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EFFECT OF MAT PILATES VERSUS SWISS BALL EXERCISE TO IMPROVE CORE MUSCLE STRENGTH IN COLLEGE LEVEL BADMINTON PLAYERS – A COMPARATIVE STUDY

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ABSTRACT

Background: Badminton is a high-intensity intermittent sport that requires optimal core muscle strength for efficient transfer of force between the upper and lower extremities during dynamic movements such as lunges, jumps, trunk rotations, and rapid changes in direction. Improved core stability enhances movement efficiency, balance, and injury prevention by reducing excessive spinal loading and maintaining postural alignment during sports-specific activities. Exercise interventions such as Mat Pilates and Swiss ball exercises are commonly used to improve core muscle strength in athletes

Methodology: A comparative interventional study was conducted on 50 college-level badminton players who were randomly divided into two groups: Group A (Mat Pilates, n=25) and Group B (Swiss ball exercises, n=25). Both groups performed supervised exercise sessions five times per week for a duration of six weeks. Core muscle strength was assessed using the Prone Bridge Test (PBT) and 60-degree Curl-Up Test.

Results: Both groups showed statistically significant improvement in core muscle strength ($p < 0.05$). Between-group comparison revealed no significant difference in PBT scores ($p = 0.199$), whereas a

statistically significant improvement was observed in the 60-degree Curl- Up Test in the Swiss ball exercise group ($p = 0.01$).

Conclusion: Both Mat Pilates and Swiss ball exercises are effective in improving core muscle strength among college-level badminton players. Mat Pilates is more beneficial for improving static core endurance, whereas Swiss ball exercises are more effective in enhancing dynamic abdominal endurance.

Keywords: Badminton players, Core muscle strength, Mat Pilates, Swiss ball exercises, PBT, Curl-Up Test

INTRODUCTION

Badminton is one of the most popular sports in the world, with 200 million adherents. Originating in China and created in England. it is the national sport of various Asian countries. It can be practiced by anyone regardless of age or experience, and is the fastest racket game. Performance factors in badminton are many-fold, revealing the sport's complexity. Badminton is characterized by high-intensity, intermittent actions. This sport has five events: men's and women's singles, men's and women's doubles, and mixed doubles, each requiring specific preparation in terms of technique, control and physical fitness **[1]**.

Badminton is a non-contact racket sport which requires jumping, changing direction, rapid arm movements and a wide range of body postures. Badminton can be considered an intermittent individual sport, characterized by combining moments of high intensity interspersed with short periods of low intensity or rest.

The Pilates method can be performed on the ground, also known as mat Pilates, using only the body weight, promoting an increase in the intensity through variation and difficulty of the exercise. This increase in loads provides important benefits to the individual's physical conditioning and trainable physical abilities, improving strength and being able to influence the results of body composition **[2]**.

Pilates results in various physical improvements such as, increases in flexibility, bone density and dynamic balance as well as favorable changes in body mass index and have a positive effect on muscular strength and endurance. Correct breathing during Pilates can also prevent excessive stress on the heart, result in total body relaxation and mental calmness. This reduction in stress as a result of Pilates can reduce other serious complications. It may directly or indirectly result in an improvement in cardio-metabolic parameters, especially in the elderly, resulting in reduced risk of developing coronary artery disease (CAD) **[3]**.

The Swiss ball (or gym ball) is widely reported in the recreational training

environment to be a training device for core stability exercises.1 However, there is little scientific evidence to support its use. It is also not clear whether performing an exercise on a Swiss ball has greater benefit than performing the same exercise on a stable surface **[4]**.

The use of Swiss ball training for core muscle development has been popular for several years.8 Multiple studies have examined core muscle recruitment during varying types of Swiss ball abdominal exercises and during traditional abdominal exercises like the crunch (abdominal curl-up) and bent-knee sit-up. Most researchers who studied the use of Swiss ball exercises quantified abdominal muscle activity during the crunch, push-up, and bench press exercises, and typically investigated the recruitment patterns of only 1 or 2 muscles. Numerous other Swiss ball exercises are used in training and rehabilitation to enhance core development and stability. For example, prone hip extension performed on a Swiss ball is commonly used for gluteus Maximus and hamstrings development **[5]**.

In badminton, the Swiss Ball practices for arms focus on the biceps, the triceps just as the external and inward lower arms. Portable weights can be an extraordinary quality preparing exercise and can focus on each muscle in your body when utilized the correct way **[5]**. This exercise has been assembled to concentrate on the chest area and tosses in a couple of absolute body movements too that likewise center around the chest area. Both the preparation programs are particularly identified with building up the dangerous explicitly for the focused-on muscle gatherings **[6]**.

Pilates Exercise increases muscle mass, body, and shoulder strength, and the hamstring-to-quadriceps strength ratio in baseball players. Similar results have shown that PE positively affects trunk strength in baseball athletes **[8]**.

From a biomechanical perspective, Swiss ball exercises enhance the ability of the core musculature to act as a stable base for limb movements. In many sports, effective force generation in the upper and lower extremities depends on proximal stability of the trunk. Swiss ball exercises challenge this stability by requiring athletes to control trunk posture while performing limb movements, thereby closely simulating sport-specific demands. Behm *et al*. (2002) emphasized that although maximal force production may be reduced under unstable conditions, the neuromuscular adaptations gained from such training are highly relevant for athletes who require dynamic stability rather than isolated strength **[7]**.

Badminton is one of the most popular sports in the world, with 200 million adherents. There is a lack of research directly comparing the effectiveness of these two training methods on core muscle strength

specifically among college level badminton players. These finding will not only contribute to the existing body of knowledge in sport but also will offer practical recommendations for enhancing athletic performance and minimizing injury risk in sport.

MATERIALS AND METHODOLOGY

The study conducted after taking ethical consideration from the college and the committee after that the data collection was done from the badminton academy after acquiring written consent and explaining the procedure to them.

Inclusion criteria are **[9]** Subjects enrolled for college badminton team, Subjects within the age group of 18-25 years., Subjects not undergoing any core strengthening program, Subjects willing to participate, Males included, Subjects playing badminton at least from 1 year.

Exclusion criteria are **[9, 10]** Subjects with pain or inflammation, Subjects on any medication (muscle relaxants or anti-inflammatory drugs), Subjects with joint pathologies (RA, spondylolysis, spondylolisthesis, spondylosis), Subjects with cardiovascular disease, Players with any recent injury in past 6 months involving mainly the lower back, Participants currently enrolled in any other clinical trial.

OUTCOME MEASURES

1. Prone bridge test **[11]** - The Prone Bridge Test was performed with the participants in the plank position in a smooth and stable surface. Participants were asked to hold the position volitional exhaustion or until repeated technique failure. The Time was recorded.
2. 60 degrees curl up test **[11, 12]** – it was done with subjects positioned on the plinth against a wedge supporting the back so that the hip was flexed to 60 degrees. Knees flexed to 90 degrees as measured with goniometer in that stable arm is parallel to the ground and movable arm is at the supporting wedge. The test began when the wedge was removed and was terminated when the subject could no longer maintain the 60-degree angle independently. Subjects were asked to hold the position as much as possible. The duration on the stopwatch was noted for the individual subject.

PROCEDURE:

The study conducted after obtaining Institutional Ethical Approval. The study commences by taking a written consent form. A detail explanation of the treatment and purpose of study will be given to the patient. Based on inclusion criteria patient are divided into 2 groups.

Group A will be given Mat Pilates exercises and Group B will be given Swiss ball exercises. Outcome measures will be taken pre and post intervention. Each patient in

both the group receives a treatment protocol of 5 days in a week for 6 weeks.

GROUP A [13]

Week	Exercises	Reps, hold time
1	Abdominal bracing, hollowing, prone, supine, side bridge	All the exercises will be held for 20 sec
2	Quadruped alternate-arm leg raise, supine bridge exercise with alternate leg extension, seated marching on physio ball, crossover crunch	20 reps
3	Dead bug, Supine bridge on physio-ball, Prone bridge on physio-ball, Superman exercises.	20 reps Hold 20 sec Hold 20 sec Hold 2 sec/20 reps
4	Medicine ball floor twist, Curl-up on physio-ball, Pelvic bridge alternating knee extension and shoulder flexion, Superman on physio-ball.	20 reps 20 reps 20 reps Hold 2 sec/20 reps.
5	Lunge with medicine ball twist, Abdominal rollout, Ball bridge with alternate knee extension.	20 reps 20 reps Hold 2 sec/20 reps.
6	Physio-ball lunge, Side bridge with shoulder abduction, Physio-ball alternate superman	10 reps on each leg 15 reps on each side 20 reps

GROUP B [12]: The subjects performed this exercise protocol in their warmup program before starting the badminton exercises

Exercise name	Exercise set
Warm up	10 min
Roll away	At first four weeks: 3 sets 10 times – at final two weeks: 3 sets 12 times
Reverse bridge	At first four weeks: 2 sets until the hips starts falling - at final two weeks: 3 sets until the hips starts falling
Side curl	For each side of body: At first four weeks: 10 sets 10 iterations - at final two weeks: 3 sets 12 iterations
Plank	At first four weeks: 2 sets until the pelvis starts falling - at final two weeks: 3 sets until the pelvic begin falling
Hamstring curl	At first four weeks: 10 sets 10 iterations - at final two weeks: 3 sets 12 iterations
Press up	At first four weeks: 10 sets 10 iterations - at final two weeks: 3 sets 12 iterations
Back extension	At first four weeks: 10 sets 10 iterations - at final two weeks: 3 sets 12 iterations
Reverse plank	At first four weeks: 2 sets until the pelvis starts falling - at final two weeks: 3 sets until the pelvic starts falling

STATISTICAL ANALYSIS

The entire data is statistically analyzed using (SPSS version 26.0, IBM Corporation, USA) for MS Windows. The Shapiro-Wilk test for normality reveals that data was not normally distributed. Probabilities of less

than 0.05 considered as statistically significant.

Wilcoxon Sign Rank test was used to check significant difference on dependent sample.

Mann Whitney U test was used to compare two independent groups and comparison of groups.

RESULTS

Table 1: Within The Group Comparission Of Prone Bridge Test And 60° Curl Up Test

GROUPS	TEST	MEAN ± SD	P-VALUE
SWISS BALL	pre PBT	72 ± 8.53	0.001*
	Post PBT	82.6 ±8.18	
	pre CURL-UP	32 ±5.4	0.001*
	post CURL-UP	40 ±5.95	
MAT PILATES	pre PBT	72.8 ±8.54	0.001*
	Post PB	85.80 ±9.53	
	pre CURL-UP	32 ±5.2	0.001*
	post CURL-UP	35.92 ±5.33	

Table 1 describes that the both the outcome measure that is prone bridge test and 60 degree curl up test has been found highly significant in both the groups Swiss ball and mat Pilates with $p<0.005$

Table 2: Between The Group Comparission Of Prone Bridge Test And 60° Curl Up Test

VALRIABLE	GROUPS	MEAN	PVALUE
PBT	SWISS BALL	84.2	0.199
	MAT PILATES		
CURL UP	SWISS BALL	38.84	0.01*
	MAT PILATES		

The collective assessment of the sixty-degree curling test and the lying down footbridge test is shown in the **Table 2** aforementioned. The Sixty degree curling test showed an important result in both categories with an independent p-value of 0.01; the reclining footbridge test did not show any findings that were noteworthy.

with p value 0.19

DISCUSSION

Badminton is a high-intensity intermittent sport characterized by lunges, jumps, rapid changes in direction, trunk rotations, and overhead strokes. Efficient force transfer between the lower and upper extremities depends heavily on optimal core stability **[14, 17]**. Improved core strength enhances movement efficiency, balance, and injury prevention by reducing excessive spinal loading and maintaining postural alignment during dynamic activities.

The findings of the present study suggest that Mat Pilates is more effective in improving static postural control, while Swiss ball exercises are superior in enhancing dynamic abdominal endurance. These adaptations are particularly beneficial for badminton players, as poor core stability has been associated with increased injury risk and decreased performance efficiency **[12]**.

The present study was conducted to compare the effectiveness of **Mat Pilates and Swiss ball exercises** on **core muscle strength** in college-level badminton players using the **Prone Bridge Test (PBT)** and **60-degree Curl-Up Test** as outcome measures. The findings demonstrated that **both intervention protocols produced statistically significant improvements in core muscle strength**, with differences observed in static and dynamic core endurance between the groups.

Effect of Mat Pilates on Core Muscle Strength

The results of the present study revealed a **highly significant improvement in core muscle strength following Mat Pilates training,** as reflected by significant increases in both the Prone Bridge Test and the 60-degree Curl-Up Test scores ($p = 0.001$). Hence, the **null hypothesis ($H0_1$)** was rejected and the **alternative hypothesis (H_{11})** was accepted.

Mat Pilates emphasizes **controlled movement patterns, precision, postural alignment, and sustained activation of deep stabilizing muscles**, particularly the transversus abdominis, multifidus, internal oblique, and pelvic floor muscles [16]. These muscles are essential for maintaining spinal stability and postural endurance during isometric tasks such as the prone bridge position. The observed improvement in PBT scores in the Mat Pilates group suggests enhanced **static core endurance and neuromuscular control,** which are vital for badminton players who frequently maintain prolonged semi-flexed and rotational postures during play.

These findings are supported by Ammar *et al*., who reported significant improvements in core strength and agility following mat Pilates training in badminton players, attributing the gains to improved trunk muscle endurance and coordination **[13]**. Similarly, Cattolico *et al*. found significant increases in core muscle strength and flexibility in young athletes following prolonged mat Pilates training, highlighting its effectiveness in enhancing neuromuscular efficiency **[14]**. Morzia Khatoon also demonstrated significant improvements in core endurance and dynamic balance among elite badminton players following Pilates-based core strengthening programs **[15]**.

From a biomechanical standpoint, Pilates training enhances **feed-forward activation of the deep core musculature,** which improves anticipatory postural adjustments during dynamic limb movements **[14]**. This mechanism is particularly important in badminton, where rapid trunk stabilization is required before executing overhead strokes and sudden directional changes

Effect of Swiss Ball Exercises on Core Muscle Strength

Within-group analysis of the Swiss ball exercise group showed **statistically significant improvements** in both PBT and 60-degree curl-up test scores ($p = 0.001$), leading to rejection of the **null hypothesis ($H0_2$)** and acceptance of the **alternative hypothesis (H_{12}).**

Swiss ball exercises are performed on an **unstable surface**, which increases neuromuscular demand and requires continuous postural adjustments to maintain balance **[17]**. This instability enhances activation of both superficial and deep core muscles, including the rectus abdominis, external obliques, and spinal stabilizers. The greater improvement observed in the 60-degree Curl-Up Test suggests enhanced **dynamic abdominal endurance**, which is essential for repetitive trunk flexion and rotational activities commonly performed in badminton.

Marshall and Murphy demonstrated that performing core exercises on unstable surfaces such as Swiss balls significantly increases trunk muscle activation compared to stable surfaces **[17]**. Vera-Garcia *et al*. also reported increased abdominal muscle co-contraction during Swiss ball exercises, contributing to improved trunk stability and motor control [43]. Furthermore, Jasim *et al*. observed significant improvements in neuromuscular control and functional performance in athletes following Swiss ball training, supporting its effectiveness in enhancing dynamic core strength **[16]**.

Comparison Between Mat Pilates and Swiss Ball Exercises

Between-group analysis revealed **no statistically significant difference in Prone Bridge Test scores** between the Mat Pilates and Swiss ball groups ($p = 0.199$), indicating that **both interventions were equally effective in improving static core endurance.** Therefore, the **null hypothesis ($H0_3$)** was accepted for the Prone Bridge Test outcome.

This finding aligns with previous research showing that different core training modalities can produce comparable improvements in static trunk endurance [15,20]. Both Mat Pilates and Swiss ball exercises emphasize sustained core activation, which likely explains the similar improvements in PBT performance.

However, a **statistically significant difference was observed in the 60-degree Curl-Up Test**, favor the Swiss ball exercise group ($p = 0.01$). This finding led to the acceptance of the **alternative hypothesis (H_{14})**, indicating that Swiss ball exercises are more effective than Mat Pilates in improving **dynamic abdominal endurance.**

The curl-up test requires sustained concentric and isometric activation of the abdominal muscles under dynamic conditions. Swiss ball training closely

replicates these demands by continuously challenging trunk stability during movement, thereby enhancing neuromuscular coordination and proprioceptive feedback **[18, 21]**. Behm *et al*. reported that unstable surface training improves neuromuscular adaptations and balance, which are more relevant for athletic performance than maximal force production alone **[21, 22]**.

CONCLUSION

The findings of the present study indicate that both Mat Pilates and Swiss ball exercises are effective interventions for improving core muscle strength among college-level badminton players. Mat Pilates showed greater effectiveness in enhancing static core endurance, as demonstrated by improved performance in the Prone Bridge Test. In contrast, Swiss ball exercises were more effective in improving dynamic abdominal endurance, as evidenced by significantly better results in the 60-degree Curl-Up Test.

However, neither training approach proved to be superior across all components of core strength. Therefore, both exercise protocols can be successfully incorporated into badminton conditioning programs, with the choice of intervention guided by the specific performance goals of the athlete.

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