Effect of sports exercises combined with electricity stimulation device on strength and electricity activity for thigh muscles of futsal female players

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Abstract

Purpose: This study aimed to examine the effect of sports exercises combined with an electrical stimulation device on the strength and electrical activity of the thigh muscles in female futsal players.

Materials and Methods: An experimental method was used in present study. A total of 12 female futsal players from Babylon University's College of Physical Education & Sports Sciences comprised the study's population, and they were treated as a single group. The participants shared comparable ages, training schedules, and educational backgrounds. Participants underwent tests and measurements, including assessments of muscle strength, strength endurance, and physiological variable such as electrical stimulation. The training program included (4-6) exercises in each training unit, and the number of training units was (48), at a rate of (3) units per week, the time of the training units were ranged between (40-90) minutes. Whereas, the number of repetitions was between 1-8, depending on the type of exercise and its intensity, which ranged between 85%-100%. The rest periods were between 60-90 seconds, depending on the type and intensity of the exercise. However, electrical stimulation sessions were conducted simultaneously with exercise and on the same date, so the total number of sessions was (24) sessions, with (1) session per week. As for the stimulation flashes, they were suitable for each player and started from 2 watts up to 9 watts, and the duration of one session started from 20 to 30 minuts.

Results: The findings revealed that the combined intervention significantly improved muscle strength, strength endurance, and electrical activity in the thigh muscles of the participants. These improvements underscore the effectiveness of combining traditional exercises with electrical stimulation in enhancing muscle function.

Conclusions: The study concluded that the combination of sports exercises and electrical stimulation is an effective method for improving physical attributes, such as strength and endurance,

as well as physiological variables like electrical activity in female futsal players. Furthermore, the results confirmed a strong relationship between electrical signals and force production, highlighting the importance of incorporating electrical stimulation into training programs to optimize athletic performance.

Keywords

Sports exercises, electrical stimulation, muscle strength, thigh muscles, electrical activity, futsal players.

Introductıon

In recent decades, there has been an active development of women's football. Women's participation in futsal has attracted the attention of scientists who have studied the into three main categories: 1) Research related to conditioning factors of training and competition in women, 2) Research related to injuries and other psychological variables in women and 3) Other topics investigated (Sanmiguel-Rodríguez, 2021).

Using an Electricity Stimulation Device is crucial for elevating athletes to a superior level of performance. Given the remarkable scientific progress that the world has witnessed, especially in recent years, which has become evident in achieving sporting achievements for various events, it has become necessary to use different training programs with diverse exercises and modern methods and methods that suit each sporting event to bring the athlete to a high level of achievement(Faria et al., 2005; Bieuzen et al., 2014).

The science of sports training is related to physiology, which studies the physiological changes that occur before and after physical effort (Pavlović et al., 2017). As is known, sports training leads to many changes, whether internal changes, which include physiological changes to the various body systems, or external changes, which include physical changes from development. For the general physical characteristics of the player, previous studies have shown that sports training leads to improving the speed of nerve impulses in addition to muscle strength, and organized exercise for a sufficient duration is one of the important and effective requirements in developing the physiological and physical aspects (Goranovic, et al., 2021;Tazabek et al., 2024; Ilham, et al., 2024). as exercise works It helps eliminate muscle weakness by developing and improving the strength and endurance of the muscles working on the joints, as well as increasing the strength of the ligaments and the degree of neuromuscular compatibility(Beirami, et al., 2020; Jeffries et al., 2021).

Electrical muscle stimulation is also one of the effective methods(Kolen & Puszka, 2018). It is used to develop strength quickly and effectively away from boredom in performing strength exercises using weights through muscle contraction, activating muscle tension within specific muscle cells (Burd et al., 2012). The physiology of muscle contraction does not necessarily mean shortening(Gash et al., 2023). Muscles where muscle force can be produced without contraction because some muscles can contract without changing the length of the muscle, as muscle contraction is followed by muscle relaxation, which means that the muscle fibers return to their normal position with less tension of the fibers (Cretoiu et al., 2018).

This strength also depends on some physiological variables that occur within the muscle or the athlete's body, such as the number of nerve impulses that reach the muscle during the performance

of the motor task and the ability of the heart to deliver the amount of blood loaded with oxygen to the muscle through the heart rate and percentage(Suchomel et al., 2018). Testosterone in the blood after exertion has an important role in producing the player's muscular strength(Anderson et al., 2016).

Futsal skills depend largely on the thigh muscles, which allow the player to overcome his opponent(Sekulic et al., 2021). Players with high thigh muscle strength are better than athletes with less thigh muscle strength because this strength helps withstand the effort expended in completing the game(Agapito et al., 2022).

Because of the presence of many female futsal players who suffer from weakness in the strength and endurance of the thigh muscles, which is the basis for performing motor duties correctly in this game, and thus affects their ability to continue performing until the end of the match, their level will not be at the level of ambition compared to the levels that should be(Pinho et al., 2022). Female athletes reach it, which is why researchers want to harness everything new to raise the level of performance among female athletes(Kavoura, 2018). Thus, researchers have harnessed scientific development, including the electrical muscle stimulation device, to identify its effect on this category of female athletes.

Hence, the idea and importance of research came about from preparing sports exercises accompanied by an electrical stimulation device and knowing its effect on some physical variables such as strength, force endurance, and physiological variables represented in the electrical activity of the muscles working on the knee joint.

This study aimed to examine the effect of sports exercises combined with an electrical stimulation device on the strength, srength endurance and electrical activity of the thigh muscles in female futsal players.

The study hypothesized that exercise accompanied by an electrical stimulation device has an effect on developing the strength, srength endurance, and electrical activity of the thigh muscles for female futsal players and that there are statistically significant differences between the pre-and post-tests for the research sample in the tests mentioned above and in favor of the post-tests.

Materıals And Methods

Subject

A total of 12 female futsal players from Babylon University's College of Physical Education & Sports Sciences comprised the study's population, and they were treated as a single group. The participants shared comparable ages, training schedules, and educational backgrounds. Because of their strong dedication to carrying out the training regimen given to them, none of the players were disqualified. The program was run under the guidance of a futsal-specific coach, and as indicated in Table 1, the sample was homogenized with certain morphological factors to make sure it was suitable for the current investigation.

Tabe 1. illustrates the sample description

Variables	Unite	Mean	Standard division	Median	Skewness
High	meter	174.53	1.04	175.00	-0.095-
Weight	kilogram	74.93	1.25	75.00	-0.312-

Age	year	25.33	0.95	25.00	0.261
Training age	month	٢4.86	0.73	35.00	0.214

Table (1) illustrates the sample description. Since every skewness result fell between -1 and +1, the sample was considered homogenous.

Methods

Field research procedures:

Determine the variables investigated: The researchers worked to determine the variables that were appropriate for the study, and the following variables were agreed upon:

1. Physiological variable include measuring muscle electrical signals using an EMG device (Fig.1).

2. Physical variables: including maximum strength and strength endurance using a barbell pushing machine.

Physiological test discription

Measuring muscle electrical signals:

1. General instructions before carrying out the test: The researchers work to teach the female players how to conduct the test, as shown below.

- The player sits on the pushing machine and places her feet on the weight-pushing base.
- Her legs should be bent before starting the movement and then extended forward when pushing the weight, and the distance from the sitting chair to the pushing base should be appropriate for the player.
- The back should be straight, the arms should be placed next to the body, and they should not use leg support when pushing the machine.
- Use 100% intensity while measuring electrical signals.
- Balances have been set appropriately to the level of each player.
- Place electrodes (sensors) on the front and back of the thigh.

2. Test procedure: The test is conducted by the player starting to push the machine from the leg bent position to the extended position with maximum force for one time. During the test, the electrical signals reaching the thigh muscles were measured.

3. Recording method: The results of the muscle electrical signals were recorded during the maximum strength test for one time only.

Physical test discription:

A leg press machine device was used to measure the maximum strength and force endurance of the thigh muscles in one direction and with different weights, as follows:

1. Maximum strength test:

• Arrangements before the test: Inform the players to arrive at the appropriate time and to warm up before the test.

• Tools used: leg press machine.

• How to conduct the test: Before implementing the test, the researchers work to teach the players how to conduct the test, and then the maximum strength of the thigh muscles is measured at 100% intensity by the player sitting on the pushing machine and according to what she deems appropriate, the distance of her legs from the base of the feet, and the back is straight, and the arms are by the side. The body and not using body support when pushing the machine. After that, the athlete begins pushing the machine with maximum force for one time.
• Recording method: The maximum weight reached by the athlete during the test was recorded, and the athlete can perform only two attempts.

2.: Strength endurance test:

•Arrangements before the test: Inform the players to arrive at the appropriate time and to warm up before the test.

•Tools used: leg press machine.

•How to conduct the test: Before implementing the test, the researchers work to teach the players how to conduct the test, and after that, the strength endurance of the thigh muscles is measured at 70% intensity by the player sitting on the pushing machine and according to what he deems appropriate, the distance of her legs from the base of the feet, and the back is straight, and the arms are by the side. The body and not using body support in the process of pushing the machine, and after that, the player begins to push the machine forcefully until the effort is exhausted.

Recording method: The maximum repetitions reached by the players during the test were recorded, and the player can perform only one attempt.

Study Design

Pre-tests.

Tests were conducted on Wednesday and Thursday, corresponding to 15-16/12/2023, for the variables specified in the research, and the tests were according to the following sequence:

1- The first day: It included physical tests (maximum strength and endurance)

2- The second day: It included physiological tests (measuring neural electrical signals), and the results of the tests were recorded directly through evaluation forms prepared for that in advance.

Exercise Program:

The main research experiment was conducted on the sample from 17\12\2023 until 18/2/2024. after looking through numerous sources and scientific references, twelve exercises were created and performed with electrical stimulation of the muscles.

Exercise Units:

The training units were formed based on test results, 4-6 exercises were chosen in each training unit such as (Side Shuffle Switch, Plyometric Squat, Side Lunge Sweep, Single-Leg Circle, Dumbbell Squat, Lunges with Dumbbells, Ballerina Plié, Low Lunge with Isometric Adduction) and the number of training units was (48) training units, at a rate of (3) units per week, and according to the times for the selected exercises with repetition and rest. The time of the training units they were ranged between (40-90) minutes. The number of repetitions was between 1-8, depending on the type of exercise and its intensity, which ranged between 85%-100%. The rest periods were between 60-90 seconds, depending on the type and intensity of the exercise.

Electrical stimulation:

Electrical stimulation sessions were conducted simultaneously with exercise and on the same date, so the total number of sessions was (24) sessions, with (1) session per week. As for the stimulation flashes, they were suitable for each player and started from 20 Hz up to 60 Hz, and the duration of one session started from 20 to 30 minutes.

Table 2. shows one training unit

N	exercises	İntensity	Repetetion	Groups	Rest	Nots
1	Side Shuffle Switch	85%	6	3	75s	
2	Plyometric Squat	85%	6	3	75s	
3	Single-Leg Circle	85%	6	3	75s	
4	Dumbbell Squat	85%	6	3	75s	
5	Lunges with Dumbbells	85%	6	3	75s	
6	Low Lunge with Isometric Adduction	85%	6	3	75s	

Table 3. shows electrical stimulation units

N	electrical stimulation	Density	frequency	Time
1	First week	20 Hz	1 time	20 m
2	Secound week	25 Hz	1 time	25 m
3	Third week	30 Hz	1 time	25 m
4	Fourth week	35 Hz	1 time	28 m
5	Fifth week	40 Hz	1 time	28 m
6	Six week	45 Hz	1 time	30 m
7	Seventh week	50 Hz	1 time	30 m
8	Eight week	60 Hz	1 time	30 m

Post-tests:

The tests were conducted in the same manner as the pretests, which were on Sunday and Monday, corresponding to 19-20/2/2024, for the variables specified in the research, and the tests were according to the following sequence: -

1- The first day: It included physical tests (maximum strength and strength endurance)

2- The second day: It included physiological tests (measuring neural electrical signals), and the results of the tests were recorded directly through evaluation forms prepared for that in advance.

Statistical data analysis

The researchers used the statistical package (SPSS) to perform the required statistical operations, which are: - (skewness coefficient, arithmetic means, standard deviations, and (T. value) for correlated samples).

Results of the study

Table 4. Indicators of differences between the arithmetic means, standard deviations, and T-value for samples related to the investigated variables for the study group.

Variables	Unite	Pre-test		Post-test		T value	Significant	Percentage
		m	sd	m	sd			
Strength	kg	96.66	5.87	111.00	3.87	-7.88-	p>0,05	9.03
Strength endurance	reputation	9.80	1.26	13.13	1.06	-7.82-	p>0,05	8.61
Stimulation	UV	229.06	4.62	286.80	4.81	-33.51	p>0,05	10.02

Table 2 shows the differences between the arithmetic means, standard deviations, and T-value for samples related to the investigated variables for the first and second groups.

It is clear from Table 2 that all signal level values for the tests are smaller than the level of statistical significance (0.05). This means that there are significant differences between the pre-and post-tests in all the variables investigated and in favor of the post-test, as follows:

- In measuring strength: The calculated (T) value was (-7.88) at the significance level (000.0), which is smaller than the statistical significance level (0.05). This means there is a significant difference between the pre-and post-tests in favor of the post-tests.
- In measuring force endurance, the calculated value of (T) was (-7.82) at the signal level (000.0), which is smaller than the level of statistical significance (0.05). This means there is a significant difference between the pre-and post-tests and in favor of the post-test.
- In measuring electrical signals, The calculated value of (T) reached (-33.51) at the signal level (0.000), which is smaller than the value of the statistical significance level (0.05). This means there is a significant difference between the pre-and post-tests and in favor of the post-test.

Discussıon

The aim of present study was to determine the effects of sports exercises combined with an electrical stimulation device on the strength and electrical activity of the thigh muscles in female futsal players. It was hypothesized that players performing exercise program accompanied by an electrical stimulation device would achive an improvement in post intervention test values, thus improving their physical performance. The main findings found in the project were: (i) 8 weeks with the strength-based intervention protocol significantly improved strength, strength endurance, and electrical signales.

These results are consistent with previous research in futsal players showing similar results regarding the effects of exercise programs on strength and strength endurance (Paz-Franco et al., 2017). One study showed similare results of our study that exercise accompanied by electrical stimulation has a major role in improving the strength, strength endurance, and electrical signals of the muscles working on the thigh joint (Mukherjee et al., 2023). According to De Borja et al. (2022) and Lilić et al. (2022), obesity impairs physical and physiological performance and is the reason for muscular weakness in female futsal players. Nonetheless, if the training is effective, the fat percentage will drop and performance will rise (Viana et al., 2019).

To achieve a good level of strength and strength endurance in female soccer players, a good level of basic leg strength is necessary. The results of our study have shown that 8 weeks of exercise training may improve strength endurance. These results are similar to the results of Bernerth & Aguinis (2016), they showed that regular exercise training improves thigh muscle strength and

endurance. However, other studies have shown that muscle strength increases whenever a player trains regularly, along with that this training increases the production of strength and ability (Lilić et al., 2020; Suchomel et al., 2018). Oscar Villanueva-Guerrero et al. (2024) discovered that an 8-week strength training program significantly improved the lower body's physical performance in young futsal players. Strength, jumping ability, and linear velocity are performance metrics that show these gains.

According to Goran Sporiš et al. (2011) strength and strength endurance are positively impacted by regular strength training. After 8 weeks of exercise training, the muscle strength of female soccer players has improved by 9.03% and the strength endurance by 8.61%. These data suggest that our exercise training has caused the improvement in muscular strength and strength endurance. These observations may point to potential changes so the coaches are encouraged to use more strength training with female soccer players.

Some other studies mentioned that improving muscle strength leads to improvement of physiological variables (Chomani et al., 2022; Suchomel et al., 2016). These studies stated that some muscles produce great force due to the electrical signals received from the nerves, which contribute to mobilizing the largest amount of fibers to contract and thus produce greater force (Tomalka, 2023). For this reason, the post-tests were better than the pretests in the results, as mentioned earlier. According to one study, following leg training, there was an improvement in electrical muscle activity indicators such the quadriceps muscle with straight femoral heads and the membranous muscle (behind the quadriceps) (Mazin Ahmad, 2022).

Researchers believe that the reason that made the post-tests better than the pretests is the exercise training and electrical stimulation device that led to an increase in muscle strength, which allows electrical signals to reach the muscle at high speed and for proper muscle contraction to occur, thus producing sufficient force to perform the required skill, and this has been confirmed by several studies. Other studies have concluded that strength training leads to an increase and improvement of the nerve signals to the muscles (Del Vecchio et al., 2019; Siddique et al., 2020). Therefore, these studies agree with the researcher's opinion that the athlete depends on the extent of the muscle training, which results in great muscle strength and endurance due to the improvement of the electrical signals reaching the muscles (Fusco et al., 2021; Milosevic et al., 2020; Wang et al., 2019).

Maxime Billot and his colleagues (2010) discovered that three weeks of electrical stimulation training regimens appear to be suitable for strengthening soccer players' knee extensor muscles under both isometric and eccentric situations. Nevertheless, it seems that two more weeks are required to see improvements in every contractile state. Additionally, certain soccer tasks, like ball speed performance, improve with electrical stimulation training. The quadriceps femoris muscles may not benefit much from electrical stimulation training alone when it comes to enhancing amateur soccer players' jumping abilities. An electrical stimulation training program lasting three or five weeks seems to be a feasible way to enhance force and certain soccer duties both before and during the season, in addition to conventional soccer training. Actually, this novel approach could be utilized to enhance conventional soccer training. It would add variation to the training regimen, which could increase some players' drive.

Malatesta et al., (2003) found an increase in strength after 4-week electrical stimulation training. However, following ten days of electrical stimulation training, they found no increases. Additionally, they showed that training with electrical stimulation increased neural drive or preferred

activation of fast muscle fibers. They clarified that by controlling the neuromuscular properties in the best possible way during complicated dynamic movements, it also enhanced explosive motions. Maletesta et al.'s (2003) study, which found that jumping training combined with electrical stimulation for six weeks increased the strength of vertical jumping, was corroborated by a study by Gulick et al. (2011).

Conclusions

In light of the results of the study, the researchers concluded that exercise accompanied by an electrical stimulation device has an important role in improving physical variables such as strength and strength endurance for female futsal players and that exercise accompanied by an electrical stimulation device has an important role in improving the physiological variables (electrical signals) for female futsal players.

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