

Ergonomic Risk-Related Musculoskeletal Disorders Among Farmers in Nakhon Sawan, Thailand

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Received December 25, 2023
Accepted March 5, 2024
Published April 30, 2024

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ABSTRACT

Introduction: Farmers are a major group who encounter health problems from their work, particularly musculoskeletal disorders. The musculoskeletal problems of farmers are related to ergonomics in every step of their work. The study aimed to understand ergonomic problems among farmers living in Nakhon Sawan Province.

Methods: A cross-sectional study design was applied to identify risks of musculoskeletal disorders related to ergonomic risk among farmers who had registered with the Ministry of Agriculture and Cooperatives system and lived in Thanamaoy Sub-district, Mueang District in Nakhon Sawan Province. The sample size was calculated using Krejcie and Morgan's formula, and 195 participants were required for the analysis. Participants were selected voluntarily. The rapid entire body assessment (REBA) assessment was used to assess ergonomics risk. Participants were interviewed about their body discomfort related to musculoskeletal disorders. Descriptive statistics were used to describe the characteristics of participants and risk factors.

Results: A total of 195 were recruited into the study; 69.20% were males. The total ergonomic risk was 8.55 REBA (± 2.72), presented at a high risk. The mean REBA score in posture of ploughing was 8.33 (± 2.75). The mean REBA score in sowing rice seeds and fertilizer was 8.42 (± 2.78). The mean REBA score in a posture of the harvest was 8.91 (± 2.93). It was found almost hard in the body discomfort assessment at 3.31 ± 1.17 . According to the total body discomfort, it was found that participants felt mostly in the lower back 4.83, (± 0.78), thigh 4.78, (± 0.92), and neck 4.41, (± 0.92).

Conclusion: Farmers who work on farms are suffering from ergonomic risks, particularly musculoskeletal systems. Effective public health interventions should be introduced to reduce the ergonomic problem among the farmers in Nakhon Sawan Province, Thailand.

Keywords: Ergonomics; Musculoskeletal; Farmers

Introduction

"Ergonomics" comes from the Greek "Ergon," meaning work, and "Nomos," which means law [1]. Ergonomics is the scientific discipline that deals with understanding the interaction between humans and other elements of a socio-technical system. In this definition, ergonomics is the profession that applies theory, principles, data, and design methods to optimize human well-being and the overall performance of a system. It is, in particular, responsible for designing and evaluating tasks, jobs, products, environments, and systems to make them compatible with people's abilities, needs, and limitations [2]. In Europe, the focus of ergonomics is to be found in industry, and it has been

linked to an interest in improving worker performance and satisfaction. In this way, studies began on anthropometry, work medicine, architecture, lighting, etc. The definition of ergonomics is extended today to all human activities in which artifacts are implemented [1]. In Thailand, The Royal Institute [3] has coined the term ergonomics to mean the science of arranging work conditions so that people work in a comfortable state and have welfare resulting in good performance according to the set goals of a work system that produces effective results and working people have a good quality of life. Illnesses and accidents from work have been minimal, eventually, particularly work-related musculoskeletal disorders (WMSDs), which are a group

of symptoms resulting from ergonomic risk factors. The WMSD has been reported to have a high prevalence every year.

Farmers are the main national economic drivers of Thailand. Many agricultural products have been contributed to world food product chains. Regarding farmer's health, it was reported that almost half of Thai farmers suffered from musculoskeletal system (45.%) [4]. The musculoskeletal problems of farmers are related to ergonomics in every step of their work. As Phanwong et al. [5] reported, several processes of farming were producing health problems for Thai farmers, including the process of harvesting the rice, followed by the process of maintaining the crop, the process of planting rice, and the process of preparing the area for rice cultivation, respectively. Considering the farming process, improper physical position while working in the field was the main source of physical health problems, particularly in preparing the area for rice cultivation. The majority of ergonomics and psychosocial risk factors among Thai farmers were found in the process of planting rice, the process of maintaining the crop, and the process of harvesting the rice. There are eight steps of rice farming; various steps are detected in different levels of occupational health hazards among Thai farmers, particularly presenting body pain after the field and musculoskeletal disorders caused by improper working positions [6]. A study conducted in Chiang Rai Province [7] reported that physical moving during farming was the source of health problems (80.3%), such as forward or sideway and lifting heavy materials.

Nakhon Sawan Provincial Agricultural Extension office reported that Nakhon Sawan Province currently has 4,716,060 rai (accounting for 79.18% of the overall province area) farming. The major crop is rice, which is the largest area in the northern region of Thailand [8]. Previous studies on farmers' health focused on the impacts of chemical use [9] and factors that affect the decision-making to purchase chemicals

[10]. Therefore, in this study, we aim to investigate ergonomic problems among farmers living in Thanamaoy Sub-district, Phayuha Khiri District, Nakhon Sawan Province, where most people work in rice farming [8].

Methodology

Study design

A cross-sectional study design was applied to identify the risks of musculoskeletal ergonomics among farmers living in Thanamaoy Sub-district, Phayuha Khiri District, Nakhon Sawan Province, Thailand.

Study population and study sample

The study population was 386 farmers registered with the Ministry of Agriculture and Cooperatives Farmer System and lived in the Thanamaoy Sub-district. Mueang District in Nakhon Sawan Province. A sample size of 195 participants was determined using Krejcie and Morgan's formula. Participants were selected by random method.

Inclusion criteria: (i) able to participate in the study till the end of the research; (ii) never experienced an accident that caused bone and muscle abnormalities previously; (iii) not less than three years in continuing working as a farmer; and (iv) aged 18 years and over.

Research instruments

Two research tools were used in the study. First, five experts in the field validated a rapid entire body assessment (REBA) (Fig.1) assessment to assess an ergonomics risk (IOC = 1.00). Second, the musculoskeletal discomfort questionnaire on the body parts of farmers was adapted from the Cornell Musculoskeletal Discomfort Questionnaire (Fig 2). The five scales were classified; 1= none, 2=easy, 3=medium, 4=hard and 5=maximal hard. The piloting was applied among 50 farmers, and Cronbach's alpha coefficient was found to be 0.84.

REBA Employee Assessment Worksheet

based on Technical note: Rapid Entire Body Assessment (REBA), Hignett, McAtamney, Applied Ergonomics 31 (2000) 201-205

A. Neck, Trunk and Leg Analysis

Step 1: Locate Neck Position

 Step 1a: Adjust...
 If neck is twisted: +1
 If neck is side bending: +1
 Neck Score:

Step 2: Locate Trunk Position

 Step 2a: Adjust...
 If trunk is twisted: +1
 If trunk is side bending: +1
 Trunk Score:

Step 3: Legs

 Adjust: 30-60°
 Add +1
 Add +2
 Leg Score:

Step 4: Look-up Posture Score in Table A
 Using values from steps 1-3 above, locate score in Table A
 Posture Score A:

Step 5: Add Force/Load Score
 If load < 11 lbs: +0
 If load 11 to 22 lbs: +1
 If load > 22 lbs: +2
 Adjust: If shock or rapid build up of force: add +1
 Force/Load Score:

Step 6: Score A, Find Row in Table C
 Add values from steps 4 & 5 to obtain Score A.
 Find Row in Table C.
 Score A:

Scoring:
 1 = negligible risk
 2 or 3 = low risk, change may be needed
 4 to 7 = medium risk, further investigation, change soon
 8 to 10 = high risk, investigate and implement change
 11+ = very high risk, implement change

SCORES

Table A

	Neck			Trunk			Legs					
	1	2	3	1	2	3	1	2	3			
Legs	1	2	3	4	1	2	3	4	1	2	3	4
Trunk	1	2	3	4	1	2	3	4	1	2	3	4
Posture	2	3	4	5	3	4	5	6	4	5	6	7
Score	3	2	4	5	6	4	5	6	7	5	6	7
	4	3	5	6	7	5	6	7	8	6	7	8
	5	4	6	7	8	6	7	8	9	7	8	9

Table B

	Wrist			Upper Arm		
	1	2	3	1	2	3
Wrist	1	2	3	1	2	3
Upper Arm	1	2	3	1	2	3
Score	2	1	2	2	3	4
	3	3	4	4	5	5
	4	4	5	5	6	7
	5	6	7	8	7	8
	6	7	8	8	9	9

Table C

Score A (score from table A + load/force score)	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	1	2	3	3	4	5	6	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9
6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	7	8	9	9	9	10	10	11	11	11
8	8	8	8	9	10	10	10	10	10	11	11	11
9	9	9	9	10	10	10	11	11	11	11	12	12
10	10	10	10	11	11	11	11	11	12	12	12	12
11	11	11	11	11	12	12	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12	12	12	12

Table B

Score B (table B value + coupling score)	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	1	2	3	3	4	5	6	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9
6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	7	8	9	9	9	10	10	11	11	11
8	8	8	8	9	10	10	10	10	10	11	11	11
9	9	9	9	10	10	10	11	11	11	11	12	12
10	10	10	10	11	11	11	11	11	12	12	12	12
11	11	11	11	11	12	12	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12	12	12	12

Step 7: Locate Upper Arm Position:

 Step 7a: Adjust...
 If shoulder is raised: +1
 If upper arm is abducted: +1
 If arm is supported or person is leaning: -1
 Upper Arm Score:

Step 8: Locate Lower Arm Position:

 Lower Arm Score:

Step 9: Locate Wrist Position:

 Wrist Score:

Step 9a: Adjust...
 If wrist is bent from midline or twisted: Add +1

Step 10: Look-up Posture Score in Table B
 Using values from steps 7-9 above, locate score in Table B
 Posture Score B:

Step 11: Add Coupling Score
 Well fitting Handle and mid range power grip: *good*: +0
 Acceptable but not ideal hand hold or coupling acceptable with another body part: *fair*: +1
 Hand hold not acceptable but possible: *poor*: +2
 No handles, awkward, unsafe with any body part: *Unacceptable*: +3
 Coupling Score:

Step 12: Score B, Find Column in Table C
 Add values from steps 10 & 11 to obtain Score B. Find column in Table C and match with Score A in row from step 6 to obtain Table C Score.
 Score B:

Step 13: Activity Score
 +1 1 or more body parts are held for longer than 1 minute (static)
 +1 Repeated small range actions (more than 4x per minute)
 +1 Action causes rapid large range changes in postures or unstable base
 Activity Score:

Final REBA Score
 Table C Score + Activity Score =

Task name: _____ Reviewer: _____ Date: _____

This tool is provided without warranty. The author has provided this tool as a simple means for applying the concepts provided in REBA.

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Figure 1 REBA employee assessment worksheet

The musculoskeletal discomfort questionnaire

Name.....Surname.....

Gender: ☐ Male ☐ Female

Age..... years

	None	Easy	Medium	Hard	Maximal
Neck	☐	☐	☐	☐	☐
Shoulder	☐	☐	☐	☐	☐
Upper Back	☐	☐	☐	☐	☐
Upper Arm	☐	☐	☐	☐	☐
Lower Back	☐	☐	☐	☐	☐
Forearm	☐	☐	☐	☐	☐
Wrist	☐	☐	☐	☐	☐
Hip/Buttocks	☐	☐	☐	☐	☐
Thigh	☐	☐	☐	☐	☐
Knee	☐	☐	☐	☐	☐
Lower Leg	☐	☐	☐	☐	☐

Figure 2 The musculoskeletal discomfort questionnaire

Data collection procedure

The letter for asking permission and cooperation from relevant organizations was sent out, including Thanam Oi Muang Hak Subdistrict Municipal. A random method was used to select the study samples based on inclusion-exclusion criteria. Before the interview commencement, all selected samples were provided with information about the study, including potential risks. Research tools were used as the main research materials for collecting data.

Statistical analysis

Descriptive statistics were used to present the general information of the participants in the forms of percentages (for categorical data) and means with standard deviation (SD) for continuous data.

Ethical considerations

The study was approved for its ethical research in human subjects by the Human Research Ethical Committee of Nakhonsawan Province (NSWPHO-028/65), which was approved on 8 December 2022.

Results

General information of participants

A total of 195 people were recruited into the analysis: 69.20 % were males, 47.7% were aged 36-45, and 38.50% were aged 46-55 (Table 1).

Table 1 General characteristics of participants.

Personal characteristics	n	%
Gender		
Male	135	69.20
Female	60	30.80
Age (years)		
26-35	9	4.60
36-45	93	47.70
46-55	75	38.50
56-65	18	9.20

Ergonomic risks from posture by Rapid Entire Body Assessment (REBA)

The total ergonomic risks result was detected at 8.55 (± 2.72). This was informed that farmers were at high risk and needed to investigate, and behavior changes were required. The REBA scores on different working positions, ploughing, sowing rice seeds and fertilizer, and harvest are presented in Table 2

Posture of ploughing

The majority of the participants worked their farming on wheel ploughs. The ergonomic risks assessment showed in posture of ploughing; neck bent down and the trunk leaned to forward about 0-20 degrees; legs had continue movement and in unbalanced

position; knees bent about 30-60 degrees and more than 22 pounds of force or workload used while moving; hands or upper arms were raised about 45-90 degrees; and the lower arms had angle between 60-100 degrees and the position of the wrists (palm bone line) had flexion and/or extension not more than 15 degrees. The hold, lift, or force positions were detected for over 1 minute. The mean REBA score was 8.33 (± 2.75), which was detected as high risk, and more investigation and implementation changes were required.

Posture of sowing rice seeds and fertilizer

Most farmers used backpack gasoline seeds and fertilizer spreaders. The ergonomic risks assessment showed in a posture of sowing rice seeds and fertilizer; neck bent down and the trunk leaned forward about 0-20 degrees; legs were continued movement and in an unbalanced position; knees bent about 30-60 degrees and more than 22 pounds of force or workload used while moving; hands or upper arms were raised about 20-45 degrees; the posture of the lower arm has raised at an angle more than 100 degrees; the posture of the wrists (palm bone line) had flexion and/or extension more than 15 degrees, and it deviated (ulnar-Radial), and their body movement was repeated with small range action which was more than four times per minute. The mean REBA score was 8.42 (± 2.78), which indicates a high risk that required more investigation and implementation of behavior change.

Posture of harvest

The ergonomic risks assessment showed in a posture of harvest; neck bent down more than 20 degrees. The trunk leaned forward more than 60 degrees; the legs continued movement and located unbalanced position; the knees bent more than 60 degrees; hands or upper arms were raised about 45-90 degrees; lower arms have been angle between 60-100 degrees; posture of the wrists (palm bone line) were flexion and/or extension more than 15 degrees and it twisted and deviated (ulnar-Radial), and The body movement was repeated small range action more than four times per minute. The mean REBA score was 8.91 (± 2.93), which indicated that it was at a high-risk level requiring more investigation and behavior change implementation.

Table 2 Ergonomic risks by REBA assessment of participants.

REBA assessment	Mean o ergonomic risks (REBA score)	S.D.
Posture of ploughing	8.33	2.75
Posture of sowing rice seeds and fertilizer	8.42	2.78
Posture of harvest	8.91	2.93
Total ergonomic risks	8.55	2.72

Total body discomfort from working of farmers

Body discomfort assessment using the musculoskeletal discomfort questionnaire showed that the body discomfort was almost hard (3.31, ± 1.17). It means that participants felt body discomfort mostly in the lower back (4.83, ± 0.78), thigh (4.78, ± 0.92), neck (4.41, ± 0.92), lower leg (2.68, ± 1.33), and hip/buttocks (2.74, ± 1.21) (Table 3).

Table 3 Total body discomfort reported by participants.

Body parts	Level of body discomfort	
	Mean	S.D.
Neck	4.41	0.92
Shoulder	3.89	1.11
Upper back	3.89	1.11
Upper arm	3.67	1.44
Lower back	4.83	0.78
Forearm	3.02	1.33
Wrist	3.33	1.32
Hip/Buttocks	2.74	1.21
Thigh	4.78	0.92
Knee	3.78	1.42
Lower leg	2.68	1.33
Total	3.73	1.17

Discussion

Farmers in the inThanamaoy Sub-district lived at a high risk of ergonomic problems, including musculoskeletal discomfort from their framing practices. Farmers worked improperly in their daily lives, leading to ergonomic-related health problems.

Ergonomic problems are frequently reported among farmers who have difficulty in a proper position while working on their farms. Several steps of farming were detected as an improper position for farming, including sowing rice seeds and fertilizing; farmers were working with backpacks of gasoline seeds and fertilizer spreaders. They needed to carry hard equipment of more than 10 kg [5] and walk in the field. This was strongly related to body discomfort with hard pain (3.31, ± 1.17) level. Pengseesang [6] reported that 99.7% of farmers suffered from physical pain due to their position in their work in farming, particularly in the harvest processes. Characteristics of farming that require muscles and bones are lifting, reaching, pulling, dragging, bending, and standing. A working posture unsuitable for a long time could lead to injury. Lower back pain is the main physical problem of farmers in Thailand [11] due to these muscles acting to control the balance of the whole body while standing. The lumbar is a muscle that keeps stability for the body in efficient movement [12]. Then, several muscles collaborate to maintain the position while framers work on their farms. If working in an improper position and cannot maintain

balance [13], muscles could have injury that causes pain and discomfort [14].

In addition, this study found that continued movement and the imbalanced standing position affected thigh discomfort (4.78, ± 0.92), which is an extremely hard level. Plowing, sowing, and fertilizing steps of farming and walking through muddy ways, the muscles control body balance for a long time, leading to pain and discomfort [15].

Conclusion

Farmers in Thailand are suffering from working at high ergonomic risk. More investigation is needed, and behavior change is required. The farmers also face a high level of musculoskeletal discomfort. Most farmers have lower back, thigh, and neck discomfort at hard to most hard levels. Implementing proper ergonomic positions among Thai farmers urgently requires measures to reduce the suffering and well-being of the core Thailand national economic drivers.

Acknowledgments

All participants in this study are gratefully acknowledged. We also thank Nakhon Sawan Rajabhat University and Thanamaoy-Muanghak Subdistrict-municipality Office for making this study possible.

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