Survey of Aerobic Capacity Levels in Basketball Referee Training Participants with C and B2 Licenses for Basketball Student Club, Universitas Negeri Semarang

Hasna Tri Oktavia [1*], Sheli Putri Deswanti [2], Dwi Gansar Santi Wijayanti [3]

[123] Semarang State University

*Corresponding author : dwigansarsanti@mail.unnes.ac.id

Abstract: Basketball is a high-intensity sport. The intensity of the game has an impact on the referee, especially the accuracy of decision making, focus, alertness and speed of decision-making and can be supported by good aerobic capacity. Aim of this study was to determine the level of aerobic capacity of participants in the C and B2 license basketball referee training at Semarang State University. Subjects of this research were participants in the C and B2 license basketball referee training at basketball Student Club at Universitas Negeri Semarang with a total of 41 participants, including 31 male participants, 10 female participants. 29 training participants were for the C license and 12 training participants were for the B2 license. The average age of boys is 26 years and girls is 22 years. Type of research is descriptive quantitative using a survey method through tests and measurements of a multistage 20 m shuttle run. Data processed using Microsoft Excel Version 2021. The results of the research showed that the VO2Max calculation results were 6.5% of male participants Excellent, 19.4% good, 22.6% aquate, 22.6% indequate, and 19% very poor. Meanwhile, 10% of female referees are good, 50% are sufficient, 30% are indequate and 10% are very poor. Conclusion of this research is that 14 participants passed and 27 participants did't pass according to the applicable graduation standards. Based on the results of the VO2Max scores resulting from measurements of 2 male participants, the categories were excellent, 6 was good, 7 was aquate, 7 was indequate, and 9 was very poor. The female referees, 1 participant was in the good category, 5 were aquate, 3 less and 1 very less. So it is necessary to increase the aerobic capacity of basketball referees in order to improve quality and maximize the accuracy of making decision.

Keywords: Basketball, Referee, Aerobic, VO2Max, Survey

INTRODUCTION

The development of sports after the Covid-19 pandemic has developed rapidly (Susanto & Nurharsono, 2022). This is characterized by the proliferation of people interested in physical activity both in groups and individually. Globally, basketball is a very popular sporting activity, played in groups, and involving various age groups, including children, teenagers and adults (Hulteen et al., 2017). This type of sport is a favorite among the public as one of the most popular types of group sport. Many people tend to spend their free time doing physical activity through playing basketball. This sport is not only part of physical activity, but also has a significant impact on physical, emotional, mental and social conditions.

Basketball is a team sport played by two teams. Each team will consist of five players with seven reserve players. This game is played in four rounds and one half time in the middle of the second and third rounds with each round lasting ten minutes. The aim of this game is to score as much as possible by putting the ball into the opponent's basket (FIBA, 2023). This sport was first introduced by Dr. James A. Naismith was a physical education teacher in Springfield in 1891, United States. Initially this game was played using a soccer ball and a peach basket and developed over time into a basketball game which is generally known to the public. FIBA is the parent international basketball organization as the basic reference for the official game of basketball, including the rules and regulations set (Saichudin & Munawar, 2019).

At the start of the competition, the rules for men and women were different. This is based on the possibility of cardiac hypertrophy in the female group (Ponciano et al., 2018). The number of group members is 9 players depending on the width of the field used (Mamanazarqizi, 2021). ubsequently, this sport spread from Europe to the Asian plains through recreational games that were often played by local youth. Until finally it was developed and internalized into the educational curriculum in schools (Ponciano et al., 2018). Competitions in this sport were first held at the 1936 German Olympics, and since then they have become very famous (Sansone et al., 2023). Initially, basketball matches were held in a 5 versus 5 format, with the aim of scoring as many points as possible by putting the ball into the ring. However, over time, the sport of basketball has developed into two types of games that are officially recognized, namely the 3x3 and 5on5 game concepts..

In Asia, basketball began to be developed by China in 1984. This game was introduced by Bob Baily as a representative of the YMCA in Tienstein Province, China. The development of basketball in Asia, which was pioneered by China, began to spread to Japan and the Philippines. And the spread occurred significantly in 1900 (Putri, 2018). The internalization of basketball in Indonesia was carried out by China through trade in 1920. Those who migrated formed a community and founded a Chinese basketball school. This sport is growing rapidly in Chinese schools because it is mandatory for students, so every school has a basketball

court. At that time, various basketball sports associations began to form in Indonesia. Around the 1930s, big cities such as Jakarta, Surabaya, Bandung, Semarang, Yogyakarta and Medan became central to the development of basketball (Saichudin & Munawar, 2019).

The game of basketball was officially introduced in Indonesia through the first National Sports Week (PON I) which was held in Solo in 1948. The All Indonesian Basketball Association was formed on October 23, 1951, three years after PON I, as a sports entity under the auspices of KONI to supervising Basketball (Saichudin & Munawar, 2019). In 1955, the term was changed to the All Indonesian Basketball Association (PERBASI). PERBASI then joined FIBA, the world basketball federation, in 1953. The Indonesian basketball team first participated in the Asian Games in Manila in 1954. The history of basketball also originates from the Main Basketball Competition or KOBATAMA which started as a competition between Professional basketball club in Indonesia. Subsequently, this professional competition developed into the Indonesian National Basketball League (NBL), and the women's professional basketball league became known as the Women's National Basketball League (WNBL). The name was later changed to the Indonesia Basketball League (IBL) and the Woman Indonesia Basketball League (WIBL). A prestigious event for students is also held and is known as the Development Basketball League (DBL) (Saichudin & Munawar, 2019).

The game of basketball is a sport that requires high aerobic abilities (Conte et al., 2023). This can be analyzed through the characteristics of games that run quickly, are dynamic or can change, and take a long time (Mancha-triguero et al., 2020). Apart from that, it can also be shown through the heart rate value produced after the game which ranges between 87% of the maximum heart rate and for 75% of the game time it is at 85% of the maximum heart rate and 15% of the game time is at 95% of the maximum heart rate (Rupčić et al., 2012). These characteristics of the game not only have implications for the need for high aerobic abilities in players but also affect the referees who serve as match officials (Kovalchuk & Mospan, 2020). Research from Ibáñez in 2024 produced heart rate data from basketball referees with a maximum heart rate of 158 ± 3.35 resulting in an average heart rate of 129.11 ± 4.71 bpm from three games (Ibáñez et al., 2024). Research conducted by Inchauspe in 2021 with subjects of 7 female basketball referees with an average age of 29.1 ± 3.9 years, height 179.1 ± 6.1 cm, weight 75.9 ± 11.4 kg, and fat percentage of 21.2 ± 4.8% produced an average heart rate was 149.7 ± 18.2 bpm or 78.7 ± 8.8 % of maximum heart rate (Inchauspe et al., 2021).

Based on research conducted by Borin et al in 2013 with the subject of 18 basketball referees, 16 of whom had international qualifications and 2 had national qualifications. The average age was 40.06 ± 6.93 years, weight 85.28 ± 11.12 kg, and height 1.78 ± 0.05 m and a health test had been carried out before treatment. It shows that during one game time, a basketball referee can move 2.45 ± 0.22 km in

the first half and 2.51 ± 0.23 km in the second half. A referee in one game can move approximately four to five km (Borin et al., 2013). Based on research conducted by Ibáñez et al in 2024 with the subject of four professional Spanish basketball referees who will be on duty at the Copa de Andalucía Tournament in 2022 with an average age of 41.8 ± 10.82 years and have experience in international level basketball officiating. for 9.75 ± 9.29 years and is not injured. Obtaining the results from three matches, it was found that the average distance covered was 4239.83 m in game 1, 3950 m in game 2, 4209.62 m in game 3 and the average result was 4133.15 m with a standard deviation of 159.33 m (Ibáñez et al., 2024).

Based on research carried out by Alfonso in 2023 which examined the physical abilities (aerobics) of soccer referees on decision-making abilities with 22 male subjects national-level soccer referee. With weight: 72.7 kg, height 178.0 cm age 23.4 years. explained that the referee's decision-making ability will be more precise if the referee has good aerobic abilities. This has something to do with the anxiety value generated during the match. A person with low aerobic ability has a high heart rate and imperfect oxygen circulation. So the brain lacks oxygen which reduces concentration and causes errors in decision making (Castillo-Rodríguez et al., 2023). Apart from good psychological abilities, Alfonso et al's research also explains that good physical abilities are characteristics of a professional referee (Castillo-Rodríguez et al., 2022). Good aerobic ability is not only needed by basketball and football referees. However, in most sports, aerobic or physical ability is what is taken into account. especially in sports that require quite long movements. The higher the level that will be supervised, the higher the level of concentration required. especially if conditions are equal and the determination of victory is in the referee's decision. In this case the referee must concentrate and give the right decision and not harm both parties (Babity et al., 2022).

Aerobic ability is needed as a response to increased oxygen demand during physical activity. Aerobic use of energy can support physical activities that require long periods of play and will not cause excessive fatigue (Rahmat Hermawan, 2020). Ability component on the physical plane is essential to their success in competition. It has been recognized that aerobic capacity is its main constituent. Most experts agree that the most accurate indicator of an organism's aerobic capacity and an athlete's physical capacity is maximal oxygen uptake, or VO2max. The biological foundation of an organism's physical ability includes its functional ability to raise its metabolic rate in response to the amount of physical work it is subjected to. By metabolic processes, we imply the conversion of chemical energy to mechanical energy (Ranković et al., 2010). Oxygen use will increase during sports activities, especially in the skeletal muscles which function as the body's main movers (John E. Hall, 2011). Dynamic game movements also influence the work demands of skeletal muscles in carrying out their duties as active limbs

which occur from the beginning of the quarter to the end of the quarter which can cause fatigue (Ibáñez et al., 2024).

The oxygen transport system in the body is called cardiorespiratory. Cardiorespiratory can be influenced by heart rate, stroke volume and the difference in oxygen mixed in the arteries and veins (a combination of the cardiovascular system and the respiratory system) (Rahmat Hermawan, 2020). Cardiorespiratory ability can also be interpreted as the muscle's ability to distribute oxygen during the exercise process and the muscle's ability to absorb oxygen to produce ATP (Windiastoni & Haritsah, 2019). Apart from that, cardiovascular ability is also a predictor of an individual's fitness. Aerobic capacity in individuals is influenced by cardiovascular capacity. Cardiovascular comes from the words cardiac and vascular which mean heart and blood vessels (Sudibjo, 2019). The cardiovascular function is to pump blood throughout the body and transport oxygen, nutrients, hormones and metabolic waste products (Joyner & Coyle, 2008). The cardiovascular and cardiorespiratory systems work together and are interconnected with each other. This is based on their functions working in tandem. The cardiovascular system is the heart and blood vessels that circulate oxygen throughout the body. Meanwhile, the cardiorespiratory system consists of the lungs which function to absorb and release oxygen and carbon dioxide in the body (Nabli et al., 2019). Cardiorespiratory ability can be assessed through the maximum oxygen volume capacity called VO2Max (Millah & Priana, 2020). The value resulting from vo2max measurement can be a reference in assessing aerobic capacity, cardiorespiration and general physical fitness (Astorino et al., 2019). The greatest quantity of oxygen that an organism can take in per unit of time while engaging in increasing-intensity activity is known as aximal oxygen uptake, and it cannot be raised further with greater exercise intensity. The worldwide standard of physical capacity has been established as maximal oxygen uptake as a measure of aerobic capacity (Ranković et al., 2010).

Annual international tournaments that provide nations and players the chance to display their skills in top games are planned and managed by the International Basketball Federation (FIBA) and its Regional Offices. As a result, there has been an increase in interest in the physiology and physical aspects of great basketball players' practice and game performance. Similar interests have also grown in the performance of professional basketball referees, who must maintain high levels of perceptual and cognitive functioning despite severe physical obstacles and a build-up of neuromuscular and mental exhaustion (Suárez Iglesias et al., 2021).

Two referees oversee a basketball game in its entirety. Over time, though, there were three referees in charge of officiating games. This is predicated on how well referees make decisions and how complicated the game regulations are. The number of referees that step in during a match determines how the refs call the

action. There are contests going on right now with varying numbers of referees. It is important to note that the two officials in the formative category officiate, and their motions differ greatly from the three refs in the FIBA. In this instance, the roles are assigned based on the areas in which the game's strong and weak aspects are present. The trail and lead referees are responsible for controlling the strong side of the game while the middle referee is responsible for controlling the weak side. highlighted in their investigation that three-referee referees reduce their movements, training intensity, and physical and psychological fatigue, which would make them better prepared in making decisions (Godoy-Hernández et al., 2023).

Based on the standards determined by FIBA as the main reference, the value of the multistage 20 m shuttle run that must be achieved by a basketball referee in the men's and women's categories is different. For the men's category, the minimum limit that must be achieved is 10 minutes with 86 turns, for women the time is 8 minutes and can achieve 64 turns (Inchauspe et al., 2020). Meanwhile, in the Brazilian standard, it was found that the minimum standard of returns that can be obtained is 66 returns (Inchauspe et al., 2021). This standard is not determined based on age, but is a patent reference for passing referee candidates for each category. So the participant's age does not affect the score of the graduation standards that have been set. However, measurements based on age will be used as a categorization of VO2Max capacity based on applicable norms. In Indonesia itself, there are certain standards that have been set by the Indonesian Basketball Association (PERBASI) in accordance with the license taken (Febriani & Suhartini, 2024). The graduation standards include:

Table 1. Pass Standard (*multistage 20 m shuttle run)*

Pass Standard	C	B2
Man	60	70
Woman	50	55

Source: Central Java PERBASI Provincial Government

Next there is an assessment (multistage 20 m shuttle run) which has been adjusted for gender. With the existing assessment, it has been adjusted to the predicted value of VO2Max results (Nohan & Wahyudi, 2021).

Table 2. Norms for VO2Max Capacity Assessment (Men and Women)

Category	Age (Year)					
Man	10-14	15-19	20-29	30-39	40-49	50-59
Excellent	≥ 52	≥ 48	≥ 43	≥ 36	≥ 31	≥ 26
Good	46-51	42-47	37-42	31-35	26-30	22-25
Aquate	41-45	38-41	33-36	27-30	22-25	18-21
Indequate	35-40	33-47	29-32	22-26	17-21	13-17
Very Poor	≤ 36	≤ 32	≤ 28	≤ 25	≤ 16	≤ 12
Category	Age (Year)					

Woman	10-14	15-19	20-29	30-39	40-49	50-59
Excellent	≥ 48	≥ 42	≥ 36	≥ 29	≥ 25	≥ 19
Good	42-47	36-41	31-35	24-28	20-24	12-18
Aquate	36-41	31-35	25-30	20-23	15-19	5-11
Indequate	33-35	27-30	21-24	15-19	7-14	3-4
Very Poor	≤ 32	≤ 26	≤ 20	≤ 14	≤ 6	≤ 2

Source : (Hartati & Victorian, 2024)

Based on the description that the researcher has outlined and several previous studies. So researchers are interested in examining the level of aerobic capacity in participants in the C and B2 License basketball referee training conducted by Universitas Negeri Semarang Basketball Student Club.

METHOD

- Subject: The population in this study were participants in the C and B2 license referee training carried out by the Universitas Negeri Semarang Basketball Student Club. The sample in this study consisted of 41 participants consisting of 31 male participants, 10 female participants, of which 29 training participants for the C license and 12 training participants for the B2 license. The average male participant is 26 years old and female participants are 22 years old. This research was carried out on May 25 2024. The sampling technique used was total sampling with the entire population used as subjects.

- Study Design: This type of research is quantitative descriptive with a survey method. The results of this research will be described using a table showing the VO2Max values of upgrading participants. The data will be taken using VO2Max measurements and tests. The instrument used to collect data in this study used the Bleep Test as a measure of the aerobic endurance abilities of upgrading participants.

- Procedure: This research was carried out in accordance with the provisions set by FIBA. The test is carried out in the form of basic measurements of aerobic capacity values using a multistage 20 m shuttle run test (FIBA, 2020). These procedures include that each participant will be divided into 4 sessions with each session totaling 10 participants. Participants will run behind one of the lines with a distance of 20 m which has been marked with a cone at a speed that matches the audio with increased volume and repeats itself along the specified line. The speed will increase each time and the participant is declared finished if they cannot reach the line twice within the specified time.

- Statistical Analysis: The statistical analysis used in this research is descriptive statistics by describing the test scores obtained by participants which will be adjusted to the passing standards for C and B2 licenses using Microsoft Exel 2021 tools. Apart from that, the passing criteria for boys and girls will be differentiated accordingly. with applicable provisions.

RESULTS

Based on the number of participants and licenses taken along with the results of the 20 m multistage shuttle run measurement test. For C and B2 license basketball training participants at Semarang State University, participant data based on gender and type of license was obtained as follows:

Table 3. Number and Criteria for Taking Licenses

Gender	Total	Licence C	refreshment C	Total B2	Licence B2	refreshment B2
Man	21	20	1	10	5	5
Woman	10	8	0	2	0	2

Source : Number and Criteria for Taking Licenses

Based on the table, the number of male participants who participated were mostly participants who would carry out the C license referee training. The number of male participants was 31 participants with 20 individuals participating in the C license upgrading, 1 C license refresher, 5 people upgrading to B2 license and 5 people upgrading their license. B2. Meanwhile, there were 10 female participants with 8 C license participants and 2 B2 license refreshers. In addition, it was found that the average age of male participants was 26.12 ± 4.97 years and female participants were 22.3 ± 2.83 years.

Table 4. Average Results of Multistage 20 m Shuttle Run and Passing Results According to PERBASI Standards

Gender	Licence C	Licence B2	combination
Man	57,04 ± 15,26	62,8 ± 16,48	58,9 ± 15,63
Number of Participants Passed/Failed	9/12	3/7	
Woman	38,62 ± 12,11	41,5 ± 0,7	39,2 ± 10,75
Number of Participants Passed/Failed	2/6	0/2	

Source: Research Data

The table shows that 9 male participants with C licenses met and 12 did not meet the standards with an average score of 57.04 ± 15.26 returns. There were 3 B2 license male participants who met and 7 did not meet the passing criteria with an average of 62.8 ± 16.48 returns. 2 female C license participants met and 6 did not meet the criteria with an average of 38.62 ± 12.11 returns. Meanwhile, none of the female B2 license participants met the passing standards with an average of 41.5 ± 0.7 returns

Table 5. Hasil Rata-Rata VO2Maks Berdasarkan Norma

Gender	Licence C	Licence B2	Licence C dan B2
Man	46,16 ± 5,14	34,12 ± 5,58	32,72 ± 5
Woman	25,98 ± 3,88	27 ± 0,3	26,11 ± 3,44

Source: Research Data

The results described in table 5 show the average VO2Max value of basketball referee training participants with C and B2 licenses. For male participants with a C license, the average was 46.16 ± 5.14, for male participants with a B2 license, it was 34.12 ± 5.58 and the average for both was 32.72 ± 5. Meanwhile for female participants with a C license, it was 25.98 ± 3.88, female participants with a B2 license 27 ± 0.3 and the female average is 26.11 ± 3.44.

Table 6. Categorization Results of VO2Max Values Based on Norms and Age

Category	Man	Woman	Man (Percent)	Woman (Percent)
Excellent	2	0	6,5	0,0
Good	6	1	19,4	10,0
Aquate	7	5	22,6	50,0
Indequate	7	3	22,6	30,0
Very Poor	9	1	29,0	10,0
Total	31	10	100,0	100,0

Source: Research Data

The results of categorization based on VO2Max norms are described in table 6. A total of 2 male participants were in the excellent category, 6 participants were good, 7 participants were aquate, 7 participants were inadequate, and 9 participants were very poor. Meanwhile, among female referees, 1 participant was in the good category, 5 people were in the aquate category. 3 participants were in the indequate category and 1 participant was in the very poor category.

DISCUSSION

The results of the research show that the dominance of participants in this training program is filled by boys and C license training participants. Most of the participants have not met the criteria determined by PERBASI as standard requirements for graduation for C and B2 license training participants, both men and women. Aerobic capacity as a result of the VO2Max value according to the gender and age of the participants showed that 16 male participants were still in indequate or very poor condition and 4 female participants were in very indequate and very poor condition. With these results, some participants have not met the criteria that have been set and there is a need for a re-test on participants which will be carried out 3 months after the test is carried out..

The referee as a match official is responsible for decisions made during the match. Basically, a referee has certain qualifications that have been set as standards. One of them is fitness which shows an individual's aerobic value or capacity and is measured through the Multistage 20 m Shuttle Run. Based on the results of this research, the majority of upgrading participants did not meet the specified criteria. This needs to be a concern because this game requires high intensity which also has an impact on the referee. Based on several research results, it has been shown that a referee can move approximately 4 km in each match (Borin et al., 2013; Mancha-triguero et al., 2020). Apart from that, high

intensity can be described through the heart rate value produced by the referee during a match which is around 80% of the maximum heart rate (Ibáñez et al., 2024; Inchauspe et al., 2021; Kovalchuk & Mospan, 2020; Rupčić et al., 2012). So a referee also requires high aerobic abilities (Leicht, 2008) seen from the resulting physiological demands and the characteristics of basketball games which tend to require long periods of time and sudden attack and defense movements (Karabalcik et al., 2020).

Referee competency standards are also influenced by physical fitness, psychological and technical tactical abilities. Basketball referees must be able to move to the ideal position deftly so that no decisions are missed. Having good aerobic abilities can make a good contribution to the referee's ability to think and not easily get distracted from outside. Good aerobic capacity will increase the self-confidence of referees, coaches and other match officials. Because this is able to provide an overview of competence from a good image (Febriani & Suhartini, 2024).

A good VO2Max ability will optimize a referee's level of alertness and accuracy in decision making (Karabalcik et al., 2020). This is based on good cardiorespiratory and cardiovascular quality so that a referee will not get tired so that decisions are appropriate. A referee's focus on the course of a match will be greater (Paulauskas et al., 2024). Good fitness is considered to be related to making the right decisions (Riiser et al., 2019). Apart from good fitness, the accuracy of decision making is also largely influenced by a referee's experience and understanding of the match rules. The referee's ability to place himself in the right position is also important in the match. Good experience and understanding will automate the referee in making a decision. Although refereeing experience and knowledge are very influential on decision making. As a referee you also need speed in making decisions at all times in a match which requires high aerobic ability (Silva et al., 2019).

CONCLUSION

Based on the results of a survey carried out at the basketball referee training at Semarang State University's Basketball Student Club, it was found that many test scores and measurements for the multistage 20 m shuttle run did not meet the standard passing criteria for obtaining the intended license. With the B2 license male graduation results, 3 met and 7 did not meet the graduation criteria with an average of 62.8 ± 16.48 returns. 2 female C license participants met and 6 did not meet the criteria with an average of 38.62 ± 12.11 returns. The results of the VO2Max calculation were 6.5% of male participants in the excellent category, 19.4% good, 22.6% of participants sufficient, 22.6% of participants indequate, and 19% of training participants very poor. Meanwhile, for female referees, 10% of participants were in the good category, 50% were in the aquate category, 30% of

participants were in the indequate category and 10% of participants were in the very poor category. This is because aerobic capacity is really needed to support accurate decision making, increase alertness, focus and speed of decision making so that mistakes can be avoided during the match. Given this, it is necessary to increase the aerobic capacity of basketball referees in order to improve quality and maximize the accuracy of decision making.

Conflict of Interest

In this case, the author has no interest in any particular party and the data and analysis presented are in accordance with applicable norms. Apart from that, there is no conflict of interest with any party in this writing.

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