Analysis of Ergonomic Risks and Individual Factors Affecting Musculoskeletal Complaints Among Vegetable Farmers in Mamalam, Tayan Hilir Subdistrict, Sanggau Regency

Fajar Hakim[1], Ismael Saleh[2], Elly Trisnawati[3], Marlenywati[4], Eka Puspitasari[5]
[1,2,3,4] Faculty of Health Sciences and Psychology, Muhammadiyah University of Pontianak, [5]CSR PT. Antam Tbk. UBPB West Kalimantan
Email: ismael.irmawan@gmail.com

Musculoskeletal Disorders (MSDs) are one of the occupational health issues that can be influenced by physical activity, work duration, and non-ergonomic work postures. This study aims to analyze the ergonomic and individual risk factors associated with musculoskeletal complaints among the Mamalam Vegetable Farmers' Group in Tayan Hilir Subdistrict, Sanggau Regency. This study employed a quantitative approach with a cross-sectional design and an analytical observational method. A total of 52 farmers were selected using purposive sampling. Data collection was conducted using the Nordic Body Map (NBM) questionnaire to identify musculoskeletal complaints and the Rapid Entire Body Assessment (REBA) method to assess work posture risks. The data were analyzed univariately and bivariately using the chi-square test with a significance level of $\alpha = 0.05$. The results showed that 28 respondents (53.8%) experienced moderate musculoskeletal complaints and 24 respondents (46.2%) experienced low musculoskeletal complaints. There was a significant association between work duration ($p = 0.006$), work posture duration ($p = 0.011$), work posture risk based on REBA ($p = 0.015$), and musculoskeletal complaints. Meanwhile, gender ($p = 1.000$), age ($p = 0.521$), and length of employment ($p = 0.086$) did not show a significant association. It is concluded that work duration and work posture are factors associated with musculoskeletal complaints among farmers. Therefore, it is necessary to improve work posture, manage work and rest times, and use more ergonomic aids to reduce the risk of MSDs among farmers.

Keywords: Musculoskeletal disorders, Ergonomics, Work duration, Work posture, Farmers

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Corresponding Author:
Fajar Hakim
Public Health Program, Faculty of Health Sciences and Psychology, Muhammadiyah University of Pontianak
Jl. Jenderal Ahmad Yani No. 111, Pontianak, West Kalimantan
fajar7600@gmail.com

1. Introduction

Musculoskeletal disorders (MSDs) are a global health issue that has a significant impact on people's quality of life. The burden of MSDs is highest in high-income countries, with 441 million cases, followed by countries in the Western Pacific Region with 427 million cases, and Southeast Asia with 369 million cases (WHO, 2021) [1]. Globally, approximately 1.71 billion people live with musculoskeletal conditions, which are the leading contributor to global disability, causing limitations in mobility and functional ability (WHO, 2022) [2]. According to the HSE report (2021/2022), work-related musculoskeletal disorders totaled 477,000 incidents (1,430 per 100,000 workers) and resulted in the loss of 7.3 million productive days, with the back (42%), neck (37%), and lower body (21%) as the most affected body parts [3]. At the national level, BPJS Ketenagakerjaan data show that MSDs rank second among work-related illnesses in Indonesia after respiratory disorders, with 52,500 cases recorded during the 2021–2023 period [4]. According to a health profile study by the Indonesian Ministry of Health, approximately 40.5% of illnesses experienced by workers in Indonesia are directly related to their work activities [5]. Meanwhile, the Indonesian Health

Survey (2023) reported a national prevalence of joint disease of 7.30% [6], and the highest prevalence of MSDs has been reported among farmers, fishermen, and manual laborers, reaching 31.2% [7].

The agricultural sector is an urgent concern because farmers are exposed every day to heavy loads during transportation, non-ergonomic body postures, and repetitive movements, all of which contribute to the high prevalence of MSDs [8]. These risks can be prevented by applying ergonomic principles that adapt work, equipment, and the work environment to human capabilities and limitations [9]; However, ergonomic mismatches still frequently occur in the field and lead to poor work posture, MSDs, and reduced productivity [10]. The main triggers include lifting loads with incorrect posture, carrying heavy loads on the shoulders, using vibrating equipment, static work, and excessively long work durations [11], The habit of hunching over while working has been significantly associated with increased MSD complaints [12]. MSDs reduce work capacity, productivity, and quality of life [13], While the use of traditional farming tools with non-ergonomic postures increases the risk of work-related MSDs among agricultural workers [14], because cultivation activities place repetitive biomechanical loads on muscles, joints, and the spine [15]. Among vegetable growers, awkward working postures have been closely related to body discomfort [16], which makes the Rapid Entire Body Assessment (REBA) relevant for assessing the varied postures of vegetable cultivation [17]. In addition, individual characteristics such as age and gender also influence musculoskeletal complaints [18], as physical capacity declines with age [19] and the physiological capacity to handle workloads differs between men and women [20].

This study focused on the Mamalam Vegetable Farmers' Group, Tayan Hilir Subdistrict, Sanggau Regency. According to the group's membership records, the group has 211 registered farmers who grow vegetables such as kale, spinach, pak choi, chili peppers, and crystal guava using conventional methods and manual tools such as hoes, sickles, knapsack sprayers, and harvest baskets. Preliminary observations carried out by the research team at the cultivation sites before data collection showed that fieldwork lasts on average about 7 hours per day in open fields with uneven ground surfaces, with ergonomic hazards during nursery, planting, weeding, and harvesting activities, mainly bending, kneeling, or squatting that is repeated and held for long periods. Carrying knapsack spray tanks and transporting harvested crops manually further add to the physical load borne by the farmers. Accordingly, the scope of this study was limited to ergonomic factors, namely daily work duration, the duration of maintaining a work posture, and work posture risk assessed with REBA, and to individual factors, namely gender, age, and length of service, in relation to musculoskeletal complaints measured with the Nordic Body Map.

Because these factors have not been examined together among vegetable farmers in Tayan Hilir Subdistrict, this study aims to analyze the association of ergonomic factors (work duration, duration of work posture, and work posture risk level based on REBA) and individual factors (gender, age, and length of service) with musculoskeletal complaints among members of the Mamalam Vegetable Farmers' Group in Tayan Hilir Subdistrict, Sanggau Regency. The findings are expected to provide local evidence for the farmers' group, primary health care services, and partner institutions in designing ergonomic interventions to reduce the risk of MSDs and maintain the health and productivity of farmers.

2. Literature Review and Problem Statement

Musculoskeletal complaints are symptoms of pain, discomfort, or stiffness in muscles, tendons, joints, and other soft tissues, ranging from mild to very severe, that arise when these structures repeatedly receive static or excessive loads over a long period [9]. In agriculture, these complaints develop when the biomechanical loads produced by awkward and static postures, repetitive movements, manual load handling, and long working hours are repeatedly placed on muscles, joints, and the spine [11], [14], [15]. Systematic reviews have shown that MSDs are common among agricultural workers in low- and middle-

income countries and in Southeast Asia [15], [19], and observational methods such as REBA are widely applied to assess postural risk among farmers [14]. Studies on vegetable cultivation have likewise reported that awkward postures are related to body discomfort [16] and that work posture is an important determinant of musculoskeletal complaints [17], while longer daily work duration has been associated with a higher likelihood of back, shoulder, and neck pain [21].

Individual factors determine a worker's capacity to tolerate these loads. Physical capacity and tissue elasticity decline with age, and musculoskeletal complaints are generally reported to begin appearing at around 35 years of age [10]. Men and women differ in physical characteristics and physiological capacity to handle workloads [20], and women have been reported to be at higher risk of muscle fatigue [22], whereas a longer length of service reflects a longer cumulative exposure to physical work [18]. However, the evidence on individual factors is not uniform. Associations with gender [18], [22], age [10], and length of service [18] have been reported, but these findings came from different populations and study designs and were not always tested together with objectively measured ergonomic exposure. Many previous studies also analyzed only one group of factors or were conducted among rice farmers or farmers in general [3], [11], [22], [23], while studies on vegetable farmers have generally focused on work posture alone [17] or on environment- and work-related diseases and sociodemographic factors [20]. To the authors' knowledge, no study has examined these factors together among vegetable farmers in Tayan Hilir Subdistrict, Sanggau Regency. These gaps show the need for a study that assesses posture objectively with REBA and analyzes ergonomic and individual factors together among conventional vegetable farmers, whose work involves frequent changes of posture across the nursery, planting, weeding, and harvesting stages.

Based on this research gap, the problem addressed in this study is formulated as follows: are ergonomic factors (work duration, duration of work posture, and work posture risk level based on REBA) and individual factors (gender, age, and length of service) associated with musculoskeletal complaints among members of the Mamalam Vegetable Farmers' Group in Tayan Hilir Subdistrict, Sanggau Regency? Accordingly, the hypotheses tested were that musculoskeletal complaints are associated with work duration (H1), duration of work posture (H2), work posture risk level based on REBA (H3), gender (H4), age (H5), and length of service (H6).

3. Methods

This study employed a quantitative approach with an analytical observational design and a cross-sectional approach, in which the independent and dependent variables were measured at the same time. This design was chosen because it allows exposure factors and musculoskeletal complaints to be measured simultaneously in a defined working population within a limited period, which is appropriate for identifying associations between variables, although it cannot establish causality. The study aimed to determine the association between ergonomic and individual factors and musculoskeletal complaints among farmers. It was conducted from June to July 2025 among members of the Mamalam Vegetable Farmers' Group in Tayan Hilir Subdistrict, Sanggau Regency.

The population comprised all 211 registered members of the Mamalam Vegetable Farmers' Group, from which 52 respondents were selected using purposive sampling. The inclusion criteria were: (1) registered as an active member of the group; (2) directly involved in vegetable cultivation work (nursery, planting, weeding, and/or harvesting) during the study period; (3) present at the cultivation site during data collection; and (4) willing to participate and sign an informed consent form. The exclusion criteria were: (1) a history of injury, fracture, or surgery of the musculoskeletal system; (2) a congenital or acquired skeletal deformity; and (3) a physician-diagnosed chronic joint disease, such as rheumatoid arthritis or gout, that could cause

musculoskeletal complaints unrelated to work. The independent variables were gender, age, length of service, work duration, duration of work posture, and work posture risk level (REBA), while the dependent variable was musculoskeletal complaints. Educational level was recorded only to describe the characteristics of the respondents.

Musculoskeletal complaints were measured using the Nordic Body Map (NBM), and work posture risk was assessed using the Rapid Entire Body Assessment (REBA) method; both instruments have been widely used in previous Indonesian studies of musculoskeletal complaints [4], [18], [21]. The NBM covers 28 body parts, each rated on a four-point scale: 0 = no pain, 1 = slight pain, 2 = pain, and 3 = very painful. The questionnaire was administered through guided interviews, and a body part was recorded as having a complaint when it received a score of ≥ 1. The total score of each respondent (range 0–84) was classified as low (0–20), moderate (21–41), high (42–62), or very high (63–84). For the REBA assessment, the posture of each respondent during the main cultivation activity was photographed from the side, and the angles of the neck, trunk, legs, upper arms, forearms, and wrists were measured on the photographs using an angle-measurement application. The segment scores were then combined with the load/force, coupling, and activity scores according to the REBA worksheet and tables to obtain a final score of 1–11+, which was classified as negligible (1), low (2–3), medium (4–7), high (8–10), or very high (11+) risk. Data on gender, age, length of service, daily work duration, and duration of maintaining a work posture were collected using a structured questionnaire.

Data were analyzed univariately to describe the frequency distribution of each variable and bivariately to test the association between each independent variable and musculoskeletal complaints. Before the bivariate analysis, all variables were grouped into two categories. Musculoskeletal complaints were grouped into low (0–20) and moderate (21–41), because no respondent had a score in the high or very high category. REBA risk levels were grouped into moderate risk (final score ≤ 7, combining the low and medium levels) and high risk (final score ≥ 8, combining the high and very high levels), because the low and very high categories contained only 2 and 1 respondents, respectively, which would produce cells with very small expected counts. Age was grouped into ≥ 35 years and < 35 years because musculoskeletal complaints generally begin to appear at around 35 years of age [10]; work duration was grouped into ≥ 7 hours and < 7 hours per day, corresponding to the average daily working time of about 7 hours found in the preliminary observations; length of service was grouped into ≥ 5 years and < 5 years; and duration of work posture was grouped into ≥ 15 minutes and < 15 minutes, in accordance with the operational definitions of this study. Associations were tested using Pearson's chi-square test at a significance level of $\alpha = 0.05$. The chi-square test was chosen because all variables were categorical, and its assumptions were checked before the analysis: each respondent was counted only once, so the observations were independent, and the expected count in every cell of the 2 × 2 table had to be at least 5. When this last assumption was not met, Fisher's exact test was used instead. Data were processed using SPSS.

4. Results and Discussion

Univariate Analysis

Table 1. Analysis of Research Respondent Characteristics

No.	Variable	Frequency	Percentage (%)
	Gender		
1.	Male	10	19.2%
2.	Female	42	80.8%
	Age		
1.	≥ 35 years	39	75.0%

No.	Variable	Frequency	Percentage (%)
2.	< 35 years	13	25.0%
	Education level		
1.	SMA	6	11.5%
2.	SMP	7	13.5%
3.	SD	30	57.7%
4	No Schooling	9	17.3%
	Work Duration		
1.	≥ 7 hours	20	38.5%
2.	< 7 hours	32	61.5%
	Length of service		
1.	≥ 5 years	28	53.8%
2.	< 5 years	24	46.2%

Table 1 shows that most respondents were women (42; 80.8%), while 10 respondents (19.2%) were men. Most respondents were aged ≥ 35 years (39; 75.0%), and 13 respondents (25.0%) were aged < 35 years. By educational level, most respondents had completed elementary school (SD) (30; 57.7%), followed by those with no schooling (9; 17.3%), junior high school (SMP) (7; 13.5%), and senior high school (SMA) (6; 11.5%). Based on daily work duration, most respondents worked < 7 hours (32; 61.5%), while 20 respondents (38.5%) worked ≥ 7 hours. Based on length of service, 28 respondents (53.8%) had worked for ≥ 5 years and 24 respondents (46.2%) for < 5 years.

Table 2. Frequency distribution based on work postures among vegetable farmers

Work Posture	frequency	Percentage (%)
Low	2	3.8
Medium	31	59.6
High	18	34.6
Very High	1	1.9
Total	52	100

Based on Table 2, out of a total of 52 respondents, the distribution of work posture risk levels among vegetable farmers was as follows: 2 respondents (3.8%) were in the low risk category, 31 respondents (59.6%) were in the moderate risk category, 18 respondents (34.6%) were in the high risk category, and 1 respondent (1.9%) was in the very high risk category.

Table 3. Frequency Distribution of Body Parts Experiencing Musculoskeletal Complaints Among Vegetable Farmers

No	Types of complaints	Complaints			
		yes	%	No	%
1	Upper neck	28	53.8	24	46.2
2	Left shoulder	37	71.2	15	28.8
3	Left upper arm	31	59.6	21	40.4
4	Right upper arm	34	65.4	18	34.6
5	Hip	32	61.5	20	38.5
6	Left elbow	4	7.7	48	92.3
7	Left forearm	12	23.1	40	76.9
8	Left wrist	21	40.4	31	59.6
9	Left hand	13	25.0	39	75.0
10	Left thigh	26	50.0	26	50.0

No	Types of complaints	Complaints			
		yes	%	No	%
11	Left knee	38	73.1	14	26.9
12	Left calf	24	46.2	28	53.8
13	Left ankle	26	50.0	26	50.0
14	Left sole	14	26.9	38	73.1
15	Nape of the neck	32	61.5	20	38.5
16	Right shoulder	41	78.8	11	21.2
17	Back	38	73.1	14	26.9
18	Waist	37	71.2	15	28.8
19	Buttocks	12	23.1	40	76.9
20	Right elbow	12	23.1	40	76.9
21	Right forearm	19	36.5	33	63.5
22	Right wrist	30	57.7	22	42.3
23	Right hand	22	42.3	30	57.7
24	Right thigh	28	53.8	24	46.2
25	Right knee	35	67.3	17	32.7
26	Right calf	26	50.0	26	50.0
27	Right ankle	28	53.8	24	46.2
28	Right sole	14	26.9	38	73.1

Based on the table above, most farmers reported pain in their right shoulder (78.8%), most likely because the right shoulder and arm are used most frequently for repetitive work in uncomfortable positions. In contrast, the left elbow was the body part reported least often (only 7.7%), indicating that the workload in this area is relatively lighter.

Table 4. Distribution of the Prevalence of Musculoskeletal Disorders (MSDs)

No	Musculoskeletal Disorders	frequency	percentage (%)
1	Moderate Complaints (21–41)	28	53.8
2	Low Complaints (0–20)	24	46.2
	Total	52	100

Based on the table above, respondents experienced moderate MSD-related complaints, specifically 28 respondents (53.8%). Meanwhile, 24 respondents (46.2%) experienced mild complaints.

Data Processing Using REBA

Posture assessment is conducted using the Rapid Entire Body Assessment (REBA) method to evaluate the level of ergonomic risk that could potentially lead to musculoskeletal disorders (MSDs) based on work postures while workers are performing their activities. To provide an overview of the REBA assessment process, three examples of posture angle calculations and score determinations are provided, representing the activities of seedling cultivation, vegetable planting, and weed removal.



Figure 1. Nursery workers

Table 5. Calculation of angles in work postures at the nursery

Body Part	Angle	Score
Neck	18°	1
Back	37°	4
Legs	0°	1
Upper arms	60°	3
Forearms	36°	2
Wrists	15°	2
Final Score (Risk Level)	6 (Moderate Risk)	

Based on Figure 1, the assessment results show 18° neck flexion (score 1), 37° back flexion accompanied by twisting (score 4), and a stable leg position at a 0° angle (score 1). In the upper extremities, the upper arm had 60° of flexion (score 3), the forearm had 36° of flexion (score 2), and the wrist had 15° of flexion/extension with a twisted condition (score 2). Based on the results from the REBA table, a final score of 6 was obtained, which falls into the moderate risk category.



Figure 2. Workers planting vegetables

Table 6. Calculation of Work Posture Angles for Vegetable Planting

Body Part	Angle	Score
Neck	20°	2
Back	60°	4
Legs	+2	1
Upper arms	24°	3

Body Part	Angle	Score
Forearms	101°	2
Wrists	18°	3
Final Score (Risk Level)	**10 (High Risk)**	

The work posture observed was when workers were planting vegetables, as shown in Figure 2, while the angle measurement results are presented in Table 6. The REBA assessment results showed 20° neck flexion with twisting (score 2), 60° torso flexion (score 4), an unbalanced foot position (score 2), 24° upper arm flexion with abduction (score 3), 101° forearm flexion (score 2), and 18° wrist flexion/extension with a twisted condition (score 3). Based on the score matching in the REBA table, a final score of 10 was obtained, which falls into the high-risk category.



Figure 3. Work Posture in Weed Control

Table 7. Calculation of Work Posture Angles for Weed Control

Body Part	Angle	Score
Neck	20°	1
Back	46°	3
Legs	37°	3
Upper arms	72°	3
Forearms	50°	2
Wrists	15°	3
Final Score (Risk Level)	**7 (Moderate Risk)**	

Based on Figure 3, an example of work posture angle measurements is shown for one of the respondents, while the measurement results are presented in Table 7. The REBA assessment results show neck flexion of 20° (score 1), torso flexion of 46° (score 3), an unstable foot position (score 3), upper arm flexion of 72° (score 3), forearm flexion of 50° (score 2), and wrist flexion/extension of 15° with twisting (score 3). Based on the calculations in the REBA table, a final score of 7 was obtained, which falls into the moderate risk category.

Bivariate Analysis

Table 8. Results of the Bivariate Analysis of Independent Variables and the Dependent Variable

Variables	Musculoskeletal Disorders (MSDs)				Total		p-Value
	Moderate Complaints		Low complaints				
	n	%	n	%	n	%	
Gender							
Male	5	50.0%	5	50.0	10	100.0	1.000

Variables	Musculoskeletal Disorders (MSDs)						p-Value
	Moderate Complaints		Low complaints		Total		
	n	%	n	%	n	%	
Female	23	54.8%	19	45.2	42	100.0	
Age							
≥ 35 years	22	56.4%	17	43.6	39	100.0	0.521
< 35 years	6	46.2%	7	53.8	13	100.0	
Work Duration							
≥ 7 hours	6	30.0	14	70.0	20	100.0	0.006
< 7 hours	22	68.8	10	31.3	32	100.0	
Length of Service							
≥ 5 years	12	42.9	16	57.1	28	100.0	0.086
< 5 years	16	66.7	8	33.3	24	100.0	
Duration of Work Posture							
≥ 15 minutes	21	46.7	24	53.3	45	100.0	0.011
< 15 minutes	7	100.0	0	0.0	7	100.0	
Work Posture (REBA)							
High Risk	6	31.6	13	68.4	19	100.0	0.015
Moderate Risk	22	66.7	11	33.3	33	100.0	

Table 8 shows that the proportion of moderate complaints was similar among male (50.0%) and female (54.8%) respondents, and there was no significant association between gender and musculoskeletal complaints (p = 1.000). This result differs from a study among farmers in Cilegon [22], which found a significant association between gender and musculoskeletal complaints, with women at a higher risk of muscle fatigue than men. The small number of male respondents in this study (n = 10) limits the comparison between the two groups, so this result should be interpreted with caution.

Moderate complaints were more common among respondents aged ≥ 35 years (56.4%) than among those aged < 35 years (46.2%), but this difference was not statistically significant (p = 0.521). The direction of this difference is in line with a study [10] reporting that workers aged ≥ 35 years are more susceptible to musculoskeletal disorders due to decreased tissue elasticity and muscle strength. However, in this study the difference was not large enough to be significant, and only 13 respondents were aged < 35 years.

Bivariate analysis revealed a significant association between work duration and musculoskeletal complaints, with p = 0.006 (p < 0.05). These findings are consistent with a study [21] that showed workers who worked ≥7 hours per day were twice as likely to experience pain in their back, shoulders, and neck. This is caused by prolonged static work postures, which lead to repetitive muscle strain without adequate opportunities for recovery.

No significant association was found between length of service and musculoskeletal complaints (p = 0.086). The proportion of moderate complaints was 42.9% among respondents who had worked for ≥ 5 years and 66.7% among those who had worked for < 5 years. This result differs from a study among farmers in Deli Serdang Regency [18], which reported an association between length of service and musculoskeletal complaints, in which a longer length of service reflects a longer cumulative exposure to physical workload. Based on the results of the analysis using Fisher's exact test, a p-value of 0.011 (p < 0.05) was obtained, indicating that the duration of work posture has a significant correlation with musculoskeletal complaints among the respondents, and that maintaining a work posture for ≥ 15 minutes is associated with the onset of musculoskeletal complaints among the respondents. These findings are consistent with a study

[24],showing that static work postures, repetitive movements, and work performed without adequate rest periods can contribute to the onset of musculoskeletal complaints.

Furthermore, a significant association was found between work posture and musculoskeletal complaints, with a p-value of 0.015 ($p < 0.05$). Complaints in the back, lower back, and shoulders were more frequently found among workers at risk of non-ergonomic work postures. These results are consistent with a study of rice farmers in North Toraja Regency [23], which showed that planting and hoeing while in a bent-over position for a certain period of time can increase the static load on the lower back muscles.

Overall, the results show that the factors related to how the farmers work, namely daily work duration, the duration of maintaining a work posture, and the REBA posture risk level, were significantly associated with musculoskeletal complaints, whereas the individual characteristics of gender, age, and length of service were not. This pattern is consistent with the view that musculoskeletal complaints in agriculture arise mainly from repeated and sustained biomechanical loads [14], [15], and it indicates that preventive efforts among vegetable farmers should prioritize the organization of work and working posture. These preliminary conclusions need to be confirmed in further studies with a larger sample and more detailed exposure measurement.

5. Conclusion

This study shows a significant relationship between work duration ($p = 0.006$), duration of maintaining work posture ($p = 0.011$), and work posture risk level based on REBA ($p = 0.015$) with musculoskeletal complaints among members of the Mamalam Vegetable Farmers' Group. Conversely, individual factors such as gender ($p = 1.000$), age ($p = 0.521$), and length of service ($p = 0.086$) showed no significant association. Practical OSH implications should focus on improving work postures, scheduling rest breaks, and utilizing ergonomic aids.

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