ORIGINAL ARTICLE

# Risk factors for musculoskeletal problems in paddy field workers in northern iran: A community-based study

**Mohsen Sharifirad[1], Alireza Poursaeed[2], Farhad Lashgarara[1], Seyed Mehdi Mirdamadi[1]**

[1]Department of Economics, Agricultural Extension and Education, Science and Research Branch, Islamic Azad University, Tehran, Iran, [2]Department of Agricultural Extension and Education, Ilam Branch, Islamic Azad University, Ilam, Iran

**Background:** Paddy cultivation of rice requires substantial physical strength, perseverance and manual labor. During the manual harvesting of paddy rice in Iran, laborers are exposed to several work-related physical risks. Paddy cultivation has been reported as one of the most important causes of nonfatal occupational injuries and accidents among farmers. With the aim of identifying which parts of the musculoskeletal structure are mostly affected as a result of working on paddy rice fields, the present study aimed to investigate the potential risk factors for musculoskeletal problems in paddy field workers in Mazandaran Province, Iran. **Materials and Methods:** A cross-sectional, analytical study was conducted among paddy field workers via multistage sampling in 2019. Prior to the interviews based on the Nordic Musculoskeletal Questionnaire, the participants were briefed about the objectives of the research and their consent was obtained for voluntary participation. Through interviews, data were collected on demographics, agricultural utilization systems, use of paddy tractors, frequency of tiller and tractor use, injuries sustained during the daytime, and outcomes of injuries by paddy field working. Responses were obtained from 384 workers using structured interviews. The respondents were asked to describe problems and pain in their neck, shoulders, elbows, wrists and hands, upper back, hip and lower back. Logistic regression models were used to identify potential risk factors for musculoskeletal problems in specific body regions. **Results:** The most commonly reported ailments were back pain ($n$ = 29; 7.6%), cardiovascular disease ($n$ = 25, 6.5%) and hypertension ($n$ = 22, 5.7%). The results of logistic regression analysis indicated that the odds of back and shoulder injuries was higher among workers who used tillers and combine harvesters (2.85 and 1.66), transplanting machine (3.68), and those who did not use safe footwear (7). Knee injury risk was higher among those who cultivated rice manually (odds ratio [OR] = 1.35) and who used safety footwear (OR = 1.93), but was lower among those who used tractors (OR = 0.53). There was a small increase in the risk of knee injury with age (OR = 1.03). Confirming earlier works, musculoskeletal problems were found to be highly prevalent among rice workers. **Conclusion:** Disorders in certain body regions could be explained by specific individual and work-related factors. While the prevalence of work-related injury was high, mostly due to ignorance and disregard for personal convenience of the workers, the findings call for improvements in mechanization and division of labor time and force. Another highlight is that social worth is not given sufficiently to the health of paddy field workers. These should be worked on in future research to find ways of allocating machinery and worth to the workers.

**Key words:** Musculoskeletal disorders, Northern Iran, paddy field workers

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## INTRODUCTION

Today, musculoskeletal disorders are one of the most common causes of occupational injuries and disabilities in both developed and developing countries. These work-related disorders are the causes of lost workdays, inefficient performance by workers and medical costs. Despite the development and expansion of mechanization processes, work-related musculoskeletal disorders remain the most important cause of workforce injury[1] and are burdensome on different industries.[2] The economic burden of poor occupational health and safety practices is estimated at 4% of the global Gross Domestic Product each year.[3] Underreporting is another

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**Address for correspondence:** Dr. Alireza Poursaeed, Department of Agricultural Extension and Education, Ilam Branch, Islamic Azad University, Ilam, Iran. E-mail: ar.poursaeed@gmail.com

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issue in occupational injuries. Precise information does not exist in some countries that enforce weaker safety measures, thereby being in stark contrast with countries that have strict regulations.[4]

Although often portrayed as idyllic, farming is an arduous profession. Among the many physical hazards and stressors involved are lifting and carrying heavy loads, exposure to whole-body vibration from farm vehicles, and hand-transmitted vibration from chain saws and powered hand-tools.[5] In one relevant study conducted in the northwest of Iran, more than 80% of farmers were found to suffer from back pain.[6] This percentage is important given that 18% of Iranians are engaged in the agricultural industry and because of the fact that the agricultural sector in Iran is not mechanized and widely suffers from a lack of new equipment. In addition, there are serious obstacles to improving the health of farmers in Iran, including the low level of farmer awareness about occupational ergonomic and hazards, the unwillingness of farmers to participate in medical checkups, and a low level of education among farmers.[7] Evidence suggests that the risk of occurrence and severity of accidental injuries is very high in agricultural occupations.[8] During the manual harvesting of paddy rice in Iran, in particular, laborers are exposed to work-related physical risks.[9] Further, paddy cultivation requires a great deal of physical strength and manual labor. Paddy cultivation has been reported as one of the most important causes of nonfatal occupational injuries and accidents among farmers.[10] There are a number of occupational health hazards, which are commonly reported among farmers and those involved in agricultural work, which include farm machinery hazards, biological and chemical hazards, and social and environmental stresses.[11] These hazards are also present among farmers in rice fields, while working with motorized plowing machines. Rice (*Oryza sativa* L.) is an important staple crop. It is eaten by almost half of the world population and is cultivated more in Asia.[12] Iranians consume an average of 100 g of rice per day, and rice is the second most popular, favorite staple food in Iran after bread.[13] This crop is cultivated in several provinces, mostly in the northern parts of the country, especially in the provinces of Mazandaran and Gilan.[14] Given the importance of a healthy workforce in food production, it is necessary to identify the risk factors for musculoskeletal disorders so as to maintain food safety and introduce interventions to reduce the severity and complications of work-related injuries. Despite the heavy manual labor involved in agriculture, few studies have evaluated musculoskeletal problems among rice farmers. For instance, a survey of rice farmers in 9 Thai villages found that over 65% of the farmers grapple with musculoskeletal problems because they usually lift heavy rice sacks and seed containers, carry backpack pesticide sprayers, and lift heavy pumping hoses.[15] Since the practice of paddy field working in each region or country has undergone unique historical routes, and the people of each place have developed different subsets of actions (micro-actions) while working in paddy fields, the necessity of this research was to explore and quantify the types of injuries that can occur to workers within the specific geographical context of the study, i.e., the north of Iran. The novelty of the research lies in its regional-specific focus, the workers' features, and the availability or inaccessibility to necessary equipment which collectively shaped the outcomes of injuries and, thus, created an opportunity for discussions and recommendations. Since each geographical location, the participants and their particularities would require unique recommendations, the unprecedented nature of this research comes into the spotlight due to an absence of previous comprehensive research on the area of study which is covered herein. Therefore, the aim of the current research is to investigate the risk factors for musculoskeletal injuries in paddy field workers in the north of Iran.

## METHODOLOGY

### Study design and participants

This cross-sectional, analytical study was conducted on paddy field workers on rice fields. The workers were selected using a multistage sampling method in 2019. Considering that the worker population on farms is about 144,805 (according to the latest national census), with 95% confidence level and $P = 0.5$, the multistage sampling involved taking small samples of the population at each stage of assessment, as representatives of each population. A sample size of 384 was calculated based on Cochran's sample size formula. In the first sampling stage, farm workers from each of 21 towns (strata) who performed active labor on paddy field cultivation were considered in the Mazandaran Province. The inclusion criteria for participants were based on the General Health Questionnaire–28 (GHQ-28) which is a self-reporting assessment of psychological integrity and health for individuals. The questionnaire is tasked with identifying individuals who cannot perform regular functions and those who show symptoms of distress.[16] Individuals who did not score minimum requirements on the GHQ-28 questionnaire were excluded from the sample population. After inclusion of healthy individuals, the statistics of the sample population was recorded and considered as percentages relative to the average values of the total population in the province. Thus, the sample size was allocated as quota sampling.

### Study instrument and variables assessment

The samples were randomly selected from among people who were working in paddy fields in Mazandaran Province. To obtain a random sampling of farmers, we randomly

selected a region from each of the provincial cities that had rice fields. Then, we randomly interviewed farmers in the rice fields. Prior to the interviews, the participants were briefed about the objectives of the research. They were also informed of the voluntary nature of participation in the research and were ensured about the confidentiality of their personal information.

Body mass index (BMI) was classified as "<18.5 kg/m$^2$ underweight, 18.5–24.4 kg/m$^2$ normal weight, 25–29.9 kg/m$^2$ overweight, and ≥ 30 kg/m$^2$ obesity."

Verbal consent was obtained and the data were collected through structured interviews, which included questions about demographic information, agricultural utilization system, work experience, use of a paddy tractor, use of mechanical equipment, frequency of tiller and tractor use, frequency of transplanting machine use, frequency of herbicide use, rice varieties, whether they pay attention to safety instructions before using equipment, personal safety equipment, the associated season with the highest frequency of occupational injury and damage, injuries sustained during the daytime, and outcomes of injuries by paddy field working. In addition, musculoskeletal problems in major body parts were evaluated using the Nordic Musculoskeletal Questionnaire.[17] In the available literature, this questionnaire has been used as a reliable measure to compare the degrees of individuals' complaints of pain in the lower back, the shoulders and neck. It is comprised of 40 multiple-choice questions that inquire into nine symptom-sites in the body, i.e., shoulders, elbows, neck, upper back, lower back, hands and wrists, thighs and hips, ankles, feet and knees. Participants are specifically asked if they have experienced any pain or trouble affecting the said body regions during the past year and more recently in the week before the interview.[18] The standardized version of the questionnaire further inquiries into the occurrence of "accidents" that may have caused musculoskeletal problems, but we skipped this second stage of inquiry because musculoskeletal problems in paddy field workers are mostly chronic. They are rarely caused by accidents and, thus, the injuries are seldom acute. In general, the reliability and validity of this questionnaire has been approved by previous cases of research on car drivers,[19] forestry workers,[20] office workers[21] and nursing environments.[22]

### Statistical analysis

All statistical calculations were performed with IBM SPSS Statistics software (version 22, IBM Corporation, Armonk, NY, USA), with a statistical significance level of 95%. Survey responses were summarized using descriptive statistics. Chi-square tests were used for categorical data.

Subsequently, multiple logistic regression models were fit using two dichotomous dependent variables for each major body. Specifically, these dependent variables were yes/no responses to: (1) the presence of pain in the past 12 months and (2) the current presence of pain. Where the Chi-square test found a variable to be significant, it was used as an independent variable (i.e. risk factor). A forward stepwise selection method was utilized to obtain final logistic regression models.[23]

## RESULTS

Several of the demographic responses are summarized in Table 1. The largest number of workers were aged 50–59 years and had normal BMI. Most workers had no history of disease, but the most commonly reported ailments were back pain ($n$ = 29; 7.6%), cardiovascular disease ($n$ = 25, 6.5%) and hypertension ($n$ = 22, 5.7%). Most workers were males and single ($n$ = 57; 14.8%). Regarding education, 28.4% had a high school diploma, 25.8% had primary school education or lower, 7.8% ($n$ = 30) had a degree in agriculture and the rest (38%) had a degree in various other disciplines. More than two-thirds ($n$ = 262, 68.2%) of the workers practiced subsistence-commercial agriculture. The mean value (standard deviation) of work experience was 14.2 years, and the age of workers ranged from 20 to 70 years.

**Table 1: Demographic information of the paddy field workers included in the study**

| Variables | Mean±SD | *n* (%) |
|---|---|---|
| Age (years) | | |
| 20–29 | 46.9±13.1 | 36 (9.4) |
| 30–39 | | 93 (24.2) |
| 40–49 | | 82 (21.4) |
| 50–59 | | 99 (25.8) |
| 60–69 | | 58 (15.1) |
| 70–80 | | 16 (4.2) |
| BMI (kg/m$^2$) | | |
| Underweight | 24.8±3.1 | 2 (0.5) |
| Normal weight | | 211 (54.9) |
| Overweight | | 150 (39.1) |
| Obesity | | 21 (52.71) |
| History of disease | | |
| Yes | | 150 (39.1) |
| No | | 234 (60.9) |
| Sex | | |
| Male | | 337 (87.8) |
| Female | | 47 (12.2) |
| Agricultural utilization system | | |
| Cooperative | | 14 (3.6) |
| Subsistence | | 40 (10.4) |
| Commercial | | 59 (15.4) |
| Sharecropping | | 9 (2.3) |
| Subsistence-commercial | | 262 (68.2) |

SD=Standard deviation; BMI=Body mass index

Use of paddy tractors varied between 6.0% and 33.9%. Most workers ($n$ = 348, 90.6%) reported that they paid attention to safety instructions before using equipment, and nearly all ($n$ = 367, 95.6%) indicated that they used personal safety equipment. However, their equipment was limited to suitable footwear (boots) during work. Spring was noted as the season with the highest frequency of occupational injury and damage (37.2%), and workers reported that most injuries occurred during the daytime (73.2%). The highest incidence of injury occurred in paddy fields (13.3%) and when spraying pesticides in farms (9.6%), while hospitalization (35.2%) mostly ensued after these injuries. Musculoskeletal problems were commonly reported for all of the nine body regions, both in the past 12 months and at the time of the interview [Table 2]. According to the results, all risk factor univariates were statistically significant between people with and without musculoskeletal disorders ($P < 0.01$). The most common body parts with problems during the 12 months preceding the interview were, in order of prevalence, the hip/back, knees, shoulders, and neck. The patterns of pain prevalence across body regions among workers were almost similar. Logistic regression results for hip/back and shoulder problems are summarized in Table 3. The risk of hip/back injuries was higher among workers who used tillers/combine harvesters, were involved in transplantation, and did not use safe footwear, by rates of 2.8, 3.6, and 2.88, respectively. Moreover, the odds ratio (OR) for hip/back injuries with respect to the frequency of herbicide use was 0.73 (i.e. with an increase in the frequency of herbicide use, the risk of injury decreased by nearly 30%). The risk of shoulder injury was 1.6 times higher among workers who used tillers/combine harvesters. It was 2.5 times higher among those who used earmuffs. Shoulder injury risk also increased by 4% per year of age. Logistic regression results for elbow and knee problems are summarized in Table 3. The risk of elbow injury was higher for workers who were involved in transplantation (OR = 4.43) and who used earmuffs (OR = 2.06), but was lower among workers who contributed to double transplantation (OR = 0.62). Elbow injury risk also increased with respect to the frequency of tiller use (OR = 1.19) and age (OR = 1.03). Knee injury risk was higher among those who cultivated rice manually (OR = 1.35) and who used safety footwear (OR = 1.93), but was lower among those who used tractors (OR = 0.53). There was a small increase in the risk of knee injury with age (OR = 1.03).

## DISCUSSION

The highest prevalence of musculoskeletal problems among the current sample of paddy field workers was reported in the back (63%), knees (54.7%) and shoulders (35.4%). Similar results were reported among rice farmers[24] in that most participants (99%) experienced some discomfort, especially in the lower back (93.8%), shoulders (60.9%), hands (53.6%) and knees (80.9%) due to awkward posture (99%) and excessive repetitive tasks (95%) for a prolonged period of time. This prevalence of musculoskeletal problems thus confirms the general outline of results in the current study. In another study on rice farmers,[25] most participants complained of pain in the knees (95%), elbows (85%) and ankles/feet (80%). The findings of the present study are consistent with previous studies on rice farmers (Jain *et al*., 2018) in which the outcomes showed that 77.9% of the participants reported pain in at least one body part, thereby proving that MSDs are prevalent among farmers who harvest manually.[26] In a similar context, Gupta showed that lower back pain is the most prevalent type of MSDs that affect famers. Knee, shoulder and neck pain were other important MSDs that affected farmers in the study.[27] Similarly,[28] indicated that pain in the lumbar region of the spine (81.50%) is mostly common among farmers. Sombatsawat *et al*. showed that all rice farmers reported MSDs in at least one body part and the highest prevalence of MSDs (86.5%) were observed in the lower back.[29] Similarly,[30] indicated that lifetime pain, 12-month pain and point prevalence rates of the lower back pain among rice farmers were 77.4%, 56.2% and 49.1%, respectively. In line with our study, Kabir-Mokamelkhah *et al*. (2013) showed that paddy field workers who cultivate rice manually are at a greater risk of skeletal disorders in the spinal cord and lower limbs.[10] The main activities in rice farming include

**Table 2: Reported musculoskeletal problems in different body regions**

| Body region | Presence of pain in the past 12 months | | Current presence of pain | | *P** |
|---|---|---|---|---|---|
| | Yes, *n* (%) | No, *n* (%) | Yes, *n* (%) | No, *n* (%) | |
| Neck | 139 (36.2) | 245 (63.8) | 133 (34.6) | 251 (65.4) | <0.001 |
| Shoulders | 136 (35.4) | 248 (64.6) | 136 (35.4) | 248 (64.6) | <0.001 |
| Elbows | 76 (19.8) | 308 (80.2) | 72 (18.8) | 312 (81.3) | <0.001 |
| Wrists and hands | 122 (31.8) | 262 (68.2) | 115 (29.9) | 269 (70.1) | <0.001 |
| Upper back | 131 (34.1) | 253 (65.9) | 121 (31.5) | 263 (68.5) | <0.001 |
| Hip and back | 245 (63.8) | 139 (36.2) | 242 (63.0) | 142 (37.0) | <0.001 |
| One or both thighs | 92 (24.0) | 292 (76.0) | 89 (23.2) | 295 (76.8) | <0.001 |
| One or both knees | 214 (55.7) | 170 (44.3) | 210 (57.7) | 174 (45.3) | <0.001 |
| One or both feet | 164 (42.7) | 220 (57.3) | 158 (41.1) | 226 (58.9) | <0.001 |

*Significance. The comparisons of risk factor univariates between people with and without musculoskeletal disorders by Chi-square test

**Table 3: Results of the logistic regression regarding risk factors of hip/back and shoulder problems**

| Body part | Risk factor | Coefficient | SE | *P* | OR | 95% CI | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower limit | Upper limit |
| Hip and back | Tiller and combine harvester | 1.047 | 0.260 | <0.001 | 2.850 | 1.712 | 4.745 |
| | Transplanting machine | 1.303 | 0.655 | 0.047 | 3.682 | 1.020 | 13.288 |
| | Frequency of using herbicides | −0.303 | 0.151 | 0.045 | 0.739 | 0.549 | 0.993 |
| | Safety footwear | 1.105 | 0.310 | <0.001 | 2.887 | 1.573 | 5.298 |
| Shoulder | Tiller and combine harvester | 0.50 | 0.24 | 0.039 | 1.661 | 1.02 | 2.68 |
| | Earmuffs | 0.92 | 0.24 | <0.001 | 2.51 | 1.55 | 4.06 |
| | Age | 0.039 | 0.010 | <0.001 | 1.04 | 1.020 | 1.06 |
| Elbow | Double transplantation | −0.47 | 0.18 | 0.01 | 0.62 | 0.43 | 0.89 |
| | Frequency of tiller use | 0.17 | 0.04 | <0.001 | 1.19 | 1.09 | 1.31 |
| | Transplanting machine | 1.48 | 0.51 | 0.004 | 4.43 | 1.62 | 12.08 |
| | Earmuffs | 0.72 | 0.29 | 0.015 | 2.06 | 1.15 | 3.70 |
| | Age | 0.03 | 0.012 | 0.002 | 1.03 | 1.01 | 1.06 |
| Knee | Double transplantation | 0.30 | 0.143 | 0.032 | 1.35 | 1.02 | 1.79 |
| | Tractor | −0.63 | 0.25 | 0.013 | 0.53 | 0.32 | 0.87 |
| | Footwear | −0.66 | −0.33 | 0.049 | 1.93 | 1.00 | 3.73 |
| | Age | 0.03 | 0.009 | <0.001 | 1.03 | 1.01 | 1.05 |

SE=Standard error; OR=Odds ratio; CI=Confidence interval

carrying and planting seeds, picking and carrying crops, ridging, sowing, spading, sprinkling water and weeding. During such activities, farmers have to repeatedly adopt physically-demanding postures (i.e. squatting and kneeling) that can cause discomfort in multiple body regions.[26] In Iran, a large proportion of rice cultivation and harvesting is performed manually, without automatic machinery, which increases the exposure to musculoskeletal risk factors and the occurrence of such disorders. We observed no significant difference between men and women in terms of the severity of lumbar pain, i.e., pain in the lower back, which is consistent with a previous study.[31] On the other hand, in a study by Das (2015), a significant difference was reported between men and women. According to a study by Osborn *et al*., skeletal disorders are influenced by several factors.[32] As such, all demographic and occupational factors were entered into the regression model to identify factors associated with one disorder. In the present study, logistic regression analysis showed that the OR of back and shoulder injuries was higher in individuals who used tillers and combine harvesters, transplanted rice, and did not use safe footwear, compared to those who did not use tillers or combine harvesters, did not transplant, and used safe footwear. Moreover, logistic regression analysis showed that the risk of elbow injuries was higher in workers who transplanted and participated in double rice cultivation. Furthermore, with a 1-year increase in age, the risk of elbow injury increased by 17.3%. The risk of knee injury in workers who cultivated rice manually and did not use tractors or safe footwear was 1.35, 0.53, and 1.93 times higher than those who did not cultivate rice manually and used tractor and safe footwear, respectively. Furthermore, the OR of knee injury per age was 1.03 (confidence interval: 1.01–1.05) and, with a 1-year increase, the risk of knee injury increased by 3%. It seems that these findings can be explained by the average old age of the farmers participating in the study. Of course, this point cannot be considered as a limitation of this study because according to the latest national census of Iran, the number of paddy field workers has decreased by about 7% in the past decade, whereas their average age has increased. This is logical because manual and traditional planting and harvesting are still prevalent, while young workers prefer not to work in places that lack mechanized, new equipment in rice fields. Traditional farming in Iranian rice fields can grow unsustainable due to increasing awareness about health-related issues among people of the new generation. Transplantation and double transplantation are associated with skeletal abnormalities in workers due to inappropriate postures, such as bending forward and asymmetrical lifting. Consistent with the results of our research, a similar study showed that inappropriate posture was associated with abnormalities in rice workers.[31] It should be noted that persistence and repetition of inappropriate postures can lead to morphological changes of the spine and result in back injuries.[33] High workload and unbalanced work[2] have been reported as other factors associated with spinal degeneration. In line with our study, a previous research indicated that age can be regarded as a risk factor that concerns the knees, shoulders, hips and legs.[34] Given the high prevalence of skeletal disorders in paddy field workers, it is necessary for this group to undergo regular spine examinations. It is also necessary to perform regular exercises to reduce pain and strengthen lumbar, shoulder, foot and joint muscles.[33,34] Considering the effectiveness of exercise training in reducing musculoskeletal pain in the farmer population, it is suggested to devise plans in order to improve their adherence to regular exercise both at home and in the workplace. The necessity of a

structured and immediate intervention in this area has been also emphasized in similar studies.[35] According to a study by Osborn *et al*., skeletal disorders are obviously influenced by several factors, and it seems that lumbar disorders are influenced by multiple factors.[32] Similar to other cross-sectional studies, this study has some limitations that should be recognized. There was a lack of attention to psychological and social factors, heat, cold and vibration, posture analysis and daily work hours. Different periods of farming in a given agricultural year was not considered in sampling, which can be regarded as another limitation of the present study.

## CONCLUSION

We found that musculoskeletal problems are highly prevalent among rice workers, particularly in the back/hip, knees, shoulders, and elbows. These problems were found to be associated with several potential risk factors, including transplanting, use of tillers and combine harvesters, age, and the use of personal protective equipment such as footwear. Dianat *et al*.[36] reported that prevalence and severity of musculoskeletal symptoms was high among agricultural workers.

Several recommendations are offered to help control the risk of these problems. Firstly, there is a lack of a comprehensive system for health monitoring among farmers in Iran, and so a national registry of occupational diseases and injuries among agricultural workers should be established officially in the country. Given the high prevalence of physical problems, and the likelihood of rice farmers suffering from chronic injuries, it is crucial to apply screening and training in a safe environment and to teach farmers about appropriate body postures at work. In addition, doing exercise at work-intervals can alleviate pain and improve the muscles at work, while improving the productivity of the workforce and reducing pain among farmers.

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### Conflicts of interest

There are no conflicts of interest.

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