

Occupational Health and Safety in the Palm Oil Industry: A Systematic Review

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Abstract

Background: The palm oil industry is the largest contributor to global production of oils and fats. Indonesia and Malaysia are the largest producers of palm oil. More than a million workers are employed in this industry, yet there is a lack of information on their occupational health and safety.

Objective: To identify and summarize occupational hazards among oil palm plantation workers.

Methods: A search was carried out in June 2018 in PubMed, Web of Science, Scopus, and Ovid. Relevant publications were identified by a systematic search of four databases and relevant journals. Publications were included if they examined occupational hazards in oil palm plantation workers.

Results: 941 publications were identified; of these, 25 studies were found eligible to be included in the final review. Of the 25 studies examined, 19 were conducted in Malaysia, 2 in Costa Rica, and one each in Ghana, Indonesia, Myanmar, Papua New Guinea, and Cameroon. Oil palm plantation workers were found to be at risk of musculoskeletal conditions, injuries, psychosocial disorders, and infectious diseases such as malaria and leptospirosis. In addition, they have potential exposure to paraquat and other pesticides.

Conclusion: In light of the potential of palm oil for use as a biofuel, this is an industry with strong growth potential. The workers are exposed to various occupational hazards. Further research and interventions are necessary to improve the working conditions of this already vast and growing workforce.

Keywords: Palm oil; Occupation; Risk; Occupational injuries; Leptospirosis; Malaria; Pesticides

Introduction

The palm oil industry is expanding rapidly globally and is the largest contributor to world production of oils and fats.^{1,2} Palm oil is a highly versatile product and is found in a wide range of

products including foods, beauty products, and cleaning liquids such as detergents.³⁻⁵ In recent years, with the search for a sustainable energy source, palm oil has been used to make biofuel.

The oil palm is native to tropical climates. The global palm oil supply has been

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dominated by Malaysia, Indonesia, Nigeria, Thailand, and Colombia. Over 85% of the total production of crude palm oil worldwide comes from Malaysia and Indonesia.^{3,6} Indonesia has 12 million hectares of oil palm plantation and the industry employs more than four million workers.^{7,8} Malaysia had five million hectares of oil palm under cultivation in 2011 producing 40% of the world's supply.³

In recent years, the issue of sustainability has been highlighted in the palm oil industry after the expansion of areas under cultivation caused major deforestation in Indonesia and Malaysia. In 2009, the oil palm plantation area in Malaysia and Indonesia increased by five and 23 times, respectively.³ This land expansion caused major deforestation which provoked protests and pressure by conservation bodies and other international organizations.⁴

The Roundtable on Sustainable Palm Oil (RSPO) was initiated in 2004 and developed a certification process in which oil palm plantations are assessed for compliance with a set of eight principles.⁹ These eight principles include commitment to transparency, compliance with applicable laws and regulations, commitment to long-term economic and financial viability, use of appropriate best practices by growers and millers, environmental responsibility

and conservation of natural resources and biodiversity, responsible consideration of employees and of individuals and communities affected by growers and mills, responsible development of new plantings, and commitment to continuous improvement in key areas of activity. Furthermore, biomass growers can apply for the International Sustainability and Carbon Certification by abiding with six principles including safe working conditions and human and labor rights.⁹

In 2010, the World Bank highlighted that the occupational safety and health of palm oil industry workers posed a challenge for the future sustainability of the industry.³ The palm oil industry, particularly harvesting of the palm fruit, is labor intensive and there is little mechanization in the Indonesian, Malaysian or Nigerian Industries,^{8,10,11} which tend to rely on low-paid workers.¹² The Malaysian industry in particular, heavily relies on foreign labor with an estimated 450 000 foreign workers from Indonesia, the Philippines, Nepal, and Bangladesh working on its plantations. Reports from Malaysia highlight labor exploitation, including worker abuse and child labor occurring on oil palm plantations.¹²⁻¹⁵ In Indonesia, workers migrate to work in plantations from other regions of the country, with reports of low wages, insecure employment and hazardous working conditions.^{3,16}

Despite its large current size and the growth potential of this industry in the quest for biofuels, there is a lack of information on the health and occupational exposure of plantation workers. This systematic review was conducted to identify and review the occupational hazards encountered by workers in oil palm plantations.

Materials and Methods

This review was conducted using the principles of the PRISMA (Preferred Re-

TAKE-HOME MESSAGE

- Few studies have examined the occupational safety and health of oil palm plantation workers.
- A systematic review found they were at risk of musculoskeletal conditions, injuries, psychosocial disorders, and infectious diseases such as malaria and leptospirosis.
- In addition, they have potential exposure to pesticides, in particular paraquat.
- Plantations are largely unmechanized and rely on low-paid labor.

porting Items for Systematic Review and Meta-Analysis) statement.

Search Strategy

An initial search was carried out in June 2018 on PubMed, Web of Science, Scopus, and Ovid. The search terms used were divided into terms for participants and terms for occupational hazards.

["oil palm worker*" OR "palm oil worker*" OR "palm oil harvester*" OR "oil palm harvester*" OR "plantation worker*"]

AND

["occupational health" OR "occupational safety" OR "risk factor*" OR "ergonomic*" OR "musculoskeletal" OR "poisoning" OR "pesticide*" OR "injur*" OR "disease*" OR "hazard*" OR "health" OR "herbicide"]

The term "oil palm" was included as a possible term to identify palm oil industry workers but gave too many irrelevant results so it was excluded from the search terms. In addition, hand-searching for publications in selected journals was also carried out and reference lists of key publications were scanned. The search was not restricted by period of publication, however, only studies published in English, Bahasa Indonesia, and Malay were considered as they are the common languages used in the main palm oil producing countries, which produce the most literature in this area. Due to the limited information on the occupational hazards in oil palm plantations, grey literature was also sourced through personal communication with experts in the field.

Inclusion and Exclusion Criteria and Assessment of Papers

Research papers and review papers examining various occupational hazards on oil palm plantations were screened by NR. NR, LF and AR examined the articles identified in the initial search to ensure they met the selection criteria. NR, LF and AR grouped the hazards. All studies were in-

cluded in the review because of the paucity of studies undertaken on this topic. Studies had to contain information on at least one occupational hazard relating to the tasks of workers such as harvesting and collecting the fruits and caring for the crops. Studies of agricultural workers without specific mention of palm oil industry workers were excluded.

All studies included in the review were rated for bias and quality using the Critical Appraisal Skills Programme (CASP) checklists.¹ Studies were rated "good" quality if they scored a "yes" for all six questions; "average," if they scored 4–6; and "poor," if they scored <4.

Results

The search resulted in 941 papers, of which 779 were duplicated and removed; a further 75 papers were excluded due to the topic being unrelated to the occupational safety and health based on the title and abstract screening. After excluding 62 articles according to the exclusion and inclusion criteria mentioned above, 25 articles were left for analyses (Fig 1). These were published from 1981 to 2017 (Table 1).

The countries represented in the publications covered in this review were Costa Rica, Ghana, Indonesia, Malaysia, Cameroon, Myanmar, and Papua New Guinea. Malaysia provided the largest number of studies (n=19), which is appropriate as Malaysia is one of the biggest producers and exporters of palm oil. Few publications originated from Indonesia despite it also being a major producer of palm oil.

To identify where and how occupational hazards might exist for oil palm plantation workers, a brief description of their major tasks and roles is presented below. The main tasks consist of harvesting and collecting fruits, and caring for crops. Within these three major tasks, workers can be classified into six groups according

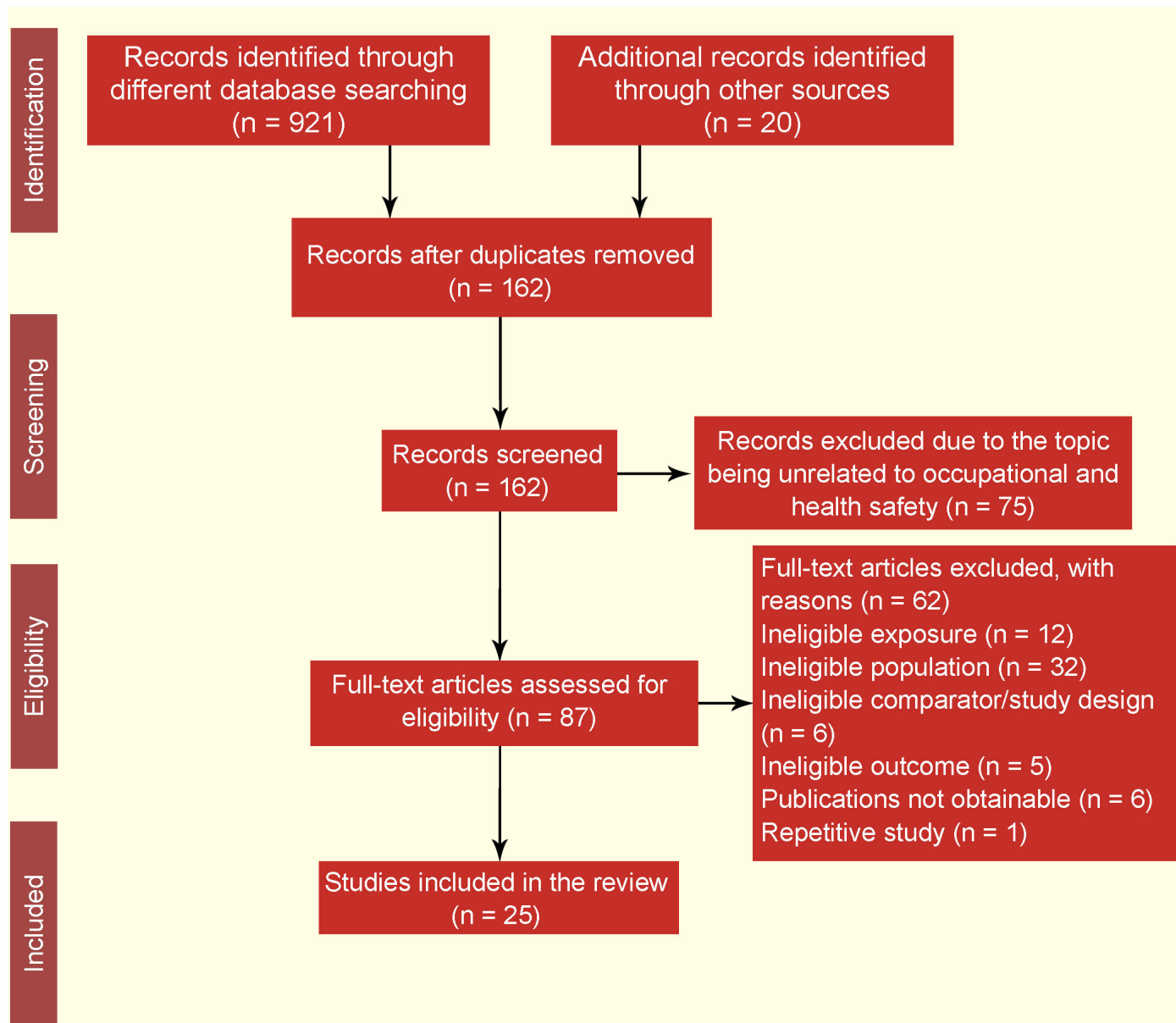


Figure 1: Study selection flowchart

to the nature of the activities carried out in each task. Below we have listed a general description of tasks undertaken on an oil palm plantation.

Harvester

Harvesting is considered the most important task on the oil palm plantation. The oil palm is harvested several times a

month as the Fresh Fruit Bunch (FFB) has to be harvested as soon as it is ripe in order to achieve a high oil value.⁸ The harvesters use a chisel or sickle to cut the FFB, which is located on the base of the frond.¹¹ An oil palm can grow as tall as 20 m,²⁷ so as the palm grows, the FFB moves further away from the ground. The tools used in harvesting tall and shorter oil palms are

Table 1: Studies examining occupational hazards among oil palm plantation workers

Author(s)	Location / year of publication	Participants	Measurement tool(s)	Main Results	CASP* Score
Ergonomics/Musculoskeletal					
Sukandarin, et al ¹⁷	Malaysia / 2016	88 male palm oil workers (all Indonesian)	Interview, video recording, direct observation by Nordic Musculoskeletal Questionnaire (NMQ)	Pain was most commonly reported in the lower and upper back. Extreme physical activity was the main cause of these problems.	Average
Nawi, et al ¹⁸	Malaysia / 2016	88 male palm oil workers		All participants reported body pain but differing in frequency and area.	Average
Deros, et al ¹⁹	Malaysia / 2016	88 harvesters from a single plantation	Modified NMQ and REBA	Upper back and lower back pain was experienced by 87.1% and 94.3% of workers, respectively.	Average
Henry, et al ²⁰	Malaysia / 2015	84 palm plantation workers sampled by predefined study criteria from 2009–2011	Standard Nordic Musculoskeletal Questionnaire (SNMQ), Quick Exposure Check (QEC)	Prevalence of work-related musculoskeletal disorders (WRMDs) among palm oil worker was 58.3%. Back pain was the most prevalent WRMD (63.5%), but based on QEC the neck was the most exposed to risk.	Average
Ng, et al ²¹	Malaysia / 2013	143 palm oil harvesters	NMQ	The prevalence of musculoskeletal disorder (MSD) in any body part was 93%, highest prevalence was seen in the lower back (58%), knee (45.5%) shoulder (32.9%, and neck (32.2%).	Poor
Ng, et al ²²	Malaysia / 2015	446 male palm oil workers	NMQ, Ovako Working Posture Assessment (OWAS)	Self-reported prevalence of MSD: 86%, the prevalence of acute (7 days) MSD: 45%. Most complained about areas were lower back, followed by knee, shoulder and neck.	Good
Syazwani, et al ²³	Malaysia / 2016	25 randomly selected palm oil workers	Modified NMQ and Rapid Entire Body Assessment (REBA)	12-month prevalence of MSD was reported as shoulder 60%, upper back 52%, neck 48% and lower back 44%.	Poor
Nawi, et al ²⁴	Malaysia / 2015	12 palm oil workers using machine	Questionnaire	All respondents were experiencing body pain.	Poor

Continued

Table 1: Studies examining occupational hazards among oil palm plantation workers

Author(s)	Location / year of publication	Participants	Measurement tool(s)	Main Results	CASP* Score
Nawi, et al ²⁵	Malaysia / 2013	Observing postures during plantation work—1 worker per activity	REBA	The workers' postures while harvesting have a REBA score of 8–13 (high to very high).	Average
Yusoff, et al ²⁶	Malaysia / 2014	273 male palm oil harvesters	RULA (Rapid Upper Limb Assessment)	51.6% of respondents scored 7 for RULA (max score).	Good
Syuaib, et al ²⁷	Indonesia / 2015	141 male palm oil harvesters (randomly selected)	Work motion and posture analysis, body-map questionnaire (RULA)	The prevalence of musculoskeletal problem was: shoulder (27.82%) and waist (28.52%). Working postures in harvesting were given the maximum RULA score of 7.	Good
Ng, et al ²⁸	Malaysia / 2013	Observing postures during harvesting (n unclear)	Observation by video	The workers were exposed to a combination of adverse ergonomic work conditions that varied by the age of the oil palms.	Good
Jusoff, et al ²⁹	Malaysia / 2009	150 harvesters oil palm fruit bunches	Questionnaire survey and video analysis	The prevalence of musculoskeletal discomfort, pain and fatigue among workers was statistically significant in the upper extremity regions among the palm oil workers.	Poor
Infectious diseases					
Pluess, et al ³⁰	Papua New Guinea / 2009	842 palm oil workers and family who live in company villages with 723 blood sample	Parasitology survey and blood test (finger prick)	33.5% of blood samples were positive for malaria (high endemicity).	Good
Soe, et al ³¹	Myanmar / 2017	406 migrant workers involved in gold mining, rubber and oil palm plantations	Interview	43.1% respondents gave a positive history of malaria that had occurred at least once in the last 2 years (while living as migrant).	Average

Continued

Table 1: Studies examining occupational hazards among oil palm plantation workers

Author(s)	Location / year of publication	Participants	Measurement tool(s)	Main Results	CASP* Score
Mohd Ridzuan, <i>et al</i> ^{β2}	Malaysia / 2016	350 palm oil workers	Interview and agglutination test	Seroprevalence of 28.6%. Risk factors for positivity were the presence of cows (OR 4.78, 95% CI 2.76 to 8.26), and the presence of landfill (OR 2.04, 95% CI 1.22 to 3.40).	Good
Krah, <i>et al</i> ^{β3}	Ghana / 2000	1722 palm oil workers	Blood, urine, stool and skin snip tests	Very high prevalence of onchocerciasis (84.1%) and helminthiasis (41.6%) and 17% asymptomatic malaria parasitemia.	Average
Mental health problems					
Leonard, <i>et al</i> ^{β4}	Malaysia / 2013	47 male palm plantation farmers	Depression-Anxiety-Stress Scales (DASS-21)	Stress (0%), depression (8.5%), and anxiety (27.7%).	Average
Nasir, <i>et al</i> ^{β5}	Malaysia / 2016	109 fresh fruit bunch cutters at oil palm plantation	Self-administered questionnaire, Kestrel heat stress tracker 4400, Rapid Upper Lim Assessment, Borg category Ratio (Borg CR-10) and salivary α-amylase assay	62.4% experienced lack of sleep due to worry, 36.7% felt constantly under strain, and 50.5% could not overcome difficulties.	Average
Pesticide exposure					
Howard, <i>et al</i> ^{β6}	Malaysia / 1981	74 workers consisting of 27 paraquat sprayers, 24 general workers and 23 latex factory workers were drawn from six rubber and oil palm states in Malaysia	Test of pulmonary function, renal function, liver function, and a full hematological screen	The results showed no significant difference in pulmonary and liver function as a consequence of occupational exposure to paraquat among sprayers, general workers or factory workers.	Good

Continued

Table 1: Studies examining occupational hazards among oil palm plantation workers

Author(s)	Location / year of publication	Participants	Measurement tool(s)	Main Results	CASP* Score
Schenker, <i>et al</i> ³⁷	Costa Rica / 2004	338 farmers from banana, coffee, and oil palm plantations	Interviewer-administered questionnaire	A statistically significant association of shortness of breath with wheeze with cumulative paraquat exposure and a small non-significant increase in chronic cough with paraquat exposure.	Good
Lee, <i>et al</i> ³⁸	Costa Rica / 2009	173 banana, coffee and palm plantation workers	24hr urine (enzyme-linked immunosorbent assay)	Detectable paraquat exposures were observed among paraquat handlers.	Average
Hossain, <i>et al</i> ³⁹	Malaysia / 2010	152 farmers of whom 62 had been exposed to paraquat or malathion in Sabah	Questionnaire and semen parameters	Semen quality of people exposed to pesticides was lower compared to unexposed group.	Poor
Mathews, <i>et al</i> ⁴⁰	Cameroon / 2003	741 growers who grow various crops including oil palm	Survey	The main herbicides used by oil palm growers were paraquat, glyphosate, while metalaxyl, maneb and copper were the principle fungicides. Cypermethrin and chlorpyrifos were the main insecticides.	Poor
Shariff, <i>et al</i> ⁴¹	Malaysia / 2008	427 independent smallholders and nursery operators	Face-to-face interview	Paraquat was the preferred herbicide but other herbicide types were also used such as glyphosate. Among those who used paraquat minor health problems were reported such as skin problems, nosebleed and nail problems.	Poor

*Critical Appraisal Skills Programme (CASP); studies that scored "yes" on 5–6 criteria rated good; 3–4 rated average; and <3 rated poor.

different. For FFB closer to the ground, harvesters use a chisel and cut the FFB with a push-cutting motion;²⁶⁻²⁸ for taller palms, the harvesters use a sickle attached to a long pole and cut the FFB with a pull-cutting motion.²⁷ During this process, the harvester often has to be in an awkward position to keep control of the long sickle. The weight of each FFB ranges from 10–50 kg depending on the age of the palm.^{8,22,27,28}

Fresh Fruit Bunch (FFB) Collector

The FFB collectors transport the FFB to the processing area (mill). They collect the FFB using a mini-tractor and/or an open truck.¹⁸ The tractor can transport up to 2000 kg of FFB in one load, but in some plantations, the palms are too close to each other to allow tractor access.¹⁸ Therefore, smaller open trucks with a carrying capacity of 500 kg are used.¹⁸ Both machine types vibrate and are very noisy.²⁸ To load the FFB on the truck, the worker pierces the FFB with a metal hook and swings it onto the truck.^{18,28}

Loose Fruit Collector

During harvest, some FFBs fall on to the ground causing some of the fruits to dislodge from the core. These loose fruits are still collected for processing, as uncollected loose fruits will eventually grow into a new oil palm, which prevents the maximum growth of other palms. The collectors use a wheelbarrow, rack, and broom to sweep the loose fruit on the ground and then pick them up and load them into a sack.^{18,28} When the sacks are full, they are loaded into a manual wheelbarrow. Loose fruit collectors also follow tractors or open trucks to pick up the fallen fruits.^{17,28}

Stalk and Frond Cutter

The oil palm stalk is big and thorny; it is considered to be waste and is removed. The cutters use a chisel and sickle similar to the harvesting tools. After cutting,

the workers cut and arrange the stalk and frond with an axe for easy collection by the tractor.^{17,18,28}

Fertilizer Spreader

Fertilizing activities are performed manually in most oil palm plantations, whether smallholder operated or large estates.⁴³ The fertilizers are distributed using a lorry, with one worker carrying the fertilizer bag (50 kg) on his shoulder while another worker spreads the fertilizer on the ground by hand.¹⁸

Weeding and Pest Control

Palm oil crops are susceptible to a range of pests and diseases and therefore a wide array of pesticides and herbicides are used in their control and/or prevention.⁴³ Application methods can vary across plantations but the most common method reported in the literature was the use of backpack sprayers.^{12,18}

Types of Occupational Hazard in the Palm Oil Industry

Musculoskeletal Disorders

Musculoskeletal disorder (MSD) risk factors have been assessed using questionnaires, observations, video analysis, and electromyography, and shown to vary by the height of the palms being harvested, and the amount of mechanization.²⁸

Several studies reported a prevalence for MSD injuries. The 7-day prevalence of lower back injuries was reported in two studies and ranged from 24.5% among 143 manual harvesters of palms with cutting heights at or below the waist⁴⁴ to 28% among 446 male harvesters and collectors from 10 plantations where the maturity of the palms was not reported.²² Seven-day prevalence for injuries of the knee (14% and 15%), neck (11% and 13%), and upper back (10% and 8%) was similar between workers on non-automated and semi-au-

tomated plantations, respectively.^{22,44}

The 12-month prevalence for MSD complaints was more commonly reported. Twelve-month prevalence for low-back pain ranged from 87.1% to 58% among manual harvesters^{22,44} to 37.5% among harvesters on a semi-automated plantation (using a mini-tractor fitted with a grabber arm and trailer), where the height was well above the head height.²⁸ The 12-month prevalence for injuries of the shoulder ranged from 60% to 28% among manual harvesters,^{19,22,23} 34.1% among harvesters on semi-automated plantations,^{18,28} and 19% among general plantation workers.⁴⁵ Twelve-month prevalence was similarly high for injuries of the upper back (94.3 to 21%)^{22,23,44} among FFB cutters and collectors on non-automated plantations, and slightly lower (upper back 35.2%)²⁸ among those on semi-automated plantations. The prevalence of knee injury was particularly high in a non-automated plantation set in hilly terrain (45.5%).⁴⁴ Among workers cutting at heights above six metres (with 69% of workers cutting at heights above 13 metres), the most commonly reported MSD was in the hand/wrist area (87%) followed by the shoulders and arms (84%).²⁹

The determinants of MSD in oil palm plantation workers, measured using a variety of tools, have been examined in several studies.^{19,20,22,27,46} These attempted to estimate where the risk of exposure to MSD might occur and which actions or postures might place the worker most at risk. Risk information has been collected in a variety of ways including questionnaire (Quick Exposure Check)²⁰ or (the Ovako Working Posture Assessment [OWAS]),²² the Rapid Entire Body Assessment (REBA),¹⁹ or the Rapid Upper Limb Assessment (RULA).²⁷ Each method measured a different component of the risk, but all measures reported high to very high exposure risks for most tasks undertaken. Overall, activities with the highest risk seemed to be lifting

FFBs,^{19,20,22} and cutting, particularly at height.^{22,27,46}

The only trial we identified was a controlled intervention using the International Labour Organizations' Participatory Action-Oriented Training.⁴⁷ Participants were manual harvesters from two Malaysian plantations working with young palms. The plantations were randomly assigned to either the intervention group or control group, with 49 and 21 participants, respectively. The intervention group had increased self-reported MSD complaints following the intervention and the authors suggested that there were psychosocial and organizational factors, such as piece work, work rate and work team structure, that were negatively impacted by the intervention.

Infectious Diseases

Since most oil palm plantations are in tropical areas, there are several tropical infectious diseases that have been documented to be common in these workers. In a study from Papua New Guinea, approximately a third of workers had positive blood slides for malaria, with no difference between men and women, and highest rates in 5–9-year-old children.³⁰ The authors calculated that several thousand days work were lost from malaria and recommended that the company invest in mosquito proofing houses, and provision of insecticide-treated bed-nets. In Myanmar, 65.4% of internal migrants who worked on oil palm plantations self-reported having had malaria.³¹ In Ghana, 17.0% of oil palm workers had asymptomatic malaria parasitemia.³³

Leptospirosis is a severe zoonosis that is transmitted through animal hosts.⁴⁸ A study in Malaysia found that 28.6% of workers had serological evidence of leptospirosis infection.^{32,49}

A study of employees of an oil palm plantation in Ghana investigated the prev-

alence of a range of worm infestations. Onchocerciasis was detected in 84.1% of workers; 41.6% of workers had intestinal worm infestations (mainly *Ascaris lubricoides* and hookworm).³³

Melioidosis, caused by exposure to *Pseudomonas pseudomallei*, occurred predominately among workers who were involved in weeding, drain cleaning, and land clearing.⁵⁰

Stress and Mental Health Disorders

Poor mental health was a concern for palm oil workers and employers because of the long-term burden of illness and resulting loss of productivity.^{34,35} High demands of manual labor, the risk of MSDs, infections, and poor living conditions coupled with low wages, long working hours, and precarious work can be major stressors for oil palm plantation workers. Furthermore, the majority of workers on oil palm plantations are migrant workers, who may not have a supportive social network.^{3,16} Only two studies examining the mental health or stress of oil palm plantation workers were identified in this review. Both of these were conducted in Selangor, Malaysia. Among 109 participants of a study examining mental health of FFB cutters, 36% reported mental distress as measured by the General Health Questionnaire-12 (GHQ). The stress marker, salivary α -amylase, was raised in relation to psychological stress and heat stress, working posture and the force required to cut a FFB.³⁵ Similarly, a high prevalence of mild to moderate anxiety (28%) and a low prevalence of mild to moderate depression (9%) was reported among 47 plantation workers aged 20–40 years, using the Depression Anxiety Stress Scales (DASS-21). The prevalence of anxiety was higher than that reported among other rural communities in Malaysia. The authors suggest that another work has found that high anxiety is associated with low income. In a separate Malaysian study,

no workers reported stress as measured by the DASS-21, and the prevalence of depression was lower than that reported in other rural Malaysian communities.³⁴

Pesticide and Herbicide Exposure

Four studies investigated paraquat exposure among farmers, including palm oil workers.^{36–39} Among 119 paraquat handlers and 54 non-handlers on a range of farms in Costa Rica, including oil palm plantations, exposure to paraquat was only detected among paraquat handlers on spray day; levels varied by crop and not among workers.³⁸ This study and another one found no association with lung disease.³⁷ Exposure to a range of pesticides among farmers, including plantation workers in Sabah, Malaysia, was reported to increase the risk of having abnormalities in three out of five semen quality parameters (sperm count, motility and teratospermia), although differences were not found by type of pesticide (paraquat or malathion) and the study sample sizes were small (62 exposed).³⁹

In addition to exposure to paraquat, palm oil workers are known to be exposed to other pesticides, however, the literature on this subject is limited. For example, studies in both Cameroon and Malaysia found that the main herbicides used by the oil palm growers are paraquat and glyphosate while metalaxyl, maneb, and captan are used as fungicides and cypermethrin and carbaryl are the most common insecticides.^{40,41}

Discussion

We found that many of the common tasks undertaken by workers on oil palm plantations during harvesting were associated with increased risks of MSD, and that the prevalence of MSDs reported in most studies was high. Additionally, palm oil workers were at risk of infectious diseases and stress and mental disorders because of

For more information on occupational and health hazards in palm wine trade: see <https://www.theijoem.com/ijoem/index.php/ijoem/article/view/177>



their working and living environments and were also exposed to a range of pesticides, in particular, paraquat. In general, work on oil palm plantations remains largely unmechanized, and reliant on low-paid workers. This lack of automation increases the risk of work-related injury and disease for these workers.

Apart from one Indonesian study, all the reviewed studies assessing risk of MSDs among plantation workers were based on Malaysian plantations.²⁷ Although there is some increasing mechanization in Malaysia, particularly in the collection of FFB and loose fruit, FFB cutting is still largely manual using the traditional chisel or sickle on a pole.^{18,26,51} The physical nature of FFB harvesting introduces ergonomic hazards with FFB weighing 5–50 kg;⁵² FFB can be harvested from waist-high to up to 20 m.^{27,28} When the harvesting involved palms in their 1st to 3rd year of growth, the FFBs were between 0.5 and 3 m high. Cutters working on younger palms adopt a stooped posture both to reach the FFB and to move under the fronds. As the height of the FFBs increases, the cutter adopts a more extended trunk posture, particularly the neck. Lower FFBs are cut with a pushing motion using a chisel and FFBs at around 3 metres high are cut using a sickle and a pulling motion. For heights in between the cutters adopt a mixture of action and tool. Collectors use a hook or metal pole to lift FFBs from the ground to a wheelbarrow, requiring significant forward bending and twisting under load and must take some care when lifting FFBs to avoid detaching or damaging fruit. The loose fruit is collected by hand using a broom. The prevalence of MSDs was high in all studies although this was generally based on self-reporting using a translated Nordic questionnaire.

Infectious diseases such as malaria, leptospirosis and meliodosis appear to be common in oil palm plantations. Oil palms

require considerable amounts of water for growth, which makes the plantations an ideal environment for mosquito breeding.³⁰ Rats are often sighted due to their attraction to fresh oil palm fruits, while cows are often allowed to graze within the plantation for their manure's effect on crop yield.^{32,53} These animals may contaminate the soil and water near the plantation, which then exposes the workers to the leptospirosis.^{53,54} In addition, palm oil workers usually live near the plantation, sometimes in poor quality housing with minimal facilities that may also contribute to the risk of infectious diseases.³⁰ Migration might also impact on the risk of malaria if the worker moves from an area with low malaria endemicity to one with high prevalence.³¹

We found little information on studies examining the use of pesticides beyond paraquat. Furthermore, most studies that examined exposure to pesticides identified in this review were relatively recent (published in 2005 or later). This suggests that paraquat might still be the pesticide of choice in many plantations. Paraquat has been used as a herbicide since the 1960s and can control a wide range of grass and dicot weeds without causing soil erosion. Its toxicity is dependent on its route of exposure; moderately toxic via oral intake, slightly toxic by the dermal route and inhalation is considered unlikely.³⁸ Paraquat is still registered and widely used in developing countries due to its low cost and effectiveness.⁵⁵

This review highlights the occupational hazards and increased risks of MSDs, infection, mental disorders, and pesticide exposure among palm oil workers. In contrast to the size and geographic reach of the palm oil industry, there is little research on the occupational health and safety of its workforce. Most studies identified in this review were based on small numbers of workers and were limited in scope, with

the vast majority of research undertaken in Malaysia. In light of the potential of palm oil for use as a biofuel, this is an industry with strong growth potential. Further research and interventions are necessary and timely to improve the working conditions of this already vast and growing workforce.

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