Analyzing Musculoskeletal Disorders in Farmers Involved in Cultivation of Rice in Selected Villages of Bangladesh

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Abstract

Agriculture is a major and important business in Bangladesh. A significant number of people are directly involved in farming and have particularly unique exposure as compared to other sectors. Musculoskeletal issues are not uncommon among farmers. The study aims to identify the factors responsible for the occurrence of musculoskeletal disorders in farmers involved with rice cultivation in three selected villages, namely Ashighar dakkin, Ashighar uttar and Gilachara of Fenchuganj Upazila, Sylhet, Bangladesh. A total of 200 rice cultivators were selected randomly from the three selected villages. A questionnaire-based interview was conducted to collect data. Data were analyzed using SPSS 26.0 version software and Microsoft Excel. The Chi-square test was employed to determine the significant association between multiple parameters and several musculoskeletal effects during various rice cultivation operations (ploughing, seeding, transplanting saplings, weeding, fertilizing, applying pesticides, cutting and threshing paddies).Findings show that except for weeding and fertilizing, the duration of work is a significant aspect in all rice cultivation operations. Work fatigue is a critical factor for seeding, fertilizing, transplanting saplings, cutting, and threshing, whereas the farmer's weight is a significant factor for ploughing, seeding, weeding, fertilizing, and applying pesticides.

Keywords
Musculoskeletal Disorder, Risk Factor, Farmer, Rice and Bangladesh

1. Introduction
Species of grains and cereals, which are the primary source of food for billions of people globally, include wheat and rice (Welch and Graham 2004). Agriculture has long been recognized as one of the most hazardous occupations for human health in developing countries (Naeini et al. 2014). Farmers may be at risk of getting musculoskeletal disorders (MSDs) because farming is typically seen as a physically demanding occupation. Numerous agricultural chores are frequently performed in hazardous and unmanaged environments, which increases the risk of accidents, illnesses, and fatalities, especially those connected to musculoskeletal disorders (Bhattarai et al. 2016)(Palmer and Goodson 2015). Various researches highlight the correlation between the occupation and the prevalence of MSDs, while other investigations have found a link between farming and the development of MSDs (Hartman et al. 2006)(Rosecrance et al. 2006). Farmers who work long hours in various tasks with awkward postures are more likely to develop musculoskeletal disorders (Jain et al. 2018).

A set of diseases known as musculoskeletal disorders include those that affect the musculoskeletal system, which includes the nerves, muscles, tendons, joints, and supporting structures including intervertebral discs, etc. (Osborne et al. 2010). Musculoskeletal disorders can lead to discomfort, musculoskeletal structure damage, poor health, a poor quality of life, and decreased productivity (Bihari et al. 2011). They are the most frequent cause of severe, ongoing pain and impairment, and it is currently estimated that hundreds of millions of people worldwide are affected by them (Ghasemkhani et al. 2008). Musculoskeletal Disorders (MSDs) are a widespread issue that significantly affect a nation's health and economy (Woolf and Pfleger 2003). Work-related issues like MSDs may not be resolved until farmers are subjected to a risk assessment for MSDs. These conditions may further result in disabilities (Stankevitz et al. 2016).

Agriculture is the main industry in Bangladesh. Agricultural activities are primarily practiced by the majority of the population, who live in rural areas. Since they provide the biggest contribution to our economy, keeping them fit is a

major concern in Bangladesh. This study focuses on rice farmers to analyze the factors responsible for the prevalence of musculoskeletal problems among them while conducting various cultivating operations, including ploughing, seeding, transplanting saplings, weeding, fertilizing, applying pesticides, cutting and threshing paddies.

1.1 Objectives

The objective of this study is todetermine the relationships of musculoskeletal disorders with different risk factors specifically, age, work experience, height, weight, duration of work and work fatigue in each operation of rice cultivation(ploughing, seeding, transplanting saplings, weeding, fertilizing, applying pesticides, cutting and threshing paddies).

2. Literature Review

The already published papers or articles on a subject are a significant key to the sources of significant problems and explanatory hypotheses; provide a helpful orientation for the definition of problems, background for the selection of procedures, and data type for the interpretation of results. Every research begins from where the previous researches have left it, and goes forward, maybe one inch or even less, towards finding the solution of a problem or answer to questions. So, every researcher should keep up to date with the latest findings and results.

Osborne et al. (2013) conducted research to explore attributed causes of LBP, investigate the relationship between LBP and personal and work-related factors and measure the impact of LBP. They concluded that lifting/pulling/pushing were identified as the most commonly attributed cause of LBP. Laura López-Aragón et al. (2018) performed study to evaluate the musculoskeletal working conditions of greenhouse workers in Spain. They used Nordic Questionnaire and their study showed a high overall rate of symptoms of musculoskeletal disorders.Manida Swangnetra et al. (2014)conducted research to examine the relationship of farmer experience and demographics to perceptions of pain and to identify body areas exposed to ergonomics risks, unknown to farmers. They found that farmer experience and age were significantly correlated with occurrence of pain and cramping.Neubert et al. (2017)conducted research to identify factors associated with pain in rice farmers for every stage of the cultivation process. They concluded that the highest risk and pain perception were found during the transplanting performance. Age exhibited significantly positive association with foot pain during transplanting and harvesting.Dohyung Kee et al. (2019)conducted research to determine the prevalence of work-related MSD in agricultural workers in Korea. They concluded that pain intensity in the shoulder, knee and lower back disorder rates were higher than those of other body parts.John McNamar et al. (2010) conducted research to establish prevalence, risk factors, and impact of work-related musculoskeletal disorders (WMSDs) among farmers in Ireland. They concluded that the most commonly affected body region was the low back 31% (n ¼ 32).Husda Oktaviannoor et al. (2015)investigated the correlation between age and period of working with MSDs complaints on palm farmers in PT. X. Their result did not show any significant correlation between age and period of working with MSDs complaints from palm farmers in PT. X.In the paper 'Prevalence of work-related musculoskeletal disorders in agricultural farmers of Bhaktapur district, Nepal', Prakash Kumar Mahto and Bhupal Gautam (2018)conducted research to find out the prevalence of musculoskeletal disorders in Bhaktapur district of Nepal and identified that that LBP was the most common MSD.

Many research works have been conducted on the prevalence and analysis of musculoskeletal disorders (MSD) in farmers involved with cultivation of rice by various researchers around the world. But no research works have been conducted on the analysis of musculoskeletal disorders developed in farmers during each operation of rice cultivation namely, ploughing, seeding, transplanting sapling, weeding, fertilizing, applying pesticide, cutting and threshing in Bangladesh.

3. Methods

An action plan was constructed so that logical and sequential progress can be made throughout the study. Action plan shown in Figure 1 describes the stages involved in this study. An idea was generated to work on determining the prevalence of musculoskeletal disorders among farmers. Some research papers about MSD and farmers were reviewed as mentioned earlier.

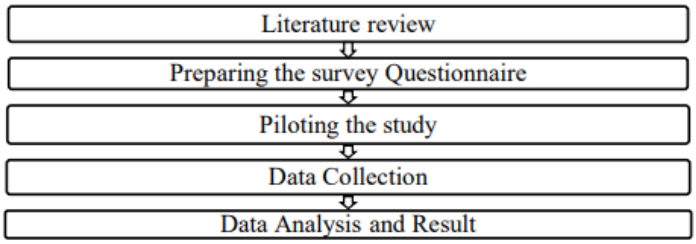

Figure 1. Action plan of this research.

The following search engines were explored for all available scientific publications relating to musculoskeletal disorders in farmer:

i. ResearchGate (https://www.researchgate.net/),
ii. Google Scholar (https://scholar.google.com/),
iii. ScienceDirect (https://www.sciencedirect.com/),
iv. PubMed (https://pubmed.ncbi.nlm.nih.gov/),
v. Springer (https://springer.com/)

The search terms were 'musculoskeletal disorder' or 'musculoskeletal symptom' and 'farmer' or 'agriculture'. There was restriction in relation to year of publication. All documents that were published after 2010 were retrieved for this study. A total of 43 publications were found using the abovesearching criteria.To be included in the final data set, the publications had to meet the following criteria:

i. Published literature contained robust and well laid out methodologies.
ii. The outputs of the publication were clear with qualitative or quantitative information relating to the study topic.
iii. Publications presenting the same information were consolidated to remove replication.

The extracted publications were thoroughly examined to remove duplicates and irrelevant publications (those that do not address musculoskeletal disorders), yielding 35 publications.The flow diagram in Figure 2 shows the selection criteria of the publications used for this research.

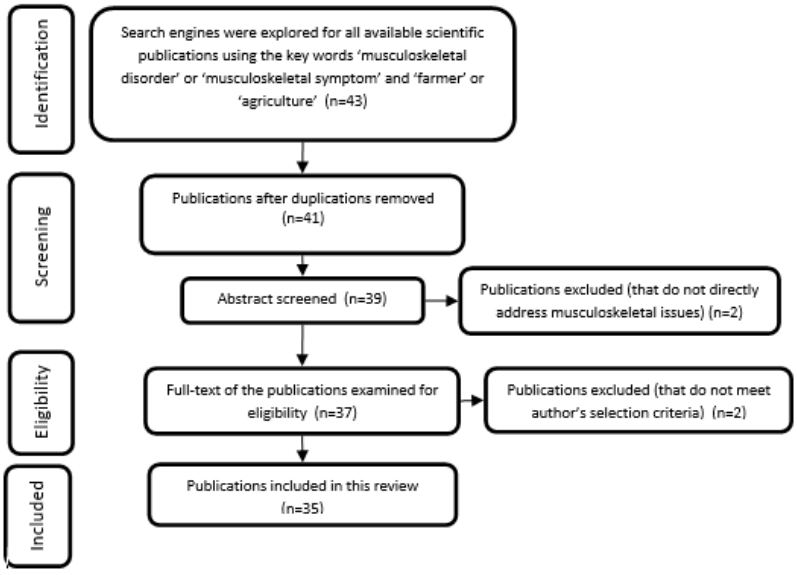

Figure 2. Flow diagram showing the procedure used for selection of publications for thisresearch.

From each of the reviewed papers, the following information were collected: i)authors; ii)publication year; iii) objectives; iv) methods and techniques used and v) musculoskeletal disorders. Bias was avoided by excluding the grey literatures. By adopting a cumulative approach to the search and analysis of independent studies of the selected subject,

we were able to detect potential publication bias. According to Gurevitch et al. (2018), reviews that analyze existing literatureto identify the gaps in the relevant field is the strength of the review approach because it directs future primary studies to the areas for which evidence is most needed.

The nature of the survey was explained to the farmers and participation was voluntary. A three part questionnaire was made by following the objectives of this research. The first part of the questionnairefeatured questions about the demographic data. The second part included questions about musculoskeletal issues experienced by the selected farmers. The third part of the questionnairefeatured questions about psychological information.

4. Data Collection

Using the survey method, data were collected from three villages namely Ashighar dakkin, Ashighar uttar and Gilachara of Fenchuganj Upazila, Sylhet, Bangladesh. In this research, Slovin's formula is used to determine the sample size, which is written as-

$$n=\frac{N}{(1+Ne^2)};$$

Where,n = Sample size, N = Total Population and e = Error tolerance level.
Let, the confidence level of this study be 95 percent, which gives e = 0.05. The population of farmers in these three villages namely Ashighar dakkin, Ashighar uttar and Gilachara of Fenchuganj Upazila are approximately 400. So, by calculating and rounding to a whole number, the sample size is found to be 200. It means that 200 respondents need to be selected for data collection from the survey questionnaire.

5. Results and Discussion

Applying Slovin's formula with 95% confidence level, a total of 200 farmers were selected from the three selected aforementioned villages of Fenchuganj Upazila, Sylhet for collecting necessary data.

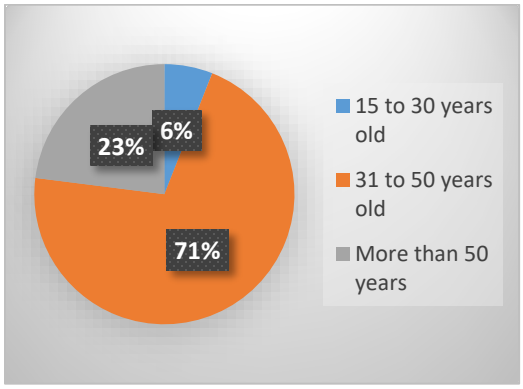

Figure 3. Age of participants

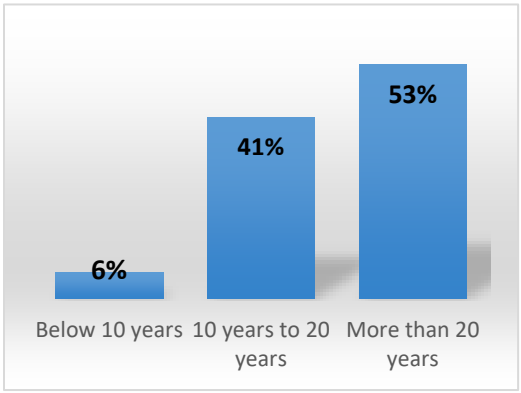

Figure 4. Work experience of participants

From Figure 3, it can be seen that most of the participants (71%) were in between 31 years to 50 years old. Figure 4 illustrates that most of the participants (53%) had more than 20 years of experience. Figure 5 illustrates that the highest percentages of (70%) participants were of 50 kg to 65 kg whereas most of them (94.5%) were of 5 feet to 5 feet 8 inches (Figure 6). Figure 7 shows that the highest percentage (74%) of participants had moderate level of work fatigue.

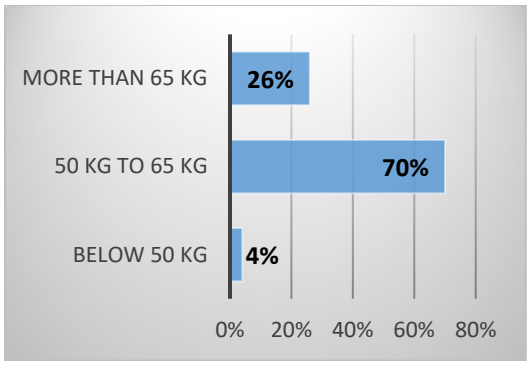

Figure 5. Weight of participants

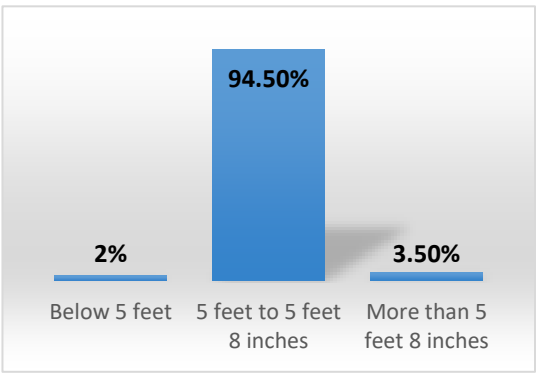

Figure 6. Height of participants

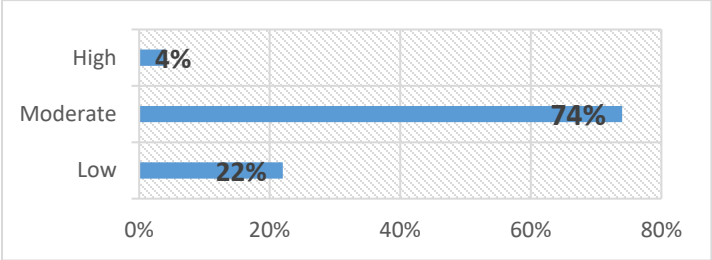

Figure 7. Work fatigue of participants

5.1Chi-Square test summary of significant relationship between different factors (age, work experience, height, weight, duration of work and work fatigue) and different musculoskeletal pains during rice cultivation

The hypotheses that were tested in this study for ploughing, seeding, transplanting saplings, weeding, fertilizing, applying pesticides, cutting and threshing paddiesare as follows:

Null Hypothesis (H_0): The factors (age, work experience, height, weight, duration of work and work fatigue) are not responsible for occurrence of musculoskeletal pains.

Alternative Hypothesis (H_1): Musculoskeletal pains are influenced by the factors (age, work experience, height, weight, duration of work and work fatigue)

According to the hypothesis testing with a 95% confidence of interval, when p value is smaller than 0.05, it indicates that the null hypothesis is rejected, that is, there is a significant relationship between the variables (factors and pains). When p value is greater than 0.05, it indicates that the null hypothesis is accepted, that is, there is no significant relationship between the variables (factors and pains). Chi Square test is used in this study to calculate the p value.

Table 1. Chi square test summary for determining association between the factors and different musculoskeletal effects during ploughing of rice cultivation

Effects	Factors for Ploughing (p-value)					
	Age	Work Experience	Height	Weight	Duration of work	Work Fatigue
Neck Pain	N/S	N/S	N/S	N/S	N/S	N/S
Lower Back Pain	N/S	N/S	0	0	0	0.036
Hand Pain	0.023	N/S	N/S	N/S	N/S	N/S
Shoulder Pain	N/S	N/S	N/S	0.007	N/S	N/S
Chest Pain	N/S	N/S	0.023	0.002	0.002	N/S
Elbow Pain	N/S	N/S	N/S	N/S	N/S	0.002
Knee Pain	N/S	N/S	N/S	N/S	N/S	N/S
Finger Pain	N/S	N/S	N/S	N/S	N/S	N/S
Wrist Pain	0.049	0.006	0.023	0.049	0.037	N/S
Heel Pain	0.024	0.05	N/S	N/S	0.012	N/S
Leg Pain	0.042	N/S	N/S	0.005	0.003	0.05

From above Table1, it is seen that age is a significant factor for hand (p=0.023), wrist (p=0.049), heel (p=0.024) and leg pain (p=0.042) during ploughing. During ploughing, work experience is responsible for wrist (p=0.006) and heel pain (p=0.05). Lower back, chest and wrist pain are associated with the height and weight of farmers (p<0.05) during ploughing. During ploughing, weight is also responsible for associating pain in shoulder region (p=0.007). Duration of ploughing is a significant factor for the occurrenceof lower back (p=0.0), chest (p=0.002), wrist (p=0.037), heel (p=0.012) and leg pain (p=0.003) whereas work fatigue is responsible for lower back (p=0.036), elbow (p=0.002) and leg pain (p=0.05) during ploughing operation.

Table 2. Chi square test summary for determining association between the factors and different musculoskeletal effects during seeding of rice cultivation

Effects	Factors for Seeding (p-value)					
	Age	Work Experience	Height	Weight	Duration of work	Work Fatigue
Neck Pain	N/S	N/S	N/S	N/S	N/S	0.048
Lower Back Pain	N/S	N/S	0.017	0.009	0.008	N/S
Hand Pain	N/S	0.034	N/S	0.012	0.007	0.012
Shoulder Pain	0.02	0.055	N/S	0.024	0.012	0.002
Elbow Pain	N/S	N/S	N/S	0.002	0.037	0.003
Knee Pain	N/S	N/S	N/S	N/S	N/S	0.022
Finger Pain	N/S	N/S	N/S	N/S	N/S	0.048
Wrist Pain	N/S	0.006	N/S	N/S	0.037	N/S
Heel Pain	N/S	N/S	N/S	N/S	N/S	N/S
Leg Pain	N/S	N/S	0.04	0.004	0.01	N/S

Table 2 shows that shoulder pain during seeding is caused by age (p=0.02). Work experience is a strong determinant of pain in the hand, shoulder, and wrist regions during seeding (p=0.034, 0.055, and 0.006, respectively). The height of farmers is associated with lower back and leg pain during transplanting (p<0.05). Lower back, hand, shoulder, elbow, and leg pain are influenced by weight and duration of seeding (p<0.05), whereas wrist pain is also significantly impacted by the duration of seeding (p=0.37). The pains in the neck (p=0.048), hand (p=0.012), shoulder (p=0.002), elbow (p=0.003), knee (p=0.022), and finger region (p=0.048) are significantly correlated with work fatigue during seeding.

Table 3. Chi square test summary for determining association between the factors and different musculoskeletal effects during transplanting sapling of rice cultivation.

Effects	Factors for Transplanting Sapling (p-value)					
	Age	Work Experience	Height	Weight	Duration of work	Work Fatigue
Neck Pain	N/S	N/S	N/S	N/S	N/S	N/S
Lower Back Pain	0.047	0.019	N/S	N/S	N/S	N/S
Hand Pain	N/S	N/S	0.014	0	0	N/S
Shoulder Pain	0.022	N/S	N/S	N/S	0.047	N/S
Knee Pain	N/S	N/S	0.023	0.002	0	N/S
Wrist Pain	N/S	N/S	N/S	N/S	0.048	0.009
Upper Back Pain	N/S	N/S	N/S	N/S	N/S	0.022
Leg Pain	N/S	N/S	N/S	N/S	N/S	0.048

Table 3 explains that age is responsible for lower back (p=0.047) and shoulder (p=0.022) pain whereas work experience is related to the lower back pain (p=0.019) during transplanting. Hand and knee pain are associated with height and weight of the farmers (p<0.05) while doing transplanting. Duration of transplanting is responsible for hand (p=0.0), shoulder (p=0.047), knee (p=0.0) and wrist pain (p=0.048). During transplanting, work fatigue is related to the pain in wrist (p=0.009), upper back (p=0.022) and leg region of farmers (p=0.048).

Table 4. Chi square test summary for determining association between the factors and different musculoskeletal effects during weeding of rice cultivation

Effects	Factors for Weeding (p-value)					
	Age	Work Experience	Height	Weight	Duration of work	Work Fatigue
Neck Pain	N/S	N/S	N/S	0.004	N/S	N/S
Lower Back Pain	N/S	N/S	N/S	N/S	N/S	N/S
Hand Pain	0.015	0.015	N/S	0.003	N/S	N/S
Elbow Pain	N/S	N/S	N/S	N/S	N/S	0.022
Wrist Pain	N/S	N/S	N/S	0.024	N/S	0.002
Heel Pain	N/S	N/S	N/S	N/S	N/S	N/S

From above Table 4, it is seen that pain in hand is related to the age (p=0.015) and work experience (p=0.015) of the farmers during weeding. Weight is responsible for pain in neck (p=0.004), hand (p=0.003) and wrist (p=0.024) while weeding. During weeding, work fatigue is associated with elbow (p=0.022) and wrist pain of farmers (p=0.002).

Table 5. Chi square test summary for determining association between the factors and different musculoskeletal effects during fertilizing of rice cultivation

Effects	Factors for Fertilizing (p-value)					
	Age	Work Experience	Height	Weight	Duration of work	Work Fatigue
Neck Pain	N/S	N/S	N/S	N/S	N/S	N/S
Lower Back Pain	N/S	N/S	0.006	0.004	N/S	0.009
Hand Pain	N/S	0.002	N/S	0.004	N/S	0.008
Shoulder Pain	0.007	0.032	N/S	0.007	N/S	N/S
Elbow Pain	N/S	N/S	N/S	N/S	N/S	N/S
Knee Pain	N/S	N/S	N/S	N/S	N/S	N/S
Wrist Pain	N/S	0.013	N/S	N/S	0.016	0
Heel Pain	N/S	N/S	N/S	N/S	0.026	0.022
Leg Pain	N/S	N/S	N/S	N/S	N/S	N/S

Table 5 explains that age is responsible for shoulder pain (p=0.007) whereas work experience of farmers plays a significant role for pain in hand (p=0.002), shoulder (p=0.032) and wrist region (p=0.013) during fertilizing. Height is responsible for lower back pain (p=0.006) whereas weight is responsible for occurring lower back (p=0.004), hand (p=0.004) and shoulder pain (p=0.007) during fertilizing. Duration of fertilizing is related to the wrist (p=0.016) and heel pain (p=0.026) whereas work fatigue is related to the lower back (p=0.009), hand (p=0.008), wrist (p=0.0) and heel pain (p=0.022) during fertilizing.

Table 6. Chi square test summary for determining association between the factors and different musculoskeletal effects during applying pesticides of rice cultivation

Effects	Factors for Applying Pesticides (p-value)					
	Age	Work Experience	Height	Weight	Duration of work	Work Fatigue
Lower Back Pain	0.045	0.009	N/S	0.023	N/S	N/S
Hand Pain	N/S	N/S	N/S	0	0	N/S
Shoulder Pain	N/S	N/S	N/S	0.005	0	N/S
Chest Pain	N/S	N/S	N/S	N/S	N/S	N/S
Elbow Pain	N/S	N/S	N/S	N/S	N/S	N/S
Wrist Pain	N/S	N/S	N/S	N/S	0.002	0.009
Leg Pain	N/S	0.032	N/S	0.007	0.001	0.009

Table 6 illustrates that lower back pain is associated with the age (p=0.045), work experience (p=0.009) and weight (p=0.023) of the farmers whileapplying pesticides. Hand and shoulder pain have significant relationships with the weight of farmers ($p<0.05$) and duration of work ($p<0.05$) whileapplying pesticides.During the applying of pesticides, wrist pain is related to the work fatigue (p=0.009) and duration of work (p=0.002). Leg pain has significant relationships with the work experience (p=0.032), weight (p=0.007), duration of work (p=0.001) and work fatigue (p=0.009) of farmers during the applying of pesticides.

Table 7. Chi square test summary for determining association between the factors and different musculoskeletal effects during cutting of rice cultivation

Effects	Factors for Cutting (p-value)					
	Age	Work Experience	Height	Weight	Duration of work	Work Fatigue
Neck Pain	N/S	N/S	N/S	N/S	N/S	N/S
Lower Back Pain	N/S	N/S	N/S	N/S	N/S	0
Hand Pain	N/S	N/S	0.038	0	0	N/S
Shoulder Pain	N/S	N/S	N/S	N/S	N/S	N/S
Elbow Pain	N/S	0.05	N/S	0.024	N/S	0.002
Knee Pain	N/S	0.038	0.008	N/S	0	0.031
Wrist Pain	N/S	N/S	N/S	N/S	0.047	N/S
Upper Back Pain	N/S	N/S	N/S	N/S	0.047	0.002

From above Table 7, it is seen that work experience is a significant factor for associating elbow (p=0.05) and knee pain (p=0.038) whereas height is responsible for hand (p=0.038) and knee (p=0.008) pain during cutting. Weight is a significant factor for hand (p=0.0) and elbow pain (p=0.024) during cutting. Duration of cutting is related to the hand (p=0.0), knee (p=0.0), wrist (p=0.047) and upper back pain (p=0.047) whereas work fatigue is responsible for lower back (p=0.0), elbow (p=0.002), knee (p=0.031) and upper back pain (p=0.002) during cutting.

Table 8. Chi square test summary for determining association between the factors and different musculoskeletal effects during threshing of rice cultivation

Effects	Factors for Threshing (p-value)					
	Age	Work Experience	Height	Weight	Duration of work	Work Fatigue
Lower Back Pain	0.05	0.047	0	0	0	0.018
Hand Pain	N/S	N/S	N/S	N/S	N/S	N/S
Shoulder Pain	N/S	N/S	N/S	0	N/S	0.018
Thigh Pain	N/S	N/S	N/S	N/S	N/S	0.048
Elbow Pain	N/S	0.01	0.04	0.004	N/S	0.001
Knee Pain	N/S	N/S	N/S	N/S	0.009	0.022
Finger Pain	0.007	0.032	N/S	N/S	0.046	N/S
Wrist Pain	N/S	N/S	N/S	N/S	0.032	0.022
Leg Pain	N/S	N/S	N/S	N/S	N/S	N/S

Table 8 explains that age is a significant factor for lower back (p=0.05) and finger pain (p=0.007) while work experience is related to lower back (p=0.047), elbow (p=0.01) and finger pain (p=0.032) during threshing. Height is responsible for lower back (p=0.00) and elbow (p=0.04) pain during threshing. During threshing, weight plays a significant role for the occurrence of pain in lower back (p=0), shoulder (p=0) and elbow region (p=0.004). Duration of threshing is related to the lower back (p=0.00), knee (p=0.009), finger (p=0.046) and wrist (p=0.032) pain whereas work fatigue is responsible for lower back (p=0.018), shoulder (p=0.018), thigh (p=0.048), elbow (p=0.001), knee (p=0.022) and wrist (0.022) pain during threshing.

The findings of this research can be summarized as: Duration of work is a critical factor for all operations of rice cultivation except weeding and fertilizing. The weight of farmer is an important factor for ploughing, seeding, weeding, fertilizing and applying pesticides whereas work fatigue is a critical factor for seeding, fertilizing, transplanting saplings, cutting and threshing.

6. Conclusion

Rice cultivation plays a vital role in the livelihood of the people of Bangladesh. The laborers engaged in rice cultivation often face serious injuries and also different musculoskeletal disorders for repetitive-type works.Musculoskeletal effects that were reported by farmers for different operations (ploughing, seeding, transplanting sapling, weeding, fertilizing, applying pesticides, cutting and threshing paddies) during rice cultivation were neck, lower back, hand, shoulder, chest, elbow, knee, finger, wrist, heel, leg, upper back and thigh pain.Factors responsible for the occurrence of each of those pains during each operation of rice cultivation were identified by using Chi-square test in this study. Six factors (age, work experience, height, weight, daily duration of operation and work fatigue) were considered in this research. From this research, it is seen that weight of farmers, duration of different activities and work fatigue of farmers shows significance for the occurrence of most of the musculoskeletal pains during rice cultivation. Future work of this research may extend to identify the risky postures that are the probable cause of musculoskeletal effects during rice cultivation. As a result of this research, farmers related to the rice cultivation can be aware of the probable factors related to those musculoskeletal effects that they were facing during their daily work.

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