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Estimation of Dynamic Balance and Its Correlation with Selected Anthropometric Variables, Agility, Flexibility and Peak Lower Limb Strength in Inter-University Footballers Position-Wise

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Abstract: ***Introduction: Football is a popular team game worldwide. The objectives of the present study were to estimate the dynamic balance of the inter-university football players, and to search its correlations with selected anthropometric variables, agility, flexibility and peak lower limb strength. Materials and Methods: A total of purposely selected 100 Indian inter-university football players (84 males and 16 females) aged 18-25 years were collected from various universities of Punjab, India. To serve these purposes, star excursion balance test of both left and right leg, five anthropometric variables, viz. height, weight, body mass index, mid-thigh circumference and percent body fat, sit and reach test, Illinois agility test and vertical jump test were measured on all the subjects. The age of the subjects was determined from their respective university records. Results: In male footballers, the one way analysis of variance showed statistically significant between-group differences (p≤0.003-0.001) in star excursion balance test of both left and right leg and vertical jump test only. No significant between-group differences were found in female footballers among any of these four sets of data. In star excursion balance test of both right and left leg, statistically significant positive correlations (p≤0.050) were found only in vertical jump test, and statistically significant negative correlations (≤0.026-0.001) with weight, BMI, percent body fat and Illinois agility test in male footballers. However, in female footballers, significant negative correlation (p≤0.014) of star excursion balance test of right leg was found only with Illinois agility test. Conclusion: It might be concluded from the findings of the present study that in male footballers, the star excursion balance test of right and left leg had statistically significant negative correlations with weight, BMI, percent body fat and Illinois agility test.***

Keywords: Inter-university footballers. Anthropometric variables. Agility test. Flexibility test. Peak lower limb strength

1. Introduction

1) Football is a complex sport, requires the repetition of runs alternated with short to long periods of recovery, which could active or passive. It is a game full of direction and speed changes with and without the ball, and agility training helps players become more agile and improves coordination. Most National Collegiate Athletic Association (NCAA) Division I collegiate football programs place great importance on controlling players' body weight, body composition, and increasing muscular strength (Fry and Kraemer, 1991; Miller et al., 2002). Several studies have examined the relationship between anthropometric measures and functional tests of athletic performance (Nikolaidis et al., 2015).

2) Anthropometric dimensions and morphological characteristics play an important role in determining the success of a sportspersons (Reco-Sanz, 1998; Wilmore and Costill, 1999; Keogh, 1999) and can assist the exercise scientist and coach in selecting and developing talented athletes. These anthropometric and morphological parameters are the sensitive indicators of physical growth and nutritional status of the athletes for their maximal performances (Wilmore and Costil, 1999; Chatterjee et al., 2006). Anthropometric characteristics can be determinative in enhancing or determining performance and ability level (Reilly et al., 2000).

3) Muscle strength testing is commonly used to evaluate, assess, and compare data regarding muscle function in athlete. Strength tests are one of the most practical measures to evaluate physical fitness of a person. Several external factors viz. altitude, position of exerting strength, diet (Keys et al., 1950) and internal factors, viz. age, sex, height, weight etc. influence the maximum force that can be exerted by a muscle.

4) In football, players have to perform various technical and tactical tasks according to their playing positions (Di-Salvo et al., 2007; Malina et al., 2000). Midfielders cover a significantly greater distance than defenders and forwards; defenders dribble a shorter distance than the others, whereas forwards perform significantly more sprints than defenders and midfielders (Wong et al., 2008; Krustrup and Bangsbo, 2001). Professional football players have positional differences in anthropometry such as body mass, height, and body mass index (Gil et al., 2007).

5) There are different physical demands in each standard playing position. Reilly et al. (2000) have accordingly, concluded that elite football teams were characterized by relative heterogeneity in body size. Therefore, there are likely to be anthropometric predispositions for positional

roles, with taller players being the most suitable for central defensive positions and for the "target" players among the strikers or forwards.

6) In football, positional differences exist, where forwards become the fastest sprinters as they cover the greatest distance by high speed during games. In contrast with results of previous studies (Wong et al., 2008) performed on Under 13 to Under 15 players, there is significant difference in jump height (standing jump and counter movement jump) between the goalkeepers, defenders, midfielders and forwards. In the present study, an attempt has been made to estimate the dynamic balance, peak lower limb strength, agility, flexibility and anthropometric variables in inter-university footballers position-wise, and the correlation of dynamic balance with rest of the variables studied.

2. Materials and Methods

1) Subjects

The present cross-sectional study was based on purposely selected 100 Indian inter-university football players (84 males; further divided into 34 forwards, 20 defenders, 20 midfielders, 10 goalkeepers, and 16 females; further divided into 5 forwards, 5 defenders, 5 midfielders, 1 goalkeeper) aged 18-25 years collected from various universities of Punjab during September-October, 2017. The age of the subjects were recorded from the date of birth registered in their respective institutes. A written consent was obtained from the subjects. The data were collected under natural environmental conditions in morning (between 8 AM to 12 noon). The study was approved by the Institutional ethics committee.

2) Anthropometric Measurements

Five anthropometric variables, viz. height, weight, body mass index, mid-thigh circumference and percent body fat were measured from all the subjects in triplicate with the median value used as the criterion. The height was recorded during inspiration using anthropometric rod to nearest 0.1 cm. Weight was measured by digital standing scales (Model DS-410, Seiko, Tokyo, Japan) to nearest 0.1 kg. Body mass index (BMI) was calculated using the formula weight (kg)/height^2 (m)^2 (Peterson et al., 2003). Total leg length was measured by anthropometric rod in cm. Mid-thigh circumference was measured by steel tape in cm. Percent body fat was calculated with the following formula (Durnin and Womersley, 1974):

Per-cent body fat = Females (17-68 years) = (1.37 × BMI – 3.47)

Males (17-76 years) = (1.34 × BMI – 12.47)

3) Sit and Reach Test

The sit and reach test is a wooden device with the following dimensions: length of base 35 cm, width 45 cm, height 32 cm and length 55 cm. To standardize the measurement scale of sit and reach, a standard meter rule was placed on the sit-and-reach box for each test, with the reading of 23 cm in line with the heel position of each test. The participants sat on the floor with shoes on, and fully extended two legs so that the sole of the foot was flat against the end of the box. They extended their arms forward, placing one hand on top of the other. With palms down, they reached forward sling hands along the measuring scale as far as possible without bending the knee of the extended leg. Throughout testing, the physiotherapist checked to ensure that the heel remained at the 23 cm mark. Three trials were performed on one side. The average of the three trials on each side was used for subsequent analyses. Reaches short of the toes were recorded as negative forward reach scores, and reaches beyond the toes were recorded as positive forward reach scores. The forward reach scores were recorded in centimetres to the nearest 0.5 cm using the scale on the box (Panteleimon et al., 2010).

4) Agility Test

This was measured by Illinois agility test. The length of the course is 10 metres and the width (distance between the start and finish points) is 5 metres. On an athletics track, you could use 5 lanes. 4 cones can be used to mark the start, finish and the two turning points. Each cone in the centre was spaced 3.3 metres apart. When counted in sprint as fast as you can through the circuit following the path indicated.

5) Dynamic Balance Test (Star Excursion Balance Test)

This was measured by star excursion balance test (SEBT). Subject received verbal instruction and visual demonstration of the SEBT. The subjects stood on one lower extremity, with the most distal expect of their great toe on the centre of the grid. The same was repeated on the contralateral limb. The subject was then asked to reach the anterior, postero-medial, postero-lateral direction, while maintaining their single-limb stance. The trail was discarded and the subject repeated the testing trail if (1) the subject was unable to maintain single-limb stance, (2) The heel of the stance foot did not remain in contact with the floor, (3) weight was shifted on to the reach foot in any of the three directions, or (4) the reach foot did not return to the starting position prior to reaching in anterior direction. Three final readings were recorded in all three directions and maximal distance in centimetres obtained was taken to calculate composite score. Scoring- the SEBT composite score was calculated by dividing sum of the maximum reach distance in the anterior (A), postero-medial (PM), and postero-lateral (PL) directions by three times the limb length (LL) of the individual, and then multiplied by 100. [{(A+PM+PL)/(LL x 3)} x 100].

6) Peak Lower Limb Strength

This was measured by vertical jump test. Before beginning, the subject stood against a wall and reached up as high as he/she can with flat feet. That point was measured as the standing reach height. The subject stood away from the wall and jumped vertically as high as he/she could and encouraged them to use both the arms and bent the legs to propel them up as much as possible for three times and recorded the best one. The distance between the reach height and the jump height was measured and calculated in cm.

7) Statistical Analysis

Descriptive statistics (mean ± standard deviation) were determined for the directly measured variables as well as the derived ones. One way analysis of variance was tested for the comparisons of data among Indian inter-university football players position-wise, followed by post-hoc Bonferroni test. Pearson's correlation coefficients were

applied to establish the relationships among the variables measured. Data were analyzed using SPSS (Statistical Package for Social Science) version 20.0. A 5% level of probability was used to indicate statistical significance.

3. Result

1) Descriptive statistics of selected anthropometric variables in male inter university footballers playing position-wise was shown in Table 1. One way ANOVA showed statistically significant between-group differences (p<0.002-0.001) in vertical jump (f=5.436), star excursion balance test of left leg (f=6.659), and star excursion balance test of right leg (f=11.500) among these four sets of data.

Table 1: One-way analysis of variance of selected anthropometric variables in male footballers position-wise

Variables	Forward males		Midfielder males		Defender males		Goalkeeper males		F-value	P-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Height (cm)	170.36	6.52	172.52	7.01	163.40	34.76	178.06	4.14	1.730	0.168
Weight (kg)	60.47	4.16	63.20	5.95	60.40	6.54	64.60	5.83	2.407	0.073
Body mass index (kg/m^2)	20.83	1.13	21.24	1.72	20.71	2.19	20.46	2.87	0.500	0.683
Mid-thigh circumference (cm)	49.62	3.11	51.13	2.86	50.58	3.78	51.60	5.28	1.239	0.301
% body fat	13.20	1.43	13.93	2.29	13.12	2.80	12.88	3.83	0.631	0.599
Sit & reach test (cm)	16.30	6.32	17.15	4.29	18.14	4.43	20.76	3.04	2.078	0.110
Illinois agility test (sec)	16.82	0.67	16.88	0.92	16.64	0.79	17.22	0.93	1.208	0.312
Vertical jump test (cm)	41.15	5.30	37.30	5.62	43.25	5.88	36.98	4.82	5.436	0.002
SEBT (left) (cm)	95.47	6.98	90.42	9.38	97.83	8.53	102.98	2.51	6.659	0.001
SEBT (right) (cm)	98.58	6.65	91.69	7.84	101.51	7.38	106.08	5.16	11.500	0.001

2) Descriptive statistics of selected anthropometric variables in inter university female footballers playing position-wise was shown in Table 2. One way ANOVA showed no significant between-group in any of the variables.

Table 2: One-way analysis of variance of selected anthropometric variables in female footballers position-wise

Variables	Forward females		Midfielder females		Defender females		Goalkeeper female		F	P
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Height (cm)	157.60	5.98	157.20	5.89	165.60	5.41	158.00	-	2.293	0.130
Weight (kg)	44.40	4.88	46.40	5.68	52.10	9.79	49.00	-	1.062	0.401
Body mass index (kg/m^2)	17.94	2.67	18.82	2.59	18.96	3.21	19.60	-	0.168	0.916
Mid-thigh circumference (cm)	45.10	4.50	44.12	2.96	47.90	4.33	48.00	-	0.907	0.466
% body fat	20.30	3.21	21.32	3.13	21.46	3.82	22.30	-	0.159	0.922
Sit & reach test (cm)	10.44	3.76	6.92	3.68	12.00	4.79	12.00	-	1.427	0.283
Illinois agility test (sec)	20.22	0.71	20.48	1.35	19.90	0.67	18.60		1.159	0.366
Vertical jump test (cm)	26.98	4.94	26.30	4.33	29.38	5.44	33.00	-	0.742	0.547
SEBT (left) (cm)	88.72	6.63	83.06	7.54	86.28	9.77	88.70	-	0.445	0.725
SEBT (right) (cm)	85.58	5.27	85.14	7.97	89.36	8.02	89.80	-	0.404	0.753

3) Table 3. showed the correlation coefficients of dynamic balance test (SEBT) with selected anthropometric variables and performance tests in inter-university male and female football players. In star excursion balance test of left leg, statistically significant (≤0.050) positive correlations (≤0.016-0.001) were found only in vertical jump test, and statistically significant negative correlations (≤0.026-0.001) with weight, BMI, percent body fat and Illinois agility test. However, in female footballers, no significant correlations of star excursion balance test left leg were found with any of the variables studied. In star excursion balance test of right leg, in male footballers, statistically significant (≤0.016-0.005) negative correlations were found with weight, BMI, percent body fat and Illinois agility test, whereas, significantly negative correlation (≤0.014) of star excursion balance test of right leg were found only with Illinois agility test in female footballers.

Table 3: Correlation coefficient of star excursion balance test of right and left leg with selected anthropometric and performance variables in inter-university male and female footballers

Variables	Star excursion balance test (left)				Star excursion balance test (right)			
	Male footballers		Female footballers		Male footballers		Female footballers	
	r	p	r	P	r	p	r	p
Height	0.025	0.819	-0.160	0.553	0.055	0.617	-0.192	0.476
Weight	-0.332	**0.002**	-0.129	0.634	-0.262	**0.016**	-0.011	0.967
BMI	-0.423	**0.001**	-0.051	0.850	-0.426	**0.001**	0.099	0.716
Mid-thigh circumference	-0.209	0.056	-0.096	0.724	-0.210	-0.056	0.214	0.425
Percent body fat	-0.408	**0.001**	-0.041	0.880	-0.420	**0.001**	0.111	0.682
Sit and Reach test	-0.052	0.639	-0.097	0.722	0.032	0.773	-0.129	0.635
Illinois agility test	-0.243	**0.026**	-0.364	0.166	-0.304	**0.005**	-0.601	**0.014**
Vertical jump test	0.214	**0.050**	0.407	0.118	0.203	0.064	0.352	0.181

4. Discussion

1) In football, performance depends on a number of factors, such as a physical fitness, psychological factors, players' technique, and team tactics. Detection and identification of talents are more difficult in team games than in individual sports such as running, cycling or rowing, where predictors of performance are more easily scientifically prescribed (Reilly, 1990). The anthropometric profile of an athlete plays an important role in determining his or her potential for success within a sport (Claessens et al., 1999; Rico-Sanz, 1998; Wilmore and Costil, 1999; Keogh, 1999; Slater et al., 2005). Although talent selection is an uncertain procedure because there are many different factors that are involved in the development of a prospective player, knowledge of fitness profiles of successful players has been indicated as a valuable resource to guide talent selection and subsequent coaching (Bangsbo, 1994).

2) The findings of the present study showed significant between-group differences in vertical jump, star excursion balance test of left and right in male footballers. These differences were, might be, due to the effects of regular physical training and exercise. While no significant between-group differences were found in any of the variables studied in inter-university female footballers. In fact, less sample size in female footballers might produce non-significant between-group differences.

3) It was also found that dynamic balance measured by SEBT test of bilateral legs had statistically significant positive correlation with vertical jump test and statistically significant negative correlations with weight, BMI, percent body fat and Illinois agility test in male footballers. In fact, dynamic balance has been proved as an important contributor in performance by Erkmen et al. (2010) also, and the findings of the present study followed their results. The dynamic balance had strong correlations with vertical jump (Jezdimirovic et al., 2013; Perroni et al., 2014) and sit and reach test (Skaggs et al., 2015) too. More future studies are required to validate the data. In fact, small sample size was the only limitation of the study.

5. Conclusion

It could be concluded from the present study that the dynamic balance had significant between-group differences among the male and female footballers and controls. In male footballers, the star excursion balance test of right and left leg had statistically significant negative correlations with weight, BMI, percent body fat and Illinois agility test. Thus, the finding may be helpful for the development of training program and identification of talents in the game.

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