



INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES



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ISSN: 2222-6990

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To Link this Article: <http://dx.doi.org/10.6007/IJARBSS/v9-i6/6765>

DOI: 10.6007/IJARBSS/v9-i6/6765

Received: 24 April 2019, **Revised:** 27 May 2019, **Accepted:** 06 June 2019

Published Online: 28 June 2019

In-Text Citation: (Haq et al., 2019)

To Cite this Article: Haq, M. Z. ul, Maqbool, U., Ali, H., Ahamad, M., & Haq, M. Z. ul. (2019). Kinematic, Physical Fitness and body composition of Heighted and Short Heighted Shot-Put Throwers. *International Journal of Academic Research in Business and Social Sciences*, 9(6), 1327–1334.

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Vol. 9, No. 6 2019, Pg. 1327 - 1334

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Abstract

The purpose of this study was to compare the kinematics of shot-put throw, physical fitness and of the university shot put players. Twenty subjects were recruited for data collection and divided in two groups by considering their height as group one ($n = 08$) and group two ($n = 12$). Data was collected with a digital video camera, measuring tape for girth, sliding caliper for bone breadth and length and dynamometer for hand grip strength. The physical fitness variables were long standing jump, hand strength, 30-meter dash, flexibility, agility, and throw distance. Independence t -test was applied for statistical analysis. The tall heighted throwers were significantly higher, than the short heighted throwers in stature, body mass, vertical jump, distance of the shot-put throw, wrist girth, upper arm length, leg length, arm span, and pelvic breadth. Except the left leg angle all selected variables were not significantly different in the kinematics analysis of the shot-put throw. It is concluded, the tall heighted find biomechanical advantage from their large muscles size and leverage of the longer bone than short height throwers. Therefore, it is proposed selector should also considered the tall throwers for final selection.

Keywords: Shot Put, Kinematic, Anthropometric, Videography, Physical Fitness.

Introduction

The performance of shot-put athletes depends on their anthropometric characteristics, physical fitness and technique. A shot-put thrower desire to maximize the distance of the thrown object. The cover distances of the shot put depends on the height, body mass, angle of release, and

muscular strength of the athlete. The spin technique involved in complex movement rather than glide technique (Coh & Jost, 2005). Kinematic analysis shows all parts of movement of the thrower which assist to improve performance. The aspects which influence the performance of shot-put players would be physical strength, body size and techniques. The analysis of the weight, stature, and kinematics of the throw would help to find causes of poor performance and enhance in future (Byun, Fujii, Murakami, Endo, Takesako, Gomi, & Tauchi, 2008). This the study is the investigation of the kinematics of the shot-put throw, bod composition and physical fitness of the university shot put throwers.

Methodology

The nature of study was a cross-sectional by using the quantitative method of data collection through videography. Eight heighted players and twelve short height players were selected for this research, through purposive sampling from the Islamia University of Bahawalpur. The selected players were 20-22 years of age, the heighted players were, stature (180 ± 0.2 cm), body mass (84.10 ± 7.35), and the short heighted players were stature (154 ± 0.64), body mass (69.56 ± 8.06). The willing consent was obtained from all participants, and procedure of data collection was briefed to all participants before the commencements of data. The data was collected at the sport gymnasium of the Islamia University of Bahawalpur, Pakistan

Instruments and Procedure of the Anthropometric Measurements

The anthropometric measures, stature was obtained with stadiometer in cm. Weight was recorded with digital weight balance in kg. A harpenden skinfold caliper to measure the skinfolds in millimeter. The skinfolds were triceps, subscapular, biceps, illiaccrest, supraspinale, abdomen, thigh, and calf. Girths with metallic 1-meter tape as arm relax, arm flex, forearm, chest, waist, hips, thigh, and calf. A bone caliper applied to assess the lengths of arm, leg, breadths of shoulders, pelvis, chest, elbow and knee. A wooden box was used to examine the sitting height. A horizontal scale was pasted on the wall to assess the arm span. The guide line of the International Kinanthropometric Society (ISAK) was followed during the anthropometric assessments.

Physical Fitness Tests

Speed was assessed by recording the time of 30-meter dash run. The time was recorded from the instigation of movement from the starting point to the finish line. The 10 x 5-m shuttle run was recorded by using 5 x 10-m shuttle sprint in the following of the previous study (Nakata, Nagami, Higuchi, Sakamoto, & Kanosue, 2013). An agility test was determined by the specific zig zag run of a subject such as three lines were marked with 5 meters. Agility times were recorded by using a digital stopwatch. The timer began as an athlete initiate his movement and stopped as crossed the finish line.

The standing long jump, the subjects were in standing position behind the starting line and jump forward as far as possible. The distance from the starting line to the heel of the closest foot was recorded, measurements was recorded in centimeter (Kohmura et al., 2008). The flexibility was judged through sit and reach. The participant had to sit on the floor without shoes,

and extend his knees. The both hands on the device for pushing with the tip of the fingers with both hands, and maximum reached point was considered as the final score. The subjects were in sat position for sit-ups on the floor, and hands crossed at the chest, move forward to touch his elbows with knees, and return back again to initial position and total within 30 seconds was recorded as final score. The hand grip strength was recorded with digital dynamometers (Koley et al., 2012), and data was interpreted in kilogram. The dynamometer is calibrated, body position for hand grip strength were in upstanding, with flexion of elbow at ninety degrees (Koley & Yadev, 2009), and subject was remained neutral while applied force (Koley et al., 2012).

Video Analysis of the Shot Put

A digital video camera, was operated at 30/ frames per second for recording the shot-put action of the throwers. The Kinovea software was used for kinematics analysis. Six throws were recorded of each participant for further kinematics analysis. One-meter calibration frame was placed in between the performing area and video camera for linear kinematics. The selected variables of kinematics were stride length, knee angle, hip angle, trunk angle, shoulder angle, elbow and wrist angle and height of release. The stride length was defined as linear distance from the toe of left foot to the toe of right foot. The angular position was considered as 180° for the vertical position of the joint and 0° for full bending of the joint (Inkster, Murphy, Bower, & Watsford, 2010). Ankle angle was considered as the connection of toe-to-ankle, and knee to ankle, knee angle from ankle to knee and hip to knee, hip angle from knee to hip and shoulder to hip, shoulder angle from hip to shoulder and from elbow to shoulder, the elbow angle from shoulder to elbow and wrist to elbow. The height was described from the toe to the put and hand contact.

Statistical Analysis

Mean and Standard Deviation of all variables were reported, and Independence *t*-test was applied to examine difference among two groups in the anthropometric and physical fitness and kinematics of shot put. The α value adjusted at $P < 0.05$ for all variables.

Result

Table 1 shows significant difference in stature (heighted throwers = 182.88 ± 4.65 ; short heighted = 154.84 ± 0.64 ; $t = 85.59$, $P = .04$), and body mass (heighted throwers = 84.00 ± 7.34 ; short heighted = 69.69 ± 8.06 ; $t = 3.22$, $P = .01$).

Table 1: Descriptive measure of university shot put male players

Variables	Groups	Mean	Std. D	<i>t.</i>	<i>Sig.</i>
Age(years)	Heighted	23.25	0.5	0.451	0.66
	Shorter	22.94	1.34		
Stature (cm)	Heighted	182.88	4.65	85.59	0.04
	Shorter	154.84	0.64		
Body mass (Kg)	Heighted	84.10	7.35	3.22	0.01
	Shorter	69.69	8.06		

Significant value $P < 0.05$

Table 2 shows significant difference in in bench press (heighted throwers = 32.52 ± 6.57 ; shorter = 25.63 ; $t = 2.06$, $P < .04$. vertical jump (heighted throwers 44.75 ± 6.60 ; shorter = 36.45 ± 7.26 ; $t = 2.06$, $P < .05$. Throw distance (heighted throwers = 7.98 ± 0.12 ; shorter = 5.99 ± 1.06 ; $t = 3.69$, $P = .00$.

Table 2: Descriptive physical fitness of university shot put male players

Variables	Groups	Mean	Std. D	t	Sig.
Hand Grip strength (Kg)	Heighted	83.5	14.36	1.32	0.20
	Shorter	70.19	18.7		
Standing broad jump (feet)	Heighted	6.78	0.93	0.73	0.48
	Shorter	6.54	0.49		
Sit-ups in one minute (sec)	Heighted	20.53	7.14	-1.19	0.25
	Shorter	24.14	5.05		
one bench press max (kg)	Heighted	32.52	6.57	2.77	0.04
	Shorter	25.63	4.29		
one squat max (kg)	Heighted	30.20	11.55	1.31	0.21
	Shorter	22.5	10		
Race 30m (sec)	Heighted	6.18	1.89	0.77	0.45
	Shorter	5.7	0.89		
Flexibility (inch)	Heighted	9.75	3.3	0.16	0.87
	Shorter	9.5	2.6		
Agility (sec)	Heighted	11.62	1.07	0.33	0.74
	Shorter	11.49	0.57		
Vertical Jump (cm)	Heighted	44.75	6.6	2.06	0.05
	Shorter	36.45	7.26		
Balance (Sec)	Heighted	68.78	29.56	1.51	0.15
	Shorter	52.76	16.1		
Throw Distance (m)	Heighted	7.98	0.12	3.69	0.00
	Shorter	5.99	1.06		

Significant value $P < 0.05$

Table 3 shows significant difference in the scores for pelvic breadth (heighted thrower = 34.01 ± 2.14 ; short heighted = 30.32 ± 3.16 ; $t = 2.19$, $P = .04$). Wrist girth (heighted throwers = 18.26 ± 0.49 ; short heighted = 16.58 ± 0.81 ; $t = 3.94$, $P = .00$. Arm length (heighted thrower = 36.00 ± 2.45 ; short heighted = 31.88 ± 1.59 ; $t = 4.19$, $P = .00$. Leg length (heighted throwers = 96.51 ± 3.10 ; short heighted = 88.51 ± 3.87 ; $t = 3.814$, $P = .00$. Arm span (heighted throwers = 185.00 ± 0.82 ; Short heighted = 157.13 ± 1.63 ; $t = 32.741$, $P = .000$.

Table 3: Descriptive Anthropometric Measurement of University Shot Put Male Players

Variables	Groups	Mean	Std. D	t	Sig.
Arm flex girth (cm)	Heighted	30.26	2.04	1.34	0.20
	Shorter	25.70	6.62		
Arm relax girth (cm)	Heighted	26.26	1.89	1.35	0.19
	Shorter	23.39	4.08		
Forearm girth (cm)	Heighted	24.56	2.34	1.84	0.08
	Shorter	22.25	3.33		
Chest girth (cm)	Heighted	95.5	4.04	1.40	0.18
	Shorter	85.32	14.12		
Thigh girth (cm)	Heighted	51.26	2.97	1.13	0.27
	Shorter	47.94	5.62		
Calf girth (cm)	Heighted	35.51	1.72	1.45	0.17
	Shorter	33.39	2.77		
Wrist girth (cm)	Heighted	18.26	0.49	3.94	0.00
	Shorter	16.58	0.81		
Shoulder breadths (m)	Heighted	13.28	2.18	1.72	0.10
	Shorter	11.65	1.59		
Pelvic Breath (cm)	Heighted	34.01	2.15	2.19	0.04
	Shorter	30.32	3.16		
Upper arm length (cm)	Heighted	36.00	2.45	4.19	0.00
	Shorter	31.88	1.58		
Lower arm length (cm)	Heighted	28.53	1.73	1.40	0.18
	Shorter	27.14	1.74		
Hand length (cm)	Heighted	19.25	0.5	1.75	0.10
	Heighted	16.8	2.74		
Leg length(cm)	Shorter	96.51	3.1	3.81	0.00
	Heighted	88.51	3.87		
Arm span (cm)	Shorter	185.15	0.82	32.74	0.00
	Heighted	157.13	1.63		

Significant value $P < 0.05$

The left knee^o at release (heighted = 162.75 ± 16.32 ; short heighted = 146 ± 10.65 ; $t = 1.829$, $P = .04$).

Table 4: Descriptive angular kinematic of university shot put male players

Variables	Groups	Mean	Std. D	t	Sig.
Right elbow at Preparatory	Heighted	28.5	9.11	-0.64	0.53
	Shorter	31.63	8.72		
Left elbow at Preparatory	Heighted	124.5	9.82	-1.71	0.11
	Shorter	141.69	19.23		
Right knee at Preparatory	Heighted	131.75	14.43	-0.11	0.91
	Shorter	132.81	17.27		
Left knee at Preparatory	Heighted	128.25	32.57	0.38	0.38
	Shorter	122.69	24.68		
Stride length Preparatory	Heighted	0.37	0.08	-0.19	0.85
	Shorter	0.38	0.11		
Trunk angle at Preparatory	Heighted	198.25	16.91	0.28	0.78
	Shorter	193.69	30.81		
Right elbow at release	Heighted	124.12	67.83	0.87	0.40
	Shorter	94.94	58.11		
Left elbow at release	Heighted	111.75	11.18	-1.18	0.25
	Shorter	127.56	25.82		
Right Knee at release	Heighted	148.10	11.2	-0.05	0.96
	Shorter	148.5	17.34		
Left knee at release	Heighted	162.75	16.32	1.83	0.04
	Shorter	146.63	10.65		
Stride length at release	Heighted	0.59	0.14	-0.01	0.99
	Shorter	0.59	0.1		
Trunk at release	Heighted	194	16.87	0.89	0.39
	Shorter	183.19	22.71		

Significant value $P < 0.05$

Discussion and Conclusion

Eight heighted and 12 short heighted players were purposively selected for this study. Result shows the significant different in the selected variables as stature, body mass, wrist girth, pelvises girth, upper arm length, leg length, arm span, bench press, standing long jump and throwing distance. On the other hand, in the kinematic analysis except left knee angle all kinematics were not significantly different among heighted and short heighted throwers. It shows that height contribute to the playing ability of shot-put throwers. Liu ang Wang (2000) also use these variables of Kinematic analysis body mass, jump and throw distance in two groups' = 3.69, $P = .00$ because low release angle, insufficient leg strength, slower movement time, low push off force from the ground. Further, the pelvic girth, wrist girth, upper arm length, total leg length and arm span were significant difference.

The shot-put performance mostly depends on the athlete's ability with the combination of throwing velocity, angle of throw, and height of release distance. This study confirms the finding of (Aleksic-Veljkovic, Puletic, Rakovic, Stankovic, Bubanj, & Stankovic, 2011). It is necessary to correct the technique of throwers through training for higher achievements. The finding of this is useful for coaches and athletes, which assists them for further improvement in their shot put techniques.

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