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The level of aerobic endurance capacity of Semarang City handball athletes

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ABSTRACT

This study aimed to determine the level of aerobic endurance of Semarang City Handball Athletes. This type of research is descriptive quantitative with test and measurement techniques. The sample withdrawal used in this study used a purposive sampling technique with a sample of 28 athletes. Data collection using the MFT (Multistage Fitness Test) test instrument. The data analysis technique uses quantitative descriptive statistical calculations with the help of Microsoft Excel 2019. The results of research and discussion show that the aerobic endurance conditions of male athletes in the good category (14.29%), athletes in enough category (21.43%), athletes in the less category (21.43%), and athletes in the very less category (42.86%). For the measurement results of female athletes, athletes in the good category (7.14%), athletes in the enough category (21.43%), athletes in the less category (57.14%), and athletes in the very less category (14.29%). This study concludes that the aerobic endurance condition of Semarang City Handball athletes shows a low category for male and female athletes with an average VO2Max score of 36.34 kg/ml/min and 28.68 kg/ml/min respectively.

***Keywords**: endurance, aerobic, handball*

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INTRODUCTION

Sport is a series of forms of physical activity carried out in a state of consciousness that aims to benefit from various movements that are carried out that can train muscles and make the body physically and mentally healthy. Sports are carried out intentionally through forms of physical activity that provide pleasure and optimal achievement (Aristiyanto *et al*., 2021). From the perspective of sports physiology, exercise is defined as a series of organized and planned movements that an individual does consciously to improve their functional abilities (Susilawati & Atmaja, 2023). In the current era, the development of sports has increased in the field of sports achievement. Sports achievement is an activity in sports that aims to provide opportunities or opportunities for talented generations in their fields to achieve optimal performance (Gunawan *et al*., 2019). As for one of the sports achievements that began to develop in Indonesia, namely the sport of handball games.

Handball is a professional team sport consisting of 14 players in a team (García-Sánchez *et al*., 2023). Consists of 7 starting players (6 field players, 1 goalkeeper) and 7 subtitute players (Nurfaizin & Anam, 2022). Each player can play the ball using both hands, but may not use their feet (Novenda *et al*., 2023). The goal of this game is to score as many goals as possible and anticipate goals into their own goal within a predetermined time to win a match (Budi *et al*., 2019). This game dominantly uses more physical contact with a very fast tempo (Fikri & Popalri, 2020). Handball is a fast and attractive game that relies on speed, endurance, and hand skills to process the ball by bouncing, throwing, and shooting into the opponent's goal (Jose M. Saavedra *et al*., 2020). All movements in handball require fast, intense, and dynamic movements and good endurance is needed because they have to make transitions in the game pattern, from attack to defense for 60 minutes with 30 minutes each for 2 rounds of effective playing time (Przednowek *et al*., 2019). So that all players must have fit physical abilities in order to master all the movements in the game (Windy Safiraputri & Achmad Widodo, 2021).

Handball also requires tactics and techniques to be mastered for a long time, athletes are required to have good focus and concentration, as well as fast aggressive movements to be able to meet defense and attack transition situations such as fast play, fast passes, fast and accurate throws, sudden changes in place, sudden changes in direction, and strong jumps to shoot. (Kathiresan *et al*., 2020). All sports including handball also require excellent ability and skill and excellent physical condition (Muhlisin *et al*., 2022). This is in order to apply the tactics and techniques required in the game, a weak physical condition can also affect concentration to be not optimal and can result in team failure in a handball match, because any condition every second in a handball game is very meaningful (Hidayat & Permana, 2023).

Physical condition is one of the components that benchmarks the achievement of athletes' peak performance results in improving physical fitness to be able to provide the best performance during training and competition (Kurnia *et al*., 2020). Physical components must be developed to be able to improve physical conditions in accordance with the periodization of the needs and types of motility of certain sports (Fa`ot & Mukarromah, 2021). An athlete and physical training are inseparable because they include basic components that must be formed so that the techniques and tactics in the game are applied properly (Putra & Umar, 2019). The physical needs of handball athletes are very necessary and support the achievement of maximum achievement, and can prevent injuries because the sport of handball often involves physical contact between players (Basiran *et al*., 2020).

According to (Haniyyah & Akhiruyanto, 2022) the dominant physical components in the sport of handball include endurance, speed, strength, flexibility, explosiveness (power), and

agility. As an achievement sport requires the maximum ability of physical components and is the main skill that makes the greatest contribution in supporting achievement, namely heartlung endurance or commonly called aerobic endurance (Satwiko & Kumaat, 2020). Endurance is the ability of the cardiovascular system (heart, lungs, and blood vessels) to work optimally at rest and during exercise (Satriawan, 2019). This system works to take in oxygen and deliver it to body tissues that are active for body metabolism (Khasanah *et al*., 2021). The aerobic endurance component is one of the most important elements in handball, because the characteristic forms of handball games tend to take place quickly and are played long enough (Chittibabu, 2014). Athletes must require full energy and concentration to meet the defense and attack situations of the game, such as fast play, fast passes, fast and accurate throws, sudden changes in place, sudden changes in direction, and strong jumps to shoot (Kaufmann *et al*., 2022).

Aerobic endurance or often known as VO2Max is the ability of a person's body to inhale oxygen optimally when doing physical activities that are included in the heavy category, expressed in liters per minute (Moni & Iqroni, 2022). VO2Max plays a role in carrying out intensive physical activity and as the soul of athlete performance to improve good physical abilities (Budijanto & Kurniawan, 2020). Handball players must have a good VO2Max condition because it supports maximum performance and can improve a good physical work system during the match. (Andhika & Bachtiar, 2021). The endurance component is a major asset needed in the game of handball, because during the match the athlete must maintain a consistent performance from the beginning to the end of the match. In addition, handball athletes must have certain basic movement skills such as passing, catching, dribbling, and shooting. (Pujianto *et al*., 2020). Athletes also need good endurance to play for 30 minutes x 2 rounds and can perform playing techniques well without getting tired or losing focus. Based on research (Massuca *et al*., 2015), long-term running endurance and aerobic capacity are critical to the success of each player in competition (Chelly *et al*., 2011). It is based on the fact that the aerobic endurance component can contribute to the athlete's ability to maintain performance during the game and can make a short recovery to reduce effort (Michalsik *et al*., 2013).

Semarang City is known as one of the cities with good handball development in Central Java Province. This can be seen from the formation of the management of the ABTI sports branch of Semarang City starting earlier than other regions in Central Java. As well as a series of achievements obtained by Semarang City in participating in various championships. The

Semarang City handball team is a team with a fast form or model of play, so that every athlete must have a prime and qualified aerobic endurance condition to face every championship. Based on observations in the field, when participating in championships athletes experience a decrease in physical condition during matches that run with high intensity. Especially when going to run the attack strategy pattern and the process of switching from attack to defense is very slow. Signs of decreased physical condition are characterized by concentration and focus starting to be disrupted when the match enters the final minutes. This situation can be a quick counterattack by the opponent to score quickly or catch up with the lagging score. This shows that the endurance condition possessed by Semarang city handball athletes is still not optimal, so that when fatigue concentration and focus begin to disappear. Therefore, this research needs to be done because it is very important and beneficial for the development of athlete performance to be able to know the level of aerobic endurance capacity possessed and can monitor conditions regularly early on in order to achieve maximum performance to contribute to every upcoming championship.

Based on the description and explanation above, the researcher intends to conduct research with the title "The Level of Aerobic Endurance Capacity of Semarang City Handball Athletes".

METHODS

This type of research uses descriptive quantitative with survey methods with test and measurement techniques. The purpose of this study was to determine the level of aerobic endurance of athletes who are members of the Semarang City Handball Team. The population used in this study were athletes who were members of the Semarang City Handball Team in 2023 totaling 28 athletes, consisting of 14 male athletes & 14 female athletes..

The sampling technique used purposive sampling. This technique is a way of determining samples with certain considerations (Sugiyono, 2019). Determination of the sample in this study is based on inclusion criteria and exclusion criteria. (Pradono *et al*., 2018). The inclusion criteria are male and female Semarang City handball athletes who are included in the list of players in a championship, physically and mentally healthy conditions are not in a state of illness or injury, willing to participate in research. While the exclusion criteria are handball athletes who are not among the core players of Semarang city in a championship, are injured or in a state of illness, athletes are not willing to participate in the research sample.

The research instrument used in this study uses the MFT (Multistage Fitness Test) / Bleep Test to measure aerobic endurance conditions by looking for maximum oxygen volume capability (VO2Max) (Rohmah & Hamdani, 2022). Data analysis using percentage descriptive statistical analysis. The results of the study in the form of data analyzed until a conclusion is obtained.

$$p = \frac{f}{n} X\ 100\%$$

p : percentage number

f : the frequency that is being sought percentage

n : number of frequencies / number of individuals.

Source : (Setyoko et al., 2022)

RESULTS AND DISCUSSION

This study was conducted to determine the physical condition profile of aerobic endurance of Semarang City Handball Athletes. The basic characteristics of the samples used in this study can be seen from several indicators, namely age, height, weight and body mass index (BMI) of Semarang City handball athletes. Can be presented in the table as follows;

Table 1. Description of Research Sample Characteristics

Athlete	N	Mean ± SD	Min	Max
Age (th)	28	16,96 ± 1,71	14	19
Height (cm)	28	165,07 ± 7,57	150	179
Body Weight (kg)	28	59,88 ± 10,20	39	87
Body Mass Index (kg/m^2)	28	22 ± 3,26	17,3	31,2

(Source: Research Data, 2024)

Based on table 1, it can be seen that the research sample used amounted to 28 athletes who had an average age of 16.96 years, and had height and weight respectively with an average of 165.07 cm and 59.88 kg. And has a body mass index (BMI) value with an average of 22 kg/m^2.

Result

The results of the statistical analysis of the aerobic endurance of Semarang City Handball Athletes using the MFT (Multistage Fitness Test) / Bleep Test measuring instrument to find the maximum oxygen volume (VO2Maks). The following analysis results can be presented in the following table 2;

Results of Aerobic Endurance Ability of Male Athletes

Table 2. Results of Aerobic Endurance Analysis for Male Athletes

Sample	Age	*Bleep Test*		VO2Max (*ml/kg/min*)	Category
		Level	*Shuttle*		
S1	18	10	5	48,3	Good
S2	19	8	2	40,5	Enough
S3	17	5	7	32,1	Very Less
S4	19	10	1	47,1	Good
S5	19	6	7	35,5	Less
S6	19	7	8	39,2	Enough
S7	16	7	3	37,5	Less
S8	17	4	4	27,6	Very Less
S9	16	6	7	35,5	Less
S10	15	6	2	33,7	Very Less
S11	18	5	3	30,6	Very Less
S12	17	6	1	33,3	Very Less
S13	17	7	6	38,5	Enough
S14	15	4	9	29,6	Very Less

Table 3. Description of Aerobic Data for Male Athletes

Male Athlete	N	Mean ± SD	Min	Maks
Usia *(th)*	14	17,29 ± 1,44	15	19
Level	14	6,5 ± 1,87	4	10
Shuttle	14	4,64 ± 2,70	1	9
VO2Max (ml/kg/min)	14	36,34 ± 6,08	27,6	48,3

(Source: Data Processed, 2024)

According to table 3, the description of the aerobic data of male athletes shows the value of VO2Max scores with an average of 36.34 ml/kg/min from a total of 14 athletes. The average number of levels achieved is 6.5, and the shuttle averages 4.64. VO2Max score values can be classified as follows:

Table 4. Frequency Distribution of Aerobic Data for Male Athletes

Category	Male	Frequency	Percentage
Very Less	X < 35,0	6	42,86%
Less	35,0 ≤ X < 38,3	3	21,43%
Enough	38,4 ≤ X < 45,1	3	21,43%
Good	45,2 ≤ X < 50,9	2	14,29%
Excellent	51,0 ≤ X < 55,9	0	0,00%
Special	X ≥ 55,9	0	0,00%
Total		14	100%

(Source: Data Processed, 2024)

From table 4, it can be seen that the aerobic endurance condition of male athletes shows that there are 2 athletes (14.29%) who are in the good category, 3 athletes (21.43%) are in the

enough category, 3 athletes (21.43%) are in the less category, and 6 athletes (42.86%) are in the very less category.

Results of Aerobic Endurance Ability of Female Athletes

Table 5. Results of Aerobic Endurance Analysis of Female Athletes

Sample	Age	*Bleep Test*		VO2Max (*ml/kg/min*)	Category
		Level	*Shuttle*		
S1	19	5	3	30,6	Less
S2	17	4	2	26,8	Less
S3	19	6	2	33,7	Enough
S4	19	5	1	29,9	Less
S5	15	3	2	23,4	Very Less
S6	15	3	8	25,9	Less
S7	18	7	6	38,5	Good
S8	14	4	3	27,2	Less
S9	15	3	2	23,4	Very Less
S10	15	4	3	27,2	Less
S11	18	6	1	33,3	Enough
S12	15	3	6	25,1	Less
S13	15	3	7	25,5	Less
S14	19	5	4	31,0	Enough

Table 6. Description of Aerobic Data for Female Athletes

Female Athlete	N	Mean ± SD	Min	Maks
Age *(th)*	14	16,64 ± 1,95	14	19
Level	14	4,36 ± 1,34	3	7
Shuttle	14	3,57 ± 2,28	1	8
VO2Max (ml/kg/min)	14	28,68 ± 4,37	23,4	38,5

(Source: Data Processed, 2024)

According to table 6, the description of aerobic data of female athletes shows the value of VO2Max scores with an average of 28.68 ml/kg/ min from a total of 14 athletes. The average number of levels achieved is 4.36, and the shuttle averages 3.57. VO2Max score values can be classified as follows:

Table 7. Frequency Distribution of Aerobic Data for Female Athletes

Category	Female	Frequency	Percentage
Very Less	X < 25,0	2	14,29%
Less	25,0 ≤ X < 30,9	8	57,14%
Enough	31,0 ≤ X < 34,9	3	21,43%
Good	35,0 ≤ X < 38,9	1	7,14%
Excellent	39,0 ≤ X < 41,9	0	0,00%
Special	X ≥ 41,9	0	0,00%
Total		14	100%

(Source: Data Processed, 2024)

From table 7, it can be seen that the aerobic endurance condition of female athletes shows that there are 1 athletes (7,14%) who are in the good category, 3 athletes (21.43%) are in the enough category, 8 athletes (57,14%) are in the less category, and 2 athletes (14,29%) are in the very less category. When viewed from the information above, it can be presented in the form of a diagram as follow :

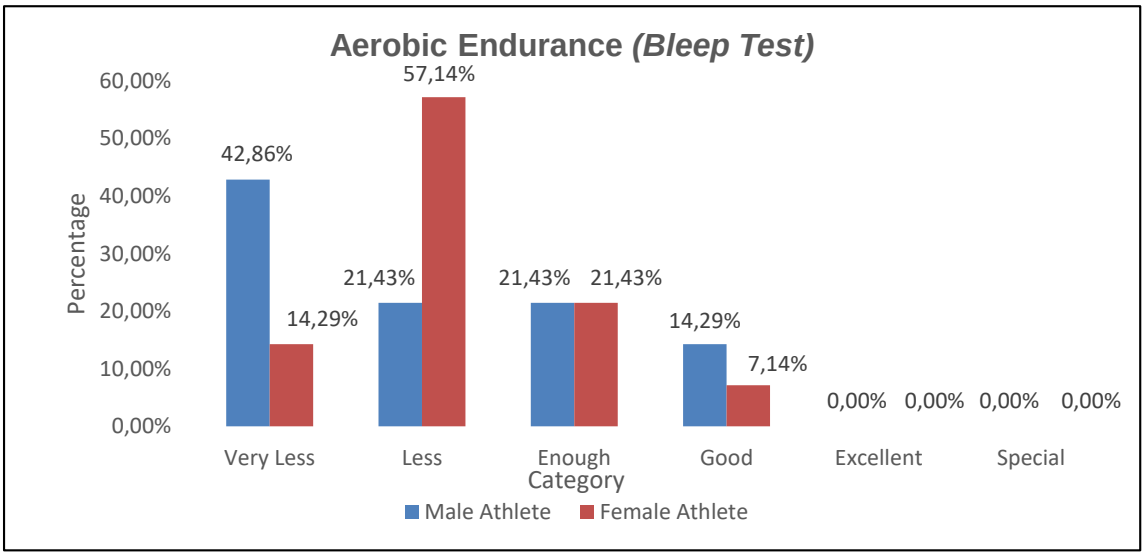

Figure 1. Bar Diagram of Aerobic Endurance Test (Bleep Test)

Judging from Figure 1, the diagram of the aerobic endurance test results shows that the endurance condition of Semarang City handball athletes, both male and female, is still in the poor and very poor categories, only a small proportion have good and sufficient endurance. This needs to be improved again with regular, structured and systematic training in running the training program.

Discussion

Based on the results of research and analysis of data that has been conducted on Semarang City Handball Athletes using the Bleep Test / (MFT) measuring instrument to measure aerobic endurance conditions in the form of VO2Max scores. The results of measuring male athletes obtained 2 athletes who fell into the good category with a percentage of (14.29%), 3 athletes fell into the enough category with a percentage of (21.43%), 3 athletes fell into the less category with a percentage of (21.43%), and 6 athletes fell into the very less category with a percentage of (42.86%). While the measurement results of female athletes obtained 1 athlete who entered the good category with a percentage (7.14%), 3 athletes entered the enough category with a percentage (21.43%), 8 athletes entered the less category with a percentage (57.14%), and 2 athletes entered the very less category with a percentage (14.29%).

From the results of the measurements that have been taken, it cannot be separated from the various factors that can cause the ups and downs of the endurance capacity of Semarang City Handball Athletes, including the following (Latifa *et al., 2023)*, heredity (Genetics), genetic factors greatly affect the quality of endurance because muscle strength and endurance are closely related to the number of muscle fibers and the composition between red muscle fibers and white muscles, age, cardiorespiratory endurance can still be improved until the age of 20-30 years, after which it begins to decline in line with increasing age. This can be prevented by regular and structured exercise, gender, in general the level of endurance capacity in men is 15-30% greater than in women. This is characterized by body composition and differences in hemoglobin content in the body, nutritional Status, nutritional intake in the diet plays a role in improving the quality of endurance, because nutrients are needed in the body's metabolic process, lifestyle, frequent habits such as smoking, staying up late, and playing games until late at night can affect the quality of endurance, physical Activity, a regularly trained physical fitness condition can have good cardiorespiratory endurance as well.

As for other factors that can affect the endurance of athletes, namely the level of aerobic and anaerobic capacity, the role of aerobic capacity is very influential on the amount of energy produced, this is related to the oxygen transport system that carries oxygen from the air to the working muscles then into the tissue. While the role of anaerobic capacity plays a role in the provision of energy produced in the absence of oxygen. The provision of ATP-PC, the percentage of white muscle fibres, the ability to withstand lactic acid, and the role of enzymes in anaerobic metabolism and the glycogen system (Bafirman & Wahyuri, 2019).

Aerobic endurance is the functional ability of the lungs and heart to supply oxygen to the body to be able to run the autonomic work system for a long time (Wicaksono & Kusuma, 2021). Athletes with a good level of lung and heart endurance will not feel fatigue for a long time (Satriawan, 2018). In the aerobic system, glycogen/glucose is chemically broken down into pyruvic acid with the help of oxygen (O_2) to produce CO_2 and H_2O. The process takes place through the Krebs cycle. The process takes place through the Krebs cycle (Tricarboxyclic Acid = TCA) and the electron transport system. The role of O_2 in the breakdown of glycogen/glucose can prevent the accumulation of lactic acid in the body. Pyruvic acid that has been formed then enters the Krebs cycle and electron transport system (Kemal & Fadhil, 2021). This reaction occurs in muscle cells, namely in mitochondrial organelles. The use of this aerobic system is very necessary when playing an attacking pattern, looking for space to shoot,

blocking the opponent's attack and maintaining consistent performance from the beginning to the end of the match.

The results of previous research showed that there were differences in aerobic endurance (VO2Max) in handball players in Sukabumi City who were in the moderate category. This was due to the lack of training sessions given only 2 days per week. Therefore, this problem becomes an assessment tool for a coach to use in designing a systematic and well-structured training program. This is in line with the opinion (Dolci *et al*., 2020) high-intensity training plays an important role in maintaining the cardiorespiratory system and metabolic adaptation that can improve the endurance fitness of athletes' performance. As an achievement sport, a proper coaching process is required in the training process.

CONCLUSIONS

Based on the results of data analysis description, processing and testing of research data results, and discussion. It can be concluded that the level of aerobic endurance capacity of Semarang City Handball Athletes as a whole shows a low category for male athletes and female athletes. This is indicated by the relatively low VO2Max score, which is 36.34 kg/ml/min for male athletes and 28.68 kg/ml/min for female athletes. Conditions like this can be prevented by doing regular, structured, and systematic training provided by the coach. Based on the results of this study, it is recommended that future research conduct research on the preparation of effective training programs to avoid a decrease in endurance, especially aerobic endurance.

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