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Abstract

This research determined the differences between two groups of female badminton players. The participants were an experimental (group = 20 and a control group = 20). The variables were obtained speed, flexibility, agility, standing jump, sit-ups, push-ups, body mass, height, anthropometric measures, and forehand services. Captured videos of the badminton serves were analyzed to obtain the kinematics measure. The experimental group followed a 6-week plyometric training and the control group continued with the same pattern of badminton practice. Factorial ANOVA with repeated measures was applied for statistical analysis. Findings showed the experimental group players were considerably greater in post-measurements in calf circumference, toe-to-toe distance stance, toe-to-toe distance connect shuttle, right elbow angle, and badminton performances. Therefore, it is concluded that the experimental groups significantly improved in physical fitness and badminton performance. It is suggested that female badminton players should follow plyometric training to enhance their fitness and badminton performance.

Key Words: Plyometric Training, Kinematics, Badminton Serves, Anthropometric Measures, Physical Fitness

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Title

Outcome of Plyometric Training on the Performance of Female Badminton Players of the Islamia University of Bahawalpur

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Contents

Abstract

This research determined the differences between two groups of female badminton players. The participants were an experimental (group = 20 and a control group = 20). The variables were obtained speed, flexibility, agility, standing jump, sit-ups, push-ups, body mass, height, anthropometric measures, and forehand services. Captured videos of the badminton serves were analyzed to obtain the kinematics measure. The experimental group followed a 6-week plyometric training and the control group continued with the same pattern of badminton practice. Factorial ANOVA with repeated measures was applied for statistical analysis. Findings showed the experimental group players were considerably greater in post-measurements in calf circumference, toe-to-toe distance stance, toe-to-toe distance connect shuttle, right elbow angle, and badminton performances. Therefore, it is concluded that the experimental groups significantly improved in physical fitness and badminton performance. It is suggested that female badminton players should follow plyometric training to enhance their fitness and badminton performance.

Keywords: Plyometric Training, Kinematics, Badminton Serves, Anthropometric Measures, Physical Fitness

Introduction

Basics skills of badminton forehand and backhand serve, rebounds are defensive shots, and smash is considered an attacking shot (Creado, 2018). Along with grip strength, anaerobic power, endurance, and muscular strength are associated with the performance of badminton players. A forceful smash with higher speed makes the opponent mistake which creates a chance of an easy point (Edwards, 1997). Agility is one of the most important qualities in badminton players to keep one's balance while moving quickly in all directions of a badminton court (Ozmen & Aydogmus, 2016). Elite female badminton players reported less body fat and higher body mass than the lower-ranked female players (Munir et al., 2019). Athletes who have impressive

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height, weight, girths, lengths, and breadth tend to perform better in racket games (Shahida et al., 2015). A solid balance and stability during badminton service assist players to control and respond well to the opponent's shots (Singh & Mishra, 2020). Female badminton players have an advantage in competition due to their flexibility which increases their range of body movements (Lu et al., 2022). Hence, novice female badminton players can improve their balance, muscular strength, and endurance through regular training (McGuigan et al., 2012). As with all other aspects, the grip plays a significant role in the performance of elite badminton (Jaworski et al., 2023). It is the dominant hand that grips the racket, the thumb on the broader end of the handle, and fingers curled around the other, and the palm must be pointing upwards (Hung et al., 2020). The feet should be shoulder-width apart, and the player's knees should be slightly bent as she prepares to hit the shuttlecock (Malwanage et al., 2022). The backswing starts when the player rotates their elbow and wrist to move the racket head rearward. Pivoting on the non-dominant foot's heel allows the body to turn in all directions of the court (Lam et al., 2020). So, clearing the shuttlecock from one end of the court to the other requires a lot of leg and core power which gives you a chance to regain control of the game (Gumantan et al., 2021). Badminton may be categorized as an active strength activity (Middleton et al., 2016).

The player must have enough power to send the shuttlecock flying to the next court with pinpoint accuracy (Ahmed et al., 2011). By bending the knees ever-so-slightly, the athlete's weight must be distributed evenly between both feet (Weng, 2014). Specific training may stimulate muscles to develop stronger to bear the shift of weight while moving (Irawan, 2017). Athletes in every sport follow plyometric training, which consists of explosive bursts of movement, to improve their performance (Chu, 1986). The first phase of a plyometric workout is a quick and unusual muscular expansion, and the second phase is a rapid and unusual muscle contraction (Johnson et al., 2011). More force is generated after the concentric phase of muscle contraction in response to the shot of smashing (Heang et al., 2012). It's possible that eccentric loading is caused by rapid muscular stretching and shortening which increase the strength of the lower body muscles (Swanik et al., 2002). Plyometric training may improve badminton players' physical appearance. Previous studies revealed that regular training helps women badminton players' physical strength (Patterson et al., 2016). This experimental research aimed to investigate the impact of plyometric exercising on the badminton performance of female athletes (Chandra et al., 2023). According to my knowledge, not nearly enough research has been undertaken to analyze this question (Markovic et al., 2010). Through extensive literature study, it has been found that lack of research in Pakistan that investigates the effect of plyometric training on female badminton athletes. Therefore, this study may assist the female athletes the sports training education as well as talent identification of female badminton athletes in Pakistan.

Research Methodology

Participants

A purposive sampling technique was adopted and an experimental research design with pre- and post-data measurements was adapted. The participants (n = 40) were female (19.23 ± 23.18 years) and were split into an experimental group and a control group. A cooperation contract was obtained from all female badminton athletes. A briefing was addressed to all members to inform the objectives of this research. Permission and ethical approval were obtained from the research committee of the university.

Instrument and Procedure of Data Collection

The anthropometrics obtained inside the indoor hall were divided into numerous areas such as body marking, skinfolds, body mass, stature, lengths, breadth, and girths (Gulati et al., 2021). Skinfold was evaluated through a Harpenden caliper with a 0.1 milli meter reading model (British indication, UK) utilized by (Ekinci et al., 2015). The line that runs along the axilla of the iliac crest is where the skinfold caliper was horizontally applied to the ilium, vertically for supraspinal, and vertically to the frontal thigh (Pastuszak et al., 2019). The abdomen skinfold was acquired from five cm away from the belly button. The skinfold caliper was used to hold the designated point using the left thumb and finger and the jaw (Demura & Sato, 2007). The left thumb and finger were used to grab the upper central indicated spot on the thigh; if this proved too challenging, another person was asked to assist by holding the leg from the inferior side. The caliper was held at eye level (Arrese & Ostariz, 2006) A caliper was used to measure the subject's medial calf from the muscles (Moore et al., 2008).

Body weight was determined using a computerized balance system made by Seiko of Tokyo, Japan. They were also told to always keep their heads up and their eyes forward 0.1kg was chosen as the minimal reading model. The height was measured from the stadiometer's base to the top of the head. Players were instructed to remove their footwear before standing in a diamond formation with their feet together, arms at their sides, and heels, buttocks, and upper back touching the wall. The individual was told to stand with their heels together, their backs on a line with the stadiometer's vertical bar, their heads up, and their arms pointing downward (Cinthuja et al., 2015).

The X-axis measured the distance in front of the player's face from the head to the impact of the shuttle. The X-axis horizontal linear velocity of the left and right segments and shuttle were determined. The velocity of the shuttle just before it crashed. The angle between the left and right ankle joints was measured from the knee. The ankle joint to knee vector and knee hips intersection were used to calculate right and left knee joint angles. The hip-to-shoulder vector and the shoulder-to-elbow joint interact to create the right and left shoulder angles. The angular measurements of upper body joints would be full in extension at one hundred eighty degrees to zero 0 degrees.

Reliability of the Anthropometric and Kinematics Variables

The technique was adopted to estimate the correctness of the apparatus and researcher. The kinematics of the badminton video were digitized and re-digitized to find the reliability of video analysis (Jacob et al., 2016), as guided (Kwan et al., 2010).

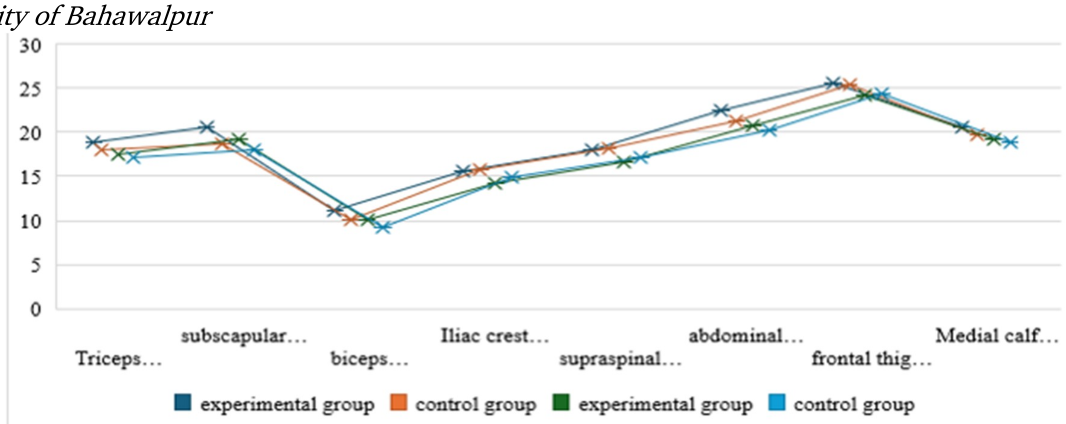
Statistical Analysis

The anthropometric and kinematics data were analyzed by using different statistical methods such as mean and standard deviation. An ANOVA (One-way analysis of variance) was repeated to compare the measurements of the experimental and control groups. Analysis of variation by factors Linear and angular kinematics of the services where similar statistical approaches were utilized to analyze popular and flop services (Ozmen & Aydogmus, 2017). The significance of the differences between the groups was examined using Tukey's post hoc test. Following the guidelines for repeated measures, we ensured that our data satisfied the conditions of normality, homogeneity of variance, and multicollinearity (Winter, 2009). The study participants' badminton performance, as well as their agility and lower-body power, were significantly improved by the plyometric exercise. The significant value was adjusted as $P < 0.05$ by using SPSS software for statistical analysis.

Results

Figure 1

Skinfold Measure of Experimental and Control Groups of Female Badminton Players of The Islamia University of Bahawalpur



The table showed no significant differences were reported among groups in pre-post measurements of both groups except the supraspinal skinfold $F(0.03) = P < 0.03$. There was a significant difference in the supraspinal skinfold of the experimental before the start of training and after training measurements.

Figure 2

Circumferences of Body Segments of Experimental & Control Groups Female badminton Athletes

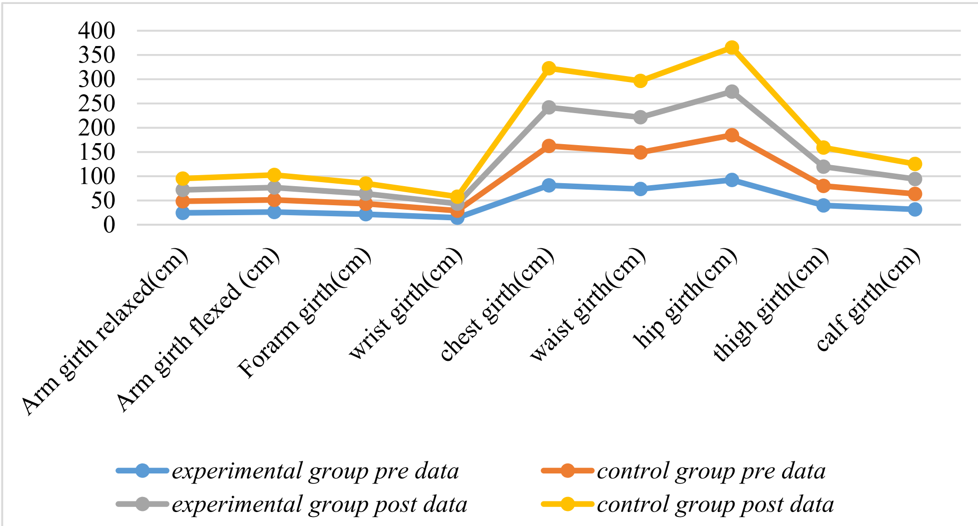


Figure 2 depicts a significant contrast in both the quantity of wrist girth $F(0.16) = P < 0.00$ and calf girth $F(0.16) = P < 0.00$. Tukey post hoc showed there was a significant difference in wrist girth and calf girth before the start of training and after training measurements of female badminton girls.

Figure 03

Length Measurement Experimental and Control Groups of Female Badminton Girls Athletes

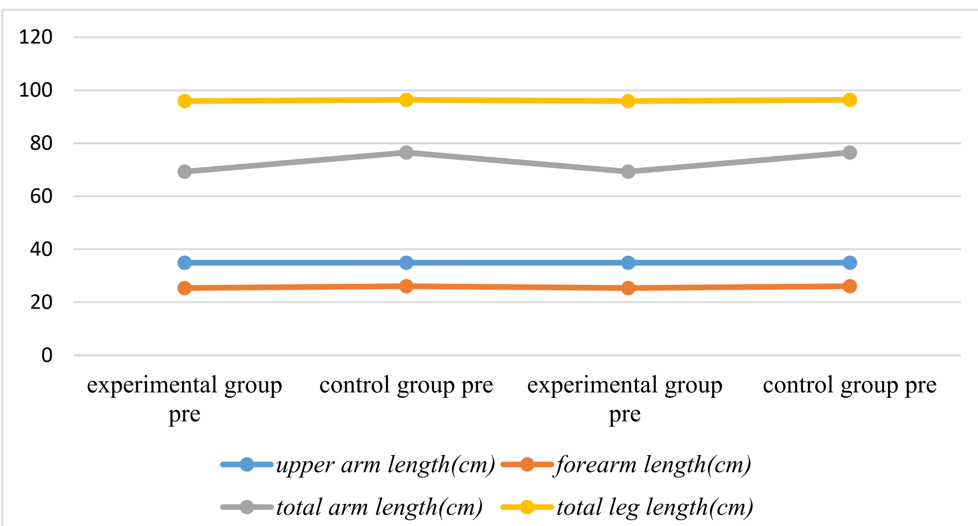
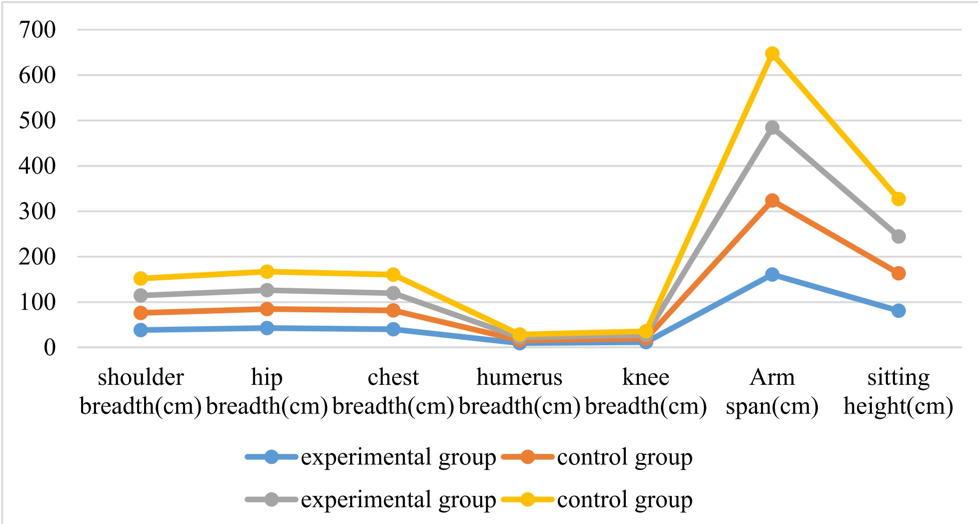


Figure 03 showed no substantial deviation in the group in pre and post-measurements in all segmental lengths.

Figure 4

Breadth Measurements Experimental Control Groups of Badminton Female Athletes



The table showed no significant difference between groups comparison of pre and post-data of the experimental and control group in the measurement of shoulder breadth F(1.09) = *P*<0.30.

Figure 5

Physical fitness measures of experimental badminton how female athletes, control group athlete

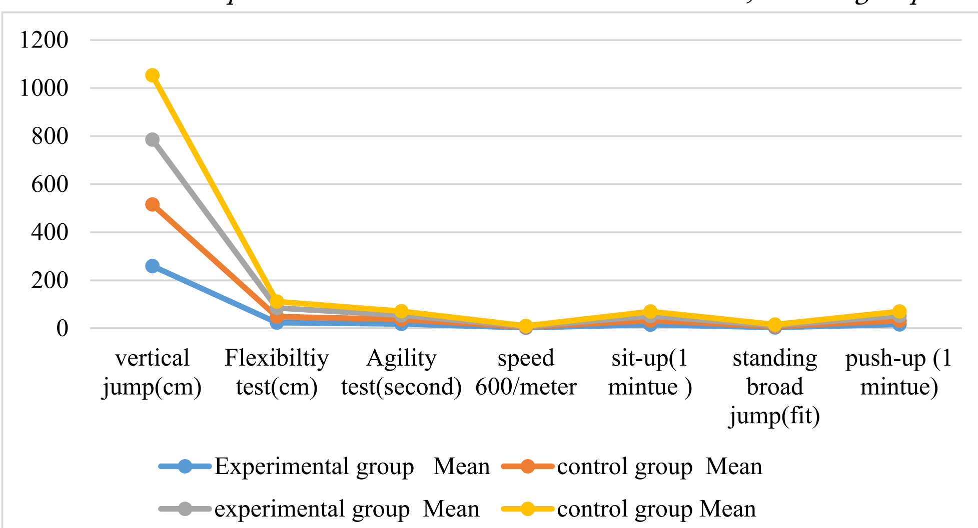


Figure 05 did not show any substantial distinction in groups in pre and post-facts of physical fitness.

Figure 6

Performance Data Experimental and Control Groups of Female Badminton Players

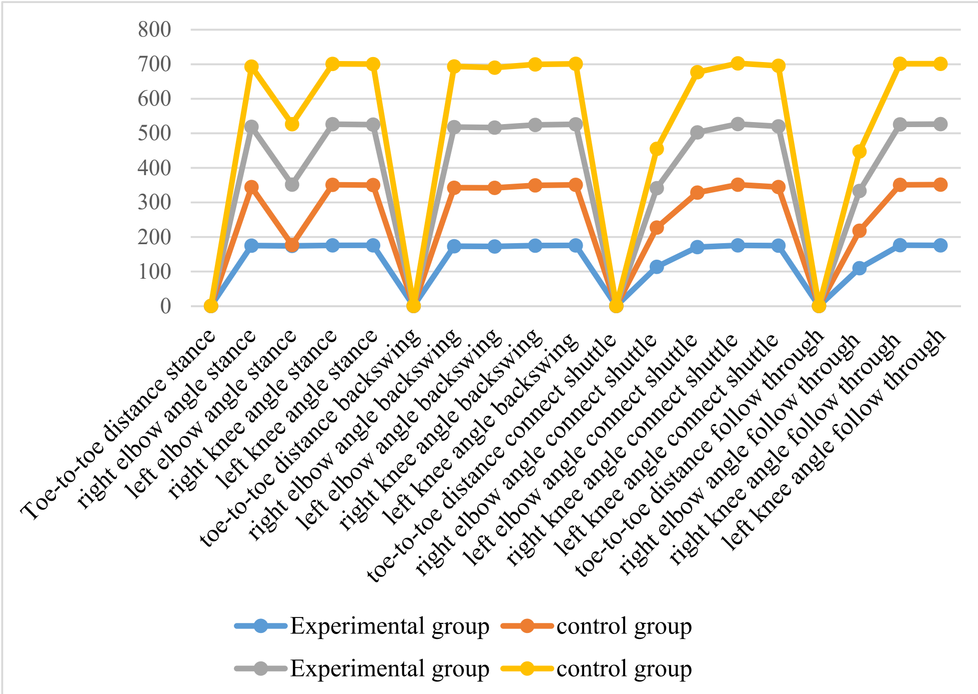


Figure 06 showed substantial variations in both groups in pre-post statistics as in toe-to-toe gap stance *F* (6.19) = *P*< 0.02. Tukey post hoc showed there was a significant difference in toe-to-toe distance stance pre and post-data the plyometric adopted group increased their stance toe-toe gap.

Figure 07

Shuttle Speed of Experimental of Badminton Girls Athletics and Control Girls Athletes

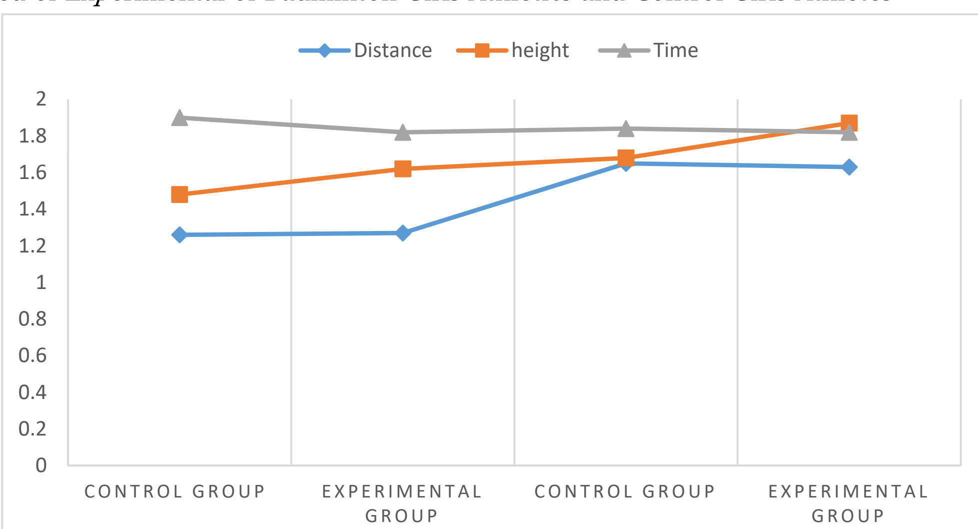


Figure 07 showed substantial distinctions in both groups at pre- and post-statistics as the height of shuttle F (4.12) = *P*<0.05. The following players of plyometric training were better in shuttle height than not following the training group of girls' badminton athletes.

Discussion

The basic reason to investigate the differences between the two groups regarding anthropometric measurements. The fat was lesser in the plyometric training follower female players than non-followers because it may decrease after 8 weeks of polymetric training. The results of the present research were favored by past research (Chen et al., 2019; Chatterjee & Banerjee, 2021). The arm girth was lesser in the plyometric training follower female players than in non-followers. The current study supports the previous research (Zhu et al., 2020) Chen et al., 2019). The upper arm length measurement was lesser in the plyometric training follower female players than non-followers as supports the previous study (Saha et al., 2017) Singh et al., 2017; (Zhu et al., 2020) find a significant decrease in measurement in lower leg length. The shoulder breath measurement was less as supported by past research (Lin et al., 2020).

The hand grip strength was increased in the plyometric training follower female players than non-followers female badminton athletes as confirmed by past research (Chiu et al., 2020; Wu et al., 2022). The experimental group had increased flexibility in physical fitness measures than the control group. excessive flexibility in the lower limbs may lead to decreased power production and a decrease in jump performance in badminton female players. It was observed significant performance and the number of forehand serves performed by female badminton players (Hung et al., 2020; Mocanu et al., 2023).

The current study supports the previous study (Rozikovich, 2022) A stance with a narrower toe-to-toe distance can contribute to improved agility and faster lateral movement, both of which are significant abilities in the sport of badminton. In another study (King et al., 2020) smaller elbow angle at the point impact and a lower racket head speed generate power and accuracy in the service (Rusdiana et al., 2020). The right and left knee angles (Cui et al., 2022; Ahmed & Ghai, 2020) find a negative relationship between knee angle and the correlation between knee flexion velocity in badminton players. The toe-to-toe distance backswing, right and left elbow angle backswing, and right and left knee angle backswing impact the higher velocity of the shuttlecock and improve stroke accuracy. The current study supports the previous study (Ramasamy, 2021) finds a lower velocity of the shuttlecock and less improved stroke accuracy in badminton players. Another study (Geng, 2021) finds that lower ability power and reduced accuracy in kinematics follow through in badminton female players. The distance, height, and time of forehand services a player's ability to cover distance quickly and jump to hit the shuttle at a height can also better performance. The current study supports the previous study (Cui et al., 2022). Another study (Shen et al., 2019) finds the unable to accurately jump to hit the shuttle in forehand services in female badminton players.

Conclusion

The experimental player's segment lengths and segment widths were much greater than the control group players. Adolescence is a time of rapid growth, both in terms of length and width. Since they weighed more and were more robustly built, the experimental players had greater hand grip strength. During the stance, backswing, shuttle connect, and follow-through, the kinematics of the forehand services of the plyometric training follower female players than non-followers were equated via the measurement of four linear displacements, eleven angular locations, two temporal positions, and thirteen linear velocities. Female player due to greater abduction of the left and right shoulders during contact. The experimental player also performed better than the normative sample when it came to left-angle extension. The shuttle's speed is increased by flexing the elbows during the rear lift and then extending them during the forward swing. The pull of the left hand is associated with flexion similar arm's elbow, and the pushing of the right hand is associated with flexion of its elbow.

It is demonstrated that plyometric drills increase the implementation of badminton girls' athletes. It improves the following capacities vertical hop, quickness, and return time of badminton girls' athletes. Further, the drills increase the coordination and performance of athletes.

Recommendations

The plyometric drill begins with necessary drills and increases steadily with time. Plyometric training should incorporate a category of drills that improve muscle strength and skill accuracy. Teachers, athletes, and badminton are properly trained which can assist players in proper guidance which improves performance and reduces the chances of injuries. Frequently examining the performance also helps to check the effectiveness of the training on players' performance.

References

Ahmed, M., & Ghai, G. D. (2020). JOINTS ACTIVITY AND ITS ROLE IN THE UPPER EXTREMITY IN BADMINTON STROKES: A BIOMECHANICAL PERSPECTIVE OF SPORTS EDUCATION. *Humanities & Social Sciences Reviews*, *8*(4), 522–529. https://doi.org/10.18510/hssr.2020.8451
Google Scholar WorldCat Fulltext

Ahmed, S., Bari, M. A., Ahmad, A., Mohammad, A., & Khan, A. (2011). Analysis of arm movement in badminton of forehand long and short service. *Innovative Systems Design and Engineering*, *2*(3), 13-17
Google Scholar Worldcat Fulltext

Arrese, A. L., & Ostáriz, E. S. (2006). Skinfold thicknesses associated with distance running performance in highly trained runners. *Journal of Sports Sciences*, *24*(1), 69–76. https://doi.org/10.1080/02640410500127751
Google Scholar Worldcat Fulltext

Chatterjee, S., Banerjee, N., Bhattacharjee, S., Chatterjee, S., Banerjee, D., & Mukherjee, S. (2021). Influence of Indian classical dancing on the postural stability of adult Bengalee females. In *Design Science and innovation* (pp. 831–840). https://doi.org/10.1007/978-981-15-9054-2_98
Google Scholar Worldcat Fulltext

Chiu, Y. L., Tsai, C. L., Sung, W. H., & Tsai, Y. J. (2020). Feasibility of Smartphone-Based Badminton Footwork Performance Assessment System. *Sensors*, *20*(21), 6035. https://doi.org/10.3390/s20216035
Google Scholar Worldcat Fulltext

Chu, D. A., & Panariello, R. A. (1986). Jumping into Plyometrics. *National Strength & Conditioning Association Journal*, *8*(5), 73. https://doi.org/10.1519/0744-0049(1986)008
Google Scholar Worldcat Fulltext

Cinthuja, P., Jayakody, J. a. O. A., Perera, M. P. M., Weerarathna, W. V. D. N., Nirosha, S., Indeewari, D. K. D. C., Kaethieswaran, T., & Adikari, S. B. (2015). Physical fitness factors of school badminton players in Kandy District. *World Academy of Science, Engineering and Technology, International Journal of Sport and Exercise Sciences*, *2*(5). https://www.omicsonline.org/2165-7025/2165-7025.S1.003-005.pdf
Google Scholar Worldcat Fulltext

Creado, S. (2018). Badminton, squash, and tennis. In *Routledge eBooks* (pp. 69–80). https://doi.org/10.4324/9781315211664-7
Google Scholar Worldcat Fulltext

Cui, X., Lam, W. K., Gao, Q., Wang, X., & Zhao, T. (2022). Biomechanical Analysis on Skilled Badminton Players during Take-Off Phase in Forehand Overhead Strokes: A Pilot Study. *Biology*, *11*(10), 1401. https://doi.org/10.3390/biology11101401
Google Scholar Worldcat Fulltext

Demura, S., & Sato, S. (2007). Suprailiac or Abdominal Skinfold Thickness Measured with a Skinfold Caliper as a Predictor of Body Density in Japanese Adults. *Tohoku Journal of Experimental Medicine*, *213*(1), 51–61. https://doi.org/10.1620/tjem.213.51
Google Scholar Worldcat Fulltext

Edwards, J. (1997). *Badminton: Technique, Tactics, Training*. Crowood Sports Guides.
Google Scholar Worldcat Fulltext

Ekinci, N. E., & Bajorek, W. (2015). Effects of during six months volleyball training on some anthropometric measurements. *International Journal of Physical Education, Sports and Health*, *1*(4), 81–84. http://www.kheljournal.com/archives/2015/vol1issue4/PartB/13.1-986.pdf
Google Scholar Worldcat Fulltext

Geng, Z. (2021). RETRACTED ARTICLE: The change of groundwater quality in shallow layer based on parameter estimation and tennis physical fitness recovery. *Arabian Journal of Geosciences*, *14*(15). https://doi.org/10.1007/s12517-021-08009-y
Google Scholar Worldcat Fulltext

Gulati, A., Jain, R., Lehri, A., & Kumar, R. (2021). EFFECT OF HIGH AND LOW FLEXIBILITY ON AGILITY, ACCELERATION SPEED AND VERTICAL JUMP PERFORMANCE OF VOLLEYBALL PLAYERS. *European Journal of Physical Education and Sport*, *6*(11). https://doi.org/10.46827/ejpe.v6i11.3652
Google Scholar Worldcat Fulltext

Gumantan, A., Nugroho, R. A., & Yuliandra, R. (2021). Learning During the COVID-19 Pandemic: Analysis of E-Learning on Sports Education Students. *Journal Sport Area*, *6*(1), 66–75. https://doi.org/10.25299/sportarea.2021.vol6(1).5397
Google Scholar Worldcat Fulltext

Heang, N. L. J., Quin, N. C. K., Yin, N. L. H., & Hoe, N. W. E. (2012). Effect of plyometric training on the agility of students enrolled in required college badminton programme. *International Journal of Applied Sports Sciences*, *24*(1), 18–24. https://doi.org/10.24985/ijass.2012.24.1.18
Google Scholar Worldcat Fulltext

Hung, M., Chang, C., Lin, K., Hung, C., & Ho, C. (2020). The applications of landing strategies in badminton footwork training on a backhand side lateral jump smash. *Journal of Human Kinetics*, *73*(1), 19–31. https://doi.org/10.2478/hukin-2020-0002
Google Scholar Worldcat Fulltext

Irawan, D. (2017). Six Weeks Progressive Plyometrics Training on Badminton Player's Agility. *In Health Science International Conference*. https://doi.org/10.2991/hsic-17.2017.4
Google Scholar Worldcat Fulltext

Jacob, A., Zakaria, W. N. W., & Tomari, M. R. B. M. (2016). Implementation of IMU sensor for elbow movement measurement of Badminton players. *In 2016 2nd IEEE International Symposium on Robotics and Manufacturing Automation (ROMA)*. https://doi.org/10.1109/roma.2016.7847813
Google Scholar Worldcat Fulltext

Jaworski, J., Lech, G., Żak, M., Witkowski, K., & Piepiora, P. (2023). Relationships between selected indices of postural stability and sports performance in elite badminton players: Pilot study. *Frontiers in Psychology*, *14*. https://doi.org/10.3389/fpsyg.2023.1110164
Google Scholar Worldcat Fulltext

Johnson, B. A., Salzberg, C. L., & Stevenson, D. A. (2011). A systematic review: plyometric training programs for young children. *Journal of strength and conditioning research*, *25*(9), 2623–2633. https://doi.org/10.1519/JSC.0b013e318204caa0
Google Scholar Worldcat Fulltext

King, M., Towler, H., Dillon, R., & McErlain-Naylor, S. (2020). A correlational analysis of shuttlecock speed kinematic determinants in the badminton jump smash. *Applied Sciences*, *10*(4), 1248. https://doi.org/10.3390/app10041248
Google Scholar Worldcat Fulltext

Kwan, M., Cheng, C., Tang, W., & Rasmussen, J. (2010). Measurement of badminton racket deflection during a stroke. *Sports Engineering*, *12*(3), 143–153. https://doi.org/10.1007/s12283-010-0040-5
Google Scholar Worldcat Fulltext

Lam, W., Wong, D. W., & Lee, W. C. (2020). Biomechanics of lower limb in badminton lunge: a systematic scoping review. *PeerJ*, *8*, e10300. https://doi.org/10.7717/peerj.10300
Google Scholar Worldcat Fulltext

Lin, W., Lee, C., & Chang, N. (2020). Acute Effects of Dynamic Stretching Followed by Vibration Foam Rolling on Sports Performance of Badminton Athletes. *Journal of Sports Science & Medicine*, *19*(2), 420–428. https://www.jssm.org/hfpdf.php?volume=19&issue=2&page=420
Google Scholar Worldcat Fulltext

Lu, Z., Zhou, L., Gong, W., Chuang, S., Wang, S., Guo, Z., Bao, D., Zhang, L., & Zhou, J. (2022). The effect of 6-Week combined balance and plyometric training on dynamic balance and quickness performance of elite badminton players. *International Journal of Environmental Research and Public Health/International Journal of Environmental Research and Public Health*, *19*(3), 1605. https://doi.org/10.3390/ijerph19031605
Google Scholar Worldcat Fulltext

Malwanage, K. T., Senadheera, V. V., & Dassanayake, T. L. (2022). Effect of balance training on footwork performance in badminton: An interventional study. *PloS One*, *17*(11), e0277775. https://doi.org/10.1371/journal.pone.0277775
Google Scholar Worldcat Fulltext

Markovic, G., & Mikulic, P. (2010). Neuro-Musculoskeletal and performance adaptations to Lower-Extremity plyometric training. *Sports Medicine*, *40*(10), 859–895. https://doi.org/10.2165/11318370-000000000-00000
Google Scholar Worldcat Fulltext

McGuigan, M. R., Wright, G. A., & Fleck, S. J. (2012). Strength training for athletes: Does it really help sports performance? *International Journal of Sports Physiology and Performance*, *7*(1), 2–5. https://doi.org/10.1123/ijspp.7.1.2
Google Scholar Worldcat Fulltext

Middleton, G., Bishop, D., Smith, C., & Gee, T. (2016). Effectiveness of a low-frequency sports-specific resistance and plyometric training programme: the case of an elite junior badminton player. *International Journal of Coaching Science*. https://eprints.lincoln.ac.uk/id/eprint/23880/
Google Scholar Worldcat Fulltext

Mocanu, G. D., Murariu, G., & Potop, V. (2023). Differences in explosive strength values for students of the faculty of physical education and sports (male) according to body mass index levels. *Pedagogy of Physical Culture and Sports*, *27*(1), 71–83. https://doi.org/10.15561/26649837.2023.0109
Google Scholar Worldcat Fulltext

Moore, C., Dobson, A., Kinagi, M., & Dillon, B. (2008). Comparison of blood pressure measured at the arm,

ankle and calf. *Anaesthesia*, *63*(12), 1327–1331. https://doi.org/10.1111/j.1365-2044.2008.05633.x
Google Scholar Worldcat Fulltext

Saha, S., Dutta, S., Halder, R., Mukherjee, D., Pal, D. K., Gupta, G., Mukherjee, D., & Das, A. (2017). RESULT OF ULNAR COLLATERAL LIGAMENT RECONSTRUCTION IN POST–TRAUMATIC VALGUS INSTABILITY OF ELBOW. *Journal of Evolution of Medical and Dental Sciences*, *6*(22), 1750–1753. https://doi.org/10.14260/jemds/2017/385
Google Scholar Worldcat Fulltext

Munir, M., Li, B., Mardon, I., Young, B., & Baroutian, S. (2019). Integrating wet oxidation and struvite precipitation for sewage sludge treatment and phosphorus recovery. *Journal of Cleaner Production*, *232*, 1043–1052. https://doi.org/10.1016/j.jclepro.2019.06.007
Google Scholar Worldcat Fulltext

Ozmen, T., & Aydogmus, M. (2016). Effect of core strength training on dynamic balance and agility in adolescent badminton players. *Journal of Bodywork and Movement Therapies*, *20*(3), 565–570. https://doi.org/10.1016/j.jbmt.2015.12.006
Google Scholar Worldcat Fulltext

Ozmen, T., & Aydogmus, M. (2017). Effect of plyometric training on jumping performance and agility in adolescent badminton players. *TüRk Spor Ve Egzersiz Dergisi*, 222–227. https://doi.org/10.15314/tsed.319749
Google Scholar Worldcat Fulltext

Pastuszak, A., Gajewski, J., & Buśko, K. (2019). The impact of skinfolds measurement on somatotype determination in Heath-Carter method. *PloS One*, *14*(9), e0222100. https://doi.org/10.1371/journal.pone.0222100
Google Scholar Worldcat Fulltext

Patterson, S., Pattison, J., Legg, H., Gibson, A., & Brown, N. (2016). The impact of badminton on health markers in untrained females. *Journal of Sports Sciences*, *35*(11), 1098–1106. https://doi.org/10.1080/02640414.2016.1210819
Google Scholar Worldcat Fulltext

Rozikovich, S. I. (2022). Methods of Improving the Start Reaction of Short DistanceRunners. *American Journal of Social and Humanitarian Research*, *3*(11), 293-298.
Google Scholar Worldcat Fulltext

Rusdiana, A., Subarjah, H., Imanudin, I., Kusdinar, Y., Syahid, A. M., & Kurniawan, T. (2020). Effect of fatigue on biomechanical variable changes in overhead Badminton jump smash. *Annals of Applied Sport Science*, *8*(3), 0. https://doi.org/10.29252/aassjournal.895
Google Scholar Worldcat Fulltext

Shahida, N., Zawiah, M. S., & Case, K. (2015). The relationship between anthropometry and hand grip strength among elderly Malaysians. *International Journal of Industrial Ergonomics*, *50*, 17–25. https://doi.org/10.1016/j.ergon.2015.09.006
Google Scholar Worldcat Fulltext

Shen, L., Zhang, H., Zhu, M., Zheng, J., & Ren, Y. (2019). Measurement and performance evaluation of LOB technique using aerodynamic model in badminton matches. In *Advances in intelligent systems and computing* (pp. 53–58). https://doi.org/10.1007/978-3-030-35048-2_7
Google Scholar Worldcat Fulltext

Singh, A. P., & Mishra, V. B. (2020). A biomechanical analysis of badminton forehanservice. *Vidyabharati International Interdisciplinary Research Journal 140*, 71-73.
Google Scholar Worldcat Fulltext

Singh, D. K. A., Rahman, N. N. A., Seffiyah, R., Chang, S. Y., Zainura, A. K., Aida, S. R., & Rajwinder, K. H. S. (2017). Impact of virtual reality games on psychological well-being and upper limb performance in adults with physical disabilities: A pilot study. *PubMed*, *72*(2), 119–121. https://pubmed.ncbi.nlm.nih.gov/28473675
Google Scholar Worldcat Fulltext

Chandra, S., Sharma, A., Malhotra, N., Rizvi, M. R., & Kumari, S. (2023). Effects of plyometric training on the agility, speed, and explosive power of male collegiate badminton players. *Journal of Lifestyle Medicine*, *13*(1), 52–58. https://doi.org/10.15280/jlm.2023.13.1.52
Google Scholar Worldcat Fulltext

Swanik, K. A., Lephart, S. M., Swanik, C. B., Lephart, S. P., Stone, D. A., & Fu, F. H. (2002). The effects of shoulder plyometric training on proprioception and selected muscle performance characteristics. *Journal of Shoulder and Elbow Surgery*, *11*(6), 579–586. https://doi.org/10.1067/mse.2002.127303
Google Scholar Worldcat Fulltext

Zhu, H., Chen, A., Guo, W., Zhu, F., & Wang, B. (2020). Which Type of Exercise Is More Beneficial for Cognitive Function? A Meta-Analysis of the Effects of Open-Skill Exercise versus Closed-Skill Exercise among Children, Adults, and Elderly Populations. *Applied Sciences*, *10*(8), 2737. https://doi.org/10.3390/app10082737

Google Scholar Worldcat Fulltext

Chih-Yi, & Weng. (2014). The effect of different feedback methods impact the learning of novice badminton forehand serve in fifth grade students. *美中教育评论：A*, *4*(2), 130–138. http://www.cqvip.com/QK/88583X/201402/48618640.html
Google Scholar Worldcat Fulltext

Winter, D. A. (2009). *Biomechanics and motor control of human movement*. https://doi.org/10.1002/9780470549148
Google Scholar Worldcat Fulltext

Wu, Y., Gao, X., Nguyen, T. T., Wu, J., Guo, M., Liu, W., & Du, C. (2022). Green and Low-Cost Natural Lignocellulosic Biomass-Based Carbon Fibers—Processing, Properties, and Applications in Sports Equipment: A review. *Polymers*, *14*(13), 2591. https://doi.org/10.3390/polym14132591
Google Scholar Worldcat Fulltext

Ramasamy, Y., Usman, J., Sundar, V., Towler, H., & King, M. (2021). Kinetic and kinematic determinants of shuttlecock speed in the forehand jump smash performed by elite male Malaysian badminton players. *Sports Biomechanics*, *23*(5), 582–597. https://doi.org/10.1080/14763141.2021.1877336
Google Scholar Worldcat Fulltext