Industrial Health 2014, **52**, 78–85

**Field Report**

# The Prevalence of Musculoskeletal Disorder and Association with Productivity Loss: A Preliminary Study among Labour Intensive Manual Harvesting Activities in Oil Palm Plantation

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*Received January 30, 2013 and accepted November 21, 2013*
*Published online in J-STAGE November 29, 2013*

**Abstract: Production agriculture such as harvesting in oil palm plantation has been frequently associated with MSD and significant loss of productivities. This study tends to evaluate from the viewpoint of health, the association between self-reported prevalence of musculoskeletal disorders and productivities; the impact of musculoskeletal disorders on productivity. A cross-sectional study was conducted among 143 harvesters in oil palm plantation. A general questionnaire was used to collect socio-demographic background data while Nordic Musculoskeletal Questionnaire was used to determine the prevalence of MSD. Expressed in 4 different indicators; daily harvesting quantity, efficiency score, sick leave and presenteeism, the productivity data were analysed for association. There is significant association between reported acute prevalence of MSD (within 7 d) and productivity loss in terms of presenteeism ($\chi^2$=5.088; $p$<0.05) as well as quantity of daily harvest ($\chi^2$=7.406; $p$<0.01). Logistic regression adjusted for age, BMI and smoking indicate that harvesters with MSD (past seven days) were more likely to be engaged in presenteeism (OR=2.87 95% CI=1.34, 6.14) and had lower daily productivity (OR=2.09 95% CI=1.02, 4.29) compared to harvesters without MSD (past 7 d). This study reveals that oil palm harvesters suffering acute MSD (for the past week) were likely to be still present to work and produce half lesser than their healthy counterparts. Thus, further study with comprehensive surveillance strategy is essential in order to determine the urgency or need of appropriate intervention.**

**Key words:** Ergonomics, Musculoskeletal disorders, Oil palm, Harvesters, Productivity

## Introduction

The Malaysia oil palm industry has been rapidly expanding since the last decade. Similar to many other sectors of agricultural commodities, work tasks in an established oil

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palm plantation (OPP) typically includes field upkeep and maintenance (including pruning, weeding, fertilizer and pesticides application) harvesting, grading, collection and transportation for downstream processing uses.

In the context of labour management, OPP in Malaysia are heavily reliant on foreign labour for the labour intensive manual work tasks in many key activities[1, 2]. With the concern labour shortage hogging the industry's stakeholders[3, 4], the plantation management had sought multifocal alternatives encompassing political measures, paradigm shift in policies, mechanization and incentives to address the problem and ensure affordable competitive edge of the sector[5].

The efforts were however yet to be fruitful since each harvester currently still covers larger land acreage in order to maintain productivities as stakeholders are seemingly reluctant to support recently proposed mechanized solutions justifying their feasibility to the work environment in OPP[1]. Furthermore, burdens of the harvesters were worsen as the job demand harvesting cycle of 7−10 d (3 cycles/month) corresponding to the maturity or ripeness of fresh fruit bunches (FFB)[6].

Consistent with the acknowledgement that agriculture is one of the most hazardous industries, the existing ergonomics risk factors with respect to the Occupational Safety and Health (OSH) were of no exception in OPP[7]. Primarily, musculoskeletal disorders or complaints appear to be common among harvesters in OPP[8, 9] although further studies are warranted to validate the locally published studies.

In the aspect of productivity, work-related health impairment or disorders due to hazardous work environment can result in sick absenteeism[10]. More recently, sickness presenteeism, refers to the phenomenon of attending to work despite rightfully being absence from work has been discussed in several studies[11–13]. Interestingly, empirical evidence with regards to presenteeism has begun to unravelled significant loss of productivities[14] which was all along underestimated[15].

In a review article Johns[16] ascribe absenteeism as the visible tips of the iceberg portion. Beneath the tips were the larger chunk of presenteeism practice which were expressed as aggregated productivity losses. However, the validity and reliability of currently existing assessment methods of presenteeism were still premature as general model for industries wide-use or dollar and cents of economics losses are still far from being quantifiable[13, 17].

Various studies[11, 18–23] have demonstrated substantial productivity loss as a consequent of health risks or problem in various industries. However, in Malaysia, insufficient insight was given to discuss the agricultural environment particularly in the OPP setting, which dominantly consist of foreign labour workforce. In addition, where productivity is concerned, presenteeism has recently become the subject of interest.

Thus, this study intend to evaluate from the viewpoint of health, the association between self-reported prevalence of musculoskeletal disorders and productivities expressed in 4 different indicators; daily harvesting quantity, efficiency score, sick leave and presenteeism. A logistic regression model which also examines the impact of musculoskeletal disorders on productivity was estimated.

## Methods

*Subjects/study population*

This study involve four OPPs (owned by the same subsidiary company) in the southern part of Peninsular Malaysia. Using purposive sampling, these four neighbouring plantations were selected based on a list of OPPs from the regional office. The primary inclusion criteria at plantation level was early harvesting stage − within first to third harvesting year or oil palm trees aged within 3 to 5 yr old.

In our observation, the management system of all four plantations were the same as the managers including the staff had the same training and received the same directives from the regional headquarters. The reason for separate management was due to cost effectiveness considering the size (or area which was too large and far apart) and too many workers to be managed under a single office.

Further inclusion criteria besides harvesting stage were the use of chisel to severe the FFBs' stalk (Fig. 1). The average weight of FFB during the study varied between 5 to 10 kg and was collected using a wheelbarrow with either a metal pole or hook (Fig. 2) as well as a sweepers to collect loose fruits (Fig. 3).

Subsequently, a list of all workers were obtained and provided by the management of each office as the sampling frame. Using purposive sampling, administrative workers, pesticides sprayers, general workers and supervisors were eliminated leaving only harvesters. Harvesters as defined by the oil palm management in this study were a set of two workers; FFB cutter and FFB collector.

*Questionnaire*

Besides socio-demographic, occupational and lifestyle information, data such as prevalence of musculoskeletal disorders and productivities of the respondent were collected using questionnaire. The interviewer assisted ques-

**Fig. 1. FFB cutter cutting ripe oil palm fruit on oil palm trees.**

**Fig. 2. FFB collector loading detached FFB onto wheelbarrow.**

tionnaire was translated into Indonesian language and pretested with Cronbach's α value of 0.92. The prevalence of MSD was assessed using modified Nordic Musculoskeletal Disorder Questionnaire[24] for both acute (past week − 7 d) and chronic condition (past 12 months).

Productivities defined in this study were assessed using different indicators; sick leave, presenteeism and work efficiency (which were self-reported by respondent). On the other hand, average daily harvest quantity for a month were determined using secondary data − from management records. These different indicators measure different dimension or aspects of productivity.

Using simple question, sick leave was recorded for absence from work during the past month. Potential for recall biased was minimal for this case as harvesters kept close track of absence from work due to attendance incentives. Conversely, presenteeism was reported and quantified using modified Osterhaus method[14]. This instrument require respondents to indicate the number of days they experienced musculoskeletal pain or disorders and yet

**Fig. 3. FFB collector sweeping to collect loose oil palm fruits.**

went to work for the past week.

As for efficiency, adapted QQ instrument[13] were used to indicate quantitatively how much work were actually performed and the quality of their work during presenteeism, if any during the past week. The questions featured a 10-point numerical rating scale where "0" represents "nothing/no output" or "low quality" and "10" represents "normal quantity/output" or "normal quality" on quantity and quality scale respectively.

*Analysis*

For the main variables, descriptive statistics were used to generate the socio-demographic, occupational and social lifestyle data in means and percentages. Similarly, the prevalence of MSD of respondents for the past 12 months and 7 days were also descriptively analysed for each body parts. Total musculoskeletal disorders for both durations were quantified for each individual who had complaint pain in at least one part of the body.

In this study, productivities were dichotomized into normal productivity vs. productivity loss using mean or median score of each variable as cut-off point for each respondent[23]. Table 1 shows the summarized categorical decision. Subsequently, the results were tested for association with complaint of MSD using chi-square analysis followed by binary logistic regression on the set of significantly associated variables at statistical significance of $p<0.05$ to determine the effect of MSD on the productivity among harvesters.

## Results

A total of 143 harvesters had consented to participate in this study. The socio-demographic characteristics, lifestyle and occupational information were summarized in Table 2.

**Table 1. Summary decision of definition and cut-off point used in dichotomy category**

| Variables defining productivity: | Definition of: | |
|---|---|---|
| | Normal productivity | Productivity loss |
| Sick leave | Did not took any sick leave from harvesting work in the past month | Took sick leave from harvesting work in the past month |
| Presenteeism | Did not experience MSD during the past week when present for harvesting work | Experienced MSD during the past week and yet went for harvesting work |
| Daily harvest quantity | Daily FFB harvest quantity ≥ group mean value | Daily FFB harvest quantity < group mean value |
| Efficiency score | Perceived harvesting efficiency score during presenteeism ≥ median | Perceived harvesting efficiency score during presenteeism < median |

**Table 2. Socio-demographic characteristics and occupational information of respondents**

| Variables | n | % | Mean ± SD |
|---|---|---|---|
| Age (yr) | | | 28.30 ± 7.24 |
| 19–29 | 92 | 64.3 | |
| 30–39 | 34 | 23.8 | |
| 40–49 | 15 | 10.5 | |
| ≥ 50 | 2 | 1.4 | |
| No. of Household Members | | | 3.8 ± 2.39 |
| 0 | 7 | 4.9 | |
| 1–5 | 112 | 78.3 | |
| 6–10 | 21 | 14.7 | |
| >10 | 3 | 2.1 | |
| Education | | | |
| None | 15 | 10.5 | |
| Primary School | 39 | 27.3 | |
| Lower Secondary | 49 | 34.3 | |
| Upper Secondary | 40 | 28.0 | |
| BMI | | | |
| <18.5 (Underweight) | 9 | 6.3 | |
| 18.5–24.9 (normal range) | 123 | 86.0 | |
| 25–29.9 (pre-obese) | 11 | 7.7 | |
| ≥30 (obese) | 0 | 0 | |
| Occupational information | | | |
| Daily working duration (hours) | | | 6.60 ± 1.23 |
| Resting duration (minutes) | | | 43.15 ± 23.94 |

n=143 respondents.

**Table 3. Prevalence of musculoskeletal disorders among harvesters**

| Body parts | Prevalence | |
|---|---|---|
| | 12 months | 7 days |
| Neck | 32.2% | 11.2% |
| Shoulder | 32.2% | 9.8% |
| Upper back | 28.0% | 9.8% |
| Lower back | 58.0% | 24.5% |
| Elbow | 20.3% | 6.3% |
| Hand/arms | 26.6% | 6.3% |
| Thigh | 21.0% | 5.6% |
| Knee | 45.5% | 14.0% |
| Ankle/Feet | 25.2% | 4.9% |
| Any body parts (Total MSD) | 93.0% | 43.4% |

n=143 respondents.

Most (96.5%) of the respondents were foreign labour, all of whom were from Indonesia, primarily the Lombok Island. The mean age of respondents were 28.3 (± 7.24), ranging from 19−55 yr old. Frequency of age, when categorized was highest (64.3%) in the 19−29 yr old age category.

Due to the nature of the job tasks, it was observed that most respondents have muscular and athletic feature with 86% of the respondents fall under normal body mass index (BMI) range while the rest were underweight (6.3%) and overweight (7.7%). Smoking was prevalent among the respondents whereby 87.4% were smokers. In terms of education, majority of the respondents (89.5%) have at least attended primary school.

The mean daily working duration of the respondents were 6.60 ± 1.23 h whereas the mean rest duration was 43.15 ± 0.23.94 min. Resting hour was non-specific for the harvesters due to the dynamic and physically intensive nature of work. Commonly, workers had two short break (5−15 min) in the morning and evening to rehydrate and smoking as well as a longer lunch break (15−30 min).

Based on the self-reported MSD complaints, Table 3 shows that the prevalence of total MSD (in any body parts) for the past 12 months were 93%. Among the 9 body parts, highest prevalence of MSD reported was for complaints in lower back (58%) followed by knee (45.5%), shoulder (32.9%), neck (32.2%), upper back (28.0%), hand/arms (26.6%), ankle/feet (25.2%), thigh (21.0%) and elbow.

On the other hand, the prevalence of MSD was lower for the past week during which the data collection was conducted where total MSD (in any body parts) was 43.4%. Consistently, the highest prevalence of the body

**Table 4. Association between MSD complaints (past week) and work productivity**

| Variables | | Productivity | | $\chi^2$ | *p*-value |
|---|---|---|---|---|---|
| | | Normal | Loss | | |
| Daily harvest quantity | MSD | 11 | 51 | 5.088 | 0.024* |
| | Without MSD | 13 | 68 | | |
| Efficiency | MSD | 46 | 16 | 1.630 | 0.202 |
| | Without MSD | 42 | 39 | | |
| Sick leave | MSD | 11 | 43 | 0.072 | 0.788 |
| | Without MSD | 40 | 41 | | |
| Presenteeism | MSD | 33 | 29 | 7.406 | 0.006* |
| | Without MSD | 55 | 26 | | |

* significant at $p<0.05$.

parts complaint was still for lower back (24.0%). This was follow by knee (14.0%), neck (11.2%), shoulder (9.8%), upper back (9.8%), hand/arms (6.3%), elbow (6.3%), thigh (5.6%) and ankle/feet (4.9%).

For the bivariate analysis, Table 4 shows that all variables defining productivity; sick leaves, presenteeism, daily harvesting quantity and efficiency were not significantly associated with the 12 months prevalence of MSD complaints. On the other hand, daily harvest quantity and presenteeism among the productivity variables were found to have significant association ($p<0.05$) corresponding to MSD complaints for the past week whereas productivity defined in sick leaves and efficiency did not indicate any association with prevalence of MSD complaints over the past week.

Subsequently, using daily harvest quantity and presenteeism as dependent variable, the regression analysis using enter method revealed that the odd ratios (OR) of harvester who had MSD complaint over the past week was 2.09 (95% CI = 1.02, 4.29) and 2.87 (95% CI = 1.34, 6.14) respectively, both adjusted for age, BMI and smoking (as tabulated in Table 5).

The result indicates that respondent who complaint to had experienced MSD during the past week produced twice as less daily harvest quantity when compared to those who were healthy (did not have MSD). Similarly, of those who had MSD during the past week and yet went to work, they were almost three times as likely to be less productive compared to their healthy (did not experience MSD) counterparts.

**Table 5. The impacts of musculoskeletal disorders on the odds of productivity loss**

| Variables** | OR | 95% CI | | *p*-value |
|---|---|---|---|---|
| | | Upper | Lower | |
| Daily quantity | | | | |
| MSD on the past week | 2.09 | 1.02 | 4.29 | 0.044* |
| Without MSD | 1.00 | | | |
| Presenteeism | | | | |
| MSD on the past week | 2.87 | 1.40 | 6.14 | 0.007* |
| Without MSD | 1.00 | | | |

* significant at $p<0.05$. ** analysis adjusted for age, BMI and smoking.

## Discussion

*Prevalence of MSD*

Harvesting task in oil palm plantation is associated with manually labours intensive as locally accepted, ergonomically and economically sound sustainable technology were still unavailable. Based on ergonomics risk factors described[7] high prevalence of musculoskeletal disorders has been reported to be associated with the hazardous task in the past.

Although literature with regards to occupational safety and health in oil palm plantation has been scarce, a locally published study[9] in Indonesia found that all 117 respondents (100.0%) experienced MSD although the history of its prevalence was unreported. Nevertheless, the study found that age and the number of working years as well as the types of work are significantly risk factors associated with MSD.

Their result was almost reflected in this study where the total prevalence of MSD over the past 12 months of respondent was 93%. However, it should be cautious to directly compare the results among both group of respondent considering the differences of ergonomics and other risk factors corresponding to difference in palm tree height (i.e.: young − low vs. matured − high) and hence the tool used in their plantation (i.e.: chisel vs. sickle)[7].

Across individual body parts, the 12 months and 7 d

prevalence of MSD in this study were consistently the highest for lower back; 58.0% and 24.5% respectively. Our finding was similar to the prevalence of low back pain in another locally published study[8] in Malaysia which reported 12 months prevalence of low back pain at 67%.

Similarly to the former study, our result were not directly comparable as the respondents in their study were mixed (particularly in terms of work tasks hence the ergonomics risk factors). Additionally, the study lack information pertaining to the use of tool or trees height which would at least give an idea of potential risk factors[7].

In comparison to agricultural practices in general, several studies[25–28] reported higher prevalence rate of MSD among farmers than other occupationally active population. For example, a study[29] among Irish farmers revealed that the 12 months prevalence of MSD was 56% for back pain followed by neck/shoulder (25%).

Likewise, a prior cross-sectional, population based cohort study[27] among Swedish farmers reported higher low back pain (67.7%) and hip symptoms (31.7) compared to a matched reference group. A systematic review[29] confirmed that the prevalence of MSD among farmers was greater than general non-farmers population citing lower back pain as the most common MSD followed by upper and then lower extremities.

In the present study, the trend of MSD prevalence for both 12 months and 7 d based on body parts suggests a different trend where MSD prevalence for knee was successfully higher than neck and/or shoulder after low back pain compared to the trends commonly found in different literatures[27–32] whereby the MSD prevalence for knees were ranked after low back pain and shoulder and/or neck pain.

Nevertheless, the tendency may be attributable to the hilly landscape or terrain of the OPP observed in this study although there was no past study to indicate such provenance or any measurement and comparison made available for this study. Hence, knee pain and knees osteoarthritis as indicated in the study[33] suggests heavy physical activities of manual handling and occupational specific such as animal husbandry origin.

Regardless, evidence from various literatures in the past has unanimously agreed that agriculture is among the most hazardous industry[34–36]. Being the most prevalent and costly of all work-related injuries across various other industries[37–39], MSDs in agricultural workers were the result of exposure to a multitude of risk factors particularly in production agriculture as is the respondent in this study.

*Productivity*

Apart from concern of social responsibility and quality of life, the distress of MSD is loss or decrease of productivities which leads to substantial direct and indirect costs. As aggressively advocated, the use of absenteeism as an indicator and measurement of productivity loss have been thought to be superficially insufficient and lack of severe consideration[15]. Thus, the use of sick leave, presenteeism and efficiency alongside immediately quantifiable measure of daily harvest quantity in this study was to provide better perspective which would otherwise be overlooked or ignored.

Nevertheless, analysis using 12 months prevalence of MSD (data not shown) did not find any significant association with all four indicators of productivity while for MSD prevalence of the past week, only presenteeism and daily harvest quantity yield significant association. A possible explanation of the non-significant association for all selected indicators of productivity with 12 months MSD prevalence was attributable to the differences in terms of duration of data collected for each pair of variables analysed.

For example, although the questionnaire used in this study collected data for sick leave of the previous one month, the analysis using 12 month prevalence of MSD may not have been coherent as other indicators of productivity. Besides, the use of chronic MSD of 12 months prevalence is potentially biased in terms of recall memory. In contrast, the short term data for productivity were better associated with the reported acute MSD problem among the harvesters.

It is however noteworthy that the daily harvest quantity attain significant association with MSD in the past week of the study. Thus, using logistic regression, respondents who had MSD during the past week produce less FFB compared to their healthy counterparts after adjusting for age, BMI and smoking factor. This suggests that the loss of productivity were better predicted in acute association whereas productivity losses were not seen in long term or chronic health effect.

In their study it was found that lower or productivity loss is attributable to MSD which was reflected in this study[13]. Again, high physical loads job of the blue-collar workers reported significant productivity loss using the QQ instrument (efficiency score in this study) which were correlated significantly with objective work output. On the other hand, although respondent[18] were white-collar workers, musculoskeletal disorders appear to also ascribe significant productivity loss in both men and women.

Several other studies[20, 22, 23] associated ill health and

several other risk factors with productivity loss or decreases in their studies. The significance of their studies including the present study serves as justification for workplace health intervention particularly in relation to musculoskeletal disorders in order to prevent further loss. Thus, the call for change of workplace policy specifically wages structural review which were also warranted especially in labour intensive manual work tasks of blue-collar workers.

In relation to presenteeism, our finding indicates that presenteeism among those who experienced MSD were common. Several studies[11, 13, 14, 18] found significant productivity loss associated with presenteeism were highlighted as specific occupational groups which have substantially higher presenteeism due to the nature of their job demand[11].

*Limitation*

In this study, it is not practical to record the days respondents were absent from work for the past week as sick leave was rarely applied. The primary reason was due to the wage structure which was weight-rated system. Thus, respondents are paid for the weight of daily harvested FFB, which means that they do not get paid during sick leave. Moreover, monthly full attendance incentive was also introduced whereby the incentive will be significantly deducted by almost half the full amount for a single day of absence from work and fully deducted for 3 d of absence from work. Such stimulus in the work organization indirectly promotes presenteeism among respondents in our study.

Besides that, recall bias were also potential factor limiting the current study. Similarly to other study[18], the limitations raised in their study were also experienced in the present study which questions validity of self-reporting. Conversely, under-reporting were also suggested as the limitation of the study design whereas irreplaceability of work hours[14]. A longitudinal cohort study with appropriate surveillance and reporting of productivity data were necessary in order to observe association of chronic MSD with long term productivity.

Among other limitations considered in this study were the efficiency score which were calculated based on the quantity and quality rating. For this question, respondent bias or interviewer bias may have affected the outcome of respondents' self-rating. During the interview assisted questionnaire session, situation or examples which were presented in order to explain the rating-type question could have potentially be perceived differently by different respondent who were confused or did not fully understand the rating-type questions.

## Conclusion and Recommendation

The aim of this study was to determine the prevalence of musculoskeletal disorders among foreign labour engaged in high physical work tasks and the effect to productivity. The results of our study suggest high potential of presenteeism which consequently affects productivity not only to organization but also to workers socio-economically which wages structure were piece-rate system.

With regards to work tasks in oil palm plantation, it is highly recommended for further study using better productivity indicators and study design although the current preliminary result were indicative of consideration for the stakeholders to invest in cost-effective health and engineering intervention such as revised workplace incentive or policy and particularly the introduction of mechanized solution for harvesting in oil palm plantation.

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