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Ergonomic Risk and Musculoskeletal Disorders in Rice Farmers at Karang Tanjung Village, Karawang Regency

Nana Rahdiana[1,*], Sani Suhardiman[1], Sukarman[2]
[1]Industrial Engineering Department, University of Buana Perjuangan Karawang, 41361, Indonesia
[2]Mechanical Engineering Department, University of Buana Perjuangan Karawang, 41361, Indonesia
*Corresponding Author: nana.rahdiana@ubpkarawang.ac.id

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ABSTRACT

This study discussed musculoskeletal risk analysis related to ergonomics, occupational safety, and health in agriculture in the Karawang district. Musculoskeletal Disorders (MSDs) are occupational diseases that cause pain in the joints. The working position of rice farmers, especially during planting rice seeds and harvesting rice, is not suitable for ergonomics. This study aims to identify the MSDs experienced by farmers in Karang Tanjung village, Karawang district. The study used an analytical method using the Nordic Body Map (NBM) and RULA questionnaires to assess work posture. A sample of 30 workers was chosen for an observational cross-sectional study. The results showed that the ergonomic risk level entered level 4 in the high category. The most dominant MSDs felt by rice farmers in Karang Tanjung village were the waist (98%) and the neck (95%). This research was expected to serve as a model for future musculoskeletal risk reduction research.

INTRODUCTION

The agricultural sector is vital to Indonesia's economic development because it is an agriculturally based country (Simanungkalit & Sitepu, 2020). The agricultural sector is one type of work that has a high risk for workers (Rekha & Bajpai, 2016; Kuta et al., 2015).The level of health and safety of farmers is determined by extreme environmental conditions and the method and use of technology in land management, which is still lagging behind other countries (Chandra & Prasetyo, 2016). Health services for workers in the agricultural sector are currently not commensurate with the severity of their work. Hence, workers are vulnerable to health problems such as musculoskeletal disorders (MSDs), especially workers who still use the traditional work system. Recent incidents serve as a reminder of the dangers in the workplace. According to the latest ILO estimates, over 1.8 million people die at work in Asia and the Pacific each year. Asia accounts for two-thirds of all work-related deaths worldwide. Each year, more than 2.78 million people die due to workplace accidents or diseases around the world. In addition, there are approximately 374 million non-fatal work-related injuries and illnesses annually, which

results in many work absenteeism (ILO, 2018).

Karawang was known as the "Large of Rice" not only in West Java but also throughout Indonesia from the colonial era until the 1980s. The majority of Karawang's residents work as farmers, both as landowners and as labourers. The government has designated Karawang as Indonesia's largest rice-producing agricultural area due to its large area of rice fields (Aditiya, 2020). The area of Karawang Regency is 1,752.27 km^2 consisting of 30 sub-districts and 309 villages/kelurahan, 54% of the area is paddy fields or the agricultural sector (BPS Karawang, 2020).

Agricultural workers face a wide range of workplace safety and health issues, necessitating immediate research to address these concerns. Traditional agriculture in Indonesia is in poor ergonomic condition and is linked to a high rate of musculoskeletal symptoms. Body posture analysis also shows a high risk from farmer activities (Widyanti, 2018). Several studies have concluded that work-related risk factors are the primary causes of skeletal muscle disorders. Awkward and unnatural bodywork postures, excessive muscle systems, repetitive movements with high frequency, work for long periods, static muscle loading, mechanical contact pressure from tools or workpieces are all factors relevant to the work (Yassierli et al., 2020). Land preparation, sowing seeds, planting rice seeds, maintenance, fertilization, and harvesting are all activities that impact a rice farmer's working situation. A non-ergonomic work position is commonly encountered by rice farmers, particularly while planting rice seeds and harvesting rice. Figures 1 and 2 illustrate common working positions for rice farmers, particularly when planting rice seeds and harvesting rice has not been in an ergonomic position.

Figure 1. Rice seed planting process

Figure 2. Rice harvest process

Several studies on musculoskeletal disorders (MSDs) were conducted by (Chapman & Meyers, 2001; Kirk horn et al., 2010; Mo-Yeol et al., 2016; Dianat et al., 2020; Sombatsawat, 2019). In agricultural workers in the United States, Chapman and Meyers identified and prevented ergonomic injuries. Injury and musculoskeletal disorders were found to be common. Musculoskeletal disorders research in agriculture was conducted in Korea. The results showed that farming is a tough job, with various health risks and musculoskeletal disorders (MSDs) being some of the most common. The wide range of agricultural jobs must be considered when attempting to prevent musculoskeletal injuries. As a result, agricultural ergonomics must deal with a wide range of issues while remaining adaptable in the long run. More efficient production processes, lower labour costs, lower injury and turnover absenteeism, lower medical and worker compensation spending, and lower costs associated with musculoskeletal injuries all result from paying attention to ergonomics (Chapman & Meyers, 2001).

Further research was also conducted by Kirkhorn et al. (2010). The goal of the study was to see how likely agricultural workers were to develop ergonomic and musculoskeletal problems. The findings of the study provided an overview of agricultural ergonomics science and practise for agricultural stakeholders (Kirkhorn et al., 2010). Research with similar themes was also conducted by Mo-Yeol et al. (2016). Musculoskeletal disorders research in agriculture was conducted in Korea. The results showed that farming is a tough job, with various health risks and musculoskeletal disorders (MSDs) being some of the most common. Data obtained from the survey of occupational diseases and injuries of Korean farmers, who interviewed 16,113 farmers, identified risk factors for MSDs in the upper neck at 5.89%, lower neck at 19.62%, and back at 26.9%. MSD risk increases significantly according to the number of years of farming (Mo-Yeol et al., 2016). Research related to the theme of Musculoskeletal disorders in agriculture was also carried out by Sombatsawat (2019). The study was carried out in Thailand's Nakhon Ratchasima province. The results showed that musculoskeletal injuries are a significant health problem for rice farmers in Thailand. The study suggests that appropriate agricultural practices such as work posture, selection of equipment size and haul load should be recommended to prevent MSDs. Research recommends improving workers' occupational health and safety services (Sombatsawat, 2019). Dianat et al. (2020) conducted a more detailed investigation related to the working posture, working conditions, and musculoskeletal of agricultural workers in Iran. The results showed the overall value of musculoskeletal symptoms, especially in the lower back (75.1%), knees (62.1%), upper back (61.55%), and neck (59.9%). The average RULA value of 6.7 means that most farmers in Iran require urgent investigation and a change in their work posture (Dianat et al., 2020).

Unlike previous research, this study applied ergonomics and musculoskeletal disorders risk analysis to traditional agricultural workers in Karawang Regency, West Java, Indonesia. This study aims to obtain preliminary ergonomic risk data related to the impact of musculoskeletal disorders on traditional farmers in the Karawang Regency. The research method was carried out using a Nordic Body Map (NBM) and a RULA questionnaire on 30 agricultural workers. This study uses age, gender, years of service (experience), work procedures, workload, duration, physical activity, body size, health status, and weight as input variables. The response variables in this study were musculoskeletal and fatigue, respectively. Agricultural work posture and fatigue were chosen as the inverting variables.

RESEARCH METHOD

Identification of Parameters

The research variables used in this study have been identified, such as variables (independent), intervening variables, and output/independent variables (responses). The input variable is a parameter that will affect the response variable and functions as a predictor. An intervening variable is a variable that affects the relationship between input and response variables in theory and can be observed and measured. The value of the input variable influences the value of the response variable. The input variables selected in this study were age, gender, years of service (experience), work procedures, workload, duration, physical activity, body size, health status, and weight. In this study, the intervening variables were work posture and fatigue. The complaining Level of Musculoskeletal Disorders (MSDs) has been chosen as the response variable in this study. The relationship between the three variables is presented in Figure 3.

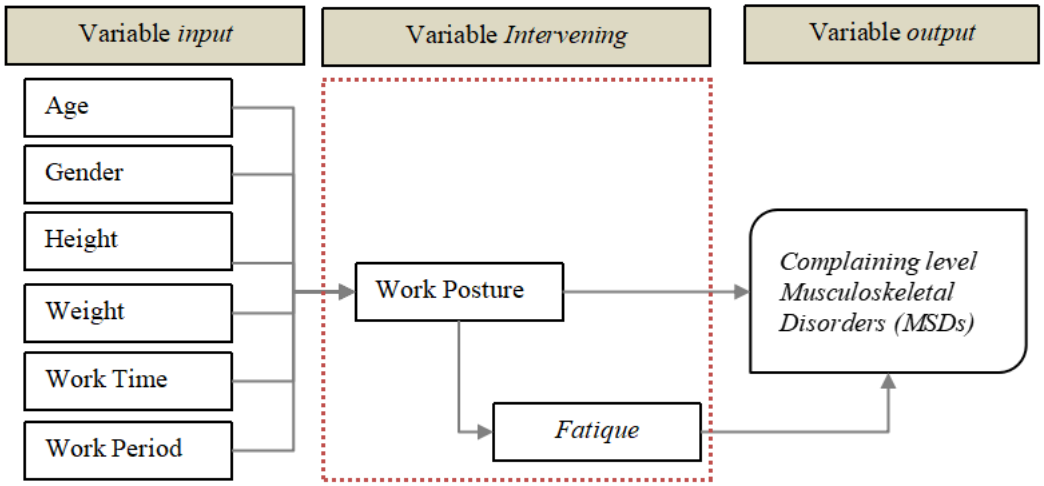

Figure 3. Framework

Questioner of Nordic Body Map (NBM)

An evaluation of the risk of skeletal muscle system complaints is carried out to determine whether a particular job has a risk of skeletal muscle disorders. This evaluation also aims to quantify how considerable the risk is. The tools are used to determine the level of ergonomic risk in MSDs of farmers using the NBM questionnaire. The NBM questionnaire matrix used is presented in table 1.

Table 1. NBM questionnaire matrix

No	Type of Complaint	Pain Level *				Type of Complaint	No
		NP	LP	P	VP		
0	Pain/stiffness in the upper neck					Pain in left wrist	14
1	Pain/stiffness in the lower neck					Pain in right wrist	15
2	Pain in left shoulder					Pain in the fingers of the left hand	16
3	Pain in right shoulder					Pain in the fingers of the right hand	17
4	Pain in left upper arm					Pain in left thigh	18
5	Pain in the back					Pain in right thigh	19
6	Pain in right upper arm					Pain in left knee	20
7	Pain in the waist					Pain in right knee	21
8	Pain in the buttocks					Pain in left calf	22
9	Pain in the ass					Pain in right calf	23
10	Pain in left elbow					Pain in left ankle	24
11	Pain in right elbow					Pain in right ankle	25
12	Pain in left forearm					Pain in left toe	26
13	Pain in right forearm					Pain in right toe	27

*Pain level: NP=No pain (score 1), LP=Little pain (score 2), P= Pain (score 3), VP=Very pain (score 4)

The RULA Worksheet

The angle formed by the wrist corresponds to the process of cutting rice stalks, which involves adjusting the swing movement of the cutting tool (scythe), specifically the position of the wrist, which forms a +/- 15° angle. If held in this position for an extended period of time, it can cause MSDs and increase the risk of carpal tunnel syndrome, an occupational disease (CTS). The work posture levels were analyzed at a rate of 98 percent and 95 percent, respectively.

Table 2. Recommended action recommendations RULA worksheet (Mcatamney, 1993).

Risk level	Final score	Risk category	Action category
1	1-2	Minimum	Acceptable
2	3-4	Small	Investigate further
3	5-6	Medium	Investigate further and change soon
4	7	High	Investigate and change immediately

The Data Analysis Method

The science of ergonomics aims to find a fit between workers and working conditions, to ensure workers are not injured, safe, comfortable, and productive, which is affected by Baron et al. (2001). The analysis data statistics were tested and were conducted with univariate and bivariate tests (Rahdiana, 2017). This study used univariate and bivariate analysis. The univariate analysis describes the data set in the form of frequency, the value with the highest frequency, the minimum value, and the maximum value of the research variables. Bivariate analysis was used to analyze the relationship between the communication ability variable. Analysis data of univariate and bivariate results has been performed by using statistical software. The confidential level was set at 5%, which means that the P-value of variable input less than 5% has a significant impact on the variable response (Sukarman et al., 2020; Budianto et al., 2020).

RESULTS AND DISCUSSION

Analysis of Nordic Body Map (NBM)

Identification of the muscle parts of the body that experience complaints were identified using table 1. The Nordic Body Map (NBM) questionnaire data for 30 respondents was presented in table 3. Table 3 shows the distribution of MSDs from 30 respondents. The most significant type of complaint, "very sick", from the table above, was a pain in the waist with 93% and pain/stiffness in the upper neck with 80%.

Table 2 shows the distribution of MSDs among 30 respondents. It is still difficult to tell which muscles in which body parts cause the most problems. Table 2 shows that "very sick" was the most common type of complaint, followed by "waist pain" (93 percent) and "pain/stiffness in the upper neck" (80 percent). Furthermore, by adding all of the Nordic Body Map scores from each body's muscle parts for 30 respondents, data for 10 of the body's muscles with the highest MSDs can be obtained. Figure 3 showed the data of MSDs in worker farmer in Karawang regency.

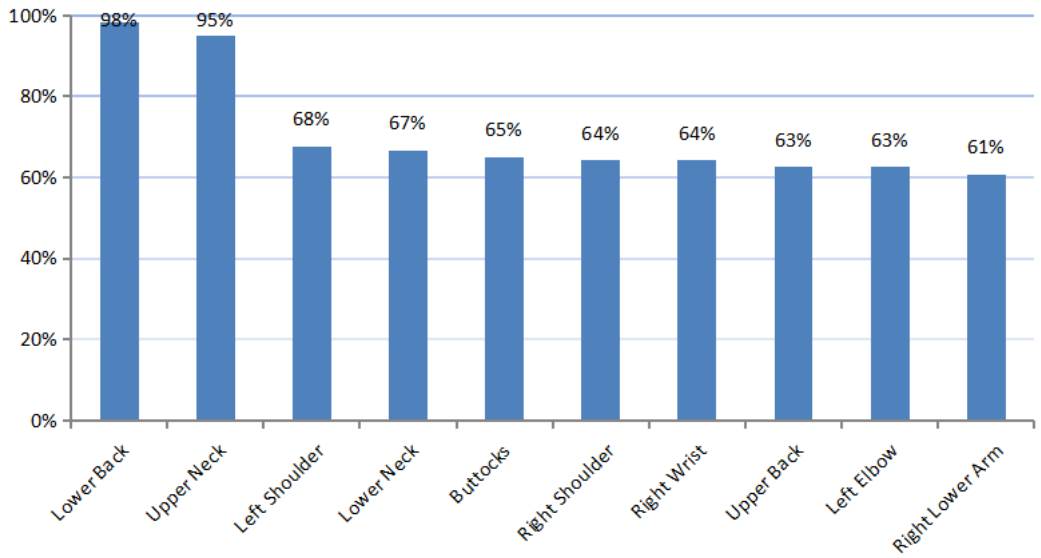

Figure 4. The figure represents the top ten body parts in terms of MSDs.

The highest level of MSDs was found in the muscles of the waist by 98%, upper neck by 95%, left shoulder by 68%, lower neck by 67%, buttocks by 65%, right shoulder by 64%, right wrist by 64 %, 63% back, 63% left elbow, and 61% right forearm. From Figure 5, it can be seen that the most significant percentage or the highest pain intensity is the upper waist and neck.

The data obtained of working postures of farmers who are carrying out the rice harvesting process is carried out using a capture technique, where the angle measurement of certain body parts of farmers is measured through image/photo media using the angulus for android application, the results can be

seen in the following figure 5.

Table 3. Percentage of MSDs of farmers in Karang Tanjung village

No	Type of Complaint	Pain level								Total	
		No pain		Little pain		Pain		Very pain			
		∑	%	∑	%	∑	%	∑	%	∑	%
0	Pain/stiffness in the upper neck	0	0	0	0	6	20	24	80	30	100
1	Pain/stiffness in the lower neck	0	0	15	50	10	33	5	17	30	100
2	Pain in left shoulder	2	7	12	40	9	30	7	23	30	100
3	Pain in right shoulder	1	3	13	43	14	47	2	7	30	100
4	Pain in left upper arm	9	30	15	50	4	13	2	7	30	100
5	Pain in the back	2	7	14	47	11	37	3	10	30	100
6	Pain in right upper arm	5	17	15	50	9	30	1	3	30	100
7	Pain in the waist	0	0	0	0	2	7	28	93	30	100
8	Pain in the buttocks	1	3	14	47	11	37	4	13	30	100
9	Pain in the ass	10	33	13	43	5	17	2	7	30	100
10	Pain in left elbow	1	3	17	57	8	27	4	13	30	100
11	Pain in right elbow	5	17	21	70	3	10	1	3	30	100
12	Pain in left forearm	2	7	16	53	12	40	0	0	30	100
13	Pain in right forearm	2	7	14	47	13	43	1	3	30	100
14	Pain in left wrist	2	7	15	50	11	37	2	7	30	100
15	Pain in right wrist	2	7	15	50	7	23	6	20	30	100
16	Pain in the fingers of the left hand	6	20	21	70	3	10	0	0	30	100
17	Pain in the fingers of the right hand	3	10	22	73	4	13	1	3	30	100
18	Pain in left thigh	6	20	19	63	5	17	0	0	30	100
19	Pain in right thigh	7	23	18	60	5	17	0	0	30	100
20	Pain in left knee	1	3	22	73	6	20	1	3	30	100
21	Pain in right knee	3	10	21	70	5	17	1	3	30	100
22	Pain in left calf	10	33	13	43	7	23	0	0	30	100
23	Pain in right calf	9	30	13	43	8	27	0	0	30	100
24	Pain in left ankle	9	30	18	60	3	10	0	0	30	100
25	Pain in right ankle	10	33	17	57	3	10	0	0	30	100
26	Pain in left toe	17	57	11	37	2	7	0	0	30	100
27	Pain in right toe	18	60	11	37	1	3	0	0	30	100

Figure 5. Work posture of farmers during the rice harvesting process with a traditional sickle

Analysis RULA Worksheet and NBM Questioner

Assessment of body posture on the working posture of farmers during the rice harvesting process with the traditional sickle can be calculated with the help of the RULA Assessment Worksheet. Figure 6 presented the RULA employee assessment worksheets.

Based on the results of the RULA analysis, the work posture of farmers during the rice harvesting process with the traditional sickle tool has a score of 7. The working posture is high risk (category level 4), and it needs immediate action/improvement. Based on the results of observations and interviews, it can be stated that the rice harvesting process using the traditional sickle is not EASNE (Effective, Safe, Healthy, Comfortable, and Efficient). The most dominant causes are the factors of work tools, methods, and humans/farmers themselves (Rahdiana et al., 2021). According to the Nordic Body Map and RULA analyses, agricultural work has a very high risk of ergonomics and MSDs, especially when exposed to

the waist and neck muscles. With risk farmers using the RULA assessment worksheet on the rice harvesting process, they found a final score of 7 based on the risk level category table (Tarwaka, 2015). In the RULA worksheet, a score of 7 means high risk. Corrective action must be taken immediately or now. In the rice harvesting process, the farmer's working posture is in the neck position, forming an angle of > 20°, and even an extension process occurs. The standard or natural position of the neck is to form an angle that is not greater than 10° so that there is no pressure on the cervical disc. The neck position that is lowered by > 20° and maintained for approximately 10 seconds, approximately two times per minute, is an awkward posture in the neck position. The position is perpendicular to the head or in a neutral position. The pressure experienced by the cervical spine is 4.5 kg–6.8 kg, and it is the best and most efficient position (Wibawa & Ardi, 2019).

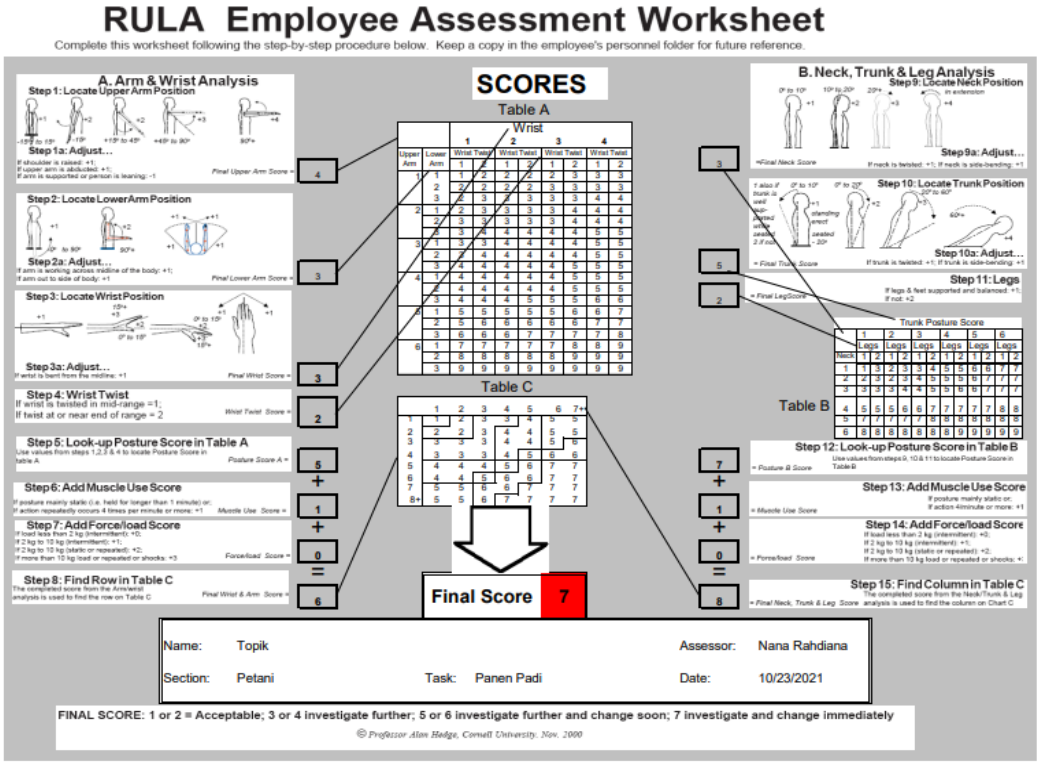

Figure 6. Results of farmer work posture analysis using RULA assessment worksheet

The back posture of rice farmers in this process forms an angle greater than 60°. It happened because farmers had to bend down to carry out the harvest process using a sickle. The risk of low back pain is very high, especially when a body movement is rotated at an angle of 0°–65°. It happened because farmers had to store their crops and their body position. The risk of low back pain increases by 15% when the back is flexed (Wibawa & Ardi, 2019). The extreme posture of the back can cause stretching of the lumbar and abdominal muscles, resulting in spinal compression.

Leg posture in this harvesting process is relatively high-risk because farmers must bend their legs by 30o to 60o. When the leg must be bent, there is a correction factor of +1 in the RULA analysis. This position adds weight to the pressure on the feet. Good posture for the feet means workers do their work in an upright position or a sitting position. The position of the upper arm in the rice harvesting process shows an awkward posture because it forms an angle of 45°–90°. The farmer's upper hand must move away from the farmer's body when doing work. Based on the RULA method, this position poses a greater risk to the upper arm because the more significant the angle formed, the further the hand's position will be from the body, and it is a risky position. The cutting rice stalks and storing rice stalks next to the farmer's standing position. The forearm posture forms an angle of 0°–60° with a move across the line in the middle of the body or out to the side. This condition also contributed to the increase in the RULA score.

The angle formed by the wrist is in line with the process of cutting rice stalks, adjusting the swing movement of the cutting tool (scythe), namely the position of the wrist that forms an angle of +/-15°. If

held like this, it can cause a person to get MSDs and, if done for a long time, can lead to the risk of an occupational disease called carpal tunnel syndrome (CTS). For the analysis of the work posture levels, 98 per cent and 95 per cent were reached, respectively.

The Statistical Data Analysis

The results of a bivariate analysis of age, gender, body mass index, length of work, work period, and MSDs of farmers in Karang Tanjung village are presented in Table 4. The univariate test resulted in the finding that, at the age of > 35 years, the frequency was 17 people (56.7%), and at the age of 35 years, there were 13 people (43.3%). Based on gender, there were 11 men (70.0%) and nine women (30.0%). The body mass index (BMI) is the ratio between body weight and height squared (Rahdiana, 2019). The findings revealed three BMI categories: a thin category of 6 people (20.0%), a standard category of 22 people (73.3%), and an obese category of 2 people (6.7 per cent). Then there are two categories in terms of work length: > 8 hours for as many as 20 people (66.7 per cent) and 8 hours for as few as ten people (33.3 per cent). For the working period, there are three categories, namely > 10 years, as many as 14 people (46.7%), 5-10 years, as many as ten people (33.3%), and five years, as many as six people (20.0%).

Furthermore, to be able to know and assess in more detail the complaints of musculoskeletal disorders and the level of ergonomic risk (skeletal muscle risk) experienced by farmers, especially after work, using Nordic Body Map (NBM) data processing results, as many as eight people (26, 7%) with a high level of complaints, as many as 20 people (66.7%) with a moderate level of complaints, and as many as two people (6.7%) with a low level of complaints.

In the bivariate test, statistical tests were carried out in a chi-square test with SPSS 19; the results were obtained using a P-value. A P-value less than 5% means the input variable significantly influences the variable input. The age variable has a P-value of about 4.8% means there was a significant relationship between age and MSDs. Although the P-value is almost close to 5%, the level of the correlation is weak. Respondents who experienced MSDs with a high-risk level (41.2%) and a moderate risk level (58.8%) were respondents aged >35 years. In contrast, for respondents aged <35 years, respectively, the risk level for MSDs was 7.7% high risk, 76.9% moderate risk, and 15.4% low risk. The data shows that farming at the age of >35 years tends to have a high risk of MSDs and does not rule out the possibility of being very high. These results confirmed with previously research by Dianat et al. (2020).

The gender variable has a P-value of about 55.1%. It means that there was no relationship between gender and MSDs. The composition of the level of complaints of male and female respondents is the same in comparison. For male respondents, the risk level for MSDs is 28.6% high risk, 61.9% moderate risk, and 9.5% low risk. Meanwhile, for female respondents, the risk level for MSDs is 22.2% high risk and 77.8% moderate risk. The body mass index variable was not a significant parameter of MSDs responses. The P-value of the body mass index was about 49.2%. The composition of respondents' complaints with a "thin" and "fat" body mass index had the same level of MSDs risk, namely 50% high risk and 50% moderate risk.

In comparison, respondents with a "normal" body mass index had 72.7% complaints of moderate risk MSDs. The length of work and the working period have P-values of 35% and 27.7%, respectively. Both input variables have a P-value of more than 5%. There was no relationship between the length of work and years of service with MSDs. The majority of respondents experienced moderate levels of MSDs. Thus, farmers' length of work and tenure were stated to not correlate with the level of MSDs; all conditions have the same risk.

According to the findings, individual factors influencing the incidence of MSDs include age, gender, body mass index, length of work, and years of service. Most of the respondents aged > 35 years old who experienced MSDs had a high-risk level (41.2%) and a moderate risk level (58.8%). These findings showed that the older a person gets, the higher his or her risk of MSDs becomes. It occurs due to bone degeneration, which begins around the age of 35 and reduces bone elasticity, raising the risk of musculoskeletal problems. Other factors did not correlate with MSDs, implying everyone was at the same risk level.

Table 4. The results of bivariate analysis of age, gender, body mass index, length of work, work period, and level of MSDs.

Variable	Complaint Level								*P-value*
	Very high		High		Medium		Low		
	N	%	N	%	N	%	N	%	
Age									
≤35 year old	-	-	1	7.7	10	76.9	2	15.4	
>35 year old	-	-	7	41.2	10	58.8	-	-	0.048
Gender									
Man	-	-	6	28.6	13	61.9	2	9.5	
Woman	-	-	2	22.2	7	77.8	-	-	0.551
Body mass index									
Thin	-	-	3	50.0	3	50.0	-	-	
Normal	-	-	4	18.2	16	72.7	2	9.1	
Fat	-	-	1	50.0	1	50.0	-	-	0.492
Work length									
≤8 hour/day	-	-	4	40.0	6	60.0	-	-	
>8 hour/day	-	-	4	20.0	14	70.0	2	10.0	0.350
Work period									
<5 years	-	-	1	16.7	4	66.6	1	16.7	
6-10 years	-	-	6	42.9	8	57.1	-	-	
>10 years	-	-	1	10.0	8	80.0	1	10.0	0.277

CONCLUSION

The rice planting and harvesting process is at risk of falling into the level 4 category in terms of ergonomics. According to the RULA (Rapid Upper Limb Assessment) method analysis, the high category with recommendations for an investigation and change immediately. Gender, BMI, length of employment, and tenure have no bearing on MSD levels. The waist and the neck have a percentage of MSDs of 98 % and 95%, respectively. These were the body parts subjected to a high level of ergonomic risk. Traditional agriculture workers were advised to improve work procedures and tools before the situation worsened to reduce long-term risks.Several factors, including job demands, socio-cultural factors, workplace characteristics, and environmental factors, cause or exacerbate work-related disorders, according to WHO (1985). Otherwise, musculoskeletal problems such as awkward posture, prolonged standing, kneeling, slouching, and repetitive muscle activity occur in most cases of agricultural work due to the physical demands on the body. Fatigue, illness, and accidents will inevitably result from this posture. Workers' lack of knowledge of agricultural health and safety puts them in the most dangerous situations. This study included agricultural activities in the occupational group with the highest risk of musculoskeletal disorders (MSDs). When combined with tool design and related educational interventions, these ergonomic considerations effectively prevent MSD problems. The study's conclusion emphasizes the importance of ergonomic hand tool design as a form of intervention.

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