International Journal of Physical Education, Sports and Health 2022; 9(4): 278-285

P-ISSN: 2394-1685
E-ISSN: 2394-1693
Impact Factor (RJIF): 5.38
IJPESH 2022; 9(4): 278-285

www.kheljournal.com
Received: 17-05-2022
Accepted: 21-07-2022

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The effects of swiss ball training on core muscle endurance and agility in male intercollegiate basketball players

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Abstract
Basketball is a multifaceted team sport which requires agility. Core stability in sporting environment is defined as ability to maintain the position of trunk over the pelvis to efficiently produce the force as per the nature of the athletic activity. Improved Core muscle endurance may aid in a successful athletic performance.
Aim: The aim is to find out the effects of Swiss ball training on core muscle endurance and agility in basketball players.
Methodology: 20 Basketball players were included in the study. 4 weeks core muscle training on Swiss ball was given. Pre and Post Data of McGill core endurance test and Illinois Agility Test were recorded.
Statistical analysis: Statistical Analysis is done by appropriate analytical software. As the data was normally distributed, paired 't' test was used for within group analysis for each outcome measure respectively.
Results: Significant changes were observed in the pre and post values of Agility and Core muscle endurance ($p < 0.05$).
Conclusion: It can be concluded that dynamic core training with Swiss ball improves agility and core muscle endurance.
Clinical significance: Dynamic core training should be incorporated in regular training to improve the core muscle endurance, agility and athletic performance**.**

Keywords: Swiss ball, core, agility

Introduction

Basketball is one of the popular contact sport being played globally [1]. Apart from playing the game on a regular basis, it is also played in India amongst various school and colleges at a competitive level. The nickname of Indian National Basketball team is "Young Cagers". In any high demanding sport such as Basketball, the game demands the athlete to be highly agile (ability to move quickly and easily) in order to perform better. Change of direction and agility are multidimensional skills requiring the athletes to control individual components and thus manipulate the degrees of freedom of the movement to enable constant adaptation within reactive unpredictable environments [2, 3]. It may take athletes several weeks and months to see improvements in speed and agility. So, agility should be trained as an important component of the routine training program. Core stability in sporting environment is defined as ability to maintain the position of trunk over the pelvis to efficiently produce, transfer and control the force and motion to the terminal segments during an athletic activity. Core stability is achieved through stabilization of one's torso, thus allowing optimal production, transfer, and control of force and motion to the terminal segment during an integrated kinetic chain activity [4-7].

Core endurance is the most crucial component in core training because it supports core muscles in maintaining an efficient trunk position [8]. Barati *et al.* indicates that core endurance is important to spinal stability during prolonged exercise [9]. There is development of force and motion from proximal to distal segment by the "summation of force" principle [10]. The term "Swiss ball" was coined because one of the earliest noted uses of an exercise ball was 1965 in Switzerland. Traditional floor exercises such as sit-up, focuses on improving the potential of global but not local muscles.

One characteristic of Swiss ball is that core stabilizer muscles are activated more on unstable rather than stable surfaces. The spherical shape of the Swiss ball may help to stimulate more motor units of the stabilizing muscles than traditional floor exercise as a possible consequence of enhancing overall balance and core muscle stability and activation of motor units. Swiss ball have been demonstrated to active some regions of the brain stem, vestibular system and cerebellum, which leads to body control, balance and posture. Improved Core Musculature helps an athlete to perform their game efficiently, as it provides a more stable base for forearm and leg movements, improving the control of movements. As mentioned above regarding the complexity of agility the purpose of this study was to determine whether Swiss ball training can have positive effects on agility.

The present study was aimed at evaluating the effects of Swiss ball training on core muscle endurance and also on agility which is an important factor for basketball players.

Materials and Methods

Study design: Experimental Study.

Study setting: Various colleges of Ahmedabad.

Sampling technique: Random sampling.

Study duration: 1 year.

Duration of intervention: 5 sessions per week for 4 weeks.

Sample size: 20 [A pilot study was performed and power analysis with 80% power of study was done. Illinois Agility test was taken as the main independent variable. The sample size was calculated to be 10 in each group, that total is 20 participants].

Inclusion Criteria: Male basketball intercollegiate players having age 18-22 years.

Exclusion Criteria: Any history of recent injury or surgery (4-6 months).

Materials

Proforma, Swiss Ball, Matt, Agility, Cones, Measure Tape, Stop Watch, Bench, Straps, Pen/paper.

Fig 1: Figure showing materials used

Outcome Measures

A) Agility: Illinois Agility Test: [11]

The Illinois Agility test was set up with four cones forming the agility area. On command, from a standing position athlete sprinted 10 m, turned and returned back to the starting line, then, he swerved in and out of four markers, completing two 10 m sprints to finish the agility course. No technical advice was given as to the most effective movement technique. Athletes were instructed to complete the test as quickly as possible. They were instructed not to cut over the markers but to run around them and total time taken was recorded.

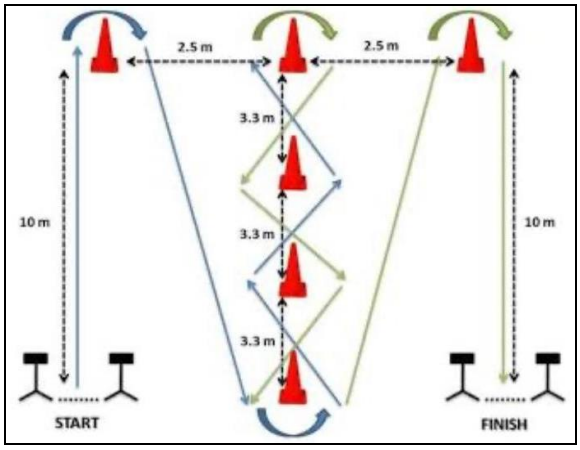


Fig 2: Illinois Agility Test

B) Core Muscle Endurance: McGill core endurance test [12] Reliability – 0.9.

- **Lateral Bridge Test (Bilateral):** Legs are extended and the top foot is placed in front of the lower foot for support. Athlete support themselves on one elbow and on their feet while lifting their hips off the floor to create a straight line over their body length. The uninvolved arm is held across the chest with the hand placed on the opposite shoulder.
- **Flexor Endurance Test:** The athlete sits at 60 degrees with both hips and knees at 90 degrees, arms folded across the chest with hands placed on the opposite shoulder, and toes secured under toe straps or by the examiner.
- **Extensor Endurance Test:** The athlete is prone over the edge of the table with the pelvis, hips and knees secured. The upper limbs are held across the chest with the hands resting on the opposite shoulders.

Fig 3: Lateral Bridge Test

Fig 4: Flexor Endurance Test

Fig 5: Extensor Endurance Test

Procedure

Ethics approval was taken from the Institutional Review Board of the college. Basketball players from various colleges of Ahmedabad were selected according to the inclusion/ exclusion criteria. Participants were explained the procedure and written informed consent for the same was taken. Two groups were taken that is experimental group and control group and the participants were allocated by random sampling method. Before the initiation of intervention, the outcome measures were explained to them and taken.

After taking informed written consent patients were divided into 2 groups by random sampling method. And treatment was given 5 sessions per week for 4 weeks.

Group A: Experimental group Subjects of this group were given graded Swiss Ball training programmer along with the routine basketball training.

Group B: Control group Subjects of this group were given routine basketball training only [24]. Both the groups performed warm up, Basketball playing session for 1 hour and cool down session as a part of routine basketball training. Warm up included running and some basketball drills. Cool down included stretching of major muscle groups.

Table 1: Graded Swiss ball Exercise Protocol

No.	Exercise	Week 1	Week 2	Week 3	Week 4
1.	Balanced Sitting	1 set : 60 sec	2 set : 60 sec	2 set : 60 sec	2 set : 60 sec
2.	Sitting March	1 set : 60 sec	2 set : 60 sec	2 set : 60 sec	2 set : 60 sec
3.	Crunches	2 set : 10 reps	2 set : 15 reps	2 set : 20 reps	2 set : 20 reps
4.	Bridging on Ball	2 set : 10 reps	2 set : 15 reps	2 set : 20 reps	2 set : 20 reps
5.	Hip Extension (b/l)	2 set : 10 reps	2 set : 15 reps	2 set : 20 reps	2 set : 20 reps
6.	Decline Pushups	2 set : 10 reps	2 set : 15 reps	2 set : 20 reps	2 set : 20 reps
7.	Hamstring Curls	2 set : 10 reps	2 set : 15 reps	2 set : 20 reps	2 set : 20 reps
8.	Roll Out	2 set : 10 reps	2 set : 15 reps	2 set : 20 reps	2 set : 20 reps
9.	Superman	-----	2 set : 10 reps	2 set : 15 reps	2 set : 15 reps
10.	Pike	-----	2 set : 10 reps	2 set : 15 reps	2 set : 15 reps

Both the groups performed warm up, Basketball playing session for 1 hour and cool down session as a part of routine basketball training. Warm up included running and some basketball drills. Cool down included stretching of major

muscle groups.

Stretching of major muscle groups: Athletes performed three sets of six static stretching exercises for the major muscle groups. Stretching positions were maintained for 30 seconds, and a 30-second rest interval was allowed between them.

Both groups were given exercises 5 days a week for 4 weeks.

Outcome measures were taken before starting the intervention and again after completion of 4 weeks. Dropouts were not reported.

Results

Table 2: Demographic data within the groups

Characteristic (Mean ± SD)	Group A	Group B
Age (years)	19.6±1.74	19.9±1.81
Height (cm)	175.7±1.84	174.6±2.97
Weight (kg)	60.51±1.94	61.19±2.61
B.M.I (kg/m^2)	19.63±0.85	20.09±0.98

Table 3: Baseline comparison of pre-intervention outcomes of both the groups

Variables (Mean ± SD), (In sec)	Group A (Experimental)	Group B (Control)	T-Value	P-Value	Significant
Illinois Agility Test	18.257±0.899	18.31±0.894	0.137	0.892	No
Flexor Endurance Test	157.569±6.195	157.999±11.805	0.102	0.919	No
Extensor Endurance Test	93.738±6.805	91.666±6.577	0.692	0.497	No
Right Side Lateral Bridge Test	85.534±3.258	83.459±5.247	1.062	0.302	No
Left Side Lateral Bridge Test	85.548±4.005	83.210±5.9743	1.027	0.317	No

There was no significant difference between pre-intervention outcome measures in both groups. Hence, the groups were comparable with each other.

Table 4: Comparison of outcomes within the group A

Variables (In sec)	Pre-Post	Group A (Experimental) (Mean ± SD)	T-Value	P-Value	Significant	Cohen's d
Illinois Agility Test	Pre	18.25 ± 0.8	2.48	0.03	Yes	1.01
	Post	16.84 ± 1.8				
Flexor Endurance Test	Pre	157.56 ± 6.19	5.97	0.0002	Yes	1.93
	Post	174.14 ± 10.42				
Extensor Endurance Test	Pre	93.73 ± 6.8	5.84	0.0002	Yes	1.62
	Post	109.27 ± 11.73				
Right Side Lateral Bridge	Pre	85.53 ± 3.2	4.27	0.0002	Yes	1.10
	Post	89.14 ± 3.33				
Left Side Lateral Bridge	Pre	85.54 ± 4.0	6.21	0.0002	Yes	0.99
	Post	90.08 ± 5.03				

Within group analysis for different outcomes, pre and post intervention was carried out by paired t-test, there was statistical significant difference of all the outcomes in Group A.

Cohen's d test was applied to check effect size in Group A. Large effect size was observed for all outcome measures. Effect size of Flexor Endurance Test is highest amongst all outcome measures suggesting highest clinical effect on Flexor Endurance Test.

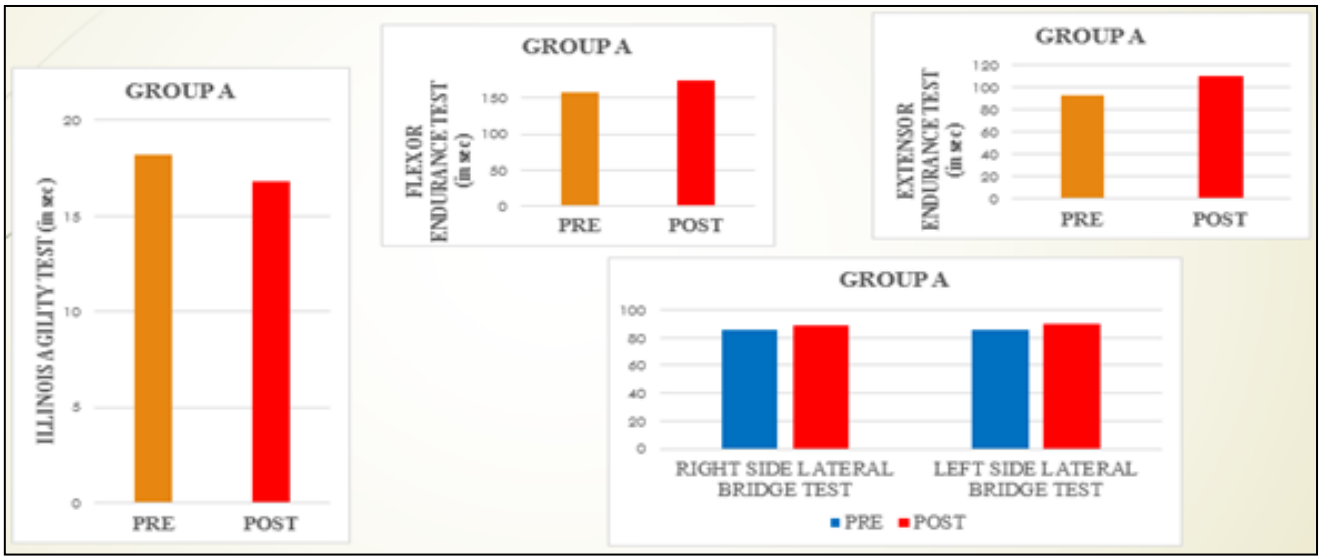


Fig 6: Outcome Measures of Group A

Table 5: Comparison of outcomes within the group B

Variables (In sec)	Pre-Post	Group B (Control), (Mean ± SD)	T-Value	P-Value	Significant
Illinois Agility Test	Pre	18.31 ± 0.89	0.22	0.83	No
	Post	18.29 ± 0.86			
Flexor Endurance Test	Pre	157.99 ± 11.80	2.00	0.07	No

	Post	158.46 ± 11.45			
Extensor Endurance Test	Pre	91.66 ± 6.57	1.18	0.26	No
	Post	91.85 ± 6.46			
Right Side Lateral Bridge	Pre	83.45 ± 5.24	2.04	0.07	No
	Post	83.79 ± 5.04			
Left Side Lateral Bridge	Pre	83.21 ± 5.97	1.64	0.1352	No
	Post	83.37 ± 5.77			

Within group analysis for different outcomes, pre and post intervention was carried out by paired t-test, there was not any statistical significant difference of all the outcomes in Group B.

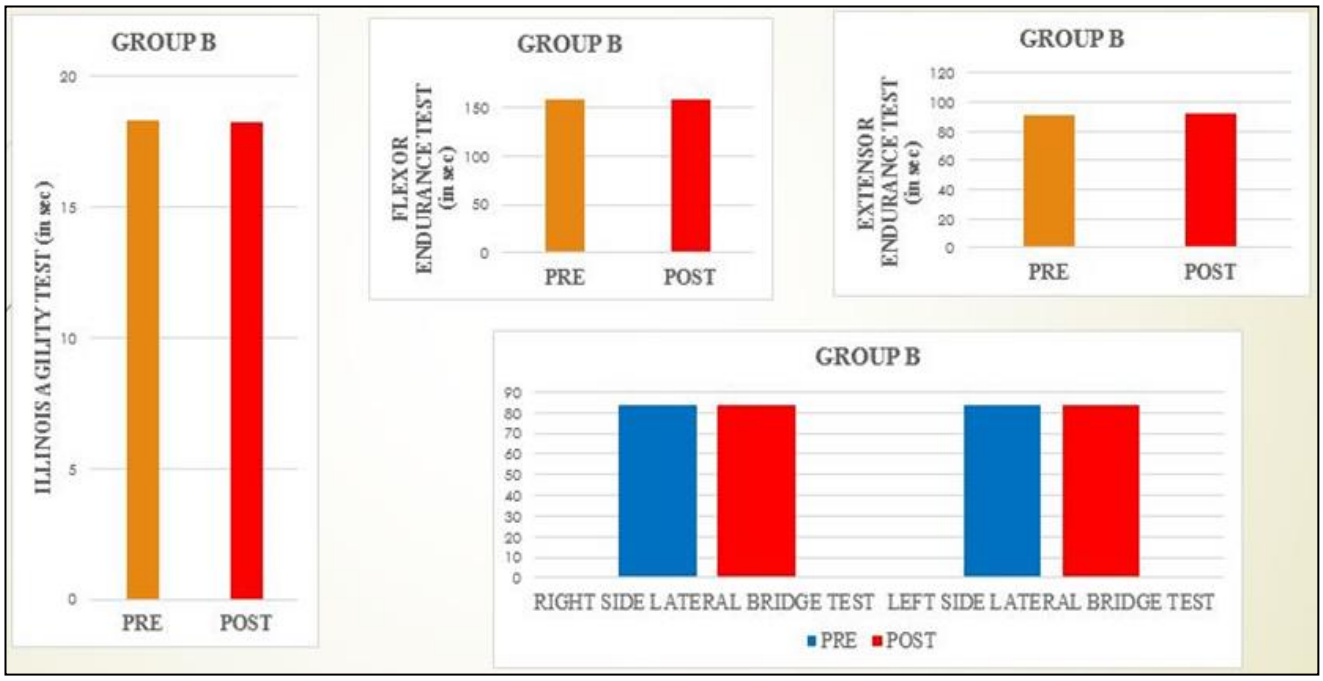
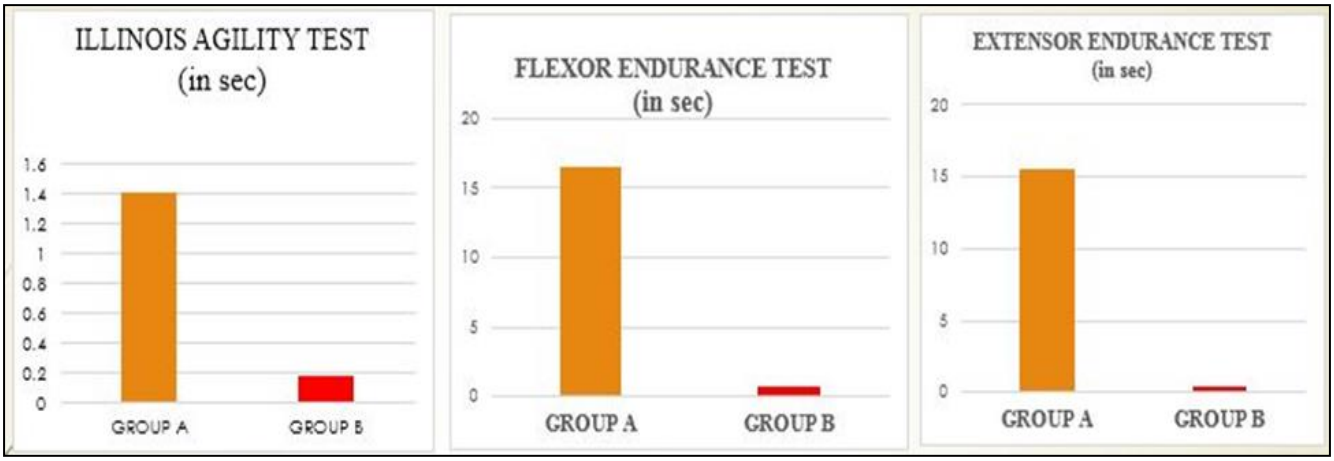


Fig 7: Outcome measures of Group B

Table 6: Mean Difference in the outcome measures of the subjects between control and experimental groups

Outcome Measure	Group	Mean± SD (In sec)	T-Value	P-Value
Illinois Agility Test	Experimental Group	1.41 ± 1.7	2.17	0.04
	Control Group	0.176 ± 0.12		
Flexor Endurance Test	Experimental Group	16.57 ± 8.76	5.69	0.0001
	Control Group	0.756 ± 0.348		
Extensor Endurance Test	Experimental Group	15.53 ± 7.9	5.67	0.0001
	Control Group	0.424 ± 0.297		
Right Side Lateral Bridge Test	Experimental Group	3.60±2.66	3.65	0.001
	Control Group	0.5 ± 0.31		
Left Side Lateral Bridge Test	Experimental Group	4.54 ± 2.19	5.77	0.0001
	Control Group	0.307 ± 0.172		



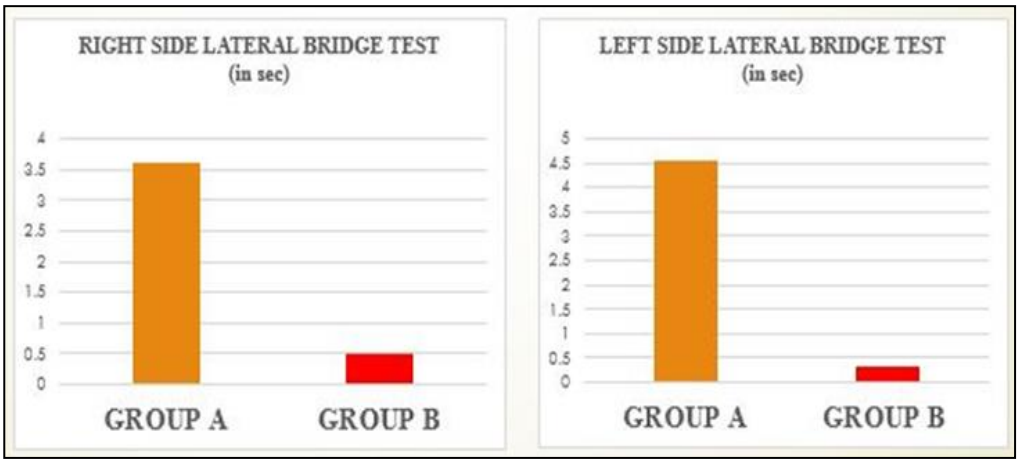


Fig 8: Mean Difference between the outcome measures of both the groups

Between group analysis for different outcomes was carried out by unpaired t-test, there was statistical significant difference of all the outcomes in Group A than that of B.

Discussion

The present study was designed to find out the effects of Swiss ball training on core muscle endurance and agility in male intercollegiate basketball players. A pre-test/ post-test design was implemented over a period of four weeks. Illinois agility test was used for assessing agility and the McGill core endurance test (*i.e.*: Flexor endurance test, Extensor endurance test, Right and Left Lateral Bridge Test) was used to assess core muscle endurance. After four weeks re-evaluation of all outcome measures was being carried out. Results of the present study have shown that there is statistically significant improvement in the experimental group in terms of agility and core muscle endurance, there was not statistically significant improvement in the control group. Between Groups analysis showed significant improvement in all the outcome measures ($p < 0.05$).

Rafael F. Escamilla (2010) [18] *et al.* did a study on core muscle activation during Swiss ball and traditional abdominal exercises. Eighteen young normal individuals performed five repetitions for each exercise. Electromyography (EMG) data were recorded on the right side for upper and lower rectus abdominis, external and internal oblique, Latissimus Dorsi, lumbar par spinals, and rectus femoris, and then normalized using maximum voluntary isometric contractions (MVICs). The study demonstrated that Swiss ball exercises were as effective in generating core muscle activity compared to the traditional exercises. [18] It can be hypothesized from the above mentioned study that the core exercises program based on Swiss ball may recruit the core muscles more and hence improve the athletic function which is consistent with the present study which states that in the experimental group there is significant improvement in core muscle endurance *i.e.* Flexor endurance test ($p < 0.05$), Extensor endurance test ($p < 0.05$), Right side lateral bridge test ($p < 0.05$), and Left side lateral bridge test ($p < 0.05$) post intervention.

Robert Stanton *et al.* (2004) [17], did a research on the effect of short-term Swiss ball training on core stability and running economy. Eighteen subjects performed two Swiss ball training sessions per week for six weeks. The study demonstrated a significant effect of Swiss ball training on core stability in the experimental group. No significant differences were observed for running economy (performance) in either group. It appeared that Swiss ball training may positively affect core stability without significant improvement in physical performance in young athletes. The reason postulated by them for detrimental running economy (performance) was that the Swiss ball exercises utilized in this study failed to induce specific adaptation required to enhance run performance. The principle of specificity should reflect position specificity, timing, and functional specificity. In the above mentioned study, the exercises used were different from the present study except the Roll out and Superman. Therefore, the selection of Swiss ball exercises that recruit the core musculature in the manner required for running may have elicited specific adaptation, leading to improved running performance. [17] These findings are consistent with the findings obtained in present study for improvement in core muscle endurance but at the same time the findings are not consistent with the present study for agility as there is statistically significant improvement in the Illinois agility test in the present study ($P < 0.05$).

Kwong-Chung Hung *et al.* (2019) [26], did a study on Effects of 8-week core training on core endurance and running economy. Twenty-one male college athletes were randomly divided into 2 groups: a control group and a core training group. Both groups maintained their regular training, whereas core training group attended 3 extra core training sessions per week for 8 weeks.

The study demonstrated that 8-week core training may improve static balance, core endurance, and running economy in college athletes [27]. The findings of this study are consistent with the findings obtained in the present study for improvement in core muscle endurance as well as agility (performance). The result postulated by them for the same is that in their study a comprehensive program, unstable surfaces was included because spinal stability is required for efficient execution of physical tasks. Effective core muscle function may reduce excessive limb motion during exercise, because proximal core activation enhances the efficiency of distal segment function. (Proximal stability improves distal mobility).

Jim F. Schilling *et al.* (2013) [27], did a study on effect of core strength and endurance training on performance in college students. The core training protocols influenced all musculature of the core, but one was to emphasize muscle endurance and the other muscle strength. They performed exercises, two times per week for six weeks. There was improvement in specific core endurance positions along with squat exercise strength in both the groups. However, neither core training protocol used in the above mentioned study improved performance tests measuring jumping, agility, and

sprinting activities in an untrained college-aged population. Neither training protocol claimed superiority and both were ineffective in improving performance [28]. The findings of this study are consistent with the findings obtained in present study for improvement in core muscle endurance but at the same time the findings are not consistent with the present study for agility as there is statistically significant improvement in the Illinois agility test in the present study ($p < 0.05$).

Yakup Akif Afyon *et al.* (2017) [19], did a research on the effects of core training on speed and agility skills of soccer players". The subjects in experimental group also took 30 minutes core training program after warm up exercises. They have concluded that agility and speed performance of players is improved positively. It is found that improved strength affects both agility and speed positively [19]. The findings of this study are consistent with the findings obtained in the present study for improvement in agility. The reason postulated by them for the same is that in season preparation period or weeks so close to matches, it can be necessary to start speed and agility trainings after maximal strength trainings for the strength improvement of players. It is thought that training core in the in-season period may improve physical performance of the players positively.

Conclusion

The Swiss ball training showed statistically significant improvement in core muscle endurance and agility in male intercollegiate basketball players. Thus, Swiss ball training needs to be incorporated to the routine training to enhance the overall athletic performance of the basketball players.

Clinical Implications

In 4 weeks, there was significant improvement seen in agility and core muscle endurance in male intercollegiate basketball players. It is easy to learn and perform these exercises and players can get out the time conveniently in their busy schedules and can implement the exercises in their daily routine which will improve their overall performance.

References

1. S Parimalam. *et al.* Effect of specific basketball training program on physical fitness and skill performance variables of intercollegiate women basketball players. IJALS. 2013 Feb;6:1.
2. McInnes, SE, Sheppard JM, Young WB. Agility literature review: Classifications, training and testing. J Sports Sci. 2006 Sep 1;24(9):919-932.
3. Young WB, Farrow D. A review of Agility: Practical applications for strength and Conditioning. Strength Cond. Journal. 2006 Oct 1;28(5):24-29.
4. Cook, G. Baseline sports-fitness testing. In: High Performance Sports Conditioning. B Foran, ed. Champaign, IL: Human Kinetics Inc, 2001.
5. Kiblar WB, Press J, Sciascia A. The role of core stability in athletic function. Sports medicine. 2006 Mar;36(3):189-198.
6. Liemohn, WP, Baumgartner TA, Gagnon LH. Measuring core stability. Journal of Strength and Conditioning Research. 2005 Aug 1;19(3):583-586.
7. Panjabi MM. The stabilizing system of the spine. Part 1.function, dysfunction, adaptation and enhancement. J Spinal Disord. 1992;5(5):383-389.
8. Faries MD, Greenwood M. Core training: Stabilizing the confusion. Strength & Conditioning Journal. 2007;29(2):10-25.
9. Barati A, Safar Cherati A, Aghayari A, Azizi F, Abbasi H. Evaluation of relationship between trunk muscle endurance and static balance in male students. Asian Journal of Sports Medicine. 2013;4(4):289–94., PMID: 24800004
10. Tinto A, Campanella M, Fasano M. Core strengthening and synchronised swimming: TRX(R) suspension training in young female athletes. J Sports Med Phys Fitness. 2016. Younes Hachana *et al.* Test-retest reliability, criterion-related validity, and minimal detectable change of the Illinois agility test in male team sports athletes, The Journal of Strength & Conditioning Research. 2013 Oct 1;27(10):2752-2759.
11. Getchell B. Physical Fitness: A Way of Life, 2nd Ed. New York: John Wiley and Sons, Inc., 1979.
12. Stuart M. McGill, Endurance times for low back stabilization exercises: Clinic targets for testing and training from a normal database, Archives of physical medicine and rehabilitation. 1999 Aug 1;80(8):941-948.
13. Cug M. Swiss ball & proprioception & core strength & dynamic balance: Effect of Swiss ball training on proprioception, Core strength & dynamic balance. J Strength Cond Res. 2010;24(11):3032-40.
14. Behm, D, Anderson K. The role of instability with resistance training. Journal of Strength and Conditioning Research. 2006 Aug 1;20(3):716-722.
15. Mccurdy KW, GA Langford, MW Doscher, LP Wiley KG. Mallard. The effects of short-term unilateral and bilateral lower-body resistance training on measures of strength and power. The Journal of Strength & Conditioning Research. 2005 Feb 1;19(1):9-15.
16. Schibek JS, KM Guskiewicz, WE Prentice, S Mays, JM Davis. The effect of core stabilization training on functional performance in swimming. Master's thesis, University of North Carolina, Chapel Hill, 2001.
17. Robert Stanton, Peter R Reaburn. The effect of short term Swiss ball training on core stability and running economy, Journal of strength and conditioning research. 2004;18(3):522-528.
18. Rafael F Escamilla, Clare Lewis. Core muscle activation during Swiss ball and traditional abdominal exercises, Journal of orthopaedic and sports physical therapy. 2010 May;40(5):265-276.
19. Yakup Akif Afyon. The Effects of Core Trainings on Speed and Agility Skills of Soccer Players, International Journal of Sports Science. 2017;7(6):239-244.
20. Rajan, *et al.* The effectiveness of core stabilization exercise on floor and Swiss ball on individual with non-specific low back pain. International Journal of Physical Education, Sports and Health. 2016;3(1):347-356.
21. Ludmila M. Cosio-lima, *et al.* Effects of Swiss ball and Conventional floor exercises on early phase adaptations in back and abdominal core stability and balance in women. Journal of Strength and Conditioning Research. 2003;17(4):721-725.
22. Mikolajec, Kazimierz, Waśkiewicz, Zbigniew, Maszczyk, Adam, *et al.* Effects of stretching and strength exercises on speed and power abilities in male basketball players. Isokinetics and Exercise Science. 2012 Jan 1;20(1):61-69, 10.3233/IES-2012-0442.
23. Bacurau, Reury, Monteiro, Gizele, Ugrinowitsch, Carlos, *et al.* Acute Effect of a ballistic and a static stretching exercise bout on flexibility and maximal strength. The Journal of Strength and Conditioning Research. 2009 Jan

1;23(1):304-308, 10.1519/JSC.0b013e3181874d55.
24. Dalrymple, Kortney, Davis, Shala, Dwyer, Gregory, *et al.* Effect of static and dynamic stretching on vertical jump performance in collegiate women volleyball players. Journal of strength and conditioning research / National Strength & Conditioning Association. 2010 Jan 1;24(1):149-55. 10.1519/JSC.0b013e3181b29614.
25. Carolyn Kisner, Lynn Allen Colby, Therapeutic exercises, 6th edition, 641:701.
26. Hung KC, Chung HW, Yu CCW, Lai HC, Sun FH. Effects of 8-week core training on core endurance and running economy. PLoS ONE. 2019 Mar 8;14(3):e0213158.
27. Schilling JF, Murphy JC, Bonney JR, Thich JL. Effect of core strength and endurance training on performance in college students: randomized pilot study. Journal of bodywork and movement therapies. 2013 Jul 1;17(3):278-90..