

Analyses of Working Postures among Malaysia Pineapple Plantation Workers Using Ovako Working Posture Analysis System

Nur Fazrina Binti Mohamad Salleh
Occupational Safety and Health Program
Faculty of Engineering Technology, Universiti Malaysia Pahang
26300, Gambang Pahang Malaysia
fazrinaasalleh@gmail.com

Ezrin Hani Binti Sukadarin
Occupational Safety and Health Program
Faculty of Engineering Technology, Universiti Malaysia Pahang
26300, Gambang Pahang Malaysia
ezrin@ump.edu.my

Abstract — Ovako Working Posture Analysis System (OWAS) is a method which was extensively used in studying work postures. In this study, OWAS method was utilized to evaluate working postures of pineapple plantation workers on full job cycles in plantation and to determine if there was significant association with the prevalence of musculoskeletal symptoms among them. There were 103 pineapple plantation workers, with an average working experience of one to three years, participated in this study. Four major job activities of pineapple plantation were videotaped at the plantation and the process of analyzed was conducted afterward. OWAS identified for an overall distribution that planting, manual weed and harvesting were tasks which fell into category Action Category (AC) 3 which indicated distinctly harmful and AC4 which indicated extremely harmful. This study also identified there was a significant relationship between OWAS postural category and the prevalence of musculoskeletal symptoms of lower back and waist. To sum up, working in a pineapple plantation was a physical demanded job which involved poor prolonged postures. Consequently, some preventive actions must be applied to reduce the exposure.

Keywords— Pineapple Plantation, Posture, Musculoskeletal Symptoms, OWAS

1. INTRODUCTION

Awkward working postures are one of ergonomic risk factors identified in musculoskeletal injury. Previous published studies suggested that two types of detrimental health effects from prolonged awkward postures at work were (1) body pain, discomfort or numbness and (2) work-related musculoskeletal disorders (WMSDs) [1,2]. Some of the examples of awkward postures were kneeling [3], stooping [4], squatting [5] and bending forward [6].

Agriculture sector is identified as one of the most hazardous and risky occupational sector [7]. This claimed was supported by Meksawi [8] who reported that high prevalence of musculoskeletal problems were found among farmers. In placing more emphasis, several published studies have reported the association of awkward body postures related pains or symptoms of musculoskeletal injuries among farmers [9, 10, 7, 4].

Pineapple plantation is one of the most aggressive agricultural process [11]. Pineapple plantation workers are directly exposed to numerous musculoskeletal injuries risk factors, including prolonged awkward postures in their routine work, which are unavoidable. The examples of such awkward postures are stooping, squatting, kneeling, forward bending and heavy lifting. According to the result of a risk assessment conducted by Tamrin and Aumran [12] in a Malaysia pineapple plantation, most job activities especially planting and manual weed removal poses high risk toward workers, which can contribute to musculoskeletal injuries due to poor postures.

Many postural observational methods had been advocated to evaluate the exposure towards WMSDs risk factors [13]. One broadly used postural observation method assessment is Ovako Working Posture Analysis System (OWAS) [14]. This method was developed in Finland for a steel industry company, Ovako Oy, in year 1973 to describe the workload in the overhauling of iron smelting ovens [15]. OWAS was based on observation, analyzing and controlling workers' insufficient and poor postures

while performing their functions in their jobs [16]. OWAS which described the whole body postures using four digit codes (refer Table 1) representing the position of back (4 options), arms (3 options), legs (7 options) and the load to be handled (3 options) [17]. OWAS method offers a look-up table for translating the four digit code into four action categories. There were a total of 252 possible combinations that can be derived, and these combinations were categorized into four category actions. These actions were used as a guide to indicate the need for change or any ergonomics intervention. A possible limitation for this method is that the posture categories of OWAS could be quite broad to provide a precise description of posture [26]. However, according to Beheshti et al., [23], the inter observer reliability of this method has been reported as 90% and higher. Hence, this method is significant to be use in postural analysis studies.

In this study, OWAS method was used in order to analyze working postures among pineapple plantation workers. The purpose of this study was to (1) discover the prevalence of musculoskeletal symptoms among pineapple plantation workers and (2) identify and examine awkward posture risk factors that could contribute to musculoskeletal disorders among pineapple plantation workers.

Table 1: Postural Codes of Trunk, Arm, Leg and Force in OWAS

Posture	Trunk		Arm		Leg		Force (kg)	
Postural Categories	1	straight/upright	1	both arms below shoulder height	1	sitting	1	<10
	2	bent forward	2	one arm above shoulder height	2	standing on both legs straight	2	10-20
	3	straight and twisted	3	both arms above shoulder height	3	standing on one straight leg	3	>20
	4	bent and twisted			4	standing or squatting on both legs bent		
					5	standing or squatting on one bent leg		
					6	kneeling on one or both legs		
					7	walking		

2. METHODOLOGY

The study areas were located in Pahang. Three different pineapple plantations were chosen according to their similar nature of work. A total of 103 respondents were participated in this study which their ages were ranged from 17 to 52 years old with mean and standard deviation of (3.57 and 1.57). They were all had been employed for one to three years with mean and standard deviation of (1.21 and 0.41).

A. Prevalence of Musculoskeletal Problems

A study on the prevalence of musculoskeletal problems was performed by using a modified questionnaire adapted from Nordic Musculoskeletal Questionnaire [18]. This survey questionnaire comprised of a sequence of objective questions with multiple-choice responses which emphasized the lower extremities of worker's body. To investigate musculoskeletal discomfort, comprehensive questionnaires on work-related pain were included. Interview session was conducted among the pineapple plantation workers to determine any sort of pain or discomfort affecting any of their body regions during each work activity related with pineapple plantation.

B. Postural Analysis Assessment

Postural analysis assessment by using OWAS method was conducted among pineapple plantation workers by using digital photography (Canon, Japan). A dynamic activity for a certain process was captured and by using a stand still photos, OWAS was conducted. Frequent, extreme and worst postures of workers while executed their job were chosen.

C. Statistical Analysis (Statistical Package Social Science (SPSS) software version 24)

After obtaining the results for both assessments, Chi-square test was applied to investigate if there was a significant association between the specific pain or discomfort complaints and OWAS postural category. This statistical analysis was important for justification on any musculoskeletal problems aroused and its relationship with poor working postures among pineapple plantation workers. Figure 1 show the process flow of methodology for this study.

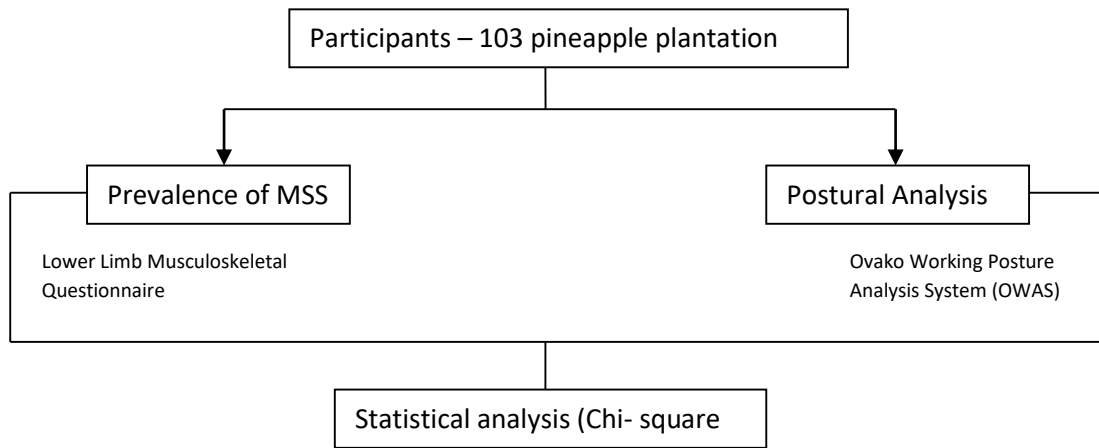


Figure 1: Flow chart of methodology

3. RESULTS

Figure 2 presents the prevalence of musculoskeletal symptoms for back and lower extremities among the population. Pineapple plantation workers reported having musculoskeletal complaints during the last 12 months predominantly on the lower back of the body with 62.1% followed by waist with 58.3% and knees with 33%. On the other hand, 32% of musculoskeletal complaints on upper back of the body, 19.4% on thighs and lastly, 14.6% on ankles. In general, symptoms were more prevalent on lower back followed by waist and knees. Normal job cycles in a pineapple plantation involved four main tasks begins with planting, maintaining crops (hormone, fertilizer), manual weed control and harvesting (refer Figure 3). In this study, OWAS postural analyses were conducted for all job activities.

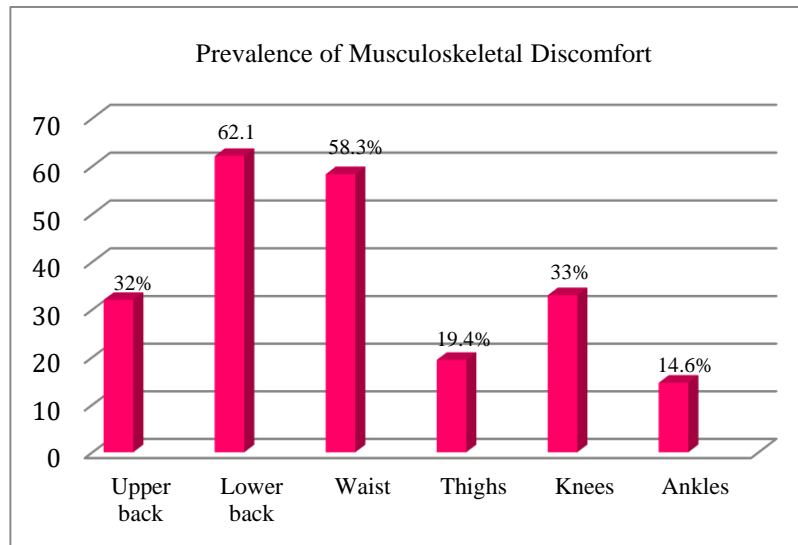


Figure 2: The prevalence of musculoskeletal symptoms among pineapple plantation workers



Figure 3: A worker is planting pineapple suckers into plant crop beds (1); A worker is using sharp sickle to manually remove weed (2); Maintaining crop process (fertilizer and hormone) using spray method (3); Harvesting pineapple fruit process was conducted by worker by using a sharp machete or sickle (4)

Table 2 shows the overall percentage distribution of postures score for trunk, arms, legs and force for pineapple plantation workers while executed the four main jobs. In planting activity, the most frequent posture for the trunk, arms and legs were bent forward (58.3%), both arms below shoulder height (100%), and kneeling on one or both legs (50.5%). All force was less than 10 kg (100%). In maintaining crops activity (hormone and fertilizing), the most frequent postures for the trunk, arms and legs were straight or upright (55.3%), both arms below shoulder height (66.9%) and walking (71.8%). The force was mostly less than 10 kg (63.1%). Meanwhile, in manual weed activity, the most frequent postures for the trunk, arms and legs were bent forward (62.1%), both arms below shoulder height (57.2%) and standing on both legs bent (71.8%). The force involved was completely below 10 kg (100%). In the last activity which was harvesting, the most frequent postures for the trunk, arms and

legs were bent forward (67%), both arms below shoulder height (60.2%) and standing on both legs bent (38.8%). All forces were under range of 10 kg (100%).

Table 2: Distribution of postures in pineapple plantation activities (planting, maintaining crops, manual weed, harvesting)

Body Part/Force		Activities (%)			
		Planting	Maintaining crops	Manual weed	Harvesting
Trunk	straight/upright	17(16.5)	57 (55.3)	2 (1.9)	4 (3.9)
	bent forward	60 (58.3)	21 (20.4)	64 (62.1)	59 (67.0)
	straight and twisted	0 (0)	6 (5.8)	0 (0)	11 (10)
	bent and twisted	26 (25.2)	19 (18.4)	37 (35.9)	29 (28.2)
Arms	both arms below shoulder height	103 (100)	70 (66.9)	59 (57.2)	63 (60.2)
	one arm above shoulder height	0 (0)	32 (31.1)	43 (41.7)	40 (38.8)
Legs	sitting	6 (5.8)	0 (0)	0 (0)	0 (0)
	standing on both legs straight	0 (0)	47 (28.2)	29 (27.2)	34 (33.0)
	standing on one straight leg	8 (7.76)	0 (0)	0 (0)	0 (0)
	Standing/squatting on both legs bent	29 (35.9)	0 (0)	74 (71.8)	41 (38.8)
	Standing/squatting on one bent leg	8 (7.8)	0 (0)	0 (0)	27 (26.2)
	kneeling on one or both legs	52 (50.5)	0 (0)	0 (0)	0 (0)
	walking	0 (0)	56 (71.8)	0 (0)	0 (0)
Force	<10 kg	103 (100)	67 (63.1)	103 (100)	103 (100)
	10-20 kg	0 (0)	35 (33.9)	0 (0)	0 (0)

The action categories which were classified from one to four indicated the severity for each posture analyzed followed by subsequent need of corrective actions (refer Table 3). The higher the value of the action category, the more severe the musculoskeletal system was affected, hence the corrective action became higher in priority. The four body parts were assessed by referring the description of position and their corresponding OWAS code was obtained. After four codes had been identified, an action category table was referred in order to classify the level of risk and its required related action.

Table 3: OWAS action categories and action required

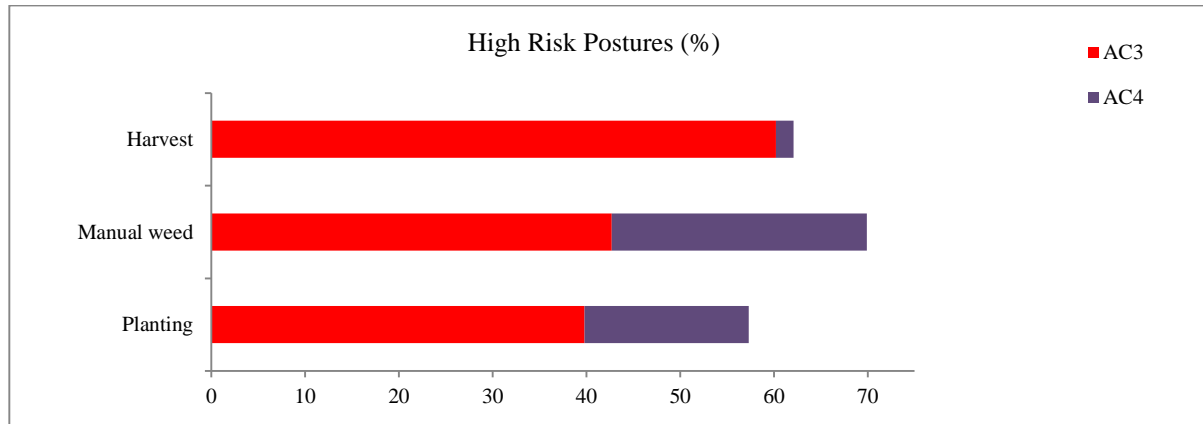
Action Category	Description	Action Required
AC1	Normal posture	No action required
AC2	Slightly harmful	Action required in the near future
AC3	Distinctly harmful	Action required as soon as possible
AC4	Extremely harmful	Action required immediately

Of all 103 stand still dynamic activity photos of workers, OWAS identified three activities; planting (39.8%), manual weed (42.7%) and harvesting (60.2%) which categorized mainly in AC 3. Meanwhile, planting (17.5%) and manual weed (27.2%) fell into AC 4 category which indicated as extremely harmful. Table 4 listed the percentages of postures failing into AC 1, 2, 3 and 4 for four major jobs. Besides showing great differences across the tasks, OWAS also drawn a comparison from these tasks according to the number of postures which needed to be corrected soon (AC 3) or immediately (AC 4). Figure 4 presents the percentages of poor postures for major jobs. Poor working postures by pineapple plantation workers were observed frequently with 60.2% distinctly harmful postures during harvesting and 27.2% for extremely harmful posture during manual weeding.

Table 4: Postures of pineapple plantation workers for all jobs

N=103	NP (%)	SH (%)	DH (%)	EH (%)
Planting	15.5	27.2	39.8	17.5
Maintaining crops	59.2	39.8	0	0
Manual weed	0	30.1	42.7	27.2
Harvesting	1.9	35.9	60.2	1.9

Note: NP = Normal Posture, SH= Slightly Harmful, DH = Distinctly Harmful, EH = Extremely Harmful



Note: *Only maintaining crops was not listed under the category of extreme poor posture

Figure 4: High risk posture (Action Categories 3 and 4) for planting, manual weed and harvest process

Table 5 shows the result from chi-square test on the prevalence of musculoskeletal symptoms and OWAS analysis. Chi-square test revealed that there is a significant relationship between musculoskeletal symptoms and OWAS analysis during planting (lower back and waist), maintaining crops (lower back), manual weed (lower back and waist) and harvesting (waist).

Table 5: Chi-Square test between musculoskeletal symptoms and OWAS analysis

Body Parts	χ^2 P-value			
	Planting	Maintaining crops	Manual weed	Harvesting
Upper back	0.18	0.16	0.07	0.06
Lower back	0.03*	0.04*	0.03*	0.07
Waist	0.04*	0.20	0.01*	0.01*
Thighs	0.07	0.07	0.06	0.20
Knees	0.09	0.40	0.09	0.07
Ankles	0.22	0.35	0.10	0.06

Note: * p < 0.05= significant

4. DISCUSSIONS

OWAS postural analysis method was used to investigate working postures of pineapple plantation workers during work. The purpose was to assess the exposure and risk for work-related musculoskeletal problems for pineapple workers. The prevalence of musculoskeletal symptoms among pineapple workers illustrated the most affected body parts in this study were the lower back, waist and knees. In terms of self-reported musculoskeletal symptoms, the 12 months prevalence of having pain at any body parts among workers were considerably medium as compared to a study by Rani et al., [19]. However, the result in this study were consistent with the previously reported postural risks in developing musculoskeletal problems in pineapple plantation by Tamrin & Aumran [12].

Pineapple plantation workers are exposed to musculoskeletal problems such as low back pain due to awkward and extreme postures. This claim can be supported by similar research done by Rani et al., [19] which revealed that low back pain symptoms among pineapple plantation workers was linked with excessive bending during planting and manual weed process. As they also have long working hours (six hours on plantation), the constant exposure was considered prolonged and hazardous. Moreover, heavy lifting is always significantly associated with low back pain [20]. Harvesting process in pineapple plantation was also considered strenuous as the amount of weight carried by the workers was massive with 30-40 kg per basket. A number of similar findings were also reported where risks of low back pain in agricultural sector were heavy physical work and awkward postures [21, 22].

Postural assessment phase observed experienced and competent workers in plantation. The observations covered four major job cycles which assured the content validity of this study. It is identified that planting, manual weed and harvesting were the major jobs with poor working posture exhibited by pineapple plantation workers. It is further found that the most critical postures which associated with these three tasks are trunk (bend forward) and legs (squatting, stooping, and standing one leg bent). Apart from that, there was also significant association between prevalence of musculoskeletal symptoms and OWAS postural category which are at lower back and waist of workers during the four major jobs.

It was observed in a study by Gangopadhyay et al., [9] which also applied OWAS method in agricultural postural study, that the workers performed work constantly in awkward postures during certain agricultural job activities. Some of the activities were compatible with pineapple plantation activities such as planting and manual weeding. This remarks that these two postures need corrective action immediately. It is concluded from the study that agricultural workers work continuously in a bent posture and by enduring in an awkward or stressful posture during a particular agricultural activity, they suffer from discomfort or pain in different parts of their body particularly the lower back, neck and knee regions.

In a study of investigating postural risk factors among farmers by Beheshti et al., [23], the results indicated that 77% of the body posture observed was harmful and only 23% was normal during harvesting. According to a study by Sett and Sahu [24], awkward postures adopted by workers especially farmers were very stressful. This claim can also be supported by a similar research done by Das and Gangopadhyay [25] where the results revealed that types of work postures which frequently adopted by farmers particularly in low grow crops plantations caused several musculoskeletal complaints and LBP. It was then found that most of the working postures are of high risk and require immediate corrective measures, as indicated by OWAS system.

5. CONCLUSIONS

This study highlighted awkward and extreme postures in Malaysia pineapple plantation. The findings show that manual weed is the most high risk task as it involves extreme postures which required trunk to bent and twisted while arms are sometimes above shoulder height. Meanwhile, planting activities is also considered as high risk as it occupies prolonged and repetitive awkward postures. Development and intervention programs such as modification of tools should be implemented in order to increase efficiency and to allow reduction of exposure. In addition, training on safe postures should be cultured among pineapple plantation workers to prevent or mitigate the developing of musculoskeletal problems among them.

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