Aerobic and anaerobic capacities in determining adolescent futsal players' performance levels

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Abstract

Futsal is characterized as a high-intensity sport. Thus, aerobic and anaerobic capacities are essential factors for supporting athletes' performance when competing. Data related to adolescent futsal players in Indonesia still lacked. Therefore, this research objective was to determine how much aerobic and anaerobic abilities became the predictors of futsal athletes' performance levels. The research method was observational research with a quantitative approach. The research subjects consisted of 15 Regional Training Center (PELATDA) athletes and 15 non-PELATDA athletes from West Java with an average of (age= 18.23 ± 1.13 years old, height= 170.23 ± 3.82 cm, body weight 59.57 ± 5.28 kg, BMI 20.56 ± 1.82 kg/m^{-2}, and FAT 10.05 ± 1.29%). The results showed that body mass, body composition, VO_{2max}, peak power, vertical jump, and fatigue index of PELATDA athletes were better than non-PELATDA athletes. Thus, this research could provide an overview for coaches regarding the aerobic and anaerobic capacities standards of adolescent futsal players and could be used as a reference in making an exercise program to improve athletes' aerobic and anaerobic capacities.

Keywords: peak power, vertical jump, young athlete.

INTRODUCTION

Futsal is an intermittent high-intensity sport that requires players to perform a series of intense activities repeatedly (e.g., sprinting, change of direction, accelerated kicks, decelerations) (Spyrou *et al.*, 2020). It can be seen from previous research, which reported that during a match, futsal players could cover a distance of 3000-4500 m (Álvarez *et al.*, 2009; Barbero-Alvarez *et al.*, 2008). Furthermore, 26% of the total distance traveled was done with high-intensity levels ranging from 86% to 90% of maximum heart rate (Caetano *et al.*, 2015; Doğramacı & Watsford, 2006). The rapid changes in the futsal game required athletes to maintain the best possible intensity when playing (Junior *et al.*, 2017). These actions were punctuated by short recovery periods, with low-intensity actions or pauses. 75% of game action lasted approximately from one to 18 seconds. This result suggested that anaerobic strength might be necessary for success in futsal (Álvarez *et al.*, 2009).

Research conducted by Juniarsyah *et al.* (2019) revealed that the average aerobic endurance (VO_{2max}) of professional futsal players from

Indonesia was in the range of 45-52 ml/kg/minute. Meanwhile, professional futsal players from Latin America had VO_{2max} values ranging from 60-70 ml/kg/minute (Castagna *et al.*, 2009; Sekulic *et al.*, 2020; Stubbs-Gutierrez & Medina-Porqueres, 2020). The difference in VO_{2max} value was very far compared to professional athletes from Indonesia. Thus, this difference could be used as a standard for coaches to improve their athletes' condition. It was vital because good aerobic endurance could support the accuracy of passing, acceleration, sprinting, and kicking (Astagna, 2010). Thus, the physiological characteristics of athletes, such as the aerobic and anaerobic capacities of futsal players, must be considered to maintain good playing performance and support a team to achieve success in competing (Astagna, 2010).

Besides aerobic and anaerobic capacities, anthropometric characteristics such as height, body mass, and body composition are other essential components that futsal athletes must possess. An example is athletes who have excessive body fat can interfere with performance in team sports (Nikolaïdis, 2012). In contrast, a more significant percentage of skeletal muscle mass tends to improve sports performance as it contributes to energy production during high-intensity activities and increases the strength-producing capabilities of athletes (Nikolaïdis, 2012; Sekulic *et al*., 2020; Vila Suárez *et al*., 2008).

The very dynamic development of futsal in Indonesia encouraged further research on futsal, especially for adolescent futsal players. Research on aerobic and anaerobic capacities as predictors in determining the adolescent futsal players' performance has not been done much. The latest research only discussed anthropometric profiles and body composition in young football athletes (Bernal-Orozco *et al.*, 2020). Meanwhile, no one has researched aerobic and anaerobic capacities yet. Therefore, it was necessary to prepare young players to have almost the same abilities as professional players to find out to what extent the differences between young futsal players could help the team and coaches develop training strategies. In addition, this research was expected to provide a more objective understanding of the talent scouting program and the young futsal players' performance. Thus, this research objective was to determine how much aerobic and anaerobic capacities became predictors of adolescent futsal players' performance levels.

METHOD

The research method used was observational research, where the research subjects did not receive any other intervention. Thus, the data collection was only done once. Research subjects were selected based on inclusion criteria. Participants did not have a history of cardiovascular and asthma, did not smoke, and exercised at least three to four times per week for the last six months. The total research subjects consisted of 30 male futsal athletes consisting of 15 athletes from the *Regional Training Center* (PELATDA) of West Java and 15 non-PELATDA futsal athletes from local futsal clubs in Bandung. Furthermore, all research subjects got the same tests, namely, anthropometric measurements (age, height, weight, FAT, and BMI), aerobic endurance (VO_{2max}), anaerobic endurance (RAST), and *vertical jump*.

Before the research was conducted, all subjects were given an explanation both in writing and orally regarding the objectives, procedures, and risks of this research. All research subjects must fill out informed consent to participate in this research. The Research Ethics Committee of Bandung Polytechnic of Health-The Ministry of Health has approved the research protocol under Number 09/KEPK/EC/III/2021.

Measurement and Research Procedure

Anthropometry

Data on the age were collected using a questionnaire filled out independently by the subjects. Meanwhile, data on the height used *Vertec* (*SPRI Commercial SKU: 07-70250*). Furthermore, for the athlete's body weight, BMI and FAT, researchers used the OMRON Karada *Body Fat Scan* tool (HBF-375). The data collection procedure was carried out by the subjects standing upright on the unit by placing their feet on the electrodes barefoot, then holding the display with both hands straight in front of the chest to form 90°. After the weight measurement results appeared, it blinked two times and waited until the sensor stopped working. After the sensor stopped, the weight and body composition measurement results appeared on the monitor.

Aerobic Capacity (VO_{2max})

The measurement of VO_{2max} in this research used the field method (*bleep test*). The *bleep test* was carried out in a closed field with a flat surface then marked between the distances A and B using cones with a distance of 20 meters. The subjects ran a 20-meter line back and forth to the rhythm of the *bleeps*, and gradually the sound of the *bleep* markers got faster. The test stopped when the research subjects were unable to keep up with the rhythm of the *bleep* and did not reach the target line on two consecutive occasions. In the *bleep test*, there were 21 levels with 16 feedbacks. The conversion of the VO_{2max} value was taken from the number of feedbacks and the level on the *bleep test*.

Anaerobic Capacity *(Peak Power)*

Anaerobic endurance data was collected using the RAST (Running-Based Anaerobic Sprint Test) method. Athletes had to sprint 35 m as much as six times with an interval of 10 seconds between sprints. The purpose of this RAST was to see the peak power of each athlete. The timing was recorded for each sprint using a *stopwatch* (Casio HS-80TW, Shibuya, Tokyo, Japan). *Power* in *Watts* (W) for each *sprint* was calculated based on body mass (BMI) in kilograms (kg) and distance (35 m) to the power of two. After that, this result was divided by the time of each sprint, in seconds (s), to the power of three. As an example; Peak Power = body mass (kg) × distance $(m)^2/\text{time } (s)^3$. The highest power value produced in a sprint was considered peak power. Meanwhile, assessment of the *fatigue index* (FI) was done by subtracting the maximum power minus the minimum power then dividing the total time from six *sprints*, for example, was (maximum power - minimum power)/ total time of six sprints.

Vertical jump

Jump height measurements were assessed using Vertec (SPRI Commercial SKU: 07-70250). Vertec is a vertical jump measuring instrument in a pole with some flat iron such as *vanes*. The distance between the vanes was one inch. The lowest vane was adjusted to the subject's height in a standing position with the right/left arm straight up. The jump height was calculated from the highest vane reach by hand that could be reached when the subjects jumped.

The research procedure included collecting the anthropometric of the research subjects, such as age, height, weight, BMI, and FAT at the initial stage. Then, all subjects warmed up for five until 15 minutes and were prepared to do a series of tests which included endurance tests or VO_{2max}, anaerobic capacity, and vertical jumps. In the VO_{2max} test, the researchers used the *bleep test* method, where the results of the number of levels and feedback were converted into a VO_{2max} table. Then, for anaerobic data retrieval, the researchers used the RAST method. This test was taken to see the *peak power* and fatigue index of athletes. Furthermore, researchers used a *vertec* tool in the vertical jump test to see the highest hand reach when making a jump.

Data Analysis

The presentation of the data was displayed in the form of the mean value and standard deviation. This research used a *one-way analysis* or *one-way Anova* test, which compared PELATDA and Non-PELATDA futsal players. Statistical analysis used SPSS application Version 22 with a significance level of $p < 0.05$.

RESULTS

The results showed that the mean (±SD) of Age and Body Weight between the two groups did not show a significant difference, but the weight of PELATDA athletes was lower than the weight of non-PELATDA athletes. Furthermore, significant differences were seen in the means of the height, FAT, and BMI of the two groups. The Pelatda athletes had a higher height but lower FAT and BMI rather than the non-PELATDA athletes (see Table 1).

Table 1. Anthropometric Data for PELATDA vs Non-PELATDA Futsal Players

Variable	Total sampling (N=30)	Group		P-value
		PELATDA (*n*=15)	Non- PELATDA (*n*=15)	
Age (years)	18.23 ± 1.13	18.06 ± 1.03	18.40 ± 1.24	0.431
Weight (kg)	59.57 ± 5.28	58.6 ± 4.49	60.46 ± 5.98	0.362
Height (cm)	170.23 ± 3.82	171.18 ± 2.55	168.6 ± 4.25	0.017*
BMI (kg/m^{-2})	20.56 ± 1.82	19.87 ± 1.59	21.25 ± 1.82	0.035*
FAT (%)	10.05 ± 1.29	9.55 ± 1.21	10.55 ± 1.21	0.032*

Abbreviations: BMI = Body Mass Index
*Significant average difference $p<0.05$

Table 2. Aerobic and Anaerobic Data for PELATDA vs. Non-PELATDA Athletes

Variable	Group		P-Value
	PELATDA (*n*=15)	Non-PELATDA (*n*=15)	
VO_{2max} ($ml.kg^{-1}.min^{-1}$)	49.84 ± 4.04	44.86 ± 3.86	0.002*
Peak Power (watt)	435.16 ± 115.40	333.32 ± 92.67	0.013*
Vertical Jump (cm)	50.80 ± 5.64	44.06 ± 3.05	0.001*
Fatigue Index (%)	6.86 ± 3.45	4.40 ± 2.40	0.031*

Abbreviations: VO_{2max} = *Volume Oxygen Maximum*
*Significant average difference $p<0.05$

The results in Table 2 showed that the aerobic ability marked by VO_{2max} between the two groups showed a significant difference (p=0.002), where the PELATDA athletes had a higher VO_{2max} value compared to non-PELATDA athletes. The next significant difference was an anaerobic capacity, characterized by peak *power, vertical jump,* and *fatigue index*. The three variables showed that PELATDA athletes were superior to non-PELATDA athletes (*peak power* p=013, *vertical jump* p=0.001, *fatigue index* p=0.31).

DISCUSSION

This research presented that aerobic and anaerobic capacities could determine the adolescent futsal players' performance levels for the first time. The research results showed no significant difference between the average age and weight of the PELATDA and non-PELATDA athletes, but that the PELATDA athletes were lighter in weight than non-PELATDA athletes (PELATDA 58.6 ± 4.49, vs. non-PELATDA 60.46 ± 5.98). Meanwhile, there were significant differences for height, BMI, and FAT (height p=0.017, BMI p=0.035, FAT p=0.032). PELATDA athletes had a higher height, lower BMI, and lower FAT than non-PELATDA athletes.

The research results conducted by Milioni *et al.* (2016) revealed that being overweight was associated with a person's level of physical fitness. Athletes with a higher BMI and FAT showed decreased physical fitness compared to those with a higher BMI and low FAT. Although PELATDA and non-PELATDA athletes showed normal BMI and FAT, significant differences between the two groups affected the athletes' physical fitness. It can be seen from the VO_{2max} value of the two groups, where the PELATDA athletes had a higher VO_{2max} value when compared to the VO_{2max} value in the non-PELATDA group (see Table 2).

Furthermore, the average height in both groups was within the normal population in Indonesia (Riskesdas, 2018). Although PELATDA athletes' height was higher than non-PELATDA athletes', this research results differed from the results of research conducted in Brazil and Spain, which showed that the average height of semi-professional athletes from these two countries was on average 174 cm (Campos *et al.*, 2021; Romero *et al.*, 2020; Sekulic *et al.*, 2020). However, in futsal, no research concluded the correlation between height and performance in the field. It was different from football, swimming, volleyball, and basketball, which positively correlated height and player performance on the field. Thus, based on these research results, the researchers had not been able to explain the phenomena yet (Bernal-Orozco *et al.*, 2020).

There was a significant difference in aerobic capacity between the two groups (p=0.002). The aerobic capacity of PELATDA athletes was higher than that of non-PELATDA athletes. However, when compared with previous research by Alvarez *et al.* 2009; Astagna, 2010; Ohmuro *et al.* 2020; Romero *et al.* 2020; Stubbs-Gutierrez & Medina-Porqueres (2020) on semi-professional athletes in several countries in the Americas and Europe, it was known that the VO_{2max} value of athletes in Indonesia was still deficient (Brazil 55-59 $ml.kg^{-1}.min^{-1}$, Italy 56-60 $ml.kg^{-1}.min^{-1}$, and Spain 60-70 $ml.kg^{-1}.min^{-1}$).

The difference in aerobic capacity was due to the different frequency and duration of exercise between the two groups. PELATDA athletes practiced eight sessions a week, with the duration of each training session lasting 90 - 120 minutes. In comparison, non-PELATDA athletes only exercised five sessions a week with a duration of 90 minutes. The research results supported previous research conducted by Álvarez *et al.* (2009), which suggested that athletes who did nine training sessions with 90 minutes a week could increase their aerobic capacity.

Furthermore, regarding anaerobic capacity when viewed from a physiological point of view, it was reasonable to hypothesize that the vertical jump test had a strong relationship with the athlete's *peak power*. It was due to the primary energy metabolism pathway required during the action of the two tests, namely by using ATP-PC (*Adenosine Triphosphate-Phosphocreatine*), the higher the *vertical* jump, and the higher the *peak power* or leg muscle Power (Fukutani *et al.*, 2021). In addition, the 35-meter *sprint* speed was tested using RAST could be increased by training that required a high level of strength development, such as jump training. Thus, it showed that the height of the *vertical* jump was related to the athlete's peak power (Sales *et al.*, 2018).

The level of athletes' fatigue, marked by the fatigue index (FI), represented how the strength or power level would decrease in the athletes' performance (Álvarez *et al.*, 2009). The lower the *FI*-value, the better the participants' ability to maintain their performance, and vice versa. Athletes with high *FI*-values might need to increase their anaerobic capacity to maintain fatigue levels (Queiroga *et al.*, 2013). However, the FI variable in both groups in this research was still at the threshold value (<10%) so that both groups were considered still able to maintain their level of fatigue (Queiroga *et al.*, 2013).

Aerobic and anaerobic capacities to perform repetitive high-intensity activities were necessary components for physiological fitness in adolescent futsal players. Thus, with an excellent level of aerobic capacity, futsal players could perform intense, repetitive movements from the beginning to the end of the match and improve the recovery mechanism after several days of playing in matches (Romero *et al.*, 2020). Thus, the research results could be used as an illustration for sports coaches and practitioners to evaluate performance in futsal matches and play a role in distinguishing well-trained futsal players or not. The research results showed that the value of aerobic and anaerobic capacities in PELATDA athletes was still relatively low for the size of semi-professional players. Therefore, a more intense exercising program and additional adequate nutritional intake for futsal players, especially in this research, must be programmed by the coach to impact later the aerobic and anaerobic capacities of adolescent futsal players.

CONCLUSION

This research concluded that PELATDA athletes had better aerobic and anaerobic capacities than non-PELATDA athletes. However, these results were still far from being compared to semi-professional athletes. Thus, the research results could provide an overview for coaches about the aerobic and anaerobic capacities standards of adolescent futsal players and could be used as a reference in making an exercise program to improve the aerobic and anaerobic capacities of futsal athletes.

ACKNOWLEDGMENT

Thank you to the Research, Community Service, and Innovation Program of the Institute for Research and Community Services, The Bandung Institute of Technology, for funding this research and all research participants who helped complete this research well.

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