



## The Effect of Sports Activities on Changes in Vo2max and the Difference in Recovery Period Between Trained and Untrained Student Groups

Ade Rahmanda Kamil<sup>1</sup>, Gusbakti Rusip<sup>2</sup>

Universitas Muhammadiyah Sumatera Utara, Indonesia

Email: [aderahmandakamil@gmail.com](mailto:aderahmandakamil@gmail.com)<sup>1\*</sup>, [gusrusip@gmail.com](mailto:gusrusip@gmail.com)<sup>2</sup>

---

### KEYWORDS

VO2Max, Recovery, Exercise, Trained Student Group, Untrained Student Group, Six-Minute Walking Test.

### ABSTRACT

A sedentary lifestyle among university students can negatively affect cardiovascular health, as reflected by low VO<sub>2</sub>Max values and prolonged recovery periods. This study aimed to examine the impact of sports activities on changes in VO<sub>2</sub>Max and the differences in recovery time between trained and untrained students at the Faculty of Medicine, University of Muhammadiyah North Sumatra. Using an experimental pre-post test design, 32 students were divided into trained (n=16) and untrained (n=16) groups based on their participation in the university's Sports Student Activity Unit. VO<sub>2</sub>Max and recovery times were measured before and after a Six-Minute Walking Test (6MWT). Data were analyzed using paired and unpaired t-tests. Results showed significant improvements in VO<sub>2</sub>Max in both groups (trained: p=0.002; untrained: p<0.001) and significant differences in post-exercise VO<sub>2</sub>Max between groups (p=0.005). Recovery times also significantly differed (trained: 85.94 ± 8.14 vs. untrained: 96.81 ± 12.03; p=0.005). These findings highlight the positive physiological effects of regular exercise on cardiovascular endurance and recovery capacity. The study implies that integrating structured sports programs into academic institutions could enhance students' overall health and physical fitness, particularly in cognitively demanding environments like medical faculties. Future research should explore long-term training modalities, such as HIIT or moderate-intensity training, and their sustained impacts on VO<sub>2</sub>Max and physiological recovery across diverse student populations.

---

DOI:

**Corresponding Author:** Ade Rahmanda Kamil  
**Email:** [aderahmandakamil@gmail.com](mailto:aderahmandakamil@gmail.com)

### INTRODUCTION

The lifestyle of today's people who tend to have a sedentary *lifestyle* or do not do much physical activity is something to watch out for because this habit can have an impact on health. Various kinds of deterioration of organ function in this sedated society can be prevented through exercise. It is proven that increased physical freshness is associated with a reduced risk of cardiovascular disease in children and adolescents, as well as a decrease in blood pressure in men and women (Ibrahim & Mohamed, 2021).

Along with the improvement and development in today's technological world, it facilitates all activities so that it causes us to move less (*low body movement*) or often referred to as *hypokinetic*. This

can cause *overweight* and obesity resulting in symptoms and the onset of diseases such as diabetes, cholesterol, hypertension, and also the risk of heart disease (*cardiovaskuler*) (Karim, 2002).

Absent physical activity (lack of physical activity) is an independent risk factor for chronic disease, and overall is thought to cause death globally (Fraser et al., 1983).

The WHO states that physical activity insufficiency ranks 4th in the world in risk factors that cause death. Regular physical activity is beneficial for regulating weight, strengthening the heart system, and blood vessels. It is estimated that there are 3.2 million deaths and 32.1 million *Disability-adjusted Life Years* (DALYS) which represents approximately 2.1% per year which contributes to the number of physical activity insufficiencies. People with physical activity insufficiency mortality of up to 20%-30% compared to people who spend 30 minutes per week exercising (Álvarez et al., 2023; Shear et al., 1986).

The results of cardiorespiratory endurance studies conducted in the United States show that there is a relationship between VO2Max values and the risk of cardiovascular disease. The results of the study stated that a person with a poor Maximum Oxygen Volume value is at a higher risk of suffering from cardiovascular disease than a person who has a good VO2Max value even though the person is obese (Tangkilisan et al., 2013). Studies in several countries showed low VO2Max status in the population studied. African-American youth (6-18 years) had a low cardiorespiratory fitness status with a value of 29.8 ml/kg/min (WHO, 2017).

A study conducted in Augusta, Georgia in 2005, on school students with an average age of 16 years showed that the average VO2Max value was 38.7 ml/kg/min, which means that it was at a low level (Ministry of Health of the Republic of Indonesia, 2013). Studies on Iranian children aged 13-17 years have shown that their grades are at a low to medium level compared to other populations (C. Lee et al., 2001).

Regular physical activity has a significant protective effect against the possibility of contracting several diseases. On the other hand, a *sedentary lifestyle* is known to be at risk of these things happening. According to the National Health Survey, the prevalence of the population who do not do physical activity is 72.9% (S. J. Lee & Arslanian, 2007).

According to the Basic Health Research of the Ministry of Health of the Republic of Indonesia, the criteria for 'active' physical activity are individuals who engage in strenuous or moderate physical activity or both, while the criteria for "less active" are individuals who do not engage in moderate or strenuous physical activity. 'Less active' behaviors such as sedentary behavior are relaxed behaviors such as sitting, lying down or examples of daily life behaviors such as watching TV, playing *games*. This behavior is a risky behavior for blockage of blood vessels and affects life expectancy. In Indonesia, the average population aged  $\geq 10$  years who do 'active' physical activity is 73.9% and those who do 'less active' physical activity is 26.1%. For sedentary behavior in Indonesia with the criterion of 3-5.9 hours a day with an age of  $\geq 10$  years shows a figure of 42% (Huang & Malina, 2002). According to data from the Central Statistics Agency of Indonesia's population, those aged 10 years and above who played sports in 2009 were 21.76%, increasing in 2012 to 24.9% (Amra et al., 2009).

Based on the above data showing high results, several studies have also been conducted in Indonesia and most of them show that the VO2Max value is still low. Research on VO2Max values conducted in 31 provinces in children aged 7-13 years stated that the average VO2Max value of respondents was low, which was 29 ml/kg/min (Widayati, 2018).

There are several factors that have been proven to be related to VO2Max values, VO2Max values that are influenced by gender. A study of children aged 8-15 years in Portugal suggested that male respondents had better VO2max values than female respondents (Gandasari & Manurung, 2020). A

---

study conducted in the United States with respondents aged 12-19 also came to the same conclusion that male respondents had better VO<sub>2</sub>Max values than females (Candra Dewi et al., 2020).

Exercise or physical exercise is very important to maintain and improve physical freshness. What is called physical freshness is the body's ability to adjust to the physical load given to it so that it can avoid excessive fatigue (Kushartanti, 2015).

Higher physical freshness can improve the appearance of athletes and reduce the likelihood of injury (Sherwood, 2011). The most important element in physical freshness is cardiorespiratory endurance. Cardiorespiratory endurance is the ability of the heart and lungs as well as blood vessels to function optimally at rest as well as exercise to take in oxygen and then distribute it to active tissues to be used in the body's metabolic processes (Puspa, 2009).

The purpose of this study is to determine the effect of sports activities on changes in Maximum Oxygen Volume (VO<sub>2</sub>Max) and the difference in recovery period between trained and untrained student groups at the Faculty of Medicine, University of Muhammadiyah North Sumatra. While prior research has extensively examined the relationship between physical activity and VO<sub>2</sub>Max in varied populations, including Iranian, Portuguese, and American adolescents (Lee et al., 2001; Candra Dewi et al., 2020; WHO, 2017), this study presents a contextual novelty by focusing specifically on medical students at the University of Muhammadiyah North Sumatra—a population with demanding cognitive load but potentially limited physical engagement. Furthermore, the study contrasts trained (active in the sports student unit) and untrained student groups using the Six-Minute Walking Test (6MWT), providing empirical data on both VO<sub>2</sub>Max and recovery time pre- and post-exercise. Although similar studies (Budriarsa, 2013; Giriwijoyo & Sidik, 2013; Krisnawati et al., 2021) have addressed fitness and cardiovascular outcomes, this research distinctively integrates localized demographic data, direct physiological assessments, and training status differentiation—adding value to academic discourse on student health and informing future physical fitness interventions in university settings.

## **METHOD**

This research is in the form of an experimental study. Data were obtained before and after the six-minute walking test (6MWT). This research was conducted at the Faculty of Medicine, University of Muhammadiyah North Sumatra starting from September to December 2016. The target population in this study is all students of the Faculty of Medicine, University of Muhammadiyah North Sumatra divided into trained student groups, namely participating in the Sports Student Activity Unit, and untrained student groups at the Faculty of Medicine, University of Muhammadiyah North Sumatra. The sample used in this study is a group of trained and untrained students who meet the inclusion criteria at the Faculty of Medicine, University of Muhammadiyah North Sumatra. Sampling technique using the consecutive sampling method.

## **RESULT AND DISCUSSION**

### **Description of respondent characteristics**

Respondent data collection was carried out at the Faculty of Medicine, University of Muhammadiyah North Sumatra. The data measured first was the measurement of weight, height, then the body mass index of each respondent was determined. Then a physical examination was carried out, namely a muscle strength check using a Manual Muscle Test (MMT), a balance test using a balance test (quick test) before a six-minute walking test. Then blood pressure and pulse rest before and after doing the six-minute walking test.

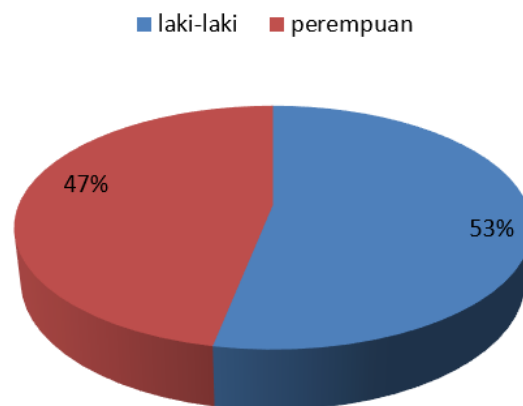
The data obtained will be analyzed so that it can be known. who are willing to become samples, sign an informed consent, fill out questionnaire measuring instruments and all research protocols have been approved by the ethics commission of the Faculty of Medicine, University of North Sumatra NO. 22 /TGL/KEPK FK USU-RSUP HAM/2017.

**Respondent demographic data**

The students who became respondents amounted to 32 people who were determined through an average formula for two independent groups. Subjects with a group of trained students were 16 people (50%), and respondents with an untrained student group were 16 people (50%).

**Gender frequency distribution**

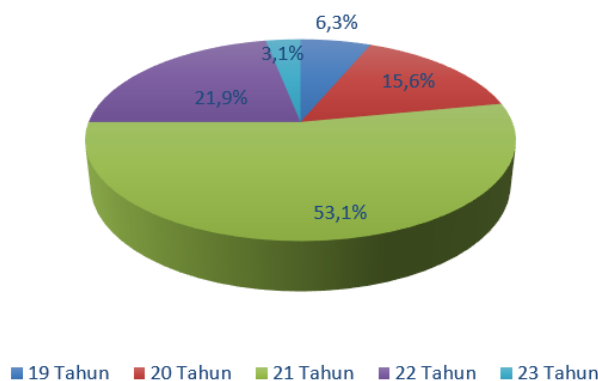
Based on the results of the research conducted, it can be seen that the distribution of the most gender frequencies is from 32 students, there are 17 people with male sex frequencies (53.1%) and 15 people with female sex frequencies (46.9%).



**Figure 1. Sex frequency distribution diagram**

**Age frequency distribution**

Based on the results of the study on 32 students, it was found that the distribution of the highest age frequency was 21 years as many as 17 people with a percentage of 53.1%, followed by the age of 22 years which was 7 people (21.9%). Then followed by 5 people (15.6%) at the age of 20 years, then 2 people (6.3%) at the age of 19 (6.3%), and 1 person (3.1%) at the age of 23 years (3.1%) who became the lowest representative.



**Figure 2. Age frequency distribution diagram**

**Deskriptif data**

*VO2Max group of trained students.*

**Table 1. Average VO2Max scores of the group of trained students.**

| VO2Max Trained Student Group | Average (Standard Deviation) |
|------------------------------|------------------------------|
| Before 6 MWT                 | 69.0819 (13.28436)           |
| After 6 MWT                  | 67.4475 (12.53702)           |

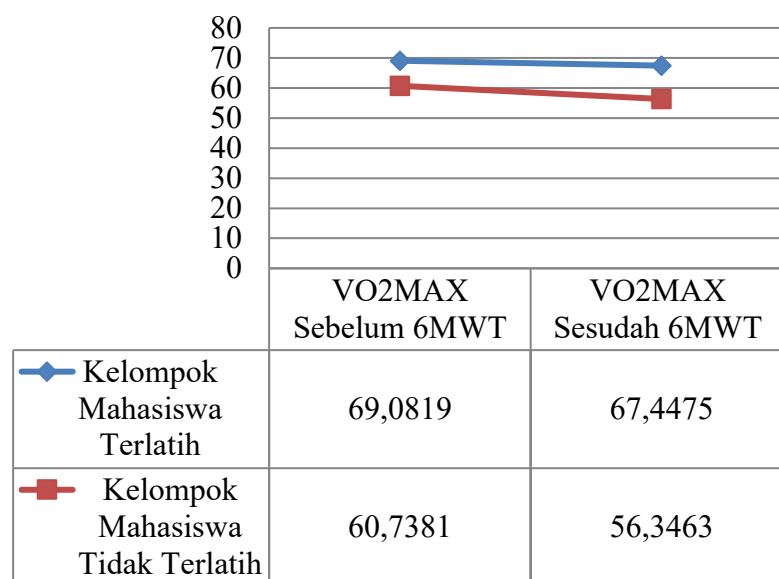
The results of the VO2Max measurement before the six-minute walking test in the group of trained students were obtained on average 69.0819 ml/kg/min with 67.4475 ml/kg/min after

*VO2Max group of untrained students*

**Table 2. Average VO2Max scores of the untrained group of students.**

| VO2Max Untrained Student Group | Average (Standard Deviation) |
|--------------------------------|------------------------------|
| Before 6 MWT                   | 60.7381 (13.00182)           |
| After 6 MWT                    | 56.3463 (11.64904)           |

The results of the VO2Max measurement before the six-minute walking test in the group of untrained students were obtained on average 60.7381 ml/kg/min with 56.3463 ml/kg/min after 56.3463 ml/kg/min. The results of VO2Max measurements in trained and untrained students before the six-minute walking test showed differences and changes after the six-minute walking test exercise.



**Figure 3.** Graph Average VO2Max scores before and after the six minute walking test (6MWT)) between the group of trained and untrained students

**Recovery Period**

**Table 3 The average value of the recovery period of the group of trained and untrained students.**

| Recovery Time)           | Average (Standard Deviation) |
|--------------------------|------------------------------|
| Trained Student Groups   | 85.9375 (8.13608)            |
| Untrained Student Groups | 96.8125 (12.02896)           |

In the untrained student group, the average recovery period was 96.8125 X/i, while in the untrained student group, the average recovery period was 85.9375 X/i

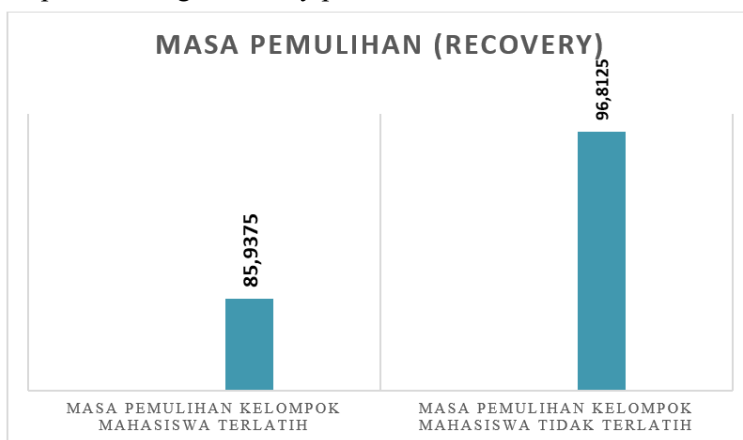


Figure 4. Graph The average value of the recovery period of the six minute walking test (6MWT) between the group of trained and untrained students

Results of statistical analysis

Statistical analysis of variables

a. Normality Test

The measurement results were carried out a normality test to see the distribution of numerical data. Data that are normally distributed will be parametric tests while those that are not normally distributed will be tested non-parametrically. After the normality test was carried out, the following results were obtained.

Table 4. Tests of VO2Max normality and recovery period of trained and untrained student groups.

|   | Nilai p Shapiro-Wilk |
|---|----------------------|
| The difference in VO2Max in the group of trained students   | 0,064                |
| The difference in VO2Max in the group of untrained students | 0,787                |
| A Period of Recovery for Trained Students                   | 0,070                |
| Recovery period of untrained students                       | 0,254                |

Based on the table above, it shows that the results of the normality test on all differences in VO2Max data for the group of trained and untrained students before and after 6 minutes walking distance/test (6MWT), and the recovery period shows a normal distribution of data distribution ( $p > 0.05$ ), then a parametric test will be performed. So that in this test, a paired t-test and a non-paired t-test are carried out

b. VO2Max difference between trained and untrained student groups

Table 5. Paired t-tests before and after the six-minute walking practice test for the group of trained students

|  | Rerata (s.b)   | Difference (s.b) | IK 95%   | Value p |
|--|----------------|------------------|----------|---------|
| VO2Max before the group of trained students (n=16) | 69.089(13.284) | 1,634(1,721)     | 0,71-2,5 | 0,002   |
| VO2Max after the group of trained students (n=16)  | 67.447(12.537) |                  |          |         |

s.b : Baku Junction

IK : Trust Index

Paired t-test

Based on the table above, it shows that the results of the paired t-test obtained a significant difference in VO2Max for the group of trained students before and after the six-minute walking distance/test (6MWT) with a value of  $p=0.002$  ( $p<0.05$ ). It can be concluded that  $H_0$  was rejected and there was a difference in the six minute walking distance/test (6MWT) to VO2Max.

**Table 6. Paired t-tests before and after the six-minute walking practice test group of untrained students.**

|  | Rerata (s.b)  | Difference (s.b) | IK 95%    | Value p |
|--|---------------|------------------|-----------|---------|
| VO2Max before the untrained group of students (n=16) | 60.738(13.01) | 4.39 (3.20)      | 2.68-6.10 | <0,001  |
| VO2Max after the group of untrained students (n=16)  | 56.346(11.65) |                  |           |         |

s.b : Baku Junction

IK : Trust Index

Paired t-test

Based on the table above, it shows that the results of the paired t-test were obtained with a significant difference in VO2Max for the group of untrained students before and after the six-minute walking distance/test (6MWT) test with a value of  $p=0.001$  ( $p<0.05$ ). It can be concluded that  $H_0$  was rejected and there was a difference in the six minute walking distance/test (6MWT) to VO2Max

c. Difference in VO2Max before and after between the group of trained and untrained students

**Table 7. Unpaired t-test differences before and after the six-minute walking practice test group of trained and untrained students.**

|  | Rerata (s.b) | Value p | Average difference (IK 95%) |
|--|--------------|---------|-----------------------------|
| VO2Max group of trained students (n=16)          | 1.63(1.72)   | 0.005   | 2.76(0.90-4,61)             |
| VO2Max of the untrained group of students (n=16) | 4.39(3.20)   |         |                             |

Unpaired t-test

Based on the table above, it shows that the results of the unpaired t-test found a significant difference in VO2Max between the two groups, namely the group of trained and untrained

students. with a value of  $p=0.005$  ( $p<0.05$ ). It can be concluded that  $H_0$  was rejected, and there was a difference between the group of trained and untrained students. with the six-minute walking distance/test (6MWT) method

- d. Difference in recovery period between trained and untrained student groups

**Table 8. Unpaired t-test recovery period a six-minute walking practice test between a group of trained and untrained students.**

|   | Rerata (s.b) | Value p | Average difference (IK 95%) |
|---|--------------|---------|-----------------------------|
| A Period of Recovery for Trained Students | 85,94(8,14)  | 0,005   | 10,88(3,46-18,29)           |
| Recovery period of untrained students     | 96,81(12,03) |         |                             |

#### Unpaired t-test

Based on the table above, it shows that the results of the unpaired t-test were obtained with a significant difference in the recovery period between the two groups, namely the group of trained and untrained students. with a value of  $p=0.005$  ( $p<0.05$ ). It can be concluded that  $H_0$  was rejected, and there is a difference between the group of trained and untrained students. with the six-minute walking distance/test (6MWT) method

## Discussion

The results showed that the majority of respondents were 21 years old, followed by 22 years old, then 20 years old, followed by 19 years old, and 23 years old. Because the class of 2013 is the highest batch at this time and the most who participate in the student sports activity unit, where the class of 2013 is dominated by students who are 21 years old. The sample in this study consisted of 17 men and 15 women. The number of male samples is more than that of women because in this population the number of men is more dominant than women.

The results of the analysis of paired t-test data obtained a significant difference in VO<sub>2</sub> Max between the two groups, namely the group of trained and untrained students before and after the six-minute walking distance/test (6MWT) was carried out. And an analysis of unpaired t-test data showed that there was a significant difference between the difference before and after the six-minute walking test in the trained and untrained groups of students. There was also a significant difference in the recovery period between the two groups, namely the group of trained and untrained students. This result is in line with a study conducted in 2012, a significant difference in average scores between students who regularly exercise and students who do not regularly exercise with a value of  $p = 0.000$  ( $p<0.001$ ) (Herman, 2014).

The results of VO<sub>2</sub>Max measurements in trained and untrained students before the six-minute walking test showed differences and changes after the six-minute walking test exercise. Because there are many factors that influence and determine the VO<sub>2</sub>Max value. The factors that affect the change in VO<sub>2</sub>Max are 1) cardiorespiratory endurance, 2) body composition, 3) red blood cells (haemoglobin), 4) muscle strength, 5) muscle endurance. And the determining factors are 1) age, 2) gender, 3) genetics, 4) temperature, 5) training conditions.

The effect of exercise causes an increase in the efficiency of the work of a trained person's lungs so that they can process more air, with less energy. During laborious work, a trained person can process air almost twice as much per minute as an untrained person. Then trained people can provide more oxygen to be used in the process of energy formation. The muscles of the athletes are well developed,

as are the hearts (Krisnawati et al., 2021). This is in line with the results of a study conducted by Huldani in 2008 showing that students who practice football have a greater VO2Max than those who do not practice which statistically means  $p < 0.005$  (Budriarsa, 2013).

The above is supported by the results of a study conducted by Deasy, that the intensity of a person's physical exercise is directly proportional to his VO2Max value. A person who does physical exercise regularly will have a better VO<sub>2</sub> Max value compared to someone who does not do physical exercise (Prianto et al., 2022).

In this study, the results of the measurement of recovery periods in trained and untrained students showed significant differences and changes, after the six-minute walking practice test exercise. As the theory mentions Decreased Heart Rate: Trained people will have a lower resting heart rate than untrained people. A lower heart rate results in higher VO2Max values in trained people. The heart rate can decrease after doing physical exercise for a certain amount of time, this is the body's compensation for physical exercise. As a result, trained people will work more effectively than untrained people. This is in accordance with research conducted on medical students of the Islamic University of Indonesia, it was found that there was a significant difference between the trained group, namely DIY runner athletes, and the group of FK UII students who were not trained ( $p = 0.004$ ) (Giriwijoyo & Sidik, 2013).

In general, when a person becomes in better fitness, then the resting pulse will be slower, a sign that the heart is pumping blood more efficiently. So the effectiveness of the heart pump of each heart beat can be 40%-50% greater in highly trained athletes compared to untrained people (Asnawati et al., 2013).

Pulse is an indicator to see the intensity of exercise or work being done. In one person, there is a linear relationship between intensity and pulse, meaning that an increase in the intensity of work or exercise will be followed by an increase in pulse rate accordingly. Pulse monitoring is carried out every time immediately after finishing doing health exercise within a time limit of ten seconds and must always be done to find out what the pulse value it reaches, so that the intensity of the physical exercise carried out can be adjusted again (Man et al., 2017).

Some of the advantages found in this study are that this research is the first research conducted at the Faculty of Medicine, University of Muhammadiyah North Sumatra so that it can be a new learning material for the faculty so that it can be developed by other students to conduct similar research in the future, and this research can be a reference material for the faculty to find out the physical fitness, both physical and spiritual, of students and student (Mapanyukki, 2011).

Some of the limitations found in this study are due to the limitations of time, energy and materials, so the research design used is cross sectional, the measurement of the variables is only done once, at a time. The pulse test was done manually and counted for 15 seconds, requiring a long study time, because the study subjects who met the research criteria were difficult to coordinate to undergo the VO2Max test and the recovery period (*recovery*).

## **CONCLUSION**

The study found significant differences in VO2Max (paired t-test: trained  $p < 0.002$ , untrained  $p < 0.001$ ) and recovery (unpaired t-test:  $p < 0.005$ ) between trained and untrained students after the 6MWT, with influencing factors including cardiorespiratory endurance, body composition, hemoglobin, muscle strength/endurance, and non-modifiable factors like age, gender, and genetics. Future research should investigate long-term effects of structured training (e.g., HIIT vs. MICT over 8–12 weeks) on VO2Max and recovery, while quantifying the impact of modifiable (training, diet) vs. non-modifiable (genetics) factors using advanced modeling. Additionally, exploring physiological

markers (e.g., heart rate variability, lactate clearance) and population-specific adaptations (e.g., athletes, elderly) could optimize training protocols and clarify individual variability in cardiorespiratory fitness.

## REFERENCES

- Álvarez, C., Cadore, E. L., Gaya, A. R., Mello, J. B., Reuter, C. P., Delgado-Floody, P., Ramos Sepúlveda, J. A., Carrillo, H. A., Devia, D. G., Burgos, A. V., Vásquez-Gómez, J., Ramírez-Vélez, R., Alonso-Martínez, A. M., & Izquierdo, M. (2023). A descriptive ranking of blood pressure and physical fitness of Latin–American ethnic schoolchildren. *Ethnicity and Health*, 28(1). <https://doi.org/10.1080/13557858.2021.2002827>
- Amra, B., Kelishadi, R., & Golshan, M. (2009). Peak oxygen uptake of healthy Iranian adolescents. *Archives of Medical Science*, 5(1).
- Asnawati, Huldani, & Hariri, N. (2013). Perbandingan nilai vo 2 maks antara siswa terlatih dengan siswa tidak terlatih. *Perbandingan Nilai VO2 Maks Antara Siswa Terlatih Dengan Siswa Tidak Terlatih Di SMAN 1 Martapura*, 9(I).
- Budriarsa, G. (2013). Pengaruh pelatihan lari tiga sudut dan side jump sprint terhadap denyut nadi istirahat. *Jurnal Ilmu Keolahragaan Undiksha*, 1(1).
- Candra Dewi, N. K. A. T., Astra, I. K. B., & Suwiwa, I. G. (2020). Motivasi Mahasiswa Prodi Pendidikan Jasmani Kesehatan Dan Rekreasi Fakultas Olahraga Dan Kesehatan Menjaga Kebugaran Jasmani Pada Masa Pandemi COVID-19. *Jurnal Ilmu Keolahragaan Undiksha*, 8(1). <https://doi.org/10.23887/jiku.v8i1.29573>
- Fraser, G. E., Phillips, R. L., & Harris, R. (1983). Physical fitness and blood pressure in school children. *Circulation*, 67(2). <https://doi.org/10.1161/01.CIR.67.2.405>
- Gandasari, M. F., & Manurung, J. S. R. (2020). Evaluasi Potensi Fisik Siswa Sma Sebagai Suatu Hasil Belajar Mata Pelajaran Penjasorkes (Studi Pada Sma Negeri Di Kecamatan Sengah Temila). *Riyadhoh : Jurnal Pendidikan Olahraga*, 3(2). <https://doi.org/10.31602/rjpo.v3i2.3577>
- Giriwijoyo, S., & Sidik, D. Z. (2013). Ilmu Faal Olahraga (Fisiologi Olahraga): Fungsi Tubuh Manusia pada Olahraga untuk Kesehatan dan Prestasi. *Bandung: Remaja Rosdakkar*.
- Herman. (2014). Pengaruh Latihan Terhadap Fungsi Otot dan Pernapasan. *Jurnal ILARA*, 1(2).
- Huang, Y. C., & Malina, R. M. (2002). Physical activity and health-related physical fitness in Taiwanese adolescents. *Journal of Physiological Anthropology and Applied Human Science*, 21(1). <https://doi.org/10.2114/jpa.21.11>
- Ibrahim, N. I., & Mohamed, I. N. (2021). Interdependence of anti-inflammatory and antioxidant properties of squalene—implication for cardiovascular health. In *Life* (Vol. 11, Issue 2). <https://doi.org/10.3390/life11020103>
- Karim, F. (2002). Panduan Kesehatan Bagi Petugas kesehatan. *Tim Departemen Kesehatan*.
- Kementrian Kesehatan RI. (2013). Riset kesehatan dasar (RISKESDAS). Badan Penelitian dan Pengembangan Kesehatan Kemenkes RI. *Jurnal Cerebellum*, 4(2).
- Krisnawati, D., Pradigdo, S. F., & Kartini, A. (2021). Efek Cairan Rehidrasi terhadap Denyut Nadi, Tekanan Darah dan Lama Periode Pemulihan. *Media Ilmu Keolahragaan Indonesia*, 1(2).
- Kushartanti, W. (2015). Fisiologi dan Kesehatan Olahraga. *Academia*, 2(1).
- Lee, C., Blair, S., & Jackson, A. (2001). Cardiorespiratory fitness, body composition, and all-cause and cardiovascular disease mortality in men. *Rehabilitation Oncology*, 19(2). <https://doi.org/10.1097/01893697-200119020-00044>

- Lee, S. J., & Arslanian, S. A. (2007). Cardiorespiratory fitness and abdominal adiposity in youth. *European Journal of Clinical Nutrition*, 61(4). <https://doi.org/10.1038/sj.ejcn.1602541>
- Man, W. H., De Steenhuijsen Pipers, W. A. A., & Bogaert, D. (2017). The microbiota of the respiratory tract: Gatekeeper to respiratory health. In *Nature Reviews Microbiology* (Vol. 15, Issue 5). <https://doi.org/10.1038/nrmicro.2017.14>
- Mapanyukki, A. A. (2011). Konsumsi Oksigen dalam Latihan. *Ilara*, 2.
- Prianto, D. A., Utomo, M. A. S., Abi Permana, D. A. P., Mutohir, T. C., & Suroto. (2022). Survey Tingkat Kebugaran Jasmani dan Faktor Yang Mempengaruhi Tingkat Kebugaran Jasmani Siswa Sekolah Menengah Pertama di Sidoarjo. *Jurnal Segar*, 10(2). <https://doi.org/10.21009/segar/1002.01>
- Puspa, L. (2009). Hubungan Fisiologi dengan Prestasi Olahraga. *Jurnal Ilmiah Abdi Ilmu*, 2.
- Shear, C. L., Burke, G. L., Freedman, D. S., & Berenson, G. S. (1986). Value of childhood blood pressure measurements and family history in predicting future blood pressure status: Results from 8 years of follow-up in the Bogalusa Heart Study. *Pediatrics*, 77(6). <https://doi.org/10.1542/peds.77.6.862>
- Sherwood, L. (2011). Fisiologi Manusia dari Sistem ke Sel. In *Human Physiology: From Cells to System*.
- Tangkilisan, V., Kawengian, S. E. S., & Mayulu, N. (2013). Hubungan Antara Aktivitas Fisik Dengan Kadar Hs-Crp Serum Pada Mahasiswa Obes Dan Tidak Obes Di Fakultas Kedokteran Universitas Sam Ratulangi Manado. *Jurnal E-Biomedik*, 1(1). <https://doi.org/10.35790/ebm.1.1.2013.4611>
- WHO. (2017). Cancer: WHO Definition of Palliative Care. *World Health Organisation*.
- Widayati, T. (2018). Pendidikan Keselamatan Diri Anak Usia Dini. *JIV-Jurnal Ilmiah Visi*, 13(2). <https://doi.org/10.21009/jiv.1302.5>



© 2025 by the authors. It was submitted for possible open-access publication under the terms and conditions of the Creative Commons Attribution (CC BY SA) license (<https://creativecommons.org/licenses/by-sa/4.0/>).