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Correlation between the Anthropometric Measures and Performance of the Cricket Pull Shot- A Case Study of the Malaysian National Batsmen

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Abstract *This study was conducted to examine the correlation between the anthropometric measure and kinematic of pull shot. Eighteen cricket batsmen were recruited for data collection. The variables were recorded as stature, body mass, skinfolds, girths, bone lengths, breadths and physical strengths. The pull shots were recorded with two video cameras and Aerial Performance Analysis System (APAS) software for the kinematic of the pull shot. All kinematic were not significantly correlated with the pull shot performance except the bat angle. It was concluded that the girths and breadths of upper and lower limbs are associated with higher perforamnce of pull shot at the moment of bat-ball contact. The wider arms help to maintain the body position to execute a successful pull shot. The extension of the knee, hip and elbows assist batsmen to keep body position against the short of length ball for an accurate pull shot.*

Introduction

A cricket pull shot is played with the horizontal swing of the bat from the high backlift (Woolmer, Noakes, & Moffett, 2008). The shoulder's higher position than the location of the short-pitch ball at impact assist a batsman to execute a pull shot downward as guided in the coaching manuals (Pyke & Davis, 2010). The strong body characteristics of batsmen helps to maintain an adequate body position to execute powerful shots which covers a longer distance (Taliep, Prim, & Gray,

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2010). It was also proved in a baseball study that adult batsmen were higher in batting performance because their height and body mass was also higher than young batsmen (Escamilla, et al., 2009). The handgrip and back strength also showed positive relations with batting performance (Nakata, Nagami, Higuchi, Sakamoto, & Kanosue, 2013). It was concluded that stature and arm lengths of cricket batsmen are positively correlated with the back foot off drive (Aruparayil & Chattopadhyay, 2013). Singh (2012) reported a positive relationship between the angular position of the left and right hips and the front off-drive technique of Indian university batsmen. Raza (2016) reported the angular position of the shoulders and elbows were positive relations with the pull shot technique of Indian university cricket batsmen. These studies examined the relationship between the performance of front-foot shots, alongside the anthropometric measures and kinematic variables of the stroke. No study has yet examined the relationship between the performance of the pull shot with anthropometric measures and kinematics of national-level cricket batsmen.

This study investigates the relationship between the anthropometric measures and the kinematic variables with the pull shot technique. It was hypothesized that national cricket batsmen have no relationship between the pull shot performance with anthropometric and kinematic variables.

Method and Material

Purposively, (n=18) right-handed batsmen were selected from Malaysian national batsmen, with the age range of 16-24 years. The consent forms were obtained from all participants to ensure their volunteer participation in the study procedure. Data was collected at the Malaysian National Cricket Ground Oval, Kuala Lumpur. The approval of data collection was obtained from the research ethical committee of Sultan Idris Education University, Malaysia.

Measurements of the Anthropometric Variables

The anthropometric variables were obtained as guided ISAK-International Society for the Advancement of Kinanthropometry (Norton & Olds, 1996). All participants were barefooted with light clothes at the time of anthropometric measurements. The measurements procedure was divided into six stations as; 1) landmarking, 2) girths, 3) lengths, 4) breadths, 5) stature, sitting height, body mass, arm span, and 6) physical strengths.

The body marking of subject as acromial-to-radial, subscapular, radial-to-stylion, mid-stylion, chest, ilacrest, supraspinal, mid trochanteric- tibial, midthigh, tibial-to-lateral and sphyrion. One-meter tape was used to record the girth of arm, forearm, chest, waist, hips, thigh and calf. A large sliding callipers (Lafayette, USA) was used to estimate bone length of arm, leg, and breadths shoulder, pelvis, transvers, humerus and femur. Stature was recorded with stadiometer (Holtain Ltd., UK), which considered from the ground surface to highest point of the skull of the human body. A cubic box and a meter chart were posted at wall for the measurement of the sitting height, which was recorded from surface of the box to the highest point of head. The arm span was obtained with the posted meter chart at the wall, fully stretched arms, and from the right-hand tip to the left-hand tip. Weight was recorded with the digital weight balance (Seiko, Tokyo, Japan). The reading for girths, lengths, breadths, stature, sitting height, arms span and bat length was recorded in cm and kg for the body mass, strengths and bat mass.

The handgrip strength was recorded with digital hand dynamometer (Taki, Japan). All participants were properly Warmed up before the time of data collection. They were in standing position with the flexion of elbow at ninety degrees, the musculature of the right hand applied the maximum force by squeezing the dynamometer. It was instruted to players their knees should be straighten while applying the force at the handle of dynamometer. Three tries were given with the break of one-minute and best score was noted for further analysis.

Data Collection of Pull Shots Action

Two HDV video cameras were placed 13 meters from the batting crease, lenses height 1.40-meter and camera capturing speed was 60 hz as used in pervious cricket batting studies (Renshaw, Oldham, David & Gold, 2007). The 1st camera was in front of the batsman near to batting crease and 2nd was laterally near the bowling crease. Twenty-four points calibration frame was used to control the volume as three meters at X-axis, two meters Y-axis, and one and half meter at Z-axis.

Fifteen markers were placed at the body segments of each batsman as guided by the study (Renshaw, Oldham, David & Gold, 2007). The 2 markers placed at the mid-toes of left and right foot, 2 at the outer bone of right and left ankles, 2 at the outer side of the left and right knees, 2 placed at the left and right of hips joints. The 2 markers fixed at right and left shoulders, two at the left and right elbows, and two at the right and left wrists. A marker was displaced at the frontal side of the helmet to track the movement of the head. The handle and four corners of the blade were digitized for the kinematics of the bat, where a similar method was adopted in another study (Taliep, Galal & Vaughan, 2007). All batsmen performed the pull shot with protective gears in order to prevent the risk of injury

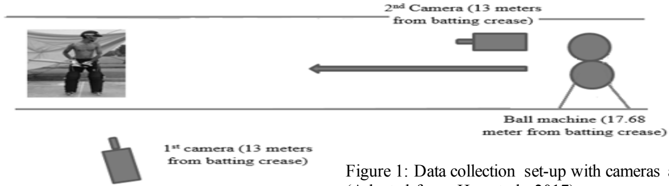

Figure 1: Data collection set-up with cameras and a ball machine (Adapted from: Haq et al., 2017)

Procedure of Video Analysis

A ball machine (Bola, Stuart, UK) was adjusted at 17.68 meters from the batting position, and height was 2.30-meter (Taliep, Galal & Vaughan, 2007). The ball speed was at 25 m/s to 30 m/s and bounce was 8-10 meters before the batsman. Each ball was shown to the batsman before it was fed into the ball machine. Six pull shots of each batsman were recorded. The video clips of the pull shot were examined by two certified cricket coaches. A ten-point scale was adopted for evaluating the pull shot technique (Raza, 2016).

The selected videos of the pull shot were analyzed with The APAS (Ariel Dynamics, USA) software as conducted (Stuelcken, Portus, & Mason, 2005). The video of the first and second cameras was synchronized and from the initiation of the back lift until the bat-ball contact. The stick figure method was adopted for digitizing the 15 points of the joints and 6 of the bat swings as adopted from Stuelcken, Portus and Mason (2005). The direct linear transformation (DLT) method was used for the conversion of 2-D digitized videos into 3-D as guided (Abdel-Aziz & Karara, 1971). The digital low filter pass was applied at six-to-twelve for smoothing raw data as did in all in the study of baseball (Escamilla, et al., 2009). The pull shots actions were digitized and re-digitized to examine reliability. The coefficient of variance (CV) statistics was used for testing the reliability with the range of 3.1 to 10.7mm for the linear and angular kinematics, as performed in Stuelcken, et al. (2007). The kinematics of pull shot was defined as stride length, toe-to-toe in x-axis. The bat height and centre of gravity were measured from the ground surface. The head and ball distance were recorded from the head marker to the bat-ball impact. The linear velocities of lower and upper body segments were considered in x-axis. The angular positions of the joints were defined 180° degrees as a full extension and zero degree as a full flexion (Inkster, Murphy, Bower & Watsford, 2010).

Statistical analysis

Descriptive statistics with means and standard deviations were applied for all the variables of anthropometric, linear and angular kinematics. Pearson's product of correlation was applied to examine the correlation between the anthropometric and kinematics variables with the pull shot technique. The significance level was adjusted at $P < 0.05$.

Results and Discussion

This study was aimed to examine the relationship between anthropometric and kinematics variables with the pull shot technique of the Malaysian national cricket batsmen. The result shows a significant correlation between the pull shot technique and body mass, the girths of chest, waist, hips, thigh, and calf, arm length, pelvis breadth, transverse as well as the knee breadths. All kinematics variables except the bat angle were not significantly correlated with the performance of the pull shot.

Table 1: Correlation between anthropometric measures and the performance of pull shots

Measures	Mean ± STD	*r*	Measures	Mean ± SD	*r*
Coaching points	43.33±10.36		Arm length(cm)	56.97±2.44	0.42
Age months	226.22±58.10	0.09	Hand length(cm)	18.51±0.88	.544*
Stature (cm)	168.58±9.47	0.31	Leg length(cm)	89.27±2.36	0.34
Body mass (kg)	61.78±11.71	.573*	Shoulder breadth(cm)	39.06±2.54	0.36
Arm flex girth(cm)	29.31±3.15	0.39	Pelvis breadth(cm)	26.86±2.56	.576*
Forearm girth(cm)	25.09±1.71	0.35	Transvers chest(cm)	26.64±2.52	.520*
Chest girth(cm)	84.91±9.03	.498*	Elbow breadth(cm)	6.75±0.63	0.12
Waist girth(cm)	72.83±8.71	.503*	Knee breadth(cm)	9.52±0.75	.508*
Hips girth(cm)	90.64±7.98	.528*	Hand strength(kg)	37.21±6.45	0.28
Thigh girth(cm)	51.46±4.58	.583*	Back strength(kg)	97.44±11.77	0.24
Calf girth(cm)	34.54±2.44	.658**	Bat weight (kg)	1.09±0.13	0.05
Sitting height(cm)	85.77±4.59	0.32	Bat length (cm)	84.36±1.95	0.02
Arm span(cm)	175.39±7.03	.533*			

The significant level at 0.05.*

Table 1 showed the significant correlation between the performance of the pull shot and body mass (r = .573*). At back foot stride, the body weight of batsman transfer from front leg to back leg. The body of batsmen pivots at the ball of the right toe which helps to bring the body position against the short of length ball. A batsman requires an optimum balance position to strike the successful pull shot. It is concluded that a higher body mass increases the balance of batsmen at bat-ball impact (Stuelcken, Portus & Mason, 2005). It is concluded that heavier batsmen would be more stable at the impact during the execution of the pull shot. The current study supports the findings of Nakata, Nagami, Higuchi, Sakamoto and Kanosue (2013), that body mass is associated with the hitting performance in baseball (reference number). Results shows the chest girth (r = .498*), waist girth (r = .503*), hip girth (r= .528*) thigh girth (r = .583*), calf girth (r = .658**). The strong muscles of the chest, waist, hips, thighs and calves are significantly correlated with the pull shot technique. The strong muscles of the calf and thigh assist batsmen to extend their knees and hips joints which help in straightening the position of legs and trunk at impact. On the other hand, the large size calf and thigh muscles provide added strength to execute a successful softball shot (Lund & Heefner, 2005). The strong muscles of the chest, waist and hip assist the batsmen for the rotation of the trunk in the direction of the ball to execute a cross bat shots.

Table 1 shows the arm span (r = .533*) and hand length (r = .544*) was significantly correlated with the performance of the pull shot. The longer arm span increases the radius of the bat swing which helps the batsmen to execute the pull shot in front of the chest and towards the leg-side of the ground. The hand length assists the batsmen in holding the bat strongly and maintain its position against the short of length ball. It is concluded that the calf muscles, leg length and back strength may assist the batsman to straighten their leg, and extend their trunk which is associated with the successful execution of a pull shot (Bradman, 1958; Nakata, Nagami, Higuchi, Sakamoto & Kanosue, 2013). The pelvis breadth (r = .576*), transverse chest breath (r = .520*), knee breadth (r = .508*) are correlated with the performance of the pull shot. The wider shoulder, chest and pelvis increase the rotation of batsmen to execute the pull shot towards the square leg position of the ground. As it was suggested in coaching manuals that bat-ball impact should occur in front of the batsmen and in the direction of the leg-side or mid-wicket (Woolmer, Noakes & Moffett, 2008; Pyke & Davis, 2010).

Table 2: Correlation between the kinematic variables and performance of the pull shot

Kinematics	Mean ± STD	*r*	Kinematics	Mean ± STD	*r*
Bat velocity(m/s)	12.11±2.65	-.336	Right hip velocity(m/s)	0.65±0.24	-.443
Max bat velocity(m/s)	14.61±4.07	.088	Left shoulder angle(°)	69.85±11.76	.036
Bat angle(°)	84.58±7.81	-.550*	Left shoulder velocity(m/s)	2.09±0.29	-.019
COG height(m)	1.01±0.10	-.147	Right shoulder angle(°)	51.13±14.49	-.184
Left knee angle(°)	145.41±9.51	.079	Right shoulder velocity(m/s)	0.79±0.13	-.412
Left knee velocity(m/s)	1.07±0.37	-.144	Left elbow angle(°)	150.96±13.47	.114

Right knee angle(º)	128.45±13.47	.087	Left elbow velocity(m/s)	2.19±0.50	-.081
Right knee velocity(m/s)	0.83±0.64	-.283	Right elbow angle(º)	124.52±10.64	-.083
Left hip angle(º)	140.64±12.97	-.074	Right elbow velocity(m/s)	1.66±0.21	.110
Left hip velocity(m/s)	1.34±0.42	-.458	left wrist velocity(m/s)	3.67±.79	.276
Right hip angle(º)	156.60±6.26	.081	Right wrist velocity(m/s)	2.44±0.39	.156

Table 2 showed the performance of the pull shot and kinematics of the stroke was significantly negatively correlated with the bat angle (r = -.550*). Lesser bat angle is more important for the pull shot to execute shots in a specific time to enhance the accuracy of the shot (Stretch, Bartlett & Davids, 2000). It is concluded that the accuracy of the pull shot increases as the bat face angle decreases. The lesser bat angle increases the accuracy of the pull shot and reduces the chances of top edge. The current study confirms the suggestions of Bradman (1958) and Noorbhai and Noakes (2016) that the bat angle would be lesser than 90° to execute a successful pull shot (one of the cross-bat shots) along the ground.

Conclusion

This is a first attempt to evaluate the relationship between the anthropometry and performance of the pull shot of the Malaysian national cricket batsmen. The pull shot technique was correlated with body mass, girths of chest, waist, hips, thigh and calf, as well as breadths of pelvis, transverse chest and knee. It was concluded the circumferences of the body segments are associated with the performance of pull shot. It is suggested that trainers and coaches should focus on the development of the muscle size of calves and thighs which can help improve the performance of pull shot. The balance of the batsmen is very important at the time of the pull shot. The larger muscle sizes of the arm, leg, wider shoulder, hip and chest can increase the balance of batsmen during the execution of successful pull shots. The wider arm span increases the range of bat swing which is associated with the performance of the pull shot. The present study is supporting the conclusion of Stretch et al. (2000) which states that the cricket batting is more influenced physical size of batsmen. The higher bat angle opens the face of the bat which can potentially cause an unsuccessful pull shot. It is proposed that the bat angle should be taken into account for the training of all level of cricket batsmen. Experimental research is proposed for future studies to investigate the effects of anthropometrics and kinematics measures on the pull shot technique.

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