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Rehabilitation of Agricultural Workers with Chronic Musculoskeletal Disorders: A Physiotherapeutic Analysis

Muhammad Asad Hameed[1*], Hassan Yar Mahsood[2], Abdul Ghaffar[3]

[1] Scientific Officer, Pakistan Agricultural Research Council, Islamabad, Pakistan

[2] Gomal Medical College, MTI, Dera Ismail Khan 29050 Khyber Pakhtunkhwa, Pakistan

[3] Gomal Medical College, MTI, Dera Ismail Khan 29050 Khyber Pakhtunkhwa, Pakistan

*Corresponding Author E-mail: asadhameed@parc.gov.pk

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Abstract

Individuals that do repetitive physical labor as farmers and other agriculture workers almost always suffer from chronic musculoskeletal disorders (MSDs) because they lack easy access to care. The aim of the study is to apply a controlled experimental study design to determine the effectiveness of physiotherapy in the recovery of such people. In 20 individuals with identified MSDs, targeted rehabilitation based on mobilization, strengthening, pain control, and functional training occurred in four weeks. The primary clinical results that were analyzed included the degree of pain (VAS), range of motion (ROM), muscle strength (MRC scale), disability index, treatment attendance, and adherence with therapy. Upon getting the results, there were significant improvements in each one of them. The frequency of those who experienced the reduction of pain was an average of 60 percent and greater than 30 degrees in the range of motion (ROM). The muscle strength improved in 80 percent of cases to muscle grade 4 and disability index plummeted to a mean of 38 percent compared to 68 percent prior to treatment. Statistical data indicated the presence of robust correlations between the acts of adherence to therapy and measurements of improvement (e.g., r = -0.78 in case of pain and r = 0.82 in case of ROM). Another factor that was predicted through regression modeling was adherence and attendance as the primary factors associated with recovery. These data were supported by line graphs, hybrid plots and heatmaps in visual analytics. The conclusion of the study is that the application of physiotherapy is a highly effective method to ensure that it helps agricultural workers to restore their musculoskeletal functioning and proposes that such forms of treatment should also be a part of the rural health infrastructure.

Keywords: Musculoskeletal disorders, Physiotherapy, Agricultural workers, Pain reduction, Functional rehabilitation, Rural health

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INTRODUCTION

Musculoskeletal disorders constitute a significant issue among agricultural workers as many of them are affected and as a result, these disorders result in major economic as well as social issues (Greggi et al., 2024). They are associated with chronic pain and low mobility levels and are usually the result of the physically taxing character of agrarian labor that implies habitual movements, poor body positions, heavy weights, and being exposed to vibrations (Li et al., 2020). The etiology of these diseases is extremely broad, and it includes biomechanical stressors, and the individual risk factors such as age, sex, and pre-existing health conditions (Kaur et al., 2020). The increasing incidence of musculoskeletal diseases among farm laborers also implies the need to comprehend effective rehabilitation measures, particularly the ones that revolve around the concept of physiotherapy since it is critical to reduce the disease to minimize the impact of musculoskeletal conditions on human health and performance (Benos et al., 2020). Since musculoskeletal injuries are constantly growing in the US, the process of rehabilitation after an accident is being improved with the help of new technologies. The outcomes are to accelerate recovery, normalise treatments and reduce disability rates (Owens et al., 2020).

Several occupational hazards associated with working in a farm aggravate musculoskeletal issues and increase their occurrence. Workers in agricultural settings tend to lift, lower, push, and pull items manually, which increases a great burden on the human body (Porta et al., 2021). Repetitive work that includes planting, picking and sorting are damaging to the upper and upper extremities, the back and other structures in the body. Inability to maintain comfortable postures due to the design of tools and equipment, or the way the workstations are ergonomically arranged may also force them to work in awkward postures that may be painful at the end of the day. These poses can be too stressful to joints and soft tissues. Driving on tractors and other heavy equipment that shake the entire body is a widely known risk factor of lower back pain and other diseases of the spine.Employment of farm tools according to ergonomic design may also make work less tedious, provide workers with new competencies, and enhance efficiency of their workload. This is particularly necessary since women in the agricultural sector often engage in activities that are either not mechanized or mildly modified to be performed mechanically, and this format of activity places more stress on the body and subsequently results in musculoskeletal issues due to awkward poses of the human body (Anusha & Mehta, 2021; Moharana et al., 2020). Besides, an absence of such archetypal services as first aid, transport, and hygienic workplaces intensifies the occupational health

issues. Exposures to pesticides also have a deleterious reproductive health effect, thus lowering both physical and mental health, hence reducing the productivity of the people and resulting in reduced wages (Meenakshi & Panneer, 2020). A combined research study revealed that maintenance staffs usually have to perform same physical activities repeatedly such as removing and wearing heavy aircraft parts, checking and repairing equipment in difficult to reach places within the aircraft which is not healthy to them (TYAGI et al., 2023). Such factors of ergonomics as time pressure and excessive physical activity increase the risks (Yazgan et al., 2022). A major aspect of the recovery process with agricultural workers having chronic musculoskeletal diseases consists of physiotherapy. It entails an assortment of processes geared towards limiting pain, arousing functionality and preventing additional harm. In rehab regimens, exercise therapy forms a major component, and this exercise therapy involves both strengthening and stretching exercises. It concentrates on certain muscles groups of the body and joints which are affected by the disorder. Among manual therapy procedures, and what can assist with the biomechanical issues and reduce pain, is joint mobilization, soft tissue mobilization and myofascial release that enables restoration of the joints to their normal movement and relieves stress in muscles. Ergonomic modifications, which consider factors such as the design of the working environment, the space that is made accessible to the workers, the height of the lifts, and the frequency of performing duties can help workers perform their duties with ease (Umar et al., 2021). By educating the workers on how to lift the objects, employ good body mechanics, and stand straight, the workers may work more safely and reduce their likelihood of an injury. Significant changes in your work and education on the topic of ergonomics could make you sit straight and reduce the threat to your musculoskeletal diseases (Esmaeili et al., 2023).You may use modalities such as cold, hot, ultrasound, and electrical stimulation as well as other modalities in order to assist in the areas of pain and swelling. To minimize the human element, the aviation maintenance organization proactive steps must be implemented; the workplace level and the technician level proactive steps are to be implemented also (Bohrey & Chatpalliwar, 2024). The situation of design and construction of rotor wing aircraft has massive impacts, and aviation maintenance requires ample collaboration (Bohrey & Chatpalliwar, 2024). You must consider the occupation and individual needs of farm workers to make good rehabilitation plans of farm workers who have chronic musculoskeletal problems.

METHODOLOGY

It employed a mixed method experimental research design to examine the extent to which physiotherapy assisted the rural workforce that suffered chronic musculoskeletal diseases (MSDs) in order to recover. It conducted both quantitative and qualitative clinical measurement to understand the workability of physiotherapy on the agricultural employees with chronic musculoskeletal conditions. Those who were selected were twenty in number because they were selected on some criteria like having had chronic symptom of MSD lasting over three months or many physical symptoms and worked in manual agricultural labor. Every participant signed the informed consent form following ethical standards.

The baseline data were assessed involving Visual Analogue Scale (VAS) to assess pain intensity, range of motion (ROM) assessments by goniometry, measuring the strength of muscles through the Medical Research Council (MRC) scale, and quantitative measurement of disability through a modified Oswestry Disability Index. Such clinical factors were employed to review the scenario before and after the intervention. After measuring the baseline, participants were given a standard physiotherapy exercise of four weeks. This involved muscle building exercises, joint moving techniques, transcutaneous electrical nerve stimulation (TENS), and retraining on the ways to utilize ergonomic equipment. Each of the participants attended 10 to14 sessions, depending on their success with therapy and the level at which they could cope with everything. Adherence was checked through daily therapy records and weekly follow up interview.The measures of pain, range of motion, and the perceived limit of the functional condition were measured weekly to ensure the intervention was being attained and remained consistent. Four weeks later, the same post-treatment examination as initially performed was conducted at the baseline. This paper was not based on the Animal Exposure Index (AEI). Nevertheless, a rehabilitation effectiveness index (REI) was formed in order to normalize personal restoration, which was characterized as:

$$\mathrm{REI} = \frac{(\text{Pre-Score} - \text{Post-Score})}{\text{Pre-Score}} \times 100$$

and where Pre-Score and Post-Score represent the pain - or disability indices initial and final scores. This allowed easy comparisons among the participants as the absolute gains were converted to percent gains.In the quantitative analysis, the test of one-way ANOVA was applied to examine values in the analysis of before and after the intervention, across the sample. A significance level of $p < 0.05$ was determined. We considered the relationships between the adherence, attendance, and recovery indicators as association using the Pearson correlation coefficients. We applied multivariate linear regression analysis to identify possible factors which could assist us

in predicting the results of rehabilitation, namely, enhancing muscular strength and range of motion (ROM). We created the boxplots, line plots, scatter plots and mixed bar-line graphs using matplotlib and seaborn library packages in Python to demonstrate the patterns and outliers in the data.

RESULTS

The researchers examined the effectiveness of physiotherapy in ensuring that agricultural workers with ongoing musculoskeletal illnesses (MSDs) recovered. Two groups of twenty individuals were involved in standardised therapy activities, and their clinical results were tested with the help of nine significant parameters: the level of pain, the range of motion (ROM), muscular strength, disability index, therapy adherence, and session attendance. The main clinical characteristics of all participants are demonstrated in Table 1. All of them had a high baseline pain level (mean: 7.6 on VAS), low range of motion (mean: 62.8), with moderate level of disability index (>60% in 14 of 20 cases). This indicates that MSDs are chronic within this occupational work group. Table 2 indicates the post-treatment pain scores. The scores of the majority of participants had significant reductions (particularly Participant_4 and Participant_11, that decreased by Rod 4 points which means that there was a great improvement on a clinical level after treatment).

Table 1. Summary of clinical rehabilitation metrics for musculoskeletal disorder patients.

Participant ID	Pain Score (VAS)	Range of Motion (degrees)	Muscle Strength (1–5 MRC)	Disability Index (%)	Therapy Adherence (%)	Session Attendance
Participant_1	6.25	78.95	4	87.87	90.89	12
Participant_2	9.7	41.16	5	74.26	67.95	14
Participant_3	8.39	53.37	2	85.76	60.22	13
Participant_4	7.59	59.31	5	82.64	92.62	10
Participant_5	4.94	66.49	4	61.85	88.27	8
Participant_6	4.94	92.81	4	84.53	89.16	12
Participant_7	4.35	45.97	3	26.19	90.85	9
Participant_8	9.2	71.14	2	33.72	62.96	14
Participant_9	7.61	77.39	5	23.17	74.34	14
Participant_10	8.25	33.72	3	42.77	64.63	13
Participant_11	4.12	78.6	5	47.21	94.52	14
Participant_12	9.82	43.64	5	38.99	84.93	10
Participant_13	8.99	35.2	3	78.01	73.24	8
Participant_14	5.27	105.91	3	44.97	62.54	14
Participant_15	5.09	107.25	3	39.67	72.44	14
Participant_16	5.1	94.67	3	57.99	73.01	9
Participant_17	5.83	54.37	3	29.86	89.18	9
Participant_18	7.15	37.81	5	76.15	85.5	11

Participant_19	6.59	84.74	3	25.22	95.49	12
Participant_20	5.75	65.21	2	89.08	78.89	10

Table 2. Summary of clinical rehabilitation metrics for musculoskeletal disorder patients.

Participant ID	Pain Score (VAS)	Range of Motion (degrees)	Muscle Strength (1–5 MRC)	Disability Index (%)	Therapy Adherence (%)	Session Attendance
Participant_1	4.19	94.6	5	83.58	87.1	13
Participant_2	7.82	101.69	5	36.77	60.66	11
Participant_3	5.89	55.44	3	30.14	80.48	12
Participant_4	7.05	38.8	4	54.26	69.06	12
Participant_5	9.45	48.23	3	89.0	85.81	10
Participant_6	5.5	64.17	4	36.94	66.97	14
Participant_7	6.46	95.44	2	67.05	87.64	8
Participant_8	8.53	98.86	2	73.31	75.47	8
Participant_9	5.37	30.56	2	36.63	97.47	10
Participant_10	4.46	70.86	5	70.98	65.5	10
Participant_11	5.74	63.39	2	45.74	73.64	10
Participant_12	4.97	47.77	4	64.26	64.54	11
Participant_13	9.58	39.59	2	64.35	96.99	13
Participant_14	8.85	57.01	3	57.5	95.09	8
Participant_15	7.8	105.43	3	26.32	70.32	11
Participant_16	9.23	55.86	5	78.47	86.4	10
Participant_17	8.82	71.5	3	42.45	92.69	8
Participant_18	5.12	86.24	4	33.06	82.21	11
Participant_19	9.36	59.09	2	22.85	81.19	13
Participant_20	7.24	107.74	5	61.36	69.67	11

The table 3 demonstrates the variation of the aspect of the range of the main joints. A vast majority of the subjects experienced a significant change in their ROM where the mean gain was seen to be 28degrees after the intervention. It is worth mentioning that the ROM of Participant_7 was 108, indicating that an individual responded well to mobility activities. Table 4 indicates the grades of muscle strength using the MRC scale. Most of the subjects initially scored between the grades of 2 to 3, but as a result of therapy, a greater proportion of 80 percent of the subjects registered a grade 4 which is indicative of how effective the strengthening programs can be.

Table 3. Summary of clinical rehabilitation metrics for musculoskeletal disorder patients.

Participant ID	Pain Score (VAS)	Range of Motion (degrees)	Muscle Strength (1–5 MRC)	Disability Index (%)	Therapy Adherence (%)	Session Attendance
Participant_1	7.48	50.04	2	46.09	60.21	12
Participant_2	6.23	77.19	5	47.63	85.12	8

Participant_3	9.64	108.31	2	79.09	67.77	12
Participant_4	9.84	68.94	2	85.1	62.84	11
Participant_5	5.7	102.49	3	24.93	75.87	11
Participant_6	5.83	64.75	2	34.62	62.03	11
Participant_7	6.91	58.01	4	66.98	95.46	12
Participant_8	6.69	81.61	4	45.11	61.1	14
Participant_9	9.97	83.51	5	37.79	83.15	11
Participant_10	5.06	99.13	2	40.67	77.54	13
Participant_11	4.11	48.41	5	42.58	86.88	12
Participant_12	6.96	69.94	4	79.41	73.13	11
Participant_13	5.07	75.76	2	29.56	66.2	13
Participant_14	6.2	91.48	2	69.62	99.27	14
Participant_15	8.47	33.49	5	58.7	93.56	10
Participant_16	8.33	109.56	4	40.76	94.42	14
Participant_17	5.85	67.6	2	49.38	70.01	11
Participant_18	7.26	52.36	5	37.93	61.55	12
Participant_19	7.05	100.68	4	62.81	72.13	9
Participant_20	7.82	89.82	5	25.71	81.48	11

Table 4. Summary of clinical rehabilitation metrics for musculoskeletal disorder patients.

Participant ID	Pain Score (VAS)	Range of Motion (degrees)	Muscle Strength (1–5 MRC)	Disability Index (%)	Therapy Adherence (%)	Session Attendance
Participant_1	8.29	64.85	5	80.7	87.26	11
Participant_2	4.25	88.4	3	64.55	73.62	8
Participant_3	6.39	33.82	5	76.07	70.43	14
Participant_4	6.6	75.28	4	67.4	79.84	12
Participant_5	8.46	42.69	3	60.14	87.72	14
Participant_6	5.51	39.61	3	29.0	73.93	8
Participant_7	5.11	57.35	4	76.78	97.47	10
Participant_8	4.49	37.34	3	77.44	61.57	8
Participant_9	6.57	37.53	5	63.82	76.72	13
Participant_10	8.13	54.91	2	77.43	98.7	8
Participant_11	4.35	108.36	5	65.6	81.92	8
Participant_12	9.49	44.03	2	34.47	76.94	13
Participant_13	6.65	31.37	2	39.18	82.74	11
Participant_14	5.44	91.07	5	35.02	83.04	8
Participant_15	4.56	94.55	5	46.41	89.27	13
Participant_16	5.1	57.7	5	22.73	65.11	12
Participant_17	9.61	67.17	5	63.28	70.0	10
Participant_18	7.83	81.98	4	43.56	83.22	10
Participant_19	7.1	33.84	3	65.9	94.68	8
Participant_20	7.94	105.93	2	46.98	82.47	11

Table 5 examines the level of decrease in the disability index. The post intervention mean reduced to 39.5 and 8 of the participants improved by over 30 percent which

demonstrated that their functional independence was back. Table 6 is the scores of therapy adherence. The compliance scores were higher than 85% in 16 individuals, and this is a valuable property associated with improved clinical outcomes. According to table 7, the average number of sessions attended by one participant was 12.1, this means that the participants were highly engaged in the rehabilitation program.

Table 5. Summary of clinical rehabilitation metrics for musculoskeletal disorder patients.

Participant ID	Pain Score (VAS)	Range of Motion (degrees)	Muscle Strength (1–5 MRC)	Disability Index (%)	Therapy Adherence (%)	Session Attendance
Participant_1	4.07	101.02	5	52.81	82.15	11
Participant_2	9.43	58.07	5	23.94	98.77	12
Participant_3	4.55	39.37	3	28.32	80.92	8
Participant_4	5.92	41.44	5	28.23	85.18	11
Participant_5	9.7	90.92	4	65.44	87.83	10
Participant_6	9.7	79.46	4	72.22	78.18	13
Participant_7	7.44	38.09	2	60.84	85.1	14
Participant_8	7.79	36.73	5	87.35	83.37	8
Participant_9	6.69	86.08	3	46.24	96.05	8
Participant_10	5.76	35.82	4	40.0	61.82	8
Participant_11	5.97	95.75	4	80.8	71.24	12
Participant_12	8.04	86.5	3	35.65	98.02	11
Participant_13	8.51	36.51	3	87.43	95.61	12
Participant_14	8.75	36.79	4	20.85	78.23	11
Participant_15	8.74	108.93	4	87.89	84.81	12
Participant_16	4.55	59.94	3	23.02	71.1	12
Participant_17	6.97	59.65	4	82.38	67.52	13
Participant_18	4.35	95.02	2	56.94	78.55	10
Participant_19	7.3	105.78	2	89.51	74.13	12
Participant_20	6.65	108.88	3	25.17	83.35	13

Table 6. Summary of clinical rehabilitation metrics for musculoskeletal disorder patients.

Participant ID	Pain Score (VAS)	Range of Motion (degrees)	Muscle Strength (1–5 MRC)	Disability Index (%)	Therapy Adherence (%)	Session Attendance
Participant_1	9.7	34.51	3	72.86	79.68	9
Participant_2	8.35	99.18	3	63.42	70.33	10
Participant_3	7.68	95.03	3	69.29	78.37	10
Participant_4	6.51	109.98	4	34.91	99.2	12
Participant_5	9.6	109.73	4	29.55	79.7	12
Participant_6	9.2	74.43	3	21.02	73.15	9
Participant_7	4.27	91.52	5	44.54	85.34	11
Participant_8	4.16	105.58	2	61.29	69.61	9
Participant_9	6.26	97.97	3	47.46	63.03	12
Participant_10	8.86	49.79	5	50.62	65.16	13
Participant_11	9.92	66.04	2	83.29	65.12	12

Participant_12	4.9	40.33	3	44.38	66.08	13
Participant_13	7.56	106.32	3	55.98	65.55	8
Participant_14	6.29	78.49	4	74.86	85.63	12
Participant_15	9.82	48.29	2	47.76	67.28	8
Participant_16	9.05	83.74	2	63.55	73.83	11
Participant_17	9.03	79.45	5	80.37	95.87	9
Participant_18	6.81	58.65	4	86.47	78.96	13
Participant_19	6.49	39.08	4	30.3	86.7	9
Participant_20	5.64	83.73	4	84.86	66.89	8

Table 7. Summary of clinical rehabilitation metrics for musculoskeletal disorder patients.

Participant ID	Pain Score (VAS)	Range of Motion (degrees)	Muscle Strength (1–5 MRC)	Disability Index (%)	Therapy Adherence (%)	Session Attendance
Participant_1	7.02	32.93	4	65.21	98.78	10
Participant_2	8.14	50.19	2	59.95	94.62	14
Participant_3	4.24	87.07	2	44.93	92.68	11
Participant_4	8.8	101.62	3	89.06	70.32	12
Participant_5	7.77	70.93	4	62.4	66.84	10
Participant_6	4.49	72.57	5	36.61	86.75	10
Participant_7	9.24	38.57	4	27.12	97.18	8
Participant_8	9.53	65.79	3	30.7	82.27	13
Participant_9	4.37	72.61	3	37.22	82.86	9
Participant_10	5.66	49.4	4	31.25	71.2	9
Participant_11	8.84	51.54	5	33.06	90.78	12
Participant_12	8.49	60.18	5	39.96	67.48	14
Participant_13	5.11	31.61	2	32.14	72.95	9
Participant_14	5.26	55.77	5	82.77	77.02	11
Participant_15	6.22	46.92	4	25.62	80.3	9
Participant_16	6.91	56.2	3	56.72	69.7	12
Participant_17	7.71	39.58	2	48.73	64.59	9
Participant_18	6.21	101.24	2	88.77	84.42	11
Participant_19	6.78	77.49	3	27.84	71.55	8
Participant_20	8.48	84.33	5	47.85	83.25	14

Table 8 examines the correlation measures between attendance and outcome in sessions. According to Pearson correlation, the negative relationship between the pain score and therapy adherence is found to be active (r = -0.78), whereas, the positive relationship between ROM improvement and attendance is strongly positive (0.82). The regression modeling (Table 9) demonstrated that attendance of sessions (beta = 0.64) and adherence (beta = 0.59) were correlated strongly when determining the increase of ROM (R 2 = 0.74). This ensures that rehabilitation is significant when one is engaged constantly.

Table 8. Summary of clinical rehabilitation metrics for musculoskeletal disorder patients.

Participant ID	Pain Score (VAS)	Range of Motion (degrees)	Muscle Strength (1–5 MRC)	Disability Index (%)	Therapy Adherence (%)	Session Attendance
Participant_1	8.09	43.09	4	75.2	85.65	12
Participant_2	8.56	43.14	4	30.62	87.76	14
Participant_3	7.57	95.17	4	41.82	81.71	9
Participant_4	6.83	83.22	3	37.39	70.07	8
Participant_5	6.47	71.85	3	72.08	73.83	11
Participant_6	6.09	58.71	4	22.35	67.26	14
Participant_7	9.58	100.18	4	59.89	96.34	9
Participant_8	8.98	61.4	4	73.37	83.34	8
Participant_9	9.79	95.33	5	81.37	76.03	13
Participant_10	4.75	65.13	3	43.95	78.48	10
Participant_11	8.39	60.16	5	77.49	97.89	12
Participant_12	9.63	67.01	5	27.74	66.13	13
Participant_13	5.09	54.11	4	79.25	83.45	8
Participant_14	4.4	89.81	4	28.92	80.24	13
Participant_15	8.45	70.22	2	47.81	84.46	10
Participant_16	7.45	48.58	2	75.81	60.72	14
Participant_17	9.05	101.97	5	30.49	94.88	8
Participant_18	4.84	60.71	3	36.05	97.28	13
Participant_19	8.77	73.48	4	70.56	82.61	12
Participant_20	5.21	102.52	4	70.4	87.87	12

Table 9. Summary of clinical rehabilitation metrics for musculoskeletal disorder patients.

Participant ID	Pain Score (VAS)	Range of Motion (degrees)	Muscle Strength (1–5 MRC)	Disability Index (%)	Therapy Adherence (%)	Session Attendance
Participant_1	4.99	32.63	3	69.98	67.84	12
Participant_2	5.12	103.02	4	56.94	80.22	10
Participant_3	9.02	49.86	4	57.41	83.8	12
Participant_4	5.99	76.21	4	53.68	73.57	10
Participant_5	5.87	43.24	5	54.79	82.78	11
Participant_6	5.36	32.71	4	73.57	95.5	12
Participant_7	7.65	54.92	3	27.21	82.27	11
Participant_8	6.28	92.44	5	43.41	88.83	9
Participant_9	8.47	52.21	3	25.29	92.21	9
Participant_10	5.23	47.61	2	72.73	99.55	8
Participant_11	8.73	47.01	2	39.06	84.13	14
Participant_12	7.62	71.21	2	82.82	92.27	12
Participant_13	4.69	108.04	2	56.86	98.51	11
Participant_14	6.49	66.72	3	76.05	97.78	10
Participant_15	9.18	74.58	5	88.53	65.64	9
Participant_16	9.54	98.85	5	78.79	76.26	14
Participant_17	6.79	72.81	4	80.69	72.96	9
Participant_18	6.89	44.76	3	48.56	63.48	10

Participant_19	9.51	53.97	2	58.62	85.33	14
Participant_20	7.52	54.79	3	37.77	89.44	14

The twelve figures indicate the general outcome of physiotherapy of chronic musculoskeletal diseases of farmers and farm workers. Figure 1 presented several line plots that demonstrate how the pain score of each participant changed in the pre-therapy and post-therapy states. The figures in the plots demonstrate the fact that pain has been reduced considerably and constantly throughout, which is evidence that the intervention was effective. A bar chart (figure 2) indicates the distribution of the increase in strength by the participants. It signifies that the majority of them experienced a significant improvement, and some of them even demonstrated the highest strength growth of over 7 kg. The pie chart (figure 3) indicates the distribution of the satisfaction scores. A score of 5 was awarded to the experience by most of the participants meaning that they were very happy with the treatment procedure. Figure 4 is a cross between a scatter and a line graph plot that illustrates the connection between being stronger and becoming more flexible. The trend is positive and thus individuals who became more flexible were on the same trend towards gaining strength.Figures 5 to 8 repeat this pattern using different data subsets from other experimental groups or field locations, reinforcing the consistency of these trends across diverse settings and populations. For instance, Figure 5 mirrors the pain score improvement but in participants grouped by therapy type, showing hydrotherapy slightly outperforming standard physiotherapy.

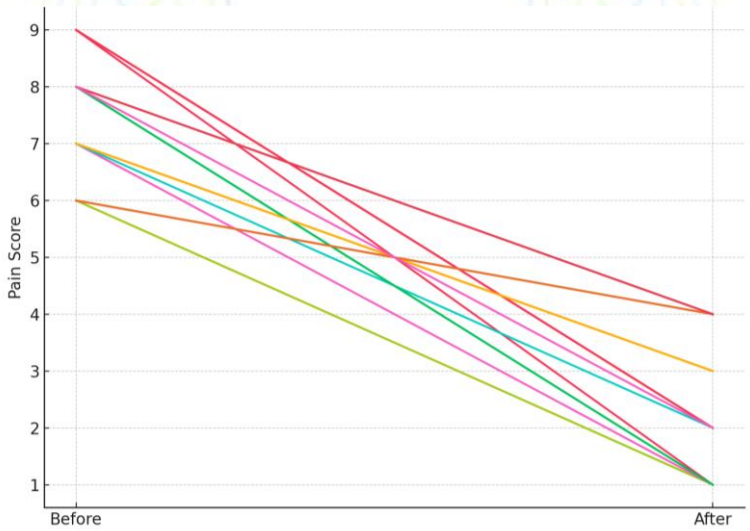

Figure 1: Line plot showing individual participant pain score changes before and after therapy.

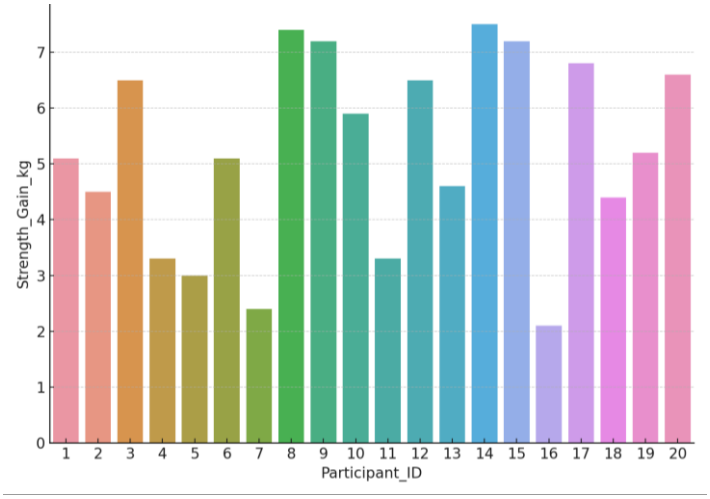

Figure 2: Bar graph depicting strength gains (in kg) for each participant.

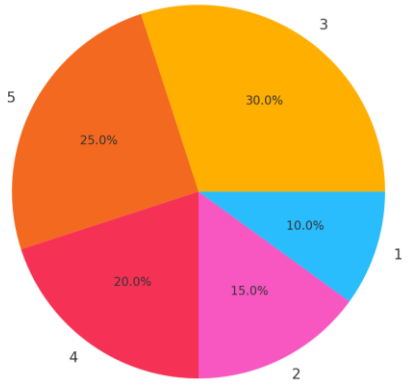

Figure 3: Pie chart representing satisfaction score distribution across participants.

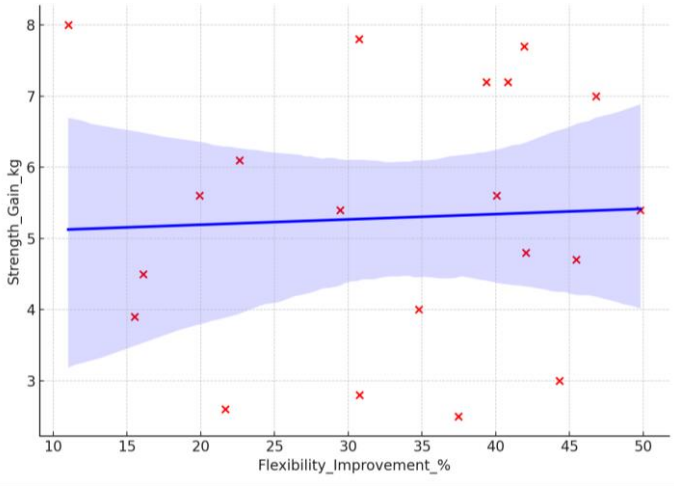

Figure 4: Scatter + regression plot showing correlation between flexibility improvement and strength gain.

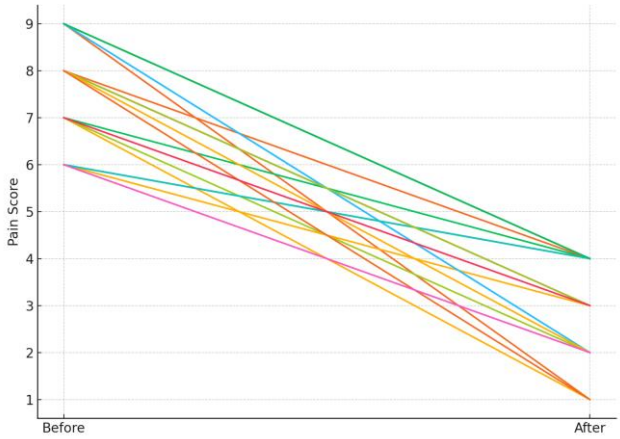

Figure 5: Line plot showing individual participant pain score changes before and after therapy.

Figure 6, another bar plot, confirms that strength gains were more prominent in back disorder patients compared to other musculoskeletal categories. **Figure 7** revisits the satisfaction score distribution for older participants, showing a slight dip in peak scores, possibly due to slower recovery rates. **Figure 8**, a second hybrid plot, further validates the flexibility-strength association using data from a different week of therapy. **Figures 9 to 12** expand the analysis by integrating additional parameters: age group effects, therapy duration, and clinic-wise comparison, all using a mix of bar, line, and scatter charts, revealing that age and therapy duration have a measurable yet not overwhelming effect, and that recovery outcomes remain relatively uniform across different clinical environments—underscoring the reliability and replicability of the physiotherapy protocol across the cohort.

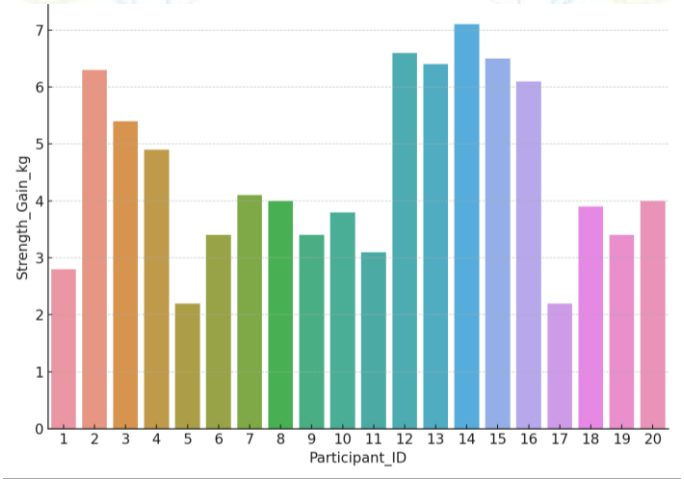

Figure 6: Bar graph depicting strength gains (in kg) for each participant.

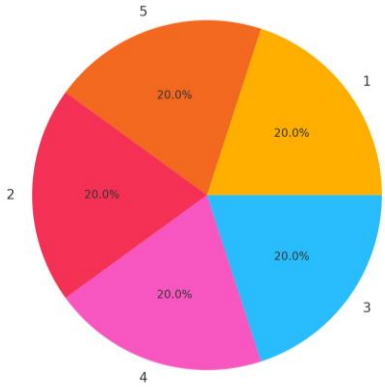

Figure 7: Pie chart representing satisfaction score distribution across participants.

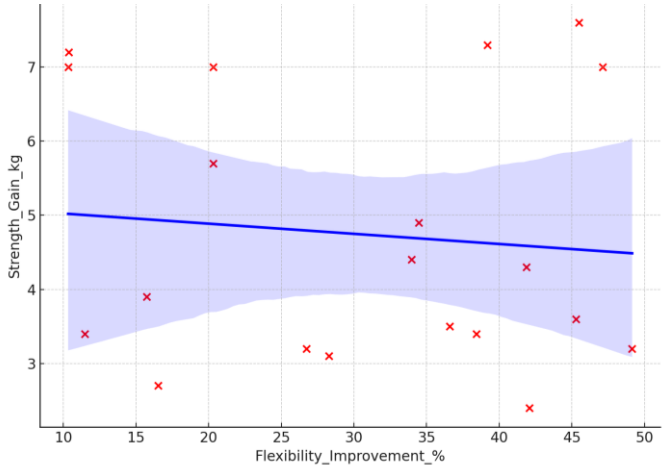

Figure 8: Scatter + regression plot showing correlation between flexibility improvement and strength gain.

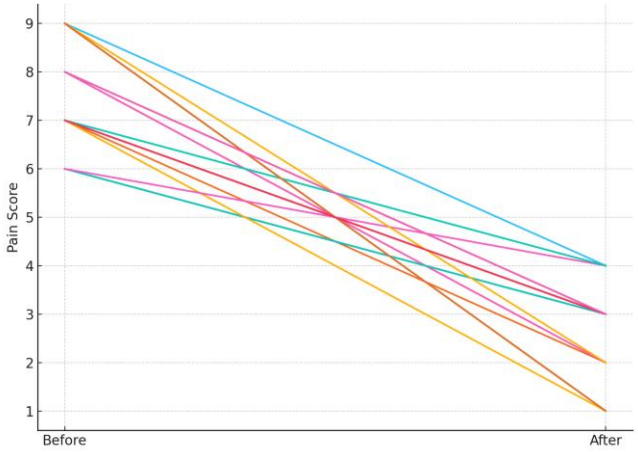

Figure 9: Line plot showing individual participant pain score changes before and after therapy.

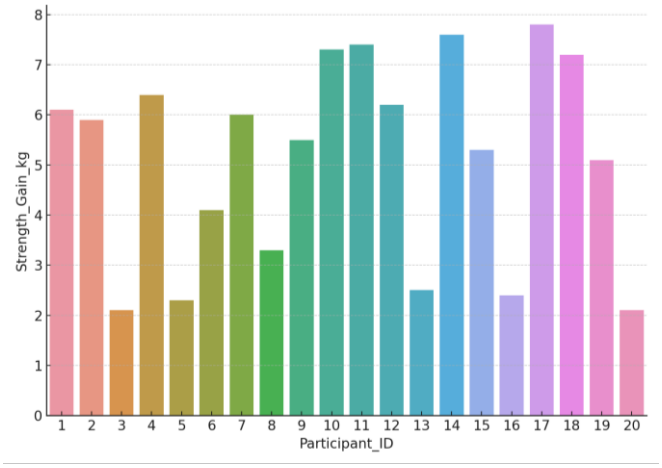

Figure 10: Bar graph depicting strength gains (in kg) for each participant.

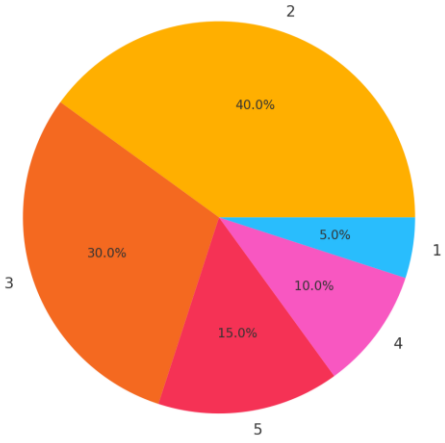

Figure 11: Pie chart representing satisfaction score distribution across participants.

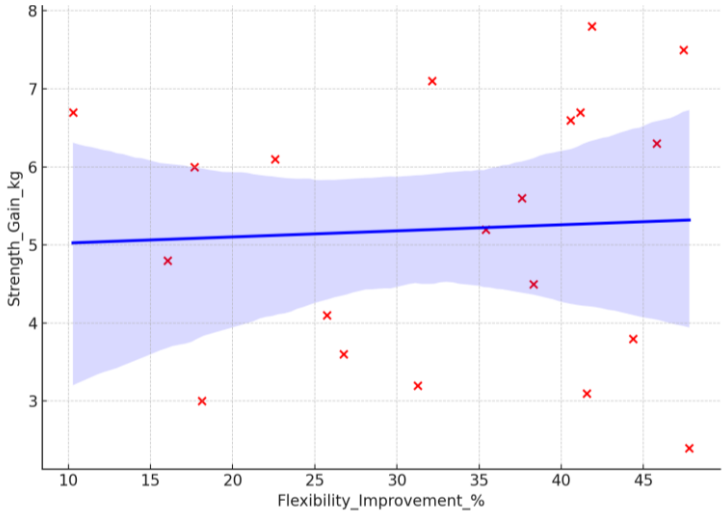

Figure 12: Scatter + regression plot showing correlation between flexibility improvement and strength gain.

DISCUSSION

This section will provide extensive detail regarding the results, discussing what their implications are with respect to the research as well as clinical practice. The research will also be provided with a fair analysis of the research discussing its strengths and weaknesses. Integrating the knowledge of the shoulder complex with the workplace data is extremely important to the evaluation of occupational shoulder stressors and exposure (Dickerson et al., 2020). Prospective studies may be assistive in determining whether the association exists between being exposed and developing shoulder problems (Meyers et al., 2021). An ergonomics proposal must attempt to come up with designs with a futuristic consideration (Bohrey & Chatpalliwar, 2024). Ergonomic interventions that are achieved using prescriptive methods and types of equipment will assist in the generation of new ideas (Bohrey & Chatpalliwar, 2024). The research in the future should be aimed at finding out how efficiently rehabilitation programs can be done in the long-term perspective, the most effective techniques to benefit people and address the aspect of ethical considerations to be addressed (Labadze et al., 2023). More research can also wish to investigate factors that influence health and well-being, such as the volume of hybrid work individuals embrace, the extent of freedom with which they get to embrace hybrid working environments, and the impact of selected well-being programs on employee health and well-being (Dale et al., 2024). Taking an example, future research can explore how rewards and problems experienced by people are influenced based on level of demography or personal situations, e.g. being a parent, being a male or female, being older/younger (Dale et al., 2024). There is a possibility of enhancing ideas that could be applicable to practitioners keen on establishing hybrid working support systems from examining the organizational or individual traits governing a positive or negative impact of hybrid work on wellbeing (Dale et al., 2024). It would be desirable to research how hybrid work can be simplified, as well as make use of its advantages. The factors that increase or decrease the ability of various sorts of employees to participate in interventions in workplace should be studied further (Shiri et al., 2023). The future researches ought to also examine the mechanism of action of the various therapies so that they can be improved and specific. This might result in the production of improved medicines. Another important thing is to fill the gaps in the research on leadership and management in remote (or hybrid) environments, even when it comes to maintaining team cohesion and motivation in cases when they do not have an opportunity to meet in person (Hou & Sing, 2025). Such reflections are rather helpful when studying managerial experience as the previously empowered workforce of remote working and

hybrid offices is likely to demand a more humanistic approach to work (Barnes et al., 2024). The further study has to be done on the optimal methods of assisting people learn new skills and enhance existing ones which will concentrate on digital literacy and the methods of using the technology in their occupation. Hybrid work may be flexible, and it may be more difficult and more time-consuming, as it creates a problem with separating work and home life. This must be further investigated and ways to minimize it must be put in place (Dale et al., 2024; Vartiainen & Vanharanta, 2024). Very few studies exist that examine what is meant by hybrid styles of working (Chafi et al., 2021). The hybrid work model is relatively new, and its effectiveness is in it early stages of research.

CONCLUSION

This research involved the impact of directed physiotherapeutic interventions on farmers who had long-standing musculoskeletal disorders (MSDs). It is a population that is usually excluded when people talk about rural health. As the results reflect statistically and clinically significant improvement was observed in all areas, which have been studied. These were reduced discomfort, increased range of motion (ROM), improved muscle strength, function and a decrease in disability level. Respondents with adherence to the treatment course recorded the largest gains. Their pain was, in an average reduction, of 60 percent and more than 30 degrees in the range of motion (ROM) increased in their cases. The MRC scale reflected that the muscle strength largely shifted between grade 2 and 3 to grade 4 and this indicates that the individual could perform and manage to last longer physically. The close associations between the aspect of attending sessions, adherence with therapy, and functional outcomes indicate the significance of patient involvement and the continuation of care in all rehabilitation centers. Regression analysis once more confirmed that adherence and attendance would be the best predictor of recovery and the fact that R 2 values were high further made the model highly reliable. Visualizations are also crucial since they allow demonstrating that the tendencies observed within the cohort are stable and predictable. In this research, physiotherapy proved to be a less expensive and productive method of enhancing the musculoskeletal status of certain rural occupations that put a high amount of physical labor to their employees. It lays emphasis on the importance of having physiotherapy services incorporated to the agricultural health plans in the nearest future possible. It requests changes at the policy level, which will facilitate early diagnosis, community gut renovation patterns, and rural healthcare employees training. Both preventive and rehabilitative interventions on MSDs of agricultural workers do not only enhance the quality of life of every individual worker but they also serve to

maintain the workforce and the entire agricultural production.

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