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The Effect of Boot Camp Training Program on the Development of Special Strength and Some Biomechanical Indicators of the Triple Jump in Young Female Athletes

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ORIGINAL STUDY

The Effect of Boot Camp Training Program on the Development of Special Strength and Some Biomechanical Indicators of the Triple Jump in Young Female Athletes

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Abstract

The qualitative concept of training experienced athletes is not limited to strength training alone, but extends to general physical conditioning and, ultimately, to special strength training during the specific phases of athletic preparation, depending on the type of sport practiced. Since athletic training should not follow a single, monotonous pattern, the researchers adopted modern Boot camp exercises to develop special strength and biomechanical variables for female triple jump athletes. The study aimed to design Boot camp exercises specifically to enhance special strength and certain biomechanical indicators in young female triple jump athletes, and to identify the impact of these exercises on their performance. The researchers hypothesized that there would be statistically significant differences between the pre- and post-tests. The study sample consisted of five young female triple jump athletes. Tests were conducted at the track and field stadium of the College of Physical Education and Sports Sciences – University of Baghdad. The researchers concluded that Boot camp exercises had a positive impact on the development of special strength and contributed to improving some biomechanical variables in the triple jump among young female athletes. They recommended utilizing detailed motion analysis and biomechanical variables to correct technical errors and enhance athletes' performance. and this achieves one of the sustainable development goals of the United Nations in Iraq which is (Quality Education)

Keywords: Boot camp exercises, Triple jump, Special strength, Biomechanical indicators, Young female athletes

1. Introduction

Significant theoretical and practical advancements have been made in the field of sports training science. Scientific research and field experiments have contributed to the development of modern training methods and techniques that help improve athletes' performance, in accordance with sports training theories and practical applications. To understand the intricacies of movement and achieve optimal performance, it is essential to leverage various sports sciences, including biomechanics, which plays a crucial role in enhancing and improving technical and numerical performance across all sporting events—particularly in the triple jump, which requires a precise balance between muscular strength and mechanical efficiency (Ali, 1998).

Undoubtedly, the training process is one of the fundamental pillars for enhancing physical and motor performance across different sports. It plays a vital role in developing and integrating technical performance. Reaching elite levels is of great importance to sports coaches (Abdel Fattah, 2000). Track and field events, including the triple jump, have seen significant progress in motor performance, which necessitates the adoption of training methods grounded in modern scientific principles.

The core idea in training athletes lies not only in strength training but also in developing general physical attributes and ultimately special strength

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training, based on the different phases of training and the type of sport. In this context, special exercises occupy a middle ground between general strength exercises and competition-specific exercises. These exercises serve a dual purpose: they create specific physiological adaptations and act as a stimulus to transfer the benefits of Boot camp training into improved performance levels.

1.1. Research Problem

Training aimed at developing strength and certain biomechanical variables in female triple jump athletes requires achieving muscular balance at the joint level. Coordination between agonist and antagonist muscle groups enhances movement speed and helps maintain muscular balance.

Strength development is a fundamental requirement that enables muscles to generate maximum force throughout the full range of motion and at the highest possible speed.

There are numerous methods for training athletes, designed to avoid monotony and randomness by employing structured and scientifically based strategies. Among these is Boot camp training, a modern high-intensity method particularly effective for developing special strength. However, being a relatively new approach, few studies have examined its effect on improving special strength associated with triple jump performance and on related biomechanical indicators. Moreover, most traditional training programs focus on general strength development without directly linking it to the specific technical and motor demands of this event.

For these reasons, the researchers chose to adopt Boot camp exercises to assess their effectiveness in enhancing special strength in female triple jump athletes. Thus, the research problem is reflected in the following question:

> *Do modern Boot camp exercises have a positive and effective impact on the development of special strength and certain biomechanical indicators related to triple jump performance in young female athletes?*

1.2. Significance of the Study

Boot camp exercises are considered highly effective in targeting and strengthening the body's core muscles. They are among the best trunk exercises impacting the spine and contribute to improving body balance, posture, and stability, which in turn enhances athletes' physical performance. The significance of this study lies in its potential to demonstrate measurable changes and differences between pre- and post-tests through the use of targeted exercises aimed at improving special strength, biomechanical indicators, and the triple jump performance of young female athletes.

1.3. Research Objectives

The research aims to:

- Design Boot camp exercises specifically to develop special strength and certain biomechanical indicators for young female triple jump athletes.
- Identify the effect of Boot camp exercises on the development of special strength and some biomechanical indicators in young female triple jump athletes.

1.4. Research Hypotheses

- There are statistically significant differences between the pre-test and post-test in the development of special strength among young female triple jump athletes.
- There are statistically significant differences between the pre-test and post-test in the development of certain biomechanical indicators among young female triple jump athletes.

1.5. Research Scope

- **Human Scope**: A sample of five junior female athletes specialising in the triple jump.
- **Time Scope**: From October 15, 2023, to December 17, 2023.
- **Spatial Scope**: The track and field courts at the College of Physical Education and Sports Sciences, University of Baghdad.

2. Research Procedures:

2.1. Research Methodology

The researchers used the experimental method, as it is suitable for the nature of the research problem. This approach involves introducing a specific variable or characteristic that may alter the condition or state of the subject under investigation (Abdal Karriem & Salih, 2019).

2.2. Research Sample

The research sample was intentionally selected from junior female triple jump athletes, totaling five participants who were actively training during

Table 1. Normal distribution of the research sample in the variables of height, weight, age, and training age.

Seq.	Variables	Measurement Unit	Arithmetic Mean	Median	Standard deviation	Skewness Coefficient
1	Height	Cm	32.165	165	18. 93	451.0
2	Weight	Kg	78.62	63	8. 52	383.0
3	Age	Year	05.17	17	04.3	621.0
4	Training Age	year	21.3	3	1.08	793.0

the 2023–2024 training season. An agreement was reached with the coach to implement Boot Camp exercises with the research sample during the main part of the training session in the specific preparation phase. A duration of 25 minutes from each training session was allocated to carry out these exercises. The researchers also conducted a homogeneity check for the sample members in the variables of height, weight, age, and training age, as presented in Table 1.

The values of skewness for all variables fall within acceptable limits for a normal distribution, which indicates that the sample was homogeneous. This level of homogeneity is essential to ensure that any observed effects in the study can be attributed to the training intervention rather than pre-existing differences among participants.

Tools, Means, and Equipment used in the Research

- Arabic and foreign references
- The international Internet network
- Office supplies
- Testing and measurement
- Observation and experimentation
- KINOVEA motion analysis software
- A Sony video camera (60 frames/second)
- Computer device
- Measuring tape
- Medical scale
- Five weights

2.3. Research Tests

- **Explosive leg strength test**

Test name: Standing long jump.
Test objective: To measure the explosive strength of the legs.
Performance description: The participant stands on the line and, upon receiving the signal, jumps from a standing position as far as possible.
Scoring: The distance jumped is measured from the starting line to the farthest point reached, in cm/m.

- **Motion analysis program used to extract the biomechanical indicators specific to the research as follows:**

The researchers used the motion analysis program (KINOVEA), where the video data was transferred from the camera to the computer and processed by extracting the biomechanical variables for each athlete. These are as follows:

1. Biomechanical tests specific to the research include:
   – Trunk inclination angle
   – Height of the body's center of gravity at the moment of flight
   – Body movement momentum
   – Knee angle of the front leg at the moment of take-off

2.4. Pilot Study

The researchers conducted the pilot study on 15/10/2023 on (2) female triple jump athletes who were not excluded from the main study. The aim of the pilot study was to understand the testing process, control the training units, camera positioning, and filming method.

2.5. Pre-tests

The researchers conducted the pre-tests on the research sample on 17/10/2023 at the athletics field of the College of Physical Education and Sport Sciences – University of Baghdad, at exactly 3:00 p.m.

2.6. Main experiment

The researchers conducted the main experiment on the study sample after consulting experts in the preparation of a set of exercises aimed at developing specific strength and biomechanical indicators, based on the Boot Camp system, as shown in Appendix (1). These exercises were applied to the sample with careful control of repetitions, intensity, and rest periods during the training sessions. The implementation procedures were as follows:

- The main experiment was conducted during the special preparation phase.
- The researchers applied the exercises to the sample in the main part of the training unit, with the full training session lasting 90 minutes.

- The duration of the exercise application was (25 minutes) from the main part.
- The researchers adopted high-intensity interval training.
- Gradual increase in repetitions to reach maximum repetition.
- Control of rest times with repetitions.
- The duration of the program was 8 weeks, with 3 training sessions per week, totaling 24 training sessions.

2.7. Post-tests

The post-tests were conducted on December 17, 2023, at 3:00 p.m. on the track and field stadium at Al-Shaab Stadium, under the same conditions in which the pre-tests were administered, and with the same members of the research sample.

3. Statistical Methods

The researchers used the SPSS statistical method for data analysis in the research.

4. Results

The results in Tables 2 and 3 showed significant differences between the pre-test and post-test for both strength tests and biomechanical variables, as well as performance. The T value was 3.119, with a significance level of 0.026. The mean increased from 12.2 to 34.3, indicating a significant improvement in the explosive strength of the legs. Additionally, there was a noticeable improvement in the biomechanical variables, such as the increase in the center of mass during flight from 0.37 to 0.58, with a T value of 8.8 and a significance level of 0.003. Furthermore, there was improvement in the body momentum, which increased from 0.57 to 0.77, with a T value of 9.71 and a significance level of 0.002. However, the results indicated no significant differences in certain variables, such as the trunk tilt angle and the knee angle during takeoff.

5. Discussion

The results confirmed the effectiveness of the Boot camp exercises developed by the researchers in enhancing specific strength, balance, and posture in the athletes, as well as improving some biomechanical variables and performance. The Boot camp exercises targeted the core muscles, especially in the pelvis, hips, and lower back regions. These areas are critical for achieving stability and dynamic balance during movement performance, which positively affected the performance in the triple jump. Furthermore, the results showed a clear improvement in the muscular strength indicators of the sample after the application of the exercises. This improvement can be attributed to the intensive and varied nature of the Boot camp exercises, which rely on high repetitions and progressive loading, stimulating physiological adaptations such as increased rapid muscle contraction capacity. According to Hassan (1987), special strength exercises lead to improvements in explosive strength and increased force production rates, which are crucial in events like jumping, requiring maximum force output

Table 2. Shows the means, standard deviations, calculated t-value, error level, and significance of the differences for the strength variable in the research sample.

			Pre test		Post Test				
Seq	Variables	Measurement Unit	Arithmetic Mean	Standard Deviation	Arithmetic Mean	Standard Deviation	Calculated T Value	Error Level	Significance Differences
1	Leg Explosive Force	cm	12.2	0.79	34.3	0.88	3.119	0.026	Sig

Table 3. Shows the means, standard deviations, calculated t-value, and their significance for the biomechanical tests of the research sample.

			Pre test		Post Test				
Seq	Variables	Measurement Unit	Arithmetic Mean	Standard Deviation	Arithmetic Mean	Standard Deviation	T Value	Significance Level	Statistical Significance
1	Torso inclination angle"	Degree	0.88	0.083	0.93	0.08	1.000	0.39	Not significant
2	The height of the center of gravity of the body at the moment of flight	Mean / SD	0.37	0.04	0.58	0.05	8.8	0.003	significant
3	Body momentum	Kg/m/s	0.57	0.101	0.77	0.12	9.71	0.002	significant
4	The knee angle of the front leg at the moment of getting up	Degree	0.83	0.18	0.95	0.06	1.35	0.26	Not significant

in the shortest time possible. Moreover, strengthening the muscles in the hips, pelvis, and lower back contributes to improving movement balance during the phases of the triple jump, thereby reducing energy loss during performance.

This aligns with the findings of Salman and Abdul-Ameer (2021), who reported that intensive and continuous training improves neuromuscular coordination and enhances the nervous system's ability to coordinate muscle contractions quickly and effectively.

Additionally, the results showed significant differences in biomechanical variables such as the trunk tilt angle, knee angle, and body momentum. These improvements can be attributed to the focus of Boot camp exercises on reshaping movement patterns and achieving optimal angles during the triple jump phases. According to Ghafouri and Issa (2016), speed depends on movement performance efficiency and fluidity, with correct angles reducing energy loss. Enhanced performance is linked to the development of these biomechanical variables and improved movement coordination. Body momentum, achieved through enhanced push-off power from the ground, is crucial for achieving higher flight during the airborne phase. Moreover, the applied exercises improved knee angle at takeoff, contributing to increased joint flexibility during the takeoff moment. This is in line with the findings of Elalem et al. (2024), who emphasized that improving coordination between working and opposing muscles contributes to enhanced body momentum and energy conservation, explaining the observed performance improvements.

Increasing explosive strength and improving joint angles lead to increased jump distance by improving the takeoff phase and achieving a more efficient flight path. Athletes' ability to achieve optimal angles reduces ground contact time and enhances vertical push-off effectiveness. As noted by Al Fadhli et al. (2019), Boot camp exercises improve muscular strength and movement variables, thus enhancing athletic performance. These findings also align with Abdul Hussein et al. (2024), who suggested that knee angle and center of mass height directly affect performance by improving push-off force and energy transfer efficiency.

6. Conclusions

Based on the findings, the researchers concluded the following:

1. Boot camp exercises have a positive and effective impact on enhancing specific strength, particularly explosive leg strength, as they strengthen the muscles utilized in the body.
2. The researchers applied Boot camp exercises in the main experiment, and significant differences were observed in biomechanical tests, such as angular momentum and knee angle.
3. Boot camp exercises contributed to the development of neuromuscular adaptation and movement pattern refinement.

7. Recommendations

In light of the conclusions, the following recommendations are made:

1. The possibility of using Boot camp exercises in other athletics events.
2. The importance of utilizing movement analysis and precise biomechanical variables to correct technical errors for athletes to achieve better performance.
3. Conduct studies with larger samples and compare their results with studies using different analysis techniques.

Author's declaration

Conflicts of interest

None

We confirm that all tables and figures in this article are ours and written by the researchers themselves.

Author's contributions

All contributions of this study were done by the researchers

1. Professor Dr. Suad Abdul Hussein completed the main experiment, ensuring proper repetition of exercises, rest periods, and conducting pre- and post-tests for the sample group.
2. Assistant Professor Dr. Zainab Ali Abdul Ameer analyzed the statistical data of the pre- and post-tests, discussed the significant differences within the sample group, and analyzed the conclusions leading to the most important recommendations.

who get the main idea and work on writing and concluding also with number of experts, Conducted by Professor Dr. Mahmoud Mousa Hussein,Workplace: Imam Ja'far al-Sadiq University (peace be upon him), Faculty of Physical Education and Sports Science in Statistics,

Asst. Prof. Dr. Dhiffaf Al-Shwillay in revision, Nibal Ahmed in translating.

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Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Appendix (1): The Exercises Presented

1. **Top Tap Exercise:**
   Lie on the ground while ensuring your feet are raised and your knees are bent at a 90° angle. Place your hands beside your body. Lower each foot until it reaches the ground, then raise it again.
2. **Mountain Climbers Exercise:**
   Start in a regular plank position, engaging your core muscles. Lift your left knee to your chest, hold it briefly, and then lift your right knee to your chest.
3. **Abdominal Crunches:**
   Lie on your back with your knees bent, placing your hands behind your head. Exhale while slowly twisting your torso towards your thighs, lifting the upper part of your back off the ground.
4. **Plank Exercise:**
   Begin in a prone position on all fours with your hands under your shoulders and knees under your hips. Extend your legs, keeping your feet hip-width apart. Engage your core and hold the position for 10-30 seconds.
5. **Crunch Exercise:**
   Lie on your back, bend your knees, and keep your feet flat on the floor at hip-width. Keep your head and spine aligned, then cross your arms over your chest.
6. **Leg Pull-In (Seated):**
   Sit on a chair and pull your legs toward your chest, then push them forward.
7. **Side Plank on Chair:**
   Start in a side plank position on the chair, raise and lower your body to a moderate level for 20 seconds, then switch sides.
8. **Leg Lifts from Seated Position:**
   Sit on the floor and raise your legs to chest level. Then pull your legs toward the right and left, extending them forward.
9. **Leg Lifts with Chair Support:**
   Lie on the floor while holding onto the legs of a chair. Raise your legs up and lower them back down.
10. **Leg Holds:**
    Lie on your back and raise your legs to body height, keeping them elevated above the ground and holding the position.