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The effect of Plyometric Training in Sea Sand on Developing Muscular Endurance in under-21 Football Players

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Abstract

The study aimed to investigate the effect of plyometric training in sea sand on developing the muscular endurance of soccer players under the age of 21. Given the nature of the study, the researchers adopted an experimental approach. The sample was divided into two homogeneous groups, each containing 10 players, for a period of nine weeks. The researchers then conducted post-tests on both samples. The results revealed statistically significant differences at a significance level of 0.05 and a degree of freedom of 9.00. This means there is a significant difference between the averages of the results, favoring the experimental group, in the muscular endurance tests.

1. Introduction

Achieving high athletic levels can only be accomplished through sound training based on scientific foundations, enabling one to keep pace with the sporting renaissance. Attaining peak performance is linked to the coach's ability to manage the training process, i.e., to organize and deliver a comprehensive training season.

Physical preparation, from the perspective of those working in the sports field in general, and training in particular, is the fundamental foundation for launching soccer players toward excellence. Improving the basic foundation of physical and skill preparation helps the player reach the highest levels and achieve optimal tactical performance, whether at the individual or collective level, thus increasing the team's chances of winning competitions.

Many researchers are calling for the necessity of building soccer players' physical preparation in line with the nature of the effort required during competitions. Developing physical attributes is not achieved in an abstract manner, but rather in connection with the distinctive characteristics of the nature and requirements of performance (Imad al-Din Abbas Abu Zaid, 2005).

Through analyzing soccer activity, it became clear that there has been an increase in the percentage of sporting events and situations whose achievement depends on the elements of strength and speed (muscular capacity) compared to what was the case in soccer. The foot previously (cometti.G,2002.p23.39) and due to the importance of muscular capacity and its connection to the level of physical performance, the focus on developing muscular capacity has become very important for football players. In this regard, several training methods have emerged to train and develop it, and from it emerged multi-form plyometric training. Today, we see many clubs and sports teams conducting sports training on sandy beaches with plyometric training, known as training on sand using the plyometric training method. Sand training is characterized by the weight of movement compared to other surfaces, whether natural grass, artificial grass, or even dirt floors. Sand training contributes to strengthening muscles, increasing the range of motion in the joint, and increasing sand resistance, as it works to raise and improve the level of the trainee and develop muscle efficiency in terms of speed, strength, and endurance.

A study by Assadi (2015) concluded that training on sand is a viable complement to traditional training, aiming to enhance athletes' muscular

performance. Furthermore, there is the potential for transfer of training effects after training on sand surfaces, which occurs when moving to play on firm surfaces (Binnie et al., 2013). There is a reciprocal relationship between physical abilities and skill levels, as physical abilities contribute to improving skill levels in team sports (Jabar, 2018). Therefore, the development of physical efficiency after training on sand surfaces indicates an increase in the player's ability to perform muscularly over a long period of time, as physical efficiency is linked to increased efficiency of the circulatory and respiratory systems (Jassim and Saeed, 2010). Muscles can produce muscular force when attempting to overcome or confront an external force, and this is achieved through muscle contractions (Alawi, 1994).

The topic of sand training caught our attention. Despite the availability of sandy areas during training camps, most sports teams head to coastal cities during July, August, and even September. However, they do not engage in plyometric training on sand to develop the muscular endurance of soccer players. This motivated us to delve into this issue and to raise awareness among coaches and physical trainers on the importance of plyometric training on sand to develop the muscular endurance of soccer players.

To address this gap and contribute to a solution to this problem, the researcher poses the following question:

Does plyometric training on sand positively affect the muscular development of soccer players under the age of 21?

Research Hypotheses:

Plyometric training on beach sand has a positive effect on the development of muscular endurance in soccer players under the age of 21.

The researchers hypothesized that there would be statistically significant differences between the experimental and control groups in muscular endurance tests for soccer players, in favor of the experimental group.

2. Method and Materials

This section describes in detail the following:

2.1.Research Population

1- Study Population: The original research population was identified, which consisted of soccer players under the age of 21 active in the National Division II for the 2023/2024 sports season.

1- Sample and Method: The research sample was selected in a purposive way from the Chlef Association team. The researcher conducted

anthropometric measurements of the research sample, and the results confirmed the equivalence and homogeneity of this sample.

2.2.Research / Study Procedures:

2.3.1. Method: In this pilot study, an experimental approach based on the type of data available was adopted.

-2 Tests Used:

First: Test power jumping The Vertical Jump Test

Jumping Ability Test Using the MyoTest Device

Objective:

To assess the explosive power of the legs

Test Description:

Using the MyoTest Device, the subject is given 5 repetitions to reach the maximum height.

The method of use is easy and is shown on the device. After pressing the Start button, press the "suit sj" button, then press the "enter" button.

Place the player in a ready position with the knees bent at a 90-degree angle. When you hear the signal, jump upwards while keeping your hands together. Then repeat the process after you hear the signal.

Results:

They appear automatically on the device screen. Results can be saved in the device's memory.

Second: Test relaxation jump

High Jump Test Using the MyoTest Device

Objective:

To assesse the jump height.

Test Description:

Using the MyoTest Device, the subject is given 5 repetitions to reach the maximum height.

The method of use is easy and is shown on the device. After pressing the Start button, press the "CMJ" button, then press the "enter" button.

Place the player in a ready position with the knees bent at a 90-degree angle. When you hear the signal, jump up while keeping your hands together. Then, repeat the process after you hear the signal.

Results:

They appear automatically on the device screen. Results can be saved in the device's memory.

Third: Demi Squat Test

Purpose: To assesse the development of lower extremity performance (power, strength, speed).

Test Description:

Using a **MyoTest** device, the tester is given 5 repetitions to reach the maximum height.

The method of use is easy and is shown on the device. After pressing the start button, press "Demi Squat -" and then press the "Enter" button (the device is connected to the barbell).

The player is in a ready position with the barbell above the shoulders without moving. When the signal is heard, bend the knees 90 degrees. After hearing the second short beep, jump as far as possible, then return to the starting position.

Results:

They appear automatically on the device screen. Results can be saved in the device's memory.

Figure 1: Shows the muscular power tests performed using the Myotest device

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2.4.Scientific Basis For Testing

2.4.1. Reliability

The initial test and repeat test were applied on a sample of 04 soccer players. The initial test results are repeatable from the same Sample. Pearson correlation coefficient (Pearson's r) value was extracted. The calculated t-value was greater than the tabulated t-value ($r = 0.87$, $p < 0.001$), which confirms that the tests are considered to have a high level of stability.

2.4.2. Validity

To ensure the test validity, the square root of the reliability coefficient was calculated. All tests were found to have a high degree of validity, as the calculated t-values (0.98-0.94) were greater than the tabulated t-values for Pearson's r ($r = 0.87$, $p < 0.001$).

2.4.3. Objectivity:

Accurate and fairly easy to use tests were applied to participants, where a research objective was clarified and spatial and climatic conditions that may affect the test results were standardized as well as adequate and suitable tools were adopted.

2.5. Data Analysis:

For the quantitative analysis, SPSS software (Statistical Package for the Social Sciences) was used to process data, and produce descriptive and inferential statistics.

3.Results

In this section, following the presentation, analysis, and discussion of the results, we will examine the findings in relation to the research questions posed at the beginning of this study.

Presentation, analysis, and discussion of the results.

Presentation and analysis of the results of the pre- and post-tests for the two research samples.

1-Presentation and analysis of the results of the Vertical Jump Test from a standstill.

Table 1: Shows the results of the pre- and post-tests for the two research samples on the **Vertical Jump Test** from a standstill.

Table No. 01: Shows the results of the pre- and post-test for the two research samples in the Vertical Jump Test from stability

Statistical Scales / Samples	N-Sample Size	Pre-test		Post-test		Calculated T-value	Tabulated T-value	Significance Level
		$\bar{x}1$	$\sigma 1$	$\bar{x}2$	$\sigma 2$			
Check sample	10	33,40	0,84	34,20	1,22	2.22	2.26	N.Significant
Experiment sample	10	33,70	0,94	35,60	0,96	5.46		Significant

The table comparing the pre- and post-test results for the Vertical Jump Test indicates that the control group's calculated *t*-value was 2.22, which is lower than the critical *t*-value of 2.26 at the 0.05 significance level with 9 degrees of freedom. This result suggests that the difference between the pre- and post-test scores in the control group is not statistically significant. In contrast, the experimental group recorded a calculated *t*-value of 5.46 under the same conditions, which exceeds the critical *t*-value of 2.26. This indicates a statistically significant difference between the pre- and post-test means. These findings, which favor the experimental group, demonstrate that plyometric exercises performed on beach sand had a positive effect on improving the muscular endurance of soccer players under the age of 21.

2-Presentation and analysis of the results of the Test relaxation jump. from a standstill

Table 2: Shows the results of the pre- and post-tests for the two research samples in the standing **Test relaxation jump**.

Statistical Scales Samples	N-Sample Size	Pre-test		Post-test		Calculated T-value	Tabulated T-value	Significance Level
		x̄1	σ1	x̄2	σ2			
Check sample	10	31,10	1,19	31,60	0,96	1,62	2.26	N.Significant
Experiment sample	10	31,20	1,22	32,60	0,96	4,58		Significant

The table comparing the pre- and post-test results for the relaxation jump test shows that the calculated *t*-value for the control group was 1.62, which is lower than the critical *t*-value of 2.26 at the 0.05 significance level with 9 degrees of freedom. This indicates that the difference between the pre- and post-test scores for the control group is not statistically significant. As for the experimental group, the results showed that the calculated *t*-value was 4.58 at a significance level of 0.05 with 9 degrees of freedom. This value exceeds the critical *t*-value of 2.26, indicating a statistically significant difference between the pre- and post-test means. These findings suggest that the plyometric exercises performed on beach sand had a positive effect on improving the muscular endurance of soccer players under the age of 21.

3-Presentation and analysis of the results of the Demi Squat Test **from a standstill**

Table 2: Shows the results of the pre- and post-tests for the two research samples in the standing Demi Squat Test

Statistical Scales Samples	N-Sample Size	Pre-test		Post-test		Calculated T-value	Tabulated T-value	Significance Level
		x̄1	σ1	x̄2	σ2			
Check sample	10	2025,10	1,10	2025,75	0,63	2,17	2.26	N.Significant
Experiment sample	10	2025,20	0,78	2026,60	0,69	6,32		Significant

The table comparing the pre- and post-test results for the Demi Squat Test shows that the control group's calculated *t*-value was 2.17, which is lower

than the critical *t*-value of 2.26 at the 0.05 significance level with 9 degrees of freedom. This indicates that the difference between the pre- and post-test means in the control group is not statistically significant. In contrast, the experimental group recorded a calculated *t*-value of 6.32, which exceeds the critical *t*-value of 2.26 under the same significance level and degrees of freedom. This result demonstrates a statistically significant improvement in the experimental group's performance. These findings suggest that plyometric training on beach sand had a positive effect on developing muscular endurance in soccer players under the age of 21.

Presentation and analysis of the results of the post-tests for the two research samples

Table No. 03: Shows the statistical results and t-values in the post-tests.

Statistical Scales / Tests	Control Group		Experimental Group		Calculated T-value	Tabular T-value	Significance Level
Test power jumping	34,20	1,22	35,60	0,96	2,83	2.10	Significant
Test relaxation jump	31,60	0,96	32,60	0,96	2,31		
Demi Squat Test	2025,75	0,63	2026,60	0,69	2,84		

The comparison of post-test results between the control and experimental groups in the Power Jumping Test, Relaxation Jump Test, and Demi Squat Test revealed calculated *t*-values of 2.83, 2.31, and 2.84, respectively. Each of these values exceeds the critical *t*-value of 2.10 at the 0.05 significance level with 9 degrees of freedom, indicating statistically significant differences between the two groups in all three tests.

These results confirm that the observed improvements in the experimental group are statistically significant, demonstrating that plyometric training on beach sand had a positive effect on developing and enhancing the muscular capacity of soccer players under the age of 21 when compared to those in the control group.

4.Discussion

The researchers analyzed and discussed the raw data obtained from the tests and compared the results with the research hypothesis. It was hypothesized that there would be statistically significant differences between the experimental and control groups in muscular strength tests, favoring the experimental group. After conducting statistical analyses, the results confirmed this hypothesis. Statistically significant improvements were observed in the experimental group across all three tests: the Power Jumping Test, the Relaxation Jump Test, and the Demi Squat Test. This was evidenced by the calculated *t*-values exceeding the critical *t*-value at a 0.05 significance level with 9 degrees of freedom in the post-test phase.

The researchers attribute these positive outcomes to the effectiveness of plyometric training performed on sea sand. The results of this study underscore the importance of muscular endurance in soccer, which contributes to enhanced performance in key areas such as sprinting, jumping, powerful shooting, ball control, and overall physical resilience during a match.

These findings are supported by previous research. For example, Kuchuk Seyed Ahmed (2011) concluded that weight training combined with plyometric exercises led to improvements in explosive power, speed-strength, and shooting performance in young soccer players. Similarly, Daraji Abbas and Mazari Fateh (2020) found that improving muscular endurance through enhanced explosive power and speed-strength contributed significantly to the development of maximum aerobic speed. These results highlight the multifaceted benefits of plyometric training.

Additionally, Muhammad Ahmad Ruwaini (2020) emphasized the importance of developing explosive lower-body strength in soccer. His study demonstrated that ballistic exercises integrated into scientifically programmed plyometric training routines can significantly enhance explosive strength, particularly when variables such as intensity, volume, rest intervals, and repetitions are carefully managed.

Based on the results of the current study, and in alignment with the findings of previous research, the researchers conclude that plyometric training on sea sand has a significant positive effect on developing muscular endurance in soccer players under the age of 21.

5.Conclusion

Plyometric training is a widely used method in modern football, through which we can develop the neuromuscular system's ability to generate maximum force in the shortest possible time. Plyometric exercises are characterized by high speed, short duration, and maximum effort. Furthermore, plyometric training on sand is also an effective strategy, taking into account the principles and time of adaptation. It has also been proven that sprinting and jumping are the two movements of soccer players that often lead to goal-scoring situations. In this study, we confirmed that plyometric training on sand increases the height of the vertical and broad jump, thus developing the muscular endurance of soccer players. Based on this study and a review of related research, the researchers sought to highlight the role and impact of plyometric training on sand in developing the muscular endurance of soccer players. We confirm that plyometric training on sand, well-organized according to well-scientific principles, improves the physical performance of soccer players, with improvements and development in explosive lower extremity strength, particularly in terms of leg strength and sprinting speed (muscular endurance). Therefore, training according to plyometric exercises and using them on sand is essential for improving performance and is one of the strategies in the stages of physical preparation that many working in the field of sports training and physical preparation in particular may overlook.

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