 340 foreign and multinational companies that have set up shared services and outsourcing centres in Malaysia, providing a wide range of services including: business process outsourcing, transactional back-office support services (human resource, finance and accounting), customer related services such as marketing or contact centre, information technology outsourcing and knowledge process outsourcing. (Shared Service Week Asia 2015).

In a shared service centre most employees spend most of their time at a computer workstation, where ergonomics (OSHA 2015) is the main hazard. Studies have shown that computer use is associated with musculoskeletal pain (Andersen *et al.* 2011). Musculoskeletal pain among computer users are commonly at the neck, upper extremity and lower back (Moom *et al.* 2015, Sartang & Habibi 2015, Wu *et al.* 2012).

This study was conducted in a shared service centre in Kuala Lumpur,which had 572 employees during the study period. Thirty two percent of the employees were male and sixty eight percent were female. The average age of employees was 32.

In this shared service centre, a company office ergonomics successful practice which contained a self assessment checklist and guidance on working comfortably at workstation (attachment1) had already been developed. All employees were encouraged to conduct a self assessment using the checklist and advised to consult an occupational health doctor if they had musculoskeletal symptoms likely to be due to work. This was communicated by e-mail about one and a half years before this study was conducted.

Through this study we would like to identify how common are musculoskeletal symptoms among employees, employees' work practices and their awareness of exisiting office ergonomics measures at their workplace.

Methodology

Quota sampling was used whereby each department at the service centre was requested to nominate 20% of their employees (non-randomly) to participate in the study. The researchers developed a self administered study questionnaire for the participants to fill in on the day of assessment. It included questions relating to the awareness of the company's Ergonomics Workstation Self-assessment Checklist, musculoskeletal symptoms according to body sites, perception of work-relatedness of symptoms and perceived effects of the symptoms on the wellbeing at work.The questions on musculoskeletal symptoms were adapted from Nordic questionnaire (Kuorinka *et al.* 1987). In this study, musculoskeletal symptoms were defined as musculoskeletal pain or stiffness or discomfort or numbness or weakness experienced on the day of assessment for the past one month and focused only on seven body parts, i.e. shoulder, neck, upper back, lower back, wrist, elbow and finger .

A work posture observation checklist was also developed based on the company's Ergonomics Workstation Self-assessment Checklist. This observation checklist was used to assess the posture of each participant while they were working at their own computer workstations. The assessor was the company industrial hygienist with more than 10 years' experience in ergonomics.

The Cronbach's alpha for questions on musculoskeletal symptoms was 0.80, which demonstrated good reliability. Data was analyzed using an excel spreadsheet and Statistical Package for Social Sciences (SPSS) version 21.0.

Results

Participant profile

The majority of the participants were from the finance services department (57.3%). Twenty one (26%) of the participants were male and sixty one (74%) of participants were female. The average age of participant was 31.6 ± 6.2 years and average height was 163.2 ± 8.3 cm.

Awareness of Company Ergonomics Checklist

Fourty three (52.4%) participants were aware of the company's Ergonomics Workstation Self-assessment Checklist,. eighteen (22.0%) were unware and twenty one (25.6%) were unsure.

Musculoskeletal Symptoms

- *Number of body sites with symptoms*

Sixty one participants (74.4%) had complaint of musculoskeletal symptoms in at least one body site. Twenty five participants (30.5%) had one body symptom, twenty nine (35.4%) had two to three body symptoms and seven had (8.5%) had four or more symptoms.

- *Body part with symptoms*

The most commonly reported body part with symptoms (in descending order) were shoulder (58.5%), neck (51.2%), lower back (42.7%), upper back (30.5%), elbow (20.7%), wrist (20.7%) and finger (11.0%) (table 1).

- *Body part with symptom perceived due to work*

The most commonly reported body part with symptoms perceived due to work in descending order were shoulder (41), neck (26), lower back (23), upper back (15), wrist (9), elbow (7) and finger (4) (table 2).

- *Affect on well-being*

Fourty six participants (75.4%) felt that the symptoms were affecting their wellbeing at work and fifteen (24.6%) were either not affected or unsure.

- *Severity of impact to well-being*

Twenty three participants (37.7%) were moderately affected and seven (11.5%) were severely affected by the symptoms (table 3).

Whom to consult

Thirty eight participants (46.3%) stated they would consult a doctor, general practitioner or family doctor if they had symptoms which they suspected were due to work.The other responses and number of participants were: no answer-thirty two (39.0%), not sure–two(2.4%), don't know–one(1.2%), facility management–three(3.7%), manager–2(2.4%), self rest-1(1.2%), environment health and safety-1(1.2%), physiotherapy-1(1.2%) and colleague-1 (1.2%) (table 4).No participant stated that if they ever had body

Table 1: Body part with symptoms

Body Part	Yes	No	Unsure	Total
Shoulder	48 (58.5%)	31 (37.8%)	3 (3.7%)	82 (100%)
Neck	42 (51.2%)	37 (45.1%)	3 (3.7%)	82 (100%)
Lower back	35 (42.7%)	46 (56.1%)	1 (1.2%)	82 (100%)
Upper back	25 (30.5%)	52 (63.4%)	5 (6.1%)	82 (100%)
Wrist	17 (20.7%)	61 (74.4%)	4 (4.9%)	82 (100%)
Elbow	17 (20.7%)	63 (76.8%)	2 (2.4%)	82 (100%)
Finger	9 (11.0%)	71 (86.6%)	2 (2.4%)	82 (100%)

Table 2: Body part with symptoms perceived due to work

Body Part	Yes	No	Total
Shoulder	41 (85%)	7(15%)	48 (100%)
Neck	26 (62%)	16 (38%)	42 (100%)
Lower back	23 (66%)	12 (34%)	35 (100%)
Upper back	15 (60%)	10 (40%)	25 (100%)
Wrist	9 (53%)	8 (47%)	17 (100%)
Elbow	7 (41%)	10 (59%)	17 (100%)
Finger	4 (44%)	5 (56%)	9 (100%)

Table 3: Impact of symptoms on well-being

Not at all	Slight	Moderate	Severe	Very severe	Unsure	Total
10 (16.4%)	18 (29.5%)	23 (37.7%)	7 (11.5%)	0 (0%)	3 (4.9%)	61 (100%)

Table 4: Whom to consult

Responses	Number	Percentage
Doctor, general practitioner or family doctor	38	46.3 %
No answer	32	39.0 %
Facility Management	3	3.7 %
Not sure, don't know	3	3.7 %
Manager	2	2.4 %
Self-rest	1	1.2 %
Environment, Health and Safety	1	1.2 %
Physiotherapy	1	1.2 %
Colleague	1	1.2 %

symptoms which they suspected were due to work, they would consult an occupational health doctor.

Work practice observed

Observation of the work practice revealed that the most common poor posture of participants was upper arm not close to body (89%). This was followed by shoulder not relaxed (84.1%), hand not in-line with forearm (61.0%), hand not in natural position on keyboard (45.1%) and elbow not bent at 90-100 degree angle (43.9%) (table 5).

Discussion

In this study, participation rate of 88% is better when compared to the average response rate of 52.7% from 1,607 organizational studies (Baruch & Holtom 2008). The studied sample was comparable to the targeted population pertaining to gender ($\chi 2=1.38$; $p=0.240$) and age ($t=0.24$; $p=0.839$). The average age of participants was 31.60 ± 6.11 years old. Nevertheless, a slightly higher proportion of females (74%) participated in this study compared to the proportion of females in the company (68%). The average height of participants was 163.2

Table 5: Work practice observed

Observation	No	Yes	Total
1. Are upper arms close to body?	73 (89.0%)	9 (11.0%)	82 (100%)
2. Are shoulders relaxed?	69 (84.1%)	13 (15.9%)	82 (100%)
3. Are hands in line with forearms?	50 (61.0%)	32 (39.0%)	82 (100%)
4. Are hands in natural position on keyboard	37 (45.1%)	45 (54.9%)	82 (100%)
5. Are elbows bent at around 90-110 degrees angle?	36 (43.9%)	46 (56.1%)	82 (100%)
6. Is lower back and hips fully supported?	31 (37.8%)	51 (62.2%)	82 (100%)
7. Is there some space between back of knees and front of seat?	31 (37.8%)	51 (62.2%)	82 (100%)
8. Are forearms parallel to the floor?	22 (26.8%)	60 (73.2%)	82 (100%)
9. Is head held upright?	19 (23.2%)	63 (76.8%)	82 (100%)
10. Are feet resting flat on the floor?	18 (22.0%)	64 (78.0%)	82 (100%)
11. Are knees bent at about 90 degrees angle?	16 (19.5%)	66 (80.5%)	82 (100%)
12. Is the top of screen slightly below eye level	9 (11.0%)	73 (89.0%)	82 (100%)
13. Is the monitor in front at an arms-length?	7 (8.5%)	75 (91.5%)	82 (100%)

cm which was higher than the mean height of overall Malaysian citizens (aged 15 to 80 years old) at 156.5 cm (Mohamad *et al.*, 2010). Height is an anthropometric dimension which corresponds to the vertical distance from the floor to the top of the individual's head, while standing erect and looking straight. Nevertheless, it is not as useful in assessing ergonomic mismatch among office workers whose work postures comprise mainly of sitting. For such posture, other body dimensions such as popliteal height, buttock-popliteal length, knee rest height, elbow rest height are more commonly used to acertain the compatibility between the furniture of the workstation and the body dimensions (Aminian & Romli 2012; Nazif *et al.* 2011; Odunaiya *et al.* 2014; Yusoff *et al.* 2016).

Most participants (74.4%) had at least one musculoskeletal symptom. The main location of musculoskeletal symptom reported was shoulder (58.5%), neck (51.2%) and lower back (42.7%). This was consistent with main location of musculoskeletal symptoms reported due to work: shoulder (82.0%), neck (62.0%) and lower back (66.0%). Previous studies on musculoskeletal symptoms among workers involved in computer work showed both neck and shoulder were the most common body sites affected (Eltayeb et al. 2007, Gerr et al. 2002, Ranasinghe et al. 2012, Sartang & Habibi 2015, Wu et al. 2012). About one-third to more than half of the workers reported having neck or shoulder symptoms. Another body site that seemed frequently affected was the back. Most of these studies showed that the prevalence of low back pain among computer workers were slightly lower than those of neck or shoulder symptoms. Nevertheless in a study by Moom and colleagues (2015), they found that the prevalence of low back pain was higher than both neck and shoulder pain.

In this study, most of the musculoskeletal symptoms affected wellbeing at work (75.4%) and almost half (49.2%) were at least moderately severe. A study done among computer users showed that pain severity had a moderate negative correlation with work ability (Madeleine et al. 2013).Nevertheless, other factors such as job stress, gender and other psychological factors may also affect work (Sell *et al.* 2014).

Poor work postures were common in this company. It was found that majority of the participants in this survey had poor work posture involving the upper extremity especially the shoulder where nearly 90% of them work with shoulder abducted or not relaxed. Non-neutral posture of the shoulder (flexion and abduction) are known to be associated with musculoskeletal symptoms in the neck and upper extremity (Wahlstrom J. 2005). A field study of neck and shoulder postures among computer workers had shown that those having symptoms in those regions had more non-neutral position

of the shoulders (protracted acromion) while working (Szeto *et al.* 2002). Based on the findings, intervention is needed to reduce the risk of musculoskeletal symptoms in the upper extremity.

Although this organisation had already advised their employees to complete an ergonomics self assessment and consult an Occupational Health Doctor if they had musculoskeletal symptoms, the awareness among employees was poor. Almost half (46.3%) of participants stated that they would consult a doctor, a general practitioner or family doctor if they suspected the symptom was due to work. Although this response could be considered acceptable an occupational health doctor is still the best person to investigate and manage symptoms that are suspected to be due to work. In spite of all company employees being informed about this one and a half years ago, none of the participants were able to state that this would be the correct action. This indicates that the related communication was ineffective and hence needs to be enhanced.

There is an urgent need to introduce a comprehensive and effective ergonomics program in this service centre. The NIOSH recommendations can be used as a guide to enhance the company ergonomics program. NIOSH recommends seven steps which are looking for signs of work related musculoskeletal problems, setting the stage for action, training-building in-house expertise, gathering and examining evidence of musculoskeletal symptoms, developing controls, health care management and proactive ergonomics (Cohen *et al.* 1997). To ensure effectiveness of the program communication needs to be enhanced. Among the measures to be considered to enhance communication would be clearer messages, better communication channels and media and more frequent communication.

Conclusion

Musculoskeletal symptoms are common among employees in this shared service centre. Many employees were unaware of the company ergonomics assessment tool, demonstrated poor ergonomics at work and none stated that they needed to consult an occupational health doctor if they had symptoms suspected due to work. There is an urgent need to increase the effectiveness of the ergonomics program in this service centre.

Attachment 1: Recommendations for working comfortably at workstation

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Musculoskeletal Symptoms Risk Factors and Postural Risk Analysis of Pineapple Plantation Workers in Johor

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Abstract: *Pineapple plantation workers are exposed to strenuous physical activities. This study aims to determine the prevalence of musculoskeletal symptoms (MSS), analyse the body postural risks related to work tasks and identify relevant MSS risk factors among pineapple plantation workers. This was a cross-sectional study performed at a pineapple plantation in Johor in 2016. MSS, information on socio-demographic background and occupational history were collected via structured questionnaires. Identification and risk assessment of ergonomic hazard and postural risk analysis were performed for a subset of workers. Data were entered into statistical software and analyse according to relevant objectives. A total of 108 workers participated in this study. The prevalence of MSS was 87.0% and was highest for the lower back (64.8%). In terms of ergonomic hazards, Harvesting were categorised as a task with the highest risk. Harvesting was also the task with the highest postural risk. From the multivariate analysis, lower back pain is mainly contributed by a working tenure of 10 to 25 years (Odds Ratio, OR: 3.90; 95% Confidence Interval, CI 1.05-14.4) and more than 25 years (OR: 7.45 (95% CI 1.26 to 44.0). Workers who worked more than 7-hour daily have a higher risk for reporting lower back pain. Pineapple plantation workers are exposed to excessive bending, twisting and carrying of heavy loads that may be linked to MSS. Effective preventive strategies are required to address MSS in this population in order to minimize risk for subsequent musculoskeletal disorders.*

Keywords: *Rapid Entire Body Assessment (REBA), Musculoskeletal Disorder (MSD), pineapple plantation workers*

Introduction

Work in the agriculture sector is physically strenuous and farm workers are particularly at risk for developing symptoms of musculoskeletal disorder (MSD) compared to other sectors. MSD have been consistently shown as one of the most common health problem of all non-fatal occupational injuries and illnesses for agricultural workers in the world, especially those who are involved in labour-intensive practices (McCurdy *et al.*, 2003; Meyers *et al.*, 2004; Villarejo & Baron, 1998). In terms of the volume of production, the Malaysian Pineapple Industrial Board (MPIB) has reported that Malaysia is one of the world major producers for pineapples along with Thailand, Philippines, Indonesia, Hawaii, Ivory Coast, Kenya, Brazil, Taiwan, Australia, India and South Africa (MPIB, 2012).

Work in pineapple plantations is labour-intensive. Because pineapple tree is a short-rotation crop that grows low on the ground at the maximum height of 1.5 meter, workers are therefore required to bend their body in positions which are defined as awkward posture at many job task such cultivating, weeding, harvesting and land preparation which could lead to muscle pain and the feeling discomfort (Mohd Tamrin & Aumran, 2014). Furthermore, work in pineapple plantations in Malaysia still depends solely on manual tools. As such, workers are exposed to ergonomic risk factors such as excessive bending, twisting, and carrying loads on a continuous basis. MSD have been showed to be linked with higher production costs due to absence of workers, insurance and medical cost (Kirkhorn *et al.*, 2010). The Social Security Organization (SOCSO, 2012) in Malaysia reported that MSD cases due to occupational causes have continuously increased year by year. Even though this information did not specifically represent the pineapple plantation workers, it does generally gives an overview of the current upward trend of MSDs among Malaysian workers presumably among those in working in manual jobs.

Malaysia is on its course to be one of the main exporters of pineapple products in the world. According to the Star Online, Malaysia has previously signed an agreement to export large scales of pineapple products amounting to 2,000 tonnes weekly to China starting early 2015 (Star Online, 2015). This clearly indicates that income from pineapple production and export contributes to the economy in Malaysia, and there is need to ensure that the sector continues to grow not at the expense of the health of workers.

Except for the data on the distribution of MSD and related ergonomic risks (Mohd Tamrin and Aumran, 2014) in this specific agricultural sector, there is a lack of study emphasising on the body postural risk analysis and the risk factors of musculoskeletal symptoms (MSS). The present study was designed to determine the prevalence of MSS and its risk factors among pineapple plantation workers in Johor, Malaysia. Besides, this study aims to also evaluate the specific postural risks for MSS that arise from the specific job tasks associated with pineapple plantation. The identification of the magnitude of the problem could lead to the accurate estimation of disease burden to the individual, family, organizational

or even at the national level. Furthermore, data from this study can help to contribute ideas in developing effective working tools that can be used to increase productivity and reduce MSD.

Methodology

This cross-sectional study was performed between the months of January to May 2016 and this study was conducted in one pineapple plantation at a district in Johor, Malaysia. The sampling location was selected because the activity of pineapple cultivation vigorously takes place here and the plantation is one of the largest plantations in the district. This study obtained the ethical approval of the Institutional Ethics Review Board of Universiti Putra Malaysia. Permission to conduct the study was obtained from the management of the pineapple plantation.

For this study, a total of 130 males who meets the inclusion criteria such as aged between 18 to 60 years, of Malaysian nationality and works full-time at the pineapple plantation were invited to take part in this study. No workers reported a history of chronic disease diagnosis such as rheumatism. Unlike the common practice in other plantations, each of the workers performed one specific job task of namely i) harvesting, ii) cultivating, iii) manual weeding, iv) fertilizing (hand broadcast), v) land preparing or vi) pesticide spraying. The workers were selected using simple random sampling methods.

Study instrumentations

This study employs several instrumentations as research tools. The tools used are self-administrated questionnaire, hazard identification and risk assessment form together with its matrices and an ergonomic assessment tool for postural risks.

The questionnaire used in this study were adapted and modified from the Nordic Musculoskeletal Symptoms questionnaire by Kourinka *et al.* (1987). The structured questionnaires were presented in the Malay language and included items on socio-demographic background, smoking information, MSS and other diseases, information of previous employment and accident history. The MSS was used to assess at different body parts for the past 12 months was assessed using Nordic questionnaire. The symptoms assessed included the neck, upper shoulder and lower back areas, elbows, hand/wrists, waist/thighs, knees and ankle/legs regions. Additionally, the questionnaire also asks about obstruction in performing daily tasks and MSS experienced due to job tasks. Apart from that, physical measurements of height and weight of the workers were performed using SECA Body Meter and Tanita Weighing Scale in order to calculate the body mass index (BMI).

Ergonomic Hazard Identification and Risk Assessment

Identification and risk assessment for ergonomic hazard were performed using the semi-quantitative methods of Hazard Identification, Risk Assessment and Risk Control (HIRARC) made available by the Department of Occupational Safety and Health (DOSH) (2008). The job tasks which were assessed includes 1) land preparation, 2) cultivation, 3) manual weeding, 4) harvesting, 5) fertilizing and 6) the spraying of pesticides. The outcome of this assessment was the identification of the risk levels (either high, medium or low) of the tasks

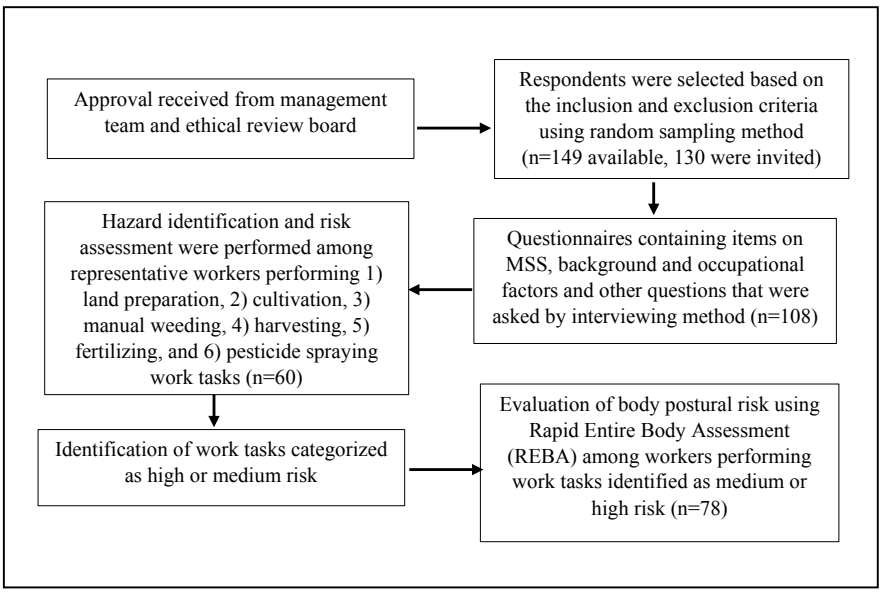

Figure 1: Flow diagram for data collection process

performed by the workers. This exercise was performed for a subset of 60 workers.

Rapid Entire Body Assessment (REBA)

The Rapid Entire Body Assessment (REBA) (Highnett and McAtamney, 2000) was performed to evaluate the whole body postural risks associated with job tasks performed. The evaluations of risk were done based on video recorded while workers were performing their work tasks. The risk levels were determined based on the obtained scores. Data were entered into Windows Excel spread sheet and were analysed using REBA software developed by Cornell University Ergonomics Web (CUErgo) (2015). The assessment was performed for 78 workers for the tasks identified as high or medium risk from the step where identification and risk assessment for ergonomic hazards were performed.

Quality control

To ensure the validity of the questionnaire, a pre-test was performed prior to the actual data collection. The questionnaire was administrated to 10% of the intended total number of sample size among agricultural workers at the Taman Pertanian Universiti, Universiti Putra Malaysia that were similar in socio-demographic characteristics with the intended respondents of this study. Ambiguous terms identified from the pre-test were amended in order to ensure respondents understand the questionnaire. A reliability test was also performed in which the alpha Cronbach was 0.85. Figure 1 presents the flow of data collection process.

Result

The response rate of this study was 83.1% (n=108). All respondents were Malaysian male with an average

Table 1: Distribution of socio-demographic characteristics and occupational information of respondents (N=108)

Variables		**N (%)**	**Mean±SD**
Age (Years)	*< 37*	24 (22.2)	43.0±7.4
	37-44	32 (29.6)	
	> 44	52 (48.1)	
Ethnicity	*Malay*	106 (98.1)	
	Chinese	2 (1.9)	
BMI	*Underweight*	3 (2.8)	23.8±3.4
	Normal	69 (63.9)	
	Overweight	31 (28.7)	
	Obese	5 (4.6)	
Marital Status	*Single*	6 (5.6)	
	Married	102 (94.4)	
Education Level	*Primary*	43 (39.8)	
	Secondary	63 (58.3)	
	College	2 (1.9)	
Smoking	*Yes*	45 (41.7)	
	No	63 (58.3)	
Work task	*Cultivating*	27 (25.0)	
	Weeding	17 (15.7)	
	Fertilizer	12 (11.1)	
	Harvesting	21 (19.4)	
	Pesticide spraying	18 (16.7)	
Years of working (Years)	*<10*	25 (23.1)	
	10-25	57 (52.8)	
	>25	26 (24.1)	
Working hour at plantation (per day)	*<6*	5 (4.6)	
	6-7	77 (71.3)	
	>7	26 (24.1)	
Previous employment	*Yes*	47 (43.5)	
	No	61 (56.5)	
Years of working at previous workplace (Years)	*<3*	12 (11.1)	
	3-8	35 (32.4)	

N = frequency; SD = standard deviation

Table 2: Distribution of one-year MSS prevalence among the pineapple plantation workers

Variables		N=108	
		Frequency	**Percent (%)**
Overall MSS		94	87.0
Symptoms at body part	*Only one body part*	8	7.4
	2-5 body parts	87	80.6
Lower back		70	64.8
Feet/ankle		58	53.7
Knee		57	52.8
Shoulder		41	38.0
Wrist		22	20.4
Neck		14	13.0
Hips/thigh		12	11.1
Upper back		10	9.3

N = frequency

(mean±standard deviation) age of 43.0±7.4 years old. The workers had an average BMI of 23.8±3.4. Almost all of the respondents (94.4%) were married and more than half of the respondents received education up to secondary level (58.3%). Less than half of the respondents reported a history of current smoking (41.7%) and 56.6% of the respondents were physically active during the times outside work.

The respondents in the pineapple plantation worked in several sections such as land preparation (12%), cultivation (25%), manual weeding (15.7%), fertilizer (11.1%), harvesting (19.1%) and pesticide spraying (16.7%). Overall the respondents had worked in the pineapple plantation for and average 17.2±9.2 years. Majority of them worked for six to seven hours per day (71.3%) and a quarter of them worked for more than 7 hours per day. About 43.5% of the respondents had previous employments in various sectors before working in the pineapple plantation and one-fifth of them had previously worked at agricultural sector. None of the respondents reported any history of work accident history at previous workplace. The information on socio-demographic background and occupational history of the respondents are presented in Table 1.

Prevalence of Musculoskeletal symptoms (MSS)

The overall prevalence of MSS was 87.0 %. Approximately 80% of the workers complained of MSS in 2 to 5 parts of the body. The most affected body part was lower back (64.8%), feet and ankle (53.7%), and knee (52.8%). The prevalence of MSS among the respondents are tabulated in Table 2.

Ergonomic Hazard Identification and Risk assessment

Tasks involving land preparation work scored a risk rating of 6, which is categorized as medium risk in the HIRARC guidelines provided by DOSH (2008). Similarly, task involving cultivation work scored a risk rating of 8 (medium). Manual weeding were categorised as medium. The task scored a risk rating of 10. Harvesting work was categorized as high risk. Other tasks such as manual fertilizing and pesticide spraying were indicated as low risk. The details of the risk assessment are shown in Table 3.

Evaluation body postural risk based on work task in pineapple plantation

From the outcome of the risk assessment, four specific work tasks which includes 1) land preparation, 2) cultivation, 3) manual weeding and 4) harvesting in the pineapple plantation was evaluated. Rapid Entire Body assessment (REBA) was done among 78 workers in the pineapple plantation. The results showed that the postural risks fall into medium, high and very high risk which corresponds to REBA score range of 4 to 7, 8 to 10 and more than 10 respectively. The results of postural body risks distributions among the workers are shown in the Table 4.

MSS risk factors

The three most prevalent MSS were included in bivariate analysis; namely symptoms on the lower back, ankle/feet and knee region. The results of association between MSS with occupational and non-occupational risk factors are shown in Table 5.

The risk factors for MSS in Table 5 which include age, years of working at plantation and working hours at plantation were further analysed using logistic regression analysis to identify its link with reported MSS. The results shown that pineapple plantation workers who reported a working tenure of 10 to 25 years experienced more MSS at lower back area (Odd ratio, OR: 3.90

Table 3: Hazard identification and risk assessment of work tasks in pineapple plantation

HAZARD IDENTIFICATION				RISK ANALYSIS		
No	**Activity**	**Hazard**	**Effect**	**Likelihood**	**Severity**	**Risk**
1	**Land preparation**	**Make small holes in depths of 10 – 15 cm using a dibble.** • Forward bending of trunk 10° – 20° • Repetitively hand motion in making hole more 20 times per minute • Working on soft ground (peat soil)	Excess fatigue Lower back pain Repetitive strain injuries Knee and feet pain	3	2	6 (medium)
2	**Cultivation**	**Planting young sucker of pineapple into holes on the ground** • Constant bending of trunk more than 60° along working hours (more than 4 hour per day) • Deviation and twisting of wrist from neutral position repetitively (more than 20 times per minute) • Working on soft ground (peat soil)	Low back pain Fatigue Repetitive strain injuries Knee and feet pain	4	2	8 (medium)
3	**Fertilizer (hand broadcast)**	**Sprinkle fertilizer manually with hand** • Repetitive motion of hand (more than 20 times per minutes) • Working on soft ground (peat soil)	Low back pain fatigue Shoulder pain Knee and feet pain	2	2	4 (Low)
4	**Weed control**	**Manually remove weed with hands** • Prolong standing and bending alternately of trunk more than 60° along working hours (more than 4 hour per day) • Deviation and twisting of wrist from neutral position repetitively • (more than 20 times per minute) • Working on the soft ground (peat soil)	Low back pain Fatigue Knee and tight pain	5	2	10 (medium)
5	**Harvesting**	**Collecting pineapple using knapsack basket at the back** • Carry heavy load during working hours (50 to 70 kilogram per session), total 500-600 kg in a day • Forceful exertions of shoulder, arm, wrist, and trunk. • Moderately flexion of trunk according to load (20°-60°) • Excessive bending during unloading the pineapple to the ground (more than 60°) • Deviation and twisting of wrist from neutral position repetitively (more than 20 times per minute) • Working on soft ground (peat soil)	Low back pain and knee pain excess fatigue shoulder pain and lower back pain Repetitive strain injuries Knee and feet pain	5	4	20 (high)
6	**Pesticide spraying**	**Manually spraying of pesticide using knapsack sprayer** • Carrying load at the back along working hours (20 kilogram) • Repetitive hand flexion and extension (more than 20 times per minutes) • Working on soft ground (peat soil)	Shoulder pain Lower back pain Repetitive strain injury	2	2	4 (Low)

(95% Confidence Interval, CI 1.05 to 14.4) compared to workers that worked for less than 10 years. For workers that worked for more than 25 years, the odds of reporting lower back pain increased by almost double (OR: 7.45 (95% CI 1.26 to 44.0) compared to the former. Workers who had working hours of less than 6 hours has an OR of 0.34 (95% CI 0.02 to 0.55) and were less likely to experience lower back MSS. Moreover, workers that worked between 6 to 7 hours per day were less likely to experience MSS at the lower back (OR: 0.21 (95% CI 0.58 to 0.79) compared to workers that worked more hours than that. Table 6 shows the outcome of logistic regression analysis to determine the predictor of MSS.

Discussion

The prevalence of MSS in this study was high and was comparable with other agricultural studies reported in Malaysia and India (Ng *et al.*, 2014; Vasanth *et al.*, 2015). Evidence have shown that farmers were exposed to various dangerous situations like excessive bending, twisting, kneeling carrying load, squatting, static and awkward stoop postures, repetitive and monotonous work which contributes to various MSDs (Gupta, 2013). Working in extreme and awkward posture causes workers to have more exertion that which ultimately leads to overusing and tiredness of muscle (Razak, 2014). High MSS prevalence reflects a high burden of disease in the

Table 4: The distribution of postural body risks among pineapple plantation workers (N = 78)

		Postural body risk (REBA Scores)		
Work task[t]	**Frequency (n)**	**Medium risk (4-7) (%)**	**High risk (8-10) (%)**	**Very high risk (>10) (%)**
Land preparation	13	0	38.5	61.5
Cultivation	27	11.1	85.2	3.7
Weeding	17	17.6	58.8	23.5
Harvesting	21	0	23.8	76.2

For Negligible (REBA score of 1) and Low (REBA score of 2-3) risk, N=0

[t] Four work tasks were chosen for this analysis from the outcome of risk assessment (medium risk category)

agricultural sector and this have repercussions such as the direct and indirect impact on financial costs apart from work performance (Piedrahitaet *et al.*, 2004).

Similar to other studies (Ng *et al.*, 2014; Gupta, 2013), MSS at the lower back (64.8%) was most prevalent among workers. Many tasks performed in the pineapple plantations involved ergonomic risks on the low back area, as such it is difficult to identify which tasks contribute most towards this specific MSS. Most strenuous tasks may likely arise from heavy lifting of loads especially which occurs during harvesting process as identified from this study. The low back pain may also be linked with excessive bending during the cultivation of shoots and manual weeding process as these tasks are performed using manual tools.

Reported MSS at the feet and ankle was the second highest prevalence of symptoms (53.7%). Among harvesters in oil palm plantations, the prevalence was less than half that reported in this study (Ng *et al.*, 2014).In the present study, pineapple trees were planted on peat soil that causes the workers to work on unstable base of land. Upon further investigation, the workers had also verbally reported that unstable base of land causes them to easily fall and sustain injuries. The risk of slipping, tripping and falling while working on uneven field have been reported to contribute to MSS among farmers (Gupta, 2013). The work tasks like harvesting of pineapples demand high physical exertion, as it requires workers to walk and collect pineapples and placing the fruits into the basket knapsack on their back until the basket is full. Harvesting process also exerts higher forces on the feet and ankle area due to walking with heavy load on soft peat soil.

MSS at the knee region were the third highest prevalence of MSS reported (52.8%). Again, this prevalence is higher than the study by Ng *et al.* (2014), which reported a prevalence of 44%, and Gupta (2013), which reported a prevalence of 39%. In the pineapple plantation, the workers complained of pain at the knee region when doing job tasks such as harvesting, weeding and cultivation.

Awkward posture was found in almost all the working process performed by workers in the pineapple plantation. In the outcome of the REBA exercise, the scores indicated that actions are needed for improvement. According to Hignett and McAtamney (2000), for work activities that fall into high postural risks, immediate investigation and implementation of changes is needed in their work tasks, while for very high postural risk, change must be implemented immediately without any investigation. The present study indicated that harvesting and land preparation are work tasks that needed implementation of immediate changes. This can be explained by the nature of these job tasks that required workers to work in awkward postures during large percentage of time. Besides, these two work tasks also need workers to deal with manual tool that are used repetitively by the same muscle groups and joints during working hours. Repetitive movements with awkward postures involving same joints and muscle groups moving in the same motion very often and quickly for long duration of time have been shown to cause physical injuries (Ghasemkhani *et al.*, 2006).

The reporting of MSS were significantly linked with longer working tenure. The majority of the workers in the pineapple plantation had working tenures of more than 10 years and up to 35 years that indicate low job turnover. These workers are indigenous to the areas of study; as such they were more likely to stay at their current job in spite of the exerting work. Due to manual handling tasks, workers are exposed to various physical

Table 5: Association between MSS with occupational and non-occupational risk factors among respondents

Variables		Lower back[m]			Feet/ankle[m]			Knee[m]		
		No	Yes	χ^2	No	Yes	χ^2	No	Yes	χ^2
		% (N)	% (N)		%	%		%	%	
Work task in pineapple plantation	*Land preparation*	5.3 (2)	15.7 (11)	10.77	12.0 (6)	12.1 (7)	7.11	7.8 (4)	15.8 (9)	9.99
	Cultivating	28.9 (11)	22.9 (16)		26.0 (13)	24.1 (14)		33.3 (17)	17.5 (10)	
	Weeding	13.2 (5)	17.1 (12)		12.0 (6)	19.0 (11)		11.8 (6)	19.3 (11)	
	Fertilizer	13.2(5)	10 (7)		16.0 (8)	6.9 (4)		13.7 (7)	8.8 (5)	
	Harvesting	10.5 (4)	24.3 (17)		12.0 (6)	25.9 (15)		11.8 (6)	26.3 (15)	
	Pesticide spraying	28.9 (11)	10 (7)		22.0 (11)	12.1 (7)		21.6 (11)	12.3 (7)	
Years of working at plantation (Years)	*<10*	42.1 (16)	12.9 (9)	12.04*	34.0 (17)	13.8 (8)	15.21	33.3 (17)	14.0 (8)	5.73
	10 – 25	42.1 (16)	58.6 (41)		58.0 (29)	48.3 (28)		47.1 (24)	57.9 (33)	
	>25	15.8 (6)	28.6 (20)		8.0 (4)	37.9 (22)		19.6 (10)	28.1 (16)	
Working hours at plantation (Hour)	*<6*	10.5 (4)	1.4 (1)	9.36[1*]	4.0 (2)	5.2 (3)	1.01[1]	7.8 (4)	1.8 (1)	3.95[1]
	6-7	78.9 (30)	57.1 (47)		76.0 (38)	67.2 (39)		74.5 (38)	68.4 (39)	
	>7	10.5 (4)	31.4 (22)		20.0 (10)	27.6 (16)		17.6 (9)	27.8 (17)	
Age (Years)	*<37*	36.8 (14)	14.3 (10)	7.26*	36.0 (18)	10.3 (6)	13.17*	35.3 (18)	10.5 (6)	10.89*
	37 - 44	23.7 (9)	32.9 (23)		32.0 (16)	27.6 (16)		19.6 (10)	38.6 (22)	
	>44	39.5 (15)	52.9 (37)		32.0 (16)	62.1 (36)		45.1 (23)	50.9 (29)	
Smoking	*Yes*	62.9 (44)	37.1 (26)	1.68	42.0 (21)	41.4 (24)	0.00	45.1 (23)	38.6 (22)	0.47
	No	50.0 (19)	50.0 (19)		58.0 (29)	58.6 (34)		54.9 (28)	61.4 (35)	
BMI	*Underweight*	7.9 (3)	0 (0)	7.50[1]	4.0 (2)	1.7 (1)	5.55	5.9 (3)	0 (0)	5.949
	Normal	60.5 (23)	65.7 (46)		72.0 (36)	56.9 (33)		58.8 (30)	68.4 (39)	
	Overweight	23.7 (9)	31.4 (22)		18.0 (9)	37.9 (22)		27.5 (14)	29.8 (17)	
	Obese	7.9 (3)	2.9 (2)		6.0 (3)	3.4 (2)		7.8 (4)	1.8 (1)	

[1]Statistical test-Fisher exact Test *p <0.05
[m] Only three most reported MSS were included in this analysis

Table 6: Logistic regression analysis to determine predictors of low back and feet/ankle MSS

Variables		Low back				Feet/ankle			
		Odds Ratio (OR)	95% Confidence Interval		p-value*	Odds Ratio (OR)	95% Confidence Interval		p-value*
			Lower	Upper			Lower	Upper	
Age (Years)	*<37[a]*	1.00	-	-	-	1.00	-	-	-
	37 - 44	2.12	0.55	8.10	0.27	2.77	0.80	9.64	0.11
	>44	1.49	0.35	6.29	0.59	3.10	0.77	12.6	0.11
Years of working at plantation (Year)	*<10[a]*	1.00				1.00			
	10 – 25	3.90	1.05	14.4	0.04*	1.22	0.37	3.95	0.75
	>25	7.45	1.26	44.0	0.03*	5.69	1.00	32.3	0.05
Working hours at plantation (Hour)	*<6*	0.34	0.02	0.55	0.02*	-	-	-	-
	6-7	0.21	0.58	0.79	0.02*	-	-	-	-
	>7[a]	1.00				-	-	-	-

*Statistically significant when P<0.05 level [a] reference group

activities that gives exertion to their muscle and skeletal system while work were being performed. This finding was supported by a study that found that higher working tenure influenced the occurrence of MSD among shipyard workers (Park *et al.*, 2010). In repetitive work, the same muscle fibres in a body part will be activated which causes tissues to exceed its internal tolerance upon accumulative work that results from exposure to long duration of exertion (Radwin *et al.*, 2001).

Working of more than seven hours per day compared to less was also linked with the reporting of MSS at the lower back. This link occurs despite the fact that workers were given flexibility in terms of working hours by their management. It may likely be that the flexibility was given because unlike oil palm plantations, workers were exposed to harsh environmental conditions such as direct sunlight throughout the cycle of their work. The workers start working early in the morning at 7 am and are allowed to have a break at 11 am. Then, the workers will continue to work from 2 pm to 4.30 pm. In addition, the workers are able to take a rest around 10 to 20 minutes during their working hours and then continue their work thereafter. Upon further analysis, it was found that total working hours varies according to work tasks and the workers work for 6 days in a given week. It may be that the work in the pineapple plantations is strenuous on the lower back when performed long hours (of seven hours or more). As such there is a need for better work time distribution throughout the week because from this study it was indicated that working shorter than seven hours per day was linked with 80% less likelihood to report low back pain.

This study has found that harvesting was the task with the highest risk rating. It involves awkward posture of the trunk area and forceful exertion while performing task using the shoulders, arms, wrists and hands. Generally, there is no standard knapsack basket for pineapple plantation workers used during harvesting process. Different workers have different knapsack basket pattern and some of them modified the basket to increase the loads depending on the ability of their body to carry loads during the collection of fruits. The minimum weight full knapsack basket with fruits was 50 kilograms and if modified the basket can carry up to 70 kilogram per session and this will go on for more than 4 hours in a day to total up to 500 to 600 kg of fruits per day. In this study, the weight of each full-load basket exceeded the National Institute Occupational Safety and Health safe limit for ideal lifting load of 23 kg or 51 lbs (Kamarudin *et al.*, 2013). To make matters worse, the condition of MSS could be worsen during the process of unloading the pineapples onto the ground where workers need to bend their body excessively. Furthermore, the workers verbally reported to be given general task training in addition to being experienced in their job but did not received any specific training in safe manual handling or correct body postures according to their work task.

Non-occupational risk factors did not show any significant association with the reporting of MSS. One of the possible reasons because, in the pineapple plantation studied there are flexible resting breaks for workers. The management did not put any specific schedule for workers to follow and they can take a rest when they are tired and can continue their work later. By doing this, it is likely that age has become a non-predictor of MSS in the studied population. However, other study indicated that increasing age was associated with MSS. A study by Engholm and Holmström (2005) reported that prevalence of MSS was increased strongly by age. The study by Weigel *et al.*, (2014) showed capacity of musculoskeletal farm workers declined as much as 25% between the age of 30 to 65 years with the most rapid period of reduction starting at the age of 45 years old.

This study has some limitation that needs to be considered. The finding was limited to workers of the present pineapple plantation only. The result cannot be generalized to other pineapple plantations in Malaysia. In addition, this was a cross-sectional study in design where the association between risk factors and MSS at a particular point in time could be determined. However, a cause and effect relationship of MSS could not be recognized. No causality can be demonstrated since both the dependent and independent variables are being measured at the same time.

Conclusion

This study concluded that pineapple plantation workers are exposed to excessive bending, twisting and carrying of heavy loads that may be linked to MSS. Body postural risk for selected work tasks in pineapple plantations requires improvements to help reduce ergonomic risk and the subsequent musculoskeletal problems. As a recommendation, there is need for innovative methods to be in place to reduce ergonomic risks such as a development of modified basket for harvesters which will prevent excessive bending of more than 60° during the unloading of pineapple onto the ground. Besides, administrative controls such as training focusing on ergonomic risks are also needed. This can be essential to help workers to perform their work in a safe and healthy method. It is also recommended that future research provide medical data on MSD to be included to support the self-reported MSS data.

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Air Velocity Flow Analysis Of Local Exhaust Ventilation (LEV)

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Abstract: *Local Exhaust Ventilation (LEV) is required to absorbed the chemical and at the same time to maintain the air quality. This study is purposed to create new design of LEV system that believe can remove air contaminants in the chemical store buildings. This research was conducted using two (2) types of LEV system which are 4 air-inlets LEV (type 1) and 3 air-inlets LEV (type 2). That LEV has been simulated using ANSYS FLUENT software for their air flow performances. LEV material and the cost of production were considered parameter for fabricating and effectiveness of LEV system. Results show that air velocity in LEV type 1 was gradually uniform throughout its ducting network but it increased at the 90° bend section with a maximum air velocity of 31.054 m/s. In the LEV type 2, the air flow simulations depicted uniformity velocity values of 8.12 m/s, 8.58 m/s and 7.69 m/s at every inlet respectively. The finding suggests that LEV type 2 was more efficient compared to LEV type 1 due to increasing streamline air velocity.*

Keywords: *Local Exhaust Ventilation (LEV), Indoor Air Quality (IAQ), ANSYS, FLUENT and air velocity*

Introduction

Indoor air quality (IAQ) is considered an important aspect of safety and health when designing a building (Wang, 2006) as the majority of the human population is spending more time indoors. Nowadays, ventilation system which divided into two categories which is general (dilution) and LEV system. The principal ventilation system is replacement of air system in the duct or dilution. In laboratory building for safety and health requirements, it should be completed by LEV system (DOSH, 2008). The main purposed of the LEV system is to remove the contaminant from our activities in the building in order to achieve healthy air in the building (ACGIH, 2007). There are many function of LEV such as controlling high toxic contaminant, handling dusts, and small amount of makeup air due to other amount of air was exhausted (Cena and Peters, 2011).

The effectiveness of LEV system in removing the contaminants is depending on the several factors such as design, usage and maintenance of the systems (Chen et al., 2011). Usage and maintenance of LEV system has been published as standard safety. However, the LEV design is still challenging to explore because it consist of exhaust hood, fan, ducting and the exhaust outlet (air cleaner) (Figure 1). Flowrate of the air which performed to the LEV system is depending on the contaminants types such listed in the Table 1. That contaminant is produced by material and equipment which used in the laboratory. However, there are 3 major contaminants which observed in lab scale such as vapor, gases, smoke, fume and fine dry dust.

The main problem of the LEV systems is located on the LEV hood which mismatch with the process and source which is caused by exposure factor (Carlo et al., 2010). Therefore, new design is approached to improve the effectiveness of the LEV systems. It simulated as first action of investigation in order to measure the heat and air flow distribution on the LEV system.

Methodology

A fabricated LEV system is designed for chemical store application due to most of the laboratory in the university conduct the process which related to the chemical material. This LEV is designed using ANSYS software with selected LEV material which listed in the Table 2.

Material Selection

In the field of mechanical engineering, the selection of material is a tedious task because there are number of factors that have to carefully evaluate before making the final decision. Mechanical, thermal, environmental, electrical, and chemical properties are the factors that must consider by the materials which depending on the application. Besides that, there are 3 factors which must be considered in material selection process such as lifetime of the field, competitive advantages and cost and design flexibility.

Cost Estimation Analysis

Cost analysis (also called economic evaluation, cost allocation, efficiency assessment, cost benefit analysis,

Table 1: The General Duct Velocities (ACGIH, 2007)

Type of contaminant	Examples	Duct velocity
Vapour, Gases	Gases and non-condensing vapours	5–10 m/s
Smoke, fume	Welding	10 m/s
Fine dry dust	Wood dust, lint	12.5m/s
Dry dusts and powders	Fine rubber dust, cotton dust, light shavings	15 m/s
Average industrial dust	Grinding dust, wood shavings, asbestos, silica,	20 m/s
Heavy dusts	clay, brick cutting	25 m/s

or cost-effectiveness analysis by different authors) is controversial set of method in program evaluation because these terms cover a wide range of method, but are often used interchangeably.

At the most basic level, cost allocation is simply part of good program budgeting and accounting practice, which allows managers to determine the true cost of providing a given unit of service. In this project the cost analysis is very important due to various materials/ equipment that use for fabrication process.

The selected materials for duct and hoods were PVC pipe due to the air flow and materials properties. PVC is cheaper compare galvanize steel is quite expensive and the cost evaluation is performing to reduce the cost of development. Detail of design of centrifugal motor and LEV system in the building is shown in Figure 2, Figure 3 and Figure 4.

It caused by that building issued a lot of fume, vapor, fine dust, chemical powder and heavy dust contaminants. Therefore, that chemical store building should be install with designed LEV system in order to create healthy work environment.

Results and Discussions

The flow analysis is based on two different types of LEV system named as type 1 and type 2. AIR FLOW simulation was used as tools for simulate the flow behavior in ducting system. The value of velocity chooses randomly by using the Guidelines on Occupational Safety and Health for design, Inspection, Testing and examination of LEV standard for defining the volumetric flow rate.

Velocity distribution at each inlet and outlet in LEV system type 1 shows in Figure 5 and Table 3. Variety

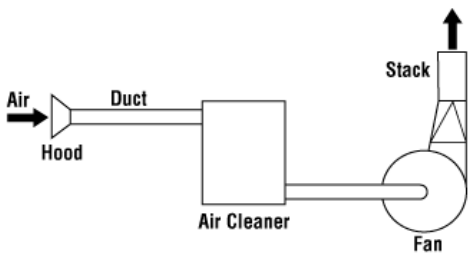

Figure 1: The Basic Components of a LEV System (Miller, 2010)

Design and Characteristic of New LEV

Design and characteristic of new LEV were emphasize which is run to simulate the performance of hood designs as it is found to be an important component of a LEV system and to ensure optimum air flow distribution. Two (2) types of LEV were designed by modifying the hood's bend angle and its material. LEV type 1 has 4 hoods which adjusted by 90° from the duct and LEV type 2 has 3 hoods which adjusted by 60° and 45°. Each LEV system type has own characteristic in air velocity streamline using selected material. The design of LEV system can be installed in building with activities that emit high concentration of volatile organic compounds such as chemical store buildings.

of air velocity was calculated at different inlet and outlet which maximum velocity was found at inlet (ii) with 21.52 m/s. In the other situation, the air velocity was gradually uniform in whole ducting network but suddenly increase in the part of 90° bend section with maximum air velocity of 31.054 m/s was recorded. Some reduction of air streamline was defined in some part of ducting area considered as stagnant or blocking air. The phenomena probably as the key factor on decreasing the efficiency of the LEV system.

The same situation of velocity increased in the bend section has been shown in Figure 6 and Table 4 for design type 2 with reduction of maximum velocity of 27.187 m/s. The results of the air flow simulations shows the

Table 2: Specific Materials and Parts

No.	Component	Function
i.	Ducts	PVC pipe
ii.	Fans	Plastic fan; Mechanical device for moving air or other gases.
iii.	Hoods	PVC pipe; Downdraft Hoods
vi.	Air Filter	Fabric Filter. Flow resistance increase with dust build-up

uniformity of velocity value with 8.12 m/s, 8.58 m/s and 7.69 m/s on each inlet respectively compare to design type 1. The blocking air was found at some part of the ducting area but the reduction of bend angle on design type 2 resulted to be more efficient by increasing the velocity streamline.

Conclusion

Two LEV systems have been designed to simulate air velocity performances using ANSYS FLUENT software in order to improve building occupants' safety and health. LEV type 1 shows non-uniform air velocity as compared to LEV type 2. The latter system showed a more uniform air velocity due to non 90° bend angles designed for each hoods. Smaller bend angle will produce more uniform air velocity which led to air velocity increment like presented by LEV type 2. Therefore, it can be recommended that LEV system type 2 to be used in building with high concentration of VOCs as measures to encourage healthy IAQ for workers and occupants.

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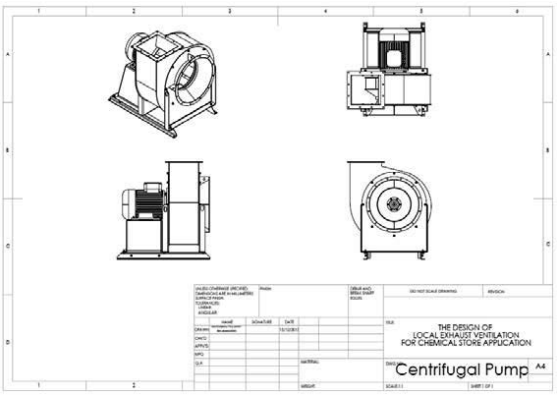

Figure 2: Design of centrifugal motor

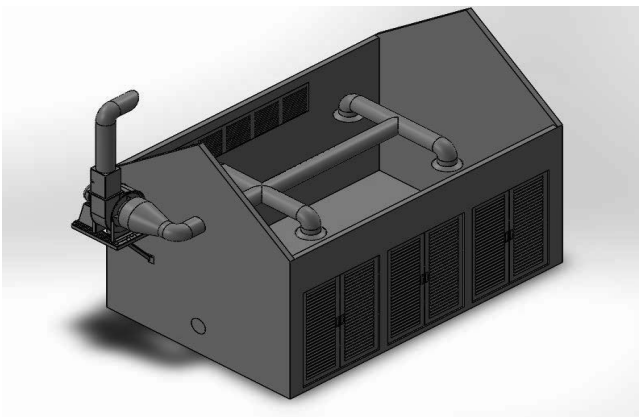

Figure 3: Design of LEV system type 1 in the selected building

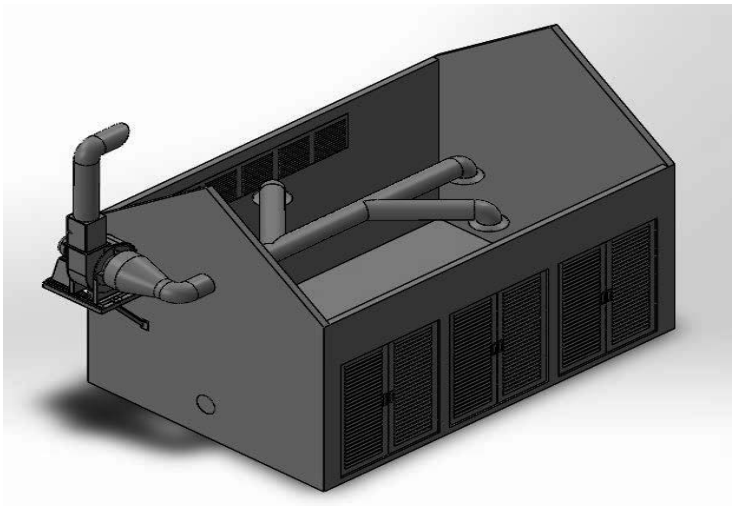

Figure 4: Design of LEV system type 2 in the selected building

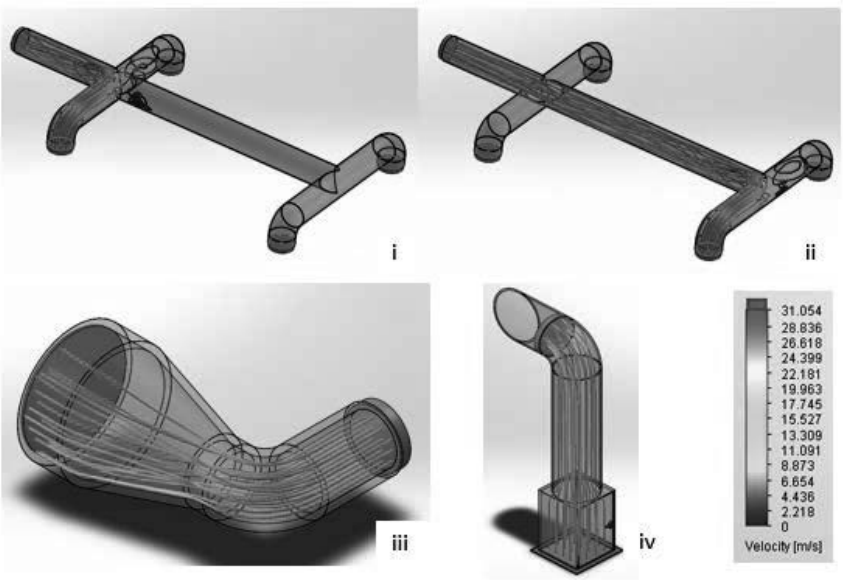

Figure 5: Air flow streamline in (i) inlet a (ii) inlet b (iii) inlet c and iv) outlet for type 1

Table 3: The result of Velocity Type 1

Volume flow	Velocity (m/s)
Inlet (i)	9.54 x 2 = 19.59
Inlet (ii)	10.76 x 2 = 21.52
Inlet (iii)	11.86
Outlet (iv)	10.41
Total average velocity	15.85

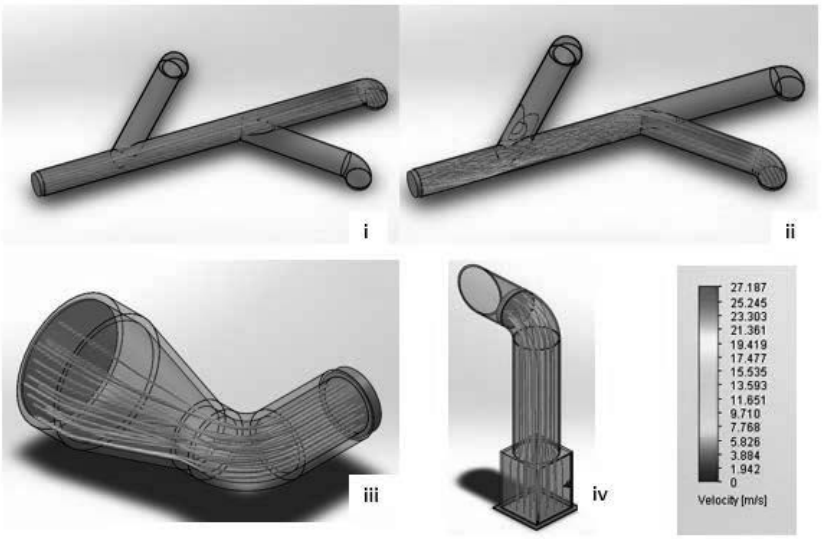

Figure 6: Air flow streamline in (i) inlet a (ii) inlet b (iii) inlet c and iv) outlet for type 2

Table 4: The result of Velocity Type 2

Volume flow	Velocity (m/s)
Inlet (a)	8.12
Inlet (b)	8.58
Inlet (c)	7.69
Inlet (d)	11.86
Outlet	10.41
Total average velocity	9.332

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Indoor Air Quality (IAQ) Monitoring In Academic Management Centre

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Abstract: *Concerns toward Indoor Air Quality (IAQ) in office building tend to risen since most people spend their working hours indoors compare to outdoors. Exposure to indoor pollutants is a considerable problem. Therefore, there is a need to monitor IAQ in order to deter further air quality deterioration in the workplace. The objective of this study is to determine the level of IAQ parameter in selected academic office. The important IAQ parameters considered in this study were the air temperature, air velocity, relative humidity, CO^2, CO, TVOC, formaldehyde and respirable particulate matter. Measurements were conducted using commercial IAQ instruments. From the study it was found that the levels of TVOC and respirable particulate matter were higher than the recommended limit during photocopying activities. The formaldehyde, CO^2 and CO level were observed to be acceptable for an office based on Industry code of practice on indoor air quality (ICOP-IAQ 2010). Results shows that the temperature and air velocity are located at acceptable value of 22-25 ºC and 0.1-0.1 m/s. Findings also show high relative humidity that exceeded the requirement level of 40%-70%. Detail investigations are needed in order to provide certain guidance in improvement of IAQ conditions in office environment.*

Keywords: *IAQ, indoor pollutant, workplaces, office building*

Introduction

Concerns toward Indoor Air Quality (IAQ) in office building tend to risen for decades. It very challenging to solve since rapid growth of industry area in Malaysia contributed to the air pollutant (Rahman *et al.*, 2015). Besides that, the way of life and work also play a significant role on the deterioration of IAQ (Ismail, Deros, & Leman, 2010). IAQ monitoring in workplace in Malaysia is very restrictive as compared to other country (Mahbob *et al.*, 2011). It caused by rapid growth of industrial scale and most of the peoples spend 90% of their times at indoor for working and living (Frontczak & Wargocki, 2011). There are many reports available on monitoring IAQ pertaining to office environments (Norhidayah *et al.*, 2013; Wolkoff, 2013; Wong *et al.*, 2009). The studies stated that the activities of occupants, the equipment used, the outdoor environment, and the ventilation system become major factor influences the IAQ (Nazri *et al.*, 2013).

Carbon Dioxide (CO^2), Carbon Monoxide (CO), respirable particulate matter, and VOCs also Total Volatile Organic Compound (TVOC) form as the major group of air pollutant in indoor environment (Aizat *et al.*, 2009; Sun *et al.*, 2015; Wolkoff, 2013). Exposure to those pollutant is considerable problem to environment and have bad effect on human health. Aizat *et al.* (2009) studied regarding IAQ which have some parameters considered are Relative Humidity (RH), temperature, Carbon Dioxide (CO^2), Carbon Monoxide (CO), ventilation rate, TVOC, Particulate Matter (PM) and air velocity. They founded that high CO^2 concentration as major factor contribute to the Sick Building Syndrome (SBS). Norhidayah *et al.* (2013) also reported that SBS is influenced by ventilation and contaminants within the indoor environment. Thus, the maintenance of the IAQ is extremely needed for sustainable and healthy life (Ismaiel, Aroua, & Yusoff, 2013; Yoo *et al.*, 2015). Recently, in Malaysia have a strictly rules of the IAQ for community consumption (Toe & Kubota, 2015). Department of Occupational Safety and Health Malaysia have regulated the indoor air exposure limits in Industry code of practice on indoor air quality (ICOP-IAQ 2010) which listed in Table 1(DOSH, 2010).

There are several methods to maintain the indoor air quality such as by improving ventilation system and proper maintenance of air conditioning system (Ponsoni & Raddi, 2010). Air contaminant distribution in the office building come from many outdoor pollutions and also can be through on air conditioning system. The adjacent with several industry to the office building also contribute their pollutant for every hours (Fernández et al., 2013). Therefore, it very interesting to investigate the effect of the outdoor air quality towards inside air quality. The main objective of this research is to determine level of IAQ parameter in selected office in academic management centre. The researchers also emphasized on the general symptom of SBS among the staff. The study was performed by measuring the air temperature, air velocity, relative humidity and the concentration of five

common IAQ contaminants which is CO^2, CO, TVOC content, formaldehyde and particulate matter using commercial measurement instruments.

Methodology

This research was conducted using direct reading for IAQ, TVOC and particulate matter monitoring activity. This study was performed on selected office in academic management center and it focused on the air conditioning system and occupant activity that contribute to the poor air quality. The number of occupants varied throughout the day and was recorded during each sample.

Building selection

The building as the object of this study is based on the complaint issued by staff who served as print a bulk of document. They have illness or fever immediately after printing process. The academic management centre is located on ground level of low rise-building and the layout of this office is shown in Figure 1. For this study, there are only two areas divided for IAQ monitoring activity which are main office and printing room. The office was equipped with non-central air conditioning system (single split-type) in order to provide thermal comfort as well as for air circulation. The office had two main doors to allow natural ventilation but usually interrupted when doors are closed.

Data collection

Data collection was performed by using the appropriate method and equipment. It was collected within the working hours at 8.00 am to 5.00 pm for 7 days under environmental condition and actual condition. IAQ conditions were monitored by using commercial IAQ measuring equipment which is shown in Figure 2. Equipments were installed in selected room of academic management center such as office room and printing room according to ICOP- IAQ 2010 (DOSH, 2010). The sampling point placed approximately of 2 meter from door and approximately of 1 meter from printer. The sampling probe is located at 75 to 150 cm from the floor.

Results and Discussion

Physical parameter analysis

Figure 3 shows the variations of average relative humidity, air temperature and air velocity in the office with time for 7 days measurement. Based on ICOP-IAQ 2010 stated that the acceptable thermal comfort condition in relation to IAQ which relative humidity (40% - 70%) and air speed (0.15 m/s-0.5 m/s) respectively (DOSH, 2010).

The relative humidity in the office was generally located at above of acceptable ICOP-IAQ standard of 40-70% during the measurement. Even though humidity is not a major concern, long-term high-humidity indoors that is not properly controlled may causes of mould and fungi, thus, increased the breeding of microbial growth (Cheong et al., 2006). During measurement, average indoor air temperature levels detected were within the requirement. The average air velocity during the measurement was found relatively low with minimum average velocity 0.08 m/s was recorded. Low velocity or stagnant air can cause uncomfortable condition and also lead to build-up odour.

Total Volatile Organic Compound (TVOC) and Formaldehyde analysis

Most of the average TVOC level was measured slightly above the allowable limits of 3 ppm based on ICOP-IAQ 2010 (DOSH, 2010). The results of average TVOC monitoring are summarized graphically in Figure 4.

Table 1: List of physical parameter and chemical exposure limits based on ICOP-IAQ 2010 (DOSH, 2010)

Indoor Air Contaminants	**Acceptable Limit**			
	ppm	**mg/m^3**	**°C**	**%**
Contaminant				
a. Carbon Monoxide	10	-	-	-
b. Formaldehyde	0.1	-	-	-
c. Respirable particulates	-	0.15	-	-
d. Total Volatile Organic Compound (TVOC)	3	-	-	-
e. Carbon Dioxide	1000	-	-	-
Temperature	-	-	23 -26	-
Relative Humidity	-	-	-	40 -70

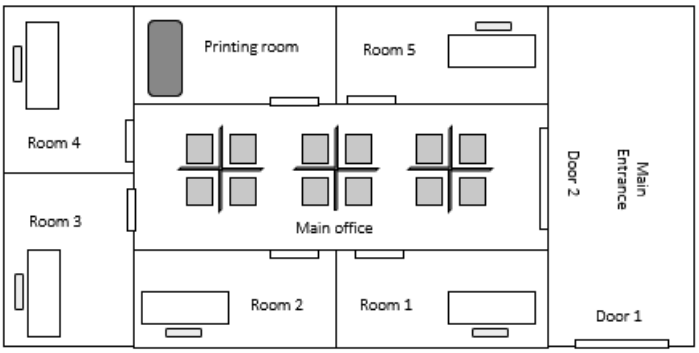

Figure 1: Layout of academic management centre

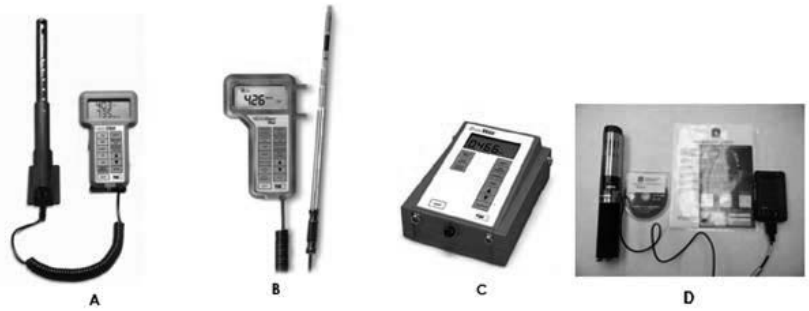

Figure 2: IAQ monitoring equipment

During five day earlier of IAQ measurement process, some of the staff was busy on photocopying a bulk of paper. High TVOC was detected subsequently at the areas of the office. In the process of printing, VOCs was significantly contributed to the environment (Hsu & Huang, 2009). Despite that, indoor air temperature, humidity and other environmental factors also affect the concentration of indoor TVOC (Huang, Xiong, & Zhang, 2015). Detail result of formaldehyde illustrated in Figure 5. Concentration of formaldehyde recorded within the limits by ICOP-IAQ 2010 which is below than 0.1ppm (DOSH, 2010).

Respirable particulate analysis

Respirable particulate is one of the major concerns in indoor environments. The standardization of maximum allowable particulate based on ICOP-IAQ at 0.15 mg/m³ for 8-hours (DOSH, 2010). According to results shown in Figure 6, the variations of average respirable particulate matter tend to be higher for all day of measurement process.

The results suggested that printing activity not only released VOC, but also contribute to the emission of particle. The suspended particles in indoor air can become serious when it exceeds acceptable limits (Vilčeková, Eštoková, & Pilipová, 2013). Air circulation through air-conditioning system did not seem to have significant effects in reducing the indoor air contaminant especially for VOC and respirable particulate matter. Therefore, it may be practical to install an effective techniques on VOC and respirable particulate matter controlled system such as activated carbon filter to diminish the harmful pollutant (Muala *et al.*, 2014; Son *et al.*, 2011).

Carbon dioxide and Carbon monoxide analysis

The variation of average CO^2 levels with day show in Figure 7. The CO^2 levels are show to be maintained below the ceiling limits value of 1000 ppm throughout the time of measurement. Number of occupant and room size could have affected the ability to dilute the CO^2 level however there is no significant association was observed during this study. Based on Figure 8, the maximum average concentration of CO at the day of monitoring in the office was 4.4 ppm below the allowable limits. The results indicated that, the sudden released of pollutant during printing activities and building occupants activities did not seem to be effected the concentration of CO^2 and CO level.

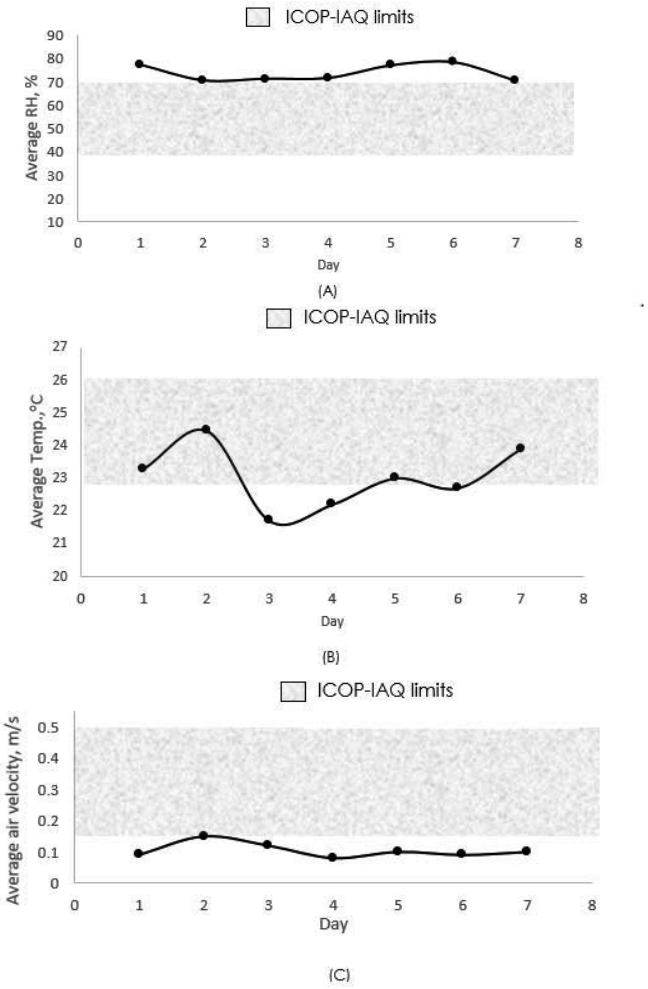

Figure 3: (A) Variation of average relative humidity with day. (B) Variation of average temperature with day. (C) Variation of average air velocity with day.

Conclusion

Studies on IAQ in Academic Management Centre at Higher Education Institutions were successful. Some problems or issues need further attention pertaining IAQ improvement such as:

(1) High TVOC and respirable particulate matter concentration in the office during the photocopying process as a result of insufficient ventilation reflecting the weakness in the air conditioning system as air circulation system of academic offices.

(2) Low air velocity occured during measurement because of insufficient fresh air supply to the academic offices.

(3) Lack of best practice on hygiene and regular maintenance of MVAC systems.

(4) Need further observation of SBS symptoms reported by academic office staff especially during photocopying activities.

Detail investigations are needed in order to provide certain guidance in improvement of IAQ conditions in office environment. The invention of activated carbon used in air cleaning filtration system could promising on dilution of polluted gases especially VOC.

Acknowledgement

The authors would like to thank the Ministry of Higher Education Malaysia, Universiti Tun Hussein Onn Malaysia (UTHM) through the funding supported MTUN-Gallery Showcase Grant Vot No.C059 and Centre for Graduate Studies – UTHM.

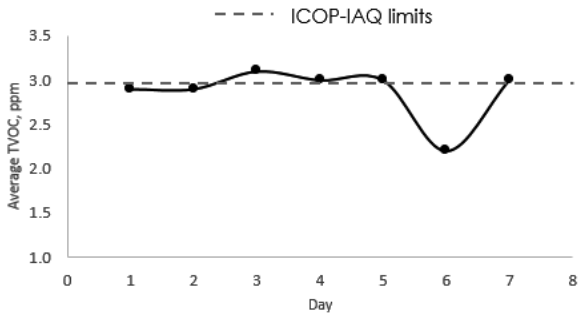

Figure 4: Variation of average TVOC with day

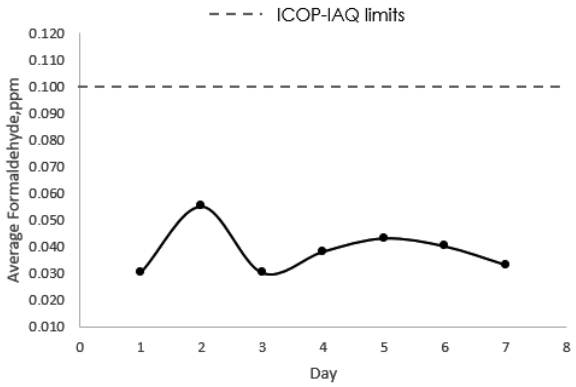

Figure 5: Variation of average formaldehyde with day.

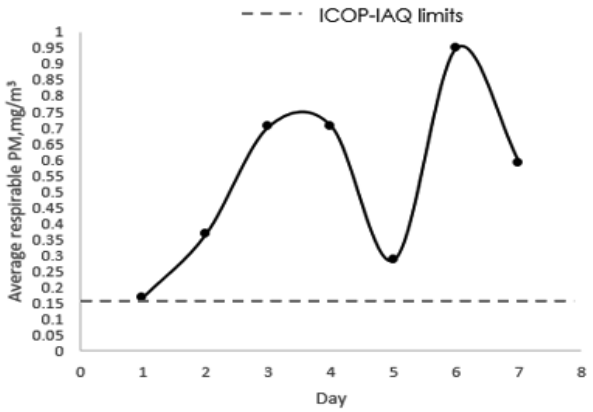

Figure 6: Variation of average respirable particulate matter with day.

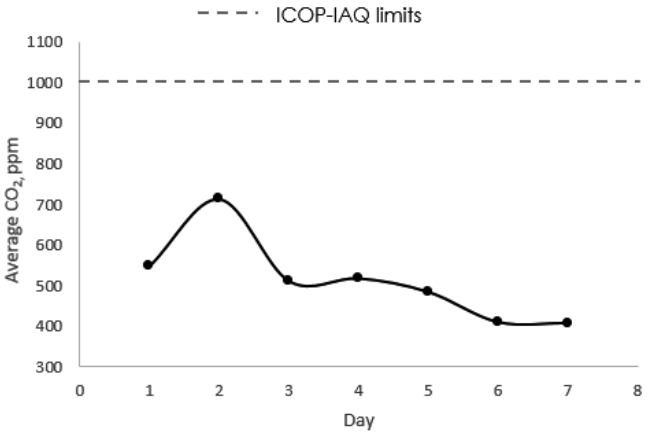

Figure 7: Variation of CO_2 with day.

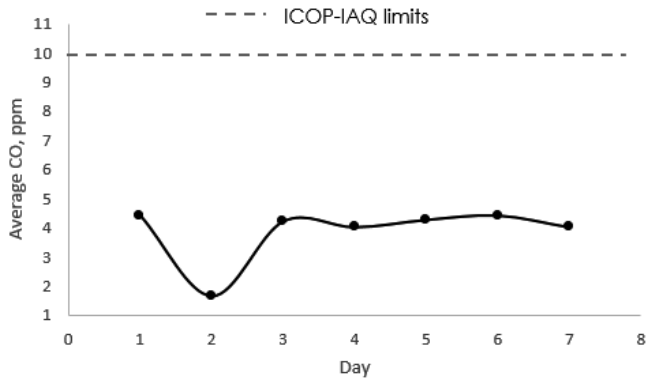

Figure 8: Variation of CO with day.

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Knowledge, Attitude And Practice (KAP) Of Safety And Health Among Students In School

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Abstract: *Students' knowledge, attitude and practice towards safety and health are one of the important aspects of their learning process in school. Negligence of this aspect can increase the risk of accidents among students. This study was conducted to assess the level of knowledge, attitudes and practices (KAP) of students toward safety and health aspects in school. This study was participated by 410 Form Four students that were randomly selected. They are from SMK Sultan Alauddin Riayat Shah 1 (SARS1), SMK Taman Dato' Harun (SMKTDH) and SMK Agama Sheikh Hj. Mohd Said (SHAMS). Questionnaire used consists of demographic components, knowledge, attitude and practice items towards safety and health aspects. Majority of the respondents are female students (58.3%) while the rest are male students (41.7%). Higher percentage of respondents are from SMKTDH (59.5%) followed by SHAMS (24.1%) and SARS1 (16.3%). This study found that the level of knowledge, attitude and practice of students toward safety and health aspects in school are high. The mean score of all knowledge, attitude and practice items in the questionnaire are 4.29±0.40, 4.07±0.46, and 4.13±0.48, respectively. In addition, this study found that the school factors are significantly associated with student's attitude and practice, while the gender factor is only significantly associated with student's attitude towards safety and health in school. Meanwhile, correlation analysis showed a significant relationship between student's knowledge, attitude and practice ($p<0.001$). Student's knowledge, attitude and practice towards safety and health aspect have moderate relationship among each other. Therefore, education on all aspects of safety and health in school should be provided and improved from time to time to enhance student's knowledge, thus improving the attitude and practice of students toward safety and health in school*

Keywords: *Knowledge, attitude, practice, safety and health, students*

Introduction

A study by Breslin and Smith (2005) states that young workers aged from 15 years to 24 years are more risky for injury at work rather than older workers because lack of experience. The methods used to prevent injuries and accidents among young workers are less effective. Study by Pisaniello *et al.* (2013) suggested, one approach to reduce injuries of young workers in the industry is to improve the provision of safety and effectiveness of training programs in schools.

Safety and health's education should be promoted at school level. Students should be made aware of the importance of safety and health aspects. This is because, safety and health is one of the important aspect for the students, especially when they are in school. In order to produce the competent future workforce in safety and health aspects, education of safety and health should be foster to students so that knowledge learned can be practiced in the future.

Thus, the main objective of this study is to assess the level of knowledge, attitude and practice of safety and health among students in school. From this study, we can suggest the area of improvement to enhance students' knowledge, attitude and practice towards of safety and health in school.

Methodology

This cross sectional study was conducted over four months. Data were collected at three schools in SMK Sultan Alauddin Shah Riayat 1 (SARS1), Pagoh, Johor; SMK Taman Dato Harun (SMKTDH), Petaling Jaya, Selangor and SMK Agama Sheikh Hj. Mohd Said (SHAMS), Seremban, Negeri Sembilan. A total of 410 form four students participated in this study.

A questionnaire was used to determine sociodemographic information, knowledge, attitude and practices towards safety and health in schools. This questionnaire consist of four parts. Ten questions for each part for the knowledge, attitude and practices of respondents towards safety and health in schools.The survey questions were analysed for descriptive statistics such as mean, standard deviation and percent. From this questionnaire we can determine the level of knowledge, attitude and practice of safety and health of the students through their mean score.

Pre-testing of questionnaire was conducted in November 2014 involving 30 form four students of SARSI. Pre-test questionnaire study to determine the reliability of Cronbach's alpha 0.789, showed strong consistency for each part of the questionnaire

All the data obtained were analysed using SPSS (Statistical Package for Social Sciences version 20). Chi-square test was performed to determine the association between demographic factors and the level of knowledge, attitude and practice of safety and health in schools. In addition, Pearson correlation test was conducted to examine the relationship between knowledge and attitude level and practical level students about safety and health.

Results

Table 1 shows the socio-demography information of the respondents and their level of knowledge, attitude and practice (KAP) towards safety and health in school. All 410 respondents are form four students. Majority of the respondents are female students (58.3%) and male students (41.7%). Majority of the students participated in this study are from Sekolah Menengah Kebangsaan Taman Dato' Harun (SMKTDH) (59.5%), followed by Sekolah Menengah Kebangsaan Agama Sheikh Hj. Mohd Said (SHAMS) (24.1%) and SekolahMenengah Sultan AlauddinRiayat Shah 1 (SARS1) (16.3%).

The results for mean score's levels of knowledge, attitude and practice among students towards safety and health in schools are 4.29 (SD=0.400), 4.07 (SD=0.464) and 4.13 (SD= 0.483), respectively. Table 1 shows that students of all schools involved in this study have high level of knowledge, attitude and practice towards safety and health in school.

Chi square test showed that there was no significant association between gender and school on the students' level of knowledge of safety and health in schools. However, Chi square test shows that there is a significant association between gender and school factors on the students' attitudes towards safety and health in schools ($p<0.05$; $p = 0.001$). For level of attitude, Chi square test shows only school factors have association with the students' level of practice towards safety and health in schools ($p<0.05$; $p = 0.001$).

Spearman's rho correlation test shows that there is significant relationship between each knowledge, attitude and practice of safety and health (Table 2). There is significant relationship between these three variables ($p<0.001$: $p= 0.001$). The strength of relationship is moderate which all the r values are above 0.4.

Discussion

The mean scores shows that all respondents have high level of knowledge, attitude and practice towards safety and health in schools. A study by Md Zan and Shapie (2014) found that the level of students' knowledge and practice towards workshop safety is high. The study conducted by Sallehuddin (2013) also found that the level of practice among university students in the engineering workshop are high. In addition, a study by Rahman *et al.* (2010) reported that the level of knowledge and practice of students on safety aspects in workshop is high in the workshop.

However, research done by Boon and Kamarudin (2010) showed that the level of knowledge and attitude of students towards safety aspects in *'Kemahiran Hidup'* is moderate. The difference between this study with previous study is this study assesses general aspects of safety and health in school which involve the field, laboratory, classroom, canteen and also workshop.

Based on researcher's observation, the education of safety and health aspects in schools are emphasized through the enforcement of school regulations and campaigns such as warning signs and safety poster. This is because the student awareness towards safety practices must be fostered from the beginning so that positive attitude and practice is always embedded as student's essence so that the quality of work can be improved and working environment is safe (Abu Samah *et al.*, 2014).

Results show that students in all three schools have a high level of attitude towards safety and health in schools. According to Noor and Safirul (2014), attitude plays a key role in safety practices, particularly when in workshops and laboratories. This is because an accident can happen anytime anywhere without being invited. According to Abu Samah *et al.* (2014), negligence attitude towards safety aspects during work can cause threat to themselves as well as colleagues. Yob *et al.* (2014) stated that students have a positive attitude towards safety regulations in practice safety regulations, especially while in the workshop.

This study also found that the level of practices of students in the three schools towards safety and health in schools is at a high level. According to Saleh and Kassim (2002), any practical work mainly in workshops should give priority to security to ensure the safety of individuals while achieving good results. This is because all the work done during the workshop will be constantly exposed to the risk of accidents if ignoring the factor of safety.

The results showed that there is a moderate relationship between knowledge towards attitudes and practice of students. Studies by Abu Bakar *et al.* (2010) also states that knowledge has a strong influence on the work performed. If students have a good knowledge and training, they are able to implement security practices with discipline. He said that the knowledge and training received will be applied during the next session of learning and practice.

Lastly, this study also found that there is a moderate correlation between attitude and practice of students on the aspects of safety and health in schools. This is because the attitude played a major role in safety practices while in the workshop and laboratory (Noor & Safirul 2002).

Table 1: Socio-demography of respondents and their level of knowledge, attitude and practice level towards safety and health in school

Factor	Knowledge Level		χ^2	p value
	Moderate	High		
Gender			13.701	0.001*
Male	7	164		
Female	2	237		
Schools			6.692	0.035*
SARS1	0	67		
SMKTDH	5	239		
SHAMS	4	95		
	Attitude Level		χ^2	**p value**
	Moderate	**High**		
Gender			4.924	0.026*
Male	21	150		
Female	7	232		
Schools			3.098	0.212
SARS1	0	67		
SMKTDH	18	226		
SHAMS	10	89		
	Practice Level		χ^2	**p value**
	Moderate	**High**		
Gender			0.850	0.357
Male	14	157		
Female	14	225		
Schools			6.058	0.048*
SARS1	0	67		
SMKTDH	19	225		
SHAMS	9	90		

*p value <0.05

Table 2: Spearman's rho correlation test relationship between each knowledge, attitude and practice of safety and health in school

Variables		Knowledge	Attitude	Practice
Knowledge	Correlation, *r* p value		0.475 0.001*	0.533 0.001*
Attitude	Correlation, *r* p value	0.475 0.001*		0.759 0.001*
Practice	Correlation, *r* p value	0.533 0.001*	0.759 0.001*	

*p value <0.05

Conclusion

The knowledge, attitude and practice towards safety and health in schools are high among students. However, the study has shown that there is a moderate relationship between students' knowledge, attitude and practice towards safety and health in school. Thus, safety and health education program at school level need to be implemented and improved from time to time. The aim is to create human capital acknowledged with safety and health aspects while in school and in the job market later. The results of this study could be the basis for the initial measurement of the level of knowledge, attitudes and practices among secondary school students.

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

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