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ABSTRACT

Anthropometry attributes are among the contributing factors needed to ensure the good performance of athletes. Anthropometry attributes can also be used as an indicator for other fitness components. The present study aimed to determine the relationship between anthropometry attributes and cardiovascular fitness among male Universiti Putra Malaysia futsal athletes. A total of 14 male university futsal athletes participated in this study. Anthropometry measurements taken in this study were height, weight, BMI, body fat percentage, and skeletal muscle percentage. For cardiovascular fitness test, several tests were conducted which were the Beep test, Illinois agility test and Running Anaerobic Strength Test (RAST). The correlation test showed that weight, BMI, and body fat percentage have a negative relationship with VO2 max and a positive relationship with the fatigue index. On the other hand, skeletal muscle percentage showed a positive relationship with VO2 max. The results show that anthropometry attributes have a relationship with cardiovascular fitness, especially VO2 max.

Keywords: *anthropometry, futsal, cardiovascular fitness, fatigue index*

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INTRODUCTION

Futsal is the indoor version of football that is played by a 5-a-side team. In competitions, unlimited substitutions are permitted, which results in high-intensity game and physical demands throughout the game (Barbero-Alvarez, Subiela et al. 2015).

Nowadays, futsal is slowly becoming a popular sport that is rapidly played with an intensive tempo. The sport requires not only aerobic but also higher anaerobic strength (Ranković, Mutavdžić et al. 2010). Futsal is a team sport that relies on high-intensity intermittent activities that require high physical, tactical, and technical efforts from the players. Previous studies have suggested that anthropometry measurements must be related to physical fitness components in team sports (Nikolaidis, Chtourou et al. 2019).

Speed, agility, anaerobic strength, and anthropometric structure are some of the most important characteristics of players in sports teams like futsal, which are generally played with an intensive tempo with sudden accelerations and sudden direction switches. The main sport in which the above-mentioned characteristics are used is futsal. Well-developed speed, muscle strength, agility, and power are important in the execution of specific futsal performances and movements, and consequently, there are key indicators of overall performance in futsal matches.

Based on match analysis and heart rate monitoring during the game, futsal is considered as an intermittent high- intensity game that requires aerobic and anaerobic energy pathways(Barbero-Alvarez, Soto et al. 2008). Recent studies have reported that cardiovascular stress is higher than the 85% maximum heart rate (HRmax) in more than 80% of actual playing time, with futsal players reaching HRmax in most of the matches (Trabelsi, Aouichaoui et al. 2014, Ayarra, Nakamura et al. 2018). Previous studies also suggest that futsal athletes should have well developed aerobic capacity with a maximal oxygen uptake (VO2 max) of approximately 60 ml/kg/min, which shows the high intensity nature of this team sport (Baroni and Leal Junior 2010).

Besides that, anthropometric structure such as body composition, weight, percentage of fatty tissue, and muscle mass contributes to performance in high levels (Parnow, Ghrakhanlou et al. 2005). This knowledge can help players identify their required features and reinforce them. It can also help coaches develop appropriate exercise plans. As the selection of players is a permanent process that goes ahead of coaches, the development of criteria for identifying outstanding players will be of great use.

Anthropometry direct translation can be ‘measurement of man’ or ‘measurement of human’ where the Greek word of ‘anthropos’ mean human while ‘metron’ mean measurement (Herron 2000). Anthropometric values of human are related to inherited genetic, environment, social, lifestyle, functional status, risk for non-communicable disease and health (Padilla, Ferreyro et al. 2021).

In early days, human gain interested in anthropometry due to their use for cloths fitting, designing tools and equipment. In ergonomic world of interest, anthropometry data is essential in designing materials and tools to ensure optimum human working performance (Herron 2000).

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Anthropometry data application has been used in other field of study such as medical and health. Due to the simplicity of its assessment, anthropometry data also been used to provide the insight into human nutritional status and health(Eveleth 1996) malnutrition and obesity (Padilla, Ferreyro et al. 2021).

In sports science, anthropometry is used to evaluate health related physical status such as fitness and performance. Anthropometry is considered as important tool in the field of test and measurement of athletes attributes that contribute to strength and performance(Malina, Battista et al. 2002).The anthropometric and body compositions of athletes have been the subject of many investigations as many researchers have hypothesized that trained athletes may be expected to exhibit structural and functional characteristics that are specifically favourable for their specific sport (Popovic, Bjelica et al. 2014). Such information is useful to determine possible differences or similarities and may assist in planning for coaches, managers, and players. Thus, this study was carried out to study the relationship between anthropometry attributes and cardiovascular fitness in Universiti Putra Malaysia male futsal athletes.

METHOD

Subjects.

This cross-sectional study was undertaken in May 2022. Participants in this study were chosen via purposive sampling. The participants for this study were male university futsal athletes (n=14) from Universiti Putra Malaysia. All these university futsal athletes were selected to represent the university with an average age of 22.5 ± 1.5. A cardiovascular fitness test was done as part of the team preparation program for an upcoming competition. The subjects were given explanations on the nature of the testing and informed consent was obtained from all the subjects.

Anthropometry measurements.

This study measured the height of the subject using a SECA 782 stadiometer. Weight, BMI, body fat percentage and skeletal muscle percentage was measured using Omron HBF-516B.

Cardiovascular fitness measurements.

Agility test was done using the Illinois agility test method. For VO2 max, Beep test was conducted. The protocol for Beep test is that the athletes must run on a 20 meters track continuously with a pre-determined speed until they are unable to keep up with the pace. Data from the Beep test was used to calculate athletes' VO2 max. Running Anaerobic Strength Test (RAST) is a test procedure where athletes must sprint on a 35 meters track six times. Data from the RAST test were used to calculate anaerobic power (maximum and average) and fatigue index.

Statistics.

Data were expressed as mean ± standard deviation (SD). Pearson correlation coefficient test was used to analyse the relationship between anthropometry measurement and cardiovascular

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fitness. The significance level was set at p<0.05. All statistical analyses were performed using SPSS Statistical Package Version 27.

RESULTS

Correlation between cardiovascular fitness and anthropometry measurement. Results on anthropometry measurement and cardiovascular fitness is presented in Table 1.

Table 1: Anthropometry and cardiovascular fitness measurement

Parameters	Measurements
Age (years)	22.5 ± 1.5
Height (cm)	167.8 ± 4.8
Weight (kg)	61.25 ± 8.2
BMI (kg/m2)	21.66 ± 2.8
Body fat percentage	14.6 ± 6.8
Skeletal muscle percentage	43.6 ± 3.8
Agility (sec)	17.3 ± 1.4
VO2max (ml/kg/min)	42 ± 7
Maximum anaerobic power (watts)	563. 4 ± 90.7
Average anaerobic power (watts)	405.4 ± 96.4
Fatigue index (watts/sec)	8.4 ± 5

Values are expressed as mean ± SD. n=14

The scatter-plot diagram of cardiovascular fitness and height is presented in Figure 1, cardiovascular fitness and weight in Figure 2, cardiovascular fitness and BMI in Figure 3, cardiovascular fitness and fat percentage in Figure 4, and cardiovascular fitness and muscle percentage in Figure 5. Significant correlation between cardiovascular fitness and anthropometry measurement is indicated by a single fit line in the scatter-plot diagram.

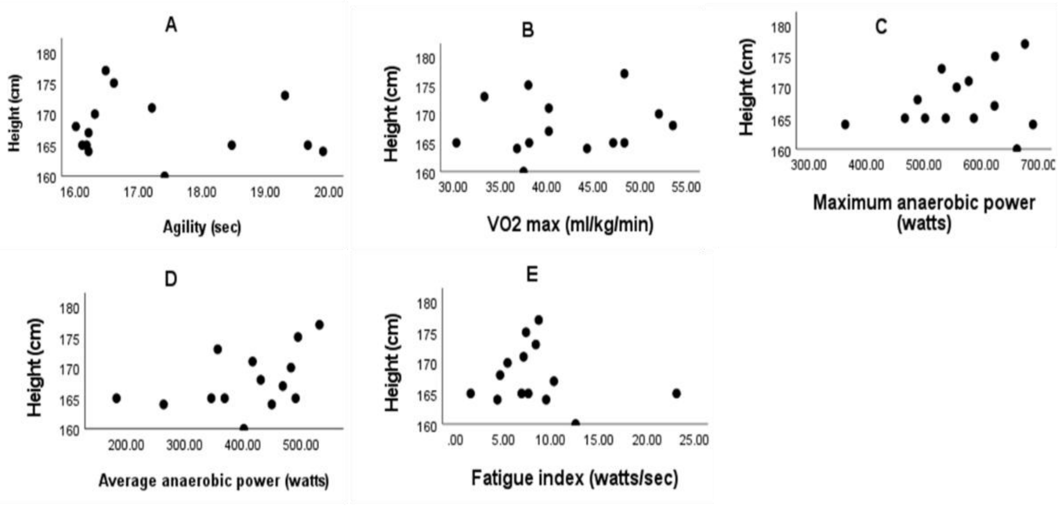

Figure 1: Relationship between height and cardiovascular fitness in university male futsal athletes. A: Height and agility score. B: Height and VO2 max. C: Height and maximum anaerobic power. D: Height and average anaerobic power. E: Height and fatigue index.

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There were no significant correlations between height and cardiovascular fitness observed in this study.

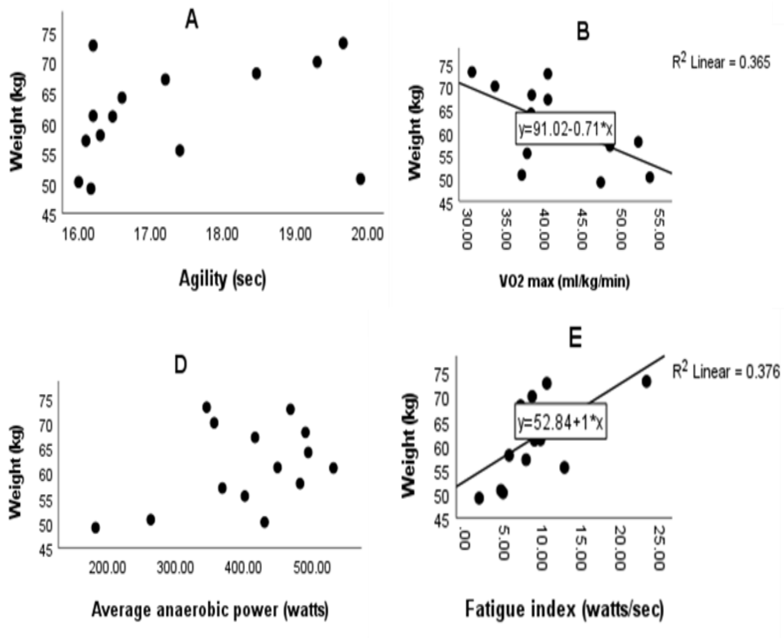

Figure 2: Relationship between weight and cardiovascular fitness in university male futsal athletes. A: Weight and agility score. B: Weight and VO2 max. C: Weight and maximum anaerobic power. D: Weight and average anaerobic power. E: Weight and fatigue index.

Correlation test found that weight was significantly related to VO2 max (r = -0.604, p = 0.022) and fatigue index (r = 0.613, p = 0.020).

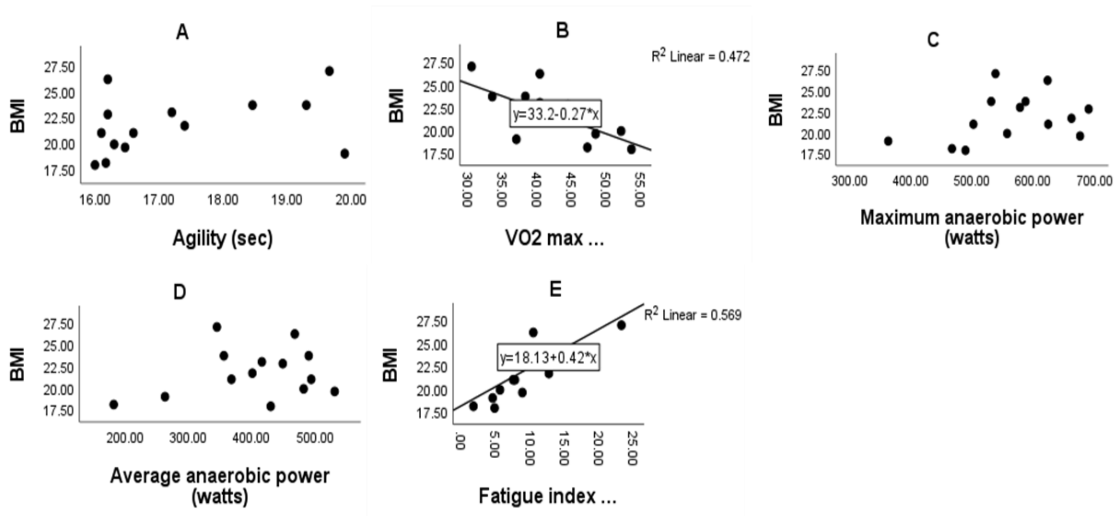

Figure 3: Relationship between BMI and cardiovascular fitness in university male futsal athletes. A: BMI and agility score. B: BMI and VO2 max. C: BMI and maximum anaerobic power. D: BMI and average anaerobic power. E: BMI and fatigue index.

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Significant negative relationship was detected between BMI and VO2 max (r = -0.687, p = 0.007) and positive relationship to fatigue index (r = 0.754, p = 0.002).

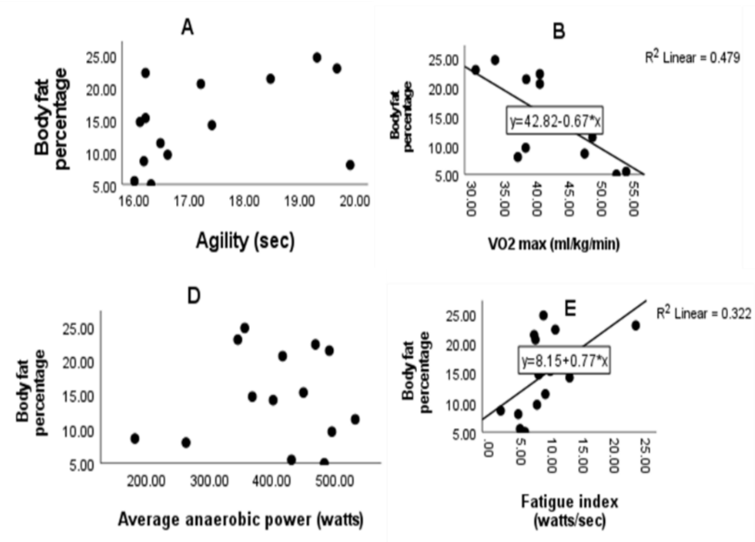

Figure 4: Relationship between body fat percentage and cardiovascular fitness in university male futsal athletes. A: Body fat percentage and agility score. B: Body fat percentage and VO2 max. C: Body fat percentage and maximum anaerobic power. D: Body fat percentage and average anaerobic power. E: Body fat percentage and fatigue index.

Significant negative relationship was detected between body fat percentage and VO2 max (r = -0.692, p = 0.006) and positive relationship to fatigue index (r = 0.568, p = 0.034).

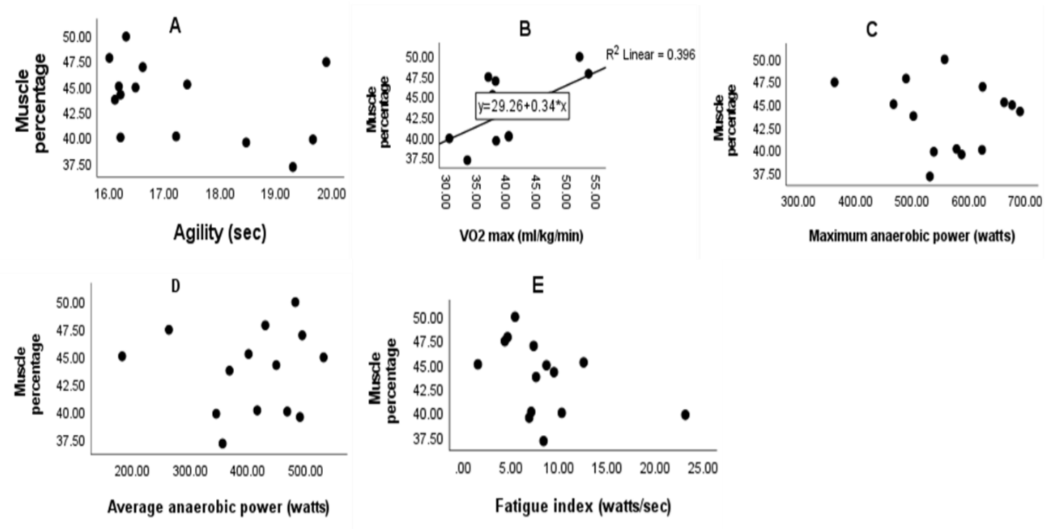

Figure 5: Relationship between skeletal muscle percentage and cardiovascular fitness in university male futsal athletes. A: Muscle percentage and agility score. B: Muscle percentage and VO2 max. C: Muscle percentage and maximum anaerobic power. D: Muscle percentage and average anaerobic power. E: Muscle percentage and fatigue index.

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Correlation test found positive relationship between muscle percentage and VO2 max (r = 0.629, p = 0.016).

The correlation test between cardiovascular fitness parameters and futsal players' height shows that there were no significant correlations between them. The correlation test between cardiovascular fitness parameters and body weight shows a significant negative relationship to VO2 max (r = -0.604, p = 0.022) and positive relationship to fatigue index (r = 0.613, p = 0.020) (Figure 2). The correlation test between cardiovascular fitness parameters and BMI also shows a significant negative relationship to VO2 max (r = -0.687, p = 0.007) and positive relationship to fatigue index (r = 0.754, p = 0.002) (Figure 3). The correlation between fat percentage and cardiovascular fitness parameters shows a significant negative relationship to VO2 max (r = -0.692, p = 0.006) and positive relationship to fatigue index (r = 0.568, p = 0.034) (Figure 4). The correlation between skeletal muscle percentage and cardiovascular fitness parameters shows a significant positive relationship to VO2 max (r = 0.629, p = 0.016) (Figure 5).

DISCUSSION

This study aimed to study the relationship between anthropometry attributes and cardiovascular fitness in university male futsal athletes. This cross-sectional study measured anthropometry parameters which are height, weight, BMI, body fat percentage and skeletal muscle percentage. Cardiovascular fitness parameters for this study are VO2 max, agility, anaerobic power, and fatigue index.

Correlation between body weight, BMI, and body fat percentage to cardiovascular parameters.

Previous studies on professional futsal athletes showed that their VO2 max was at 50-55ml/kg/min while in this study, the mean for VO2 max for male university futsal athletes was only 42ml/kg/min (Alvarez, D'ottavio et al. 2009, Castagna, D'Ottavio et al. 2009). However, a significant negative relationship was found between body weight, BMI, and body fat percentage with VO2 max in athletes. VO2 max is the highest rate of oxygen consumption during maximal exercise and is considered as the best indicator of an athlete's physical fitness(Ranković, Mutavdžić et al. 2010, Shete, Bute et al. 2014). A negative relationship indicates that increments in body weight, BMI or body fat percentage causes reduction in VO2 max among athletes. A study using the high intensity intermittent training (HIIT) protocol found that increases in VO2 max are also accompanied by reduction in body fat mass among adolescents(Alonso-Fernández, Fernández-Rodríguez et al. 2019).

Correlation analysis between muscle percentage and VO2 max showed a positive relationship. This indicates that the higher the muscle percentage, the higher the VO2 max level in these athletes. This result is in accordance with previous studies which show that muscle mass has a positive relationship with VO2 max level either in young athletes or the elderly(Kim, Wheatley et al. 2016) and decline when muscle mass loss is due to aging in non-training personnel(Fleg and Lakatta 1988). Since VO2 max represents the maximum oxygen consumption by skeletal during exercise, further needs of energy beyond this limit must be supplied through anaerobic energy pathways that lead to lactate acid accumulation.

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Fatigue can occur due to depleted liver and muscle glycogen, dehydration due to sweating, muscle soreness, and accumulation of metabolite by-products such as lactate, hydrogen ion and carbon dioxide. This condition can limit an athlete's performance where physical and cognitive function is limited up to days after a match or training session(Marshall, Cross et al. 2018). A positive relationship was shown between body weight, BMI and body fat percentage to fatigue index. Fatigue index is an indicator that is used to study the development of fatigue during anaerobic exercise. Anaerobic exercise is known to rely on glycogen as fuel rather than oxygen. A high fatigue index indicates that an athlete's power output declines fast during anaerobic exercise and has problems in maintaining power over a series of anaerobic exercises (Pavlovic, Idrizovic et al. 2016).

CONCLUSION

In this study, it was shown that body weight, BMI and body fat percentage had a negative effect on VO2 max and fatigue index while muscle mass percentage has a positive effect in VO2 max level. Cardiovascular fitness is important for futsal players due to the high-intensity nature of the game. This game also involves repetitive sprinting and running that may cause fatigue and eventually affect an athletes' performance. These findings reveal that anthropometry status has a relationship to cardiovascular fitness in male university futsal athletes.

Suggestion

Since anthropometry parameters are easier to be measured compared to cardiovascular fitness, coaches and athletes can use the anthropometry measurement as their indicator for cardiovascular fitness status during training or athlete selection.

Conflict of Interest
All author declare that they have no conflict of interest.

Author's Contribution
Azhar Yaacob and Shahrulnizar Nurhalim contributes to designing study concept, data analysis and interpretation and revising the manuscript.
Azhar Yaacob, Shahrulnizar Nurhalim and Mohd Rozilee Wazir Norjali Wazir involve in data collection and drafting the manuscript.
Mohd Rozilee Wazir Norjali Wazir contributes to study concept approval, data interpretation and given final approval.
Siti Zubaidah Nur Marthuan and Ahmad Termizi Ahmad Kami! contribute to results interpretation and drafting the manuscript.
All authors give final approval and agree to be accountable for all aspects.

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