International Journal of Early Childhood Special Education (INT-JECSE)
DOI:10.48047/intjecse/v18i3.22 ISSN: 1308-5581 Vol 18, Issue 03 2026

# Effectiveness of Specific Rehabilitation Exercises Using Sensory Feedback in Improving Motor Stability, Functional Efficiency, and Proprioception of the Wrist Joint in Volleyball Players

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## Abstract

This study aimed to determine the effectiveness of certain motor stability exercises with sensory feedback for enhancing motor stability, functional efficiency, and proprioception of the wrist joint in volleyball players. The researcher used the experimental method with one group pre-test-post test design because it was appropriate for the nature and the objectives of the study. The research population was 15 volleyball players from AlZawraa Sports Club and the research sample was 10 volleyball players that were selected using intentional sampling. Three sessions of a 5-week sensory feedback rehabilitation program were conducted each week, for a total of 24 rehabilitation sessions. The wrist joint motor stability functional efficiency and proprioception were used as the study variables. The data obtained were analyzed using the Statistical Package (SPSS) with the mean standard deviation and paired samples t test. The results showed all the study variables to be statistically significant between pre test and post test measurements in favor of post test measurement. A good improvement in the functional efficiency of motor stability and proprioception of the wrist joint after the application of the rehabilitation program was noted. The researcher believe that certain exercises of the wrist joint with sensory feedback are an effective method to enhance functional performance of wrist joint and enhance neuromuscular control among volleyball players. The study recommended that exercises be included in sports rehabilitation and injury prevention programs.

***Keywords:*** *Sensory Feedback, Motor Stability, Functional Efficiency, Wrist Joint.*

## Introduction

Sports injuries are a common problem faced by volleyball players due to the continuous repetition of skillful movements that require high levels of strength speed and motor precision. The wrist joint is one of the key joints that plays an important role in executing the basic skills of the game particularly setting serving spiking and court defense. Due to the exposure of this joint to repetitive mechanical loads during training and competition it becomes more susceptible to injuries and functional disorders that may negatively affect athletic performance efficiency and increase the likelihood of re injury (Wilk et al., 2017; Majeed et al., 2026).

Joint stability is considered one of the essential requirements for effective skill performance as it relies on the integration of muscular nervous and sensory systems to maintain the proper anatomical position of the joint during movement. Disruption in the integration can be led to impaired motor control and reduced functional efficiency which directly affects athletic performance. The scientifics literatures indicates the

modern rehabilitation programs are no longer limited to restoring muscle strength and range of motion but have begun to focus on developing neuromuscular control and proprioception to achieve better functional stability of the joint (Hrysomallis, 2011; Myer et al., 2013; Obeid et al., 2025).

Sensory feedback is considered one of the advanced methods in the rehabilitation field it relies on providing the athlete with continuous sensory information about the joints position and movement during performance its help to correct motor errors and improve neuromuscular responses. It also contributes to the development of deep joint sensation and increases the players ability to control movement precisely and maintain balance in various sports situations (Han et al., 2015; Grooms et al., 2021; Yahya et al., 2024).

Many studies have confirmed that incorporating sensory feedback exercises into rehabilitation programs leads to improved motor stability and functional efficiency of the joints as well as its role in reducing injury rates and enhancing the quality of skill performance among athletes. Moreover developing the proprioceptive sense of the joint helps the player adapt to the rapid motor changes required in team sports, including volleyball which contributes to enhancing athletic performance and improving specialized skill execution (Aman et al., 2015; Needle et al., 2017).

## Research Problem

Thru the researcher observation of the field reality of volleyball players it was note that many players suffer from a relative weakness in the motor stability and functional efficiency of the wrist joint after injuries or due to the repeated stress associated with training and competitions which necessitates the search for modern rehabilitation methods capable of addressing this issue. Therefore this research was conducted to identify the effectiveness of qualitative rehabilitation exercises using sensory feedback in improving the motor stability and functional efficiency of the wrist joint among volleyball players and to reveal their contribution to enhancing joint proprioception and improving overall motor performance.

## Research Objectives

- Preparing a qualitative rehabilitation program using sensory feedback to rehabilitate the wrist joint of volleyball players.
- Identifying the impact of qualitative rehabilitation exercises using sensory feedback on improving the motor stability of the wrist joint in volleyball players.
- Identifying the impact of qualitative rehabilitation exercises using sensory feedback on improving the functional efficiency of the wrist joint in volleyball players.
- Identifying the impact of specific rehabilitation exercises using sensory feedback on the development of motor perception of the wrist joint in volleyball players.

## Research Hypotheses

- There are statistically significant differences between the pre test and post test results in the motor stability of the wrist joint among volleyball players favoring the post test.

- There are statistically significant differences between the pre test and post test results in the functional efficiency of the wrist joint among volleyball players favoring the post test.
- The pre test and post test scores statistically significantly differ in the level of kinesthetic perception of the wrist joint among volleyball players favoring the post test.

## Research methodology and procedures

### *Research Method*

The researcher adopted the experimental design of a single group with pre test and post test as it suits the nature and objectives of the research. The pre measurements of the variables of motor stability functional efficiency and proprioception of wrist joint were carried out with the sample members. Then the qualitative rehabilitation program was applied using sensory feedback. Post measurements of the same variables were taken at the end of the program to assess the extent of change as a result of the impact of the rehabilitation program.

### *Research community and its sample*

The research population consisted of volleyball players from Al-Zawraa Sports Club for the sports season (2025 – 2026), who included (15) volleyball player students ranging in age from (15 – 18) years. The researcher selected this community because of the nature and goals of the study and the fact that volleyball requires repetitive movements of the wrist joint when using basic skills, which makes it vulnerable to stress and functional injuries that could impact sport performance. The volleyball players from Al-Zawraa Sports Club were deliberately selected and the number of the sample players who were selected was 10, representing 66.67% of the research population (15 players). The participants were randomly chosen from those who qualified for the rehabilitation programme and were able to attend the training sessions regularly during the experiment. The researcher also checked the homogeneity of the subjects in terms of basic variables that might affect the results of the research such as chronological age, height, weight and training age so that the differences observed in the variables of the research subjects are caused by the effect of qualitative rehabilitation exercises using sensory feedback, not by the effect of individual differences. Pre and post tests were conducted for all of the sample members in the same conditions of place of test, timing tools and measurement procedures.

**Table (1).** ***Homogeneity of the Sample***

| Measurement | Mean | Standard Deviation | Skewness Coefficient | Median |
|---|---|---|---|---|
| Height (cm) | 175.60 | 5.20 | -0.12 | 176 |
| Weight (kg) | 71.80 | 6.10 | -0.20 | 72 |
| Age (years) | 16.20 | 1.00 | 0.06 | 16 |
| Training Age (years) | 2.80 | 0.85 | 0.18 | 3.0 |

***The means, devices, and tools used in the research***

- Personal interviews with experts and specialists in the field of sports rehabilitation and volleyball.
- Organized scientific observation.
- Data collection and recording forms.
- Arabic and foreign sources and references related to the research topic.
- The tests and measurements specific to the research variables.

***The devices and tools used in the research***

- Electronic stopwatch
- Metric measuring tape.
- Medical scale for measuring weight.
- Height measuring device
- Balance pad
- Resistance bands.
- Official volleyballs.
- Training whistle.
- Result registration forms.
- Electronic calculator.
- Laptop for statistically processing data.
- The statistical software (SPSS) for analyzing research results.
- ***The scales used in the research***

***The scales used in the research***

***Kinematic Stability Scale of the Wrist Joint***

***The purpose of the scale:***

Measuring the level of dynamic stability of the wrist joint in volleyball players.

***Description of the scale:***

The researcher adopted a special evaluation form for the motor stability of the wrist joint, which included a set of indicators related to the players ability to control the joint during the performance of various movements and to maintain its stability while executing basic volleyball skills.

***Method of registration:***

The level of dynamic stability was evaluated by a committee of experts and specialists according to an assessment scale ranging from (1–10) degrees where a higher score indicates a better level of dynamic stability while a lower score indicates poor dynamic stability of the joint.

***Wrist Joint Functional Efficiency Scale***

***The purpose of the scale:***

Measuring the level of functional efficiency of the wrist joint during the performance of volleyball specific motor skills.

***Description of the scale:***

The researcher prepared a functional competency assessment form that included a set of indicators related to the players ability to perform basic skills using the wrist joint with appropriate efficiency accuracy and speed.

***Method of registration:***

The players performance was evaluated by a committee of experts and specialists using a rating scale from 1 to 10 where higher scores indicate a high level of functional efficiency of the joint while lower scores indicate a deficiency in functional performance.

***The proprioceptive sense scale for the wrist joint***

***The purpose of the scale:***

Measuring the level of proprioception in the wrist joint of volleyball players.

***Description of the scale:***

The researcher used an assessment form for sensory perception which incorporated indicators of players' ability to perceive the position of the wrist joint and control its movement while performing exercises and various motor skills.

***Method of registration:***

The level of proprioception was assessed by a committee of experts and specialists using a rating scale from (1–10) degrees where higher scores indicate a good level of proprioceptive perception of the joint, while lower scores indicate a weakness in proprioception and control of joint movement.

### *The scientific foundations of the scales used in research*

#### *Validity*

The researcher used the face validity method by presenting the stability functional efficiency and proprioception assessment forms for the wrist joint to a group of experts and specialists involved in sports rehabilitation measurement and evaluation and volleyball, to obtain opinions about the suitability of the items in the research scale for measuring the variables. The experts' comments were considered and changes were applied to a few items and all items had an agreement rate of 80% or higher, which means that the scales have face validity and are appropriate for the research sample.

#### *Reliability*

To ensure the reliability of the scales used the researcher adopted the Test Retest method on a pilot sample outside the main research sample where the scales were applied and then reapplied after a period of 7 days under the same conditions. After statistically processing the data using Pearson correlation coefficient between the first and second applications high correlation coefficients appeared indicating that the scales possess a good degree of reliability which confirms their dependability in measuring the studied variables.

#### *Objectivity*

Objectivity was achieved by preparing clear and specific instructions for the evaluation process as well as by relying on a committee of experts and specialists to assess the sample members scores according to pre established and standardized criteria. The average scores of the evaluators were also adopted in recording the results which contributed to reducing personal bias and increasing measurement accuracy, indicating that the measures possess an appropriate degree of objectivity.

### *The pilot study*

The researcher carried out the pilot experiment on (13/4/ 2026) using a sample of (3) players outside the main samples of the players of the Al-Zawraa volleyball club with the aim of determining the time required to carry out the tests, determining the difficulties and obstacles that the researcher may encounter during the implementation of the experiment, and verifying the validity of the measures used and the clarity of the instructions for the players. The results of the pilot study showed the feasibility of applying the research procedures and tests appropriately which contributed to creating suitable conditions for conducting the main experiment.

### *Pre test*

The researcher carried out the pre-tests for the research sample (10) players, on (18/4/2026) in the sports hall of Al-Zawraa Volleyball Club before starting the implementation of the rehabilitation program. The tests included measuring the variables of motor stability functional efficiency and proprioception of the wrist joint. The researcher ensured the appropriate conditions and standardized the measurement procedures for all sample member in terms of the test location timing tools used and execution method aiming to obtain accurate data that represent the true level of the sample members before applying the rehabilitation program, and to use it as a basis for comparison with the results of the post tests.

### *The main experiment*

The researcher started conducting the main experiment of the study on the research sample (10 players) from Al-Zawraa Volleyball Club after completing the exploratory trial procedures and confirming the reliability of the measuring instruments and tools used in pre-testing the motor stability functional efficiency and motor sensation of the wrist joint. The main experiment was conducted for (8) weeks and with (3) rehabilitation sessions a week held on (Saturday/Monday/Wednesday) for (24) rehabilitation sessions. The rehabilitation sessions were held within the sports hall of Al-Zawraa Club and directly supervised by the researcher and all the necessary was applied to make the rehabilitation program successful. The rehabilitation program consisted of a series of qualitative exercises to enhance motor stability functional efficiency and proprioception of the wrist joint with the support of sensory feedback techniques. Balance and motor control exercises, resistance exercises with elastic bands, and sensory motor perception exercises to improve the players' ability to control the movement of the wrist and perceive its position during motor performance were among the rehabilitation units.

The duration of each rehabilitation session was (30–40) minutes and consisted of three main sections. The preparatory section included warm up exercises and general and specific preparation for the wrist joint while the main section included specialized rehabilitation exercises using sensory feedback taking into account the principle of progression in load intensity and training volume to match the level of the sample individuals. As for the concluding section it included cool down and relaxation exercises, as well as restoring the joint to its normal state.

The researcher was keen to standardize the conditions for implementing the program in terms of execution time location tools used and the method of performing the exercises for all sample members in addition to continuously monitoring the players responses throughout the duration of the program. After completing the implementation of all the rehabilitation units post tests were conducted for the studied variables under the same conditions and procedures used in the pre tests, with the aim of identifying the extent of change brought about by the rehabilitation program in the research variables.

***Table (2) Proposed Rehabilitation Program Using Sensory Feedback to Improve Motor Stability, Functional Efficiency, and Proprioception of the Wrist Joint***

| Week | Rehabilitation Sessions | Phase Objective | Exercises Used |
|---|---|---|---|
| First | 1–3 | Adaptation to the program and enhancement of sensory awareness of the joint | Wrist warm-up exercises, wrist movements in all directions, sensory balance exercises, target-touch exercises with eyes open and closed |
| Second | 4–6 | Development of proprioception and initial joint control | Motor coordination exercises, wrist rotation exercises using a light medicine ball, light resistance exercises with elastic bands |
| Third | 7–9 | Development of joint motor stability | Hand support exercises, balance pad stability exercises, weight-transfer exercises between the upper limbs |
| Fourth | 10–12 | Increasing the efficiency of the muscles acting on the wrist joint | Progressive resistance exercises using elastic bands, wrist flexion and extension exercises, ulnar and radial deviation exercises |
| Fifth | 13–15 | Development of dynamic joint stability | Ball catching and throwing exercises, response exercises to visual and auditory stimuli, |

| Week | Rehabilitation Sessions | Phase Objective | Exercises Used |
|---|---|---|---|
| | | | dynamic balance exercises |
| Sixth | 16–18 | Enhancement of functional efficiency related to sport-specific skills | Volleyball skill simulation exercises, passing and setting exercises using the wrist, hand-eye coordination exercises |
| Seventh | 19–21 | Improvement of neuromuscular response speed | Sensory feedback exercises, rapid movement exercises with directional changes, precise joint-control exercises |
| Eighth | 22–24 | Achieving the highest level of stability and functional efficiency | Combined balance and resistance exercises, volleyball-specific skill exercises, final evaluation exercises |

### *Post tests*

In order to measure the development level of the variables of motor stability functional efficiency and motor sensation of wrist joint, the researcher conducted post test on the research sample of (10) players at the end of the proposed rehabilitation program after completing (8) weeks and (24) rehabilitation units on 20/6/2026. The post tests were administered in the same test area as the pre tests were administered using the same testing instruments and procedures, with the exception of uniformity of test time, execution method and instructions given to the sample members. This was done to make sure that the differences between the pre test and the post test results was a result of the rehabilitation program used that contributed to the accuracy and objectivity of the research result.

### *Statistical methods*

The data were statistically treated using the Statistical Package for the Social Sciences (SPSS) and the following statistical methods were employed:

- The arithmetic mean.
- Standard deviation.
- Paired t test
- The percentage.

## Results

***Table (3)Means, Standard Deviations, Mean Differences, t-values, and Significance of the Pre- and Post-Measurements for the Research Variables***

| Variables | Measurements | Mean | Standard Deviation | Mean Difference | Difference SD | t-value | Sig. (p) | Significance |
|---|---|---|---|---|---|---|---|---|
| Motor Stability | Pre-test Measurement | 3.0000 | 0.81650 | 4.30000 | 1.41814 | 9.588 | 0.000 | Significant |
| | Post-test Measurement | 7.3000 | 0.82327 | | | | | |
| Functional Efficiency | Pre-test Measurement | 3.5000 | 1.17851 | 3.40000 | 1.07497 | 10.002 | 0.000 | Significant |
| | Post-test Measurement | 6.9000 | 0.87560 | | | | | |
| Proprioception Level | Pre-test Measurement | 2.2000 | 1.39841 | 4.00000 | 1.88562 | 6.708 | 0.000 | Significant |
| | Post-test Measurement | 6.2000 | 0.78881 | | | | | |

*Significant when the Sig. (p) value is less than 0.05.*

## Discussion

The results of the research showed that there were statistically significant differences between the pre test and post test of the variables motor stability functional efficiency

and sensory perception of the wrist joint in the favor of the post test. This shows the effectiveness of the qualitative rehabilitation exercises by sensory feedback in the improvement of these variables in volleyball players. The mean scores for motor stability were (3.00) degrees in the pre test which changed to (7.30) degrees in the post test. The t value calculated was (9.588) at a significance level of (0.000) showing a significant improvement in the players ability to control the wrist joint and maintain its stability when carrying out the different skills. The researcher suggests this is due to the type of rehabilitations exercises employed, being sensory based. This resulted in enhancing the neuromuscular coordination and making the sensory receptors used in the joints, muscles and tendons more efficient leading to the players control over their movements and ability to react rapidly to different motor changes. Motor stability refers to the stability of the body's motors and is one of the basic conditions of skillful volleyball performance as it decreases the risk of injuries and enables the joints to be controlled precisely during basic volleyball skills. The findings were similar to Sherif (2020) who suggested that sensory motor exercises and balance training is an effective way to improve the stability of the joints and enhance the ability of the athletes to control their body movements during performance. The results also indicated a significant increase in the functional efficiency of wrist joint as the mean score rose from (3.50) in pre test to (6.90) in post test with t value of (10.002) at significance level of (0.000). This suggests that the rehabilitation program was effective in enhancing the player's capacity to perform activities of daily living (ADL) that were related to the fundamental abilities of the sport. The researcher believes that this improvement is due to the qualitative exercises that focused on developing neuromuscular coordination and enhancing the efficiency of the muscles working on the wrist joint as well as improving the speed of motor response and performance accuracy. One of the most significant indicators of the effectiveness of rehabilitation programmes is the functional efficiency of the joint as it shows the ability of a player to restore motor function to their normal level and perform specific skills to a higher functional level. This finding is in line with the finding of Abdul Hussein (2019) which stated that specialised functional exercises have a positive effect on the development of motor and skill performance in volleyball players, and enhanced the efficiency of the execution of basic skills in volleyball players. As for the variable of joint proprioception the results showed a significant improvement as the mean increased from (2.20) degrees in the pre test to (6.20) degrees in the post-test with a calculated t value of (6.708) at a significance level of (0.000).The researcher attributes this development to the rehabilitation program reliance on sensory feedback exercises which provided continuous information to the players about the joint position and movement during performance (Abdulkareem et al., 2025). This led to an improvement in proprioceptive awareness and sensory perception of the joint as well as an increased ability to determine its position during movement. Kinesthetic sense is one of the essential elements associated with motor control and functional stability of the joints as it helps the athlete adapt to rapid motor changes maintain performance accuracy and reduce the risk of injury. This result aligns with what Abdullah (2021) indicated the use of sensory feedback exercises contributes to the development of kinesthetic sense and improves the efficiency of sensory receptors responsible for perceiving joint movement in athletes (Abdulhussein et al., 2026).

In general the results confirm that qualitative rehabilitation exercises using sensory feedback had a positive impact on improving motor stability functional efficiency and

motor sensation of the wrist joint in volleyball players which reflected in the improvement of joint control during motor performance and increased efficiency in executing the basic skills of the game.

## Conclusions

1. Involvement with the qualitative rehabilitation exercises with sensory feedback, led to a significant improvement in wrist joint stability in volleyball players. Volleyball players demonstrated motor stability of the wrist joint improved significantly with the use of qualitative rehabilitation exercises with sensory feedback.

2. Rehabilitation program resulted in positive functional efficiency of the wrist joint, which showed the positive influence on the players ability to perform the motor skills related to the game. The functional efficiency of the wrist joint developed in the rehabilitation program and it was beneficial for the players' performance of the motor skills related to the game.

3. The rehabilitation exercises used achieved a significant improvement in the level of proprioception of the wrist joint among the research sample participants. The rehabilitation exercises used achieved a significant improvement in the level of proprioception of the wrist joint among the research sample participants.

4. The sensory feedback improved the motor control of the wrist joint during the performance and neuromuscular coordination during the task. Neuromuscular coordination and motor control of the wrist joint improved during performance with sensory feedback.

5. The rehabilitation program has proven effective in improving the functional and motor variables of the wrist joint making it a suitable method that can be utilized in the rehabilitation of volleyball players.

## Recommendations

1. Adopt qualitative rehabilitation exercises using sensory feedback within rehabilitation programs for wrist joint injuries in volleyball players. Adoption of qualitative rehabilitation exercises using sensory feedback within rehabilitation programs for wrist joint injuries in volleyball players.

2. Paying attentions to the developments of motor stability and proprioception of the joints by incorporating balance and motor control exercise into training and rehabilitation programs. Focusing on developing joint stability and proprioception by incorporating balance and motor control exercises into training and rehabilitation programs.

3. Using sensory feedback methods at different stages of sports rehabilitation due to their role in improving joint functional efficiency. Using sensory feedback methods at different stages of sports rehabilitation due to their role in improving joint functional efficiency.

4. Conduct similar studies on different samples and age groups in other sports to verify the effectiveness of this type of exercise. Conduct similar studies on different samples and age groups and in other sports to verify the effectiveness of this type of exercise.

5. Conduct future research addressing the impact of sensory feedback based rehabilitation exercises on other physical and functional variables and in different joints of the body.

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