Educational Administration: Theory and Practice
2024,30(4), 8369-8381
ISSN:2148-2403
https://kuey.net/

Research Article

A Comparative Study Of Plyometric And Circuit Training On Agility And Strength In Badminton Players: An Experimental Study

Dr Dipsa Shah[1*], Dr Keerthi Rao[2]

[1*](MPT Sports student, Chandigarh University),
[2](Professor, Chandigarh University)

Citation: Dr Dipsa Shah (2024), A Comparative Study Of Plyometric And Circuit Training On Agility And Strength In Badminton Players: An Experimental Study *Educational Administration: Theory And Practice*, *30*(4), 01-10
Doi:10.53555/kuey.v30i4.2732

ARTICLE INFO

ABSTRACT

BACKGROUND: Badminton is amongst the world's most popular racquet games, challenging motor aids such as agility and vertical jump mainly for hitting a shuttle. Agility refers to the capacity to change the direction of the physique quickly. Strength denotes the skill of the muscles to produce energy with a solitary utmost exertion and is a vital component of aptness and performance. Plyometric is the term given for a type of workout that is planned to increase intensity or explosive control in certain muscle groups. Circuit drill is a way to train with limited equipment including series of stations including variations between different muscle groups for lower limb exercises.

AIM: To check the effectiveness of plyometric and circuit drill training over agility and strength in Badminton Players of Chandigarh University

MATERIAL AND METHOD: The research includes Badminton Players of Chandigarh University by use of simple random sampling. Only male subjects were included in my study those who were eligible according to inclusion and exclusion criteria. SEMO agility test was used to quantify agility and the Vertical jump test was used to quantify the strength of the lower limb at a baseline value,6 weeks of plyometric and circuit training was provided to Group A and Group B, and further readings were obtained at the end of 6th week.

RESULT: Unpaired and paired t-tests were used to compare means between two groups and within groups. Results were measured to be significant as $p<0.05$. There is improvement in both agility and strength within the group as the value for agility $p=0.001$ and value post strength training $p=0.083$ hence a significant difference was found only in the agility group for between the group comparison. In the Plyometric group, for agility, at baseline and end of the 6th week, t-value= 13.78 and associated significant value $p=0.000$. For strength, at baseline and end of 6th week, t-value=-10.298 and associated significant value $p=0.000$.

In Circuit training group, for agility, at baseline and end of the 6th week, t-value= 12.894 and associated significant value $p=0.000$. For strength, at baseline and end of 6th week, t-value=-7.669 and associated significant value $p=0.000$.

The result shows that there is a significant difference found within groups for all the variables at baseline and end of the 6th week with $p=0.000$ ($p<0.05$). So, improvement was seen in both the Plyometric and circuit groups at the end of the training session

CONCLUSION: It can be clinched from the results that there was substantial difference found in agility performance after the circuit training protocol and strength performance after the plyometric training protocol. There is a noteworthy difference found within the group for both circuit training and plyometric training groups over agility and strength performance.

KEYWORDS: Agility, Badminton, Circuit training, Plyometric training, Strength

INTRODUCTION-

To hit a shuttlecock, participants in the sport of badminton need to have good agility and a good vertical leap. Badminton is one of the most popular racquet sports played across the world. It is considered a non-contact sport because there is no indication of contestants making any kind of physical contact with one another. To hit the shuttle from various angles, a player must shift their direction of movement rapidly, jump, attack the net, and quickly move their arms [1]. Players need to possess certain physical characteristics, including a high level of muscular strength and endurance, power, quickness, agility, flexibility, and overall stability and coordination. The badminton player is required to make their strokes while sprinting to each of the four corners of the court, and then they must run back to the center [2]. Training strategies that are more effective and up-to-date, in combination with in-game analysis, have made it possible to achieve the highest level of performance attainable in this game. To explain it more plainly, the objective of the game is to place a shuttle in a part of the court that the opponent is unable to access or lift. This makes it tough for the opponent to return the shuttle with a smash or come up short of gaining a point [3].

The term "plyometric" that is currently used to define exercise that has its origins in "Europe," where it was initially known as "jumping training." In the early 1970s, there was an increase in interest in this jump training as East European players became the greatest in the world of sports. As Eastern block countries began to produce more athletes in sports such as weightlifting, gymnastics, and track and field, the aura of their success began to center on the drill approaches [4]. Plyometric exercises are distinguished by a rapid concentric phase that immediately follows a muscular lengthening period. This phase is popularly known as the stretch-shortening cycle (SSC), and it is what defines plyometric exercises. The lengthening and shortening cycle is responsible for a significant portion of the recovery of the muscles' and tendons' ability to generate tremendous strength in the shortest amount of time [5]. Plyometric training is highly valuable for badminton players because it targets explosive power, speed, and agility, all of which are crucial for success in the sport. Here's why plyometric training is important for badminton:

1. **Enhanced Explosive Power:** Plyometric exercises involve rapid, powerful movements that mimic the explosive actions required in badminton, such as smashing, jumping, and lunging. Developing explosive power is critical for generating fast and forceful shots on the court.
2. **Improved Speed and Agility:** Plyometrics help improve a player's speed and agility by enhancing neuromuscular coordination. Quick footwork, lateral movements, and rapid changes in direction are common in badminton, and plyometric training can directly translate to improved on-court movements.
3. **Increased Jumping Ability:** Plyometric exercises, particularly those focusing on jumping, can enhance a player's ability to jump higher and reach shuttlecocks that would otherwise be out of reach. This is particularly important for strong offensive play and effective net play.
4. **Better Reaction Time:** Plyometric training can improve reaction time, which is crucial in badminton. Faster reactions enable players to respond more swiftly to their opponent's shots and anticipate their opponent's moves.
5. **Injury Prevention:** Plyometrics can help strengthen the muscles, tendons, and ligaments around the joints, reducing the risk of common badminton injuries, such as ankle sprains and knee injuries. The improved stability and control gained from plyometric training can enhance joint support during quick movements.
6. **Overall Conditioning:** Plyometrics contribute to overall physical conditioning by improving cardiovascular fitness and muscle endurance. This can help players maintain a high level of performance throughout long and demanding matches.
7. **Mental Toughness:** Plyometric training can be mentally challenging due to the explosive nature of the exercises. This can help develop mental toughness and the ability to push through physical discomfort during intense rallies and matches.
8. **Specificity to Badminton Movements:** Plyometric exercises can be tailored to mimic badminton-specific movements, making them highly relevant to the sport's demands.
9. **Enhanced Core Strength:** Many plyometric exercises engage the core muscles, which are essential for stability and power generation in badminton strokes [6].

Circuit training was developed in 1953 as a practical and successful method for coaches to train a large number of athletes in a short period of time with limited equipment. The method was conceived as a way to maximize the use of the available time and resources In the past, the duration of the workout at each station ranged from 15 to 45 seconds, and there was very little to no rest time (15 to 30 seconds) in between each station [7]. Circuit training is a form of exercise that combines resistance training with endurance training. A person's overall physical performance, including power, endurance, strength, agility, and speed, can be improved by the practice of circuit training, which is a sort of exercise [8]. The following are some of the benefits that come with doing circuit training:

1. Increase in the strength of one's muscles
2 Improvements in both aerobic capacity and muscular strength
3. Improved capacity for prolonged muscle contractions

4. Facilitates interaction with other people while exercising
5. Increased commitment to physical activity[9].

Strength is the ability of the muscles to generate force with a single, maximal effort. Another criterion that represents the level of expertise of a badminton player is the capacity for strength that the player possesses. The movement pattern of the smash is similar to that of shots done in other sports, such as handball, volleyball, or tennis[10]. strength training offers several benefits that can significantly enhance a player's performance:

1. **Improved Power:** Strength training helps players generate more power in their shots. A stronger upper body, particularly the shoulders and arms, allows for more forceful smashes and clears. A stronger lower body, especially the legs, aids in explosive movements, such as quick lateral movements and jumping.
2. **Enhanced Endurance:** Strength training can improve overall endurance, enabling players to maintain a high level of performance throughout a match. It reduces the risk of fatigue-related errors late in games or matches.
3. **Injury Prevention:** Strengthening the muscles and connective tissues around joints can reduce the risk of common badminton injuries, such as ankle sprains, knee injuries, and shoulder issues. Strong muscle tissues offer higher aid and balance to the joints.
4. **Improved Balance and Stability:** Strength training contributes to better balance and stability, essential for quick changes in direction and maintaining proper court coverage. It also helps players recover from awkward positions more effectively.
5. **Increased Core Strength:** A strong core (abdominal and lower back muscles) is essential for generating power in badminton strokes, maintaining posture, and preventing lower back pain.
6. **Better Control:** Strength training can lead to better control over racket movements and more precise shot placement. Improved strength in the forearm and wrist muscles enhances the ability to execute delicate shots like drops and net plays.
7. **Enhanced Speed and Agility:** While badminton is primarily a sport of speed and agility, strength training can complement these attributes. Strong leg muscles aid in quick acceleration and deceleration, and strong arms can help in rapid changes in racket direction.
8. **Confidence:** Being physically strong can boost a player's confidence on the court. Confidence is crucial in badminton, as it allows players to take calculated risks and seize opportunities during a match.
9. **Overall Athleticism:** Strength training contributes to overall athleticism, which is valuable in badminton, a sport that requires multi-directional movements, explosive power, and quick reactions.
10. **Mental Toughness:** Strength training often involves mental challenges and perseverance, which can transfer to mental toughness on the badminton court. This mental resilience can help players stay focused and composed during matches [11].

Agility is a versatile and valuable attribute that has applications in sports, fitness, injury prevention, cognitive function, and daily life [12]. Agility is an essential attribute in various aspects of life, including sports, fitness, and everyday activities. Its importance can be summarized in several key points:

1. **Athletic Performance:** Agility is crucial in many sports, including soccer, basketball, football, tennis, badminton, and martial arts. It enables athletes to change direction rapidly, react quickly to opponents' movements, and maintain balance and control during dynamic movements. In sports, agility often translates to a competitive advantage.
2. **Injury Prevention:** Good agility involves balance, coordination, and proper body mechanics. This can reduce the risk of injuries during physical activities. Improved agility can help athletes move safely and effectively, reducing the likelihood of accidents.
3. **Functional Fitness:** Agility is a component of overall fitness that contributes to functional strength. It allows individuals to navigate obstacles, perform daily tasks with ease, and maintain independence as they age.
4. **Enhanced Coordination:** Agility training promotes better coordination between the body and the mind. This coordination can have applications beyond sports, such as in dance, music, and various forms of artistic expression.
5. **Reaction Time:** Agility training can improve reaction time, helping individuals respond more quickly and accurately to stimuli. This can be valuable in sports, as well as in professions that require quick decision-making, such as emergency responders and the military.
6. **Mental Agility:** Agility isn't limited to physical movements; it also applies to mental flexibility and adaptability. Developing mental agility can enhance problem-solving skills, creativity, and adaptability in various aspects of life.
7. **Enhanced Cognitive Function:** Some research suggests that physical agility training may have cognitive benefits, including improved memory, attention, and executive function. Engaging in activities that challenge both the body and mind can promote overall brain health.
8. **Weight Management:** Engaging in agility exercises and activities can contribute to weight management by burning calories and promoting overall physical fitness.

9. **Social and Teamwork Skills:** In team sports, agility is crucial for effective teamwork. Players who can move quickly, adapt to changing situations, and coordinate their movements with teammates are more likely to contribute positively to the team's success.
10. **Enjoyment of Physical Activity:** Developing agility can make physical activities more enjoyable because individuals feel more confident in their movements. This can encourage people to stay active and maintain a healthy lifestyle [13].

In summary, the study addresses a range of needs related to improving the performance and overall well-being of badminton subjects. It has the potential to inform training practices, enhance player development, and contribute to the broader understanding of sports science in the context of badminton.

PROCEDURE-

STUDY DESIGN-

Experimental study(pre and post experimental study)

STUDY LOCATION-

Chandigarh University, Mohali Punjab

STUDY SETTING-

Badminton court, Sports Complex Chandigarh University.

STUDY PARTICIPANTS-

Recreational male badminton subjects of Chandigarh university with playing experience of the game of minimum 1 year.

SAMPLING DESIGN-

Simple random sampling method is used with number generator software to avoid bias in the study.

SAMPLE SIZE ESTIMATION-

Sample size was calculated using G-Power version 3.1.9.2.At effect size=0.8, Power=0.90 and alpha value at 0.05, the required sample size was estimated at 56. Assuming 7% as drop out chances, the final sample size was adjusted to 60(Kang, 2021)(Erdfelder et al., 2009).

SELECTION CRITERIA-

3.7.1 INCLUSION CRITERIA
a) 18-25 years of age
b) Only male subjects
c) Recreational player with experience of >1 year
d) Chandigarh University subjects
3.7.2 EXCLUSION CRITERIA
a) Player associated with any other sport.
b) Player actively participating in any other research study at current period of time.
c) Subjects who have <1 year of experience
d) Player with Cardiovascular disease which may rise heart rate above 120
e) player with neurological disorder like stroke affecting lower limb/ Alzheimer's which may impact our result.
f) player with musculoskeletal disorder involving lower limb like Osteoarthritis or Rheumatoid Arthritis
g) Subjects who are not willing to participate.
h) Player who have recently undergone knee replacement or ligament surgery of ankle spine and hip in past 6 months

STUDY DURATION-

The duration of the study was 1 year including the formulation of a research question, application, data collection analysis, and reporting.

MATERIALS USED-

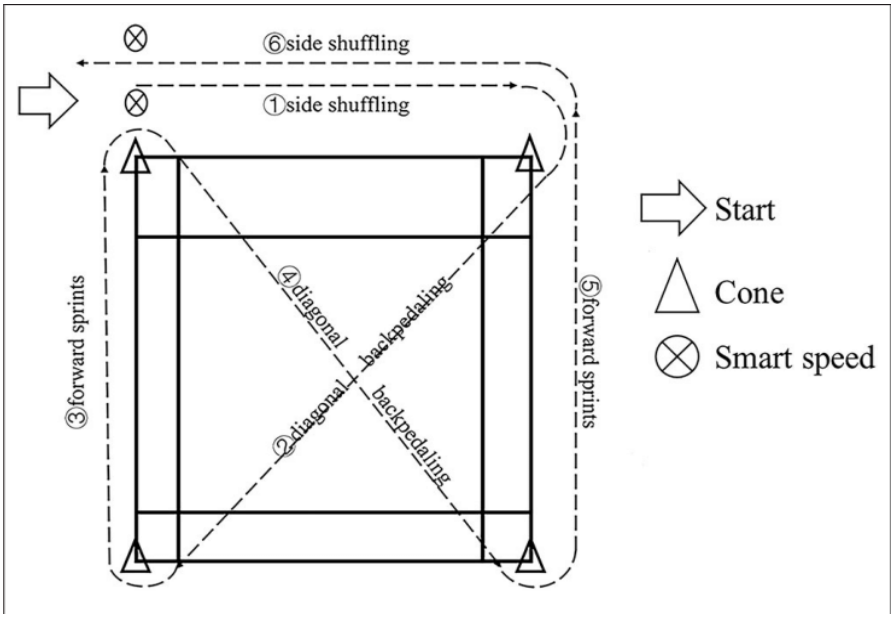
- Consent form
- Demographic sheets
- Recording assessment sheets
- Badminton court
- Marker cones
- Stairs
- Stopwatch
- Measuring tapes

OUTCOMES VARIABLES

- **SEMO AGILITY TEST (Pezeshk et al., 2021)**

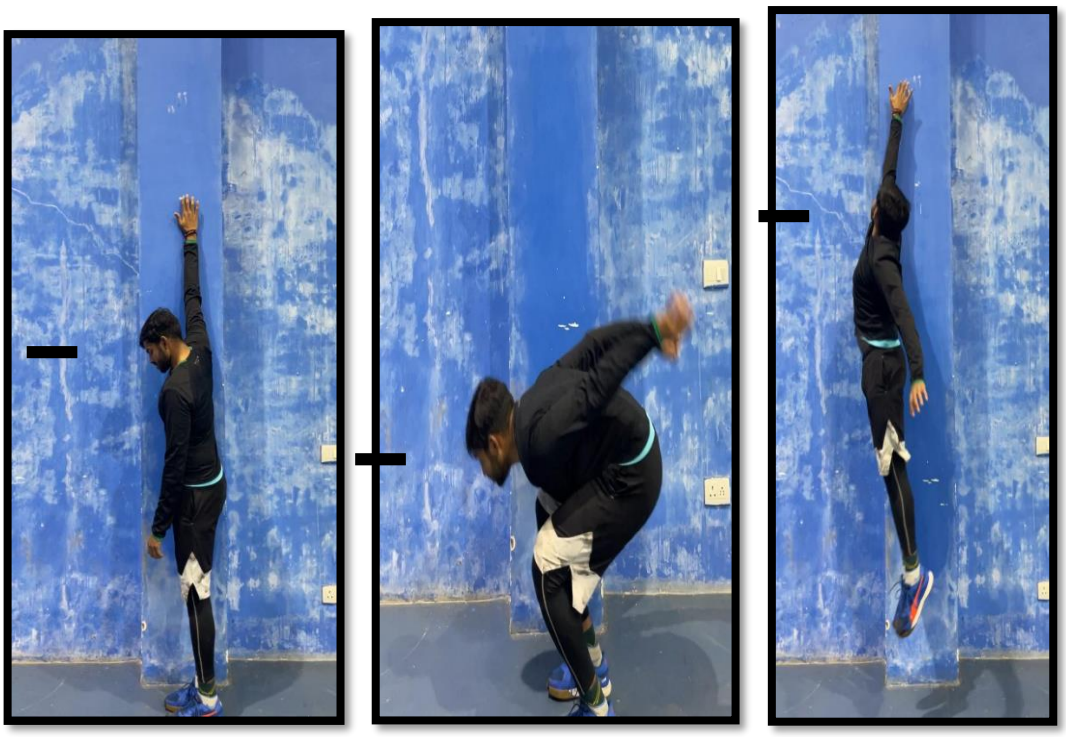
At this point in time, the Hexagon test, the 5-0-5 COD exam, and the Modified SEMO test have all been widely utilized to evaluate Change of direction (COD) ability in badminton, and they have all been confirmed as representative tools for assessing on-court performance for player. One must initiate with side shuffle further pedal diagonally backward across the court, run ahead, again backpedal diagonally and then side-shuffle to the

finish line while facing the court. There was a notation of the times for the tests. The fastest times were obtained for the procedure, consisting of three consecutive trials followed by a brief interval of inactive rest between each one.



- **VERTICAL JUMP TEST(Aragon-Vargas, 2000)**

- The vertical leap test is a measurement of one's physical fitness. Utilized for the purpose of determining the power of the lower limbs. The major purpose of this exercise is to determine how far a participant can leap using only the explosive strength of their lower bodies. Therefore, this was used as an outcome measure in the current study to determine the vertical jump height of badminton subjects. The participant stands side on to a wall and reaches up with the hand closest to the wall. Keeping the feet flat on the ground, the point of the fingertips is marked or recorded. This is called the standing reach height. The athlete then stands away from the wall, and leaps vertically as high as possible using both arms and legs to assist in projecting the body upwards. The jumping technique can or cannot use a countermovement. Attempt to touch the wall at the highest point of the jump. The difference in distance between the standing reach height and the jump height is the score. The best of three attempts is recorded.



VERTICAL / SARGENT JUMP TEST

ETHICAL STATEMENT-

Primary researcher had seeked the ethical approval of the study from an institutional ethics committee of Chandigarh university. Safety of participants was ensured by therapist and study procedure was planned to eliminate any negative effects on participants health. The study had been carried out in accordance with the Helsinki declaration revised in 2013 and National Ethical Guideline for biomedical research involving human participants,2017.

RECRUITMENT-

Participants in the study were included based on inclusion criteria which is male recreational badminton subjects with experience of game of more than or equal to 1 year, without any lower limb injuries in the past 6 months, and not indulged in any other research training. Participants were recruited by simple random singling with a single-blinded approach. Recruitment was done through computer computer-generated app randomized sampling tool. Participants were assessed by questionnaire to check fulfillment of eligibility criteria further first 60 participants were randomly divided into 2 groups. Group-A consisted plyometric training group and Group B consisted Circuit training group. A baseline evaluation of agility and lower limb strength was conducted again at the end of the sixth week.

METHODS OF DATA COLLECTION

A researcher approached the participant in person. Informed consent was signed by subjects Participant were given instruction regarding procedure. Baseline data were noted for agility and lower limb strength score. Subjects were divided into two groups GROUP A and GROUP B. Both the group performed either of the protocol for 3 times a week for period of 6 week following group warm up and followed by group cool down session. Further at the end of 6 week again agility and lower limb strength score were noted. Data was analysed by using statistically software and result were obtained further.

GROUP-A PLYOMETRIC GROUP [4]

The Plyometric training program consist of combination of upper body and lower body exercise. A program of 4-8 exercises were made to be performed at maximal intensity with 2-4 sets and 10-15 repetitions each were applied. Depending on the exercise and number of sets performed during trial rest period varied between 15-19 seconds. Proper exercises were explained during demonstration. Plyometric session was for 30-60 minutes and was followed by 5 min cool down protocol. Plyometric group was trained thrice weekly

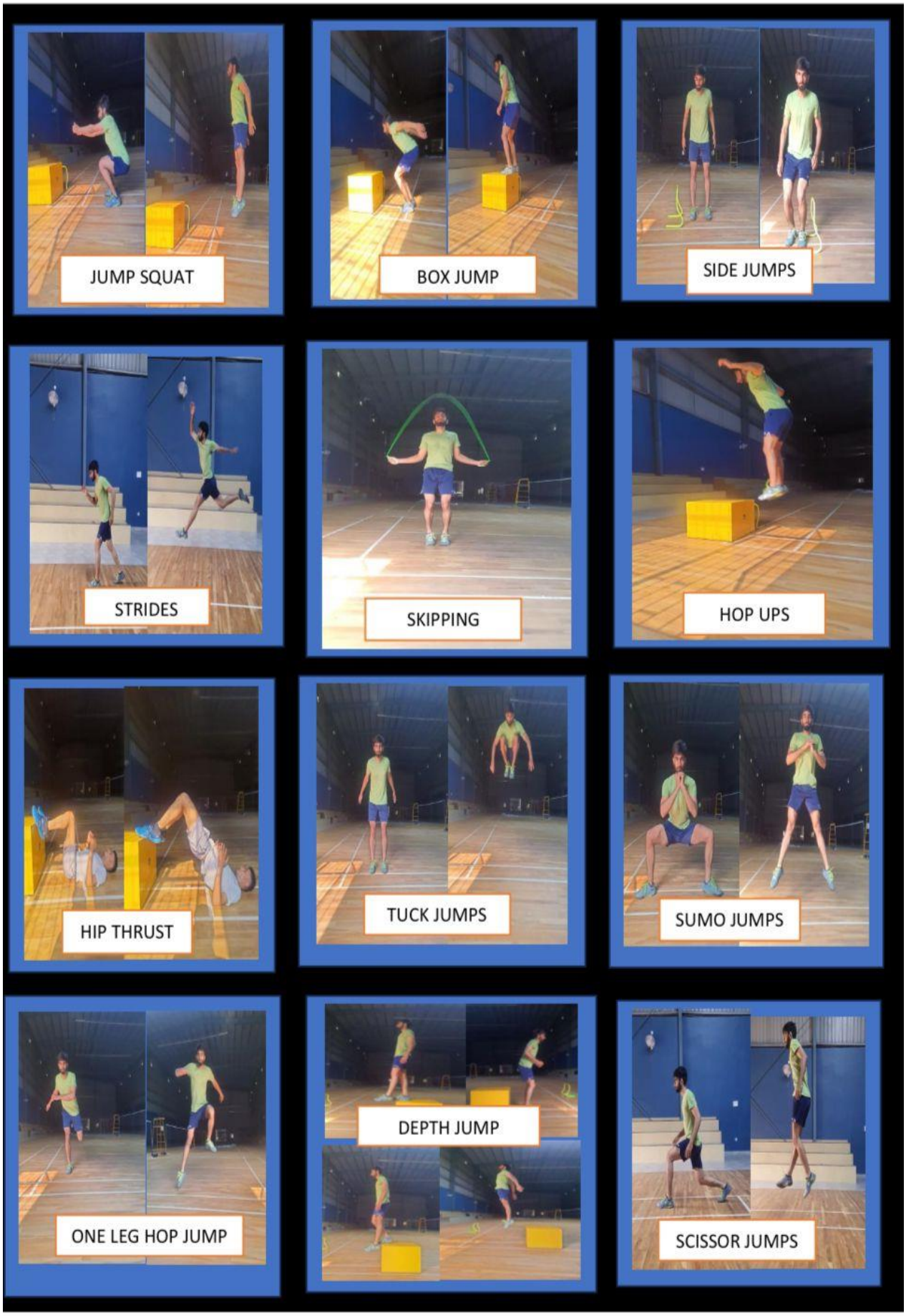
GROUP-B CIRCUIT TRAINING GROUP [4]

Circuit training group were given 3 sessions of exercise training on alternate days in a week. Training protocol included 5 minutes of warm-up followed by 30-45 minutes session of circuit training which consisted of 8 stations. Each exercise lasted for 30 seconds to 60 seconds. Exercise performed at 8 stations were-

1-JUMPING JACKS
2-KICKING BACK
3-HIGH KNEE STRIDES
4-SIDE HOPS
5-SQUAT
6-FLUTTER KICK
7-PILATES LEG PULL (UP)
8-PILATES LEG PULL (DOWN)

DATA ANALYSIS:

Readings were collected on day one of intervention, last day of 6th week. The information became analysed with the aid of using the usage of the software program bundle SPSS 24 for window version. Mean and fashionable deviation of all of the variables had been calculated. The level of significance was set at $p<0.05$. Paired t-test will be used to compare the differences within the group and unpaired t-test will be used to compare the difference between the groups



GROUP- A PLYOMETRIC TRAINING GROUP EXERCISES

GROUP-B CIRCUIT TRAINING PROTOCOL

RESULT -9962767347-ashwini.

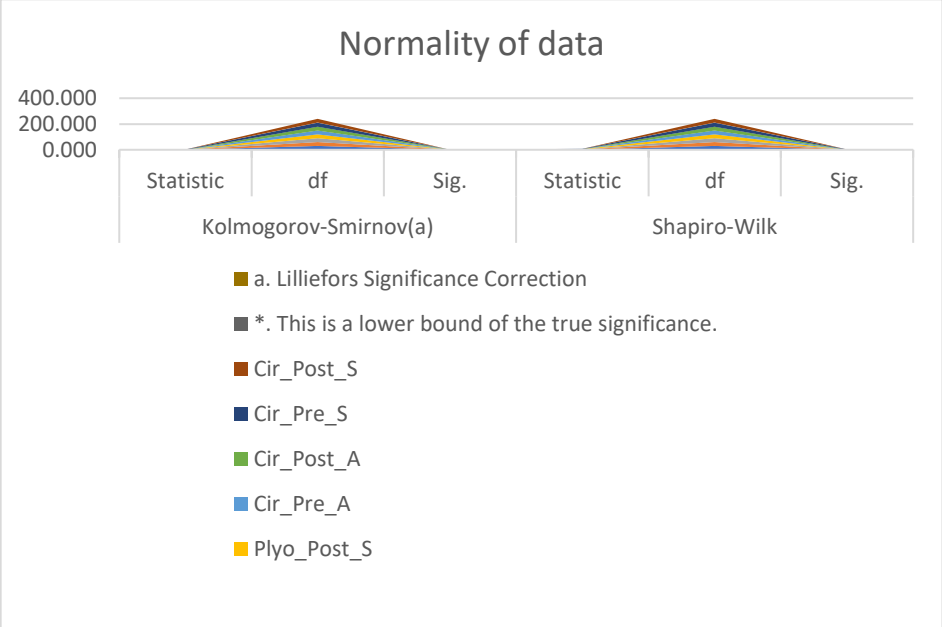
The researcher was in charge of gathering, entering and analyzing the data. Kolmogorov-Smirnov test and shapiro wilk test was applied to check normality for data. Descriptive statistics including mean and standard deviation (SD) were analysed. Descriptive statistics of age, height and weight among 60 subjects was done. Mean of age (years), height (cm), weight (kg) were 20-21 years ,178-180cm and 76-78 kg respectively. The

parametric Independent Sample t-test was used for comparing means between Plyometric training (PT) and Circuit training (CT) groups. The parametric Paired samples t-test was used for comparing means within Plyometric training and Circuit training groups. Results were considered to be significant at $p \leq 0.05$ and confidence interval was set at 95%. All statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) software version 15.0.

Table-1 Tests of Normality

	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Plyo_Pre_A	0.224	30	0.001	0.909	30	0.014
Plyo_Post_A	0.162	30	0.044	0.923	30	0.032
Plyo_Pre_S	0.158	30	0.054	0.943	30	0.107
Plyo_Post_S	0.120	30	.200(*)	0.982	30	0.871
Cir_Pre_A	0.184	30	0.011	0.938	30	0.082
Cir_Post_A	0.234	30	0.000	0.901	30	0.009
Cir_Pre_S	0.133	30	0.183	0.939	30	0.085
Cir_Post_S	0.162	30	0.044	0.940	30	0.091

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction



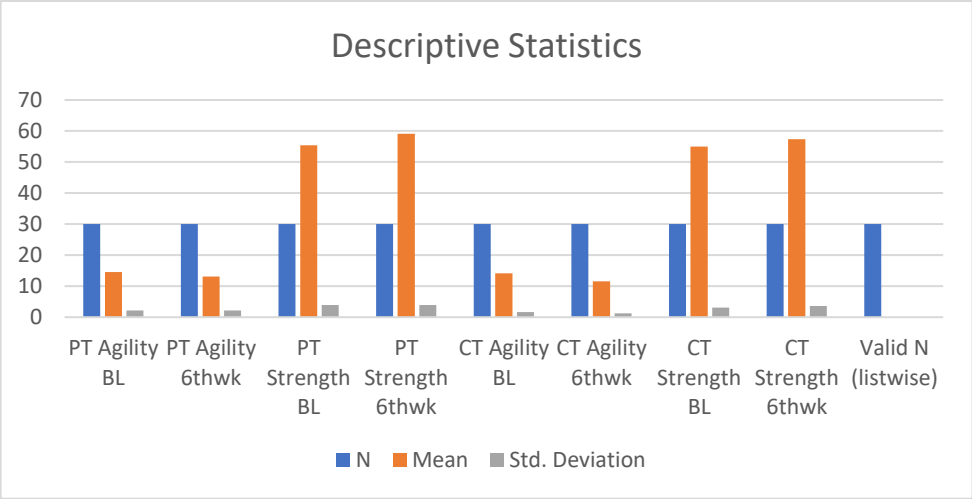
This graph describes that sample was distributed normally. Kolmogorov-Smirnov test and shapiro wilk test was applied to check normality for data.

Table 2: Descriptive Statistics

	N	Mean	Std. Deviation
PT Agility BL	30	14.4967	2.16436
PT Agility 6thwk	30	13.1133	2.18265
PT Strength BL	30	55.4333	3.94517
PT Strength 6thwk	30	59.1333	3.94561
CT Agility BL	30	14.1190	1.65266
CT Agility 6thwk	30	11.5933	1.19854
CT Strength BL	30	55.0000	3.11836

CT Strength 6thwk	30	57.4000	3.65400
Valid N (listwise)	30		

PT= Plyometric Training, CT= Circuit Training, BL= Baseline, 6thwk= 6th week
Table 1 represents mean and SD of PT Group and CT Group for agility and strength at baseline and end of 6th week.

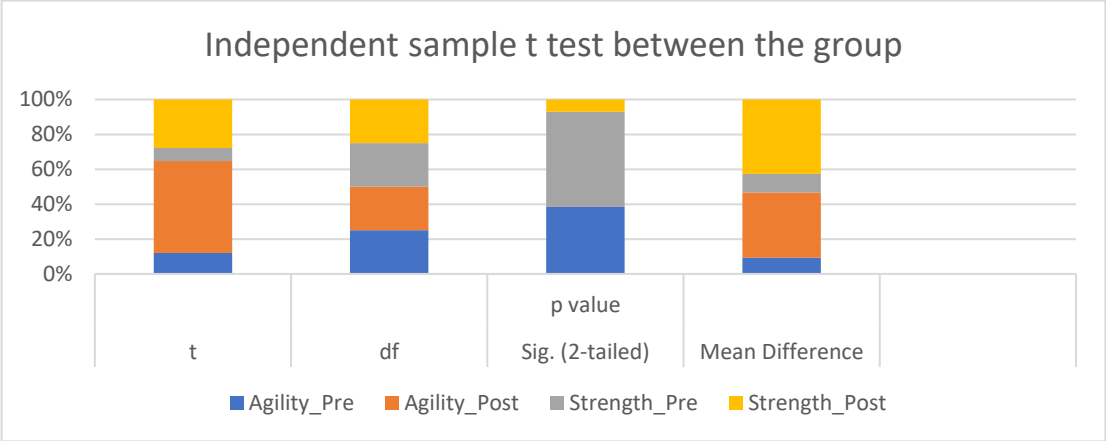


At the end of the 6th week the mean of agility for PT Group and CT Group are 13.11 and 11.59 respectively. The result shows that PT Group takes more time than CT Group to complete the agility test. So, there is significant difference seen in CT group as compare to PT Group at the end of training session.
At the end of the 6th week the mean of strength for PT Group and CT Group are 59.13 and 57.40 respectively. The result shows that mean of PT Group is more significant than CT Group for vertical jump. So, there is significant difference observed in PT Group as compare to CT Group at the end of training session.

Table 3: Independent Sample t-test (Between groups)

	t	df	Sig. (2-tailed) p value	Mean Difference
Agility_Pre	0.760	58	0.451	0.37767
Agility_Post	3.343	58	0.001	1.52000
Strength_Pre	0.472	58	0.639	0.43333
Strength_Post	1.765	58	0.083	1.73333

Table 2 represents mean comparison of agility and strength between PT Group and CT Group at baseline (Pre) and end of 6th week (Post).



For agility at baseline, t-value= 0.760 and associated significant value p=0.451. For agility at end of 6th week, t-value= 3.343 and associated significant value p=0.001. For strength at baseline, t-value= 0.472 and

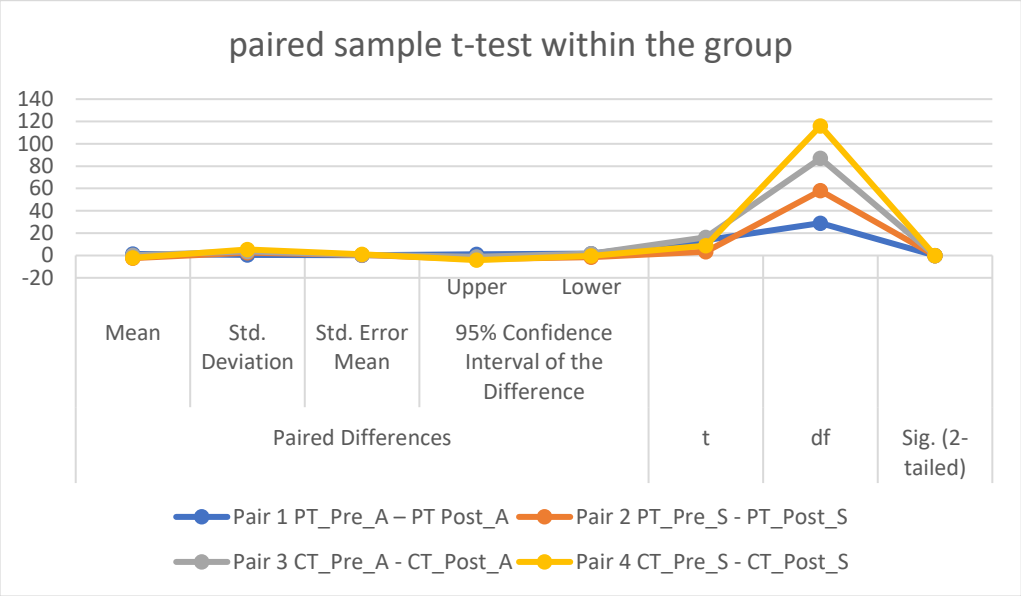
associated significant value p=0.639. For agility at end of 6th week, t-value= 1.765 and associated significant value p=0.083.
The result shows that there is significant difference found between group for only agility at end of 6th week with p=0.001 (p<0.05). For other variables there are no significant difference found between groups with p>0.05.

Table 4: Paired Samples t-test (Within group)

A= Agility and S= Strength

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Upper	Lower			
Pair 1	PT_Pre_A – PT Post_A	1.3833	0.54966	0.10035	1.17809	1.58858	13.78	29	0.000
Pair 2	PT_Pre_S - PT_Post_S	-3.7000	1.96784	0.35928	-4.43481	-2.96519	-10.29	29	0.000
Pair 3	CT_Pre_A - CT_Post_A	2.5256	1.07284	0.19587	2.12506	2.92627	12.89	29	0.000
Pair 4	CT_Pre_S - CT_Post_S	-2.4000	1.71404	0.31294	-3.04003	-1.75997	-7.66	29	0.000

Table 4: represents mean comparison of agility and strength within PT Group and CT Group at baseline (Pre) and end of 6th week (Post).



In PT group, for agility, at baseline and end of 6th week, t-value= 13.78 and associated significant value p=0.000. For strength, at baseline and end of 6th week, t-value=-10.298 and associated significant value p=0.000.
In CT group, for agility, at baseline and end of 6th week, t-value= 12.894 and associated significant value p=0.000. For strength, at baseline and end of 6th week, t-value=-7.669 and associated significant value p=0.000.
The result shows that there is significant difference found within groups for all the variables at baseline and end of 6th week with p=0.000 (p<0.05). So, improvement seen in both PT Group and CT Group at the end of training session.

DISCUSSSION-

In this study we investigated comparative effect of two different protocols that is circuit training and plyometric training on agility and lower limb strength among university level badminton players. This study proposed that Circuit training is an excellent method of fitness training that combines both of resistance and high intensity aerobic exercises that helps to improve all aspects of fitness. It is a flexible training method in which exercises can be accomplished in different patterns like circular, star, square etc. Plyometric training is broadly used in sports to generate explosive power and strength of muscles translating into better sports recital. It consists of a pre-stretch phase (eccentric contraction) followed by a rapid shortening of muscle with a very short rest interlude in between. Plyometric drills involve stopping, initiating, and altering directions in a quick manner which are necessity for agility in sports.
The research conducted by Saini, Hardeep Kaurm Bhardwaj showed positive result for significant increase in agility and strength by combining both the protocol together in there training sessions. They conducted

research on 120 Punjab state basketball players with 60 in experimental group and rest in control group. Experimental group received plyometric training thrice a week and circuit training thrice a week in alternate manner. Mean and standard deviation were calculated, however experimental group showed positive and significant result which is similar to our study when performed separately.To conclude, both groups were found to be effective in improving agility and lower limb strength. Result of the study revealed that circuit training program brought better improvement in agility compared to plyometric training program and Plyometric training program brought better result for strength compared to Circuit training group.

CONCLUSION

Agility and lower limb strength are crucial traits that impacts badminton players performace. It can be concluded from the results that there is a significant difference found in agility performance after the circuit training protocol and strength performance after the plyometric training protocol. There is a significant difference found within the group for both circuit training and plyometric training in agility and strength performance.

However, there is still limited literature available on plyometric and circuit training comparison individually amongst badminton players. More research on badminton players is required to investigate the connection and build comparision among two protocols that are cicuit training and plyometric training. It is also recommended to consider additional factor such as elite athletes or beginner athletes in this study to evaluate a complte comparative effects amongst various protocol in various age group and also the female to male badminton players.

- **Limitations-**

1. Small sample size and restricted age group.
2. Female badminton subjects were not included in the study, so any gender specific differences in the results and associated factors could not be studied.
3. Study could have been done on wider sample and on different age groups. Follow-up was not done in the study which might be varying the result.
4. Elite subjects weren't included which might manipulate the result.
5. The study only focused on participants aged 17 to 28, and it would be beneficial to extend the study to include other age category

- **Future Scope**

1. Same study can be done in greater setting
2. Inclusion of both the genders
3. Inclusion of elite and beginner subjects might be comparable.
4. More variables like speed and upper body strength can also be included.
5. Include other age category and compare results across different age group

- **Clinical Implication**

This study showed a significant improvement in agility and lower limb strength in both circuit training and plyometric training group but the circuit training group has shown highly significant result. Hence the result of the study provides the evidence that the circuit training may be useful and valuable tool in improving various fitness component of badminton subjects.

REFERENCE-

1. Panda, M., Rizvi, M. R., Sharma, A., Sethi, P., Ahmad, I., & Kumari, S. (2022). Effect of electromyostimulation and plyometrics training on sports-specific parameters in badminton players. *Sports Medicine and Health Science*, *4*(4), 280-286.
2. Albayati, M. A. K., & Kaya, Y. (2023). The Effect Of 12-Week Different Training Methods Applied To Badminton Athletes On Some Basic Motoric Properties. *European Journal of Fitness, Nutrition and Sport Medicine Studies*, *3*(1).
3. Abdullahi, Y. (2018). *Singles match analysis characteristics and work loads associated with success in male badminton players* (Doctoral dissertation, North-West University (South Africa), Potchefstroom Campus
4. Alikhani, R., Shahrjerdi, S., Golpaigany, M., & Kazemi, M. (2019). The effect of a six-week plyometric training on dynamic balance and knee proprioception in female badminton players. *The Journal of the Canadian Chiropractic Association*, *63*(3), 144.
5. Karuppasamy, G. (2018). Effect of plyometric training and circuit training on selected physical and physiological variables among male Volleyball players. *International Journal of Yoga, Physiotherapy and Physical Education*, *3*(4), 26-32.
6. Jlid, M. C., Racil, G., Coquart, J., Paillard, T., Bisciotti, G. N., & Chamari, K. (2019) Multidirectional

Plyometric Training: Very Efficient Way to Improve Vertical Jump Performance, Change of Direction Performance and Dynamic Postural Control in Young Soccer Players. *Frontiers in Physiology*, *10*(December), 1–9.

7. Shekhawat, B. P., & Chauhan, G. S. (2021). Effect of circuit training on speed and agility of adolescent male basketball players. *Int. J. Physiol. Nutr. Phys. Educ*, *6*, 1-5.
8. Muthiarani, A., & Lismadiana, L. (2021). Pengaruh latihan shadow menggunakan langkah berurutan dan langkah bersilangan terhadap kelincahan footwork atlet bulutangkis. *Jurnal Keolahragaan*, *9*(1)
9. Kr Singh Yadav, S., & Sravan Kr Singh Yadav, C. (2017). Relationship of selected motor fitness variables with the performance of badminton players. *~ 145 ~ International Journal of Physical Education, Sports and Health*, *4*(2), 145–147.
10. Ferreira, A., Górski, M., & Gajewski, J. (2020). Gender differences and relationships between upper extremity muscle strength, lower limb power and shuttle velocity in forehand smash and jump smash in Badminton. *Acta of Bioengineering and Biomechanics*, *22*(4), 1–16.
11. Elly, C. H. M. K., Urnett, a N. F. B., & Ewton, M. I. J. N. (2010). T He E Ffect of S Trength T Raining on. *Strength And Conditioning*, *25*(9), 396–403.
12. Al Farisi, M. A. H. (2018). Agility Exercise Models of Badminton. *Jipes-Journal of Indonesian Physical Education and Sport*, *4*(2), 55-60
13. 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*, *19*(3).