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Effect of core stability exercises on dynamic balance and agility in amateur badminton players

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Abstract
Background: Badminton is considered one of the most popular and agile racket sport all over the globe which requires good stability and agile footwork to match the pace of the shuttle, with core stability being the basic foundation of the body.
Aim and Objectives: To determine the effect of core stability Exercises on dynamic balance and agility in Amateur Badminton Players.
Methodology: After the study design was formulated, ethical clearance was taken from IEC. Total no. of participants screened were 75, amongst them, 40 were included in the study on the basis of inclusion criteria. Participants were randomly divided into groups of 2 i.e., Experimental group (Group A) (n=20), and Conventional Group (Group B) (n=20). Pre assessment was done for dynamic Balance using Star Excursion Balance Test and for Agility, Illinois Agility test was used. Further, the study was conducted for 4 weeks followed by post assessment after 4 weeks. Statical analysis was done using paired t test and unpaired t test and conclusion was drawn.
Result: Post intervention, it was seen that there was significant improvement in terms of dynamic balance and agility within the group with $p< 0.001$ for both. However, Group B did not have any significant result. Between the Groups comparison relieved that, a significance difference of <0.001 for posteromedial, 0.004 for medial was seen for SEBT, and 0.23 for Illinois Agility test which shows no significant difference.
Conclusion: There is significant improvement in Dynamic Balance and Agility after implication of 4 weeks of core stability exercise program among amateur Badminton Players.

Keywords: Badminton, dynamic balance, agility

Introduction
Badminton is extremely widespread sport played all over the globe. The badminton players must perform very precise movements beneath unusual physical demands whereby these includes running, jumping in unbalanced conditions. Many researches indicate that core muscles provide proximal stability for distal mobility. [1]. To improve these skills, it is thought that specific activities should be put into practice. In order for players to conduct these combined movements (with / without opponent, with / without) in optimal levels, it is necessary to develop their speed and agility [2].
Core stability is defined in athletic settings as an optimum production, which can transfer and control the amount of force from the centre of one's body to the limbs, through stabilization of the position and motion of the torso [3]. The word core itself implies deep and central. Of the various core muscles, the lumbar multifidus, transverse abdominis, and quadratus lumborum appear to be the most meaningful muscles for badminton professionals and therapist who prescribe exercises to improve physical performance or manage musculoskeletal disorders [4]
When a player swings the racket your core muscles fan up first before your limbs get to work, the importance of prevention of injury during any sport is important and for it core stability proves to be an important factor. This muscular structure distributes the forces that act and allows effective body movements; hence it provides strength and movement formation in the extremities [5]. Andersen *et al*. also showed that musculature of the lower extremities is especially important since rapid and forceful movements with the weight of the body are performed repeatedly throughout a match.

The cyclical bursts of action during games are demanding on the aerobic (60–70%) and anaerobic systems (30%) with a greater demand on the lactic metabolism [6] Bouisset initially proposed that stabilization of the pelvis and trunk is necessary for all movements of the extremities. Hodges and Richardson later identified trunk muscle activity before the activity of the lower extremities, which he felt served to stiffen the spine to provide a foundation for functional movements [7]. Core stabilization moreover precedes gross motor development, as the central nervous system activates the trunk musculature before movement to provide a stable foundation in anticipation of the forces produced by the limbs [8], when talking about core it is often refers to as lumbo-pelvic hip complex. Core training uses one's own body weight [9]. A powerful core muscles will allow forces to transfer from the trunk to the upper extremity for maintain the energy in the torso [10] The rationale of the phrase, "proximal stability for distal mobility", is that a stable core can efficiently respond to or anticipate changing sport conditions, which is believed to reduce injury risk and improve performance [11]. An interesting study was being experimented by leetun *et al*. 27, compared stability of core between genders and between athletes who reported an injury during their play offs vs people who failed to**.** Athletes who didn't sustain an injury were significantly stronger in hip abduction and external rotation, being the sole significant predictor of injury status. Thus, the authors concluded that stability of the core musculature has a crucial role in injury prevention and should be accustomed during assessment of injury risk [12].

A study says that due to weakness or due to decreased coordination in the core impairs the transfer of energy thus decreases the effectiveness of the movement leading to lack of agility [13]. Agility is usually described as a quick or slowing down the bodily response with change of direction to an abrupt stimulus [14] for it Dynamic balance plays a vital role in reactive reaction of the player. As good balance helps you to save energy during performance, thus increasing efficiency of the movement and improvement in their performances A study says that due to weakness or due to decreased coordination in the core impairs the transfer of energy thus decreases the effectiveness of performance and thus decrease in agility. If the core muscles are trained, it is thought to be keep the ground reaction forces with its limit.

Agility helps to coordinate several components such as to act and react quickly, accelerate and decelerate, move in proper direction, and to maintain the change direction balance and postural control as rapidly as possible. Moreover, it helps to strengthen the muscle and tendon all major joints and to aid in preventing injuries by improving body control through various repetition of proper movement [20]

Materials and Methods

A randomized control trail was conducted in Dr. APJ Abdul Kalam College of physiotherapy, Pravara Institute of Medical Sciences. Participants were assessed according to the inclusion criteria. Participants who were willing to participate were required to give Informed Consent before being allocated. Amateur Badminton players were eligible with age criteria between 18-25 years. Participants who got excluded from the study were players having recent injury/trauma, and who are under personalized training program. Randomization was done using Simple Random Sampling into 2 groups Group A (experimental group) and Group B (control group) The outcome measure which was used in this study was Star Excursion Balance test and Illinois Agility test for dynamic balance and agility respectively. Participants in the Group A received 4 weeks of Core Stability Exercises and those in Group B received conventional exercises for weeks.

Interventions

Experimental Group: The intervention was given for 4 weeks 4times a week. Core stability exercises were administered which included warm ups, core exercises followed by cool down phase. Each exercise was progressed after 2 weeks.

Control Group: Participants had been informed to continue with their regular exercise program and practice which involves warm ups, stretching, running, joint range of motion exercises followed by cool down phase exercises followed by cool down phase. Each exercise was progressed after 2 weeks.

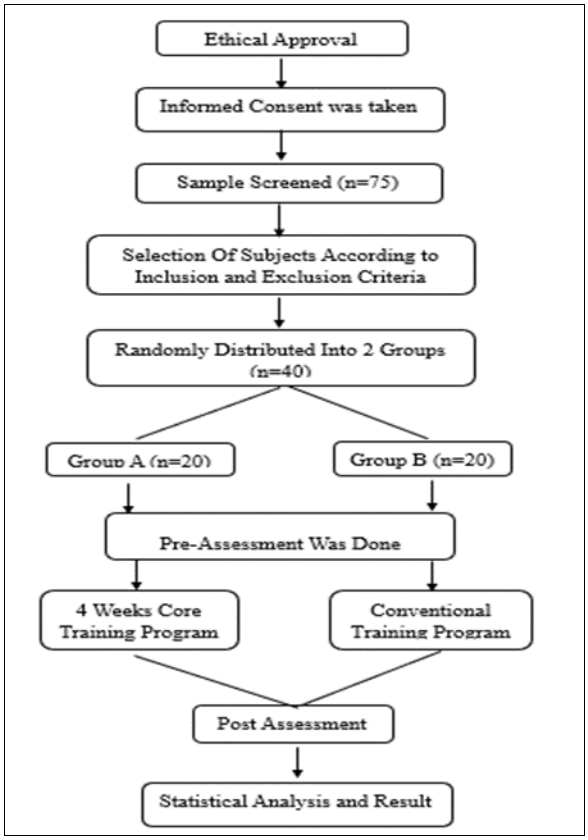

Table 1: Exercise protocol

Exercises	1-2 Week	3-4 Week
Warm up	10 min	10 min
Plank	3 x 30 Sec Hold	3 x 45Sec Hold
Abdominal crunch	3 x 20 Reps	3 x 45 Reps
Leg raises	3 x 10 Reps	3 x 20 Reps
Russian twist	3 x 20 Reps	3 x 45 Reps
Split leg scissors	3 x 20 Reps	3 x 45 Reps
(Cool down	10 min	10 min

Result

40 participants met the eligibility criteria and were randomly divided into 2 groups Group A (n=20) and Group B (n=20).

Table 2: Baseline Data

Variable	Group A (Mean ±Sd)	Group B (Mean ± Sd)
Age	19.35 ± 1.42	21.5 ± 1.27
Gender	1:1.2	1:1
BMI	22.46 ± 2.54	22.36±4.07

Star excursion balance test

Table 3: Comparison of SEBT scores within Group A and B

Groups		Pre-intervention	Post intervention	T value	P value	Significance
Group A	Anteromedial	69.7 ± 5.36	76.0 ± 7.13	7.07	<.001	Highly Significant
	Medial	70.6 ± 5.51	78.6 ± 5.95	7.79	<.001	Highly Significant
	Posteromedial	74.6 ± 6.12	80.0 ± 6.63	6.30	<001	Highly Significant
Group B	Anteromedial	71.7 ± 6.86	71.1 ± 6.88	1.037	0.313	Not Significant
	Medial	72.8 ± 6.57	72.2 ± 6.81	1.212	0.24	Not Significant
	Posteromedial	70.4 ± 9.01	71.0 ± 9.08	0.615	0.546	Not Significant

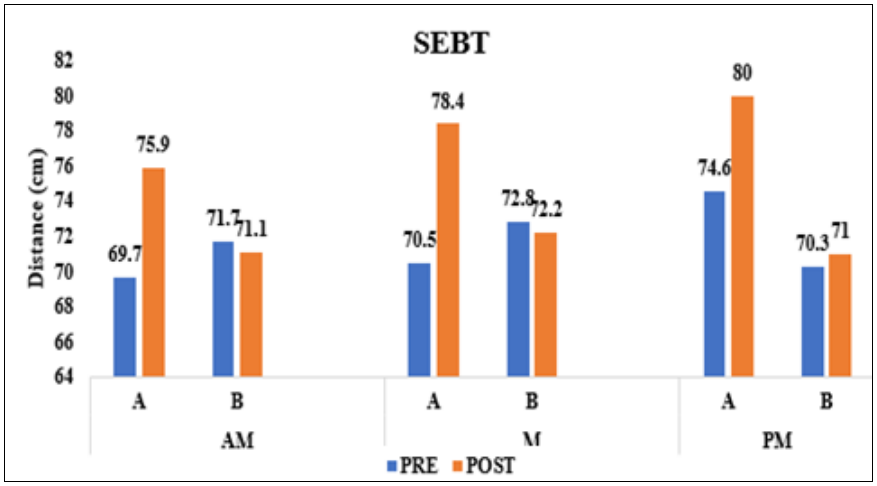

Fig 1: Comparison of SEBT scores between Group A and B

Illinois agility test

Table 4: Comparison of Illinois Agility test within group A and B

Groups		Pre- intervention	Post - Intervention	T value	P value	Significance
Group A	Illinois Agility Test	27.17 ± 5.81	24.55 ± 5.40	4.643	<.001	Highly significant
Group B	Illinois Agility Test	27.76 ± 7.06	26.95 ± 7.01	2.290	.034	Not Significant

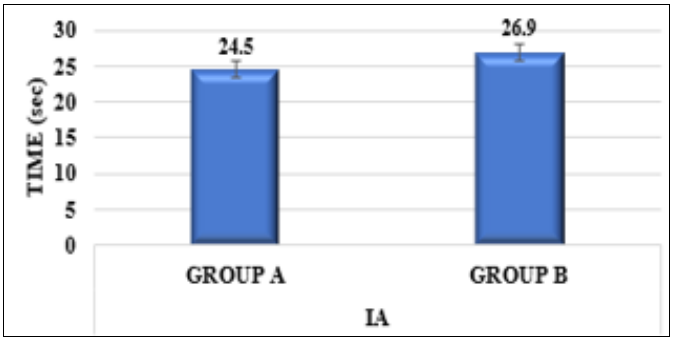

Fig 2: A graphical representation of Illinois Agility Test scores between the groups

Discussion

In our current study after the core training intervention, Group A (Experimental Group) showed there was significant improvement in SEBT all directions, for anteromedial (69.4 ± 5.36 to 76.0 ± 7.13), medial (70.6 ± 5.51 to 78.6 ± 5.95 and posteromedial (74.6 ± 6.12 to 80.0 ± 6.63) as compared to Group B. In this, Group A showed significant results within the group and as well as between the groups for Medial and Posteromedial direction Post intervention with mean difference of 6.22, 8.98 respectively. But the control group i.e., Group B did not show any significant improvement in dynamic balance. Possible explanation in improvement in dynamic balance in group A, may be due to progression in activation or firing of the muscles before the locomotory activity creating a proper platform in the form of stable posture or the to the fact that the subjects were possessed neuro muscular control system which were better suited for their movement [15].

Neuro muscular control is basically the coordination between neurons and muscles. During athletic movements, trunk stability is contingent upon neuromuscular feedback control in response to internal and external disturbances, including the forces generated from distal body segments as well as from expected or unexpected perturbations. In feedback control, information about the current state of the system (e.g., joint position, velocity, force, pain, pressure) is feedback to the (Central Nervous System) to generate control input to the muscles. The central nervous system logic transforms the feedback information into an orchestrated neuromuscular activation pattern.

For a dynamic system to be stable, three primary requirements must be satisfied

1. First system is this which implies that there should be moderately accurate and complete feedback information from mechanoreceptors about the state of the system is available to the (CNS). Then this information is used by the central nervous system to give appropriate response to the muscles which is going to be in action.
2. Secondly, the information must be sent accurately from CNS to the muscles. There should proper regulation of the signals.
3. Third the system must be controllable. This requires the muscle to have a good power to bring about quick enough changes in all degree of freedom which the joint

allows in normal ranges. Problems in any of these three are as can lead to instability, resulting in uncontrollable motions [16]. A likely explanation is that these sets of exercises must have improved the core proprioception and the conductivity which may have led to improvement in dynamic balance. And better reach distance than the control group.

Training produces increased levels of anaerobic substrates that is ATP, PCR, free creatine and glycogen accompanied by an improvement in muscular strength. Increased quantity and activity to key enzymes that control the anaerobic phase of glucose catabolism with an increase in fiber size (fast twitch muscle fibers). It also enhances the metabolic capacity of the specifically trained muscle fibers, but it also facilitates recruitment and modulation of firing sequence of the appropriate motor units achieved in the movement [19].

A Similar study was done by Mitchelle. A. Sandrey and Jonathan G. Mitzel, he found that there was significant difference in SEBT specifically for medial and anteromedial as their posttest reach directions increased after core training program. There was large effect size of 0.83 in medial, and 0.49 for anteromedial and 0.46 for posteromedial had moderate effect size. This may be due to abdominal bracing incorporated in core training program that stabilized the core for lower limb movement.

Yakup Akif Afyon, Olcay Mulazimoglu found that after 8 weeks of core training of the participants, there was significant improvement was found between the pretest and posttest values in terms of speed and agility. Outcome measure which was used was 30m speed test, Illinois Agility Test, and T drill Agility test.

Agility can be stated that it is the ability to change directions effectively and efficiently and to respond to external forces (Holmberg). Agility performance was evaluated using Illinois Agility test. Some of the researcher's states that the abdomen and lower back located within the kinetic change are the power house, which plays a very significant role in producing powerful movement keeping the body balance in position, i.e., maintaining the Centre of gravity of the body. As Illinois agility is a fitness test which is designed to test one's capability. In our current study the results showed a correlation between core and agility after training within the Group A(27.17 ± 5.81 to 24.55 ± 5.40)i.e. the time required for completing the Illinois agility got decreased, for Group B it was (27.76±7.06 to26.95±7.01.Possible explanation in increase in agility can be due to that during agility patterns when the foot strikes the ground in front of one's own body while, it takes a longer duration and higher force of breaking hGRF because the possible reason can be that the body becomes stiffer kinematically to accept the greater foot impact. Reducing the time taken of breaking the hGRF would help carry the momentum forward, helping in quick movements and faster running biomechanically [17] or due to quickness of the abdominal bracing to promote stability of pelvis and spine and to enhance the coordination of the movements and timing to act on precise time and be noted as a cause of positive results.

However, if the trunk moves, the GRF follows the trunk movement, if the athlete allows the trunk to move laterally, the Centre of mass moves with it. As GRF is followed by the COM, if it goes on the lateral aspect of Centre of knee joint, the result is there will be impaired valgus alignment, this forces the lower leg into an abducted position leading to decrease in ability to perform well [18]. So, according to our perception, Core stability exercises/ neuromuscular training facilitates the neuromuscular adaptations that teaches to utilize the joint stabilization pattern, reducing the changes of shifts of Centre of mass, and effective

Functioning of the muscles and its firing effect in jerky movement pattern thus a possible reason for increase in agility within Group A from (27.17 ± 5.81 to 24.55 ± 5.40) by decreasing the time taken to complete one's agility task, which helps the athlete to perform well and as well in preventing the risk of ACL injury. As compared to Group A, there was no increase in agility skills in Group B. When compared between the groups, statistically significant result was not seen much after post intervention between Group A and B. If there would have been adequate amount of time, the result between Group A and B would have been more remarkable and would have helped us understand the effectiveness better.

Conclusion

This study concludes that there is significant improvement in Dynamic Balance and Agility after implication of 4 weeks of core stability exercise program among amateur Badminton Players.

Implication to Practice

Physiotherapist and coaches should implement core stability exercise program in training sessions which may be beneficial in improving the dynamic balance and agility in amateur badminton players thus improving the ability of better performance.

Limitation

1. Participants were amateur badminton players.
2. Sample size for the study was moderately small.

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