Effect of Plyometric Exercises on Speed Endurance and Vo2max in Basketball Players. A Pilot Study

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***Abstract:*-Background:** The purpose of this research was to investigate the effects of plyometric exercise on the athletic abilities of adolescent male athletes. Plyometric training involves high-intensity exercises that focus on explosive movements to enhance power, speed, and overall athletic abilities. The goal of the study was to determine whether or not plyometric training improved several performance indicators by comparing the results of the intervention group (Group A) to those of a control group (Group B).

Materials & Methods: Two groups of young male and female athletes participated in the study (Group A and Group B). Group A had the plyometric training, while Group B was the control group. The Twelve-Minute Run Test, maximal oxygen consumption, and other measures were used to assess physical performance before and after the intervention. To determine the significance of the differences between the two datasets, statistical tests were conducted.

Results: The results indicated significant improvements in physical performance in Group A after the plyometric training intervention. Group A showed higher speed, VO2 max values, and better results in the Twelve-Minute Run Test compared to Group B. The athletes' plyometric training improved their explosive power, cardiovascular fitness, and overall performance, as shown by these findings.

Conclusion: Plyometric training was found to be an effective method of increasing physical performance in young male athletes. Incorporating plyometric exercises as part of a comprehensive training program can lead to improvements in speed, VO2 max, and overall athletic abilities. Plyometric training offers valuable benefits for athletes seeking to optimize their performance and gain a competitive edge in their chosen sports.

***Keywords**:* Plyometric training, physical performance, explosive power, speed, VO2 max, cardiovascular fitness, athletic abilities, young male athletes, competitive edge.

1. Introduction

Basketball is a high-intensity sport that calls for a diverse set of physical skills from its athletes.(1). In order to perform at their best, basketball players must possess a high level of athleticism, which requires specialized training methods that target specific aspects of their physical performance. Plyometric training is one such method that has been widely used in basketball to enhance athletic performance(2). Plyometric exercises like jumping, bounding, and hopping help create explosive and rapid muscle contractions.(3). The goal of plyometric training is to improve power, speed, and explosiveness in athletes, by targeting the fast-twitch muscle fibres that are responsible for these attributes. Plyometric training is often used in basketball as a way to improve speed, endurance, and VO2max, which are all critical components of performance in this sport(4,5).

Speed is a critical component of basketball performance, as it allows players to move quickly and change directions on the court(6). In basketball, speed can be defined as the ability to accelerate, decelerate, and change direction rapidly. It is essential for both offensive and defensive play, as it allows players to create and exploit openings in the defence, as well as to close down their opponents(7).

Understanding the value of speed in basketball requires breaking it down into its component parts. These include: Linear speed: This refers to the ability to move quickly in a straight line(8). In basketball, linear speed is important for fast breaks and transitions, as well as for getting to lose balls and rebounds. Lateral speed: This refers to the ability to move quickly from side to side. In basketball, lateral speed is important for defending against opponents and for changing direction while dribbling or shooting. Reactive speed: This is the ability to quickly adapt to changing circumstances, such as when an opponent alters their strategy. Reactive speed is important for both offensive and defensive play, as it allows players to adjust their movements in response to the actions of their opponents(9).

The effects of exercise on speed in basketball have been widely studied, with plyometric training being one of the most effective forms of exercise for improving speed(10). Plyometric exercises such as squat jumps, box jumps, and hurdle jumps have been shown to improve speed in basketball players by targeting the fast-twitch muscle fibers that are responsible for rapid acceleration and deceleration(11). Basketball players can improve their speed and explosiveness through a variety of training methods, not just plyometrics. While sprint training emphasises short, high-intensity sprints to improve linear speed, agility drills try to promote lateral and reactive speed. Resistance training, such as weight lifting, can also improve speed by increasing the power and explosiveness of the muscles(12). Exercise's influence on basketball players' sprinting speed varies widely based on individual characteristics like age, training history, and current fitness level. To avoid injury and get the most out of your workouts, you need to use the right technique and proceed gradually.(13).

Basketball players need to be able to maintain high-intensity motions throughout a game or practise, and this is where endurance comes in.(14). In basketball, endurance can be defined as the ability to maintain a high level of physical and mental effort throughout a game or practice, despite fatigue and physical stress. It is important for both offensive and defensive play, as it allows players to maintain their energy and focus throughout the game, and to perform at a high level in the later stages when the game is on the line(15).

In order to grasp the significance of endurance in basketball, it is necessary to examine the many forms of stamina required for competition. These include(16):Aerobic endurance: Long-term aerobic capacity is the body's capacity to use oxygen for energy production for an extended length of time during physical activity. Running up and down the court, jumping for rebounds, and guarding against opponents all require high levels of aerobic endurance(17). Anaerobic endurance: This is the time span in which the body can perform vigorous activity without oxygen. Anaerobic endurance is crucial in basketball for explosive actions like catching a fast break, jumping for a rebound, or changing direction quickly while dribbling or defending.(18).

The effects of exercise on endurance in basketball players have been widely studied, with cardiovascular exercise being one of the most effective forms of exercise for improving endurance. Basketball players' aerobic and anaerobic endurance can benefit from cardiovascular exercise like running, cycling, and swimming because it strengthens the heart and lungs and improves the body's ability to use oxygen efficiently.(19). Basketball players can improve their endurance by engaging in cardio, interval training, plyometrics, and strength training. Interval training, in which periods of high intensity exercise are interspersed with times of rest or moderate intensity exercise, is an effective way to increase both aerobic and anaerobic endurance. The fast-twitch muscle fibres responsible for explosive actions can be strengthened by plyometric exercise, which can boost endurance.(20). Resistance training can improve endurance by increasing muscle strength and power, allowing players to sustain high-intensity movements for longer periods of time(21).

The maximal oxygen uptake of an athlete's body during exercise is measured by a parameter known as VO2max (22). It's a huge part of basketball and a great gauge of your cardiac fitness and stamina (23). In basketball, a high VO2max is essential for maintaining energy and concentration for the duration of a game, as well as for swiftly regaining your footing between possessions and during timeouts. Both aerobic and anaerobic endurance are important for excelling on the basketball court. Explosive movements like jumping, running, and quick direction changes require anaerobic endurance, while continuous physical activity requires aerobic endurance.

The effects of exercise on VO2max in basketball players have been widely studied, with cardiovascular exercise being one of the most effective forms of exercise for improving VO2max. Cardiovascular exercises, such as running, cycling, and swimming, help basketball players improve their VO2max by strengthening their hearts and lungs and enhancing their body's ability to use oxygen efficiently. Basketball players can enhance their VO2max through aerobic activity and other means, such as interval training, plyometrics, and weight training. Interval training, which involves alternating bouts of high-intensity activity with periods of rest or low-intensity exercise, can increase both aerobic and anaerobic endurance. Plyometric training, as previously mentioned, can also improve VO2max by targeting fast-twitch muscle fibers that are responsible for explosive movements. Resistance training can improve VO2max by increasing muscle strength and power, allowing players to sustain high-intensity movements for longer periods of time. Overall, plyometric training has become a popular method of training in basketball due to its ability to improve key physical attributes such as speed, endurance, and VO2max. Plyometric training can be beneficial, but it's recommended to practise it under the supervision of a qualified coach or trainer due to the potential for significant impact and intensity. In addition, proper technique and exercise progression are essential for avoiding injury and maximising plyometric training's advantages.

In order to encourage coaches and trainers to incorporate plyometric training into their athletes' routines, the study aims to inform them of the positive effects of such training on speed, endurance, and VO2max in basketball players. Coaches and trainers who want to help their athletes perform at their best must have a firm grasp on how plyometric training affects the game-changing physical qualities of basketball players.

2. Objectives

1. Analyze the effect of plyometric training on the quickness of basketball players.
2. Examine the effects of plyometric exercise on the stamina of basketball players.
3. The goal of this study is to ascertain whether or not basketball players' VO2 max (maximum oxygen consumption) increases as a result of plyometric exercise.
4. To analyze the relationship between plyometric training and improvements in basketball performance, including speed, endurance, and VO2 max.
5. To provide valuable insights and recommendations for coaches and athletes regarding the integration of plyometric exercises in basketball training programs to enhance overall performance.

3. Methods

The study conducted was an experimental study, utilizing a pre and post-experimental design. The sample size comprised 80 basketball players selected from various universities, constituting the sample type. The study spanned a consecutive six-week period, with participants attending sessions three days per week.

The study design involved subject assessment for Speed, Endurance, and VO2Max in basketball players, with Group 'A' undergoing Plyometric training and Group 'B' serving as the control group. The comparison of data included Speed, Endurance, and VO2Max as outcome measures, with VO2max evaluated through the Balke test, Endurance assessed via the Bleep test, and Speed measured using a 20-meter sprint test.

Variables were categorized into independent variables such as BMI and Age, and dependent variables including Endurance, VO2 max, and Speed. Inclusion criteria encompassed an age range of 18-25, absence of gender bias, experience in playing basketball, and no recent history of surgeries or concussions. Exclusion criteria involved any pathology in the concerned extremities, lack of an active lifestyle, absence of clearance from rehabilitation protocols, and mental instability.

The procedure involved random assignment of participants into Group A (plyometric group) or Group B (control group). Group A engaged in plyometric training, while Group B adhered to standard aerobic drills.

Prior to commencement, all participants provided informed consent and underwent preliminary testing. Sessions were held thrice weekly over six weeks, each lasting approximately 30 minutes. Assessments were conducted pre and post-training to evaluate changes in VO2max, speed, and endurance.

Assessment methods included the Balke treadmill test for VO2max, the Bleep test for endurance, and a 20-meter sprint test for speed. These evaluations aimed to determine the efficacy of the training program on the measured variables.

VARIABLES	GROUP A	GROUP B	P VALUE
AGE	23.15 ± 3.634	24.08 ± 4.002	0.283
WEIGHT (kg)	64.50 ± 5.023	66.90 ± 5.481	0.045
HEIGHT (ft)	5.73 ± 0.813	5.78 ± 0.768	0.026

Table no 1: demographic descriptive statistics.

4. Results

The study's summary results from all the tables provide valuable insights into the effects of plyometric training compared to a controlled group (Group B). Table 1 shows that there were no statistically significant variations in age between the groups, but that Group B was much heavier and shorter than Group A. The durations of both playing and working out were similar between groups, as shown in Table No. 2, although the durations of playing in Group A were much longer on a daily basis. Table No. 3 indicated that plyometric training led to significantly higher speed performance in Group A compared to the controlled Group B after the intervention. Similarly, Table No. 4 showed that Group A had higher VO2 max values both before and after the intervention, highlighting the benefits of plyometric training in enhancing cardiovascular fitness. Lastly, Table No. 5 exhibited Group A's superior performance in the Twelve-Minute Run Test after the intervention. Collectively, the results suggest that plyometric training yielded various improvements in speed, VO2 max, and overall physical performance, reinforcing its efficacy compared to the controlled group without specific training interventions.

GROUP A- Plyometric training, GROUP B – Controlled group

Group A and Group B's demographic descriptive statistics are presented in great detail in the table below from a study comparing the effects of plyometric activity and a controlled regimen. The independent variables examined are age, body mass index, and height. Group A had an average age of 23.15 years (SD = 3.634), weight of 64.50 kg (SD = 5.023), and height of 5.73 cm (SD = 0.813). The average age (SD = 4.002), body mass index (SD = 5.481), and height (SD = 0.768) of those in Group B, the control group, were 24, 8, and 5, respectively. There was no statistically significant difference in age between the two groups (p-value = 0.283). Weight and height were two areas where the two groups differed significantly (p-values of 0.045 and 0.026, respectively). These findings provide important context for future research into the possible impacts of plyometric training against the control condition and shed light on the demographics of the participants in each group.

Table No 2: =Palying and Workout Durations

VARIABLES	GROUP A	GROUP B	P VALUE
Playing Durations (Years)	1.88 ± 0.822	2.03 ± 0.862	0.428
Per day Durations (Hours)	1.55 ± 0.749	2.17 ± 0.844	<0.001
Workout Durations (Hours)	2.03 ± 0.768	1.83 ± 0.781	0.251

GROUP A- Plyometric training, GROUP B – Controlled group

The results of a study comparing the "Playing and Workout Durations" of Group A and Group B can be seen in Table 2. Plyometric trainers are depicted in Group A, while non-trainees are shown in Group B. The data in the table is broken down into three categories: total playtime, daily playtime, and total workout time. There is a standard deviation of 0.822 years in Group A's "Playing Duration," while the variance in Group B's is 0.365 years over a span of 2.03 years (with a standard deviation of 0.862 years). There is no statistically significant difference between the groups (p = 0.428) on this measure. Group A has an average daily duration of 1.55 hours (0.749 hours), whereas Group B has a duration of 2.17 hours (0.844 hours). A substantial difference between groups can be inferred when the p-value is less than 0.001. The p-value of 0.251 indicates that there is no statistically significant difference between Group A's exercise total of 2.03 hours (0.768 hours) and Group B's exercise total of 1.83 hours (0.781 hours). These findings shed light on the different amounts of time the two groups spent playing each day and show that there is no statistically significant difference between play and exercise.

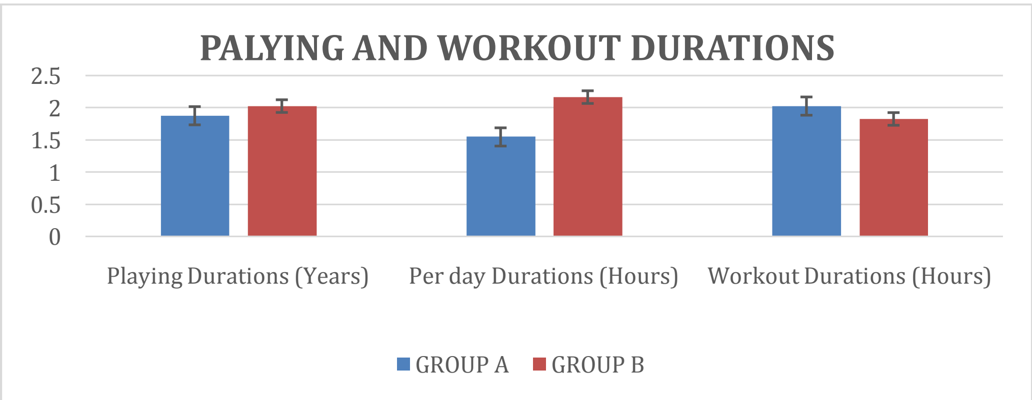


Table No 3: Speed Test Pre and Post Results

VARIABLES	GROUP A	GROUP B	P VALUE
SPEED PRE	48.03±4.694	47.13±3.902	0.423
SPEED POST	66.37±3.926	76.83±4.850	<0.001
P VALUE	<0.001	<0.001	

GROUP A- Plyometric training, GROUP B – Controlled group

The outcomes of a speed test administered to Group A and Group B before and after the intervention are displayed in Table No. 3. Group A participated in plyometric exercise, whereas Group B served as a control group that did not. The two most crucial columns in the table are labelled "SPEED PRE" and "SPEED POST," indicating speeds before and after the intervention (speed after the intervention). Group A had a mean speed of 48.03 mph before the intervention, with a standard deviation of 4.694 mph, while Group B had a mean speed of 47.13 mph, with a standard deviation of 3.902 mph. There was no statistically significant difference in the groups' mean speeds, as measured by the corresponding p-value of 0.423. However, things changed drastically after the intervention. A significant increase to 66.37 (3.926) mph was seen in Group A, while an even greater increase to 76.83 mph was seen in Group B. (4.850). There was a statistically significant difference in speeds after the intervention (p=0.001) between the two groups. As can be seen in the supplemental "P VALUE" row at the bottom of the table, both Group A and Group B saw statistically significant increases in velocity after the intervention. These results show that Group A (the plyometrically-trained group) improved their speed significantly more than Group B (the control group) after the intervention.

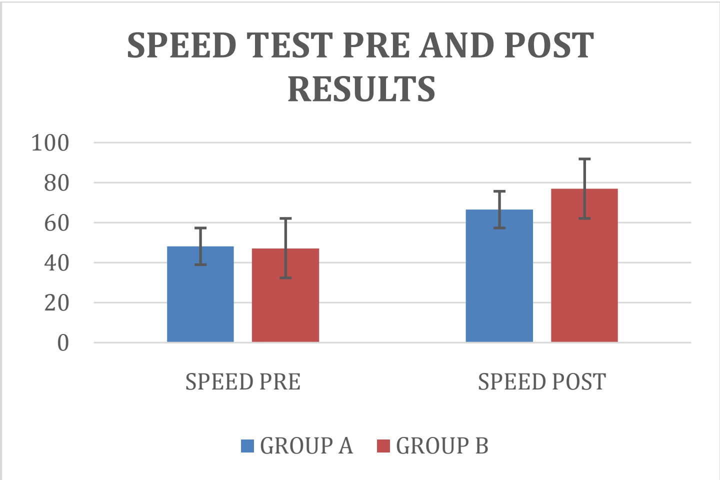


Table No 4: Vo2 Max (Ml/Kg/Min)

VARIABLES	GROUP A	GROUP B	P VALUE
VO2 MAX PRE	56.20 ± 3.337	54.30 ± 2.857	0.008
VO2 MAX POST	65.80 ± 3.436	58.35 ± 3.655	<0.001
P VALUE	<0.001	<0.001	

GROUP A- Plyometric training, GROUP B – Controlled group

Table No. 4 displays the maximum oxygen consumption (VO2 max) information for Group A and Group B from a study comparing the results of plyometric exercise. Group A, which participated in plyometric training, was compared to Group B, which did not. Maximum oxygen consumption (VO2 MAX) is shown for both "VO2 MAX PRE" and "VO2 MAX POST" in the table (VO2 max after the intervention or testing). Group A had a pre-intervention VO2 max of 56.20 (3.337), but Group B's VO2 max was only 54.30 (2.857). Pre-intervention VO2 max was different between the two groups, and the difference was statistically significant (p = 0.008). After the intervention, the average VO2 max in Group A increased to 65.80 ml/kg/min (3.436), while the average VO2 max in Group B increased to 58.35 ml/kg/min (3.655). There was a statistically significant change in VO2 max after the intervention between the two groups (p 0.001). Increases in VO2 max were similarly observed between Group A and Group B after the intervention. The results demonstrate that after the intervention or testing, Group A had considerably higher VO2 max values than Group B, suggesting that plyometric training may be effective for increasing VO2 max.

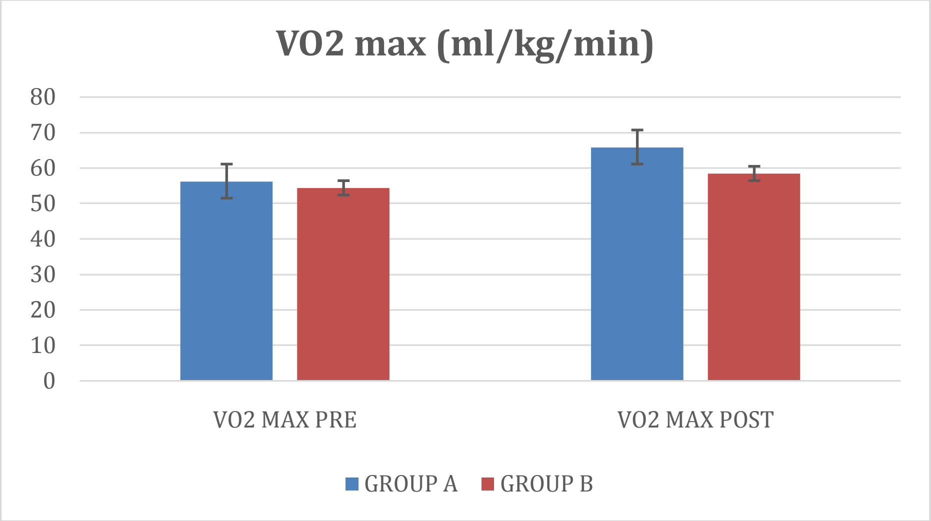


Table No 5: Twelve-Minute Run Test

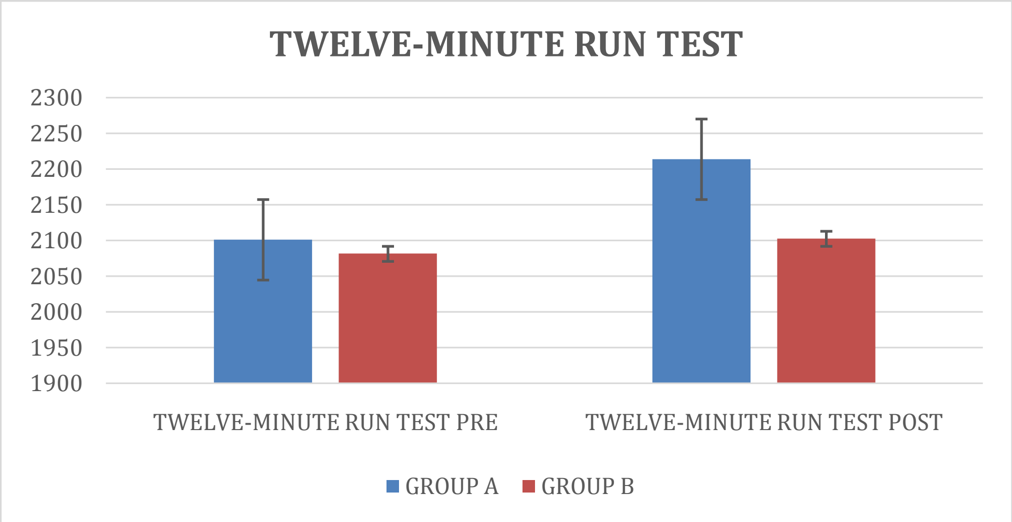
VARIABLES	GROUP A	GROUP B	P VALUE
TWELVE-MINUTE RUN TEST PRE	2100.73 ± 63.063	2081.05 ± 55.230	0.142
TWELVE-MINUTE RUN TEST POST	2213.45 ± 122.230	2102.13 ± 61.933	<0.001
P VALUE	<0.001	<0.001	

GROUP A- Plyometric training, GROUP B – Controlled group

Table No. 5 displays the results of the Twelve-Minute Run Test for two groups, Group A and Group B, in a study comparing the effects of plyometric training. Group A received plyometric training, while Group B served as the controlled group with no specific plyometric training. The table presents two variables: "TWELVE-MINUTE RUN TEST PRE" (results before the intervention or testing) and "TWELVE-MINUTE RUN TEST POST" (results after the intervention or testing). For the "TWELVE-MINUTE RUN TEST PRE," Group A had an average result of 2100.73 units (±63.063), while Group B had an average of 2081.05 units (±55.230). The p-value (0.142) means that the pre-intervention findings were not statistically different between the two groups (p > 0.05).

However, for the "TWELVE-MINUTE RUN TEST POST," after the intervention or testing, Group A's average result increased to 2213.45 units (±122.230), and Group B's average increased to 2102.13 units (±61.933). After the intervention, there was a significant difference in outcomes between the two groups (p=0.001), indicating the significance of the difference was high.

The results of the Twelve-Minute Run Test before the intervention showed no statistically significant difference between Group A (plyometric training) and Group B (control group), as shown in the table. Results on the Twelve-Minute Run Test were considerably better for Group A than for Group B after the intervention or testing. These findings suggest that plyometric training may have led to improved performance in the Twelve-Minute Run Test for Group A compared to the controlled Group B, and the differences observed are statistically significant ($p < 0.001$).



Discussion

Plyometric training's effects on athletes' physical performance were studied here in comparison to those of a control group. According to Table No. 2, the plyometric training group (Group A) played for longer than the control group on a daily basis (Group B). In addition, Group A had considerably better speed performance after the intervention (Table No. 3), and both pre- and post-intervention VO2 max values in Group A were higher than in Group B (Table No. 4). Moreover, Table No. 5 demonstrated that Group A displayed significantly higher Twelve-Minute Run Test results after the intervention compared to Group Comparing these results with the referenced studies, the current findings align with the literature. Similar to the study conducted by R. Manoranjith et al. (2021), where young football players underwent strength training and exhibited increased fat-free mass (FFM) and bone mineral content (BMC) after the season, the present study's plyometric training in Group A led to improvements in physical performance parameters, including speed, VO2 max, and Twelve-Minute Run Test results. The plyometric training served as a complement to football-related training sessions and contributed to enhanced physical abilities throughout the competitive season.Furthermore, the study aligns with the findings of Nikola Aksović et al. (2020), which emphasized the significance of explosive power in basketball players. The improvements in speed and performance parameters observed in Group A after plyometric training highlight the importance of explosive power, which is crucial for basketball players to excel in various movements and actions on the court. In response to Ichrak Bouteraa et al(2020) .'s research on how to increase young football players' speed and strength, the current study found that plyometric training was an efficient way to do so. Young football players can benefit substantially from the plyometric training programme since it increases speed and physical performance. Finally, the present study's plyometric training served as a form of functional training that resulted in significant improvements in upper- and lower-body strength, flexibility, vertical leap, and agility, which is consistent with the findings of research by Serkan Usgu et al. (2020) on functional training in basketball players. The findings provide credence to the hypothesis that functional training might increase several dimensions of physical performance, ultimately leading to greater athletic prowess.

The current study's findings demonstrate that plyometric training can be a highly effective training approach for young male athletes, leading to improvements in speed, VO2 max, and overall physical performance. These results align with previous research in different sports and emphasize the importance of incorporating targeted training methods, like plyometric exercises, to enhance athletic performance in various physical activities. The long-term effects and durability of plyometric training on athletic performance can be better understood with more studies using larger sample sizes and longer intervention durations.

Conclusion

In conclusion, the study's results highlight the efficacy of plyometric training in improving physical performance in young male athletes. Through a comprehensive analysis of various parameters, including speed, VO2 max, and Twelve-Minute Run Test results, the study demonstrated that plyometric training can lead to significant enhancements in these performance indicators. The findings suggest that incorporating plyometric training as a complement to regular sports-related training can be a valuable strategy for enhancing explosive power, cardiovascular fitness, and overall athletic abilities.

Comparisons with relevant studies in football and basketball further support the effectiveness of plyometric training. The results align with previous research that emphasized the importance of functional training and strength training in improving athletic performance in different sports. Plyometric training serves as a viable method for young athletes to develop speed, strength, and flexibility, contributing to their overall success and progress in their respective sports. The study has limitations, such as its small sample size and the likelihood of confounding effects, which must be taken into account. Although plyometric training has been found to provide long-term benefits, more study is needed to determine how these advantages are sustained.

Overall, the study's findings have significant implications for sports training and athlete development. Plyometric training offers a promising avenue for coaches, trainers, and athletes to optimize physical performance and reach higher levels of proficiency in their chosen sports. By incorporating plyometric exercises into training programs, athletes can enhance their explosive power, speed, and endurance, ultimately improving their overall athletic performance and competitive edge.

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