



# **Determination of Ballistic Six Exercises and Theraband Exercises on Physical Performance in Badminton Players: A Randomized Controlled Clinical Trial**

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## **Authors' contributions**

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

## **Article Information**

DOI: 10.9734/JPRI/2021/v33i49A33331

### Editor(s):

(1) Dr. Francisco Cruz-Sosa, Metropolitan Autonomous University, Mexico.

(2) Dr. Takashi Ikeno, National Institute of Mental Health, National Center of Neurology and Psychiatry, Japan.

### Reviewers:

(1) Tandiyo Rahayu, Universitas Negeri Semarang, Indonesia.

(2) Jon Mikel Picabea Arburu, University of the Basque Country (UPV/EHU), Spain.

Complete Peer review History: <https://www.sdiarticle4.com/review-history/76501>

**Original Research Article**

**Received 28 August 2021**  
**Accepted 02 November 2021**  
**Published 11 November 2021**

## **ABSTRACT**

**Aims:** During regular training, players sustain injuries on a regular basis. Based on the fact that badminton isn't seem at all a contact sport the majority of ailments are caused by overuse. A participant must perform a variety of quick yet repeated shoulder actions and repetitive motions put tension mostly on tissues with time, putting them at risk of damage. Current study was done to compare the effects of Ballistic Six training and Theraband exercises on shoulder strength, agility, speed and function in novice badminton player.

**Study Design:** Randomized Controlled Trial.

**Place and Duration of Study:** Sport clubs were selected according to feasibility in Wardha, from July 2020 to June 2021.

**Methodology:** 40 subjects of both gender aged between 18 to 25 years were selected who have being playing badminton for more than a year. Subjects were randomized into two groups, Group A (Ballistic Six Exercise group) and Group B (Theraband exercise group). Assessments done were

sitting medicine ball throw test (SMBT) for shoulder strength, closed kinetic chain upper extremity stability test (CKUCEST) for agility, plate tapping test (PTT) for speed and Kerlan Jobe Orthopaedic Clinical Score (KJOC) for shoulder function. Assessments were done at baseline, post 8 weeks of training and at the end of 6 months.

**Results:** Significant increase in mean sitting medicine ball throw test SMBT, CKUCEST, PTT and KJOC score in both group but Group A showed more improvement than Group B.

**Conclusion:** Study concluded that adding of Ballistic Six plyometric training for novice badminton players would increase the shoulder strength, agility, speed and function than the theraband exercises.

*Keywords: Badminton players; plyometric exercise; theraband exercise; physical performance.*

## ABBREVIATIONS

*SMBT* : *Sitting Medicine Ball Throw*

*CKUCEST* : *Closed Kinetic Chain Upper  
Extremity Stability Test*

*PTT* : *Plate Tapping Test*

*KJOC* : *Kerlan Jobe Orthopedic Clinical  
Score*

## 1. INTRODUCTION

Badminton being choice among most renowned racquet sports across the globe that was first uncovered by China, but currently there are 200 million athletes worldwide. Because of its growing popularity, this game was first featured in the Olympic Games in 1992. It is governed by the Badminton World Federation (BWF), which claims that 150 million individuals worldwide participate in the sport. There seem to be six main strokes of badminton. Smashing is the most versatile and effective offensive badminton tactic for a player to overcome an opponent. The most common killing shot is known as a smash. Smash accounts for approximately 53.9 percent of all offending shots in badminton, making badminton smash decisive in testing. To smash, player strikes the shuttle hard and slams it down as sharply as possible, so that it overflows the net [1].

The kinetics chain system allows athletes to accelerate the racquet and shuttlecock to the desired speed. Badminton requires a continual study of the changing location on court, focusing each player clearly and promptly on racketing, refining his estimation, and preparing the next pass [2]. The Kinetic Chain uses neuromuscular synchrony (the movement of elements of the body in a certain order) to move energy from land to thighs, knees, lower spine, upper back, neck and shoulders, arm, hand, and thereafter racquet [1]. Muscle power, strength, coordination, agility, flexibility, and balance are

all crucial characteristics for a player to possess [3]. Badminton however is a pastime that necessitates a significant amount of shoulder functionality, particularly in terms of movement and strength. As a result, shoulder strength training is a key aspect in developing stable shoulders and reducing the incidence of shoulder injury problems for subject [2]. Athletes are more likely to participate in traditional resistance exercise regimens in order to improve their muscle strength. These workouts are carried out with sporting equipment such as dumbbells or gadgets, elastic bands, or the body's own weight [4].

Ballistic Six training program, which comprises regularly utilized upper body movements, was previously advised for overhead-throwing sportsmen [5]. This program is given to improve the effectiveness of throwing activity as well as to strengthen the rotator cuff muscles during overhead throwing action to avoid shoulder injury. Six upper extremity plyometric workouts were devised with rapid, strong motions to allow the strains to shorten [6]. Some research on tennis players found that combining a training program with plyometric activities increased reaction time. As a result, plyometric exercise appears to be an effective way to improve neuromuscular ability to increase strength, stamina, plus response time [5].

On the other hand, elastic resistance has already been proved to be a viable alternative to hefty weights. With both concentric and eccentric muscle contractions, it can provide a wider range of movement. With using elastic resistance, certain trials reported high levels of muscular reactivation, while others have found weak to known amounts in stimulation for majority of muscles engaged [7]. Many of these resistance bands are inexpensive, safe, portable, and readily available, plus offer a range of grades as well as thickness. Such bands rarely

function over gravitation that can be utilised to simultaneously exercise single or even more joints. It's been proven to be a useful method for developing muscle strength both in adults and kids, as well as people with and without musculoskeletal discomfort [4].

The core elements for improving athletic performance and limiting injury in badminton players are strength, agility, speed, and function. There hasn't been any research done on effect of Ballistic Six and theraband exercises concerning shoulder performance in young badminton players (18–25 years old), though there have been evidence that indicate that young players who participate in a plyometric program develop their lower extremity agility and strength [3]. Therefore, goal of this study was to observe effect of an 8-week intervention Ballistic Six exercises and theraband training protocols that aimed at developing strength, agility, speed and upper limb coordination on young badminton players.

## 2. MATERIALS AND METHODS

Current study was carried out during July 2020 to June 2021. An informed written consent was taken from all participants after satisfying the inclusion criteria. Participants from both gender, aged between 18 to 25 years who were active recreational badminton player since 1 year and having a normal BMI were targeted in this study. Subjects who had any history of bone or joint disease, musculoskeletal or painful condition (such as Carpal Tunnel or Tennis Elbow Injury), history of any neurological impairment, who's been suffering from low back ache for span of a month, upper limb fracture and not willing to participate in study were excluded.

Participants were randomized into 2 units: Group A (Ballistic Six) and Group B (Theraband Group). Randomization was done through simple random technique. Participants received the protocol twice a week for 8 weeks. Pre – assessment taken were sitting medicine ball throw test for strength, closed kinetic chain upper extremity stability test for agility, plate tapping test for speed and Kerlan Jobe Orthopedic Clinic Shoulder and Elbow Score for function [1,8,9]. Training was initiated after 10 minutes of warm-up session which included calf stretches, toe touching, reach ups, jog, arm rotations, neck clock, arm hug, and windmill that are all low-intensity workouts. All of the athletes were given suitable trials of the strength, agility, and speed

tests in order to acclimate participants with assessment and, more crucially, to limit the likelihood of committing a foul.

### 2.1 Group A (Ballistic Six Exercise Group)

To reduce the deceleration phase and maximize the stretch-shortening cycle (SSC) training results, subjects were advised to ballistically use maximum effort and exercise. Exercises of 3 sets of 10–20 repetitions were completed, with each series offering 30 seconds of rest. The Ballistic Six exercise uses theraband latex tube (red) and fitness balls (2-lb for one extremity training / 6-lb for dual extremity training). The 6 exercises were External rotation with latex tube, 90/90 external rotation with latex tube, overhead soccer throws using a 6-lb (2.7kg) fitness ball, 90/90 external rotation side-throw using a 2-lb (0.9kg) fitness ball, deceleration baseball throws using a 2-lb (0.9kg) fitness ball and baseball throws using a 2-lb (0.9kg) medicine ball (Fig. 2) [10].

### 2.2 Group B (Theraband Exercise Group)

Group B were performing exercises using theraband. Therapist explained all the exercises as shown in figure 3. Participants learnt the techniques for exercises during the first familiarization session. They were taught to use a theraband, and were given correct guidance. Theraband colour is the resistance indicator for the theraband. Player's level of strength decides the form (colour) of the theraband to be used. For training exercises, they used six feet of therabands. The training strength was changed by adjusting the theraband colour, which means increasing the band's resistance. The strength of the exercises will be determined every two to three weeks by adjusting theraband colours. All repetitions were done in appropriate way by the participants. The duration of training sessions was 3 sets of 10–20 repetitions [4].

Week wise theraband training (Fig. 3):

- a) 1-3 weeks: Standing Shoulder Press, Chest Fly, Triceps French Press, Biceps Curl, Rhomboid Squeeze
- b) 4-6 weeks: Trunk Twist, Reverse Flies, Concentration Curl Scapular, Retraction
- c) 7-8 weeks: Straight Arm Pull down, Chest Press, Triceps Kick Back, Rear Deltoid, Dead Lift.

The players participating were motivated to maintain the workout schedule by adequate

physical instruction up to 8 weeks. After 8 weeks, telephonic confirmation was taken every week regarding training till end of 6<sup>th</sup> month and at the end of 6<sup>th</sup> month assessments were taken again.

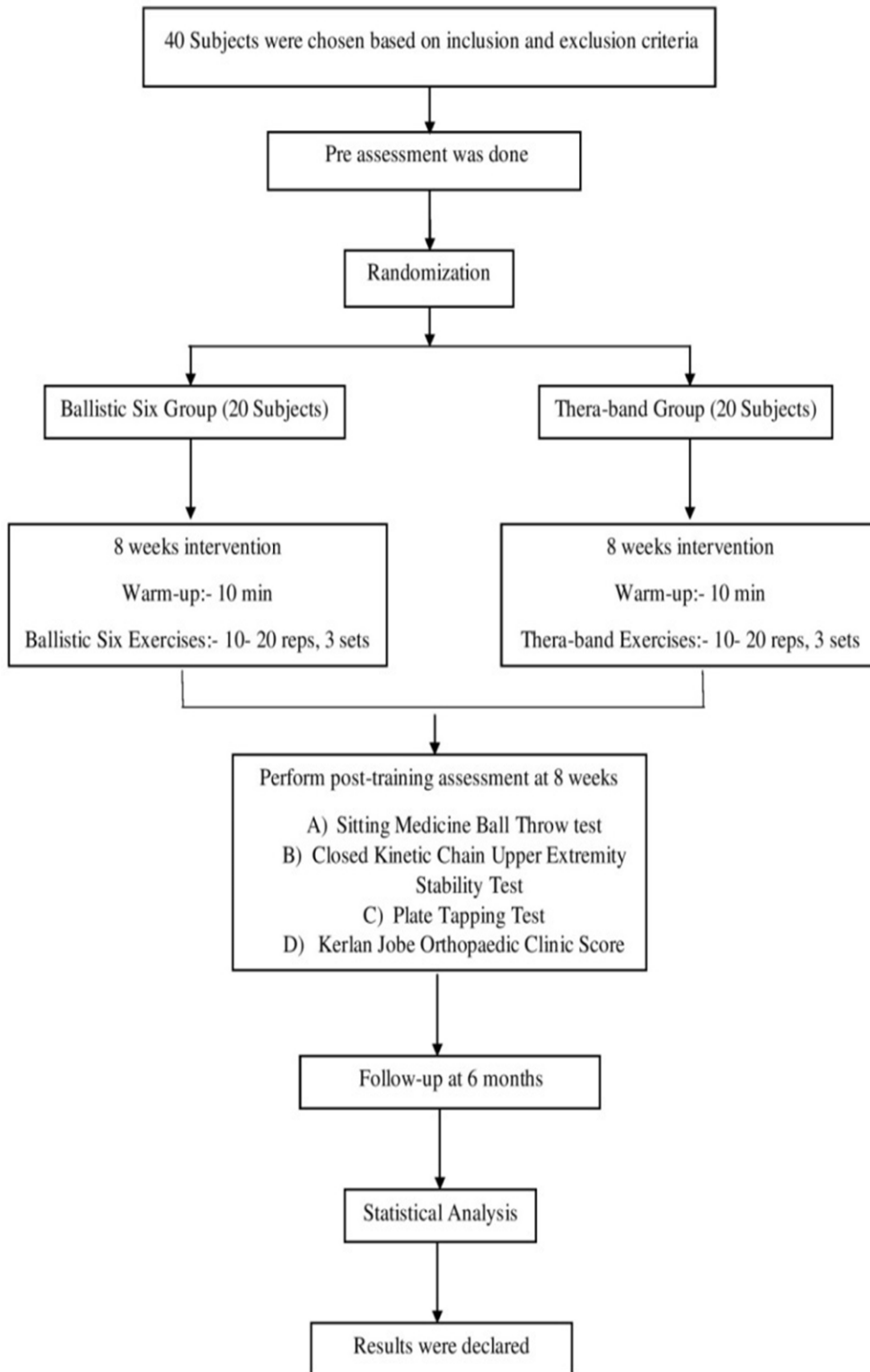


Fig. 1. Flowchart of procedure



**Fig. 2. Ballistic six training**

*Image 1: External rotation with latex tube; Image 2: 90/90 external rotation with latex tube; Image 3: Overhead soccer throws using a 6-lb fitness ball; Image 4: 90/90 external rotation side-throw using a 2-lb fitness ball; Image 5: Deceleration baseball throws using a 2-lb fitness ball Image 6: Baseball throws using a 2-lb medicine ball*



**Fig. 3. Theraband exercises**

*First row (Left to Right): Standing Shoulder Press, Chest Fly, and Triceps French Press; Second row (Left to Right): Biceps Curl, Rhomboid Squeeze, Trunk Twist; Third row (Left to Right): Reverse Flies, Concentration Curl, Scapular Retraction, Straight Arm Pull down; Fourth row (Left to Right): Chest Press, Triceps Kick Back, Rear Deltoid, and Dead Lift.*

After the sampling was done means and standard deviation were computed as part of descriptive statistics. Chi-square test, student's paired and unpaired t test, and descriptive and inferential statistics were used in the statistical analysis. For this analysis, both SPSS 27.0 versions and Graph – Pad Prism 7.0 version have been used. The significance value was chosen at  $P < .05$ .

### 3. RESULTS

Table 1 show the anthropometric data difference between groups. There have been no significant differences ( $P > .05$ ) between 2 groups as in pre - test findings linked with physical activity (age, gender, BMI). Table 2 shows mean (SD) performing parameter correlations of Group A and B across pre - test, posttest, as well as follow-up assessments. Within-group comparisons of pretest with posttest and follow-up in both groups were conducted using a student's paired t-test, which indicated remarkable improvement with  $P < .05$ , but Group A exhibited superior gain than Group B, as shown in Table 2 and Fig. 4.

### 4. DISCUSSION

The research examined on whether Ballistic six exercises and theraband exercises may help asymptomatic badminton players increase shoulder strength, agility, speed, and function between July 2020 to June 2021. The study's main findings revealed that there had been a significant difference across pre, post, and follow-up periods across both groups. ( $p < 0.05$ ). Six months of Ballistic Six training will enhance shoulder strength, agility, speed, and function when compared to theraband training.

During cocking phase, the dominant side had a strength ratio of 2.15:1 and the non-dominant side had a strength ratio of 1.71:1, however during the deceleration phase, the dominant side had a strength ratio of 0.97:1 and the non-dominant side had a strength ratio of 1.08:1. Muscle strengthening activities (shoulder stabilizers and rotator cuff muscles) and workouts to prevent loss of motion should be included in these athletes' rehabilitation [11].

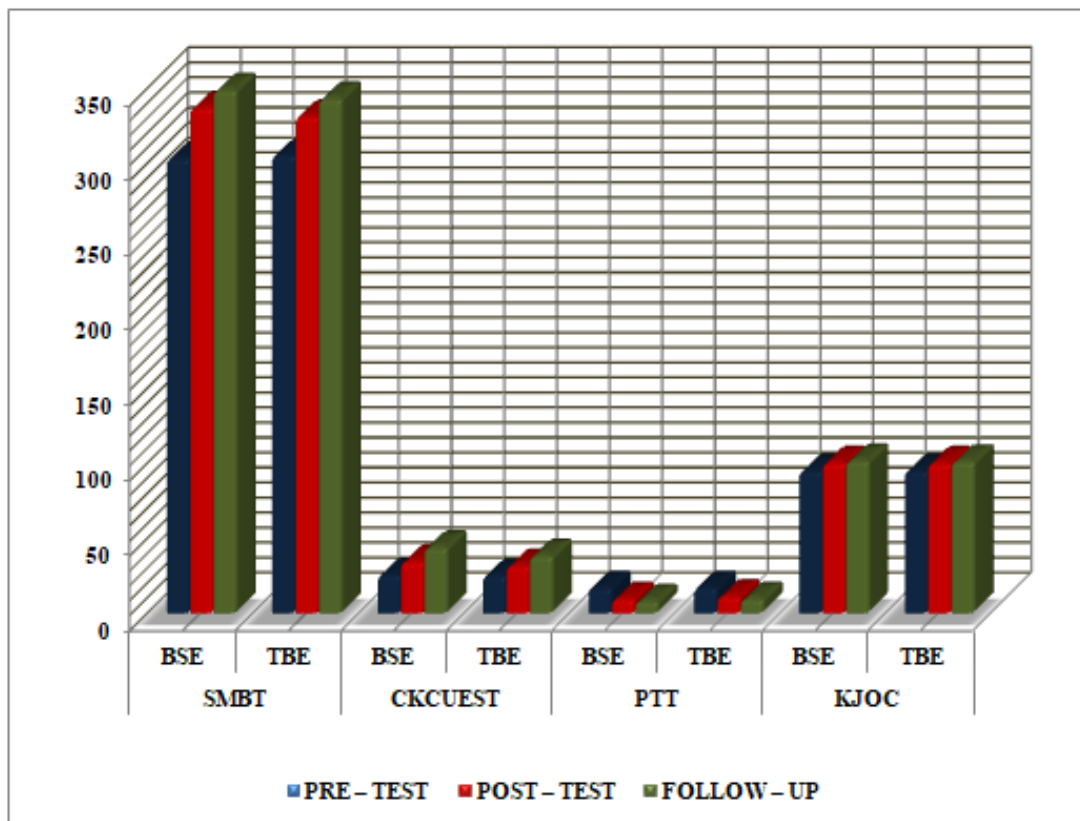
Sitting medicine ball throw test (SMBT) is a common tool for assessing bilateral upper limb strength in elite athletes, senior persons, college as well as university graduates, warriors, fit nonathletic populations, even kids. Despite this,

studies on link between SMBT, strength and power attributes, particularly among overhead athletes, is limited (9). In our study, there was significant difference within group for both Group A (pre: 301.50 and follow – up: 346.93) and Group B (pre: 303.40 and follow – up: 341.35), as a result, we may conclude that Group A improved more than Group B. Cronin and Owen (2004) discovered a modest relationship between a sitting throw with a 400-g ball with peak strength measured with a bench-press throwing among female netball athletes in a prior research [12]. Training responses among players, such as in adults, appear to be particular on movements sequence speed of movements, or contracting strength, resulting in greatest improvements in assessments best relevant to learning session.

Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST) came in second place. It is a method of activity assessment that offers measurable information (a score) for a close kinetic chain upper - extremity activity that is done in a sporting or therapy environment [13]. Though this position of such examinations is ineffective for throw (plank instead of standing), its usefulness lies in its engagement of complete kinetic chain during test execution. Ajit Dabhokar et al. (2018) discovered a strong relationship among both CKCUEST and external rotators of dominant hand in badminton players. During the follow through step of an overhead movement, shoulder joint was subjected to interruptive pressures of about 750N, which are primarily resisted by postero-inferior capsule. Posterior capsule is considered to be subjected to micro trauma as a result of recurrent loading, resulting in hypertrophy plus increased fibroblastic activity during healing phase, culminating in capsule stiffness and thickness. Capsular pliability is reduced, restricting internal rotation, extension, and horizontal adduction [14]. During this research, the CKCUEST increased from 23.90 to 42.15 in Group A and from 23.35 to 36.55 in Group B, because plyometric exercise builds a stronger foundation, which leads towards larger force production owing to both larger cross-sectional area as well as the resulting elastic element. Past evidence suggests that lower extremity preventive protocols incorporating plyometric workouts improve muscle performance [15]. If a neural benefits of plyometric were identical in multiple joints, then reduction in injury found following lower extremity training also can apply to upper extremity [16]. Treatments like plyometrics training give dynamic movements demanding significant muscle

**Table 1. Demographic data**

Demographic data			
Categories	Division	Group A	Group B
Age (in years)	18-20 yrs	9(45%)	7(35%)
	21-23 yrs	7(35%)	8(40%)
	24-25 yrs	4(20%)	5(25%)
Gender	Male	11(55%)	12(60%)
	Female	9(45%)	8(40%)
BMI		21.95	20.81



**Fig. 4. Comparison of performance variables for both groups**

Group A: Ballistic Six Exercise Group (BSE); Group B: Therband Exercise Group (TBE); SMBT: Sitting Medicine Ball Throw Test; CKCUEST: Closed Kinetic Chain Upper Extremity Stability Test; PTT: Plate Tapping Test; KJOC: Kerlan Jobe Orthopedic Score

strength, and certain training will increase agility since agility performance is likewise a dynamic movement needing high muscle force. Furthermore, plyometrics exercise, that improves balance as well as body control during movement, increases agility [17].

The plate tapping test was designed to assess the athletes' upper extremity movements' quickness. It is a response evaluation that uses an alternative tapping motion to evaluate upper extremity response timing, hand-eye quickness, as well as synergy [4]. During our study, the time

needed for complete 25 cycles with dominant hand decreased from 15.16 to 6.46 till follow-up in Group A, while it reduced from 15.18 to 7.86 in Group B. As a result of the findings, group A significantly outperformed group B in the plate tapping test. Both the decision-making speed as well as change-of-direction speed influences the agility performance, even if to varying degrees. Agility performance closely connects with decision response time, irrespective of players' sport expertise or past familiarity with agility training. It suggests both perception and decision making are perhaps the most critical

**Table 2. Performance variable for both groups**

Tests	Groups	Pre – test	Post – test	Comparison	Follow – up	Comparison	Between group comparison		
							Pre	Post	Follow – up
SMBT	Group A	301.50±6.04	335.15±7.02	24.40, P=.0001	346.93±4.66	40.75, P=.0001			
	Group B	303.40±5	329.29±3.75	37.39, P=.0001	341.35±3.18	48.66, P=.0001	1.13, P=.26	3.29, P=.002	4.42, P=.0001
CKCUEST	Group A	23.90±2.22	32.85±2.75	29.51, P=.0001	42.15±3.09	37.97, P=0.0001			
	Group B	23.35±2	30.05±2.03	22.33, P=.0001	36.55±2.25	28.91, P=.0001	0.82, P=.41	3.65, P=.001	6.53, P=.0001
PTT	Group A	15.16±1.25	7.96±0.95	27.57, P=.0001	6.46±0.62	34.49, P=.0001			
	Group B	15.18±1.26	9.53±1.37	27.90, P=.0001	7.86±1.03	38.22, P=.0001	0.05, P=.95	4.17, P=.0001	5.15, P=.0001
KJOC	Group A	93.16±3.41	98.56±1.13	7.57, P=.0001	99.94±0.14	8.74, P=.0001			
	Group B	93.18±3.44	98.41±1.73	10.58, P=.0001	99.42±0.88	9.47, P=.0001	0.02, P=.98	0.32, P=.74	2.59, P=.013

Group A: Ballistic Six Exercise Group; Group B: Theraband Exercise Group; SMBT: Sitting Medicine Ball Throw Test; CKCUEST: Closed Kinetic Chain Upper Extremity Stability Test; PTT: Plate Tapping Test; KJOC: Kerlan Jobe Orthopedic Score



factors in agility performance [18]. Our research results were analogous to those of Serban Radu Tiberiu and Hanțiu Iacob (2019), who examined the effects of a physical leisure program depending on structured tennis practice on physical performance among people who work in such a sluggish environment and discovered the existence of certain statistically significant differences in the overall fitness variables of participants in the intervention group: plate-tapping test, bent-arm-hung, shuttle run [19].

The Kerlan Jobe Orthopedic Clinical (KJOC) questionnaire was designed to measure the upper extremity's functional status, particularly in athletes participating in overhead sports. Standard pain assessment approaches, such as Disabilities of the Arm, Shoulder, and Hand questionnaire, fall short of assessing sport-specific features such as small alterations in endurance, velocity, power, and ball control. Thus according to studies, KJOC score helps discriminate between professional baseball competitors who isn't in pain, who've been performing despite discomfort, and who were not participating owing to pain. The 81.3 KJOC test score is highly accurate and reliable over other upper extremity questionnaire endpoints. A KJOC score of 81.3 or higher means that a player had resumed to playing with 95.1 % [20]. In this research, the KJOC score improved from 93.16 to 99.94 in Group A and from 93.18 to 99.42 in Group B. The KJOC score is also used to determine the functioning of throwing arm in actively healthy elite pitchers at various levels. There appeared being a significant large discrepancy KJOC score between many physically functional pitchers within AAA as well as AA teams (97.7 and 93.3), although here was no variation in the overall competitive years of expertise with estimates ranged 92.3 to 97.0. Infielders who had previously experienced shoulder or elbow injuries fared much worse than those who had not (86.7 vs. 96.9). The outcomes were also comparable to that of elite pitchers who required procedure or non-invasive treatment (88.7 and 87.8) [21].

There was a significant differences between 2 clusters, ballistic six exercise group (Group A) and theraband exercise group (Group B) once they were compared, showing that group A improved more than group B. Even though both the exercises were beneficial for improving the physical performance of shoulder in badminton players, ballistic six exercise group was better than theraband group. This finding of the study

was supported by the study done by Amrinder Singh et al., [22] which states that improved proprioception, kinesthesia and endurance of rotator cuff muscles, in addition to increased strength and power as an effect of Ballistic Six plyometric training and Carter et al.[10] found that while combined resistance plus plyometric upper-extremity programming enhanced strength over eight weeks, only plyometric exercise program boosted throw acceleration about 2.0 mph among college baseball athletes.

Swanik et al., who employed a 6-week shoulder plyometric training program for college swimmers which included rubber-tubing resistance and pitch back plyoball activities found identical results [23]. Our finding were also directly consistent with P. Sathya (2007)[6] who found that both the ballistic six exercise and free weight exercises are similarly helpful in enhancing cricket players' shoulder power. Ballistic six was shown to be more effective than free weight workouts. In addition, a prior research by Lim Joe Heang found that plyometric exercise improved lower extremity agility in badminton players during a 6-week duration. [24].

There was no evidence that Ballistic Six training improved upper body performance in young badminton players. Ballistic Six training may be used securely with normal badminton training for young adult badminton players, based on the current conclusions of this study. Because upper-extremity Ballistic Six training results in an increase in measured parameters, this could be used as a preventative program for badminton-related injuries in amateur players.

## 5. CONCLUSION

In summation, this current experiment provides data that supports use of a Ballistic Six plyometric training plan in conjunction to standard conditioning for novice badminton practitioners in attempt to optimize shoulder athletic performance contrasted to inclusion of therband training.

## 6. LIMITATIONS

Few limitations of the study were As large number of population in indulged in playing badminton, more samples could have been targeted. Due to ongoing pandemic, training was conducted indoor rather than at the badminton court itself. And lastly, the study had more number of males than females due to transportation issues.

## CONSENT

Prior to the commencement of the trial, participants were given a brief explanation and an informed written consent was acquired. In addition, authorization was obtained for the publication of photographs.

## ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the Institutional Ethics Committee of Datta Meghe Institute Of Medical Sciences and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

## FUNDING

All the necessary funds were provided by Datta Meghe Institute of Medical Sciences.

## ACKNOWLEDGEMENTS

Funding for the current study was done by Datta Meghe Institute of Medical Sciences, Wardha.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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