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Original Research Article

Correlations of Static Balance and Star Excursion Balance Test With Selected Anthropometric Variables in Inter-University Archery Players

Ashwini Patil[1], Shyamal Koley[2]

[1]MYAS GNDU, Department of Sports Sciences and Medicine, Guru Nanak Dev University, Amritsar-143005, Punjab, India.
[2]Department of Physiotherapy, Guru Nanak Dev University, Amritsar-143005, Punjab, India.

Corresponding Author: Ashwini Patil

ABSTRACT

Archery is considered as a static sport that requires strength and endurance of the upper body, especially the arms, waist and shoulder. The purpose of the study was to evaluate the static balance and star excursion balance test in 93 purposely selected Indian national archery players (51 male and 42 female) aged 16-25 years and to search their correlations with selected anthropometric variables. The samples were collected from various archery academies in Mumbai, Maharashtra. An adequate number of controls (n = 101, 51 males, 50 females) were also taken from the same place for comparison. A total of six anthropometric variables i.e. height, weight, BMI, % body fat, biceps skinfold and triceps skinfold; and two balance tests such as standing balance test and star excursion balance test (both left and right legs) were measured on each subject. In results, One way ANOVA showed significant between-group differences ($p<0.001$) in all variables except left standing balance test among these four sets of population. In Indian national archery players, static balance test (both left and right legs) had significant negative correlations ($p<0.035 – 0.001$) with triceps skinfold, whereas star excursion balance test (both left and right legs) had significant negative correlations ($p<0.010–0.005$) with weight only. From the findings of the present study it might be concluded that standing balance test had strong association with triceps skinfold. Also, star excursion balance test showed strong association with weight in Indian national archery players. The data presented in the present study carry immense practical application and may be useful in future investigation on player selection, talent identification and training program development in archery.

Keywords: Static balance, Star excursion balance test, Anthropometric variables, Indian national archery players.

INTRODUCTION

Archery is considered a static sport that requires strength and endurance of the upper body, especially the arms, waist and shoulder. The archer's skill is defined by the ability to shoot an arrow at the target within a certain range of time with maximum precision. [1] Balance is the ability to maintain the body's position over its base of support, whether that base is stationary or moving. Controlling postural sway during stable conditions is called static balance. [2] A study reported that postural balance was related to the shooting accuracy both directly and indirectly through rifle stability. The assessment and the periodic monitoring of static and dynamic balance in young athletes can be an important instrument in order to correctly determine and change training programs. [3]

Core stability is an important component maximising efficient athletic function. The core is important to provide local strength and balance and thus maximise all kinetic chains of upper and lower extremity function. [4] It can be estimated that there is a possible link between the body's core stability. To support this, there are research findings showing an increase knee injury rate in female athletes who scored lower on proprioception and neuromuscular control of the trunk. [5] A study used a core stability training program to increase dynamic stability in the core. The effects of core stability on dynamic stability in relation to decreasing ground reaction forces in runners by using the star excursion balance test to test for dynamic stability was established. [6]

Anthropometry is the science that deals with measurements of size, weight and proportions of human body. It provides scientific methods and observations on the living humans. [7-10] Anthropometric techniques (skinfold, % body fat, circumference and diameter measurements) are popular for predicting body composition because they are not much expensive, require little space and can be performed easily. [11-12]

Not much literature is available relating to the static balance, core stability, anthropometric variables and performance tests in archery players, especially in Indian context. Thus, to fulfil the lacunae of knowledge, the present study was undertaken.

MATERIALS AND METHODS

Subjects

The present cross-sectional study was based on purposely selected 93 Indian national archery players (51 male and 42 female) aged 16–25 years (mean age 19.45 ± 2.63 years) collected from the various archery academies in Mumbai, Maharashtra, India, during the months of June to October, 2018. An adequate number of controls (n = 101, 51 male and 50 female, mean age 20.67± 2.54 years) were also taken from the same place for comparison. The age of the subjects were recorded from the date of birth registered in their respective institutes. The subjects were divided in such a way that age 16 refers to the individuals aged 15 years and 6 months through 16 years and 5 months and 29 days. 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.

Anthropometric Measurements

Six anthropometric variables, such as, height, weight, BMI, biceps skinfold, triceps skinfold and percent body fat were taken on each subject using the techniques provided by Lohmann et al. [13] and were measured in triplicate with the median value used as the criterion. The height was recorded during inspiration using a stadiometer (Holtain Ltd., Crymych, Dyfed, UK) to the nearest 0.1 cm. The subject was asked to stand erect on the stadiometer with bare foot. The horizontal bar of the stadiometer was placed on the vertex of the subject and the readings were recorded in centimetres. Weight was measured by digital standing scales (Model

DS-410, Seiko, Tokyo, Japan) to the nearest 0.1 kg. The subject was asked to stand erect on the digital weighing machine with minimum cloths and bare foot. The readings were recorded from the scales of the digital weighing machine in kilograms. BMI was then calculated using the formula weight (kg)/height^2 (m^2).

For the measurement of biceps and triceps skinfold, the Harpenden skinfold calliper (British Indicators Ltd, St Albans, Herts) was used. Both the measurements were taken with the subject seated on a stool, on the right side of the body. The sites selected were as follows. (I) Biceps: over the mid-point of the muscle belly with the arm resting supinated and (2) Triceps: over the mid-point of the muscle belly, mid-way between the olecranon and the tip of the acromion, with the upper arm hanging vertically. The skinfold was pinched up firmly between the thumb and forefinger and pulled away slightly from the underlying tissues before applying the calliper for the measurement. Results were recorded from the circular reading scale of the skin fold calliper in millimetres. Percent body fat was assessed using BMI after Durnin and Womersley: [14]

Percent body fat:

Females (17-68 years) = 1.37 X BMI - 3.47

Males (17-68 years) = 1.34 X BMI - 12.47

Performance Tests

Two tests were considered for the present study, these were standing balance test and star excursion balance test.

Standing Balance Test

The subject was asked to stand on one leg for as long as possible. The subject was given a minute to practice his balancing before starting the test. The timing stopped when the elevated foot of the subject touched the ground or the subject hopped or otherwise lose his balance position. The best of three attempts was recorded. The test was repeated on the other leg also. The total length of time person could stay in the balanced position was recorded in seconds.

Star Excursion Balance Test (SEBT)

The SEBT testing grid consists of 8 tape measures secured 45º to each other from the centre. Subjects were asked to assume a single limb stance in the middle of the testing grid while attempting to reach as far as possible in designated directions with the opposite limb without compromising the base of support. The participants were instructed to make a light touch on the floor on each arm of the SEBT grid with the distal most part of the foot, and then return to a double-leg stance in the middle of the testing grid without changing the base of support. If the participant failed to perform the reach in the required manner, the trial was discarded and the reach performed again. The sum of the distance covered in each direction was them calculated in centimetres. The test was performed on each leg separately.

Statistical Analysis

Data was analysed using SPSS (Statistical Package for Social Science) version 20.0. One way analysis of variance was tested for the comparisons of data among Indian national archery players and controls. Pearson's correlation co-efficient test was done to observe the correlations among static balance, SEBT and selected anthropometric variables in the archers. A 5% level of probability was used to indicate statistical significance.

RESULTS

Table 1 showed the descriptive statistics of static balance tests and selected anthropometric variables in archery players and controls. One way ANOVA showed significant between-group differences ($p \leq 0.05 - 0.001$) in all the variables studied among these four sets of population.

Table 1: Description of one-way ANOVA of static balance, SEBT and selected anthropometric variables in archers and controls

Variables	MA (n = 51)		FA (n= 42)		CM (n = 51)		CF (n= 50)		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
HT (cm)	167.02	8.20	160.41	7.30	167.68	6.75	160.65	7.29	13.57	0.001
WT (kg)	63.87	12.20	52.35	5.39	68.38	8.96	54.48	6.19	36.17	0.001
BMI (Kg/m^2)	22.8	3.68	20.41	2.37	24.32	2.75	21.16	2.51	17.10	0.001
BSF (mm)	6.31	4.77	6.07	2.39	5.97	2.17	7.95	2.97	3.949	0.009
TSF (mm)	12.35	5.15	12.7	5.20	12.2	4.1	16.43	3.65	9.678	0.001
%BF	18.08	4.93	24.49	3.25	20.12	3.71	25.52	3.44	39.735	0.001
LSBT (secs)	147.64	102.33	169.1	66.81	156.13	54.05	128.35	56.02	2.580	0.050
RSBT (secs)	152.90	103.51	187.06	101.33	133.42	53.60	130.72	67.49	4.324	0.006
LSEBT (cm)	663.68	92.6	640.87	75.82	609.26	47.13	590.6	60.17	14.974	0.001
RSEBT (cm)	684.38	85.3	661.61	77.39	550.4	54.37	573.98	53.79	39.871	0.001

MA = male archers, FA = female archers, CM = control males, CF = control females, HT = height, WT = weight, BMI = body mass index, BSF = biceps skinfold, TSF = triceps skinfold, %BF = percent body fat, LSBT = left standing balance test, RSBT = right standing balance test, LSEBT = left star excursion balance test and RSEBT = right star excursion balance test.

The correlation coefficients of static balance and core stability with other anthropometric variables in male archers were shown in Table 2. In male archers, left standing balance test showed significant positive correlation (p<0.014) with height and significant negative correlation (p<0.031) with triceps skin fold. Right standing balance test showed significant positive correlation (p<0.037) with height and significant negative correlation (p<0.001 – 0.036) with BMI, triceps skin fold and % body fat. Also, significant positive correlation of left SEBT (p<0.010) was seen with height in male archers.

Table 3 showed correlation coefficients of static balance and core stability with other anthropometric variables in female archers. In female archers, right standing balance test showed significant negative correlation (p<0.040) with biceps skinfold only.

The correlation coefficients of static balance and core stability with other anthropometric variables in male and female archers were shown in Table 4. In pooled archers, both left and right standing balance test showed significant negative correlation (p<0.035 – 0.001) with triceps skinfold whereas both left and right star excursion balance test showed significant negative correlation (p<0.010 – 0.005) with weight.

Table 2: Correlation coefficients of static balance and SEBT with selected anthropometric variables in male archers

Variables	Standing balance test (left)		Standing balance test (right)		Star excursion balance test (left)		Star excursion balance test (right)	
	r-value	p-value	r-value	p-value	r-value	p-value	r-value	p-value
HT (cm)	0.346	<0.014	0.296	<0.037	0.363	<0.010	0.205	0.154
WT (kg)	0.111	0.443	-0.124	0.390	0.213	0.138	0.173	0.228
BMI (kg/m^2)	-0.049	0.733	-0.297	<0.036	0.062	0.670	0.106	0.465
BSF (mm)	0.013	0.929	-0.068	0.641	0.090	0.533	0.058	0.690
TSF (mm)	-0.306	<0.031	-0.512	<0.001	0.044	0.762	0.121	0.403
% BF	-0.049	0.733	-0.297	<0.036	0.062	0.670	0.106	0.465

Table 3: Correlation coefficients of static balance, SEBT and selected anthropometric variables in female archers

Variables	Standing balance test (left)		Standing balance test (right)		Star excursion balance test (left)		Star excursion balance test (right)	
	r-value	p-value	r-value	p-value	r-value	p-value	r-value	p-value
HT (cm)	-0.039	0.889	0.052	0.745	0.090	0.572	0.272	0.081
WT (kg)	-0.022	0.422	-0.015	0.924	-0.190	0.229	0.074	0.639
BMI (kg/m^2)	0.127	0.462	-0.058	0.713	-0.237	0.131	-0.155	0.327
BSF (mm)	-0.144	0.363	-0.318	<0.040	-0.091	0.565	-0.039	0.807
TSF (mm)	-0.097	0.542	-0.291	0.061	-0.107	0.501	0.064	0.688
% BF	0.117	0.462	-0.058	0.713	-0.237	0.131	-0.155	0.327

Table 4: Correlation coefficients of static balance, SEBT and selected anthropometric variables in male and female archers

Variables	Standing balance test (Left)		Standing balance test (Right)		Star excursion balance test (Left)		Star excursion balance test (Right)	
	r-value	p-value	r-value	p-value	r-value	p-value	r-value	p-value
HT (cm)	-0.081	0.443	-0.089	0.397	-0.030	0.776	-0.029	0.783
WT (kg)	0.156	0.137	0.001	0.296	0.289	<0.005	0.266	<0.010
BMI (kg/m^2)	0.033	0.753	-0.161	0.126	0.167	0.111	0.192	0.067
BSF (mm)	-0.024	0.819	-0.137	0.192	0.047	0.659	-0.046	0.663
TSF (mm)	-0.221	<0.035	-0.401	<0.001	-0.022	0.835	0.090	0.392
% BF	0.069	0.511	-0.064	0.542	-0.105	0.319	-0.069	0.512

DISCUSSION

Balance has been shown to play a fundamental role in many athletic activities as well as sport specific postural control and may contribute to a successful performance although the relationship between balance ability and athletic performance is less clear. [15,16] Earlier research findings have demonstrated that female athletes had superior balance than male athletes. [17] In fact, the findings of the present study also showed that female archers scored higher mean values in left standing balance test (169.1±66.81) than the male archers (147.64 ±102.33). Also, female archers showed higher mean values in right standing balance test (187.06±101.33) as compared to their male counterparts (152.90±103.51). It is possible that, individually or in combination, the level and the specific nature of prior training, current strength and flexibility may alter the performance in balance test in archers, as compared to the control group, resulting in differences between the groups.

The results of this study also indicated that there were no limb differences in balance performance for any group. This similarity in limbs, independent of group or testing surface, is consistent with previous literature. [18]

The study also reported higher levels of % body fat in females, archers and controls, even when they had lower BMI values as compared to their male counterparts. This is consistent with results of many previous studies and statements that females carry more body fat and less lean body mass as compared to males. [19-20]

It was also established that there was a strong associations of static balance with BMI, skin folds and % body fat in male archers, whereas only with biceps skinfold in female archers. This indicated that the balance performance improved with a more lean body mass in both male and female athletes and as already stated that higher % body fat was associated with poorer outcomes on tests of lower extremity performance. [21,22] Thus, this would help in planning training programs that focus on developing more lean body mass and reduce fat mass in archers with poor balance performance.

The study also reported that weight had a weak positive correlation with star excursion balance test. This is not consistent with the results of previous studies done in a similar age group on adolescent males. [23] It has also been reported that an increase in BMI or being overweight and obese leads to difficulty in controlling postural stability and reduces balance performance as the double leg stance phase in the gait cycle increases. This leads to poor reach and reduced performance in dynamic balance tests as well as gait. [24]

CONCLUSION

From the findings of the present study it might be concluded that, though star excursion balance test had statistically no significant correlations with any of the anthropometric variables other than weight in Indian national archery players, standing balance test, but had strong association with BMI, biceps and triceps skin fold and % body fat in Indian national archery players.

The data presented in the present study carry immense practical application and may be useful in future investigation on player selection, talent identification in archery. It can also help in training program development in archery, especially with respect to core strengthening and improving postural stability.

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