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A comparison of anthropometry and physiological characteristics of finswimming athletes on short and long distance numbers

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Abstract

Research on the comparison of physiological characteristics of Finswimming athletes at short and long-distance numbers has not been widely conducted. Therefore, the objective of this research was to determine the differences in anthropometry and physiological characteristics of Finswimming athletes at short and long-distance numbers. This research used an observational research method with a quantitative approach. The subjects of this research were 24 finswimming athletes consisting of 12 long-distance athletes and 12 short-distance athletes with an average age of 17.08 ± 1.03 years; height, 168.55 ± 3.81 cm; and weight, 63.75 ± 6.67 kg; BMI, 22.14 ± 2.96 kg/m^2. The results showed significant differences between long-distance athletes and short-distance athletes on BMI variables, total fat, total muscle mass, and VO_{2max} ($p < 0.05$). In detail, long-distance Finswimming athletes had better anthropometry and physiological characteristics when compared to short-distance Finswimming athletes. The results of this research can be used as references for training programs and considerations in talent scouting.

Keywords: VO_{2max}, Force Volume Capacity, body composition

INTRODUCTION

Finswimming was a development of swimming sport. The difference between the two sports was the use of specific equipment such as *monofin*, *bifin*, and *snorkel* (Oshita, Ross, Koizumi, Tsuno, & Yano, 2013). *Finswimming* sport has been competed or contested from regional to international levels. However, the *Finswimming* sport has not competed in the Olympics so far. Several numbers were contested in *Finswimming* based on the competition rules of *Confederation Mondiale des Activities Subaquatiques*/CMAS (Kunitson, Port, & Pedak, 2015). Among them were *surface Finswimming, apnea Finswimming, immersion Finswimming,* and

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bi-fins (Hue, Galy, Blonc, & Hertogh, 2006). *Surface Finswimming* competes for several competition numbers, including short-distance (100 m) and long-distance (200 m, 400 m, and 1.500 m). Currently, there are many *Finswimming* clubs in the regions that have started to foster potential young athletes. The guidance is intended to bring forth the high-achieving young athletes who can be projected to become regional and national athletes so that they are expected to be able to provide exemplary achievements in international competitions. However, in some situations, some athletes who compete in short-distance numbers usually participate in long-distance numbers, and vice versa. Therefore, the coaching efforts are not focused.

Anthropometry, aerobic capacity, and excellent respiratory capacity were essential aspects in improving athletes' performance (Sarmento, Anguera, Pereira, & Araújo, 2018). Sports experts agreed that athletes who had excellent anthropometry, aerobic capacity, and respiratory capacity plus a strong mentality tended to perform better (Rüst, Knechtle, Knechtle, & Rosemann, 2013). Several previous research stated that European *Finswimming* athletes aged 16-17 years had an average height of 175-180 cm and a bodyweight of 70-72 kg (Hue et al., 2006; Kunitson et al., 2015; Vasileios Stavrou & Voutselas, 2018). Meanwhile, several other researchers had concluded that *Finswimming* athletes had 10-12% fat (V. Stavrou et al., 2018; Vasileios Stavrou & Voutselas, 2018) and a total muscle mass of 60.5 kg (Hue et al., 2006). Another research conclusion stated that male *Finswimming* athletes aged 16-18 years from several Asian countries had VO_{2max} values of 52-56 ml/kg/minute (Wang, Tian, Zhang, & Gong, 2012), and a respiratory capacity of 5.8 L. (Wylegala, Pendergast, Gosselin, Warkander, & Lundgren, 2007). However, in some of the research conclusions, the researcher had not found any research comparing the physiological characteristics of *Finswimming* athletes in short and long-distance numbers.

Success in a sport could not be separated from athlete development programs, training programs, and athlete performance

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evaluations (Vitale & Weydahl, 2017). In the process of coaching sports athletes, especially *Finswimming*, a coach needs to take into account where the athlete is projected with anthropometry and their respective physiological characteristics. Thus, the participation of athletes in participating in matches in double numbers (short-distance and long-distance) can be minimized. It was done so that coaching efforts could focus on one number. Researchers have not found any studies comparing the anthropometric and physiological characteristics of *Finswimming* athletes with short and long-distance numbers yet. Therefore, the objective of this research was to determine the differences in anthropometry and physiological characteristics of short and long-distance *Finswimming* athletes. The results of this research were expected to provide a more objective understanding of the talented scouting program and athletes' performance.

METHODS

This research used a survey method with a cross-sectional approach. The researcher only took data once without giving intervention to the research subjects. Furthermore, the subjects were selected based on inclusion criteria, including participants in good health, did not smoke, had no history of asthma and cardiovascular disease. The research subjects consisted of 24 people (12 male *Finswimming* athletes with long-distance numbers and 12 male *Finswimming* athletes in short-distance numbers). The two research groups were *Finswimming* athletes from Regional Training Center *(Pelatda)* of Bogor who spent an average of 10 hours of training per week with a duration of 2 hours of training per day and had experience in *Finswimming* sport for three years.

All research subjects received an explanation orally and in writing regarding the objectives, procedures, and risks of this research. Research subjects were directed to fill out informed consent if they decided to participate in this study. The Research Ethics Commission of the Health

Polytechnic Ministry of the Health Republic of Indonesia Bandung No. 04/KEPK/PE/X/2019 had approved the research protocol.

Anthropometric data were collected at the sports laboratory of National Sports Hospital (RSON) in Cibubur, starting at 9 a.m. During testing, the temperature of the sports laboratory of RSON ranged from 22-26^{o} C, and humidity was between 60-80%. The research subjects ate snacks one hour before the test and used clothes and sports shoes suitable for the test.

The measurement of the subjects' height used a stadiometer, namely Seca 213, made in China. The research subjects were directed to face forward, an upright body position without footwear. Furthermore, the body weight and Body Mass Index (BMI) measurement used the *Omron Karada Body Fat* Analyzer. This study measured body fat and muscle percentage using the *GE Lunar Prodigy DXA (Dual Energy X-ray Absorptiometry)* instrument. The subjects' profiles (height, weight, sex, and age) were inputted into a computer and then computed using the *GE Lunar Prodigy DXA* instrument. The subjects were in a supine body position faced up on the *GE Lunar Prodigy DXA* instrument. The *GE Lunar Prodigy DXA* instrument scanned the subject's body from toe to head. Then, the measurement of data appeared on the computer screen after the scanning process.

The measurement of Maximum Oxygen Volume (VO_{2max}) in this research used a laboratory method using a treadmill based on the recommended test protocol by BASS (*British Association of Sport Science*). This research used *Cosmed CPET* (*Cardiopulmonary Exercise Testing*) made by Cosmed and a motorized treadmill with *Cosmed* CPET (Derek Tran, 2014). In the VO_{2max} determination protocol using *Cosmed* CPET, the research subjects tested with an initial treadmill speed of 4-7 km/hr for 4 minutes (one minute at each speed), then started the test at a speed of 8 km/hr and increased by 1 km/hr and the incline of the treadmill continued to increase every two minutes. The test stopped when the research subjects were no longer able to maintain their speed or were

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exhausted, and the VO_{2max} data appeared on the computer after the test ended.

The measurement of maximum heart rate used *12-Lead* Electroencephalogram (ECG) computerized with *COSMED CPET* using the Tanaka equation (208-(07*Age). The research subjects used electrodes attached to the chest when measuring VO_{2max}, then the heart rate was detected automatically on the screen computer.

The measurement of *Forced Vital Capacity* (FVC) used an *SP10 Digital Spirometer* device. The profiles of research subjects (height, weight, and age) were entered into the *SP10 Spirometer*. All subjects were seated and asked to inhale as much air as possible then expelled as much air as possible (which was in their lungs) into the *SP10 Spirometer*. After that, the FVC was recorded after the subject took measurements. In this study, the measurement of lactic acid used a calibrated *portable Accutrend Plus*. Shortly after testing VO_{2max}, a drop of blood was drawn from the tip of the finger. After the blood was drained, the portable lactate meter, *Accutrend Plus*, measured the lactate level in the blood.

Data presentation was displayed in the form of average value and standard deviation. One-way analysis or the *One-way Anova* test was used to compare the variables between short and long-distance *finswimming* athletes. Statistical analysis used SPSS application version 22 with a significance level of $p < 0.05$.

RESULTS

The data showed that the mean age and height of the two groups did not show any significant difference. However, body weight and BMI had significant differences between *finswimming* athletes, short and long-distance. (See Table 1)

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Table 1. Research Subjects of Anthropometric Data

Variable	Short-Distance	Long-Distance	*P*-Value
Age (years)	16.83 ± 1.25	17.33 ± 0.82	0.534
Height (cm)	167.27 ± 3.46	169.83 ± 4.17	0.281
Weight (kg)	65.17 ± 6.25	62.33 ± 7.09	0.046*
BMI (kg/m^2)	23.22 ± 3.42	21.07 ± 2.51	0.032*

BMI = body mass index
* Significance of $p < 0.05$

The measurement of body composition measured using the *GE Lunar Prodigy DXA* instrument. The results of the data showed that the total fat mass, fat mass index, and the percentage of muscle mass between the two groups did not show a significant difference. However, the total fat mass of short-distance athletes was greater (13.18 ± 3.87 kg) when compared to long-distance athletes (10.43 ± 3.45 kg). Furthermore, there were significant differences in the variables percentage of total fat (p= 0.001) and total muscle mass (p= 0.001). Short-distance athletes had a higher percentage of total fat compared to long-distance athletes. However, the total muscle mass of long-distance athletes was higher than the short-distance athletes.

Table 2. Athlete Body Composition Data

Variable	Short-Distance	Long-Distance	*P*-Value
Total fat mass (Kg)	13.18 ± 3.87	10.43 ± 3.45	0.062
Total fat percentage (%)	20.65 ± 2.26	16.25 ± 2.37*	0.001*
Fat mass index (kg/m^3)	3.98 ± 0.65	3.74 ± 0.39	0.348
Total muscle mass (*lean*) (Kg)	44.51 ± 11..12	50.51 ± 9.31	0.001*
Percentage of muscle mass (%)	74.86± 10.21	79.86± 8.18	0.169

* Significance of $p < 0.05$ was tested using one-way Anova

The results of the data presented in Table 3 showed the average heart rate, maximum heart rate, and lactic acid levels between the two groups did not show any significance (p= 0.671 average heart rate, p= 0.538 maximum heart rate, and p= 0.780 lactic acids). The only significant difference between the two groups occurred in the variable of VO_{2max} (p=

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0.025) where long-distance athletes had a higher VO_{2max} compared to short-distance athletes.

Table 3. Athletes Physiology Characteristic Data

Variable	Short-Distance	Long-Distance	*P*-Value
Average heart rate (Dn/min)	170.67 ± 7.20	168.00 ± 8.51	0.671
Maximum heart rate	193.67 ± 7.97	191.00 ± 9.32	0.538
Minimum heart rate	153.24 ± 4.31	146.78 ± 3.21	0.673
Acid lactate (mmol·L¯1)	11.8 ± 0.39	10.10 ± 0.86	0.780
VO_{2Max} (mL/(kg·min))	52.46 ± 2.31	56.72 ± 2.11	0.025*
FVC (L)	4.34 ± 1.08	4.42 ± 1.33	0.326

* Significance of $p < 0.05$

DISCUSSION

The main objective of this study was to compare the anthropometric and physiological characteristics of short and long-distance *finswimming* athletes. The results showed that the mean age between the two groups did not show a significant difference and was included in the adolescent age category (WHO, 2011). Furthermore, the mean height of short and long-distance *finswimming* athletes was found to be within the population norm in Indonesia. However, when compared with the players/athletes from other countries, researchers found that the average height athletes from Indonesia were lower when compared to *finswimming* athletes from Europe who had an average height of 175-180 cm and weight of 70-72 kg (Hue et al., 2006; Kunitson et al., 2015; Vasileios Stavrou et al., 2019).

There was a significant difference between body weight (p= 0.042) and BMI (p= 0.032) in the two groups due to the aerobic energy expended by long-distance athletes compared to short-distance athletes (Oshita et al., 2013). So that, it correlated with the calories spent by the athlete. Furthermore, Table 2 showed a significant difference that occurred in the percentage of total fat and total muscle mass. The difference in body composition between the two groups showed that the long-distance group had better total fat mass, total fat percentage, fat mass index, total muscle mass, and percentage of muscle mass compared to the short-distance group. This was because long-distance athletes (200 m, 400 m, and 1.500 m) used the aerobic energy system, which referred to the burning of carbohydrates and fat. So, the long-distance athletes had a smaller percentage of total fat compared to short-distance athletes (100 M) (PB, 2001). The results were consistent with research that had been done by (Dassanayake, 2016), the study said that the average percentage of total fat was 9-10% and total muscle mass was 52.3 kg (Dassanayake, 2016; V. Stavrou et al., 2018)

Furthermore, Table 3 showed the physiological characteristics of long-distance athletes as a whole who had a higher average value compared to short-distance athletes. A significant difference occurred in the variable of VO_{2max} where long-distance athletes had a higher VO_{2max} compared to short-distance athletes (p= 0.025). This was because *Finswimming* athletes often did exercises on the lung muscles including the diaphragm. After all, the increase in water pressure was related to the elasticity of the lungs and respiratory muscles. So, the pressure contained in water made long-distance swimmers needed more oxygen reserves to be able to survive in the water and would require a greater oxygen intake which resulted in the cardiorespiratory system working optimally to take oxygen which was very necessary for the combustion process (Situmorang, Lintong, & Supit, 2014; Tanzila, 2018). The results of this study were not much different from previous studies which showed the average of VO_{2Max} for the male athletes of *Finswimming* aged 16-18 years from several Asian countries who had the value of VO_{2Max} of 52-56 ml/kg/minute (D, R.A. Yeater, & Ph.D., 2020; Libicz, Roels, & Millet, 2014).

The variable of maximum heart rate recorded during the VO_{2Max} test in this study, namely 193 dn/minute for the short-distance group and 191 dn/minute for the long- distance group, these results indicated that both groups had performed the test with maximum effort or 90% of maximum heart rate. The levels of lactic acid produced after performing the VO_{2Max} test in this study were 11.8 mmol/ l for the short-distance group and 10.1 mmol/ l for the long-distance group. These results were not much different

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from previous studies, where some athletes had lactic acid levels after carrying out the VO_{2Max} test using a *CPET* device between 10-12 mmol/ l (Bahri, Resmana, Tomo, & Karim, 2017; Robianto, Apriantono, & Kusnaedi, 2017; Santos-Silva, Pedrinelli, & Greve, 2017).

The mean FVC value between the two groups did not show a significant difference. However, long-distance athletes had a higher FVC value compared to short-distance athletes. The difference of the FVC values correlated with a person's high VO_{2max}. In detail, athletes who had a high VO_{2max} value would have a high FVC value. The lung ability of athletes who had high VO_{2max} could accommodate more oxygen rather than athletes who had low VO_{2max} (Hanson & Jones, 2015; Lazovic-Popovic et al., 2016). Besides, the age factor also affected a person's FVC value, where increasing age plus consistent physical activity could increase a person's FVC. However, the FVC would decline again after 45 years of age (Tanzila, 2018).

The development of young athletes in *Finswimming* must be the primary goal to improve future achievements. Sports practitioners must know the anthropometric and physiological profiles of *Finswimming* athletes, both long and short-distance athletes. Therefore, with a database of athletes related to physiological characteristics, coaches can design a good training program by adjusting each athlete's abilities.

CONCLUSION

Based on the results and discussion of this study, it can be concluded that long-distance *Finswimming* athletes had better anthropometry, average heart rate, maximum heart rate, minimum heart rate, lactic acid, and VO_{2max} rather than short-distance *Finswimming* athletes. Thus, these research results provided evidence that a coach must know the anthropometry and physiological characteristics of athletes to create an exercise program and provide a more objective understanding for coaches in finding talent for athletes. It was necessary to do further research by increasing the research sample, including *Finswimming*

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athletes throughout Indonesia at the national level. Thereby, the characteristics of each *Finswimming* athlete can be objectively known.

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