DIGIT RATIO AND ITS RELATIONSHIP WITH AEROBIC AND ANAEROBIC CAPACITIES AMONG TALENTED YOUNG FOOTBALLERS

Zulkhairi Azam[1,2*], Ihram Johar[1], Zainal Abidin Zainuddin[1], and Fariq Rahman[2]

[1]Faculty of Education, Universiti Teknologi Malaysia
[2]Faculty of Sports Science & Recreation, Universiti Teknologi MARA, Malaysia

[*]Email: sahoca13@gmail.com
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Abstract

Digit ratio has been investigated extensively and in certain studies has been shown to be predetermined as early as in the womb. Digit ratio is often associated with varied human performance in various aspects such as fertility, psychology, disease, and sports. It has been reported that athletes with higher testosterone levels excel over than those with low testosterone levels. Therefore, this study aims to investigate the association of low digit ratio with talented young footballers' aerobic and anaerobic capacities. The study selected 29 subjects (N=29), comprising male students aged 10.41±0.57 (years) actively undergoing football training at the Kuala Lumpur Football Association (KLFA) Academy. Spearman's Rho result indicates that low digit ratio is moderately correlated with aerobic capacity, which was tested by using One Mile Run test (MRW) with = 0.406, p = 0.029. Meanwhile, concerning the association between low digit ratio and anaerobic capacity through 50-meter sprint tests, the results deduced from Spearman's Rho revealed that there is no significant correlation, with =-.128, p=0.509. In conclusion, these results may give further insights into the influence of digit ratio on energy capacities if the sample size is improved with a thorough methodology. Given a larger sample size and detailed research in future, digit ratio could be a good indicator in classifying athletes based on their dominant energy system capacity.

Keywords: Digit ratio, aerobic capacity, anaerobic capacity, talented young footballers

Introduction

Digit ratio refers to index finger's length proportion in relation with ring finger and is sexually dimorphic. Many studies indicate that this proportion, which depends on the level of pre-birth testosterone, is able to predetermine various qualities of identity characteristics. Characteristics encompassing interests, emotions, aggressions, academic performance, sports abilities, and various fields have been determined by using digit ratio extensively (Brosnan, Gallop, Iftikhar, & Keogh, 2011; Hönekopp & Schuster, 2010; Manning, Trivers, & Fink, 2017; Voracek, Reimer, & Dressler, 2010; Voracek, 2011; Voracek & Loibl, 2009). In light of this, digit ratio may be used as a crucial indicator in sports performance and in determining a person's ability through assessing their level of performances and capabilities in comparison to others.

In various sporting activities, aerobic and anaerobic capacities are deemed essential markers of performance. As suggested by Dencker, Bugge, Hermansen, & Andersen, (2010), aerobic capacity, which is represented by peak oxygen uptake (VO2max), is considered to be the best single marker for an effective outermost influence on the cardiorespiratory system. Meanwhile, anaerobic capacity is the maximum capability of the human body in producing energy over a short period of time, up to three minutes during strenuous physical activities, where the heart pulsates at a rate of approximately 170 to 220 beats per minute (Tomkinson, 2007). In football, the requirement for well-built aerobic and anaerobic agencies is critical, as the sport players engage in intermittent activities encompassing tackling and altering directions at fluctuating intensities. This is in agreement with Bangsbo, Mohr, & Krustrup (2006), whereby aerobic capacity, anaerobic capacity, speed, muscular strength, muscular power, and agility are deemed to be critical contributors to athletic performance in football.

In recent years, researchers have investigated the association of a person's hands with their innate talents. For instance, a person's dexterous game ability has been linked to their digit ratio biomarker, which could be determined by referring to the overall pre-conception testosterones (Manning & Taylor, 2001). Such biomarkers, albeit present in insignificant amounts, are deemed essential towards the overall dominant testosterones. Despite this suggestion, a definitive framework to assess a more noticeable testosterone which indicates unrivalled execution is absent. Nonetheless, researchers have associated game dexterity outcomes with factors related to diligence (Hönekopp & Watson, 2010). Additionally, several studies in the previous decade have assosicated digit ratio with abnormal state sports fulfilment (Eghbali, 2016; Manning & Taylor, 2001).

It is widely accepted that digit ratio is associated with pre-birth testosterone levels (Hönekopp, Manning, & Müller, 2006); Manning, 2002). Furthermore, studies have revealed positive associations of digit ratio to pre-birth testosterone level at the end of first trimester. The development of human digit ratio is steadily fixed by the age of two years old and relatively does not change after that (Manning, Scutt, Wilson, & Lewis-Jones, 1998; Ribeiro et al., 2016; Martin Voracek, 2011) By taking this into consideration, various studies on digit ratio have recommended similar connection. Considering this recommendation, digit ratio may be used for the purposes of talent identification or predicting the performance level in sports, since it is an earlier marker that can be used to

assess talents in a wide range of subjects, especially among young athletes. The most distinctive perception that is connected to digit ratio assumes that it subordinates vigorously upon a well-developed physical fitness, as portrayed in various sports such as football, rugby, fencing and sumo which require great amount of various energy system stimulation in the body (Bennett, Manning, Cook, & Kilduff, 2010; Kim & Kim, 2016; Tamiya, Lee, & Ohtake, 2016; Tester & Campbell, 2007; M Voracek et al., 2010).

However, few studies have investigated the association of digit ratio with aerobic and anaerobic capacities especially among talented young footballers, and also considering the facts that there are conflicting findings on the relationship of digit ratio towards performance in both energy systems. Therefore, this study aims to establish the association of low digit ratio with the aerobic and anaerobic capacities of talented young footballers.

Methodology

Participants

For study purposes, a total of 29 males (N=29) aged 10-12 years old were engaged from the Kuala Lumpur Football Association (KLFA) Academy. Participants were selected based on merit through various stages of vigorous selection by the coaching team. In addition, they have been training with the team for more than two years and playing various matches and involved in age-related football leagues. It is purposively only participants with low digit ratio were considered for this study due to the main objective and literature of this study. Prior to study, all participants were informed briefly on testing processes. Parents were provided with a consent form prior to the testing day. Since the study required the participants to be in good health, each participant was thoroughly interviewed for any pre-existing illnesses and inspected for hand deformities or injuries to the hand or fingers. To ensure the safety and well-being of the participants, participants that did not meet the aforementioned criteria were immediately excluded from the study. The participants were also asked to refrain from involvement in any vigorous physical activities and were advised take a proper rest, a day prior to testing, in order to avoid fatigue that may influence testing outcomes on the testing day. In addition, on the testing day the participants were required to go through proper warm-up session for 20 minutes prior to testing to avoid the risk of injury. This directive was briefed to the participants in alignment with counsel from their coach.

Measuring Digit Ratio

Before taking measurements, participants were instructed to clean their hands from dirt. Participants were also asked to remove any rings, watches, and other accessories as they may affect the outcomes. In measuring digit ratio, participants placed one palm at a time onto a scanner and stored as an image. The scanner used was a Canon CanoScan LiDE 120 with 2400x4800dpi high resolution. Each measurement for each participant's palm was measured twice and averaged for further analysis. Consequently, data of averaged digit ratio from left and right palms of all participants were tabulated in a spreadsheet for later analysis. A Micro Dicom viewer software with an accuracy of ±0.01mm was used to

measure the participants' palms from topmost finger to bottommost digit wrinkle proximal. Based on Allaway, Bloski, Pierson, & Lujan, (2009); Kemper & Schwerdtfeger, (2009), Micro Dicom viewer software was recommended to be used, attributed to its most precise and reliable digit ratio readings that can be recorded by using a computer-assisted investigation software or program. In addition, computer assisted measurement software eliminates potential human error through direct measurement on the digit's length and therefore makes the data more applicable and concrete.

Measuring Aerobic Capacity

One Mile Run Test (MRW) was used in this study to measure aerobic capacity. Following the guideline of Cooper Institute on FitnessGram, each participant was briefed regarding the test. Specifically, each participant was timed as they ran across a finish line. Timer was started as soon as the participant began their run. Based on FitnessGram, MRW data consists of running time, age of the child, sex, and Body-Mass Index (BMI). Aerobic capacity of each participant was computed using FitnessGram's VO2max calculator and all of the data was tabulated in a spreadsheet for later analysis.

Measuring Anaerobic Capacity

Guidelines from the International Physical Fitness Test (IBFT) were used to measure the anaerobic capacity of participants. Under the guideline, each participant was assessed for their performance in a chosen 50-meter sprint test. Prior to the sprint, a warm up session was conducted involving all participants. Upon warm up, the participants were briefed on the test. Cones were lined up along a 50-meter track. Each participant was instructed to complete the 50-meter sprint along the set-up track. Each participant was required to sprint two times. The data from each participant was averaged and tabulated in a spreadsheet for further analysis.

Statistical Analysis

IBM SPSS Version 21.0 for Windows was used as a main tool for analysing the collected data. Descriptive statistics obtained from the data are tabulated in Table 1 to Table 3. In assessing talented young footballers with objective finding the correlation, non-parametric Spearman's Rho analysis was utilized to establish an association between digit ratio, aerobic capacity and anaerobic capacity. The reason for the use of Spearman's Rho was because the amount of the participants were below 30 subjects (N=29); therefore, it is a much more suitable tool for the analysis.

Results

Referring to Table 1, the mean of participants' age is 10.41±0.57 years old, while the mean height of participants is 1.42±0.08 meters. The mean weight of participants was recorded at 32.16±6.49 kg. In terms of BMI, the mean obtained across all participants is 15.81±2.17 (kgm^2). Meanwhile, for 2D:4D, all participants possessed low 2D:4D with the lowest was recorded at 0.90mm and the highest was 0.99mm. Those measurements fall below the

standard norm of 1.00mm, which is categorized as low digit ratio, and norm above 1.00mm is counted as high digit ratio. The data signifies that overall, participants are healthy and have good fitness.

Table 1: Descriptive statistics on anthropometric data

Anthropometric, (N=29)	Min	Max	*Mean±SD*
2D:4D (mm)	.90	.99	0.95±0.02
Age (years)	10	12	10.41±0.57
Weight (kg)	21.50	45.30	32.16±6.49
Height (m)	1.25	1.56	1.42±0.08
BMI (kgm^{-2})	12.98	22.15	15.81±2.17

Association between Low Digit Ratio and Aerobic Capacity

Table 2 tabulates the performance of aerobic capacity of 29 male participants derived from the data obtained from MRW test and digit ratio. Statistically, there exists a moderate significant association between low digit ratio and aerobic capacity performance in MRW test, as indicated by r-coefficient of r_s=0.406, p=0.029.

Table 2: Low digit ratio with aerobic capacity

			Digit ratio	**MRW**
Spearman's rho	Digit Ratio	Correlation Coefficient	1.000	.406*
		Sig. (2-tailed)	.	.029
		N	29	29
	MRW	Correlation Coefficient	.406*	1.000
		Sig. (2-tailed)	.029	.
		N	29	29

*. Correlation is significant at the 0.05 level (2-tailed).

Association between Low Digit Ratio and Anaerobic Capacity

Meanwhile, Table 3 tabulates descriptive statistics of anaerobic capacity of 29 male participants derived from data obtained from 50-meter sprint test and digit ratio. The value of r_s=-.128 and the two-tailed value of p=0.509. Therefore, by normal standards, the association between the two variables digit ratio and anaerobic capacity performance would not be considered statistically significant.

Table 3: Low digit ratio with anaerobic capacity

			Digit ratio	50m sprint
Spearman's rho	Digit Ratio	Correlation Coefficient	1.000	-.128
		Sig. (2-tailed)	.	.509
		N	29	29
	50m sprint	Correlation Coefficient	-.128	1.000
		Sig. (2-tailed)	.509	.
		N	1.000	29

*. Correlation is significant at the 0.05 level (2-tailed).

Discussion

This study performed an investigation on the association of low digit ratio with aerobic and anaerobic capacities of talented young footballers. In terms of statistical significance, there exists a moderate significant association between low digit ratio and aerobic capacity (MRW test), as indicated by the r-coefficient of r_s=0.406 with p=0.029. Meanwhile, between low digit ratio and anaerobic capacity (50-meter sprint), the association is not statistically significant, as indicated by r-coefficient of r_s=-.128, p=0.509. The findings indicate that low digit ratio is able to be positively identified to correlate to aerobic capacity with superior execution. This agrees with existing literature which reported positive association between digit ratio and aerobic capacity in games and between digit ratio and quality of muscles in skiing and football (Manning & Taylor, 2001; Tester & Campbell, 2007). Additionally, the findings of r-coefficient (r=0.37) obtained from the association between low digit ratio and aerobic capacity agrees with the findings of a study conducted on the relationship between digit ratio and endurance running, whereby the r-coefficient obtained was in the range of 0.35 to 0.50 (Manning et al., 2007).

Interestingly, a paper by Mohd Azam et al., (2014) reported that there were significance correlations between low digit ratio male participants on both aerobic and anaerobic capacity that can be seen through bleep test, standing broad jump and agility t-test. That statement is also supported by Ranson, Stratton, & Taylor, (2015), proving negative correlation between lower digit ratio participants in all anaerobic and aerobic fitness tests (standing broad jump, 20m shuttle run, hand grip strength and 10x5m sprint), and outperformed high digit ratio participants (Lutchmaya, Baron-Cohen, Raggatt, Knickmeyer, & Manning, 2004; Tester & Campbell, 2007). As suggested by existing studies, aerobic capacity is rather more closely linked to digit ratio more than anaerobic capacity (Manning, Hill, & Kingdom, 2009; Manning et al., 2007). This is further corroborated by a recent study which indicates a positive relationship between the inducement of pre-birth androgen and endurance of cardiovascular muscles (Manning, Morris, & Caswell, 2007). In this study, there only exists a non-significant association between low digit ratio and anaerobic capacity, as indicated by r-coefficient of r_s=-.128, p=0.509. This finding is consistent with the findings of study which indicates that anaerobic capacity may not be successfully indicated by digit ratio (Manning et al., 2009). Nevertheless, further investigation into different digit ratio levels reveal interesting insights.

In recent years, several studies have investigated alternative reliable variables that are proven to be significantly associated with one's hands. In the last decade, dexterous sporting ability has been found to be positively associated with digit ratio. The study investigated digit ratio as a marker of overall pre-conception testosterones (Manning & Taylor, 2001). Toward this end, a lesser amount has been identified as a contributor towards a more dominant presentation of testosterones. Despite this, a definitive process that could identify a greater extent of testosterones to suggest unrivalled execution has yet to be discovered. Diligence-associated variables have been suggested to affect the outcomes that could be identified by digit ratio (Hönekopp & Thierfelder, 2009). Nonetheless, the academic community has investigated the association between digit ratio and outstanding achievement in various sports (Bennett et al., 2010; Kim & Kim, 2016; Tamiya et al., 2016). Particularly, researchers support the notion that a low digit ratio, which is a biomarker of pre-birth testosterone, may be used to predict athlete's performance level or even identify talented athletes. Despite this, other researchers have argued that digit ratio does not uniquely represent activated testosterone which influences sporting dexterity, as certain extent of matured testosterone representation, may not directly correspond to digit ratio (Bescós et al., 2009; Eghbali, 2016). However, in recent publications, digit ratio is still noted as an ideal biomarker to be used to investigate the relationship between low digit ratio and talented athletes involving tests comprising of varied sports types and skill controls across the same or different genders (Hönekopp & Schuster, 2010; Kim & Kim, 2016; M Voracek et al., 2010).

Conclusion

In conclusion, this study revealed a meaningful association between low digit ratio with aerobic capacity among talented young football players. On the other hand, no distinct association was noticeable for low digit ratio and anaerobic capacity. The results of this study may not necessarily be adopted with strict confidence to classify athletes based on their nature of sports. However, the findings reveal further insights on the role of digit ratio that is reflective of the energy systems. Despite the small sample size in the study, the findings are aligned with other studies on the role of low digit ratio and may be used as a good indicator to identify talented players for aerobic related activities. The findings suggest that further research is needed in this field, with greater emphasis on a larger sample size and a more detailed methodology. The ability of digit ratio as described in this study may be further used as a reliable sporting biomarker in finding elite sportsmen with the integration of conventional talent identification methods.

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