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# Anthropometric Variables as Predictors of Speed in Amateur Football Players

**Zulkifli Ismail[1*], Wan Mohd Rashidi Wan Rosli[2], Masshera Jamaludin[3], Nur Khairunisa Abu Talip[4], Mohd Syafiq Miswan[5]**

*[1,2,3,5] Faculty of Sports Science and Recreation, Universiti Teknologi MARA (UiTM), 02600 Arau, Perlis, Malaysia*

*[4] Faculty of Sports Science and Recreation, Universiti Teknologi MARA (UiTM), 94300 Samarahan, Sarawak, Malaysia*

*Authors' Email Address: *[1]zulkifliismail@uitm.edu.my, [2]wanrashidi0007@gmail.com, [3]masshera507@perlis.uitm.edu.my, [4]nurkhairunisa331@uitm.edu.my, [5]syafiqmiswan@uitm.edu.my*

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**ABSTRACT**

*Speed is one of the important technical skills in football. Speed is defined as the ability of an athlete to move their self with maximum velocity from one place to another. The purpose of this study is to determine the predictor variables of speed ability in amateur football players and to present equation to predict speed ability. Fifteen (N=15) participants from Universiti Teknologi MARA (UiTM) Perlis FC, aged 20 ± 1 year were recruited for this study. The selected anthropometric variables were measured by different tests and instruments. The 20 m sprint test used to measure speed ability. The results showed a significant relationship was found between speed ability and body weight ($r = 0.62$), height ($r = 0.71$), waist circumference ($r = 0.51$), leg length ($r = 0.52$), foot length ($r = 0.73$), and fat free mass ($r = 0.67$) $p \leq 0.05$. Speed ability might be predicted by the equation ($r^2 = 0.77$) speed ability = -7.330 + 0.010 (Body Weight) + 0.058 (Height) + 0.028 (Waist Circumference) – 0.017 (Leg Length) + 0.095 (Foot Length) – 0.056 (Fat Free Mass). In conclusion, anthropometric variables are related to speed ability in amateur football players. Coaches and players should focus on the development of anthropometric variables associated with the speed to improve the speed ability.*

***Keywords***: *physical properties, speed ability, 20 m sprint, amateur football players*

## INTRODUCTION

Football is the most popular sports field in the world and football players require tactical and technical physical skills to successfully finish 90 minutes of competitive play (Popovic et al., 2014). Football is classified as an intermittent high-intensity activity that is not only based on aerobic but also on anaerobic ability of players (Barbero-Alvarez et al., 2008). One of the important technical skills in football is sprinting (speed). Each training and conditioning program includes running component, and a physical fitness test which involves speed test (Rathore & Mishra, 2016).

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Speed refers to the potential of an individual to move himself from one position to another with maximum velocity (Kartal, 2016). Past studies showed that the mean sprint duration during the match is between 1 and 7 s, and the sprint displacements are less than 20 m (Haugen et al., 2014; Kartal, 2016; Nédélec et al., 2012). Massuca and Fragoso (2011) stated that specific anthropometric variables such as body weight can affect the speed of the players, where the structure of the body can influence strength and agility.

Anthropometry is the way to measure the human body or the individual parts of the body, which involves the quantitative definition of the morphological features, and insight into an objective image of the growth status of the person tested (Gusic et al., 2017). Anthropometric measurement is widely used in a sport setting, purposely for the prediction of growth and success in motor skills and evaluation of athlete capacity (Kartal, 2016). Several studies reported a strong correlation between anthropometric and variables of motor abilities (D'Hondt et al., 2009; Fogelholm et al., 2008; Halme et al., 2009; Milanese et al., 2010).

Although researchers have conducted investigations on various anthropometric variables to relate with speed ability, there is a lack in study depth of the literature on examining the relationship between anthropometric and speed among amateur football players. Therefore, the correlation between anthropometric and speed ability among amateur football players remain unknown or uncertain. In response to this problem, this study aims to determine the predictor variables of speed ability in amateur football players (body weight, height, BMI, body fat percentage, waist circumference, hip circumference, calf circumference, thigh circumference, ankle circumference, leg length, foot length and fat free mass). This study also aims to present equation to predict speed ability based on anthropometric variables.

## METHODOLOGY

### Participants

A simple random sampling method was used to select a total of 15 male amateur football players (age 20 ± 1year) from UiTM Perlis FC for this study. The Power and Sample Size Calculation software was used to determine the sample size. Participants were footballers who trained 2 to 3 days per week and represented UiTM Perlis FC at least one season. Participants with any musculoskeletal injury and/or refuse to do any test were excluded. All participants were briefed on all measuring procedures involved. All participants underwent a health screening procedure using the Physical Activity Readiness Questionnaire (PAR-Q) and provided written informed consent prior participation.

### Selection of Variables and Criterion Measures

**Table 1: Selected anthropometric variables and their criterion measures**

| Variables | Nature | Tools/Test | Measuring unit |
|---|---|---|---|
| Speed | Dependent | 20 m sprint | sec |
| Body weight | Independent | Weighing scale | kg |
| Height | Independent | Stadiometer | cm |
| Body mass index (BMI) | Independent | Calculated using formula: Body weight (kg) / height squared (m) | kg/m$^2$ |
| Body fat percentage | Independent | Bio-electrical impedance method (Tanita-305, Illinois, USA) | % |

| Variables | Nature | Tools/Test | Measuring unit |
|---|---|---|---|
| Waist circumference | Independent | Flexible measuring tape | cm |
| Hip circumference | Independent | Flexible measuring tape | cm |
| Calf circumference | Independent | Flexible measuring tape | cm |
| Thigh circumference | Independent | Flexible measuring tape | cm |
| Ankle circumference | Independent | Flexible measuring tape | cm |
| Leg length | Independent | Segmometer | cm |
| Foot length | Independent | Large sliding calliper | cm |
| Fat free mass | Independent | Calculated using formula: FFM = BM – FM | kg |

## Procedure

### Anthropometric Measurement

Body weight was measured with participants wearing light clothes and no shoes, by using weighing scales while height is measured using a stadiometer with participants standing with the heels together and the heels, buttocks and upper part of the back touching the scale. Body Mass Index (BMI) was calculated as body weight in kilograms divide by the height squared in meter (Parseh & Solhjoo, 2015). The subject body fat percentage was measured using a bio-electrical impedance method (Tanita-305, Illinois, USA). The circumference of the waist, hip, calf, thigh and ankle were assessed using a flexible measuring tape. The leg length was measured using segmometer meanwhile the foot length was measured using a large sliding calliper. The participants fat free mass is calculated using the formula [FFM = BM – FM] (Borkan et al., 1982). All the measurement is taken twice and the mean value of the anthropometric measurement is used for data analysis according to the standardised techniques by the International Society for Advancement in Kinanthropometry (ISAK) (Stewart et al., 2011).

### 20 m Sprint

Participants arrived at the running track in UiTM Perlis at 8 am and having abstained from caffeine. Standardized warm-ups were applied before starting the test to decrease the risk of injury and to improve the reliability of the test. Participants performed the test on the running track and were required to wear their running shoes. The 20m sprint test is appropriate for football sport, whereby the average sprint distance by footballers in matches is 20 m (Haugen et al., 2014). Participants were instructed to sprint 20 m with maximum effort. Participants performed the 20 m sprint test twice with 5 minutes rest interval between trails, and their best trial was recorded. Relatively long (3–5 minutes) rest interval enhanced the following performance (Spierer et al., 2004). The time for the 20 m sprint test was measured by a hand-held stopwatch Seiko S056 (Seiko Sasaki, Tokyo, Japan). Participants started the sprint in a stationary upright position and were cued to not decelerate until they reach the finishing line. Participants positioned themselves behind the starting line. At the command of ‘go’, the timer started along with the participants and stopped when they crossed the finishing line.

### Data Analysis

Data was analysed using the Statistical Packages for Social Sciences (SPSS) version 25.0 (IBM Corp., Chicago, IL, USA). The descriptive report of all variables was in means ± standard deviation. The correlation between the selected anthropometric variables and speed ability was analysed using the

Pearson correlation. Regression analysis was used to create an equation to predict speed ability from anthropometric variables. The significant level was set at $p \leq 0.05$.

## RESULT AND FINDINGS

Table 2 below shows that the summary of the descriptive statistic of age, independent variables (body weight, height, BMI, body fat percentage, waist circumference, hip circumference, calf circumference and thigh circumference) and dependent variables (speed ability). All the values are presented in mean and standard deviation.

**Table 2: Descriptive Statistic of Variables**

| Variables | Mean ± Std. Deviation |
|---|---|
| Age (y) | 20 ± 1 |
| Speed (s) | 3.15 ± 0.29 |
| Body Weight (kg) | 63.86 ± 7.52 |
| Height (cm) | 174.44 ± 5.53 |
| BMI (kg/m²) | 20.97 ± 2.12 |
| Body Fat Percentage (%) | 9.25 ± 3.41 |
| Waist Circumference (cm) | 75.12 ± 6.95 |
| Hip Circumference (cm) | 91.41 ± 4.68 |
| Calf Circumference (cm) | 53.84 ± 3.62 |
| Thigh Circumference (cm) | 36.63 ± 1.76 |
| Ankle Circumference (cm) | 27.72 ± 0.88 |
| Leg Length (cm) | 95.05 ± 5.05 |
| Foot Length (cm) | 26.07 ± 1/17 |
| Fat Free Mass (kg) | 57.77 ± 5.16 |

Table 3 shows the summary of the data for the correlation of twelve variables and speed ability. The correlation analysis shows that there are six positive correlations of anthropometric variables with speed ability. Strong relationships to speed ability are observed for the variables including foot length ($r = 0.73$, $p \leq 0.05$), height ($r = 0.71$, $p \leq 0.05$), fat free mass ($r = 0.67$, $p \leq 0.05$) and body weight ($r = 0.62$, $p \leq 0.05$). While the leg length ($r = 0.52$, $p \leq 0.05$) and waist circumference ($r = 0.51$, $p \leq 0.05$) recorded as moderate relationship to speed ability. The other variables including hip circumference ($r = 0.50$, $p > 0.05$), body fat percentage ($r = 0.28$, $p > 0.05$), calf circumference ($r = 0.27$, $p > 0.05$), BMI ($r = 0.26$, $p > 0.05$), ankle circumference ($r = 0.22$, $p > 0.05$) and thigh circumference ($r = 0.20$, $p > 0.05$) showed insignificant relationship to speed ability.

**Table 3: Correlation Analysis Between Speed Ability and Anthropometric Variables**

| Variables | Pearson Correlation | Sig | Strength of relationship |
|---|---|---|---|
| Foot Length (cm) | 0.73 | 0.00 | Strong |
| Height (cm) | 0.71 | 0.00 | Strong |
| Fat Free Mass (kg) | 0.67 | 0.01 | Strong |

| Variables | Pearson Correlation | Sig | Strength of relationship |
|---|---|---|---|
| Body Weight (kg) | 0.62 | 0.01 | Strong |
| Leg Length (cm) | 0.52 | 0.05 | Moderate |
| Waist Circumference (cm) | 0.51 | 0.05 | Moderate |
| Hip Circumference (cm) | 0.50 | 0.06 | Moderate |
| Body Fat Percentage (%) | 0.28 | 0.32 | Slightly moderate |
| Calf Circumference (cm) | 0.27 | 0.33 | Slightly moderate |
| BMI (kg/m²) | 0.26 | 0.36 | Slightly moderate |
| Ankle Circumference (cm) | 0.22 | 0.44 | Slightly moderate |
| Thigh Circumference (cm) | 0.20 | 0.47 | Low |

Based on Table 4, six independent variables (fat free mass, leg length, foot length, waist circumference, height, and body weight) are used to develop the regression equation. The value of R square is 0.774 which explains that 77.4 % of speed ability is obtained by these six anthropometric variables.

**Table 4: Pearson Correlation Between Speed Ability and Anthropometric Variables**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | 0.880[a] | 0.774 | 0.604 | 0.17981 |

Table 5 shows the effectiveness of the linear regression model. These six independent variables are found effective in estimating the speed ability of amateur football players based on the anthropometric variables since the *p*-value is found to be significant ($p<0.05$).

**Table 5: The ANOVA Table of The Linear Regression Model in Relation to Speed Ability based on Anthropometric Variables**

| Model | | Sum of Square | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 0.885 | 6 | 0.148 | 4.563 | 0.026[b] |
| | Residual | 0.259 | 8 | 0.032 | | |
| | Total | 1.144 | 14 | | | |

a. Dependent Variable: SPEED
b. Predictors: (Constant), Fat Free Mass, Leg Length, Foot Length, Waist Circumference, Height, Body Weight

Table 6 indicates the quantification of the relationship between selected anthropometric variables (body weight, height, waist circumference, leg length, foot length and fat-free mass) and speed ability. The constant - 7.330 gives the value of speed ability when these variables (height, waist circumference, leg length, foot length and fat free mass) are equal to zero (0). The unstandardised Coefficient B is the beta that will be used in the equation for the model. The B value is an indication to predict the dependent variable values.

From the findings shown in the Table 6, the multiple regression equation is as followed:
Y = a + b * X1 + b * X2 + b * X3 + b * X4 + b * X5 + b * X6

Where:

| | | |
|---|---|---|
| Y | = | Speed Ability |
| X1 | = | Body Weight |
| X2 | = | Height |
| X3 | = | Waist Circumference |
| X4 | = | Leg Length |
| X5 | = | Foot Length |
| X6 | = | Fat Free Mass |

Speed Ability = -7.330 + 0.010 (Body Weight) + 0.058 (Height) + 0.028 (Waist Circumference) – 0.017 (Leg Length) + 0.095 (Foot Length) – 0.056 (Fat Free Mass)

**Table 6: Regression Coefficient of Selected Variables in Predicting Dependent Variable (Speed Ability)**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | -7.330 | 2.964 | | -2.473 | 0.039 |
| | Body Weight | 0.010 | 0.049 | 0.271 | 0.210 | 0.839 |
| | Height | 0.058 | 0.027 | 1.121 | 2.173 | 0.061 |
| | Waist Circumference | 0.028 | 0.028 | 0.671 | 0.985 | 0.353 |
| | Leg Length | -0.017 | 0.017 | -0.296 | -0.963 | 0.364 |
| | Foot Length | 0.095 | 0.067 | 0.388 | 1.410 | 0.196 |
| | Fat Free Mass | -0.056 | 0.063 | -1.009 | -0.889 | 0.400 |

a. Dependent Variable: SPEED

## DISCUSSION

The main finding was speed ability has a significant relationship with anthropometric variables (fat free mass, leg length, foot length, waist circumference, height, and body weight). The finding of the present study is parallel with the study by Rathore and Mishra (2016). According to Rathore and Mishra (2016) there was a significant relationship between speed ability with height, weight, leg length, and thigh circumference. According to Baro et al. (2017) all the world class sprinters were assumed to have relatively longer leg length. This study reported the leg length of participants was 95.05 ± 5.05cm. The study postulated that the significant correlation between speed ability and leg length was largely due to the individual's stride length, as was previously reported (Callaghan et al., 2014; Lockie et al., 2013). Stride length is defined as a distance between alternating contacts of each foot. According to Rathore and Mishra (2016), an increase in different body segments particularly the length of leg, cause to an increase in stride length. The longer leg length, leads to increased stride length, thus increases speed ability. Due to the importance of these characteristics, it is valuable to understand how physical properties may influence the running performance. The large-scale study conducted by Paruzel-Dyja et al. (2006) on a huge number of elite 100m athletes, found the predominant stride parameter to have impact on success in the 100m sprint for the male sprinters was stride length. On the contrary, the stride frequency was predominant parameter for female sprinters. This finding recommends a difference in technical training for gender-specific, as different stride parameters of the 100m sprint are characterized to each gender.

A study by Mercer et al. (2005) reported that increase in foot length leads to an increase in running speed. This is because when the foot length is increased, it can exert larger support forces during ground contact, which has been shown to correlate with the increase in length of the foot. Accordingly, areas of friction between foot and ground will be wider and this helps in body movement at its total speed. This could also be the main reason for the strong correlation between speed ability and foot length in the current study. According to Purcell et al. (2006), force platform was used to measure ground contact time in a laboratory setting but it was difficult to measure in the field setting. However, there were limitations for this study because the researchers did not measure the ground contact time. For future research, it would be beneficial to be able to measure foot ground contact times during sprinting.

The current study found a strong correlation between speed and fat free mass. The finding of the current study is parallel with study by Hayward and Stolarczyk (1996), which reported that low body fat with large muscle mass was significant for speed. Anding and Oliver (2015) reported that athletes with the highest fat free mass and lowest body fat percentage were able to run the longest on the treadmill, and, had the highest strength and $V0_2$ max values. The possible explanation is that muscle power from lower limb and muscle stores a large number of creatine phosphate (PCr). The maximal running velocity significantly correlates with leg stiffness (Chelly & Denis, 2001). Muscle power is a great contributor during the acceleration phase of the sprinting, while muscular resilience is, the muscles ability to rebound, which is inherent in top speed running (Majumdar & Robergs, 2011). The dominant metabolic energy system during sprint is the ATP-PCr system. The ATP-PCr system generate ATP at a very high rate and muscle ATP is maintained at a moderately constant level (Majumdar & Robergs, 2011). Large muscle storage of creatine phosphate (PCr) can efficiently meet the energy demanded for maximal contraction of muscles during sprinting.

This study also found a strong correlation between speed with height and weight. According to Wong et al. (2008), the heavier young football players did better in 30 m sprint, while the taller football players performed better in 10 m and 30 m sprint. Agreeing with this, Paruzel-Dyja et al. (2006) added that a faster male athlete is taller than a slower male athlete. The finding of a previous study had found that the greater body masses were directly related to the greater ground support forces required to attain faster running speeds (Weyand & Davis, 2005). In contrast, a study by Abrantes et al. (2004) stated that body mass and height play rather a secondary role in the development of speed.

## CONCLUSION

In conclusion, a significant relationship was found between speed ability and body weight, height, waist circumference, leg length, foot length, and fat free mass. Speed could be predicted by using the equation; Speed Ability = -7.330 + 0.010 (Body Weight) + 0.058 (Height) + 0.028 (Waist Circumference) – 0.017 (Leg Length) + 0.095 (Foot Length) – 0.056 (Fat Free Mass). It is recommended for the coaches and trainers to focus on the physical development in the targeted specific anthropometric to improve speed ability among footballers.

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