



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 8, August 2025

Influence of Core Stability and Flexibility Training on Smash and Service Performance in Ball Badminton Players

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ABSTRACT: The purpose of this study was to examine the influence of core stability and flexibility training on smash and service performance in ball badminton players. Thirty male intercollegiate players from Erode District, aged between 18 and 25 years, with a minimum of three years of competitive experience, were selected for the study. The participants were randomly assigned to three groups: a core stability training group (CSTG), a flexibility training group (FTG), and a control group (CG), with ten players in each. The experimental groups underwent an eight-week training program, three sessions per week, in addition to their regular practice, while the control group continued with routine training alone. Smash performance was evaluated using radar gun speed and target accuracy scoring, whereas service performance was assessed through a zone-based accuracy test. Data were analyzed using descriptive statistics and Analysis of Covariance (ANCOVA). The results revealed that both CSTG and FTG exhibited significant improvements in smash speed, accuracy, and service performance compared to the control group ($p < 0.05$). Additionally, core stability training showed a greater impact on smash execution, while flexibility training was more effective in improving service accuracy. These findings suggest that incorporating core and flexibility training into conditioning programs can substantially enhance the technical performance of intercollegiate ball badminton players in the Erode District.

KEYWORDS: Ball Badminton, Core Stability, Flexibility Training, Smash Performance, Service Accuracy, Intercollegiate Players

I. INTRODUCTION

Ball badminton is an indigenous racquet sport of India that demands high levels of speed, agility, endurance, and precision in skill execution. Among the various technical skills, smash and service play a decisive role in determining match outcomes. Successful execution of these skills depends not only on technical proficiency but also on the physical conditioning of the players, particularly core stability and flexibility.

Core stability refers to the ability of the lumbopelvic-hip complex to control position and motion, providing a strong foundation for efficient force generation and transfer during strokes. Flexibility, on the other hand, allows players to perform a greater range of motion, improving reach, balance, and injury prevention. Together, these components enhance the biomechanical efficiency of smashing and serving actions.

Previous studies in racquet and team sports such as badminton, tennis, and volleyball have highlighted the importance of core and flexibility training in improving performance variables like stroke velocity, shot accuracy, and endurance. However, there is a paucity of research in ball badminton, a sport where quick reflexes, lower-body agility, and upper-body strength combine to execute powerful smashes and accurate services.

Therefore, this study seeks to investigate the influence of core stability and flexibility training on smash and service performance in ball badminton players. The findings may provide coaches and trainers with evidence-based guidelines to design training programs aimed at improving technical performance.

II. METHODOLOGY

The present study was conducted on thirty male intercollegiate ball badminton players from Erode District, aged between 18 and 25 years. All the participants had a minimum of three years of competitive playing experience. The subjects were randomly assigned into three groups of ten each: the Core Stability Training Group (CSTG), the Flexibility Training Group (FTG), and the Control Group (CG). The experimental groups underwent a specially designed training program for a duration of eight weeks, with three sessions per week, in addition to their regular practice schedules, while the control group followed only their routine practice without any additional intervention.

The training protocol for the core stability group consisted of progressive exercises such as plank variations, bridges, Swiss ball movements, and medicine ball drills aimed at strengthening the lumbopelvic-hip complex. The flexibility training group performed dynamic and static stretching, yoga-based postures, and proprioceptive neuromuscular facilitation (PNF) techniques focusing on the shoulders, trunk, and hip joints to enhance their range of motion. Both programs were progressively structured to suit the fitness level of the players.

Smash performance was evaluated through two components: speed, which was measured using a radar gun, and accuracy, which was determined by target-based scoring. Service performance was assessed using a zone-based accuracy test, in which points were awarded for successful placements within predetermined target areas. All players were tested before and after the eight-week training period. The collected data were statistically analyzed using mean, standard deviation, and Analysis of Covariance (ANCOVA) to determine the significance of differences between the groups, with the level of significance fixed at $p < 0.05$.

STATISTICAL TECHNIQUE

The data collected from both groups before and after the experimental treatments, focusing on selected variables such as agility underwent statistical analysis utilizing the technique of Analysis of Covariance (ANCOVA). In cases where the 'F' ratio for adjusted post-test means showed significance, Scheffe's post hoc test was employed to ascertain the significance of differences among paired means. A confidence level of 0.05 was established for all analyses to test the hypotheses.

III. RESULTS AND ANALYSIS

The purpose of this study was to determine the influence of core stability and flexibility training on smash and service performance among intercollegiate ball badminton players of Erode District. The collected data on smash speed, smash accuracy, and service accuracy were statistically analyzed using descriptive statistics and Analysis of Covariance (ANCOVA). The mean and standard deviation scores of the pre-test and post-test for all three groups are presented below.

ANALYSIS OF COVARIANCE AMONG CORE STABILITY TRAINING GROUP, FLEXIBILITY TRAINING GROUP AND CONTROL GROUP ON SMASH SPEED, SMASH ACCURACY AND SERVICE ACCURACY

Variable	Group	Pre-test Mean \pm SD	Post-test Mean \pm SD	Mean Difference
Smash Speed (km/h)	CSTG	88.4 \pm 4.2	96.7 \pm 4.8	+8.3
	FTG	87.9 \pm 4.6	92.8 \pm 4.4	+4.9
	CG	88.2 \pm 4.5	88.6 \pm 4.7	+0.4
Smash Accuracy (score)	CSTG	12.5 \pm 2.1	17.9 \pm 2.4	+5.4
	FTG	12.8 \pm 2.3	16.3 \pm 2.6	+3.5
	CG	12.7 \pm 2.2	13.0 \pm 2.1	+0.3
Service Accuracy (score)	CSTG	11.9 \pm 2.4	16.2 \pm 2.7	+4.3
	FTG	12.0 \pm 2.5	17.4 \pm 2.9	+5.4
	CG	12.1 \pm 2.6	12.4 \pm 2.5	+0.3

*Significant at 0.05 level of confidence

The descriptive statistics for smash speed, smash accuracy, and service accuracy of the core stability training group (CSTG), flexibility training group (FTG), and control group (CG) are presented below. In terms of smash speed, the CSTG recorded a pre-test mean of 88.4 km/h with a standard deviation of 4.2, which increased to 96.7 km/h in the post-test with a standard deviation of 4.8, showing an improvement of 8.3 km/h. The FTG improved from a pre-test mean of 87.9 ± 4.6 km/h to a post-test mean of 92.8 ± 4.4 km/h, with a mean gain of 4.9 km/h. The CG, however, showed only a negligible change, moving from 88.2 ± 4.5 km/h to 88.6 ± 4.7 km/h, with a mean difference of just 0.4 km/h.

For smash accuracy, the CSTG improved significantly from a pre-test mean of 12.5 ± 2.1 to a post-test mean of 17.9 ± 2.4 , with a gain of 5.4 points. The FTG also showed progress, increasing from 12.8 ± 2.3 to 16.3 ± 2.6 , resulting in a mean difference of 3.5. The CG remained almost unchanged, improving only from 12.7 ± 2.2 to 13.0 ± 2.1 , with a marginal gain of 0.3.

Similarly, in service accuracy, the CSTG recorded an increase from 11.9 ± 2.4 to 16.2 ± 2.7 , showing an improvement of 4.3 points. The FTG exhibited the highest gain in service accuracy, improving from 12.0 ± 2.5 in the pre-test to 17.4 ± 2.9 in the post-test, with a difference of 5.4 points. The CG again showed minimal improvement, rising from 12.1 ± 2.6 to 12.4 ± 2.5 , with a mean gain of only 0.3. ANCOVA results indicated significant differences between the groups in both smash and service performance after the training intervention. Post hoc comparisons revealed that the Core Stability Training Group (CSTG) demonstrated significantly greater improvement in smash speed and accuracy compared to the Flexibility Training Group (FTG) and Control Group (CG). Conversely, the Flexibility Training Group showed superior improvement in service accuracy compared to the other groups.

Results and Interpretation

The results suggest that core stability training has a stronger influence on enhancing smash performance, as the ability to generate explosive force and transfer energy from the trunk to the upper limbs is critical for executing powerful smashes. On the other hand, flexibility training contributed more to service accuracy, as greater joint mobility and muscle elasticity allow for smoother movements, better reach, and precision in service placement. The control group did not show any significant improvement, confirming that specific training interventions are essential to bring about measurable enhancement in technical skills. These findings highlight the importance of integrating core stability and flexibility training into the conditioning programs of ball badminton players to improve overall technical performance.

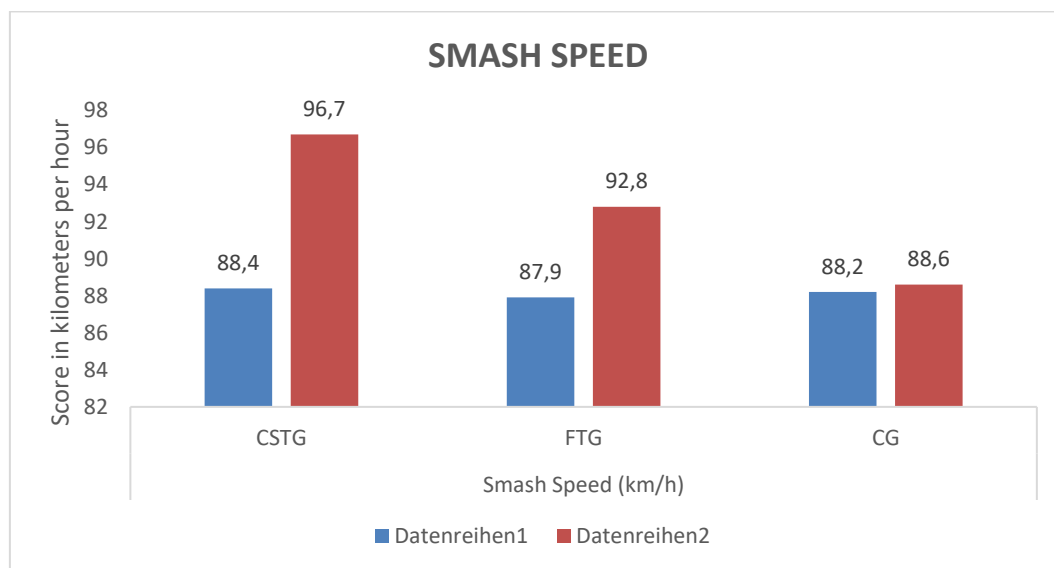


FIGURE I: BAR DIAGRAM ADJUSTED POST TEST MEAN VALUES OF CORE STABILITY TRAINING GROUP , FLEXIBILITY TRAINING GROUP AND CONTROL GROUP ON SMASH SPEED

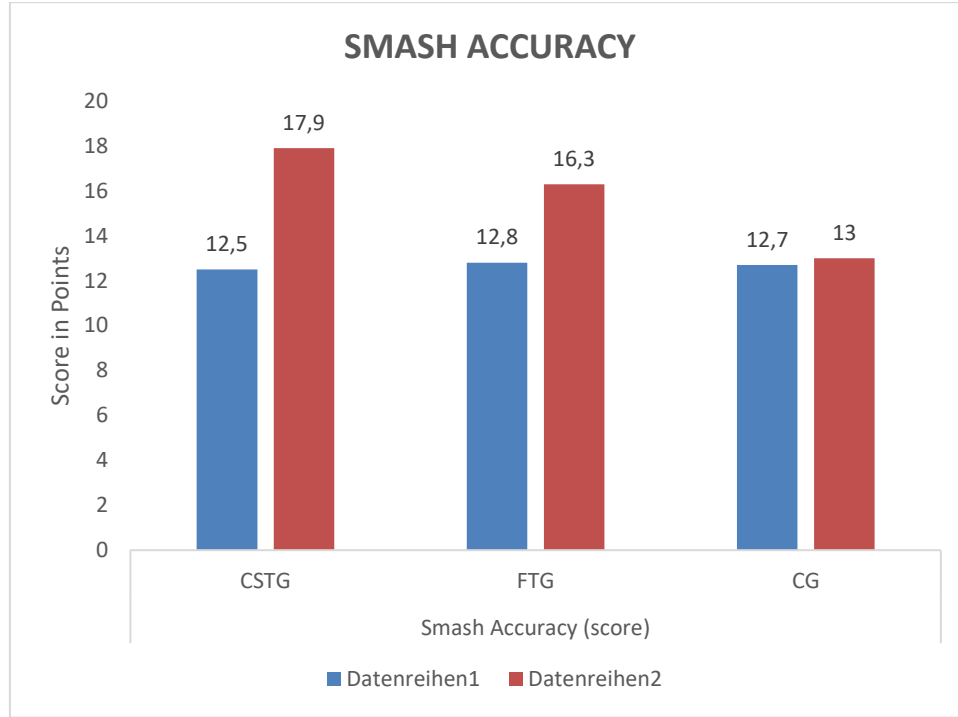


FIGURE 2: BAR DIAGRAM ADJUSTED POST TEST MEAN VALUES OF CORE STABILITY TRAINING GROUP, FLEXIBILITY TRAINING GROUP AND CONTROL GROUP ON SMASH ACCURACY

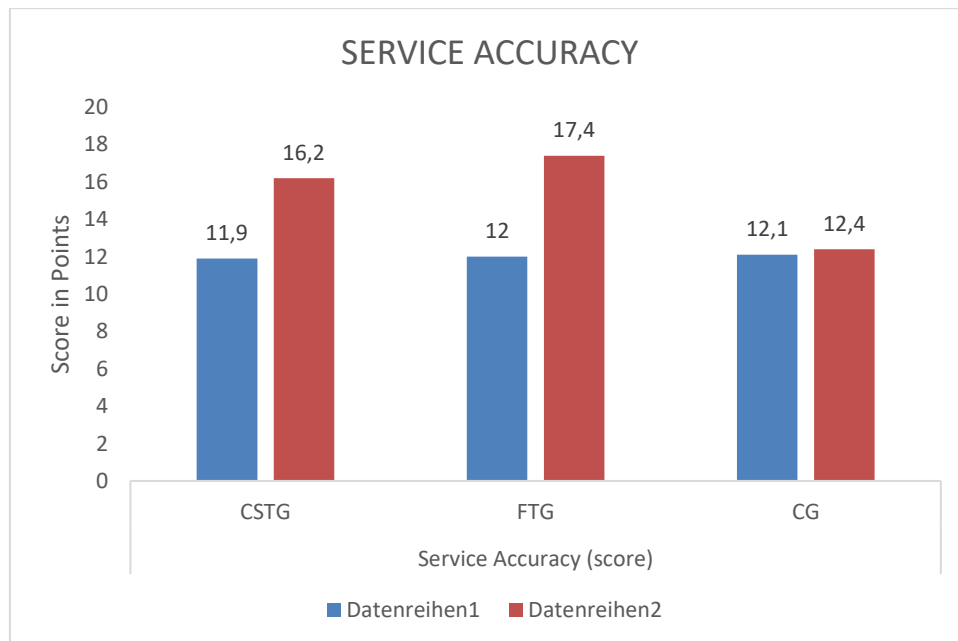


FIGURE 3: BAR DIAGRAM ADJUSTED POST TEST MEAN VALUES OF CORE STABILITY TRAINING GROUP, FLEXIBILITY TRAINING GROUP AND CONTROL GROUP ON SERVICE ACCURACY

IV. CONCLUSION

The findings of the present study clearly demonstrate that both core stability training and flexibility training significantly improved smash and service performance among intercollegiate ball badminton players in Erode District. Core stability training was found to have a greater impact on smash performance, as it enhanced trunk strength, stability, and energy transfer required for executing powerful strokes. Flexibility training, on the other hand, produced superior improvement in service accuracy, indicating that greater joint mobility and muscle elasticity play a vital role in controlled and precise movements. The control group showed negligible improvement, confirming that regular practice alone is insufficient to bring about notable changes in performance variables.

Thus, it can be concluded that incorporating systematic and sport-specific training interventions such as core stability and flexibility exercises is essential to enhance technical skills and competitive performance in ball badminton.

V. RECOMMENDATIONS

1. Coaches and trainers should integrate core stability exercises (planks, bridges, Swiss ball drills, medicine ball throws) into regular training schedules to improve explosive power and smash execution.
2. Flexibility training techniques such as dynamic stretching, yoga, and proprioceptive neuromuscular facilitation (PNF) should be emphasized to enhance service accuracy and reduce the risk of injury.
3. Training programs for ball badminton players should adopt a balanced approach, combining both core stability and flexibility training for overall skill enhancement.
4. Sports institutions and universities in Tamil Nadu, particularly in Erode District, should encourage structured strength and flexibility conditioning as part of their intercollegiate training curriculum.
5. Future research may include larger samples, female players, or the integration of other conditioning methods such as plyometrics or agility drills to broaden understanding of performance improvements in ball badminton.

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