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Study of Musculoskeletal Disorders in Farmers Involved in Manual Paddy Bagging Task

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A B S T R A C T

Filling paddy bags by hand is a common task during harvesting, but it can cause musculoskeletal disorders (MSDs) in various body regions. The current study aims to evaluate posture and find an association between MSDs and body posture scores. The Nordic questionnaire and rapid entire body assessment (REBA) were used to collect MSDs and postures from farmers. The MSD in various body regions (neck, elbows, hands, upper back, knees, ankles, lower back, hips, thighs, and buttocks) was found to be 6.7%, 10%, 3.3%, 6.7%, 16.7%, 20%, and 10%, respectively, during the last 12-month period. In REBA score findings, holding bags, filling the bucket, and the bag were found to have a very high risk of causing MSDs. Despite the fact that MSDs are not very common among farmers who engage in paddy bagging tasks, posture analysis reveals what causes MSDs. Further investigation is needed to improve and reduce MSDs.

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INTRODUCTION

Agriculture is considered one of the most hazardous operations in developed and developing countries (Benos et al., 2020) as it involves strenuous physical activities and high levels of manual labor (Rosecrance et al., 2006; Walker-Bone & Palmer, 2002). The existing literature shows several ergonomic risk factors such as repetitive lifting, moving of heavy loads, prolonged trunk flexion (also called stooping), intensive handwork, and working in awkward postures of the wrist and trunk associated with farm works (Fathallah et al., 2008; McCurdy et al., 2003; Meyers et al., 2005) thus the farmers face a higher level of work-related musculoskeletal disorders (WMSDs). According to Mahto and Gautam (2018), more than 70% of farmers among Nepal farmers have some kind of MSDs in neck, shoulder, elbow, low back, knee, and ankle. At the same time, more than 50% of the farmers reported MSDs in the lower back, fingers, shoulders and wrists/hands in manual harvesting (Jain et al., 2018, 2019).

MSDs, in addition to their physical effects, can cause unfavorable consequences such as reduction in work capacity, lower level of farmer income, deterioration of quality of life, and the onset of other health consequences such as stress and depression (Aoife Osborne et al., 2012). Further, MSDs are the leading cause of absence from work in the UK (Linaker et al., 2011). Manual work including carrying heavy loads is common in farming. Singh et al. (2016), found that carrying on head was the most common practice while back loading of filled bags is practiced for heavier loads by Indian farmers. Manual activities such as lifting, carrying heavy loads involving the back, head and shoulders are associated with spinal MSDs (Benos et al., 2020) and other MSDs among farmers (Benos et al., 2020; Kee, 2022). Heavy carrying and lifting during rice crop cultivation caused MSDs among Thai rice farmers. In another study, B. Das & Gangopadhyay (2011), found that carrying crops and seeds manually was associated with deviated wrist postures for long periods in potato cultivation causing MSDs in upper limbs. In manual apple harvesting, carrying a full apple bucket is associated with several awkward postures such as leaning far to one side and holding both hands over the heads for prolonged periods become risk factors for muscle and joint strain injuries (Houshyar & Kim, 2018). Agriculture in developing countries depends mainly on human capital; in Sri Lanka, the agriculture sector employed 25.3% of workforce and the contribution of agriculture to GDP was 7.42% (Central Bank of Sri Lanka, 2019), which indicates contribution of workforce to agriculture and the necessity of healthy workforce to sustain agricultural production.

In rice cultivation, paddy harvesting is one of the most essential and last processes, which consists of various tasks, i.e., reaping, threshing, separating, cleaning, field drying afterward bagging. Bagging is the process in which a paddy is filled into bags using various types of tools and utensils manually. According to Biswas et al. (2017), manual paddy bagging requires frequent lifting, carrying, pushing, pulling, lowering and raising, and holding gunny bags using hands. In manual paddy bagging, the farmers bend to fill utensils with paddy heaped on the ground then lift the utensils, assume a standing posture and fill the bags by putting paddy from utensils. These activities continue until

thoroughly filling the paddy bag, weighing around 65 kg to 70 kg. Sometimes, paddy bags are filled at less than a quarter level where farmers bend with bags and use their hands to fill them. After that, the aforementioned series of postures are assumed to fill the rest of the bag. In this task, the frequency of each posture assumed to fill a bag is higher with a shorter duration for each posture. Further, manual bagging task is carried out in several other industries such as rice milling, animal feed milling etc., mainly in developing countries (Gallagher & Heberger, 2015). Previous studies found that lower back MSDs or ergonomic hazards are associated with bending the trunk frequently, heavy or awkward lifting, bending or twisting the neck (Dong et al., 2019; Shockey et al., 2018) and frequent lifting, pushing, and pulling (Shockey et al., 2018) for different jobs. Studies mentioned above indicate that the frequency of trunk bending and the frequency of manual material handling are associated with MSDs in lower back. Similarly, sustained awkward posture for long hours, despite the frequency, also causes MSDs (B. Das & Gangopadhyay, 2011; D. Das & Singh, 2022). Hence, this study attempted to assess the postural risk factors associated with MSDs in paddy bagging tasks carried out by farmers in farm fields.

LITERATURE REVIEW

Agriculture is considered one of the most hazardous operations in developed and developing countries (Benos et al., 2020) as it involves strenuous physical activities and high levels of manual labor (Rosecrance et al., 2006; Walker-Bone & Palmer, 2002). The existing literature shows several ergonomic risk factors such as repetitive lifting, moving of heavy loads, prolonged trunk flexion (also called stooping), intensive handwork, and working in awkward postures of the wrist and trunk associated with farm works (Fathallah et al., 2008; McCurdy et al., 2003; Meyers et al., 2005) thus the farmers face a higher level of work-related musculoskeletal disorders (WMSDs). According to Mahto and Gautam (2018), more than 70% of farmers among Nepal farmers have some kind of MSDs in neck, shoulder, elbow, low back, knee, and ankle. At the same time, more than 50% of the farmers reported MSDs in the lower back, fingers, shoulders and wrists/hands in manual harvesting (Jain et al., 2018, 2019).

METHODOLOGY

Participants

This cross-sectional study was conducted among the farmers who engaged in paddy bagging tasks. The farmers received an explanation about the purpose of the study and gave their verbal consent to take part in the study. The study was approved by the panel members who were nominated to evaluate the research proposals after the presentation. The study was conducted in Ninthavur, Digavapi, Sagama, Malwaththa, and Oluvil areas in Ampara district in the eastern province of Sri Lanka. Only healthy participants were selected for the study. Accordingly, 30 farmers were engaging in paddy bagging task at the sites taken for the study conducted during March and April 2021. The personal characteristics of the participants who participated in the study are given in Table 1.

Table 1. Physical Characteristics of Participants (N = 30)

Factors	Mean	Standard
Age (years)	61	7.2
Height (cm)	157	6.1
Weight (kg)	67	6.9
Work experience (years)	22	7.2

Measures

The Nordic questionnaire with modifications was used to collect data on MSDs in various body regions (i.e., neck, upper back, lower back, shoulder, hands, knee, wrist and ankle) with personal characteristics of farmers. The questionnaires were filled out by interviewing farmers on the field. After allying MSDs using the Nordic questionnaire, the postural risk which can lead to MSDs were further analyzed using REBA observational tool. Previous studies used both Nordic questionnaire and REBA together to investigate MSDs (B. Das et al., 2012; Deros et al., 2016) and small sample size (30 participants) [14]. The rapid entire body assessment (REBA) tool was used to measure postures of different body regions with a scoring system for different body region postures. The postural risk for each task was assessed based on final REBA score and its corresponding risk level. The paddy bagging activities of all 30 participants were video recorded and taken to the laboratory at Department of biosystems technology where each video record was carefully watched and the postures were evaluated using a REBA sheet. The research student assigned scores to different body regions having the postures assumed by body region and the load handled. The research student was trained to collect data with Nordic questionnaire and REBA tool. The risk categories according REBA tool is 1 is for negligible risk, 2-3 for low risk, 4-7 for medium risk, 8-10 for high risk and 11+ for very high risk (Hignett & McAtamney, 2000).

Data Analysis

Data were analyzed using SPSS version 25. Descriptive analysis was performed for quantitative variables and the results are given as mean and standard deviation (SD) and percentages.

RESULTS

According to Figure 1, MSD in neck, elbows, hand, upper back, knees, ankles, lower back and hips/thighs/buttocks were 6.7%, 10%, 3.3%, 6.7%, 16.7%, 20% and 10% respectively during the last 12 months period and no participants had shoulder MSD.

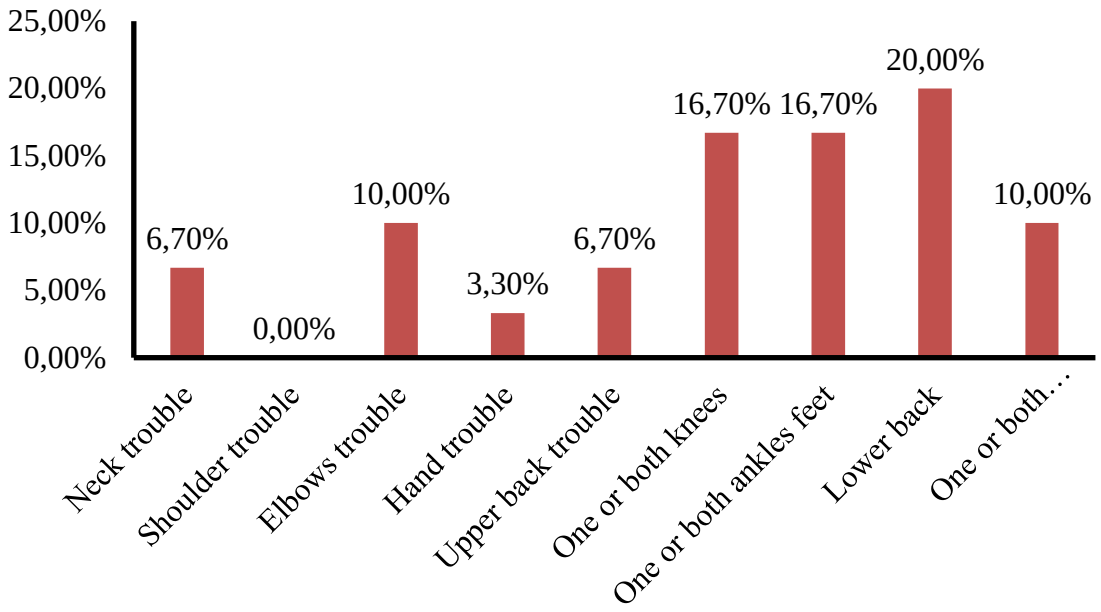

Figure 1. Prevalence of Musculoskeletal Disorder in Study Population During the Past 12 Months

According to Table 2, the participants who had no MSD in neck obtained higher mean neck score (2.61) compared to the mean neck score (2.50) of those who had MSD in neck. Likewise, participants who had no MSD in upper back obtained higher mean trunk score (3.68) than those who had MSD in upper back. The participants who had no MSD in one or both hips/thigs/ buttocks obtained higher mean leg score (3.70) compared to the mean leg score (3.33) of those who had MSD in one or both hips/thigs/ buttocks. None of the participants had MSD in shoulders and hands. The participants who had MSD in elbows and who had no MSD in elbows obtained equal mean upper arm score of 4.00, mean lower arm score of 2.00 and mean wrist score of 2.00.

Table 2. Association between Musculoskeletal Disorders and Working Posture Scores

Body region with MSDs		**Neck Score Mean ± SD**	**Trunk Score Mean ± SD**	**Legs Score Mean ± SD**	**Upper arm Score Mean ± SD**	**Lower arm Score Mean ± SD**	**Wrist Score Mean ± SD**
Neck	Yes (n=2)	2.50±0.71	2.50±0.71	5.00±0.00	3.00±1.41	4.00±0.00	2.00±0.00
	No (n=28)	2.61±0.50	3.54±0.84	3.71±0.71	4.00±0.00	2.00±0.00	2.00±0.00
Shoulders	Yes (n=0)	-	-		-	-	-
	No (n=30)	2.60±0.50	3.63±0.90	3.67±0.76	4.00±0.00	2.00±0.00	2.00±0.00
Elbows	Yes (n=3)	2.67±0.58	4.00±1.00	3.33±1.16	4.00±0.00	2.00±0.00	2.00±0.00

	No (n=27)	2.59±0.50	3.59±0.89	3.70±0.72	4.00±0.00	2.00±0.00	2.00±0.00
Hands	Yes (n=1)	-	-	-	-	-	-
	No (n=29)	2.62±0.49	3.59±0.87	3.72±0.70	4.00±0.00	2.00±0.00	2.00±0.00
Upper back	Yes (n=2)	2.50±0.71	3.00±0.00	4.00±0.00	4.00±0.00	2.00±0.00	2.00±0.00
	No (n=28)	2.61±0.50	3.68±0.91	3.64±0.80	4.00±0.00	2.00±0.00	2.00±0.00
Lower back	Yes (n=6)	2.33±0.51	3.33±0.82	3.67±0.82	4.00±0.00	2.00±0.00	2.00±0.00
	No (n=24)	2.67±0.48	3.71±0.91	3.67±0.76	4.00±0.00	2.00±0.00	2.00±0.00
One or both hips/thigs/ buttocks	Yes (n=3)	2.33±0.58	3.67±1.16	3.33±1.16	4.00±0.00	2.00±0.00	2.00±0.00
	No (n=27)	2.63±0.49	3.63±0.88	3.70±0.72	4.00±0.00	2.00±0.00	2.00±0.00
One or both Knees	Yes (n=5)	2.60±0.55	3.00±0.00	4.00±0.00	4.00±0.00	2.00±0.00	2.00±0.00
	No (n=25)	2.60±0.50	3.76±0.93	3.60±0.82	4.00±0.00	2.00±0.00	2.00±0.00
One or both Ankle feet	Yes (n=5)	2.60±0.55	3.00±0.00	4.00±0.00	4.00±0.00	2.00±0.00	2.00±0.00
	No (n=25)	2.60±0.50	3.76±0.93	3.60±0.82	4.00±0.00	2.00±0.00	2.00±0.00

According to Table 3, activities, i.e., holding bag (in a forward bent position), filling the bucket and the bag (in a forward bent position close to ground) assumed postures that are found with very high-risk levels to cause MSDs and, hence, immediate ergonomic improvements are needed to eliminate or minimize MSD risk factors associated with those activities and postures.

Table 3. Working Posture and Risk Level Based on REBA Posture Analysis for Paddy Bagging Operations

Activities in paddy bagging	**Process pictures**	**Description**	**REBA posture analysis**		
			REBA score	**Risk level**	**Actions**
Holding bag to facilitate filling the bag using a bucket		a) Forward bending of low back, both knees bent, both arms below shoulder level, wrist twisted and weight handled less than 40-50kg.	11	Very high	Implement ergonomic improvements immediately

		b) Standing with a straight back, arms below shoulder level, neck bent forward, wrist twisted and weight handled around 65kg.	4	Medium risk	Change soon
Filling the bucket with paddy		a) Forward bending and twisting of back, bending of knees, arms below shoulder level and twisted to right side, wrist twisted, weight handled around 5-8kg.	12	Very high risk	Implement ergonomic improvements immediately
		b) Forward bending of back, bending of knees, arms below shoulder level, wrist twisted, weight handled around 5kg-8kg.	11	Very high risk	Implement ergonomic improvements immediately
Filling the bag		a) Forward bending and twisting of back, bending of knees, arms below shoulder level and twisted to right side, wrist twisted, weight handled around 5kg-8kg.	12	Very high risk	Implement ergonomic improvements immediately

		b) Back upright and twisted, shoulder raised, arm flexed and small abduction, right side knee bent and twisted, neck twisted, weight handled 5kg-8kg.	5	Medium risk	Change soon
Compaction of bag by raising up and hitting the ground		(a) Back upright, arms at shoulder level and flexed, shoulder abducted, neck bent forward, weight handle 50kg.	5	Medium risk	Change soon
		(b) Back upright, neck bent forward, arms below shoulder level and flexed, knees bent, wrist twisted, weight handled 65kg-70kg.	7	Medium risk	Change soon
Compaction of bags by turning left to right and vice versa and shaking horizontally		a) Back upright, neck bent forward, arms below shoulder level and flexed, wrist twisted, weight handled 65kg-70kg.	7	Medium risk	Change soon
		b) Back bending forward, neck bent forward, knees bent, weight handled 65kg-70kg.	8	High risk	Implement change

Manual sealing of bag using needle and threads		Trunk straight and twisted, neck twisted, arms below shoulder level, wrist twisted, weight handle 65kg-70kg.	6	Medium risk	Change soon

DISCUSSION

An awkward posture is one of the crucial ergonomic risk factors that cause MSDs among farmers and they are highly prone to MSDs due to strenuous manual work. However, in the present study, only 20% of the participants reported lower back MSDs, which was the highest of all the body region MSDs reported by farmers engaged in paddy bagging activities in last 12 months. Keawduangdee et al. (2015); Sombatsawat et al. (2019), found that more than 80% of participants reported lower back MSD and found it was much more prevalent among rice farmers. Apart from this, several other research studies found that the lower back MSD is common among agricultural farmers (Amy Osborne et al., 2010; Thetkathuek et al., 2018; Tomczyszyn et al., 2018). In contradiction with the findings on body region MSDs in the present study, the posture analysis conducted using the REBA tool indicated that paddy bagging is a very high-risk task and the farmers engaged in paddy bagging activities are found to have the highest probability of the development of lower back MSD.

Therefore, the recommendation was that actions be taken for immediate ergonomic improvements of the paddy bagging task. These findings agree with previous results on assessment of MSDs using the REBA tool by (B. Das & Gangopadhyay, 2011) using child agricultural farmers as participants. The present study showed that the mean trunk score obtained with REBA was higher for those who had no lower back MSD than those who had lower back MSD in last 12 months. This finding was unexpected because the higher trunk score may indicate the awkward trunk posture and is likely to cause lower back MSD. Likewise, several unexpected inverse associations between MSDs and posture scores were obtained in the present study. Whereas (Rafeemanesh et al., 2021) conducted a postural analysis using Rapid Upper Limb Assessment (RULA) tool and found a significant relationship between the mean RULA grand score and MSDs in upper back and shoulder reported by participants as having during the last 12 months. They also found that mean RULA score was higher in individuals with upper back and shoulder pain which is a positive association between RULA score and MSDs.

Rafeemanesh et al. (2021) further found a significant relationship between the mean RULA B and neck and back pain and between the mean RULA A and upper back and wrist pain. The findings in the present study contradict with the findings of (Rafeemanesh et al., 2021). REBA tool has been used in several studies previously for posture assessment and suggest ergonomic improvements to minimize MSDs among farmers. However, several contradictory findings

obtained with REBA tool in the present study compared with the previous findings may indicate the need for further investigations of the paddy bagging activities. Though it is a manual material handling task, the authors could not find previous studies with similar tasks.

CONCLUSION

The results show that MSDs are not highly prevalent among farmers engaged in paddy bagging tasks. From the posture analysis, it is concluded that paddy bagging activities are most likely to cause MSDs. However, several inverse relationships between various body postures and MSDs indicate the need to investigate the paddy bagging task further.

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