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# SENSORY MOTOR EXERCISES AND THEIR EFFECT ON NEUROMUSCULAR BALANCE AND SOME SPECIAL PHYSICAL AND SKILL ABILITIES OF TENNIS PLAYERS

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## ABSTRACT

Experts and specialists in the field of tennis have paid great attention to training methods to develop the physical, motor and skillful performance of the players, especially their movement in the court and the compatibility between all parts of the body. This research aims at exploring the impact of using perceptual motor exercises on the neuromuscular balance and physical abilities and special skills on junior tennis players. The researcher applied an intervention exercise on 6 players, at sports talent in Diyala Governorate, whose ages ranged from 16-17 years. The researcher determined 3 special tests suggested by the International Tennis Federation (INT) test to measure the impact of such exercises on the participants. These tests are the Electromyography test, Nelson's test for the transitional motor response and sprint 20-m test from a moving start. Results showed a development in the values of electrical activity as an indicator of the neuromuscular balance. Results also showed a development in some of the special physical and skill abilities of the tennis players. It is recommending that physical training and technical development should be based on using sensory-motor exercises, and incorporating these exercises into the training curriculum to develop neuromuscular balance and special physical and skill abilities of tennis players.

**Keywords:** Impact, neuromuscular balance, perceptual-motor exercises, physical skill abilities, tennis players.

## INTRODUCTION

Professionals and experts in the tennis industry are actively seeking training methods and techniques to enhance the physical, motor, and skill performance of players and elevate their level. Tennis is a game that requires a harmonious balance between competitors, quick movements, precise performance, timely responses, agility on the court, and coordination of all body parts. Maintaining these qualities at their highest levels for extended periods of time can be physically, mentally, and skillfully challenging. Therefore, performance development is crucial, and cannot be achieved without the use of assisting methods to enhance skill performance under different conditions in order to perform correctly during matches, tennis players must master all the skills required by the game, especially the serve, forehand stroke, and backhand stroke These three fundamental skills are the foundation of the game and are essential for scoring points during matches. The forehand and backhand strokes are the most frequently used in tennis and are crucial for scoring points during matches. They are easy to learn, develop, and perform well, making them the most important offensive strokes Therefore, researching the use of sensory-motor perception exercises and their impact on neuromuscular balance for some of the basic skills for tense players is critical. Neglecting any of these skills

can hinder the players' training level and prevent them from achieving their best performance in sports competitions and tournaments. To elevate their level and reach higher levels in sports competitions and tournaments, it is essential to enhance the training level of players by using assisting methods.

### Research problem

The development of physical and specific skill abilities required tennis players is essential for achieving optimal performance. Various training methods and techniques have been utilized to achieve this goal. However, after examining international achievements, it became evident that there are significant differences in physical and skill abilities compared to Iraqi achievements. This is due to the fact that the training exercises used did not consider the essential framework of training, especially sensory-motor perception exercises, which are crucial in providing athletes with the necessary balance of strength to achieve proper technical performance. Currently, traditional training methods are being used, neglecting important indicators such as neuromuscular adaptation that plays a fundamental role in mastering skill performance. This problem delays the process of developing physical and skill performance, negatively impacting the players' achievements.

### Research objectives

1. Preparing sensory-motor exercises (SME) for tennis players.
2. Identifying the impact of Preparing sensory-motor exercises (SME)on neuromuscular balance.
3. Exploring the effect of Preparing sensory-motor exercises (SME) on some special physical and skill abilities of tennis players.

### Research hypotheses

1- There are statistically significant differences in the pre and post-test results of neuromuscular balance in Electromyography test for tennis players.

2- There are statistically significant differences in the pre and post-test results of some physical and skill abilities of tennis players.

## METHODOLOGY

### Research design

The researcher chose to use a single group experimental design because it is the only method that can accurately test cause-and-effect hypotheses. This method is considered the most reliable approach to solving various human and social problems, including those related to sports science. The study recruited players at Specialized Center for the Care of Sports Talent in Diyala Governorate played the game of tennis. It took place form 6/6/2022 to 6/9/2022 on Diyala Girl Club Square in New Baquba.

## Sample

The sample of the research was tennis players They were selected purposively and included players from the Specialized Center for Sports Talent Care in Diyala province, who. The sample consisted of 6 players, representing 100% of the total research population, aged 16-17 years. The researcher conducted homogeneity testing for the sample, as shown in Table 1.

**Table 1** Homogeneity of the research sample

| No | Variable | Measurement | Mean score | Standard deviation | medians | Skewness |
|---|---|---|---|---|---|---|
| 1. | Age | Year | 16.3 | 0.799 | 16.6 | 0.78 |
| 2. | Mass | Kg. | 64.8 | 4.66 | 66.5 | 0.664 |
| 3. | height | Cm | 166.23 | 4.42 | 169 | 0.589 |

## Data collection tools

The researcher utilized various scientific methods to gather the necessary data and information, including

1) Conducting studies and research,
2) Making observations and experiments,
3) Using registration forms,
4) Accessing international information networks,
5) Consulting relevant sources and references.

## Research tools

1) Two official tennis courts, 20 tennis balls, and tennis rackets.
2) A 10-meter metal measuring tape and 10 cones.
3) A Sony electronic scale for measuring mass.
4) Two timing watches.
5) A Lenovo 310 I laptop.
6) Colored adhesive tap
7) A whistle.
8) An 8-channel Electromyography device of myotrace-400 type.

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## Tests and Measurements

After reviewing relevant sources, the researcher selected several variables to achieve the research objectives. The following are detailed explanations of how these measurements were implemented.

## Body Mass Measurement

The researcher measured the body mass using a Sony medical scale. The measurement method involved the player standing in an upright position without shoes on the scale, then the mass is calculated to the nearest kilogram.

**EMG Test (Haghighi et al., 2021):**

**Test Objective**: To measure the electrical activity values of the targeted muscles.

**Tools Used:** An EMG device for measuring the electrical activity of the targeted muscles, electrodes specific to the type of device used, medical alcohol, a razor, and a special adhesive tape for securing the EMG signal transmitter device.

After consulting with experts and reviewing sources, the researcher identified the working muscles for which electrical activity was to be measured. Four muscles were selected, two on each side of the body, including the pectoralis major and anterior deltoid muscles. The program on the EMG device was used to determine the electrode placement areas on the player's body.

The hair was removed from the area of measurement, and the skin was cleaned with alcohol to ensure a clear EMG signal. The electrodes were attached to the muscles as previously mentioned, with the dual electrode secured at the top and middle of the muscle parallel to the direction of the muscle fibers.

All wires were secured with medical adhesive tape to prevent interference with the player's movement during performance. The cables were connected to a signal transmission and reception device, and a video camera was also connected to the computer for video synchronization before starting the tests.

Recording method: The peak values for the symmetrical muscles were calculated by the device, and the results were recorded for each muscle that was studied. This test will be conducted alongside the three skills of the International Tennis Federation (ITF) tests.

**Nelson Test for Transitive Motor Response (Moselhy, 2022)**

**Test Objective:** To measure the ability to respond and react quickly.

**Measurement Unit:** Second and its fractions.

**Tools Used**: An obstacle-free area measuring 20 meters in length and 2 meters in width, a timing tape, red and yellow cards, and two markers.

**Performance description:** To perform the timing test, the tester stands at one end of the center line, facing the timer located at the opposite end. Holding the timing clock with one hand, the tester raises it up and moves their arm to the left (red card) or right (yellow card) while starting the clock. Then, the tester sprints towards the side indicated by the timer and stops the clock upon reaching the line that is 6.4 meters away.

**Recording**: The player's fastest time for each side is recorded from five attempts for each direction.

**Sprint 20 meters Test from a Moving Start (Pyne et al., 2008):**

**Test objective**: To measure transitional speed.

**Measurement unit**: Second and its fraction

**Tools used:** A timing clock and three parallel lines. The first line represents the starting line, the second line is the speed calculation line which is 10 meters away from the first line. The third line is 30 meters away from the second line; it is the finishing line.

**Test description:** In this test, the tester starts from a standing position behind the first starting line. When the start signal is given, the tester runs towards the second starting line and aims

to reach the maximum speed. The tester then continues to run at maximum speed until crossing the third line, Appendix 1.

**Recording**: The time is recorded in seconds from the start of the second line until the moment the third line is crossed.

**ITF Tests (Olcucu & Vatansever, 2015):**

The ITF has implemented the ITN on Court clay tests, which were developed in 2004, to assess the tennis players tennis skills of players. These tests are designed to be user-friendly and applicable to players of all levels, including beginners and regular participants. The federation views these tests as a valuable tool for evaluating players' performance levels, (see, Appendix 1) for more details.

**Terms and conditions for implementing ITF tests**

Before starting the tests, it is important to ensure that the players are properly warmed up and ready. Each player is allowed to play four practice balls before the actual test begins, and these practice balls are not counted towards their final score. Additionally, players have the right to reject a thrown ball if it doesn't suit their preferences, without having to return or touch it. However, if the player touches the ball, it will be counted as an attempt. If a ball falls on a dividing line between two areas, the score will be counted based on the higher area. After each attempt, the points are recorded on a registration form. The test administrator holds the responsibility for making the final decision on scoring the points. The final evaluation is signed by the assistant team and the player, and a copy is provided to the player. To assess a skill on its own, the test can be divided, and the part specific to the desired skill can be used. Three basic skills have been chosen: serving, forehand stroke, and backhand stroke for tennis players.

**Test 1**

**Test objective:** Measuring the control and depth the skills of forehand and backhand ground strokes

**Tools used**: 1 tennis racket, 10 tennis balls.

**Procedures**: The players being tested positions themselves at the middle of the baseline, prepared to strike the balls. The individual throwing the balls stands at the opposite baseline and, upon receiving instructions, tosses the ball between the service line and the baseline. The scorer carefully watches the performance and tallies the points. The tester takes turns hitting 10 balls, alternating between forehand and backhand shots.

**Scoring**: Balls that fall outside the singles court do not score any points. A ball that lands in area number (1) earns one point. Area number (2) grants two points for a ball that lands there. Landing in area number (3) awards three points, and area number (4) gives four points for a successful ball landing.

Test 2

Serve assessment test

**Purpose**: Evaluating the accuracy of the serve.

**Tools**: 1 tennis racket; 12 tennis balls.

**Procedures**: The tester begins at the baseline, prepared to serve. The recorder watches the serve and records the points. If the ball hits the net, the serve is done again. In total, the tester performs 12 serves: 3 from the right side, 3 from the left side, followed by another 3 from the right side, and finally 3 from the left side.

**Scoring**: Points are awarded based on the location where the balls fall. Four points are given for balls that land within the target area. If the second bounce of the ball is behind the baseline, an extra point is added. Two points are awarded for balls that fall within the correct area on the second bounce behind the baseline. However, balls that land outside the serve area receive a score of zero.

## Exploratory experience

The purpose of conducting the exploratory to gather valuable information and observations about the implementation of the researcher's research procedures. The survey experience was conducted on Thursday (6/6/2022) and (7/6/2022) was on a sample of 4 players. The aim was to understand and analyze various aspects related to tennis players, such as techniques, strategies, challenges, and preferences of the players.

1) Conducting the experiments to determine the scientific parameters and conditions necessary for their success, taking into account the availability of resources.
2) Estimating the time required to carry out each experiment accurately.
3) Anticipating and addressing any challenges or difficulties that the researcher may encounter during the experiment, by offering suitable solutions.
4) Identifying potential obstacles or limitations to the implementation of the main experiment beforehand, to better prepare and overcome them.

## Pre-tests

The assistant team collaborated with the researcher to administer pre-tests to the group on June10th and 11th, 2022, precisely at 6:00 PM. The tests included the Nelson Transitional Motor Response and the 20-meter sprint test with a moving start on the first day. On the second day, the group underwent a nervous system test using EMG and the ITF tests, focusing on fundamental skills such as serving, forehand, and backhand for tennis players.

## Intervention

The researcher collaborated with tennis coaches to incorporate sensory-motor exercises (SME) with the training unit designed for players. These exercises were implemented at the beginning of each training session after warm-up by the trainers at the National Center for Sports Talent Care in Diyala for the game of tennis. The daily curriculum was organized in the main section of the daily training plan. This part is dedicated to developing speed and intensity, based on the guidelines and parameters set by the coaches. The training methodology covered a period of 12 weeks, starting from June 12, 2022, until September 8, 2022, with a total of three training

units per week (on Saturdays, Mondays, and Wednesdays) and a total of 36 training units. Each unit lasted approximately 90 minutes, with the application time for sensory-motor perception exercises ranging from 25 to 30 minutes, equivalent to 30% of the daily training volume (Appendix 1).

### Posttests

The assistant team received support from the researcher in carrying out tests on September 10th and 11th, 2022, at 6:00 PM The tests consisted of the Nelson test to assess transitional motor response and a 20m sprint test with a moving start On the first day, the nervous system was tested EMG on the second day with ITF tests were conducted, specifically focusing on serving, forehand, and backhand skills for tennis players. These tests were conducted under the same conditions as the pre-tests.

### Statistical tests

The researcher utilizes the statistical package system (SPSS) to analyze the research findings using various statistical measures such as mean, median, standard deviation, skewness, and the t-test for paired samples.

## Results and Discussion

### Pre and post-tests results of the EMG test of the muscles

Table 2 Statistical characteristics of EMG testing for pre and post tests

| Variables | Body side muscles | Test | Mean | Standard deviation | Range | Average deviation | t | Sig. | Significant level |
|---|---|---|---|---|---|---|---|---|---|
| Pectoralis major muscles | Right side muscles | Pre | 240.29 | 84.926 | 80.621 | 68.857 | 2.868 | 0.035 | Significant |
| | | Post | 320.91 | 44.773 | | | | | |
| | left side muscles | Pre | 221.336 | 36.685 | 96.210 | 72.685 | 3.242 | 0.023 | Significant |
| | | Post | 317.546 | 62.654 | | | | | |
| Anterior deltoid muscles | Right side muscles | Pre | 627.04 | 76.154 | 100.494 | 85.648 | 2.874 | 0.035 | Significant |
| | | Post | 727.53 | 56.497 | | | | | |
| | left side muscles | Pre | 649.21 | 62.185 | 99.062 | 70.657 | 3.434 | 0.019 | Significant |
| | | Post | 748.27 | 97.131 | | | | | |

DF (5) at the significance level of 0.05

Table 2 indicates that the use of sensory-motor exercises (SME) has enhanced muscle contraction more effectively with increased effort on the central nervous system and increased electrical activity values of the working muscles.

The researcher attributes this increase in electrical activity values to the intensification of sensory-motor exercises (SME) during the training sessions. The results were found significant in these variables. They are in line with some studies (Maheshwari et al., 2022; Thongpanja et

al., 2013), which suggest that Table 2 indicates that the use of sensory-motor exercises (SME) has enhanced muscle contraction more effectively with increased effort on the central nervous system and increased electrical activity values of the working muscles.

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Some studies that focused on sensory-motor exercises (SME) have shown that it enhances muscle contractions and improves voluntary control of the working muscles (Sheets-Johnstone, 2010). This type of exercise can facilitate the mechanism of muscle contractions that tennis players require during performance. The results in Table 2 above demonstrate that the sample was characterized by the development of functional electrical indicators (peak electrical activity) of the working muscles during performance in the subsequent tests. The prepared exercises played a significant role in increasing muscle tone by increasing the number of motor units involved in muscle work during performance (Pyne et al., 2008). On the other hand, using these exercises enables players to recruit a large percentage of muscle fibers for contraction, which does not occur in the case of voluntary contractions during traditional training. have helped improve muscle fluidity during performance, as well as muscle mass and range of motion.

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## ITF tests for tennis players in the pre and post tests

**Table 3** ITF tests for tennis players in the pre and post tests

| Variables | Pre | | Post | | F | Average deviation | T | Sig. | Moral |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | Std | Mean | Std | | | | | |
| Nelson test for movement response speed (seconds). | 2.278 | 0.198 | 1.818 | 0.103 | 0.460 | 0.225 | 4.999 | 0.004 | Significant |
| Sprint 20 meters from a moving start test (seconds) | 3.343 | 0.144 | 3.043 | 0.112 | 0.300 | 0.192 | 3.822 | 0.012 | Significant |
| Serve (score) | 26.666 | 1.861 | 33.833 | 2.483 | 7.166 | 3.188 | 5.506 | 0.003 | Significant |
| Forehand stroke (degree) | 17.500 | 1.870 | 22.666 | 2.065 | 5.166 | 2.994 | 2.024 | 0.008 | Significant |
| Backhand stroke (degree) | 14.166 | 1.169 | 18.833 | 2.136 | 4.666 | 3.204 | 3.568 | 0.016 | Significant |

DF (5) at the significance level of 0.05

The sensory-motor exercises (SME) prepared that the researcher prepared are as similar as possible to the body movements used in tennis. They were executed following the same motor level of the basic skills of serving, forehand and backhand strokes of a tennis player, as well as the direction and range of joint movement.

The increase in movement speed during sensory-motor perception exercises helped to improve the movement response speed measured by the Nelson test (Sheets-Johnstone, 2010) and the sprint 20 meters from a moving start test. The researcher attributes this increase to the improvement in the correct connection between physical exercises and the requirements of proper motor and skill performance. Some researchers reported that it is necessary to harmonize sensory-motor training with the specific requirements of the activity to achieve the best technical and motor performance (Ahmed, 2020; Moselhy, 2022).

The researcher attributes the significant differences in these tests to the pertained exercises. They included changing direction and speed during training, as well as sudden and varied movements in the game. This helped to shorten the time between stimulus and response (Al-Omari et al., 2021; Le Noury et al., 2021). The prepared exercises worked on increasing the body's transitional speed from one place to another. Thus, they improved the performance of the sample in less time, which is essential for a tennis player. The basis of speed training is the appropriate state to stimulate the central nervous system (Kovacs, 2006).

The researcher believes that a tennis player should exert force in a sequential and timed manner from the lower part of the body to the upper part (Knight, et al., 2010). It invests muscular work in a way that serves to increase motor speed. Therefore, any delay in muscular work directly affects skill performance, which in turn affects achievement (Pyne et al., 2008).

Physical abilities are one of the important factors on which athletic success is based. The development and promotion of these special abilities are closely related to the process of developing motor skills. These results agree with what sports training experts confirm sensory-motor exercises (SME) affect muscle response quickly and increase movement frequency speed. This is reflected directly on movement speed. These exercises simulate the forward and backward movements that the player performs during competition for backhand and forehand strokes (Knight et al., 2010).

The researcher also attributes such development in performance to the effect of the exercises used. The association of these exercises participate in developing and improving muscular and skill strength through exercises. They focused on developing power and speed for serving, whether using various balls or rackets. These exercises contributed to producing greater contraction force and engaging a group of working muscles, leading to improved test results (Thongpanja et al., 2013). In addition, appropriate guidance for training elements containing diverse sensory-motor perception exercises is necessary to develop those skills that help players, as shown in the Table 3.

## CONCLUSIONS AND RECOMMENDATIONS

### Conclusions

1- The proposed exercises had a positive impact on the players' special physical and skill abilities of tennis players.

2- Performing sensory-motor exercises (SME) directly affected muscle balance, as evidenced by the EMG test results, achieving high compatibility and smoothness that serves movement economy.

3- The use of sensory-motor exercises (SME) is crucial for achieving success in tennis, as it led to differences in some physical and skill abilities for tennis players benefiting the post-tests.

### Recommendations

1) Physical training and technical development should be based on using sensory-motor perception exercises, tools, and devices, and incorporating these exercises into the curriculum to develop neuromuscular balance.

2) Developing speed is essential for competition, in addition to controlling neural adaptation, which includes high-value exercises and increasing movement speed for tennis players.

3) Further studies should be conducted on the effectiveness of other activities using sensory-motor perception exercises and monitoring the electrical activity values of the working muscles.

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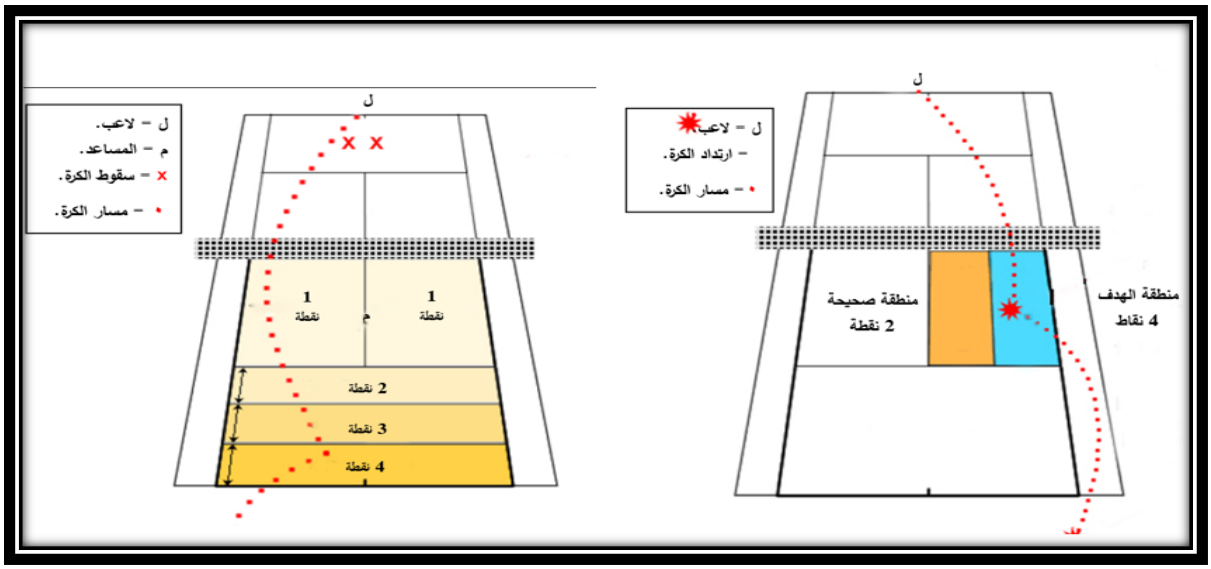
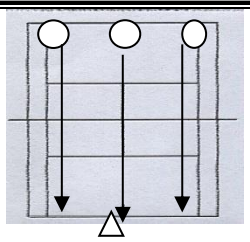
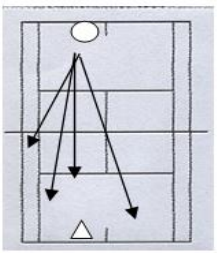
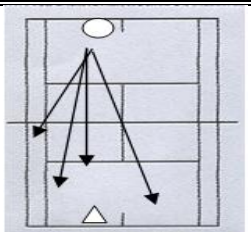
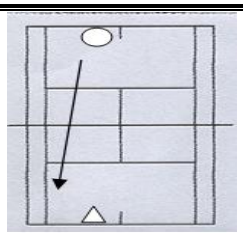
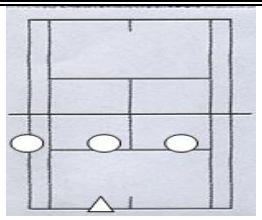
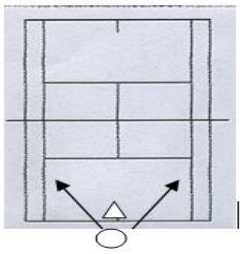
## Appendix

**Image 1**. The serve test and the forehand and backhand depth test




**The sensory-motor exercises. Note: All exercises are performed as if playing a real game (racket, tennis balls)**

| No | Exercise type | شكل التمرين |
|---|---|---|
| **Exercise 1** | Three assistants stand on the baseline. Each one hits a ball to the opponent's court. The player (receiver) hits one of the three balls and returns it over the net to the opponent's court according to the instruction (right, middle, left). |  |
| **Exercise 2** | Similar to the previous exercise, but the three assistants stand on the service line. Note 1: In exercises (1) and (2), the balls fall in three directions, with a slight difference in speed and depth according to their fall in the court. Note 2: The signal is given when the first ball hits the ground. |  |
| **Exercise 3** | Hitting a set of 10 balls consecutively over the net to the opponent's court in different directions and speeds, and the player returns them back to the opponent's court. |  |

| | | |
|---|---|---|
| **Exercise 4** | The player stands in the middle of the baseline with his back to the court, and the assistant stands in the opposite court and hits the ball to the opponent's court. When the signal is heard, the player turns to face the court and returns the ball. |  |
| **Exercise 5** | The player stands in the middle of the baseline, and three assistants stand on the service line of the same court. When the signal (1), (2), (3) is given, the player moves towards one of the assistants who represents that number and hits the ball thrown by that assistant after it bounces on the ground to the opponent's court. To increase the difficulty of the exercise, the numbers of the assistants are changed. |  |
| **Exercise 6** | Exercise 6 is similar to exercise 5, however, the assistant throws two balls at once, each one-to-one side of the court, and the player responds to one of these two balls according to the signal (right - left) and hits it after it bounces on the ground to the opponent's court. |  |

**Suggested training exercises**

| | | |
|---|---|---|
| A module from the first training unit<br>Date: 14/6/2022 | Week 1<br>Time: 5:30 -7:00 pm | Month: 6th<br>Time: 30 minutes |

| No | Suggested exercises | Exercises | Repetitions | Rest between exercises | Total training and rest time | pulse rate | total severity | Notes |
|---|---|---|---|---|---|---|---|---|
| 1 | Sensory-Motor Exercises | **Exercises 1 & 2** | 10 | 10 seconds | 10 minutes | 130 pulse per second | 75% | |
| 2 | Sensory-Motor Exercises | **Exercises 3, 4, & 5** | 10 | 10 seconds | 10 minutes | | | |
| 3 | Sensory-Motor Exercises | **Exercises, 1, 3, & 6** | 10 | 10 seconds | 10 minutes | | | |