Profile of Maximum Oxygen Uptake of Male Youth Athletes

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Abstract

Introduction: Cardiovascular endurance (CE) is one of the main bio-motor components that must be possessed by athletes to be able to support physical performance. In addition to being able to engage in physical activity for long periods, cardiovascular endurance is also needed to help and speed up the reversibility process of physical fatigue after exercising. The profile related to the athlete’s endurance is very necessary to be held, which can be used for the process of monitoring and evaluating the effectiveness of the training program that has been given.

Objective: This study aimed to determine the profile of cardiovascular endurance for male junior athletes of Track and Field (TF), Taekwondo (TK), Karate (KT), and Sepak Takraw (ST).

Methods: The method of study was a quantitative descriptive with a cross-sectional approach. A total sampling method was implemented to 60 athletes including 14 athletes ages 14-17 years old for TF, 20 samples of TK, 15 athletes of KT, and 11 athletes of ST who were prepared for National School Games. The test instrument for cardiovascular endurance used was a multistage fitness test (MFT), with quantitative descriptive data analysis in percentages.

Results: The results showed that athletes of track and field (TF) had an average value of VO2Max ranging from 35.0-38.3 ml/kg/minute, meanwhile for Karate (KT) had an average value of 33.2 - 36.5 ml/kg/minute. On the other side, athletes of Taekwondo (TK) have average cardiovascular endurance values ranging from 34.1-37.7 ml/kg/minute and athletes of Sepak Takraw (ST) have average endurance values ranging from 29.7-31.3 ml/kg/minute.

Conclusions: The cardiovascular endurance profiles for Track and Field generally have good level categories, and so does for Taekwondo where in general also have good categories. Meanwhile, the profile of cardiovascular endurance for Karate state in an average category, on the other side Sepak Takraw as generally has in a less category.

Keywords: VO2Max, multi fitness test, karate, taekwondo, sepaktakraw

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INTRODUCTION

The definition of physical fitness is a multidimensional condition, which consists of several physical components such as speed, strength, endurance, flexibility, and coordination(1). The profile of the physical fitness level of an athlete can be obtained by taking measurements of each component in general or specifically according to the needs of the sport (Hayashi, 2016). Several studies explain that the basic components of physical fitness are strongly influenced by the level of cardiorespiratory endurance, which is known as the body's ability to accommodate the maximum oxygen capacity (VO2Max) during sports activities(2). High levels of aerobic endurance will not only increase the oxygen supply to the lungs to meet the required amount during exercise but it can also help to speed up the recovery process following sports activities(3). Cardiovascular endurance is one of the main bio-motor components that must be possessed by athletes to be able to support physical performance(4). In addition to being
able to engage in physical activity for long periods, cardiovascular endurance is also needed to help and speed up the reversibility process of physical fatigue after exercising (5). The profile related to the athlete's endurance is very necessary to be held, which can be used for the process of monitoring and evaluating the effectiveness of the training program that has been given.

Besides, to support other physical abilities to have a good performance during activities, cardiovascular endurance affects the quality of movement skills in long time action as well as mental competition (6). For instance, if an athlete has a low cardiovascular endurance ability in a competition, then the ability to perform in a high level of sports skills in long-duration will also decrease and affect the mental competitiveness of the athlete as well. Several studies have shown that good endurance training plays an important role in improving sports performance, through increasing aerobic endurance, good physicality is the basis of good mastery of a skill (7)(8). Another study of health and exercise states that there is a significant effect between cardiovascular endurance on strength and flexibility (9). Similar research results also explain that low-intensity circuit training is shown to affect increasing agility and recovery abilities (10). Based on the explanation of some of the results of these studies, it can be said that aerobic physical activity has contributed to the improvement of the ability of other physical conditions.

The phase of long-term athlete development has several stages including Fundamentals, learning to train, training to train, training to compete, and training to win (11). The training to compete for the stage is a development stage where the young potential athletes, which are aged from 14-18 years, have structured regularly training under the supervisor of coaches. The training center is conducted at the PPLP, Sports School, and Club levels. The current number of Indonesian athletes at the stage of training to compete, who are eligible to proceed to the stage of training to win has decreased from year to year to date. In other words, the number of athletes who have dropped out at this level is dramatically increasing. Several studies explain that one of the factors causing the athlete's inability to pursue the next stage was lack of abilities due to limited physical abilities and skills so that they are unable to improve to a further stage (12). The low physical condition of junior athletes is needed to be further studied to get an accurate profile related to their basic physical condition abilities. Several sports events that have a good performance on the stage of training to compete are track and field (TF), Taekwondo (TK), Karate (KT), and SepakTakraw (ST). They success to deliver a good performance at both the national and regional level of competition and contributes significantly affect the sports development environment of Indonesia. Unfortunately, couple of studies shows that at the stage of elite athletes those sports events are not able to deliver a high number of athletes due to limitation of physical condition such cardiopulmonary condition (VO2Max)(13). It means that a previous study that explains the relationship between cardiopulmonary condition to sports performance generally was showed in this case. It has a significant effect on the process performance development particularly in the middle stage of the long-term athlete development stage (14). Therefore, a clear description related to the profile of the cardiopulmonary condition in junior athletes in the age area of 14 – 18 years old is important to be conducted. This study aims were to determine the profile of cardiovascular endurance for male junior athletes of Track and Field (TF), Taekwondo (TK), Karate (KT), and SepakTakraw (ST).

**METHOD.**

The method used in this study was a quantitative descriptive with a cross-sectional approach (15). It is experimental research followed by scientific interpretation based on the result received. The study was conducted at the junior national training center (JNTC) of Track and Field (TF), Taekwondo (TK), Karate (KT), and SepakTakraw (ST) and accompanied by representative’s coaches. The population of the study was all athletes age ranged from 14-18-year-old who joined JNTC, while the sample was implemented to 60 male athletes completed by inclusion and exclusion criteria (16). including 14 athletes which composition of TF for 20 athletes, 20 samples of TK, 15 athletes of KT, and 11 athletes of ST who were prepared for upcoming National School Games. The test instrument for cardiovascular endurance used was a multistage fitness test (MFT) (17), with quantitative descriptive data analysis in percentages. The pre-test was conducted in advance by collecting the informed consent, Physical Activity Readiness
Questionnaire (PAR-Q), and data of anthropometrical status including bodyweight, -height, body mass index, and basal pulse rate.

RESULTS

The study has been started by collecting data questionnaire forms and following by body weight, -height, body, and basal condition of body metabolism status. The descriptive picture of measurement will be shown in the following table.

<table>
<thead>
<tr>
<th>Table 1. Characteristics of ages, body mass index, and basal pulse rate in Track and Field, Karate, Taekwondo, and SepakTakraw.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variabel</td>
</tr>
<tr>
<td>Age (years old)</td>
</tr>
<tr>
<td>Track and Field</td>
</tr>
<tr>
<td>Basal Pulse rate (/minutes)</td>
</tr>
<tr>
<td>Body mass Index (kg/m2)</td>
</tr>
<tr>
<td>Age (years old)</td>
</tr>
<tr>
<td>Karate</td>
</tr>
<tr>
<td>Basal Pulse rate (/minutes)</td>
</tr>
<tr>
<td>Body mass Index (kg/m2)</td>
</tr>
<tr>
<td>Age (years old)</td>
</tr>
<tr>
<td>Tae Kwon do</td>
</tr>
<tr>
<td>Basal Pulse rate (/minutes)</td>
</tr>
<tr>
<td>Body mass Index (kg/m2)</td>
</tr>
<tr>
<td>Age (years old)</td>
</tr>
<tr>
<td>SepakTakraw</td>
</tr>
<tr>
<td>Basal Pulse rate (/minutes)</td>
</tr>
<tr>
<td>Body mass Index (kg/m2)</td>
</tr>
</tbody>
</table>

Based on the results above, it can be concluded that every sporting event has similar characteristics related to basal pulse rate and body mass index status. The average age of the sample of all sports at the time of data collection is in the productive age group generally, which means at the age of 16.1 years. Concerning body composition, the overall sample express the level of body mass in normal conditions of 21.12 kg/m2, even though the overall data shows in very diverse range distribution. Track and field show the lowest number of the basal pulse rate of 63.4 pulse/minute, which indicated has a high level of aerobic steady-state and acts as a primary factor in supporting both endurance capacity and reversibility process. Karate has the number of basal pulse rate around 74.9 pulses/minute as the second rank, while taekwondo show an average value of basal pulse rate around 81.5 pulses/minute and following by sepak takraw who has several basal pulse rate around 81.9 pulses/minute.

As an overall result can be concluded that the average number of the basal pulse rate of all athletes express in the average number of 63 pulse/minute, which indicate that general condition show in an unfatigued status and were in a good health and fit. The profile of cardiorespiratory was taken using Multistage Fitness Level (MFT) instrument, conducted on the indoor hall, supported by un-slippery flat flor, marking zone in the distance of 20m in...
between of start and finish line marking with coloring rubber cones, high quality of audio player, recording sheets and the registrar who stands behind the start and finish lines. The following table explains the mentioned result.

Table 2 Result of Multistage Fitness Test according to percentage.

<table>
<thead>
<tr>
<th>Level</th>
<th>VO2max</th>
<th>Fvalue</th>
<th>Fvalue</th>
<th>Fvalue</th>
<th>Categories</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>TF</td>
<td>KT</td>
<td>TK</td>
<td>ST</td>
<td></td>
</tr>
<tr>
<td>&gt;14</td>
<td>&gt;60.6</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>Excellent</td>
<td>4.54%</td>
</tr>
<tr>
<td>12-14</td>
<td>53.7-60.6</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>Good</td>
</tr>
<tr>
<td>10-12</td>
<td>46.8-53.6</td>
<td>7</td>
<td>9</td>
<td>3</td>
<td>2</td>
<td>Above Average</td>
</tr>
<tr>
<td>08-10</td>
<td>39.9-46.7</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>6</td>
<td>Average</td>
</tr>
<tr>
<td>06-08</td>
<td>33.0-39.8</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>Poor</td>
</tr>
<tr>
<td>&lt;06</td>
<td>&lt;33.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Very Poor</td>
<td>0%</td>
</tr>
</tbody>
</table>

The table describes the distribution of cardiopulmonary profile (VO2Max) which is taken with a multistage fitness test of each athlete in a different type of sports. We can conclude that the highest value of VO2max has been showing by 3 athletes in track and field with an average value of VO2Max around 60.6 mmol/Kg/bb, which means shows the number of percentage of 4.54% overall athletes. On another side, the lowest value has been displayed by 5 athletes which representing 1 athlete of Karate, 2 athletes of Taekwondo, and 2 athletes of Sepaktakraw. This amount representing around 7.57% of the total percentage of cardiorespiratory profile in overall athletes. The number of athletes who have a good VO2Max level is 8 people or 12.13%, where the highest number of athletes who have good criteria come from track and field. In the above-average category, it can be seen that the highest number is dominated by karate athletes with 9 athletes, then 7 athletes and 3 taekwondo athletes, and 2 takraw athletes. These results illustrate that almost 31.82% of the total athletes who were measured were identified to have cardiovascular endurance abilities between 46.8 mmol/kg/body weight - 53.8 mmol/kg/body weight.

When viewed from the results of the overall cardiovascular endurance measurement, it can be concluded that the majority of athletes have an average category of endurance ability with a percentage of nearly 43.93%. Then for the low category, there are several athletes from the sepaktakraw, taekwondo, and karate who only have the ability of heart-lung endurance of 33 mmol/kg/bb - 39.8 mmol/kg/bb. The average ability of athletes in athletics is in the upper-middle category, as well as for karate and taekwondo. However, on the other hand, the average cardiovascular endurance ability of the SepakTakraw is in the middle to lower category with a percentage of 72.7%, which indicates that the majority of athletes have poor endurance.

Likewise, for taekwondo, where nearly 73.3% had low cardiovascular endurance. Karate has almost the same amount of distribution between athletes with high and intermediate cardiovascular endurance abilities, with a percentage ratio of 55% for the high category, and 45% for the intermediate category. The most striking results were shown by athletics where nearly 70% of athletes had moderate and high cardiovascular endurance abilities, compared to the number of athletes with low endurance abilities with a percentage of 30%. If we look at the comparison between the number of athletes who have high endurance abilities compared to the number of athletes who have low endurance abilities, the results show that from all sports that are measured, it can be seen that the profile of athletes who have moderate to upper endurance abilities with a percentage ratio of 51%, while for the middle to lower category as much as 49%.

DISCUSSION
Aerobic endurance is influenced by physical activity and daily life. Regular physical exercise is known to improve cardiovascular fitness, increase VO$_2$ Max, and decrease body fat percentage leading to a better quality of life(22). Besides, the high and low levels of VO$_2$ Max are also influenced by several supporting components such as the ability of the heart, lungs, blood quality, blood vessels, and the ability of the skeletal muscles to consume this oxygen (1). In the term of sport, cardiovascular endurance is one of the bio motor components which also affects the quality of other bio motor components. Besides, having good endurance can also help athletes to be able to have a faster recovery process after doing sports so that athletes do not have problems with fatigue for a long time (23). Several previous studies have also explained that the ability of the heart-lung endurance to help the fatigue recovery process be faster, due to the ability of the heart to flow the amount of dirty blood to the lungs which will then be replaced with clean blood becomes large, thereby accelerating the process of breaking down lactic acid in the blood (24). The explanation from the same study also reinforces this result, which states that cardiovascular endurance ability significantly influences the increase in strength, agility, and even speed(25).

Performing complex circuit training based on low intensity and high volume by involving the upper, middle, and lower body parts of the body, has been shown to significantly increase cardiovascular endurance and local muscle endurance better, compared to low-intensity running-based endurance training at high volume (26). In other definition can be explained that having a high level of endurance can help athletes to carry out sports activities for a longer time, be able to display techniques and skills better, and help in maintaining endurance concentration for a longer time, which is due to the supply of oxygen sent to the brain has a greater amount compared to athletes who have low endurance abilities (27). The results above show that the endurance abilities of national junior athletes in athletics, karate, taekwondo, and SepakTakraw are generally in the average category. High endurance abilities are shown in athletics, where more than 50% of athletes are in the good and excellent category. On the other hand, the endurance profile of SepakTakraw shows that the majority of athletes have low endurance abilities. It is assumed that because SepakTakraw is a team sport so that in daily practice, it often emphasizes the skill element so that it does not pay attention to the aspects of improving the physical condition of the athletes. This is explained in similar studies where it explains that in in-game sports, the element of endurance is the dominant determining factor, compared to the elements of technique and skill (7). By having the ability to be in good physical condition, the athlete will be able to display the maximum and long-lasting ability of skills and techniques, so that a decrease in the quality of movement and technical errors caused by fatigue can be avoided (28). Therefore, the recommendation given to SepakTakraw based on the results obtained is to provide a larger portion of individual physical training, in an appropriate portion without having to reduce skill and skill training. The form of exercise that can be given such a complex circuit training that involve the limbs and whole body by emphasizing a lot of volumes but with low intensity.

Karate and Taekwondo seem to have similar results. It can be concluded that the athletes have an average category of endurance ability with almost the same spread. The same thing is also explained by sports studies which explain that in martial arts, physical condition is a very dominant factor affecting achievement. The demand to be able to perform fast, explosive movements by moving quickly in martial arts athletes, demands that they have good endurance abilities, both cardiovascular endurance and local muscle endurance (29). Similar studies have shown that complex training that combines physical training and skills is proven to provide more results in improving overall physical condition than a form of exercise that focuses on just one bio motor component (13). This opinion is supported by other studies which state that using skills training in advance with a form of a game to improve physical condition, yields more significant results in increasing endurance and skills than providing a separate form of exercise (30). Having an average level of physical conditions particularly in the form of cardiovascular endurance, create several difficulties that can be encountered in the process of performance development itself including the inability of the body to accept an increased training load (31), have a high level of fatigue, take a long time to recover and increasing the possibility to occur the injury due to the limited ability of the body to adapt to training loads (32). This is assumed to be one of the factors causing the high number of teenage athletes who experience drop-out so that they are unable to improve sports performance at a further stage. This is in line with research that explains the
phenomenon associated with the high number of sports injuries in adolescents in sports games and martial arts, where 33% are structural injuries to joints, and 47% are injuries caused by metabolic disorders due to overtraining which is also as a contributing factor to the decreased number of junior athletes to be able to increase performance at a later stage(33).

Therefore, recommendations that can be given based on the results of this measurement are to provide more forms of physical training starting from the general phase, then accompanied by a form of skill and skill training so that in addition to getting results from improving basic physical conditions, also obtaining increased skills and skills simultaneously(34). The form of physical exercise that is given can be in the form of complex training which is a form of combined physical training and skills with an emphasis on high volume, accompanied by low intensity and short recovery time to provide stimulation for increased endurance better (4). The thing that needs to be considered in providing skills training after complex training is that the intensity must be low(35), which means that the technical training given does not focus on the maximum quality of movement, but focuses on the number of repetitions accompanied by an emphasis on the form of basic skill training in order to have motion good basic skills.

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