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RESEARCH ARTICLE

The Effects of Plyometric Training on Speed, Strength, and Endurance in Junior Futsal Athletes: A Quasi-Experimental Study

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ABSTRACT

Speed, endurance, and strength are three essential components in futsal performance that must be trained repeatedly in a structured and systematic manner, in addition to technical and tactical training. The purpose of this study was to examine whether plyometric training has an effect on the physical condition of junior futsal athletes, specifically in terms of speed, strength, and endurance. This study employed a quantitative method using a quasi-experimental approach. The research subjects consisted of 40 junior futsal athletes from four clubs. The research design applied was a one-group pre-test and post-test design. Data collection techniques included observation, interviews, and documentation. Data analysis was conducted using SPSS software version 25. The results indicate that plyometric training significantly improves the physical condition of junior futsal athletes (speed, endurance, and strength), as evidenced by the research-based data analysis. Therefore, it can be concluded that plyometric training has a positive impact on junior futsal athletes.

KEYWORDS

Junior athletes; endurance; speed; strength; Futsal

1. Introduction

Since modern and traditional sports are physical activities that engage the entire body and play a crucial role in maintaining and improving overall health (Evans, 2014; Nikas & Poulaki, 2021). Insufficient engagement in regular physical activity is recognized as a major contributing factor to various health problems, including obesity, fatigue, sleep disturbances, joint stiffness, and declining physical fitness (Son et al., 2020). In the modern era, sport is no longer viewed solely as a means of

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achieving physical fitness and health; rather, it is understood within three fundamental pillars: sport for education, sport for achievement, and sport for recreation (Adeyemo, 2022; Decker, 2017; Sharma & Hussain, 2019). These three pillars form the foundation of contemporary sport development (Fricke et al., 2018).

Regardless of the type of sport, performance is inseparable from biomotor components such as speed, strength, flexibility, coordination, endurance, and balance. Flexibility, for example, refers to an athlete's ability to move body segments through a full range of motion, thereby reducing the risk of injury, particularly in dominant joints (Wali et al., 2023). In futsal specifically, essential biomotor components include agility, speed, flexibility, balance, strength, and endurance, all of which are integral to game performance (Wali et al., 2023).

Futsal was pioneered by Juan Carlos Ceriani following the 1930 World Cup in Uruguay (Estriana Fiwka, 2017). Although futsal resembles football in certain aspects—such as the presence of a goalkeeper who is permitted to handle the ball and the use of similar basic techniques—it differs significantly in match duration, number of players, field size, and its predominantly indoor setting (Windiartha, 2019). The term "futsal" originates from the Portuguese *futebol de salão* and the Spanish *fútbol sala*, which were later internationally adapted as futsal. The game is played by two teams, each consisting of five main players (Herdi Apria, 2020).

Futsal is characterized as a fast and dynamic sport with relatively short match durations and limited playing space. Consequently, players require high levels of speed, agility, accuracy, and endurance to maintain team performance stability (Nugraha & Hidayah, 2019). Although ten general components of physical fitness apply across most sports, including futsal (Lukács, 2020), the dominant biomotor components in futsal are speed, endurance, and strength. These three elements are often referred to as the "golden triangle" of futsal performance (Aguss & Yuliandra, 2021; Corrêa et al., 2016). Other biomotor components serve as complementary elements depending on individual athlete needs (Agras et al., 2016).

Given the importance of speed, strength, and endurance in futsal, these components must be systematically and periodically trained using appropriate methods, such as throwing and catching drills, lunges, squat jumps, and plyometric exercises (Nouchi et al., 2016; Takeuchi & Kawashima, 2012). Inappropriate training methods may negatively affect technical development (Lengo et al., 2023). Plyometric training consists of rapid and forceful movements involving eccentric and concentric muscle contractions. This type of training stimulates muscle elasticity and

proprioceptive responses, enabling athletes to generate maximal force within a short period (Kritikos et al., 2021). According to Bompa (1994), plyometric training can be categorized into low- and high-intensity forms. The effectiveness of plyometric training largely depends on proper training periodization, including careful consideration of frequency, volume, and intensity (Christou & O'Driscoll, 2020; Richens & Cleather, 2014). A well-designed training program contributes significantly to optimal physical performance during competition.

Preliminary observations conducted at four junior futsal clubs—Tifosi, Pinobola, Phantom, and BL FC—revealed that training sessions predominantly focused on technical and tactical aspects of futsal, while the development of core biomotor components received less emphasis. This imbalance was reflected in the relatively low levels of speed, strength, and endurance among junior athletes. Many players experienced rapid fatigue during training and competition, indicating insufficient endurance conditioning. Training methods were largely limited to zigzag running through cones and straight-line running drills. Interviews with four head coaches and eight assistant coaches confirmed that speed, strength, and endurance represent significant challenges for their athletes, whereas technical skills such as dribbling, passing, shooting accuracy, and agility were considered satisfactory. Moreover, plyometric training was rarely implemented; only one club (Tifosi FC) reported regularly using plyometric exercises. Another challenge identified was the limited training discipline among junior athletes, who remained highly engaged in recreational activities, thereby affecting training intensity and focus.

The principles of plyometric training are highly suitable for improving physical components relevant to futsal. This method emphasizes rapid muscle contractions through both shortening and lengthening phases to produce explosive force in minimal time (Nikolic, 2018). Therefore, its application in junior futsal training programs is expected to enhance speed, endurance, and strength—key performance determinants in futsal (Hamzah et al., 2020). Previous studies have demonstrated the positive effects of plyometric training on physical performance. Jidovtseff et al. (2014) reported improvements in agility and power among futsal athletes following plyometric interventions. Similarly, Antoanela et al. (2018) found positive effects on physical performance among 14–16-year-old football players, while Ozrudi et al. (2015) emphasized the widespread use of plyometric methods in team sports to enhance endurance, speed, power, and agility.

Plyometric-based training programs applied to junior athletes are therefore expected to improve key physical performance components, particularly speed, endurance, and strength. This study holds practical significance for coaching practices, especially in team sports, by highlighting the importance of systematically integrating plyometric training into junior futsal programs. Accordingly, this study aims to determine whether plyometric training—specifically depth jump sprint and box jump exercises—significantly affects speed, endurance, and strength in junior futsal athletes.

2. Research Methods

This study used a quasi-experimental research design, as it was conducted without a comparison group (Emylina, 2019). The design of this study was a one-group pre-test and post-test design. The population in this study consisted of 40 junior futsal athletes from four junior clubs in Aceh, specifically in Bireuen Regency. All members of the population were used as subjects in this study. Data collection in this study was carried out through observation, documentation, and interviews. The instrument used in this study was a test. Data analysis in this study was conducted using SPSS software version 25.

3. Results and Discussion

In This study aimed to determine whether plyometric-based training affects the improvement of physical component abilities of junior futsal athletes from Tifosi, Pinobola, Phantom, and BL FC clubs who agreed to become subjects in this study. The research results are presented as follows:

a. Speed

Table 1. Results of speed test analysis

Group	Pre-test	Posttest	Mean Group	Sig	ANOVA Test
Depth jump sprint	2.20/0.04	1.81/ 0.07	0.30	0.04 2	0.420
Box jump	2.19/0.06	1.88/ 0.17	0.29	0.02 4	

Based on the results presented in Table 1, the mean scores of both training methods showed differences between the pre-test and post-test. The significance

value for the depth jump sprint method was 0.042, while the box jump method yielded a significance value of 0.024. These results indicate that the subjects experienced improvement after receiving the intervention. The significant values confirm that plyometric training (depth jump sprint and box jump) had a statistically significant effect on the speed component of junior futsal athletes. Furthermore, the comparison using the ANOVA test between the two methods produced a value of 0.420.

b. Durability

Table 2. Results of the Endurance test analysis

Group	Pre-test	Posttest	Mean Group	Sig	ANOVA Test
Depth jump sprint	2.14/0.16	2.39/ 0.16	.0.23	0.005	0.006
Box jump	2. 13/0.13	2.36/ 0.18	.0.19	0.011	1

Based on Table 2, the mean scores of both training methods differed between the pre-test and post-test. The significance value for depth jump sprint was 0.005, while for box jump it was 0.011. These findings indicate that the subjects improved after the intervention. The significant values confirm that plyometric training (depth jump sprint and box jump) had a statistically significant effect on the endurance component of junior futsal athletes. Additionally, the ANOVA comparison between the two training methods resulted in a value of 0.061.

c. Strength

Table 3. Results of the Strength Test Analysis

Group	Pre-test	Post-test	Mean Group	Sig	ANOVA Test
Depth jump sprint	10.41	11.50	2.01	0.01	0.011
Box jump	8.02	11.10	1.30	0.001	

Based on the results in Table 3 above, it can be described that the mean values of both training methods show differences between the pre-test and post-test. The significance value of the depth jump sprint was 0.01 and the value of the box jump was 0.001. The subjects in this study experienced improvement after being given the treatment. There are significant values confirming whether or not there is an effect of the plyometric training method on the strength component. It was found that

plyometric training (depth jump sprint and box jump) affects the strength component of junior futsal athletes. In addition, the comparison calculation using the ANOVA test for the two training methods was 0.011.

Based on the data analysis above, it shows that plyometric-based training (depth jump sprint and box jump) affects the improvement of biomotor abilities, namely speed, strength, and endurance in junior futsal athletes. This is supported by the improvement in the ability of junior futsal athletes who did not quickly experience a decline in stamina, increased speed, were not easily pushed away during duels with opponents, and whose performance also improved during matches.

The changes that occurred in junior athletes were due to the application of training methods when training the biomotor components of junior futsal athletes, especially speed, endurance, and strength. The method used was in accordance with training principles for the purpose of training speed, strength, and endurance. In line with the statement of Bedoya et al. (2015), plyometric training methods carried out repeatedly and consistently affect biomotor performance, including speed, endurance, agility, and strength in youth football athletes. Furthermore, Perikles et al. (2016) explained that the correct and proper training process brings a significant positive impact on improving the quality of athletes' abilities in various elements needed in futsal games, especially in terms of biomotor abilities.

The influence most felt by junior futsal athletes during plyometric training was the emergence of seriousness and high awareness of the important role of speed, strength, and endurance in a match. If the quality of these three elements is not good, it will have a negative impact both individually and on the team (Spyrou et al., 2020). Therefore, the role of a coach in determining appropriate training methods and preparing training programs for junior athletes must be precise, effective, fast, and efficient (Axel et al., 2018; Rylova et al., 2021).

Depth jump sprint and box jump exercises, which are two plyometric training methods, showed significant improvement in the ability of junior futsal athletes. These two methods focus on three elements that are very important for futsal players, both professional and amateur, namely speed, strength, and agility (Fräczek et al., 2019; Irawan & Fitranto, 2020). A futsal player is not only required to master basic techniques and tactics in the game, but must also be supported by good and qualified physical condition so as to be able to collaborate other elements to achieve maximum results individually and as a team (Matjan, 2009; Moura et al., 2018).

The depth jump sprint and box jump training methods used in this study required junior athletes to perform each movement session based on the instructions of a coach, so that athletes performed movements actively and moved away from irregular and inactive training habits. Plyometric-based training patterns provided a different atmosphere felt by junior futsal athletes, for example obstacle running patterns and rope jumping to train speed, agility, and strength (Sasmita, 2015; Syahputra et al., 2021). These two methods are often used by coaches during training sessions but quickly cause boredom and early fatigue in junior athletes, resulting in less optimal outcomes (Hidayat et al., 2021). Therefore, plyometric training has a good impact on training speed, strength, and endurance in junior futsal athletes. This is in accordance with the opinion of Purnami & Purnomo (2019) that coaches must properly provide plyometric training methods to athletes to train important elements in a game, which will have a significant impact on improving athletes' physical abilities.

The results of this study are supported by other studies, such as Anwar et al. (2020), who stated that plyometric-based training has a major effect on improving the physical component abilities of futsal athletes. Furthermore, Cepeda et al. (2020) emphasized that plyometric training should be frequently used and applied to both amateur and professional athletes with training portions adjusted to their abilities. Meanwhile, Saryono et al. (2019) argued that plyometric training not only improves physical elements but can also improve an athlete's thinking ability, in this case the cognitive aspect.

Based on the results of previous studies, the researcher is of the opinion that the provision of plyometric training methods to junior athletes has a positive impact with significant improvement in biomotor component abilities, namely the three important elements in futsal games: speed, endurance, and strength of junior futsal athletes. This study has slight differences from previous research (Eraslan et al., 2021). The researcher found new results related to improving the quality of speed, endurance, and strength in junior futsal athletes after training using plyometric methods. Considering that there are many plyometric training methods in sports, especially in coaching, the selection depends on the needs desired when choosing the method.

This study is not perfect, considering the dynamic nature of science. The research sample, time, place, and biomotor components measured are some of the limitations of this study. The researcher hopes that other researchers can continue

this study more broadly in future research. This study contributes to futsal coaches, especially in preparing and implementing various training programs to improve physical abilities, particularly speed, strength, and endurance of athletes.

4. Conclusion

The results of this study indicate that the implementation of plyometric training methods (depth jump sprint and box jump) significantly improves the physical fitness components of junior futsal athletes, particularly speed, endurance, and strength. Consistent and structured training programs designed and implemented by coaches play a crucial role in enhancing athletes' physical quality. These improvements are essential during competitive matches, where speed, strength, and endurance represent key determinants of performance. In improving physical fitness among futsal athletes, the coach's role is fundamental, not only in selecting appropriate training methods but also in systematically implementing structured training programs. Overall, the findings suggest that while junior futsal coaches have performed their roles effectively, the use of specific and structured plyometric training programs remains limited. Greater integration of such methods could further enhance the physical performance of junior futsal athletes.

Conflict of interest

The author declares that they have no conflict of interest.

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