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Original Article

Association of Workplace Stressors with Salivary Alpha-Amylase Activity Levels among Fresh Fruit Bunch Cutters in Selangor

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Abstract

Background: A cross sectional study was conducted to determine the association between occupational stress risk factors and salivary alpha-amylase activity levels among fresh fruit bunch (ffb) cutters at oil palm plantation.

Methods: A total of 109 ffb cutters were selected from two oil palm plantations in Pulau Carey, Selangor at west coast of Malaysia in 2015. Questionnaires were used to determine socio-demographics and occupation information, distress level were determined by using translated 12-items-General Health Questionnaire (GHQ). Kestrel Heat Stress Tracker 4400 was used to measure wet bulb globe temperature (WBGT) for heat stress exposure. Posture analysis was examined based on Rapid Upper Limb Assessment (RULA) method in evaluating working posture and Borg CR-10 scale was rated by ffb cutters to determine exerted force during harvesting process. Stress response system was determined by measuring salivary alpha-amylase (sAA) activity by using sAA kinetic enzyme assay kit (Salimetrics).

Results: 35.8% of ffb cutter had high score indicating psychological distress. 49.5% of the cutters had high heat stress exposure. 91.8% used force exertion of 50%MVC and above to cut fresh fruit bunches and 62.4% were classified in Action Level 4 under RULA. 77.0% of the ffb cutters showed high levels of sAA activity after cutting fresh fruit bunches.

Conclusion: Workplace stressors such as working environment and ergonomics risk factors play a role to develop stress at workplace among ffb cutters. Therefore, stress preventive measures are needed to reduce the stressors at workplace.

Keywords: Psychological distress, Salivary alpha-amylase, Heat stress exposure, Oil palm plantation

Introduction

Stress at workplace is also known as occupational stress that exists due to several stress factors at workplace. Occupational stress is a global concern which did not only affect workers but also the organization. It is categorized under psychosocial hazard that threat health and safety of workers which encompassed the social, mental and physical well-being of workers. World Health Organization (1) states that excessive demands and pressure that incompatible to worker's knowledge and abilities, less opportunity to make choice or control and receive less support from others will contribute to the most stressful type of work. An online survey reported 70% of Malaysian workers showed an increased number of stress-related illnesses due to global economic crisis and 48% reported of increased stress level (2). Workplace stress statistics presented that 77% experienced of physical symp-

toms and 73% claimed of psychological symptoms (3). Recently work-related stress has grown into a major concern and advised employers to recognize it as it could lead to health problems (4). In Malaysia, many studies on occupational stress are mainly conducted within the education (5-12) and healthcare industry (13-15) as compared to agricultural industry (16-18).

Therefore this study was conducted to identify the workplace stressors that contributed to the occupational stress in agricultural industry especially among fresh fruit bunch cutters at oil palm plantations.

Materials and Methods

Study background and design

A cross-sectional study was conducted in 2015 with a participation of 109 fresh fruit bunch cutters at two oil palm plantations in Pulau Carey situated to the south of Port Klang and north of Banting town in Selangor region (coordinate: 2°51'40.5"N 101°22'02.4"E). Six divisions in two oil palm plantations were selected to represent the Selangor state (west region of Malaysia). Purposive sampling method was used to determine the sampling units that fulfill the inclusive criteria. Criteria selected for this study including workers' age between 19 to 60 yr old, male and had a minimum of a year working experience at current plantation. Exclusive criteria for this study included a subject who took medication such as anti-hypertensive; asthma medication, and similar adrenergic agonists or antagonists because these types of medications would alter the normal production of salivary alpha-amylase. This study used self-administered questionnaire, Kestrel heat stress tracker 4400 for heat stress assessment and rapid upper limb assessment (RULA) method for postural analysis, Borg Category Ratio (Borg CR-10) and salivary alpha amylase assay to measure saliva alpha amylase activity level.

Questionnaire

A set of questionnaire was used to determine socio-demographics and occupational information. General Health Questionnaire-12 (GHQ-12) was used to identify the psychological well-being of respondents for the past few weeks. GHQ-12 was translated into Indonesian version by translators using the forward-backward procedure. A reliability test was examined and the value of 0.70 Cronbach's Alpha was obtained. Each item accompanied by four-point Likert scale responses (0-1-2-3) from "*better than usual*" to "*much less than usual*". The scores were summed up by adding all the items on the scale ranging from 0 to 36 and mean score was used as a cut-off point due to the various threshold of the GHQ-12 as the rough indicator for the best cut-off point (19). A result of GHQ-12 mean score was 7.86 with cut-off point 8/9 was used to determine the prevalence of psychological distress.

Borg Category Ratio (Borg CR-10)

Borg scale CR-10 was used to measure the level of force while performing the harvesting process. This scale was used in this study due to strong support from theoretical and empirical reasons to assess ergonomics at work (20). Respondents were asked to rate the physical exertion in accordance to the scale ranged from 0 (no effort at all) to 10 (extremely strong) for every steps in harvesting ffb. The rating of perceived exertion in Borg CR-10 was further analyzed into percentage of maximal voluntary contraction (%MVC) ranging from 0%MVC to 100%MVC (21). Level of force was determined by classifying %MVC into normal force (<50%MVC) and high force (≥50%MVC).

Kestrel heat stress tracker 4400

Personal heat stress exposure among respondent was determined by wet blub globe temperature (WBGT) outdoor index from Kestrel heat stress tracker 4400. WBGT is a valid heat index in determining the risk of occupational heat stress (22). WGBT comprised of nature wet bulb temperature, globe temperature and air temperature for outdoor condition (23). The device was placed 3 feet from the ground and within 1 meter from the respondents. A minimum of 10 minutes was the acclimation time required to stabilize the device with the surrounding temperature and WBGT was measured hourly for every respondents. As WBGT index only comprising the index of the environment temperature, American Conference of Govern-

mental Industrial hygienists Threshold Limit Values (ACGIH TLV) had been referred in heat stress study to include the clothing factor and metabolic rate to determine the heat stress.

Posture Analysis

Posture analysis was conducted based on Rapid Upper Limb Assessment (RULA) method (24) by analyzing the workers' motion for the harvesting process captured via video recorder. This method was used to evaluate the level of ergonomics risk for within three stages. Basically RULA Employee Assessment Worksheet divided into two groups namely Group A evaluated the Arm and Wrist Analysis and group B evaluated the neck, trunk and leg analysis. First stage was the selection of the most difficult work postures; the longest period of time that the posture sustained and the posture where the highest loads occur for assessment. Second stage was the scoring of the selected posture by using the scoring sheet, body-part diagrams and table provided in the RULA Employee Assessment Worksheet. Finally, the grand scores were converted into action level in the third stage. The assessment method scored twice as the workers involved both sides of the limbs to perform their task to get the average grand score for classification of RULA action level from 1 until 4 (Table 1).

Salivary alpha-amylase activity

Samples were collected in the morning within 6am-7am as a baseline after providing instructions and demonstration to the repondents. Second saliva sample were taken after ensuring the respondents had already cut for at least 10 ffb for benchmark. Saliva collection was done by using Salimetrics Oral Swab (SOS)-Catalog No:5001.02; Salimetrics Swab Storage Tube (SST) -Catalog No: 5001.0; Salimetric Salivary alpha-amylase assay kit 96 wells per kit-Catalog No: 1-1902 and ice box. Instructions provided in Salimetrics' Saliva Collection Handbook 3rd edition was used a guidance to collect saliva samples accurately. Samples were futher analysed in chemical pathology laboratory by following the instructions in Salimetrics sAA kinetic enzyme assay kit manual. The unit of sAA activity is expressed in U/ml with normal adult value of 80.0U/ml (25) is referrred as cut-off point for sAA activity.

Table 1: Description of RULA action levels

	RULA action levels
Action level 1	Score 1 or 2 indicated that the postures is acceptable if it is not maintained or repeated for long periods
Action level 2	Scores 3 or 4 indicate that further investigation is needed, and changes may be required
Action level 3	Scores of 5 or 6 indicates that investigation and changes are required soon
Action level 4	Scores of 7 indicates that investigation and changes are required immediately

Statistical Analysis

Data were analyzed using Statistical Package for Social Science (SPSS) version 22 (Chigao, IL, USA). Univariate analysis was used to determine descriptive statistics such as mean, percentage, standard deviation and frequencies in interpreting the socio-demographics, prevalence of psychological distress, heat stress exposure, level of force and working posture whereas bivarate anyalsis was run to identify the significance factors for the workplace stressors.

Results

Demographic information

Table 2 showed demographic information of 109 respondents. 94.5% of the respondents were Indonesians, 3.7% were Bangladeshi, with the Malaysian were much lower (0.9%) and other nationality contribute 0.9% from the total percentage. 53.2% of the respondents attended up to primary education, 35.8% had education until primary school, 8.3% of the respondents had education up until high education level. Only 8.3% of the respondents who had no attended any formal education.

Prevalence of psychological distress

GHQ referred to the state of psychosocial health of well-being. 62.4% of respondents experienced of lack of sleep due to worry because of long distance relationship with family members. 36.7% felt constantly under strain whereas 50.5% could not overcome difficulties.

Table 2: Socio-demographics data

Variables	n (%)	Mean ± Standard Deviation	Range (Min-Max)
Age (yr)			
<20	1 (0.9)		
20-29	35 (32.1)	33.26±6.268years	19-46
30-39	50 (45.9)		
≥40	23 (21.1)		
Nationality			
Malaysian	1 (0.9)		
Indonesian	103 (94.5)		
Bangladeshi	4 (3.7)		
Others	1 (0.9)		
Marital status			
Single	25 (22.9)		
Married	82 (75.4)		
Divorced/Separated	2 (1.8)		
Education level			
None	9 (8.3)		
Primary	58 (53.2)		
Secondary	39 (35.8)		
High education	3(2.8)		
Number of dependents			
None	6 (5.5)		
1-5 persons	82 (75.2)		
6-10 persons	18 (16.5)		
≥11 persons	3(2.8)		

46.8% of respondents reported unhappy and distressed though 56.9% felt reasonably happy about life and nearest to person important. Table 3 presented GHQ-12 score with 35.8% found to have psychological distress.

Prevalence of heat stress exposure

Heat stress exposure was determined by calculation of WBGT index. Table 4 presented the temperature measured in this study with range of $WBGT_{outdoor}$ between 25.2°C to 32.7°C; mean and median resulted 28.9°C and 29.1°C. Median of WBGT was used as cut-off point to determine the prevalence for heat stress exposure for this study. Based on the result 49.5% of the respondents had been identified of having heat stress.

Prevalence of force exertion

Referred to Fig. 1, respondents increasingly applied normal force to cut oil palm frond. After the first two cut of oil palm frond, the usage of high force was decreased for the third times. 8.3% of respondents rated the force level less than 50%MVC to cut the heavy stalk of ffb. Compared to ffb cut, majority of the respondents (91.7%) reported to apply high force to cut ffb.

Table 3: GHQ-12 score

Score	n	(%)
2	2	1.8
3	5	4.6
4	7	6.4
5	14	12.8
6	16	14.7
7	15	13.8
8	11	10.1
9	7	6.4
10	9	8.3
11	5	4.6
12	6	5.5
13	3	2.8
14	4	3.7
15	4	3.7
16	1	0.8

Table 4: Environmental temperature

Variable (°C)	Mean ± Standard deviation	Median	Range (Min-Max)
Nature wet bulb temperature	28.4 ± 1.976	28.1	24.8-33.0
Globe temperature	30.3 ± 2.457	30.8	33.9-25.2
Dry bulb temperature	30.5±1.890	30.5	26.1-33.9
$WBGT_{outdoor}$	28.9 ± 1.893	29.1	25.2-32.7
Relative humidity	73.79 ±10.11	74.1	59.9-95.6
Dew point	28.0±1.794	28.4	24.6-32.4

Working posture

Results of postural analysis done with RULA method were presented on Table 5. A total of 37.6% of the respondents scored from 5 until 6 were classified under Action level 3 compared to 62.4% of found to be classified under Action Level 4.

Salivary alpha-amylase activity

Salivary alpha-amylase baseline levels showed the mean of sAA levels was 71.45U/ml with a standard deviation of 11.19 ranging from 50.11U/ml to 94.86U/ml.

After cutting ffb, salivary alpha-amylase levels showed the mean of sAA levels was 100.29U/ml with a standard deviation of 16.39 ranging from 70.08U/ml to 126.47U/ml. The difference of sAA activity level showed in Table 6 presented mean of sAA after cutting ffb was significantly higher than baseline value.

Table 5: RULA Action levels

RULA Grand Score	RULA Action Levels	n(%)
5 & 6	3	41 (37.6)
7	4	68 (62.4)

Association of workplace stressors for salivary alpha-amylase activity level

Psychological distress, heat stress exposure, working posture, age of oil palm tree, type of harvesting tool and cut of oil palm frond for three times showed significant association with sAA activity level during working as listed in Table 7.

Table 6: Comparison of salivary alpha-amylase activity

Salivary alpha amylase activity (/ml)	Mean ± Standard Deviation	Range (Min-Max)	Variance	*t*	*P* value
Pre-harvesting	71.45±11.19	50.11-94.86	125.30	-21.75	<0.001
Post-harvesting	100.29±16.39	70.08-126.47	268.61		

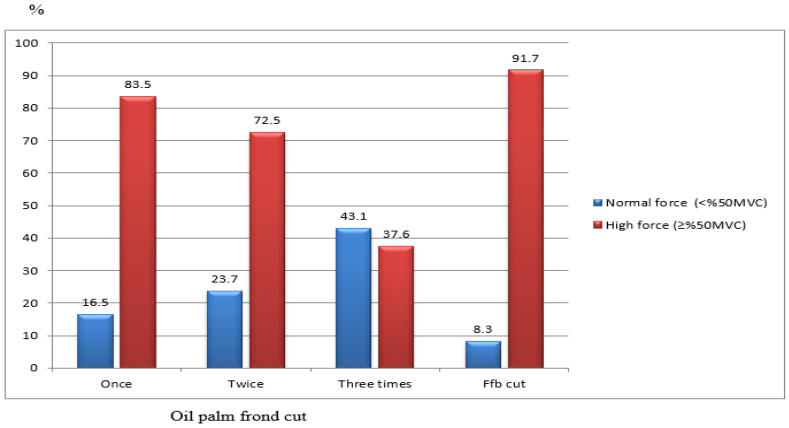

Fig. 1: Force used during harvesting process

Based on result by chi square test in psychological distress, heat stress exposure, working posture, age of tree and force exertion used when cutting three times of oil palm frond were found to be significance (*P*-value <0.05) with the activity of sAA during working.

Table 7: Association between workplace stressors with salivary alpha-amylase activity

Variables	n(%)	Alpha-amylase level (U/ml) n (%)		χ^2	*P* value
		Low	High		
Psychological distress				5.524	0.019
No	70 (64.2)	21 (19.3)	49 (44.9)		
Yes	39 (35.8)	4 (3.7)	35 (32.1)		
Heat stress exposure					
No	55 (50.5)	25 (22.9)	30 (27.5)	31.851	0.000
Yes	54 (49.5)	0 (0.0)	54 (49.5)		
Working posture					
Action level 3	41(37.6)	5(4.6)	36(33.0)	4.289	0.038
Action Level 4	68(62.4)	20(18.3)	46(42.2)		
Force exertion (%MVC)					
Oil palm frond cut					
Once				0.479	0.489
<50	18(16.5)	3(2.8)	15(13.8)		
≥50	91(83.5)	22(20.2)	69(63.3)		
Twice				0.202	0.653
<50	30(27.5)	6(5.5)	24(22.0)		
≥50	79(72.5)	19(17.4)	60(55.0)		
Three times				9.341	0.002
<50	47(53.4)	6(6.8)	41(46.6)		
≥50	41(46.6)	17(19.3)	24(27.3)		
Fresh fruit bunch cut				0.003	0.958
<50	9(8.3)	2(1.8)	7(6.4)		
≥50	100(91.7)	23(21.2)	77(70.6)		

Discussion

In the field of stress research the salivary cortisol and alpha-amylase are commonly used as salivary biomarkers (26). Saliva has been the reliable biological stress markers of the sympathetic nervous system (SNS) and the hypothalamus pituitary adrenal (HPA) axis, respectively due to the different medium and source of sAA and cortisol produced (27). Based on the study, the evidence showed that sAA could be an indicator for the activity of the sympathetic–adrenal– medullary (SAM) system as the cortisol indicated the changes from the hypothalamic–pituitary–adrenal (HPA) axis. As this study investigates the effect of psychological and physiological to stress which enable stress level measured by salivary alpha-amylase levels as the response from the sympatho-adrenal-medullary (SAM) system.

In psychological stress, saliva amylase has been used to identify the stress level because sAA produced more quick and sensitive respond to psychological stress than cortisol levels and psychological distress also showed significant association with sAA (28). Moreover salivary enzyme alpha amylase found to be more sensitive to the body changes related to stress (29, 30). Psychological effect was assessed in this study as it is a part of stress process because a healthy state of mind

would eliminate the inability to carry out normal function at work. Previous study also found that the sAA levels had responded to psychological stress (31) and more significant and rapid reaction compared to cortisol due to psychological stressor (32).

Apart from the psychological stressors, sAA had been found to provide responds to physical stressors which relevant towards the investigation of working posture. More than half of ffb cutters (62.4%) are found to be classified in Action Level 4 in RULA. This finding study also support the same finding of postural stress among ffb cutters where forceful exertion and rapid work pace lead to awkward position during cutting ffb (33). Different age of oil palm tree and type of harvesting tools are also been considered in exerting the force to cut ffb.

High force decreasingly applied when cutting the oil palm frond compared to normal force by respondents. Although, only 80.7% of the respondents reported to perform cutting the oil palm frond for three times, the action has found to be significant with sAA activity. No significance association was found during cutting ffb and cutting for oil palm frond for once and twice. This could be summarized that ffb cutters felt stressful if they need to cut of oil palm frond more than twice.

Although ACGIH index was referred, no heat stress index was adapted due to inappropriate level for heat stress in tropical country such as Malaysia. The finding based on ACGIH index indicated that all workers are in heat stress. Therefore, ACGIH's heat stress index is not applicable in local weather. Heat stress exposure level in this study is determined by median as a cut-off point. Ffb cutters who experienced heat stress exposures tend to secrete higher sAA during working due to alteration of normal physiological state. Levels of sAA also found to be significantly associated due to exposure to heat (34).

Conclusion

Physiological, psychological and physical stress has been studied as the predictive stress factors. The study indicated that there is a significant association between psychological stress, heat exposure, working posture and the force needed to cut the frond more than twice with the level of sAA. Strategies need to be designed on these stress factors to reduce and prevent stress level among ffb cutters by proposing a suitable and appropriate stress preventive measure for the future sustainable development in oil palm plantation sector.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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