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THE EFFECT OF ELECTRICAL STIMULATION OF WORKING MUSCLES ASSOCIATED WITH SPECIAL EXERCISES IN DEVELOPING STRENGTH FOR THE LEGS AND REDUCING THE SPIN TIME IN YOUNG SWIMMERS

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Abstract
The study sought to ascertain the impact of electrical stimulation of active muscles in conjunction with specialised exercises on enhancing leg strength and decreasing rotation time in young swimmers. The researcher employed an experimental methodology involving a total sample of 11 participants from the youth category, aged 15 to 18 years, representing 50% of the original population from the Amara Sports Club. The statistical analysis was conducted using the SPSS-24 software. Based on the findings of the researcher, it was determined that electromuscular planning is an effective and precise method for assessing muscle strength that influences performance. Furthermore, the implementation of specialised exercises and electrical stimulation enhances swimming rotation time, leg muscle strength, stability in the broad jump, wall push-off duration, and 50 m swimming time, thereby improving muscular balance on both sides of the body, which positively impacts performance and achievement, as concluded by the researcher. He proposed numerous suggestions, emphasising the necessity of utilising contemporary equipment to identify problems in muscular function, particularly the electromyography device for electromuscular assessment. The equilibrium of maximum muscular strength on both sides of the body during pressure elevation from a supine position necessitates the implementation of specialised exercises and electrical stimulation. This approach aims to establish a training regimen that integrates the benefits of both modalities to enhance maximum strength and improve muscular balance in swimmers.

Keywords: Electrical Stimulation, Muscles, Special Exercises, Strength, Legs, Reducing, Young Swimmers.

Introduction

The ongoing advancement in training science is evident in skill and technical performance. When coaches employ contemporary techniques and programs, they can attain desired objectives both technically and psychologically, facilitating the comfortable execution of training tasks by players (Joyce & Lewindon, 2014). The modern tools and devices utilised induce beneficial changes in the body's cells and internal organs, enhancing the body's capacity to generate strength and speed while completing training tasks (Mileva & Zaidell, 2022). Applying the principle of specificity in training, numerous scientific studies and field experiences indicate that performance enhancement is maximised when training is tailored to the specific activity, engaging the relevant muscles in a manner congruent with their use in competition and contemporary methodologies (Spiering et al,2023). The discipline of training encompasses the technique of electrical muscle stimulation, initially employed to activate injured muscles and subsequently utilised for various objectives, including enhancing physiological muscle efficiency and strength development (Li, 2025). The significance of this study lies in its focus on stimulating the muscles involved in rotational skills and strength enhancement, given the critical importance of these skills in swimming, which demands precise and exceptional technical performance (Sorgente, 2024). Additionally, it is essential to harness the momentum of both individuals and

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execute actions with vigour and speed to attain optimal results, relying solely on arm strength and efficient effort (Cereda, 2024). One of the paramount prerequisites for freestyle swimming is the swimmer's capacity to traverse the race distance as swiftly as possible. When examining a critical requirement, namely the ability to generate maximum force, numerous studies have substantiated a positive correlation between push strength and rotation distance (Sorgente, 2024). Specifically, an enhanced ability to propel off the wall with the lower limbs correlates with reduced rotation time, as affirmed by Fadaei Dehcheshmeh, Gandomi, and Maffulli (2021). The velocity of rotation in swimming is significantly influenced by the strength of the lower limb muscles. Uzzell, Knight, and Hill (2022) asserts that aquatic strength training can facilitate the notion of privacy and serve as a means to approximate authentic performance. To achieve this objective, numerous techniques and tools, including underwater electrical stimulation, are employed to enhance resistance levels. This study is significant since it elucidates the development of lower limb muscle strength in relation to rotational skills in freestyle.

Search problem:

Freestyle swimming relies mostly on arm strength, which serves as the fundamental driving force compared to the propulsion generated by the legs. Most coaches and specialists in this sport emphasise the development of the body's musculature, particularly the arm and chest muscles (Solovjova et al., 2023). They assert that the driving force in the skill of rotation is predominantly derived from leg propulsion against the wall. Furthermore, rotation is a critical factor influencing a swimmer's speed in covering distance and achieving optimal race times (Jakubovskis, Solovjova & Zusa, 2023). Based on the researcher's experience in swimming training and instruction, he observed that it is crucial to strengthen the leg muscles due to their fundamental role in enhancing propulsion towards the pool wall and achieving advantages that minimise race time. The researcher aimed to enhance leg momentum by stimulating electrically activated muscles, thereby reducing training duration, targeting deep muscle fibres unaffected by conventional training, minimising injury risk, and providing an excellent opportunity to refine rotational skills. The trainer's curriculum and the incorporation of specialised workouts enhance this crucial talent in freestyle. The muscle stimulation device will be utilised electrically, integrated into the training units, and subjected to thorough study to get the required outcomes.

Objectives of the study

1. To ascertain the impact of electrical stimulation on the functioning muscles in enhancing leg strength and diminishing rotation time in young swimmers.
2. Developing specialised routines to enhance leg propulsion and decrease turnaround time for young swimmers.

Hypotheses of the study

1. Statistically significant differences exist in the impact of electrical stimulation on the muscles associated with leg strength development and a reduction in rotation time among young swimmers.
2. Statistically significant differences indicate that specialised training greatly enhances leg propulsion, hence reducing spin time in young swimmers.

Research Areas:

1. **Human Areas**: Swimmers of the Architecture Club young ages from (15-18) years.
2. **Temporal Areas**: 15/7/2022 to 15/9/2022.
3. **Spatial Areas:** Hippie Dream Pool.

Research Methodology:

The researcher employed the experimental method utilising two equivalent groups, as it aligns with the research procedures, ensuring that the groups are"entirely equivalent in all conditions except for the

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experimental variable impacting the experimental group (Duke et al., 2021). To illustrate the distinction between them following the implementation of the pilot program.

Research Sample:

The research sample was intentionally selected, ensuring that the researcher accurately represents the original community. The total number of participants in the sample consisted of 11 players from the youth category, aged 15 to 18 years, from the Amara Sports Club. Three players were excluded for the exploratory experiment, resulting in a final sample size of 8 players, which constitutes 50% of the original community of 16 members. Protocol The uniformity of the research sample members about age, height, and weight is illustrated in Table 1.

Table 1: Shows homogeneity of the members of the research sample.

Variables	Unit of measurement	M	SD		T
Chronological age	**Year**	**17.37**	**0.517**	**18**	**0.517**
Length	**Cm**	**170.62**	**3.24**	**171**	**3.248**
Weight	**Kg**	**66.12**	**3.18**	**66.5**	**3.181**
Time of wall push and swimming 5 m	**Snd**	**4.35**	**0.49**	**5.2**	**0.49**

Methods, tools and devices used in research:

- Swimming pool.
- Dynamo Meter.
- Dynamometers: Measuring the Strength of the Muscles of the Legs (276:27)
- 3m tapeline measurement for measuring the wide jump test and for measuring muscular capacity. (400-395:27).
- Stimulation Electric Muscle Stimulator. To stimulate the working muscles The name of the device (Tens and Muscle Stimulator) The device works with a constant and intermittent electric current.
- An electronic stopwatch to measure the time of the rotation distance in swimming.
- Dynamometer.

Tests used in the research:

1. Swimming Turnover Time Test: To measure the rotation time in theswimming, the rotation time is the time it takes for a swimmer to perform the rotation by swimming 15 m (7.5 m round trip and 7.5 m back) (Riewald, & Rodeo, 2015).
2. Time test of wall push and swimming pool 5m (Collard, 2007).
3. Strength Leg Test Using Dynamometer (Lu et al., 2011).
4. Wide jump test of stability to measure the muscular ability of the legs (Hamilton et al., 2008).

Field Research Procedures:

Exploratory Experience:

The researcher executed an exploratory experiment involving three swimmers, with tests completed at 5:00 PM from July 13 to July 15, 2022, at the Happy Dream Sports Pool. The chosen tests have been implemented to replicate the problem's characteristics, as well as to verify the functionality of the stimulation device and the timing of sensor placement. The identification of the anterior and posterior muscular regions of the male, together with the assessment of the origin and muscle density. along with the sensation experienced by the swimmer when utilising the device and initiating the stimulation process. The duration of muscle stimulation and the initial electric current utilised by the researcher were both facilitated by a specialised team proficient in stimulation and physiotherapy devices at the Physical

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Therapy and Rehabilitation Centre in Maysan Governorate. Subsequently, forms were prepared to record the data from the conducted tests. The assistant staff understood the program's functionality, the timing, the utilisation of the device and exercises, as well as the duration outside the training unit established by the trainer and coordinated efforts about it.

Scientific foundations of tests: -

The researcher extracted self-honesty as shown in the table (2).

Table 2: Shows the coefficient of stability and subjective honesty of the tests under study

Tests	Unit of measurement	Coefficient of stability	Coefficient of self-honesty
Swimming Spin Time Test	Snd	0.901	0.941
Test of leg muscle strength	Number	0.923	0.960
Wide jump test of stability	Number	0.911	0.954
Wall push time test and swimming 5m	Snd	0.931	0.972

Equivalence of the two groups:

Following the assessment of homogeneity among the research sample members regarding age, height, and weight, as presented in Table (1), the tests endorsed by the experts were selected at a rate of 75-83%, therefore establishing equivalence. The study sample utilised the law (T) for independent samples of equal size, enabling the researcher to observe the variations between the two research groups and ascribe them to the experimental variable. It is essential to establish experimental groups for the study. Identical under all conditions except for the experimental variable influencing the experimental groups. As illustrated in Table 3.

Table 3: The equivalence of the sample shows the control group and the experimental group in the tests under study.

Tests	Unit of measurement	Experimental		Control		(v)
		M	SD	M	SD	Calculated
Swimming Spin Time Test	Snd	11.56	1.12	1.78	1.06	1.78
Test of leg muscle strength	Number	160.57	24.07	0.99	24.01	0.99
Wide jump test of stability	Number	234.19	16.09	1.06	16.1	1.06
Wall push time test and swimming 5m	Snd	4.22	0.16	1.8	0.16	1.8

(*) Tabular value (T) under degree of freedom (6) and error level (0.05) is equal to (2.45)

Training program for the research sample:

The researcher developed specialised training activities informed by his expertise, practical experience, and insights from experts and specialists in sports training science, utilising both Arab and international sources. The training curriculum was implemented over a period of eight weeks, comprising three training sessions per week, aimed at enhancing muscle strength in the lower limbs. The researcher employed high-intensity interval training (ranging from 80% to 90%) while considering the principles of gradation and variability in load and training intensity. The interval of rest between repetitions was determined by the recovery of the pulse to 120 beats per minute, after which the next repetition commenced, a method referred to as incomplete rest. This training method enhances overall muscle strength and targets specific muscles by electrical stimulation prior to activity. He established a designated area for the swimmer to sit and connected the sensors to the origin of the anterior quadriceps muscle and its insertion, as well as to the origin of the posterior popliteal muscle and its insertion, recording the duration of each session (15 days). Preparations for swimmers included a briefing

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for substitutes, emphasising the significance of these workouts and fostering psychological acceptance, followed by the determination of intensity. of the suitable electric wave for each swimmer individually and utilise it. Enhancing the intensity and repetitions in succeeding units is accomplished by documenting the data of each sample member using a specialised form, coinciding with the initiation of stimulation application. Subsequent to the warm-up routine and prior to pool entry, emphasis was placed on stretching and flexibility exercises targeting the leg muscles. The training regimen incorporated specialised exercises designed to enhance bilateral leg strength, utilising auxiliary equipment such as weights and implementing specific land-based exercises, concentrating on the musculature of both legs for strength development. The researcher selected times that do not conflict with the trainer's curriculum, considering the objectives of the training units, days, and times to ensure alignment in the goals of the units, thereby maintaining consistency in the experimental variable's objectives.

Statistical Methods:

The researcher employed statistical software (SPSS-24) to analyse the special grades derived from the experiment.

Results

Presentation, analysis and discussion of the results:

This part presents the researcher's conclusions, analysis, and commentary based on the tests conducted on the research sample, which include the following findings.

Table 4: Shows the arithmetic means, standard deviations and values (T) calculated for the control group in the tests under study (pretest- and test post)

Tests	Unit of measurement	Pre-test		Post-Test		(v) Calculated	T
		M	SD	M	SD		
Swimming Spin Time Test	Snd	11.56	1.12	10.11	0.057	1.78	0.001
Test of leg muscle strength	Number	160.57	24.07	174.29	26.95	0.99	0.001
Wide jump test of stability	Number	234.19	16.09	249.18	14.8	1.06	0.002
Wall push time test and swimming 5m	Snd	4.22	0.16	2.55	0.16	1.8	0.003

(*) Tabular value (T) under degree of freedom ( ) and with error level (0.05) is equal to (3.18)

Discussion of the results of the tests for the research variables of the control group:

The results presented in Table (4) indicate significant differences between pre- and post-tests in the rotation time for freestyle swimming over a distance of 15 m (7.5 m forward and 7.5 m backward after wall push), as well as in the wall push and 5 m swimming tests for the two male subjects. The post-test results demonstrate superiority, which the researcher attributes to the training curriculum developed by the trainer. Table (4) presents the arithmetic means and standard deviations of the pre- and post-tests for the control group, revealing that its members exhibited improvement in several research variables, particularly in swimming rotation time, leg muscle strength, stability in broad jumps, wall push time, and 50-meter swimming performance. The researcher ascribes this advancement to the consistent implementation of appropriate instruction by the instructor, the efficacy of the control group participants, and the application of constructive exercises in the enhancement of these factors. Table (4) indicated that the sample members' performance in the studied variables was insufficient, failing to meet the required standards. This suggests the ineffectiveness of the employed exercises and training regimen, resulting in an environment characterised by monotony and

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disengagement among the sample members, ultimately leading to challenges. Advancing to the requisite level necessitates the implementation of more effective and specialised methods, exercises, programs, and training curricula to influence these variables (Kris-Etherton et al., 2014). This underscores that the utilisation of preparatory exercises and aids, alongside competitive exercises, enhances the development and training process (Plowman & Smith, 2013; Zatsiorsky, Kraemer & Fry, 2020).

Table 5: Shows the arithmetic means, standard deviations and values of (T) calculated for the experimental group in the tests under study (pre- and post)

Tests	Unit of measurement	Pre-test		Post-Test		(v) Calculated	T
		M	SD	M	SD		
Swimming Spin Time Test	Snd	11.51	1.12	10.11	0.057	1.78	0.000
Test of leg muscle strength	Number	160.29	24.07	174.29	26.95	0.99	0.000
Wide jump test of stability	Number	234.10	16.09	249.18	14.8	1.06	0.000
Wall push time test and swimming 5m	Snd	4.25	0.16	2.55	0.16	1.8	0.000

(*) Tabular value (T) under degree of freedom ( ) and with error level (0.05) is equal to (3.18)

Discussion of the results:

Table (5) illustrates the arithmetic means and standard deviations of the pre- and post-tests for the experimental group, indicating a significant difference favouring the post-test results. The researcher attributes this improvement to the efficacy of the training curriculum utilising electrical stimulation, which enhanced the targeted muscles and elevated the overall performance of the group, as depicted in the table. The post-test results of the experimental group demonstrate a moral advantage in physical capabilities, as Fawzi Khudari affirmed that training with these methods generates a robust stimulus for muscle hypertrophy by replicating the functions executed by the nervous system. He also emphasised Stone et al., (2022) that an increased frequency alters the training focus towards strength, and the duration of the alert would correspond to this training. Regarding the specific workouts conducted with the application of motivational incentives. Due to the high efficacy of special exercises, they constitute a significant component in the foundational and concluding phases of training across several sports. Duncan et al(2024) confirms that in this exercise, the trajectory of fundamental movement aligns with the game or efficacy of the athlete, highlighting its direct influence on the stimulating muscles. Electrical stimulation directly affects the neural system, with educators being the initial influence through directives conveyed by fluids (Huang et al., 2024). The neurological system significantly influences the neuromuscular coordination between the eye and hand, which is essential for the growth of the fencing athlete, along with the coordination of the muscles associated with the execution of those actions and their alignment with the training methodology employed in the program utilising electrical stimulation (Zhang, Guberman & Feldman, 2022).

Table (5) reveals that there is a significant difference between the pre-test and post-test results of the control and experimental groups, favouring the post-test of the experimental group. The researcher attributes this improvement to the efficacy of the training curriculum incorporating electrical stimulation alongside exercises. The researcher attributed the development of the muscles to the experimental group, which utilised a structured electrical stimulation program in conjunction with the workouts, hence enhancing the overall performance of the group. The control group did not get electrical stimulation, demonstrating the significant effect of the electrical stimulation program on the experimental group, as the supplementary exercises

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combined with the stimulation program also notably enhanced strength. The functioning muscles and the coordination of their motor pathways during flexion, extension, development, and other actions, as well as the enhancement of physical attributes (Iorga et al., 2023). This aligns with the prerequisites for engaging with this trained category, which has attained a thorough and equitable growth of these attributes to guarantee the ongoing advancement of athletes in physical qualities and establish a robust foundation for progress in achievement (Bailey et al., 2010). The researcher ascribes this development to the efficacy of combining physical exercise with electrical stimulation of the active muscles, which enhanced the muscle strength of these groups, resulting in comprehensive improvement in physical capabilities and skills. The benefit of employing electrical stimulation lies in its capability. The regeneration of voluntary muscle fibres occurs due to the presence of a segment of the fibres that has not contracted, referred to as reserve force (Anderson, 2022). The greater the electrical stimulation of the muscle, the more motor units are recruited, indicating an influence on muscle strength development and the enhancement of certain physical capabilities essential for muscular activity, thereby fortifying muscle groups (Wang et al., 2024). Muñoz, Lavoie, and Pope (2024) denote the significance of the neurological system and its function in orchestrating the driving force via neural excitation, as it can enhance through training the qualitative attributes of excitement that influence training outcomes. Increased resistance leads to heightened muscle tension due to the engagement of a greater number of muscle fibres, which can result in cellular adaptations that enhance the size of the motor unit (Mallett, 2025). This improvement augments the functional capacity of the motor unit to innervate a larger number of muscle fibres or recruit more motor units, thereby increasing strength (Olmos, 2024).

Conclusions

1. The electrical stimulation device utilising electrical signal data facilitated the codification and specification of the terminology for the training curriculum of each muscle independently.
2. The values of the diverse and regulated electrical stimulation frequencies facilitated the enhancement of the specific muscular strength of the active muscles for the chosen skill abilities.
3. The application of electrical stimulation facilitated the enhancement of muscular strength.
4. The specialised workouts employed in conjunction with electrical stimulation significantly enhanced time efficiency and effort conservation, as well as the advancement of certain motor skills.
5. Diversity in training devices enhances suspense, excitement, and motivation among participants, resulting in a beneficial impact on them.
6. The integration of technology in measurement, evaluation, and training significantly enhances efficiency and reduces the time invested, hence improving player performance.

Recommendations:

1. Leveraging the findings of the current study regarding the increase in the number of youth in training centres and specialised schools due to their significant influence and efficacy in the training process.
2. The application of contemporary technology in training, development, assessment, and evaluation significantly enhances achievement and progress by optimising the work and time invested by coaches and players.
3. The significance of providing training units for athletes, particularly swimmers, during stimulation sessions targeting various muscle areas.
4. The significance of administering assessments at short intervals to evaluate the quality and degree of advantage derived from the curriculum employed in the training modules.
5. Utilising contemporary electronic technologies for the calculation and documentation of test points to provide authentic and precise findings.

6. Developing educational programs for trainers and training personnel concerning contemporary and prospective training technologies.
7. Conducting a research utilising an electrical stimulation device in conjunction with exercises on a cohort of swimmers.

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