



## UPM-SAGE Publications Young Writer's Award 2015 Papers

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## RISK FACTORS OF MUSCULOSKELETAL DISORDERS (MSD) AMONG PALM OIL MILL WORKERS

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### ABSTRACT

The palm oil industry is the fourth largest contributor to the Malaysian Gross National Income (GNI) but the importance of this industry to the nation's economy does not preclude them from the risk of being affected by the occurrence of musculoskeletal disorders (MSD) among the workers in palm oil mills. Previous studies carried out have not properly explained the exact reasons for the occurrence of musculoskeletal disorders (MSD) among the palm oil mill workers. Thus, this study aim to determine the association between risk factors and MSD among palm oil mill workers. A total of 120 male workers were consecutively enrolled in this cross-sectional study. Information on sociodemographic, working, lifestyle, health and injury factors were collected via questionnaire and face-to-face interviews. A high lifetime prevalence of MSD (71.7 percent) among palm oil mill workers was found. However, the one-year prevalence of MSD among the same population was only 50.8 percent. Logistic regression analysis adjusted for age, Body Mass Index (BMI) and smoking revealed that the risk factors: history of previous injury [2.35, 95 percent CI 1.12-4.93], Osteoarthritis [3.9, 95 percent CI 1.568-9.708] and perception of exertion [8.09, 95 percent CI 1.358-48.170] was found to be significantly associated with MSD symptoms reported in the past 12 months. As a conclusion, exposure to the combination of these risk factors may lead to an increased risk of developing MSD among palm oil mill workers.

Keywords: Risk factors, Musculoskeletal disorders, Palm oil mill, Malaysia

## INTRODUCTION

There are several types and sources of oil and fats in the world such as rapeseed oil, sunflower oil, butter, palm oil and many more. For the year 2011, Oil World stated that among all the different types of oil and fats, palm oil was the highest consumed oil, where it was consumed by up to three billion people in 150 different countries. The palm oil industry is the top contributor of Gross Domestic Product (GDP) for the agricultural sector in Malaysia (Department of Statistics, 2012). Malaysia and Indonesia are the world biggest oil palm producers where Malaysia currently accounts for 39 percent of world's palm oil production and 44 percent of world's palm oil exports (Malaysian Palm Oil Council, 2012). Until the year 2013, Malaysia has produced a total of 19,400,000 metric tonnes of palm oil for the consumption of the world. The production of Crude Palm Oil (CPO) in palm oil mills involves a series of steps. Generally, it involves preparation, oil extraction, purification and kernel extraction. Figure 1 summarizes the steps involved in the production of CPO.

In 2012, the palm oil industry is the fourth largest contributor to the Malaysian Gross National Income (GNI). This information, together with the fact that this industry is steadily developing as an important economical contributor for Malaysia, increases the importance of not excluding this industry from the risk of being affected by occurrence MSD among their workers. This can be supported by the fact that MSD is one of the most important causes of occupational injury and disability in the industrially developed and currently developing countries such as Malaysia (Shahnavaz H., 1987; Genaidy A. M. et al., 1993 and Maul A. et al., 2003).

MSD is always known as the most common among all non-fatal injuries and illnesses for agriculture workers, especially those who are involved in labor-intensive practices (McCurdy et al. 2003; Meyers et al., 1997). It is also costly and the most prevalent of all work related injury (Bernard et al., 1997). In the industry, MSD can cause problems

in many forms for the workers and employers such as disability, lost productivity and increase in production costs. MSD increases production costs due to worker absence, insurance premiums and medical costs, decreased work capacity and loss of employees to other less physically demanding industries (Kirkhorn et al., 2010). Thus, this study aims to determine the prevalence of MSD among palm oil mill workers and to assess the risk factors that may contribute to MSD as reported for the past 12 months.

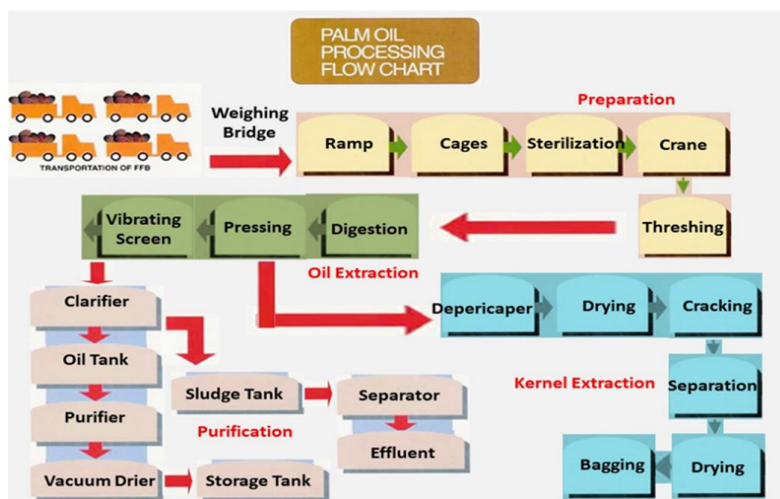


Figure 1: Flow chart of the processes involved in palm oil mill to produce CPO from Fresh Fruit Bunches (Source: Sime Darby Plantation, 2013)

## MATERIALS AND METHODS

### Study background and design

This cross sectional study was carried out among 120 palm oil mill workers in three selected palm oil mills in Malaysia. Specifically, it was located in Negeri Sembilan, Selangor and Perak. The respondents were chosen based on a simple random sampling from eight work sections (Grading Area, Loading Ramp, Sterilizer Area, Press Area, Kernel Plant, Oil Room, Boiler Area and Workshop). The sampling frame was

taken from the workers' name list of the selected palm oil mills where workers from the eight work sections were selected from the name list. Office workers in the palm oil mills were not included in this study. Inclusion criteria involved were workers who have had a working tenure of not less than one year and aged not more than 60 years old.

### Questionnaire

A set of questionnaire was used to achieve part of the objectives of this study. The questionnaire consist of seven parts, which are sociodemographic information such as general personal information such as background, age, education level, height and weight (BMI), working information such as designation, type of job, work duration, working area, and duration of employment, lifestyle information such as smoking and leisure activity, health information such as current health status, treatment and medication, injury information including type of injury and body part affected. The Standardized Nordic Questionnaire and Borg's CR-10 Scale was utilized in this survey. The Standardized Nordic Questionnaire helps in determining the prevalence of MSD and Borg's CR-10 Scale which asked for information related with perception of exertion while performing work tasks (Kuorinka et al.,1987; Borg, 1990).

### Statistical Analysis

All the data obtained were analysed by using the IBM SPSS (Statistical Package for the Social Sciences) version 22. Descriptive analysis was used to determine mean, standard deviation, percentage and frequency. Chi square test was used to determine the association between dependent and independent variables. Meanwhile, logistic regression was used to determine the strength of other associated factors with MSD.

## Ethics Committee Approval

This study was permitted for ethical clearance by the University Ethics Committee for Researches Involving Human of Universiti Putra Malaysia. Permission from respondents who was selected to participate in this study was also obtained via written consents from the respondents before study was conducted. Privacy of information and confidentiality of the respondents are, and will always be protected.

## RESULTS AND DISCUSSION

Personal profile, occupational background, lifestyle and health information of the palm oil mill workers.

All 120 study subjects are Malaysian and Malay male, with a mean age of  $38.44 \pm 11.35$  years old. Their BMI lies at an average of  $24.69 \pm 4.67$ . Majority (81.7 percent) of the respondents received education up to secondary level. Majority (67.5 percent) among them are smokers. About quarter (27.7 percent) of them are currently having Osteoarthritis. 45.8 percent of them have history of previous injury, either originating from their occupation or from other activities from their occupation. These information can be obtained from Table 1.

The palm oil mill workers studied belong to eight work sections, which are Grading Area, Loading Ramp, Sterilizer Area, Press Area, Oil Room, Kernel Plant, Workshop and Boiler Area. Most of them worked in their respective palm oil mills at an average of  $9.5 \pm 10.11$  years. Vast majority (91.7 percent) of them were involved with overtime work where 90.0% of them involved with works with repetitive tasks (Table 1). 67.5 percent of them are smokers. 45 percent of them are physically active and they choose to be involved with sports activities such as football and jogging and also with farming and fishing.

Table 1: Personal profile, occupational background, lifestyle and health information of the palm oil mill workers studied (n = 120)

Variables	Frequency	%	Mean $\pm$ S.D	Median	Range
Age (Years)			38.44 $\pm$ 11.35	41.0	38
<27	32	26.7			
28-37	20	16.7			
38-47	33	27.5			
>47	35	29.3			
Total	120	100.0			
Marital Status					
Single	29	24.2			
Married	90	75.0			
Divorced	1	0.8			
Total	120	100.0			
Body Mass Index (BMI)			24.69 $\pm$ 4.67	24.14	25
Underweight (<18.5)	7	5.8			
Normal (18.5-24.9)	61	50.8			
Overweight (25-29.9)	40	33.3			
Obese ( $\geq$ 30)	12	10.0			
Total	120	100.0			
Education Level					
Not in school	3	2.5			
Primary Education	13	10.8			
Secondary Education	98	81.7			
Higher Education	6	5.0			
Total	120	100.0			
History of Previous Injury					
Yes	55	45.8			
No	56	54.2			
Total	111	100.0			

Variables	Frequency	%	Mean $\pm$ S.D	Median	Range
<b>Work Sections</b>					
Grading Area	11	9.2			
Loading Ramp	14	11.7			
Sterilizer Area	12	10.0			
Press Area	11	9.2			
Oil Room	12	10.0			
Kernel Plant	13	10.8			
Workshop	24	20.0			
Boiler Area	23	19.2			
Total	120	100.0			
<b>Working Tenure</b>			9.5 $\pm$ 10.11	5.0	37
1-9 years	75	62.5			
10-19 years	22	18.3			
20-29 years	11	9.2			
>30 years	10	8.3			
Total	118	100.0			
<b>Overtime Work</b>					
Yes	110	91.7			
No	10	8.3			
<b>Repetitive Tasks</b>					
Yes	108	90			
No	12	10			
Total	120	100			
<b>Smoking</b>					
Yes	81	67.5			
No	39	32.5			
Total	120	100.0			
<b>Physical Activity</b>					
Yes	54	45.0			
No	66	55.0			

Variables	Frequency	%	Mean $\pm$ S.D	Median	Range
Total	120	100.0			
Osteoarthritis					
Yes	33	27.7			
No	86	72.3			
Total	119	100.0			

Missing Data: Number of Household Members (6), History of Previous Injury (9) and Working Tenure (2).

Missing Data: Osteoarthritis (1).

#### Prevalence of MSD

As shown in the Table 2, the lifetime prevalence of MSD among the palm oil mill workers studied was high (71.7 percent). However, the one-year prevalence of MSD among the same population was lower, at 50.8 percent.

Table 2: Prevalence of MSD among the palm oil mill workers studied

Variables	Frequency	%
MSD at Any Body Parts (Lifetime Prevalence)		
Yes	86	71.7
No	34	28.3
Total	120	100.0
MSD at Any Body Parts (One-Year Prevalence)		
Yes	61	50.8
No	59	49.2
Total	120	100.0



## Association of risk factors with one-year MSD symptoms reported

Chi-square tests was done to determine whether the risk factors of MSD are significantly associated with the MSD symptoms reported for the past twelve months by the workers working in the palm oil mills. The risk factors involved included age, BMI, physical activity, history of previous injury, Osteoarthritis and smoking. Risk factors originated from the occupation itself were also tested, including working tenure and overtime work. The Chi-square test results revealed that only the history of previous injury, Osteoarthritis and perceived exertion are significantly associated with the MSD symptoms reported. These information was tabulated in the Table 3.

Table 3: Chi-square tests results to test the association between risk factors and MSD symptoms reported

Variables	MSD Reporting (one-year prevalence)				Frequency (%)	X <sup>2</sup> (p Value)
	Yes		No			
	Frequency	%	Frequency	%		
Age						
<27	17	53.1	15	46.9	32 (26.7)	3.965 (0.265)
28-37	8	40.0	12	60.0	20 (16.7)	
38-47	14	42.4	19	57.6	33 (27.5)	
>48	22	62.9	13	37.1	35 (29.3)	
Body Mass Index (BMI)						
Underweight	4	57.1	3	42.9	7 (5.8)	0.991 (0.804)
Normal	32	52.5	29	47.5	61 (50.8)	
Overweight	18	45.0	22	55.0	40 (33.3)	
Obese	7	58.3	5	41.7	12 (10.0)	
Working Tenure						
1-9 years	39	52.0	36	48.0	75 (62.5)	2.941 (0.401)
10-19 years	8	36.4	14	63.6	22 (18.3)	
20-29 years	7	63.6	4	36.4	11 (9.2)	
>30 years	6	60.0	4	40.0	10 (8.3)	
Smoking						

Variables	MSD Reporting (one-year prevalence)				Frequency (%)	X <sup>2</sup> (p Value)
	Yes		No			
	Frequency	%	Frequency	%		
Yes	40	49.4	41	50.6	81 (67.5)	0.210 (0.647)
No	41	69.5	18	30.5	39 (32.5)	
History of Previous Injury						
Yes	34	38.2	21	61.8	55 (45.8)	4.902 (0.027)*
No	27	41.5	38	58.5	56 (54.2)	
Education Level						
Not in school	2	66.7	1	33.3	3 (2.5)	
Primary education	6	46.2	7	53.8	13 (10.8)	0.418 (0.937)
Secondary education	50	51.0	48	49.0	98 (81.7)	
Higher education	3	50.0	3	50.0	6 (5.0)	
Physical Activity						
Yes	27	50.0	27	50.0	54 (45.0)	0.027
No	34	51.5	32	48.5	66 (55.0)	(0.869)
Overtime work						
Yes	53	48.2	57	51.8	110 (91.7)	3.713 (0.054)
No	8	80.0	2	20.0	10 (8.3)	
Osteoarthritis						
Yes	24	39.3	9	15.5	33 (27.7)	8.422
No	37	60.7	49	84.5	86 (72.3)	(0.004)**
Repetitive Tasks						
Yes	56	91.8	52	88.1	108 (90.0)	0.448
No	5	8.2	7	11.9	12 (10.0)	(0.503)

### Logistic Regression Analysis

Three of the risk factors of MSD, which are history of previous injury, osteoarthritis and perception of exertion was found to be significantly associated with MSD symptoms reporting in the past twelve months among the respondents. These risk factors were further analyzed using Logistic Regression Analysis, adjusted for age, BMI and smoking (Table 4). The results showed that palm oil mill workers with a history

of previous injury are 2.35 (95 percent CI 1.12 to 4.93) times more likely to experience MSD symptoms compared to palm oil mill workers who did not have a history of previous injury ( $p < 0.05$ ). It was also found that palm oil mill workers with Osteoarthritis are 3.9 (95 percent CI 1.568 to 9.708) times more likely to experience MSD symptoms compared to palm oil mill workers who did not have Osteoarthritis ( $p < 0.01$ ). Another finding showed that workers with high perception of exertion (very effort demanding tasks) are 8.09 (95 percent CI 1.358 to 48.170) times are more likely to experience MSD symptoms compared to workers who have low perception of exertion (low effort tasks).

Table 4: Logistic Regression Analysis for previous injury, Osteoarthritis and perceived exertion with MSD, adjusted for age, BMI and smoking.

Variables	Odds Ratio	95% Confident Interval		p Value
		Lower	Upper	
MSD in the past 12 months				
With Previous Injury	2.35	1.120	4.930	0.024*
Without Previous Injury	1.00			
MSD in the past 12 months				
With Osteoarthritis	3.90	1.568	9.708	0.003**
Without Osteoarthritis	1.00			
Perceived Exertion				
Low Exertion (Average scale $\leq 4$ )	1.00	1.358	48.170	0.022*
High Exertion (Average scale $\geq 5$ )	8.09			

\*Significant level at  $p < 0.05$

\*\*Significant level at  $p < 0.01$

The one-year prevalence of MSD among the palm oil mill workers studied was more than half of the population, which was at 50.8 percent. This aligns with many other studies carried out in other types of industries which also reported that the prevalence of MSD was at more than 50 percent of the population studied. One of the studies was carried out by Choobineh et al. (2009), which focused on the petrochemical

industry, with the prevalence of MSD at 73 percent. Another study was carried out by Yu et al. (2012) which comprehensively included workers from many types of industries including the printing industries, metal industries and electronics industries which reported the MSD prevalence at 51.3 percent.

It is also interesting to note that among all the non-occupational risk factors, only Osteoarthritis was found to be significantly associated with the MSD symptoms reported ( $p < 0.001$ ). Osteoarthritis are also known as degenerative joint disease, which is a known risk factor for MSD (Bush 2011). Having Osteoarthritis was also analyzed using Logistic Regression Analysis with an adjustment of age, BMI and smoking and it was found that the respondents with Osteoarthritis are 3.9 (95 percent CI 1.568 to 9.708) times more likely to develop MSD symptoms. Present of Osteoarthritis leading to evolving of MSD symptoms among the palm oil mill workers was also studied.

The Borg's CR-10 Scale values obtained from the respondents were averaged for every individual and were categorized to low exertion (scale value of 4 and less) and high exertion (scale value of 5 and above). The results show that the majority of the respondents perceived low exertion (75.6 percent), while 24.4 percent of the respondents perceived high exertion while performing their respective tasks. The Borg's CR-10 Scale values were further averaged for different work sections. Only two work sections obtained high exertion values, which are Grading Area and Press Area. Both work sections subjected its workers to uncomfortable hot temperatures – Press Area involved a closed area and the press machine which generates heat, while Grading Area is an open area with exposure to direct sunlight, by which the Malaysian temperature can reach up to about 37°C maximum (MOSTI 2014). Work environment with excessive heat are one of the causes of working fatigue and weakness and it is also one of the risk factors for MSD (EASHW, 2007; WebMD, 2014).

About one-third (38.2 percent) of the palm oil mill workers studied had experienced previous injuries. The injuries originated from workplace and also non-workplace. Various parts of the body were affected by previous accidents, which resulted in injuries such as broken limbs, cracks or others. This variables were further analyzed using Logistic Regression Analysis (adjusted for age, BMI and smoking) and the results showed that the workers with history of previous injuries are 2.35 (95 percent CI 1.12 to 4.93) times more likely to experience MSD symptoms. This significant association aligns to a study conducted by Yu et al. (2012) which found the association between the same variables, which focused on the population of factory workers in various types of industries in major cities in China. A study done by Daltroy et al. (1997) found that workers with previous injuries are prone to get similar injury, but at a higher rate.

This study found that a high perceived exertion was significantly associated with one-year MSD symptoms reported among palm oil mill workers. Even though the proportion of respondents reported to experience high perceived exertion are low (24.4 percent), the Logistic Regression Analysis showed that workers with a high perceived exertion have 8.09 times likelihood to report one-year MSD symptoms compared to workers with low perceived exertion ( $p < 0.05$ ). This finding was supported by a study conducted among employees in the Iranian petrochemical industry which concluded that perceived physical demands were significantly associated with musculoskeletal symptoms with OR ranging from 1.45 to 2.33 (Choobineh et al., 2009). Another study done by Heiden et al. (2013) which focused on nurses can also be referred to support this finding. The study found that the physical job demands significantly increased the risk of MSD to 5.7 times more. Even though the exertion / job demands that were investigated in current study was only in term of “perception”, the relationship between “perception” and reality cannot be exempted. Physiological and perceptual responses should be used as indicators of both physical and mental work load (Borg, 1990).

## CONCLUSION AND RECOMMENDATION

This study concluded that the one-year prevalence of MSD was at 50.8 percent among the selected palm oil mill workers studied. Further analysis found that Osteoarthritis, history of previous injury and perception of exertion are important predictors for reporting of MSD symptoms in this study.

It is recommended that the employers of the respective palm oil mills carry out further investigation based on the fact that slightly more than half of the workers studied reported MSD symptoms in the past twelve months. The investigation may include health / medical investigation by medical personnel such as Occupational Health Doctors to confirm these MSD symptoms reported. This may be done before further preventive or control measures can be undertaken to tackle the MSD problems in their workplaces.

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## ACKNOWLEDGMENT

This study was supported by the Ministry of Education Malaysia under Long-Term Research Grant Scheme (LRGS), Grant No.: 5526107. The researchers would like to thank palm oil mills' administrators and participants for their participation and cooperation in this research project.

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