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An appraisal of flexibility and agility in Indian Basketball, Volleyball and Handball players and its comparison among them

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ABSTRACT

Background: Swiftness of ball games is one of the biggest reasons for its popularity. All ball games are very versatile and are played very recently in India. Thus, current study is undertaken to identify lacunae in technical skills of Indian Players and compare the skill related fitness.
Materials and Methods: The study was carried out in ninety Male Indian players. Basketball players (n=30), volleyball players (n=30) and handball players (n=30) aged between 16 to 25yrs after obtaining institutional ethics committee clearance. Flexibility was assessed using Modified Sit and Reach test and Goniometry. Agility was assessed using burpee's squat test, shuttle run and quadrant Jump test using standardized procedure recommended by established literature. Data was analyzed using SPSS v20.0.
Result: Our study revealed that, there is a statistically significant difference of mean values among all parameters ($p<0.0001$) except modified sit and reach test ($p=0.06$). Further analysis revealed that all groups shows statistically significant difference ($p<0.05$) except between HBP and BBP ($p>0.05$) for shoulder flexion, shoulder extension, knee flexion, knee extension and quadrant jump, between HBP and VBP for burpee's squat test, shuttle run and quadrant jump ($p>0.05$).
Conclusion: Our also revealed that shoulder flexibility was significantly more in Volleyball players while knee flexibility was significantly higher in Basketball players. Handball players had intermediate values of flexibility. Agility was significant higher in Basketball players, intermediate Handball player while least in Volleyball players. However, these players lag far behind when compared with international players and standards.

1. Introduction

Today, glamour of sports has indoctrinated cultural phenomenon of great magnitude and complexity. Many sports have great scope and good number of participations. The performance in any game not only depends on physical(body composition), physiological (cardiovascular fitness), psychological, sociological and scientific training factors but also skills related fitness parameters which are far neglected or less focused. All ball games are highly versatile that requires throughout tackling or contesting possession of the ball with competitors. Skills like dribbling, shooting and passing are of utmost important in these games. Success in these games needs ability of the players to generate tremendous power, good flexibility, agility, high muscular endurance and strength.[1]

The performance of Indian players in various ball games like Basketball, Volleyball and Handball at various national and international competitions has far less recognition worldwide and this is of great concern to coaches, sports doctors and researchers. Optimal performance thus requires a combination of technical and skillful abilities as well as a high degree of physical fitness. Efforts, to improve the standard skill related fitness of our sportsmen in ball games

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have achieved an insignificant success. Thus, current study is undertaken to identify lacunae in technical skills of Indian Players and compare the skill related fitness parameters like flexibility and agility in various ball games like Basketball, Volleyball and Handball players and to suggest methods to improvise these skills.

2. Aims and Objectives

The present study was undertaken to:

1. Assess flexibility and agility in Indian Volleyball, Handball and Basketball players.
2. Analyze and compare the results among these groups.
3. Compare the results with international standards available from literature if any.
4. Give suggestions to improve their performance.

3. Materials and Methods

The present study was carried out in the Sports Physiology laboratory of Department of Physiology, Dr Vaishampayan Memorial Govt. Medical College, Solapur. The study was carried out in Ninety male Volleyball (n=30), Handball (n=30) and Basketball (n=30) players aged between 15 to 25 yrs selected and playing at university level, state level or national level in India. All players participated voluntarily in our study. Institutional ethics committee clearance was obtained and written consent was taken from all players.

3.1. Inclusion criteria

The players in each team had more than 4yrs of playing experience and were practicing daily for 2-3 hrs for 6days a week. All the players belonged to the same socioeconomic group. The participants were advised to refrain from strenuous exercise for at least 48 h and not to consume a heavy diet prior to fitness testing.

3.2. Exclusion criteria

The players were excluded from the present study were those who were not regularly practicing, who had a past history of major respiratory or cardiovascular illness and who were injured during practice or during matches.

Skill related physical fitness parameters like flexibility by sit-n-reach test & by goniometry, agility using burpee's test (squat thrust), shuttle run & quadrant jump were assessed by standard methods. Each fitness test was performed after warming up sessions of jogging and stretching as recommended. Necessary precautions were taken for prevention of injuries during tests. These parameters were assessed by a single person and in similar situations for all subjects. Database of 90 players for flexibility and agility was compiled. After compilation of the data, descriptive statistics such as mean and standard deviation was used. Comparison of different parameters between groups was done using ANOVA test followed by post hoc Bonferroni multiple comparison test for normally distributed data and Krushkal-Wallis test followed by post hoc Dunn's multiple comparison test for data not normally distributed. A p-value less than 0.05 were considered as significant. Data analysis was performed using software SPSSv20.0.

3.3. Flexibility

Flexibility is the capacity of a joint to move through its full range of motion without undue strain to the articulation and muscle attachments.[2] Flexibility provides higher degree of freedom and ease of movement and gives greater safety from injury. The trunk flexibility was assessed by modified sit and reach test. Shoulder and knee flexibilities were assessed by goniometry.

3.3.1. Modified sit and reach test

This test is used to measure the development of hip and back flexion as well as extension of the hamstring muscles of the legs. A measuring tape was stuck on floor and a line perpendicular to the tape at 15 inches was marked on the floor. After sufficient warm-up, the subject was asked to sit down and line up his heels with the near edge of perpendicular line with the tape in between the two heels and slide his seat back beyond the zero end of the tape. An assistant stood and braced his toes against the subject's heels as he stretched forward so that his heels should not slip over the perpendicular line. Also, two assistants held subject's knees in locked position. Then, the subject was asked to stretch forwards slowly and steadily without jerks, keeping his knees locked and heels not more than 5 inches apart and to touch the fingertips of both hands as many inches down the stick as possible. The best of three trials measured to the nearest quarter of an inch was the test score of the subject[2] and players were graded according to raw score norms for modified sit and reach test (Annexure I).

3.3.2. Shoulder flexibility

The player was asked to lie supine on the bed with palms facing towards his body. The fulcrum of the goniometer was placed over the acromion process. The stationary arm and the moveable arm of the goniometer were aligned in the midline of the humerus and the lateral epicondyle. After alignment the player was asked to lift the arm up just as if raising hand to ask a question. It was seen that the player kept his hand and the palm facing towards his body. At the end point of this test the stationary arm of the goniometer should be in line with that of the lateral margin of the thorax, while the moving arm remains along with the humerus and the lateral epicondyle. Then the angle made by the moving arm with that of the stationary arm was noted.[3]

3.3.3. Knee flexibility

The player was asked to lie prone on the bed with knees fully extended. The fulcrum of the goniometer was kept constant at the lateral epicondyle of the femur. Then the player was asked to flex his knees without moving his thighs. The stationary arm was aligned with the lateral margin of the thigh while the moveable arm with that of the leg. The angle (degree) made between the two arms were noted down.[3]

3.4. Agility

Agility is defined as the ability of an individual to rapidly change the body position and direction in a precise manner. Agility was assessed using burpee's squat thrust, shuttle run and quadrant jump.[2]

3.4.1. Burpee's squat thrust

The objective was to measure the rapidity by which body position can be changed. Equipment needed for this test was stop watch. From a standing position the player was asked to bend at knees and waist and then place his hands on the floor in front of the feet. Then he was asked to thrust his legs backward to a leaning rest position and then return the squat position and then rise to the standing position. From the signal "go" the player was asked to repeat this movement as rapidly as possible until the command "stop" was given. Scoring- Scores taken were in number of parts executed in 10 sec. As for example, squatting and placing the hands on floor is one part, thrusting the legs to the rear is two, returning to the squat-rest position is three and returning to the standing position is four.[2] Each step was given 1 point and the total points were graded according to the raw score norms for burpee's squat thrust (Annexure II).

3.4.2. Shuttle run

This test was measured to measure the agility in running and changing direction. The equipment required for this test was a measuring tape and a stop watch. Two lines were marked as starting line and finishing line with a distance of 30 ft in between the lines. The player was asked to stand behind the starting line and at the signal of "go" he was asked to run as hard as possible to touch the finishing line and return to the starting line and again do the same for the second time. The time required to do this test was noted down in seconds. The best of three trials was noted down.[2] The scoring was given according to percentile chart for shuttle run (Annexure III).

3.4.3. Quadrant jump

Method: This test was performed to measure the agility of the subject in changing body position rapidly by jumping. Measuring tape and a stopwatch was needed for this test.

The player was asked to stand behind the small start mark and jump on both the feet into 1, then into 2, 3, 4 and back to 1 again. This pattern of jump was continued till the signal "stop" was given. The score was taken as the number of times the feet landed in a correct zone in 10 seconds. The best of three trials were noted.[2] The score so obtained was analyzed according to raw score norms of quadrant jump test (Annexure IV).

4. Results

It is observed that, there is a statistically significant difference of mean values among all parameters ($p<0.0001$) except modified sit-n-reach ($p=0.06$).

It is observed that there is statistically significant differences of mean values among all parameters ($p<0.0001$) except for quadrant jump.

Further analysis performed by using post hoc test Bonferroni comparison test or Dunn's multiple comparisons test, revealed that all groups shows statistically significant difference ($p<0.05$) except between HBP and BBP ($p>0.05$) for shoulder flexion, shoulder extension, knee flexion and knee extension that resulted into non significant(NS) difference.

Further analysis performed by post hoc test i.e. Bonferroni comparison test or Dunn's multiple comparisons test for agility concluded that all groups shows statistically significant difference ($p<0.05$) except between HBP and BBP ($p>0.05$) for quadrant jump, and also between HBP and VBP for burpee's squat, shuttle run and quadrant jump ($p>0.05$) which were not significant(NS)

5. Discussion

The physical requirements for versatile games like basketball, volleyball and handball demand efficiency in many of physical and skill related fitness parameters e.g. anthropometric measurement, body composition, strength, muscular endurance, aerobic capacity, power, flexibility, agility and reaction time. Many literature studies have focused on physical fitness parameters like anthropometric measurement, body composition, strength, muscular endurance, aerobic capacity, power in different games and skill related fitness parameters are many a times ignored. In the view of lack of scientific assessment of skill related fitness parameters like flexibility and agility of Indian basketball, volleyball and handball players, this study was under taken.

Our study revealed higher trunk flexibility in volleyball players(VBP) than handball players(HBP) and basketball players(BBP). Mean trunk flexibility of VBP was 19.53",18.4" in HBP while that in BBP it was least 18.1. However statistical comparison of trunk flexibility by modified sit n reach test among these three groups is not significant ($p<0.05$). These test values when compared with standard interpretation table (Annexure I) the VBP and HBP belonged to 'Intermediate' grade and BBP belonged to 'Advanced Beginner grade. Flexibility of shoulder joint measured by goniometry (flexion and extension) in VBP

Table 1: Flexibility

Group	VBP	HBP	BBP	Test statistic value	p-value
Modified sit-n-reach	19.5 ± 2.6	18.4 ± 2.8	18.1 ± 2.0	2.8	0.06
Shoulder flexion	179.3 ± 2.5	178.7 ± 3.4	174.7 ± 2.1	50.3	<0.0001
Shoulder extension	179.3 ± 2.5	178.7 ± 3.4	174.7 ± 2.2	50.3	<0.0001
Knee flexion	131.5 ± 5.2	129.8 ± 7.0	135.5 ± 2.4	17.9	<0.0001
Knee extension	131.6 ± 5.2	129.7 ± 6.9	135.5 ± 2.4	18.0	<0.0001

[VBP- Volleyball players HBP- Handball players BBP- Basketball players]

Table 2: Agility

Group	VBP	HBP	BBP	Test statistic value	p-value
Burpee's Squat test(no)	17.4 ± 2.0	19.1 ± 1.8	19.8 ± 2.0	12.5	<0.0001
Shuttle run(secs)	10.9 ± 0.6	10.4 ± 0.4	10.2 ± 0.6	17.8	<0.0001
Quadrant Jump(no)	17.7 ± 2.8	18.8 ± 2.3	19.7 ± 2.0	5.22	0.0007

Table 3: Post hoc multiple comparisons test for comparing all the groups for flexibility

Flexibility	(1)	(2)	Mean Difference (1-2)	p-value	Remarks
Shoulder flexion	HBP		4.13	>0.05	
		VBP	34.73	<0.0001	Significant
		VBP	38.9	<0.0001	Significant
Shoulder extension	HBP		4.13	>0.05	
		VBP	34.73	<0.0001	Significant
		VBP	38.9	<0.0001	Significant
Knee flexion	HBP		5.12	>0.05	
		VBP	26.6	<0.0001	Significant
		VBP	21.47	<0.0001	Significant
Knee extension	HBP		5.85	>0.05	
		VBP	26.9	<0.0001	Significant
		VBP	21.0	<0.0001	Significant

Table 4: Post hoc multiple comparisons test for comparing all the groups for agility

Agility	(I)	(J)	Mean Difference (I-J)	p-value	Remarks
Burpee's squat test	HBP		1.73	0.003	Significant
		VBP	0.67	0.52	
		VBP	2.41	<0.0001	Significant
Shuttle run	HBP		17.42	<0.05	Significant
		VBP	11.56	>0.05	
		VBP	28.98	<0.0001	Significant
Quadrant Jump	HBP		1.10	0.24	
		VBP	0.89	0.47	
		VBP	1.97	0.005	Significant

was maximum 179.25 degrees when compared with HBP 178.7 degrees and BBP 174.7 degrees. Shoulder flexibility in VBP is higher than HBP and BBP. The difference being statistically significant (p<0.001). Post hoc multiple comparison test results were not significant between HBP and BBP. While it was significant between VBP and HBP and also bet VBP and BBP. M.J Duncan et al.[4] have found mean values for sit and reach test in national level players to be 231\2 which has been more than our players. Lee E.J. et al[5] have found significant and positive correlation between vertical jump and hip flexion. He concluded that greater hip flexibility may benefit the jumping ability. Flexibility of certain joints does not necessarily indicate flexibility in other joints and there is no general flexibility test for total body flexibility. Flexibility is specific for a given joint and to a particular sport.[6] AAOS (American Academy of Orthopedic Surgeons)[7] has given maximum shoulder flexion value of 180 degrees. Thus, values in our study are closer to AAOS.

Flexibility of knee joint (flexion and extension) was maximum in BBP (135.5 degrees) followed by VBP (131.5 degrees) and least in HBP (129.8 degrees). The difference among three group was statistically significant (p<0.001). Post hoc multiple comparison test results were not significant between HBP and BBP. While it was significant bet HBP and VBP and also bet BBP and VBP. Boone et al.[8] have found mean knee flexion to be 140.2 +\-5.2 degrees. Knee joint flexibility of our players was far less than study done by Boone et al. Similar studies were done by Prafull et al.[9] and Vandana et al.[10] where in flexibility and agility was found to be greater in Basketball players[9] and sprinters[10] when compared with age matched controls. Zakas A et al.[11] proved that warming up exercises increases the flexibility markedly in lower extremity and trunk. A study done by L Angyan[12] and Rogulj[13] observed maximum flexibility in goalkeepers than other players. Another study done by V Selvam[14] found that the players with good cardio respiratory endurance had good flexibility scores.

Our study found that agility assessed by the burpee squat test score(nos) of BBP was 19.8, HBP 19.1 and VBP 17.4. This score was significantly more in BBP as compared to HBP and VBP. All players stood in the "intermediate grade" of the raw score norms as in Annexure II. Post hoc multiple comparison test results were not significant bet HBP and VBP. While it was significant bet HBP and BBP and also bet BBP and VBP. Agility score by Shuttle run test (secs) was also significant when compared among three player groups. The agility scores by shuttle run in BBP was 10.2 secs (30th percentile), in HBP it was 10.4secs(25th percentile) and in VBP it was 10.93scec (10 to 15th percentile) as per raw score norms for Shuttle run test in Annexure III. Post hoc multiple comparison test results were not significant bet HBP and VBP. While it was significant bet HBP and BBP and also bet BBP and VBP. Agility by quadrant jump (nos) was also significant among three groups. Score was maximum in BBP 19.7, 18.8 in HBP and 17.73 in VBP. Post hoc multiple comparison test for quadrant jump results were not significant between HBP and BBP and also between HBP and VBP. While it was significant between BBP and VBP. All three groups stood intermediate grade as per raw score norms Annexure IV. Scores for agility as in Annexure IV, indicate that of our players need further improvements ahead through good practice and training schedules to be elite in par with international. Similar study was done by Anula Kariyawasam et al[15] to compare skill and health related fitness parameters in Srilankan Basketball players and football players. But studies on flexibility and agility of Indian players between these three groups are not found in literature standards. Hence our study.

Table 5: AnnexureI 1: ModifiedSit and reach test.

Men	Level
23 $\frac{3}{4}$ above	Advanced
21 $\frac{1}{4}$ - 23 $\frac{3}{4}$	Adv. Intermediate
18 $\frac{3}{4}$ - 21	Intermediate
17 – 18 $\frac{1}{2}$	Adv. Beginner
Below 16 $\frac{3}{4}$	Beginner

Table 6: Annexure II: Raw score norms for Burpee's squat thrust test.

Men	Level
34 - above	Advanced
29 – 33	Adv. Intermediate
17 – 28	Intermediate
12 – 0.16	Adv. Beginner
0 – 11	Beginner

Table 7: Annexure III: Raw score norms for Shuttle run test

Percentile	Age 15 (yrs)	Age 16 (yrs)	Age 17 + (yrs)
100th	7	7.3	7
95	8.9	8.6	8.6
90	9.1	8.9	8.9
85	9.2	9.1	9
80	9.3	9.2	9.1
75	9.4	9.3	9.2
70	9.5	9.4	9.3
65	9.6	9.5	9.4
60	9.7	9.6	9.5
55	9.8	9.7	9.6
50	9.9	9.9	9.8
45	10	10	9.9
40	10	10	10
35	10.1	10.1	10.1
30	10.2	10.3	10.2
25	10.4	10.5	10.4
20	10.5	10.6	10.5
15	10.8	10.9	10.7
10	11.1	11.1	11
5	11.7	11.9	11.7
0	14.7	15	15.7

Table 8: Annexure IV: Raw score norms for Quadrant jump test

Men	Level
31 – above	Advanced
25 – 30	Adv. Intermediate
13 – 24	Intermediate
7 – 12	Adv. Beginner
0 – 6	Beginner

6. Conclusions

Our study concludes that VBP had greater trunk and shoulder flexibility, while knee flexibility was significantly better in BBP players. Flexibility of our players could be further increased from intermediate to advanced level to reach international standards by practice and right training. To attain an excellent degree of trunk flexibility along with shoulder and knee joints we should put the players to an exercise schedule comprising of light warm up rounds followed by static and dynamic stretching exercises [(16)]. This will help them attain the desired flexibility and prevent them from muscle and tendon injuries. This would surely help them improve performance, attain international standards and prevent untoward injuries. Agility was significantly higher in BBP as compared to VBP and HBP (least). Different training programme such as passing, dribbling, passing dribbles, lay up shooting can improve agility and hence should be included in training sessions

Swiftness of ball games is one of the biggest reasons for its popularity. These games demands and develops high degree of flexibility, muscular co-ordination and skills, speed of feet, good vision and great agility. Hence, before selecting the player, agility should be tested and in the training program, different means to improve agility such as passing, receiving, dribbling, passing dribbles, lay-up shooting should be included.

7. Limitations

More studies involving other parameters should be undertaken.

8. Source of Funding

None.

9. Conflict of Interest

The authors declare that there is no conflict of interest.

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