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Original Research Article

Effectiveness of Core Stabilization Exercises on Lumbopelvic Rhythm, Speed, and Agility in Adolescent Tennis Players

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Abstract

Tennis is a physically demanding sport that requires quick movements, rapid changes of direction, and powerful strokes. Core stabilization is essential for maintaining good posture, generating force, and reducing injury risk. This interventional study aimed to investigate the effectiveness of core stabilization exercises on lumbopelvic rhythm, speed, and agility in adolescent tennis players. Thus, the aim of this study was to assess the impact of core stabilization exercises on lumbopelvic rhythm, speed, and agility in adolescent tennis players. 45 participants (Age 15.66 year's ± 1.14 years) of both genders: 31 male (height 154.23± 6.67CM weight 48.30±6.36kg) (B.M.I 20.04±1.39) and 14 female (height 15.79±1.05 CM weight 49.29±5.41Kg) (B.M.I 20.54±1.67) with 6 months to 2 years of tennis experience were included in this interventional study. Participant's pre and post data were collected for lumbopelvic rhythm (Schobers test), speed (30 m sprint test) and agility (T- test). The study results showed significant improvements in lumbopelvic rhythm, speed, and agility among the participants following the core stabilization exercise program. These training programs can enhance athletic performance and reduce injury risk.

Keywords: Core stabilization exercises, Lumbopelvic rhythm, speed, agility, Adolescent tennis players, injury prevention.

INTRODUCTION

Tennis is a highly demanding sport that requires rapid directional changes, explosive acceleration, precise coordination, and efficient biomechanical control [1]. Among the physical qualities that underpin tennis performance, core stability plays a central role, providing the foundation for effective movement, energy transfer, and injury prevention [2-4]. A well-conditioned core aids in maintaining optimal alignment of the spine and pelvis, thereby enhancing postural control and functional performance during strokes, court movements, and recovery phases [5, 6].

The interaction between the lumbar spine and pelvis, referred to as the lumbopelvic rhythm, is fundamental to efficient movement mechanics. This coordinated motion ensures proper load distribution across the spine and lower extremities. Dysfunction in this rhythm—arising from muscular weakness, pelvic malalignment, or abnormal joint mobility—can lead to compromised biomechanics, reduced efficiency in movement, and an elevated risk of musculoskeletal injuries, particularly in young athletes undergoing growth and training stresses [3-6].

In addition to stability, speed and agility are decisive performance attributes in tennis. Players must accelerate explosively over short distances, decelerate rapidly, and change direction efficiently in response to unpredictable game situations. Agility, defined as the ability to perform whole-body movements with rapid changes in velocity or direction, enables players to position themselves optimally for effective ball striking. Similarly, sprinting ability over short distances provides critical insights into a player's capacity for court coverage and reaction to dynamic play situations [5-9].

The biomechanics of tennis strokes—including the serve, forehand, and backhand—demand coordinated integration of lower-body stability with upper-body force generation. Efficient lumbopelvic control ensures effective kinetic chain loading and unloading, supporting both power production and accuracy. Inadequate core stability can disrupt these mechanics, leading to decreased performance and a heightened risk of overuse injuries [8-10].

While previous studies [3, 4, 7-9] have emphasized the importance of core stability in athletic performance, limited evidence exists regarding its direct impact on lumbopelvic rhythm, speed, and agility specifically in adolescent tennis players. Considering that adolescence is a critical period for motor development and performance optimization, investigating targeted core stabilization programs may provide valuable insights for enhancing both performance and injury prevention in this population.

Therefore, the present study aims to evaluate the effectiveness of core stabilization exercises on lumbopelvic rhythm, speed, and agility in adolescent tennis players.

METHODOLOGY

A total of sixty adolescent tennis players aged 14–17 years were initially recruited from NDPS Tennis Academy, Indore, Madhya Pradesh, India. Following the screening process, ten were excluded for not meeting the inclusion criteria and five declined to provide consent, leaving forty-five participants (mean age 15.66 ± 1.14 years) who met the requirements for the study. The final sample of 45 participants included 31 males (height 1.57 ± 6.67 m; weight 48.30 ± 6.36 kg; BMI 20.04 ± 1.39) and 14 females (height 1.54 ± 1.05 m; weight 49.29 ± 5.41 kg; BMI 20.54 ± 1.67), all of whom had between six months to two years of tennis experience. Eligible participants had no injuries, illnesses, or surgical interventions within the past six months. Exclusion criteria included chronic lower back pain, previous lumbar spine surgery, recent fractures or ligament injuries, current musculoskeletal or neurological conditions, use of medications affecting performance, prior exposure to structured core stabilization training, or enrollment in other intervention programs. Before participation, all players and their guardians were informed about the study's objectives, procedures, and potential risks, and written consent was obtained.

Outcome Measures and Intervention

Spinal mobility was assessed using Schober's test, in which the distance between marks 5 cm below and 10 cm above the lumbosacral junction was measured during forward flexion. Speed was evaluated with a 30-meter sprint test, a valid method to assess acceleration and explosive power in athletes. Agility was measured using the T-test, which records the time taken to perform forward sprints, lateral shuffles, and backward running, reflecting multi directional movement ability.

Following baseline measurements, participants underwent an eight-week core stability exercise program designed to improve lumbopelvic control, agility, and speed. The program included bridging, dead bug, core crunches, prone plank, and superman exercises, performed five days per week along with regular tennis training. Each exercise was prescribed with specific sets, repetitions, and hold durations, and participants received instructions on technique, warm-up, and cool-down routines.

The below mentioned program focused on strengthening key core and lumbopelvic muscles, including the abdominals, gluteals, paraspinals, hip rotators, and stabilizers such as the multifidus and transversus abdominis. These muscles provide stability and efficient force transfer through the kinetic chain, promoting better posture, spinal alignment, and injury prevention while enhancing functional movement in tennis performance. After eight weeks, all baseline tests were repeated using the same procedures to evaluate improvements in lumbopelvic rhythm, speed, and agility.

8 Weeks Program of Core Stabilization Exercises

Sr. No	Exercise	Repitation/Hold	Frequency	Weeks
1	Bridging	10Reps/10 Sec Hold /2 Set	5 Days In A Week	8 Weeks
2	Dead Bug	3 Reps/10Sec Hold/3 Set	5 Days In A Week	8 Weeks
3	Core Crunches	3 Sets/20 Reps	5 Days In A Week	8 Weeks
4	Prone Plank	3 Set/30Sec Hold	5 Days In A Week	8 Weeks
5	Supermen	10Reps/10Sec Hold/ 2Set	5 Days In A Week	8 Weeks

8 Weeks Program of Core Stabilization Exercises

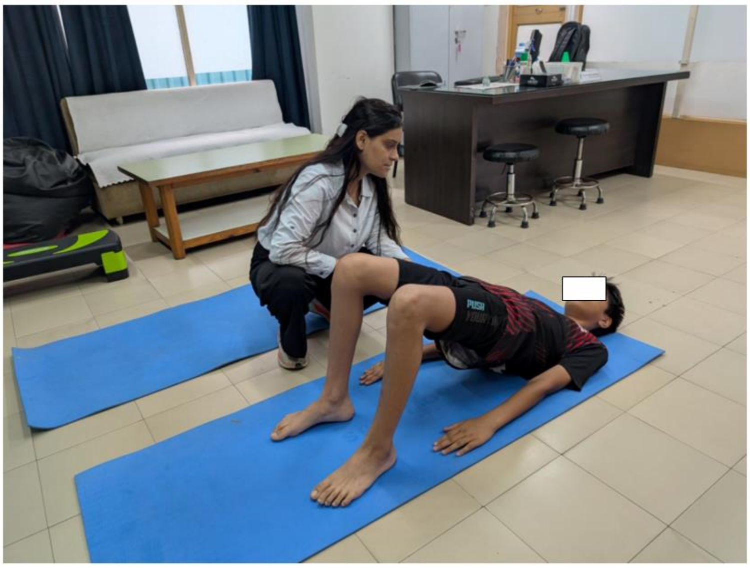

Figure 1: Bridging

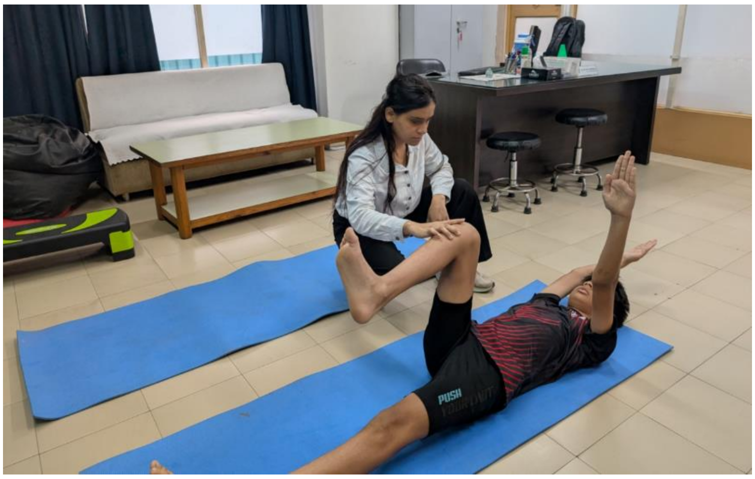

Figure 2: Dead Bug

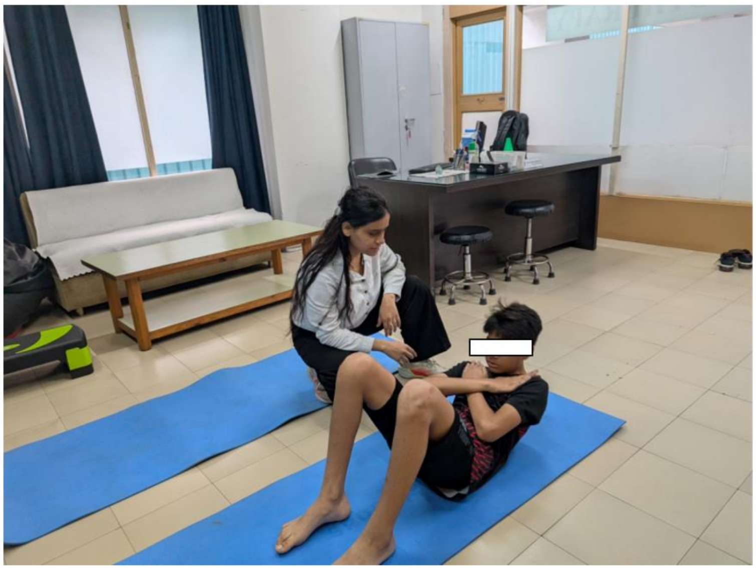

Figure 3: Core Crunches

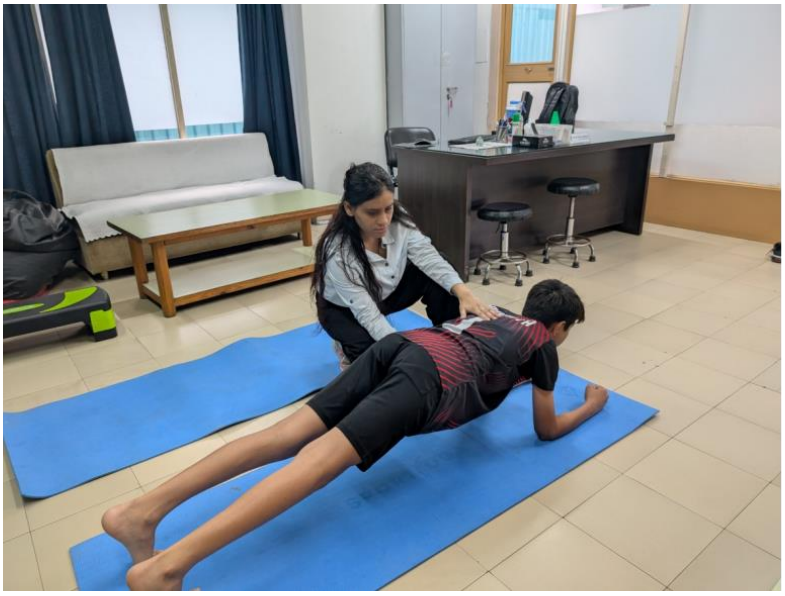

Figure 4: Prone Plank

Figure 5: Supermen

Statistical analysis

The data was analyzed using SPSS version 25 (Chicago, Illinois, USA; IBM Corp.) software. The normality of the data was evaluated using Shapiro Wilk test. The data was normally distributed and thus parametric tests were used for further analysis. The data of t-agility score was compared between pre and post session using paired t-test. Values are presented as mean and standard deviation. Significance level was set at $P<0.05$. Parametric test i.e. paired t-test was used to compare the means of our test i.e. Schobers test and 30 m sprint test, agility t test before and after intervention.

RESULTS

Table 1 summarizes the demographic characteristics of the participants, including age, height, weight, and BMI. Table 2 compares the pre- and post-training results for the Schober's test, 30-meter sprint, and agility T-test, respectively. All tests showed statistically significant improvements after the eight-week program, indicating enhanced spinal flexibility, speed, and agility.

Table 1: Age, Height, Weight, and Body mass Index of Adolescent Tennis Players

S. No	Variables	Mean	Standard Deviation
1	Age (In years)	15.65	1.14
2	Height (In m)	1.54	5.86
3	Weight (In kg)	48.6136	6.03
4	B.M.I ((Kg/m²)	20.1955	1.48

Table 2: Comparison of Pre- and Post-Training Intervention Outcomes in Adolescent Tennis Players

S. No	Test	Session	Mean	Standard Deviation	t-value	p-value
1	Schober's Test (cm)	Pre	17.80	1.25	-9.91	<0.001
		Post	20.11	0.92		
2	30-Meter Sprint Test (sec)	Pre	6.20	0.84	9.19	<0.001
		Post	4.60	0.78		
3	Agility T-Test (sec)	Pre	12.40	1.12	2.75	0.007
		Post	11.70	1.25		

In the above mentioned Table 2; Schober's Test measures lumbar spine flexion range in centimeters, 30-Meter Sprint Test assesses speed in seconds over a short distance, Agility T-Test evaluates agility through multidirectional movement time in seconds. The Pre and Post refer to measurements before and after the eight-week core stabilization training. Statistical significance was set at $p < 0.05$, indicating meaningful improvements across all tests post-intervention.

DISCUSSION

The findings of this 8-week interventional study demonstrated the effectiveness of core stabilization exercises in improving lumbo-pelvic rhythm (LPR) speed and agility in tennis players. The results show significant improvements in LPR scores after the intervention, indicating better stability and reduced impairment [11]. The study's findings are consistent with existing researches [6-10] highlighting the importance of core strength and stability for athletic performance and injury prevention. The improvement in LPR scores can be attributed to the specific exercises used in the intervention, which targeted the multifidus and transversus abdominis muscles. These muscles play a crucial role in stabilizing the spine and pelvis, and strengthening them through core stabilization exercises can help reduce the risk of lower back pain (LBP) and improve overall athletic performance [12]. The study's results have practical implications for tennis players, coaches, and sports physiotherapists. Incorporating core stabilization exercises into a tennis player's training program can help improve LPR, reduce the risk of LBP, and enhance overall performance. The 8-week protocol used in this study provides a useful framework for designing training programs that target core strength and stability, rhythm [16].

This study demonstrate that core stabilization exercises can improve agility in tennis players. This is consistent with existing research that suggests that core stabilization exercises may not be the most effective way to improve agility. However, some studies have reported small improvements in agility with core stabilization exercises, the magnitude of improvement is often limited [13]. In a study, core stabilization exercises while beneficial for core strength and stability, rhythm did not result in the same level of improvement in agility [14]. This suggests that agility training should focus on exercises that specifically target the neuromuscular and movement patterns involved in agility, rather than relying solely on core stabilization exercises. The findings of our study demonstrate the effectiveness of core stabilization exercises in improving lumbo-pelvic strength, rhythm, speed, and agility in adolescent tennis players and potentially enhance athletic performance and reduce the risk of injuries.

CONCLUSION

This study provides evidence that a structured core stabilization program can positively influence key physical parameters in adolescent tennis players. These outcomes support the inclusion of targeted core training as part of a broader, sport-specific conditioning approach aimed at optimizing performance and minimizing injury risks in youth tennis populations.

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Conflicts of Interest: There are no conflicts of interest.

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