


# IMT and VO<sub>2</sub>max analysis on junior athletes, futsal and football branches: Literature Scopus

RULIANDO HASEA PURBA<sup>1</sup> , SELF AMI SUSANTI<sup>2</sup>

<sup>1</sup>State University in Jakarta (UNJ), Indonesia

<sup>2</sup>Domestic Government Institute (IPDN), Indonesia

## ABSTRACT

State University of Jakarta students, especially the Faculty of Sports Science, consist of athletes in their respective sports, they are required to have various physical abilities or movement skills and master the techniques of these sports, as well as being able to apply them in competitions or sports competitions that they participate in, as well as are required to have achievements in the sport they do. To get an achievement, athletes must have excellent physical fitness and be supported by ideal body proportions and have high enthusiasm and motivation. This study aims to determine the condition of IMT and VO<sub>2</sub>max male junior athletes in Futsal and soccer sports at State University of Jakarta. This type of research is quantitative research using survey techniques with the method used is descriptive. The results of this study are it can be said that the IMT condition of male junior athletes in futsal and soccer at State University of Jakarta is underweight category as much as 10% or 5 athletes, normal category is 64% or 32 athletes, overweight category is 12% or 6 athletes, and obesity category as much as 14% or 7 athletes. Meanwhile, the results of the calculation of the percentage of VO<sub>2</sub>max data for male junior athletes in futsal and soccer at State University of Jakarta are 12% or 6 athletes, either 18% or 9 athletes, 44% or 22 athletes, enough categories and the less category was 26% or 13 athletes, while the lacking category was not included in the category.

**Keywords:** IMT; VO<sub>2</sub>max; Junior athletes; Futsal; Football.

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**Corresponding author.** State University in Jakarta (UNJ), Indonesia. <https://orcid.org/0000-0002-5121-6229>

E-mail: [sirusanajaf6@gmail.com](mailto:sirusanajaf6@gmail.com)

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## INTRODUCTION

Jakarta State University students, especially the Faculty of Sports Science, consist of athletes in their respective sports, they are required to have various physical abilities or movement skills and master the techniques of the sport, as well as being able to apply them in competitions or sports competitions that they participate in, and are required to have achievements in the sport they do. To get an achievement, athletes must have excellent physical fitness and be supported by ideal body proportions and have high enthusiasm and motivation. Physical fitness is very important in doing any physical activity. Physical fitness possessed by athletes is one of the basic assets in supporting their achievements. A good level of physical fitness really helps athletes to maintain their performance, especially in taking physical tests. Athletes will be able to perform physical tests optimally if they have excellent physical fitness. One thing that describes a person's physical fitness level is Body Mass Index (IMT) and VO<sub>2</sub>max. Body Mass Index refers to the proportion of the body between height and weight. It is hoped that the junior male athletes of futsal and football at the State University of Jakarta have ideal body proportions, so that they can move freely and later become an inspiration for those around them to have an ideal body. Meanwhile, VO<sub>2</sub>max is the maximum volume of oxygen processed by the body during intense activities. VO<sub>2</sub>max is a reflection of the level of physical fitness. With a high VO<sub>2</sub>max level, it is hoped that athletes can improve and maintain the achievements they have achieved.

With the description above, the author intends to examine the condition of the Body Mass Index and VO<sub>2</sub>max Capacity of Male Junior Athletes in Futsal and Football Sports at FIO State University of Jakarta.

## BODY MASS INDEX (IMT)

### ***Definition of Body Mass Index (IMT)***

The Body Mass Index (IMT) or in English is the Body Mass Index, which is the value obtained from the calculation of the quotient between body weight (BB) in kilograms and the square of body height (TB) in meters. This technique was invented in the mid-10th century in Belgium by Lambert Adolphe Jacques Quetelet. Since the first meeting of the IDECG (International Deficiency Energy Consultative Group) in Guatemala in 1987, IMT has been widely used to determine a person's Body Mass Index (IMT). The World Health Organization (WHO) in 1997, The National Institute of Health (NIH) in 1998 and The Expert Committee on Clinical Guidelines for Overweight in Adolescent Preventive Services have recommended a Body Mass Index (IMT) or Body Mass Index (IMT) as a standard measure of obesity in children and adolescents over the age of 2 years. The World Health Organization (WHO) IMT is used to measure ideal body weight or not and is a good way of measuring the risk of disease that can occur due to body weight that is not ideal. So that through the Body Mass Index (IMT), a person will know whether he is in the category of ideal body weight, thin, fat or even obese.

### ***Body Mass Index (IMT) measurements and categories***

Body Mass Index (IMT) is obtained by dividing body weight by height squared. Body weight is calculated using kilograms (kg), while height uses units of meters (m) or with the IMT formula as follows:

$$\text{IMT} = \text{Weight (kg)} / \text{Height (m)} \times \text{Height (m)}$$

The standards / categories for the Body Mass Index (IMT) of each hemisphere or continent differ because they adjust for the racial characteristics of the continents. Standards for Body Mass Index (IMT) for Indonesians has been published in 2010 by the Ministry of Health of the Republic of Indonesia.

## VO<sub>2</sub> MAXIMUM

VO<sub>2</sub>max is a measure of the maximum volume of oxygen the athlete can use. It is measured in millilitres per kilogram of body weight per minute (ml / kg / minute) VO<sub>2</sub>max(also maximum oxygen consumption, maximum oxygen uptake, peak oxygen uptake or aerobic capacity) is the body's individual maximum capacity for oxygen transport and use during additional exercise, which reflects the physical fitness of the individual. This name comes from V (volume per time), O<sub>2</sub> (oxygen), max (maximum). VO<sub>2</sub>max is expressed either as the absolute rate in litres of oxygen per minute (l / min) or as the relative level in millilitres of oxygen per kilogram of body weight per minute (ml / kg / min), the latter expression is often used to compare the performance of power sports athletes. hold on.

### Measure VO<sub>2</sub>max

Accurately measuring VO<sub>2</sub>max involves sufficient physical effort in duration and intensity to fully tax the aerobic energy system. In general, clinical and athletic trials, this usually involves a graded exercise test (either on a treadmill or on an ergometer cycle) in which the intensity of the exercise is progressively increased while measuring ventilation and oxygen and carbon dioxide concentrations of inhaled and exhaled air. VO<sub>2</sub>max is reached when oxygen consumption remains at a steady state despite an increase in workload. VO<sub>2</sub>max is defined by the Fick equation: When these values are obtained during exertion at maximal effort. Another estimate of VO<sub>2</sub>max, based on maximum and resting heart rates, was created by a group of researchers from Denmark. This equation uses maximum heart rate (DJ max) and resting heart rate (silent DJ) to estimate VO<sub>2</sub>max in ml / min / kg.

A professor of exercise and exercise science at the University of Cape Town, described a number of variables that influence VO<sub>2</sub>max, including:

1. Age.
2. Gender.
3. Fitness and training.
4. Change in altitude.
5. The action of the ventilation muscles.

Fitness can be measured by the volume of oxygen you can consume while exercising at your maximum capacity. Those who deserve a higher VO<sub>2</sub>max value and can exercise more intensely than those who do not. There are various physiological factors to determine VO<sub>2</sub>max:

- Utilization Theory (VO<sub>2</sub>max is determined by the body's ability to use available oxygen)
- Presentation Theory (the ability of the body's cardiovascular system to deliver oxygen to active tissue).

### Forms of the VO<sub>2</sub>max test

An estimate of VO<sub>2</sub>max can be determined using one of the following tests:

- 2.4 km Run Test.
- Astrand Treadmill Test - A VO<sub>2</sub>max test running on a treadmill.
- Astrand 6-minute cycle test - VO<sub>2</sub>max test on a stationary bicycle.
- Balke VO<sub>2</sub>max test - suitable for endurance sports.
- Balke Incremental treadmill protocol test - VO<sub>2</sub>max test on a treadmill (male and female test)
- Cooper VO<sub>2</sub>max test - suitable for endurance sports.
- Conconi test.

- Critical Swimming Speed - a measure of the swimmer's aerobic capacity me. Harvard Step Test - measures cardiovascular fitness.
- Multistage Fitness Test or Bleep test - VO<sub>2</sub>max test for endurance sports.
- Queens College Step Test - VO<sub>2</sub>max test.
- Rockport fitness walking test - VO<sub>2</sub>max test.
- Tecumseh Step Test - measures cardiovascular fitness.
- Treadmill VO<sub>2</sub>max test - VO<sub>2</sub>max test.
- VO<sub>2</sub>max from non-exercise data - the VO<sub>2</sub>max test.
- VO<sub>2</sub>max step test.

### **Junior athletes**

(Zouhal et al., 2020) in his research entitled the effect of interval training training on changes in the physical ability of junior volleyball athletes including the criteria for junior athletes is athletes aged 16-19 years. Triathlon sports in the United States (USA triathlon divides young athletes into 2 criteria, namely youth (age 7-15 years) and Junior (aged 16-19 years). However, the Norwegian National Ski Federation includes the criteria for junior athletes aged 17-19 Chatterjee included the junior criteria in his research, namely the age of 13-16 years. Nurjaya in his writing explained that there are stages in fostering athletes in the long term (Long Term Athletes Development) abbreviated as LTAD. LTAD is a model that has been developed by Balyi who is an expert in planning, periodization and performance improvement through short- and long-term training programs.

The stages in LTAD:

#### **1. Stage I: Action Kids (ages 0–5 years).**

Goal: To learn basic movements and combine them in a game. At this age, the child learns to do simple and single movements and then combine them in a game. The more variety of movements the better with a focus on unstructured movements.

#### **2. Stage II: Fundamental (ages 6-9 years).**

Objective: To learn all the basic movement skills to build motor movements. Fundamental movements must be practiced and mastered before athletes are introduced to specific skills. The emphasis on motor coaching will produce athletes who are able to undergo long-term training for a particular sport. In stage 2 children are given the opportunity to develop everything needed in the areas of agility, balance, coordination and speed. It was at this time that the basics of sports skills began to be learned including movement skills, basic skills to control objects and balance movements.

#### **3. Stage III: Learning to practice (9-12 years).**

Goal: To learn the basics of his favourite sports skills. This is the main stage of motor learning. At this stage movement skills begin to be directed at certain sports movements that are of interest to him. This particular movement skill begins to be developed from the age of 9-12 years including certain sports movements. If this stage is missed, the consequences will be very detrimental to efforts to achieve achievements in the future.

#### **4. Stage IV: Exercises to practice (12-16 years).**

Objective: To optimize athlete's fitness in preparation for training in a specific position. Stage IV is the stage where the aerobic capacity reaches its greatest state. In sports this is known as "*training the engine*". Its main

objective is emphasized on building aerobic capacity. The training pattern is low intensity with high weight volume, this requires adding time to the training schedule.

5. Stage V: Training to compete (16-18 years).

Purpose: optimizing the athlete's fitness in preparation for training in a specific position. Training to compete is the stage when peak strength velocity and weight velocity come together when strength reaches its maximum. This stage emphasizes the development of strength and endurance, which are very important for optimizing athlete performance.

6. Stage VI: Training to win (18+ years).

Purpose: maximizing fitness, preparation and individual position and specific skills for achievement. At this stage the skills, speed, stamina, and strength are continuously improved for maximum performance. Athletes are trained to reach peak conditions for a certain moment. At this stage, the addition of movement types will be more difficult as will the maintenance efforts.

7. Stage VII: retirement or rest (Retirements).

Goal: to retain athletes to become coaches, administrators or officials. This stage is the phase of activities performed by an athlete after permanently stopping the competition. Some athletes enter career paths related to sports such as coaches, officials, and sports administrators, small-scale entrepreneurs working or hosting competitions.

## MATERIALS AND METHODS

The research method used is descriptive research method. Descriptive research method is a method of examining the status of human groups, an object, a set of conditions, a system of thought, or a class of events in the present. This type of research is a quantitative study using survey techniques. The survey method is an investigation conducted to obtain facts from existing symptoms and seek factual information, whether about social, economic, or political institutions from a group or a region. In this study, the researcher wanted to describe the condition of the Body Mass Index (IMT) and VO<sub>2</sub>max Capacity of Male Junior Athletes in Futsal and Football Sports at the State University of Jakarta. As well as the analysis technique used, namely descriptive statistics, are statistics that function to describe or provide an overview of the object under study through sample or population data as it is without analysing and making general conclusions. Descriptive definition is describing data clearly which includes:

- Looking for the central tendency (data trends consisting of mean, median, mode, minimum, maximum, range, variance and standard deviation).
- Construct a category table.
- Displays in picture form.

The population of this study were all male junior athletes in futsal and football. The number of athletes who were subjected was 50 athletes. The data collection technique in this study used the test method.

## RESULTS AND DISCUSSION

The research results displayed are the results of data processing obtained from direct observation and the results of tests of height and weight measurements, as well as the VO<sub>2</sub>max test using the Tread Mill for male junior athletes in Futsal and Football sports at the Jakarta State University. To make it easier to understand the results of the research, it will be presented in the tables below.

**Body Mass Index (IMT)***Male junior athlete in futsal*

Table 1. Analysis of the condition research results (IMT) of male junior athletes in futsal.

Test	Highest	Lowest	Average
Height (cm)	184	158	168.1
Weight (kg)	85	46	61
IMT	28.73	17.31	21.5

Based on the table above, it can be seen that of the 30 male junior athletes in futsal, the highest value in the Body Mass Index (IMT) is 28.73 which is classified as the obesity category. Meanwhile, the lowest value in the Body Mass Index (IMT) is 17.31 which is classified as underweight. From the total data of 30 male junior athletes in futsal, it can be seen that the average body mass index (IMT) is 21.5 which is classified as ideal or normal. Analysis of the results of this study will be able to determine the percentage level of the Body Mass Index (IMT) of male junior athletes in futsal which is presented in the table below.

Table 2. Percentage of IMT conditions for male junior athletes in futsal sports.

Category	Frequency	Percentage
Underweight (<18.5)	4	13%
Normal (18.5–22.9)	17	57%
Overweight (23–24.9)	3	10%
Obesity (> 25)	6	20%
Total	30	100%

Based on the table above, it can be seen that out of 30 junior athletes in futsal, 4 athletes (13%) are underweight, 17 athletes (57%) are in the normal category, 3 athletes (10%) are overweight, 6 athletes are athletes. (20%) are obese.

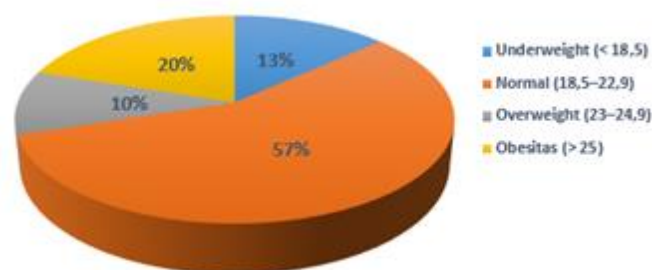


Figure 1. Diagram of IMT conditions for futsal athletes.

*Junior athletes in football*

Table 3. Analysis of the results of the research condition (IMT) of male junior athletes in soccer.

Test	Highest	Lowest	Average
Height (cm)	179	155	168.3
Weight (kg)	73	50	61.2
IMT	25.56	18.12	21.61

Based on the table above, it can be seen that of the 20 junior male athletes, the highest Body Mass Index (IMT) value is 25.56, which is classified in the obesity category. Meanwhile, the lowest Body Mass Index (IMT) value was 18.12 which was classified as underweight. From the total data of 20 junior male soccer athletes, it can be seen that the average body mass index (IMT) is 21.61 which is classified as ideal or normal category. The analysis of the results of this study will be able to determine the percentage level of the Body Mass Index (IMT) of junior male soccer athletes which is presented in the table below.

Table 4. Percentage of IMT conditions for male junior athletes in soccer.

Category	Frequency	Percentage
Underweight (<18.5)	1	5%
Normal (18.5–22.9)	15	75%
Overweight (23–24.9)	3	15%
Obesity (> 25)	1	5%
Total	20	100 %

Based on the table above, it can be seen that out of 20 junior male athletes, 1 athlete (5%) is thin, 15 athletes (75%) are in the normal category, 3 athletes (15%) are overweight, 1 athlete. (5%) are obese.

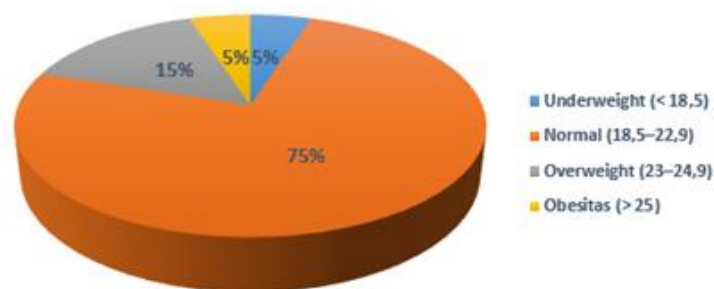


Figure 2. Condition diagram of IMT for football sports athletes.

### VO<sub>2</sub>max

#### Junior athletes in futsal sports

Table 5. Analysis of VO<sub>2</sub>max research results for boys junior athletes in futsal sports.

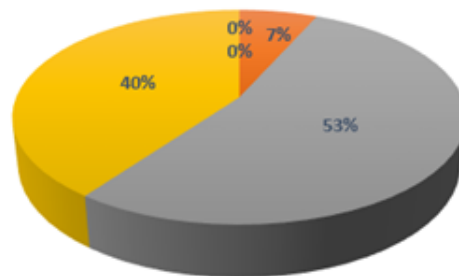
Acquisition	VO <sub>2</sub> max	Category
The highest	53.7	Well
Lowest	31.9	Less
Average	42.1	Enough

Based on the table above, it can be seen that of the 30 junior male athletes in futsal, the highest VO<sub>2</sub>max value, 53.7, is categorized as good. While the lowest norm value on VO<sub>2</sub>max, namely 31.9, is in the sufficient category. From the total data of 30 athletes, it can be seen that the average VO<sub>2</sub>max results for junior male futsal athletes at Jakarta State University of 42.1 is sufficient. Analysis of the results of this study will be able to determine the percentage of athletes' VO<sub>2</sub>max level which is presented in the table as below.

Based on the table below, it can be seen that of the 30 junior futsal athletes, 2 athletes (7%) are in the good category, 16 athletes (75%) are in the enough category, 12 athletes (15%) are in the poor category. and no athlete falls into that category. very good or very little.

Table 6. Percentage of VO<sub>2</sub>max condition of male junior athletes in futsal sports.

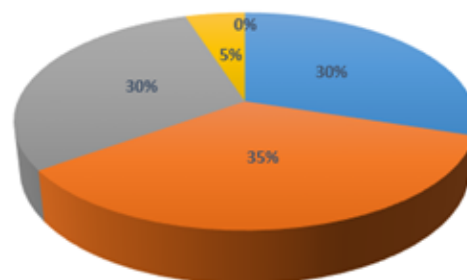
Category	Frequency	Percentage
Very well	0	0%
(> 56.8 mL / kg / m)	2	7%
Well	16	53%
(49.4-56.8 mL / kg / m)	12	40%
Enough	0	0%
(41.8-49.3 mL / kg / m)	30	100 %

Figure 3. The VO<sub>2</sub>max condition diagram for futsal athletes.Table 7. Percentage of VO<sub>2</sub>max conditions of all male junior athletes in soccer.

Acquisition	VO <sub>2</sub> max	Category
The highest	63	Very well
Lowest	32.8	Less
Average	51.1	Well

Table 8. Percentage of male junior athlete VO<sub>2</sub>max condition in football.

Category	Frequency	Percentage
Very well (> 56,8 mL/kg/m)	6	30%
Well (49,4-56,8 mL/kg/m)	7	35%
Enough (41,8-49,3 mL/kg/m)	6	30%
Less (31-41,7 mL/kg/m)	1	5%
Very Less (< 31 mL/kg/m)	0	0%
<b>Total</b>	<b>20</b>	<b>100 %</b>

Figure 4. VO<sub>2</sub>max condition diagram for athletes in football.



Based on the table above, it can be seen that of the 20 junior athletes in soccer, 6 athletes (30%) have very good and sufficient categories, 1 athlete (5%) has a poor category, and no athlete has a very bad category.

This main discussion is based on the background of the problem, literature review and research results that have been described in the previous section, so that it can support the achievements of Jakarta State University athletes. From the results of calculating the percentage of IMT data, it can be said that the condition of the Body Mass Index (IMT) of junior futsal and soccer athletes is included in the underweight category as much as 10% or 5 normal athletes. category 64% or 32 athletes, overweight category 12% or 6 athletes, and obesity category as much as 14% or 7 athletes. From the description above, it can be seen that (IMT) is the most dominant in the normal category, while the underweight category is the least.

Table 9. Percentage of IMT condition for junior male athletes in futsal and football sports.

Category	Frequency	Percentage
Underweight (<18.5)	5	10%
Normal (18.5–22.9)	32	64%
Overweight (23-24.9)	6	12%
Obesity (> 25)	7	14%
Total	50	100%

Meanwhile, from the results of the calculation of the percentage of VO<sub>2</sub>max data, it can be said that the VO<sub>2</sub>max condition of male junior athletes in futsal and soccer is a very good category as many as 12% or 6 athletes, either category is 18% or 9 athletes, enough category is 44% or 22 athletes, and 26% less category or 13 athletes. From the description above, it shows that (IMT) is the most dominant in the moderate category, while the lacking category is not included in the category.

Table 10. Percentage of VO<sub>2</sub>max condition for male junior athletes in futsal and football sports.

Category	Frequency	Percentage
Very well (> 56,8 mL/kg/m)	6	12%
Well (49,4-56,8 mL/kg/m)	9	18%
Enough (41,8-49,3 mL/kg/m)	22	44%
Less (31-41,7 mL/kg/m)	13	26%
Very Less (< 31 mL/kg/m)	0	0%
Total	50	100%

The average body mass index (IMT) of male junior athletes in futsal and soccer, Jakarta State University is normal. However, an effort is needed to maintain the IMT in order to remain in the normal category. For those who have the underweight category, they need to work hard to increase their weight in order to have a normal IMT. Likewise, those who are overweight and obese IMT categories need to work hard to reduce their weight in order to have a normal IMT. Having a normal or ideal IMT will avoid various diseases and have a proportional body to support achievement in the sport you are engaged in and always be fit in doing other activities. A person's VO<sub>2</sub>max level affects their physical fitness level, the better a person's VO<sub>2</sub>max the more physically fit they are. However, the average VO<sub>2</sub>max level of male junior athletes in futsal and soccer, Jakarta State University, is still in the low category, so there is a need for efforts to increase VO<sub>2</sub>max, so that athletes have good endurance in order to support their achievements in their sports. and can do their activities with good results.

## CONCLUSION

Based on the data that has been collected, processed, analysed, it is mentioned in Chapter IV, it can be drawn as follows:

1. The condition of the Body Mass Index (IMT) of male junior athletes in futsal and soccer at Jakarta State University is the underweight category as much as 10%, the normal category is 64%, the overweight category is 12%, and the obesity category is 14%.
2. The VO<sub>2</sub>max condition of male junior athletes in futsal and soccer at the State University of Jakarta is 12% in excellent category, 18% good category, 44% adequate category, and 26% less category. While there is absolutely no category that is included in the category.

Suggestions that can be put forward in this research are as follows:

1. In accordance with the results of research, Body Mass Index (IMT) and VO<sub>2</sub>max are quite influential because they greatly support achievement in the sports they are engaged in.
2. Based on the research results, it is expected that athletes are able to maintain their diet and be able to train themselves to improve their physical fitness.
3. Research is expected to be a reference for new athletes to see how important Body Mass Index (IMT) and VO<sub>2</sub>max are.
4. This research still needs to be developed again, it is necessary to hold further research.

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