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THE CORRELATION BETWEEN CORE STABILITY WITH ARM EXPLOSIVE POWER AND LEG EXPLOSIVE POWER IN BADMINTON ATHLETES

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ABSTRACT

This study has been undertaken to correlate core stability with Arm and Leg explosive power in badminton athletes. Core stability was assessed using the McGill Core Stability Test. Arm explosive power was measured through the Medicine Ball Throw Test (MBTT) and Upper-Quarter Y-Balance Test (UQYBT), while leg explosive power was evaluated using the Sergeant Vertical Jump Test (SVJT) and Lower-Quarter Y-Balance Test (LQYBT) in 69 participants. A significant correlation ($p < 0.05$) was found between McGill Mean SB/TET scores and MBTT performance, suggesting that core stability enhances upper-body explosive power. Additionally, a strong correlation ($p < 0.01$) was found between McGill Mean SB/TET scores and SVJT, highlighting the importance of core stability in leg explosive power. Weak but positive correlations were observed between core stability and balance measures (UQYBT & LQYBT), indicating the role of core strength in overall movement efficiency

KEYWORDS: *Correlational Study, Core Stability, Arm Explosive Power, Leg Explosive Power, Badminton Athletes*

INTRODUCTION

Badminton is a demanding sport that requires a unique blend of athletic abilities. To excel in badminton, athletes must possess exceptional levels of speed, agility, explosive power, and a refined sense of balance. The ever-changing and unpredictable nature of the game demand athlete to make rapid adjustments to their body positioning and quick reaction time, the ability to adapt seamlessly to new situations, and the capacity to execute precise movements even when under significant pressure.

A strong and stable core provides the essential base from which efficient movement and powerful force generation can originate and in unison to support the entire kinetic chain of the body. This enhanced support translates to improved overall stability, allowing for the efficient and seamless transfer of power during the complex and often rapid movements that are characteristic of badminton. This, in turn, significantly improves agility and responsiveness on the court.

Core stability specifically refers to an athlete's ability to maintain control over the position of their trunk in relation to their pelvis it is crucial as it optimizes force production and allows for the efficient transfer of power throughout the entire body, from the legs and core to the arms and racquet. Core stability is a dynamic attribute, meaning that it is not static but constantly adapting to the specific demands of each and every movement that a badminton player makes on the court not just individual muscles; rather, it relies on the integrated and coordinated function of various muscle groups,. This highlights that core must be able to react and adapt to the ever changing conditions of the game. Insufficient core strength significantly compromises a player's balance, making them more susceptible to falls and injuries. Weak core muscles also disrupt the efficient transfer of energy throughout the body, leading to compensatory movements. These compensatory movements often place undue stress on other muscles and joints, ultimately leading to overuse injuries. Conversely, core stability training has been shown to significantly enhance athletic performance in badminton. Explosive power is absolutely critical for achieving success in badminton. It enhances an athlete's ability to execute powerful shots that can overwhelm an opponent, increases court speed, enabling faster reactions and quicker movement around the court, and improves overall agility. explosive power also mitigates the risk of injury by improving the body's capacity to withstand the intense physical demands of the sport. A player with good leg explosive power is better equipped to absorb impact and recover quickly from strenuous movements, reducing the likelihood of strains, sprains, and other common badminton injuries. Arm explosive power is vital for delivering powerful serves that can put immediate pressure on the opponent, executing devastating smashes that can win points outright, and performing delicate net shots with precision and finesse. The ability to rapidly generate power in the arm translates directly to a significant advantage on the court, increasing both the raw power and the subtle finesse of a player's shots. A player who can quickly and efficiently transfer power from their core through their arm and into the racquet is a formidable opponent. However, existing research on the direct relationship between core stability and specific badminton performance measures has yielded inconsistent results. This inconsistency suggests that a more holistic approach is needed, one that involves a.

NEED OF THE STUDY

Despite existing literature, the results are conflicting and needs a comprehensive assessment of the entire kinetic chain. Focusing solely on the core in isolation may not fully capture the complex interplay of factors that contribute to performance. The primary aim of this study is to rigorously investigate and correlate core muscle stability with leg and arm explosive power in badminton athletes. The results will serve as a valuable stepping stone for the development of sports-specific exercise prescriptions and help design more effective and targeted training programs for badminton athletes.

AIMS

To Correlate Between Core Stability with Arm Explosive Power and Leg Explosive Power in Badminton Athletes

Objective

- To assess Core stability with Arm explosive power in badminton athletes.
- To assess Core stability with Leg Explosive power in badminton athletes

METHODS

The correlation study was conducted amongst 69 participants playing badminton in ages 20-40 years. Participants were recruited keeping the inclusion and exclusion criteria in mind. They included participants of both genders playing badminton Exclusion Criteria were and recent injury to upper and lower extremity and to Back as well as Acute low back pain as it can lead to further complication or increase risk pf injury. Each participant signed and informed consent form, and a patient record form. Limb length for upper and lower limb was taken and Participants were explained how to perform test for all in McGill Test for core stability followed by sergeant's vertical jump test,lower-Quarter Y-Balance Test (LQYBT),Medicine Ball Throw Test(MBTT),upper-Quarter Y-Balance Test (UQYBT) and all values were obtained.

MATERIALS

McGill Test

Each participant completed a practice trial before the actual test to become familiar with the procedure. The maximum duration for which the participant could hold the test position was recorded using a stopwatch.

- Trunk Flexor Test (TFT) This test measured the endurance of the anterior core muscles, particularly the rectus abdominis. The participant began in a seated position with the back angled at 60°, knees bent at 90°, and arms crossed over the chest. Timing began when a wooden plank supporting the back was moved 10 cm backward. The test was terminated when the subject was no longer able to maintain the 60° trunk position.
- Trunk Extension Test (TET) Each participant was asked to lay prone with their iliac crest positioned at the edge of a table, allowing the upper body to extend freely beyond the surface. The lower body was secured with two support straps placed below and above the knees. The participant held their body horizontally with arms folded across the chest for as long as possible. 32 The test was concluded when the subject could no longer maintain the position, and the time was recorded [8].
- Right and Left Flexor Test (Side Bridge Test) This test assessed lateral core endurance and was performed in a side-bridge position. The participants lay on their side with one leg stacked over the other and the elbow placed on the mat for support. The opposite arm was positioned across the chest, with the hand resting on the opposite shoulder. The participant elevated the pelvis, aligning the body in a straight line. The timer started when the subject achieved a straight-line position and stopped when they were no longer able to hold the position, allowing the hip to lower onto the mat.

Leg Explosive Power

a. Sargent Vertical Jump Test

Test was conducted to evaluate leg explosive power the participants completed a warm-up before performing the test. The subject stood sideways to a wall and reached upward with the handclosest to the wall while keeping both feet flat on the ground, the highest point reached by the fingertips was marked or recorded. This measurement was referred to as the standing reach

height then participant then moved slightly away from the wall and performed a maximal vertical jump, using both arms and legs to propel the body upwards, attempting to touch the wall at the highest pointof the jump and the jump height wasrecorded, and the difference between the standing reach height and the jump height was calculated as the final scorethree attempts givendata was recorded in cm.

b. Lower Quadrant Y Balance Test [LQYBT]

This dynamic test was performed while standing on one leg. It assessed how the core and each leg functioned when subjected to body weight loads. Before the test, participants removed their footwear and stood at the center of the Y Balance Test instrument. The subject maintained a single-leg stance while reaching as far as possible with the opposite leg before returning to the starting position on the center platform without losing balance,performing the test in three directions—anterior, posteromedial, and posterolateral— with three trials per leg. The longest reach achieved in each direction was recorded. A composite score for each leg was calculated using the formula:Composite Score = [(Sum of the greatest reach in each direction) / (3 × Limb Length)] × 100.

Figure 1

Medicine Ball Throw Test (MBTT)

The participant assumed a tall kneeling position (knees flexed at 90° with a neutral trunk) on a mat while holding a medicine ball at chest level. A 6.6 lb (3 kg) medicine ball was used, (18) the subjects was instructed to throw the ball horizontally as far as possible using a two-handed chest pass technique each participant completed three trials, and the best recorded distance was used for analysis.

Upper-Quarter Y-Balance Test (UQYBT)

To perform the test each participant assumed a closed-chain push-up position and extended one hand in three directions while keeping the other hand on the stance platform and maintaining the push-up posture testing began with the right hand on the stance platform, while the left hand reached as far as possible in the medial, inferolateral, and superolateral directions. The test was then repeated with the opposite hand the reach distance was determined by noting the position of the reach indicator on the measurement tape and maximum reach distance in each direction was recorded. A composite score for each arm was calculated using the formula: Composite Score = [(Sum of the greatest reach in each direction) / (3 × Limb Length)] × 100 The composite reach distance scores were calculated as the average of the three normalized reach distances for both limbs

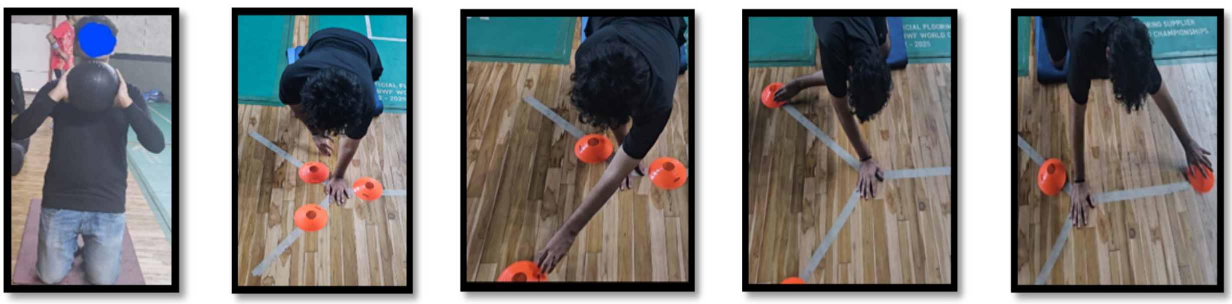

Figure 2

Statistical Analysis

All data were entered into a computer by giving coding system, proofed for entry errors.Data obtained was compiled on a MS Office Excel Sheet(2019) and was subjected to statistical analysis using Statistical package for social sciences (SPSS v 26.0, IBM). Descriptive statistics like frequencies and percentage for categorical data, Mean & SD for numerical data has been depicted. Normality of numerical data was checked using Shapiro-Wilk test & was found that the data did not follow a normal curve; or for graded data, hence non parametric tests have been used for comparisons. The Bivariate correlation between 2 numerical variables was checked using Spearman's correlation coefficient and for all the statistical tests, $p < 0.05$ was considered significant.

RESULTS AND DISCUSSIONS

Badminton is a demanding sport that requires a unique blend of athletic abilities. To excel in badminton, athletes must possess exceptional levels of speed, agility, explosive power, and a refined sense of balance. The ever-changing and unpredictable nature of the game means that players are constantly required to make rapid adjustments to their body positioning. A strong and stable core provides the essential base from which efficient movement and powerful force generation can originate. The abdominal, back, and hip stabilizing muscles work in perfect harmony and unison to support the entire kinetic chain of the body. This enhanced support translates to improved overall stability, allowing for the efficient and seamless transfer of power during the complex and often rapid movements that are characteristic of badminton.

The kinetic chain initiates from the ground, with leg push-off during jumps or lunges. Feet, ankles, knees, and hips absorb and transfer force to the upper body. Quadriceps and hamstrings generate explosive force, while glutes provide power during push-off and maintain stability during landings. Calves facilitate quick directional changes. Weak glutes or poor ankle mobility can lead to knee valgus, increasing ACL tear risk. Improper push-off mechanics reduce jump height and slow movement. During a badminton jump smash, ground reaction force (closed kinetic chain) travels upward through the core to the upper body, maximizing shuttle speed. The core acts as a bridge, efficiently transferring energy while maintaining balance. Trunk rotation is critical for powerful shots like smashes and backhand clears. The rectus abdominis supports stability and absorbs shock; obliques facilitate twisting and rotational movements; and erector spinae controls posture and movement. Hence, a weak core disrupts force transfer, resulting in weaker shots and slower reaction times, increasing the risk of lower back injuries. Compensation by the shoulder and arm leads to inefficient strokes and overuse injuries**.** Our study reinforces that core stability plays an important role in maintaining balance, transmission of force. weak core causes interrupted transmission of force, thus leading to further over use injury, it suggests that neuromuscular coordination enhances the power generation while weak muscle can lead it knee and ankle instability. The Kinetic chain plays and important role, disruption of which thus reduces performance of athlete, which acts as a segmental link between upper and lower extremities.

Table 1

Demographic Profile	Number	%
Gender		
Male	34	48.57
Female	36	51.43
Age group		
20-21yrs	26	37.14
22-23yrs	24	34.29
>=24yrs	20	28.57
Mean	22.54	
SD	2.15	
BMI		
Underweight	7	10.00
Normal	35	50.00
Overweight	28	40.00
Mean	23.89	
SD	4.24	
Dominance		
Right	67	95.71
Left	3	4.29
Total	70	100.00

Our study showed a significant correlation between McGill Mean SB/TET scores and sergeant's vertical jump test(SVJT) performance ($p < 0.01$), suggesting that core endurance and stability are essential for lower-limb power production and jump efficiency. No significant correlation with individual McGill parameters (TFT/TET and RSB/LSB) was found, (r-0.031 and 0.093 respectively), indicating over all core stability plays a more important role than isolated core muscles. The positive correlation between McGill scores and Sergeant Vertical Jump Test (SVJT) performance in our study may be due to role of enhanced neuromuscular coordination in improving lower limb power. The efficient Neuromuscular coordination between the nervous system and muscles, allows a synchronized and optimized movement pattern. this minimizes the energy loss and allows the lower limbs to exert maximum power during take-off. Additionally, neuromuscular coordination also enhances muscles while ensuring that the force generated from the legs is effectively directed toward vertical propulsion. Weak core muscles, on the other hand, can lead to postural instability, inefficient force production, and excessive trunk movement, all of which reduce jump height and efficiency**.**The core stability and Arm Explosive Power which was assessed by McGill test and Medicine Ball Throw Test. (MBTT) Our research suggests that athletes with greater core stability scores (McGill Mean SB/TET) were having better upper and lower limb explosive power, highlighting the importance of core strength in stabilizing and supporting high-performance motions MBTT scores were Weak but significant correlation (r-0.283) with McGill Mean SB/TET scores ($p < 0.05$), suggesting that athletes with stronger core stability generate more force in upper-extremity actions. While our found no significant correlation was observed with individual McGill parameters (TFT/TET and RSB/LSB), implying that comprehensive core endurance, rather than isolated muscle strength, contributes to upper limb explosive power. our findings align with study done by Ahemed et.al which also found affair but positive correlation (r-0.269) The study done by Sharrock et al. (2011), suggests that core stability influences shoulder mechanics and its contribution to upper limb force production in overhead sports such as badminton. The previous study conducted found that weak core muscles contribute to poor shoulder mechanics, increasing the risk of injuries in overhead athletes. Thus, suggesting that a stable trunk prevents excessive compensatory movements in the shoulder girdle, allowing for optimal power transfer during overhead strokes.The weak but positive correlation may be because core is responsible for transmission of power, as a stable and strong core helps transfer force efficiently from the lower body to the upper body during explosive movements like a medicine ball throw. But if core is weak transmission will be interrupted. Additionally, neuromuscular coordination is responsible for efficient control also plays an important role as in medicine ball throw test core has to engaged for longer duration for maintaining stability and posture during the MBTT but McGill Core Endurance Tests focus on isometric endurance of the core muscles. As Weak core muscles are associated with higher risk of injury rates in the lower back, knees, and ankles (McGill, 2015). Strengthening the core enhances neuromuscular control, reducing excessive compensatory movements that lead to overuse injuries.

Our study found a weak but positive significant correlation between McGill Mean SB/TET scores and Upper (UQYBT) with (for Right r=0.235,and Left r=0.285)and in Lower Quadrant Y-Balance Test (LQYBT) our study found a weak but positive correlation (for Right r=0.165,and Left r=0.146) thus indicating interrupted transmission of power in both quadrants ,since balance is crucial in badminton, players frequently perform single-leg stances, lateral lunges, and rapid directional shifts. The weak but positive correlation may be because core is responsible for transmission of power, as a stable and strong core helps transfer force efficiently from the lower body to the upper body during explosive movements like a medicine ball throw. But if core is weak transmission will be interrupted Additionally, neuromuscular coordination is responsible for efficient muscle control and plays an important role. Additionally, neuromuscular control is also responsible for reducing postural instability and reducing trunk rotation movements.

Table 2: McGill Test Correlation with UQYBT

Parameter		Correlation (r -Value)	Significance
McGill test TET/TFT	MBTT	0.282	Not Significant
	UQYBT RIGHT	0.020	Not Significant
	UQYBT LEFT	0.024	Not Significant
McGill RSB/LSB	MBTT	0.093	Not Significant
	UQYBT RIGHT	0.119	Not Significant
	UQYBT LEFT	0.114	Not Significant
McGill Score MEAN SB/TET	MBTT	0.283	Significant, ($p < 0.05$)
	UQYBT RIGHT	0.235	Significant ($p < 0.05$)
	UQYBT LEFT	0.285	Significant ($p < 0.05$)

Table 3:McGill Test Correlation with LQYBT

Parameter McGill test		Correlation (r -Value)	Significance
TET/TFT	SVJT	0.139	Not Significant
	LQYBT RIGHT%	0.145	Not Significant
	LQYBT LEFT%	0.032	Not Significant
RSB/LSB	SVJT	0.041	Not Significant
	LQYBT RIGHT%	0.173	Not Significant
	LQYBT LEFT %	0.161	Not Significant
MEAN SB/TET	SVJT	0.632	Significant ($p < 0.01$)
	LQYBT RIGHT %	0.165	Not Significant ($p < 0.05$)
	LQYBT LEFT %	0.146	Not Significant ($p < 0.05$)

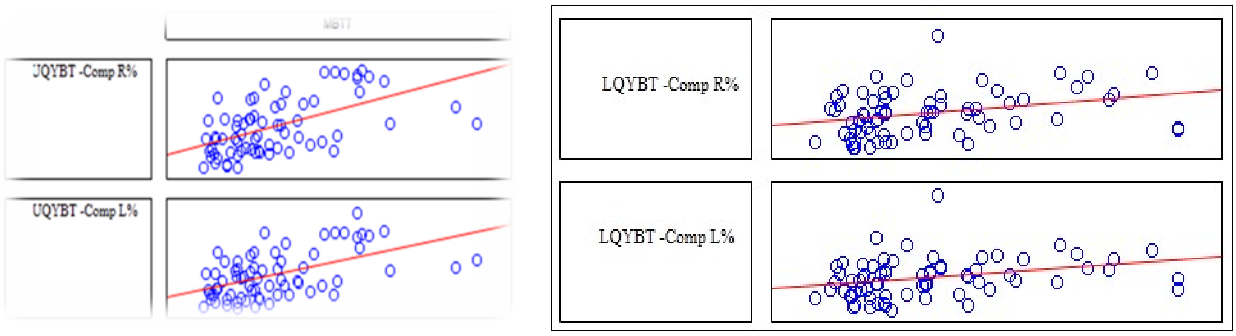

Figure 3: Scatter Diagram of Correlation between LQYBT Scores with Vertical Jump Test.

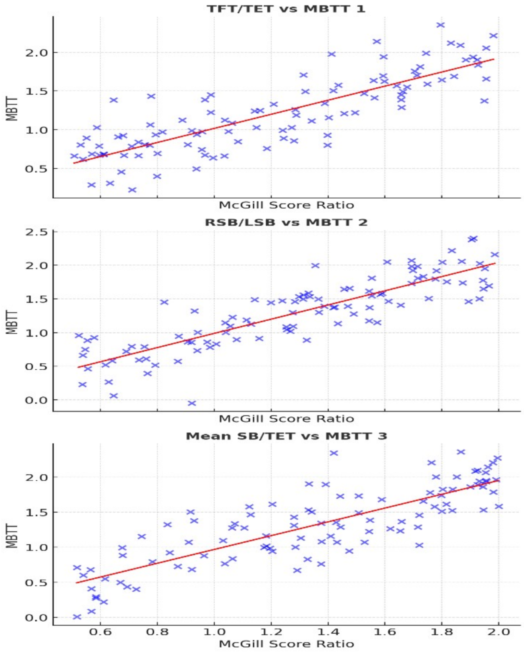

Figure 4

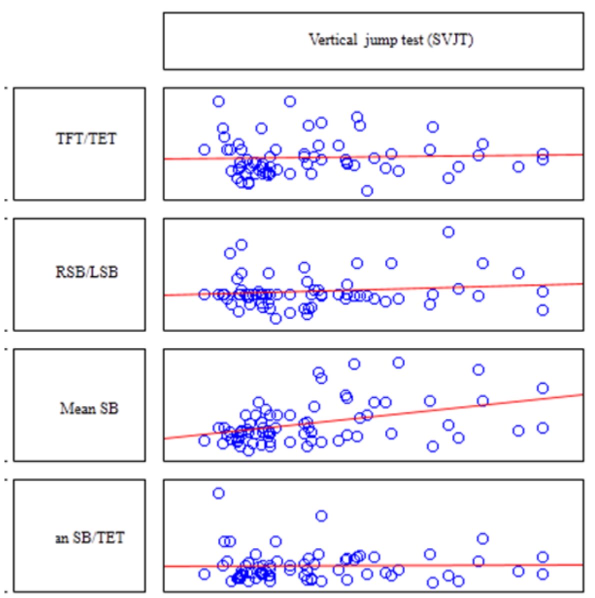

Figure 5

CONCLUSION

This study focuses on the correlation between core stability with arm explosive power and leg explosive power in badminton athletes. The significant positive correlation obtained indicate that core stability plays a vital role in improving both upper and lower extremity performance. While, individual core endurance components had no significant relationships with explosive power, overall core stability emerged as an important predictor of athletic success. These findings highlight the relevance of core stability training in badminton for improving performance, lowering injury risk, and increasing overall athletic efficiency. Future research should look into the long-term effects of core stability training programs and their impact on competitive performance in badminton players.

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