THE CORRELATION BETWEEN ANTHROPOMETRIC MEASURES, CORE MUSCLE PERFORMANCE, AND RUNNING SPEED IN COLLEGE BASKETBALL PLAYERS

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Abstract

Speed is essential in basketball. It is affected by anthropometric measures and core stability. This study aimed to investigate the correlation between weight, height, body mass index, core stability with running speed in basketball athletes. Fifty-five college basketball players were participated (35 male, 20 female). Weigh, height, and body mass index (BMI) were measured. Core muscle strength and stability test (CMSST) and the 30 m-acceleration test (30 m-AT) were applied to test the core performance and the speed. Independent t-test or Mann-Whitney test were used to analyze the difference between groups while the Spearman test was used to analyze the correlation between variables. Significance was set at $p<0.05$. The results showed male subjects were heavier and taller ($p<0.01$). There is no association between gender with CMSST and 30 m-AT ($p=1.00$ and $p=0.73$, respectively). Weight and BMI were correlated with CMSST ($r=-0.53$, $p<0.01$, and $r=-0.72$, $p<0.01$) and the 30 m-AT ($r=0.43$, $p<0.01$, and $r=0.76$, $p<0.01$). The CMSST correlated with the 30 m-AT ($r=-0.75$, $p<0.01$). BMI and CMSST had a strong while weight had a weak correlation with running speed in college basketball players.

***Key words**: Body size, core muscles performance, running speed, college basketball players*

Introduction

Core muscles play an important role in human movements. Core stability is required to maintain the alignment of the spine and pelvis when the limbs are moving so that the limb muscles can move on a stable platform (Kumar, Choudhary, & Venugopal, 2014). Good stability of core muscles can generate a better balance and posture as well as reduce injury. Most of the body movements will involve the core muscles. The highest performance in sports also requires remarkable core muscle strength. The strong and stable core muscles will ensure that sports movements such as swinging a racket, throwing a basketball, kicking a soccer ball and others will be performed better. Some previous studies confirm the effect of core muscle strength on sports performance. A study by Hung et al found that core training improved static balance and running economy in college athletes (Hung, Chung, Yu, Lai, & Sun, 2019). Core muscle training has also been shown to improve running performance in 5000-m runners (Sato & Mokha, 2009).

Basketball is one of the most popular sports in the world. It is estimated around 450 million people play basketball, with different levels of competition, from the highest professional to recreational players. Regardless of the level of competition, basketball is played in the same way. A basketball game is characterized by running fast, stopping suddenly, jumping, and change direction (Ransone, 2016). Successful basketball players usually possess high strength, speed, power and agility with proportional lean body mass. Thus, high performances of core muscles are essential in basketball.

Running speed is considered a key factor in achieving the best performance in any sports including basketball. A study by Delextrat and Cohen (2008) demonstrated that elite basketball players tended to have superior sprint times than average-level players. Besides, sprint time is associated with vertical jumping performance (Marques & Izquierdo, 2014). Therefore, a good sprint performance is useful for fast dribbling to create a fast break as well as for a better jump in the basketball game. An association between running speed core muscles has been investigated previously. A study by Fujita et al reported that sprint time was associated with core muscle thickness (Fujita et al, 2019). This study aims to investigate the correlation between core muscle strength, running speed, and body mass index in college basketball players.

Methods

This was a cross-sectional study followed by fifty-five college basketball players (35 male). Inclusion criteria were: basketball players aged 17-22 years old and able to perform Core Muscles Strength and Stability test and 30-m Acceleration Test. Exclusion criteria included: having or under the treatment of muscular injuries, having an illness that prevented undergoing the test. Participants voluntarily participate in this study by signing the written informed consent. This study was approved by the ethics committee of the Atma Jaya Catholic University of Indonesia (Number:14/06/KEP-FKUAJ/2019)

Height and weight were measured using a standard procedure. Height measurement was performed using a microtoise without using footwear, in Frankfort's position. Weight was measured using a digital scale in minimal clothes (Robusta 813, Seca, Germany). Height was expressed in cm whereas weight in kg, to the nearest 0.1 cm and 0.1 kg, respectively. Body mass index was obtained through the formula of body weight (kg) divided by the square of height (m).

Core Muscles and Speed Performance Assessment

Core muscle performance was assessed using the Core Muscle Strength & Stability Test. The test consists of eight stages which performed continuously from first to the last stage. Each stage contains a specific movement. Participants were encouraged to do warms up for minutes. The first stage was held for 60 seconds. Participants prone on a mat or soft surface while elbow and arms supported the body. The back, neck, and head were in a straight position. Knees lifted off the ground. Only forearms and toes were allowed to touch the ground. The test was stopped when other parts of the body touch the ground. This position was called a start position. The participants must return to the start position before performing the next stage. In the second stage, the participants lifted the right arm off the ground and extended it parallel with the ground while on the third stage, the participants lifted the left arm. In the fourth and fifth stages, the participants lifted the right leg and then the left leg off the ground and extended it parallel with the ground, respectively. In the sixth stage, the participants lifted the left leg and right arm off the ground and then extended it out parallel with the ground. In the seventh stage, the participants lifted the right leg and left arm off the ground, then extended them out parallel with the ground. Stage 2 up to stage 7 was held for 15 seconds each. In the eighth stage, participants returned to start position, and hold it for 30 seconds. The total test time was 180 seconds or 3 minutes. The interpretation of the test results was modified. Poor if participants accomplished 4 stages or less, good if completed 5-7 stages, excellent if completed all stages (Mackenzie, 2002).

Running speed was measured using a 30-meter acceleration test (Mackenzie, 1995). A 30-m straight distance was made and marked with lines or cones. The participants were asked to run as fast as possible from start to finishing line. The examiner started the stopwatch when the participants strike foot firstly and stopped the stopwatch as the participants crossed the finish line. Time elapse were recorded. The test was repeated three times and the test result used was the fastest time. The classification was modified as follows: poor if 4.5 seconds or above, average if 4.1-4.3 seconds, good if 4.0 seconds or less.

Table 1. Characteristics of the participants

Variables	Females	Males	*p*
Age (years)	18.8±1.2	18.6±1.6	0.39
Height (cm)	160.3±6.9	175.6±7.0	0.00
Weight (kg)	55.9±8.2	71.3±14.9	0.00
BMI (kg/m^2)	21.8±2.9	23.0±3.9	0.37
CMSST (points)	6.6±1.7	6.8±1.7	0.65
30-m AT (seconds)	4.8±0.6	4.5±0.4	0.13

Abbreviation: BMI; body mass index, CMSST; Core Muscle Strength & Stability Test, 30-m AT; 30-meter acceleration test

The normality of the data distribution was evaluated using Shapiro-Wilk. Numerical data were presented as mean ± standard deviation (SD), categorical data as frequency (percentage). Unpaired t-test or Mann-White tests were applied to compare numeric variables between gender. The correlation between body size, core muscles, and running speed was analyzed using Pearson or Spearman. Statistical analysis was conducted using SPSS. A p-value of less than 0.05 was considered significant.

Results

Characteristics of the subjects according to gender were presented in Table 1. Based on the Shapiro-Wilk test, only 'height' had a normal distribution (*p*=0.81). The difference in height between gender was analyzed using unpaired t-test, and the rest of the variables using the Mann-Whitney test. Only height and weight were different significantly between gender. Males basketball players had greater height and weight than females (p<005). Age, BMI, CMSS test and 30- m Acceleration test was not different between females and males.

Table 2. The distribution of variables category

Variables	Females	Males	*p*
BMI			
Underweight	1 (5%)	5 (14.3%)	1.00
Normal	17 (85%)	23 (65.7%)	
Overweight	2 (10%)	7 (20.0%)	
CMSST			
Poor	2 (10%)	5 (14.3%)	1.00
Good	8 (40%)	9 (25.7%)	
Excellent	10 (50%)	21 (60%)	
30-m AT (seconds)			
Poor	9 (45%)	20 (57.1%)	0.73
Average	6 (30%)	13 (37.2%)	
Good	5 (25%)	2 (5.7%)	

Abbreviation: BMI; body mass index, CMSST; Core Muscle Strength & Stability Test, 30-m AT; 30-meter acceleration test

The distribution of BMI, CMSST, and 30-m AT classification is shown in Table 2. The results indicated that the distribution of BMI, CMSST, and 30-m AT was not different between gender (*p*>0.05). The most subject had normal BMI. Surprisingly, more females tend to have better performance in CMSST and 30-m AT than males. Ninety percent of females had CMSST in the category of good or excellent, whereas in males 85.7%. A larger difference was found in the result of 30-m AT. Twenty-five percent female was reported to have good result whereas only 5.7% in male.

Table 3. The correlation between 30-m AT, CMSST, and anthropometric measurements.

	Weight	Height	BMI	CMSST
30-m AT	0.43	-0.13	0.76	-0.75
p	0.00	0.33	0.00	0.00
CMSST	-0.53	-0.07	-0.72	-
p	0.00	0.62	0.00	-

Abbreviation: BMI; body mass index, CMSST; Core Muscle Strength & Stability Test, 30-m AT; 30-meter acceleration test.

The correlation between CMSST, 30-m AT and body size was analyzed using Spearman. Results have shown (Table 3) that the positive correlation was found between the 30-m AT with weight and BMI (r=0.43 and 0.76, respectively). This result should be interpreted that the more weight and BMI, the longer the time taken to accomplished the test. The negative correlation between 30- m AT and CMSST (r= -0.75) indicated that participants with a greater score of CMSST took less time to complete the 30-m AT, which meant that greater score of CMSST ran faster than them with the lower score of CMSST. Besides, the CMSST had a negative correlation with weight and BMI (r= -053 and -0.72). The interpretation of these results was that the participants with greater weight and BMI required more time to accomplish the test.

Discussion

Basketball game requires very highly physical and fitness performance. Running speed is required to support the performance of basketball players. Running speed has been known to be influenced among others by anthropometric measures, lower body, and core muscle strength. This study aimed to confirm the correlation between body weight, height, core muscle, and running speed performance in college basketball players. Our study found that weight and BMI were correlated with core strength and stability test, and running speed in college basketball players. The correlation was also found between core muscle performance and running speed.

Basketball demands specific skills which performed under the dynamic situation. As a consequence, basketball players have to move or change direction at high speed. Thus, running speed is very important to support basketball performance. The importance of speed in basketball has been studied by Delextrat & Cohen (2009). While the need for special skills depends on the player position, speed must be possessed by all basketball players regardless of their position (Delextrat & Cohen, 2009). The running speed is also a determinant factor distinguishing between players from low and high divisions (Erčulj, Blas, & Bračič, 2010). Another study shows that elite basketball players sprint faster than average-level basketball players (Sato & Mokha, 2009). A better speed is favorable to support the jumping performance in basketball. Several previous studies indicate the relationship between jumping and sprint ability. The study by Marques and Izquierdo (2014) demonstrated that sprint time has a significant association with peak velocity during jumping. A study by Car et al. (2015) also supports the association between sprint and jumping performance in cricketers.

The role of core muscles in sports performance has been widely recognized. Core stability functions as a pivot for limb movements ranging from running to throwing. This will create efficient biomechanical kinetics to generate maximal force and minimal loads in the joint (Kibler, Press, & Sciascia, 2006). A prior study established that core stability was related to athletic performance tests (Sharrock, Cropper, Mostad, Johnson, & Malone, 2011). The similar results were also reported by Nesser et al and Okada et al which found that the core stability was significantly correlated with test performance in athletic (Nesser, Huxel, Tincher, & Okada, 2008; Okada, Huxel, & Nesser, 2011). The recent study also exhibited a quite strong correlation between core muscle performance and running speed. The negative correlation between core test and running test results indicates that participants with a higher score of core test spend less time to accomplish the running test.

There is a large agreement that body size affect sport and tests performance. Demands on body size and type are different among sports according to the sports characteristics and player position (Sallet, Perrier, Ferret, Vitelli, & Baverel, 2005; Peña, Moreno-Doutres, Coma, Cook, & Buscà, 2018; Muratovic, Vujovic, & Hadzic, 2014). In basketball, even most athletes are tall and lean, the variation in anthropometric between players maybe exist due to their position and role in the game (Delextrat & Cohen, 2009; Sallet et al., 2005; Ostojic, Mazic, & Dikic, 2006). The anthropometric measure has been known to correlate with performance and specific skills. A previous study reported that heavier and taller players had better results in fitness test including speed and game performance (Ramos, Volossovitch, Ferreira, Fragoso, Massuça, 2019). A similar result was also found by Garcia-Gil et al. (2018) which reported anthropometric attributes were related to performance predictors in elite female basketball players. The previous study also reported elite players were taller, heavier, more muscle percentage, and performed better in jump, speed, and agility compared to non-elite players(Torres-Unda, Zarrazquin, Gil, Ruiz, Irazusta, Kortajarena, Seco, & Irazusta, 2013). Our study found weight and BMI had a negative correlation with speed. However, these results are not different from those of previous results. The heavier players had better speed because they needed less time to complete the test.

Some limitations are noted. Muscle mass may have a more important role in muscular performance in sports or exercise rather than body mass itself. Therefore, an examination of muscle mass or body fat percentage should be implemented. We recommend measuring other anthropometric measures such as limb length which has a role in the biomechanics of running. The performance of basketball games is influenced by several skills performance. Therefore, including other skills such as agility is required.

In conclusion, this study shows that basketball players with heavier weight, greater BMI, and better CMSST will have a better running speed. The influence of height and BMI on running speed might be involved the increase in core muscle performance. These findings may help design a training program for improving speed as well as for the player's selection.

References

Carr C, McMahon JJ, Comfort P. (2015). Relationships between jump and sprint performance in first-class county cricketers. *J Trainology*, 4(1), 1-5.
Delextrat A, Cohen D. (2008). Physiological testing of basketball players: toward a standard evaluation of anaerobic fitness. *J Strength Cond Res*, 22, 1066-1072.
Delextrat A, Cohen D. (2009). Strength, power, speed, and agility of women basketball players according to playing position. *J Strength Cond Res*, 23(7), 1974-1981.
Erčulj F, Blas M, Bračič M. (2010). Physical demands on young elite European female basketball players with special reference to speed, agility, explosive strength, and take-off power. *J Strength Cond Res*, 24(11), 2970-2978.
Fujita S, Kusano S, Sugiura Y, Sakuraba K, Kubota A, Sakuma K, Suzuki Y, Hayamizu K, Aoki Y, Sugita M. (2019). A 100-m sprint time is associated with deep trunk muscle thickness in collegiate male sprinters. *Front Sports Act Living*, 1:32. DOI: 10.3389/fspor.2019.00032.
Garcia-Gil M, Torres-Unda J, Esain I, Duñabeitia I, Gil SM, Gil J, Irazusta J. (2018). Anthropometric parameters, age, and agility as performance predictors in elite female basketball players. *J Strength Cond Res*, 32(6), 1723-1730.
Hung KC, Chung HW, Yu CCW, Lai HC, Sun FH. (2019). Effects of 8-week core training on core endurance and running economy. *PLoS One*, 14(3): e0213158. DOI: 10.1371/journal.pone.0213158.
Kibler WB, Press J, Sciascia A. (2006). The role of core stability in athletic function. *Sports Med*, 36(3), 189–198.
Kumar AS, Choudhary R, Venugopal R. (2014). Effect of core training on anaerobic power, explosiveness, repetitive power and endurance of male players. *Int Human Res J,* 2(3), 1-8.
Mackenzie, B. (1995) 30-meter Acceleration Test [WWW] Available from https://www.brianmac.co.uk/30accel.htm [Accessed 26/2/2020].
Mackenzie, B. (2002). Core muscle strength and stability test. Available from: https://www.brianmac.co.uk/coretest.htm
Marques MC, Izquierdo M. (2014). Kinetic and kinematic associations between vertical jump performance and 10-m sprint time. *J Strength Conditioning Res*, 28(8), 2366-2371.
Muratovic A, Vujovic D, Hadzic R. (2014). Comparative Study of Anthropometric Measurement and Body Composition between Elite Handball and Basketball Players. *Monten J Sports Sci Med*, 3(2), 19–22.
Nesser TW, Huxel KC, Tincher JL, Okada T. (2008). The relationship between core stability and performance in division I football players. *J Strength Cond Res*, 22(6), 1750-1754.
Okada T, Huxel KC, Nesser TW. (2011). Relationship between core stability, functional movement, and performance. *J Strength Cond Res*, 25(1), 252-261
Ostojic SM, Mazic S, Dikic N. (2006). Profiling in basketball: physical and physiological characteristics of elite players. *J Strength Cond Res*, 20(4), 740-744.
Peña J, Moreno-Doutres D, Coma J, Cook M, Buscà B. (2018). Anthropometric and fitness profile of high-level basketball, handball and volleyball players. *Rev Andal Med Deporte,* 11(1), 30-35.
Ramos S, Volossovitch A, Ferreira AP, Fragoso I, Massuça LM. (2019). Training experience and maturational, morphological, and fitness attributes as individual performance predictors in male and female under-14 Portuguese elite basketball players. *J Strength Cond Res*, 10.1519/JSC.0000000000003042.
Ransone J. (2016). Physiologic profile of basketball athletes. *Sports Sci Exch*, 28(163), 1-4
Sallet P, Perrier D, Ferret JM, Vitelli V, Baverel G. (2005). Physiological differences in professional basketball players as a function of playing position and level of play. *J Sports Med Phys Fit*, 45, 291-294.
Sato K, Mokha M. (2009). Does core strength training influence running kinetics, lower-extremity stability, and 5000-M performance in runners? *J Strength Cond Res*, 23(1), 133-140.
Sharrock C, Cropper J, Mostad J, Johnson M, Malone T. (2011). A pilot study of core stability and athletic performance: is there a relationship? *Int J Sports Phys Ther*, 6(2), 63–74.
Torres-Unda J, Zarrazquin I, Gil J, Ruiz F, Irazusta A, Kortajarena M, Seco J, Irazusta J. (2013). Anthropometric, physiological and maturational characteristics in selected elite and non-elite male adolescent basketball players. *Sports Sci*, 31(2), 196–203.

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