

## THE EFFECT OF *AEROBIC* EXERCISE ON BLOOD SUGAR LEVELS IN ADOLESCENTS AT RISK OF DIABETES MELLITUS

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### Abstract

**Background:** Indonesia ranks fifth in the number of people with diabetes. Diabetes cases in Indonesia reach hundreds of thousands, with the majority of sufferers aged over fifteen years. Cases of diabetes mellitus have risk factors that will increase the incidence of diabetes mellitus in 3-4 years later, especially in adolescence related to bad habits towards lifestyle, one of which is lack of physical activity. Some physical activities that are suitable for adolescents such as aerobic exercise that can reduce blood sugar levels.

**Objective:** This study aims to analyze the effect of aerobic exercise on blood sugar levels in adolescents at risk of diabetes mellitus.

**Methods:** This study was *Quasi experiment* design with a *pre-test* and *post-test two group* design. The sample was 60 adolescents who were divided into intervention and control groups. Inclusion criteria were class VIII students, mild and moderate DM risk, and exclusion criteria were severe DM risk. Measurement of blood sugar levels was carried out before and after the intervention using a glucometer. For data analysis using *Paired Sample T-Tests and ANCOVA*.

**Results:** The results showed a significant decrease in blood sugar levels in the intervention group p-value 0.00, while the control group p-value 0.77. Aerobic exercise has an effect on blood sugar levels with a p-value of 0.00. **Conclusion:** Aerobic exercise can reduce blood sugar levels while in adolescents at risk of diabetes mellitus. Health promotion programs in schools should integrate regular aerobic exercise sessions into the physical education curriculum, particularly targeting adolescents at risk of diabetes mellitus

**Keywords:** Blood Sugar, Adolescents, DM Risk, Aerobic Exercise.

### Introduction

Diabetes mellitus is currently one of the most prevalent degenerative diseases (Rahmala et al., 2023). This chronic condition occurs when the body either fails to produce adequate insulin or is unable to utilize it effectively (Amidos Pardede et al., 2022). Over the past 30 years, the global prevalence of diabetes mellitus has continued to rise, with approximately 422 million individuals affected worldwide (WHO, 2023). According to the International Diabetes Federation (IDF) in 2021, around 537 million adults aged between 20 and 79 years are living with diabetes, marking an increase of 24.0%. Indonesia ranks fifth globally, with 19.47% of its population affected by the disease (IDF, 2021). Nationally, there are 877,531 diagnosed cases across all age groups, including 638,178 cases among individuals aged over 15 years (SKI,

2023). In Bandung City, the number of diabetes cases reached 44,329, rising from 43,761 in 2021 (Dinkes Bandung City, 2021). The prevalence also appears to be higher among older adults, particularly in the age groups 55–64 years (5.65%), 65–74 years (5.41%), and 75 years and above (3.23%) (Riskesdas, 2019). Several risk factors contribute to the development and progression of diabetes, which may stem from both internal (biological) and external (environmental) sources (Kabosu et al., 2019).

Various factors contribute to the risk of developing diabetes mellitus. Some of these factors are modifiable, including lifestyle choices, sleep patterns, stress management, and levels of physical activity. Others, such as age and genetic predisposition, are non-modifiable (Puspasari et al., 2022). Inadequate control of these modifiable risk factors significantly increases the likelihood of developing diabetes. Individuals who fail to adopt healthier behaviors may progress to diabetes within 3–4 years (Putri et al., 2023). Often, diabetes mellitus remains undetected until complications arise. Therefore, early preventive efforts are essential, especially during adolescence (Opara et al., 2020). Adolescents are considered at increased risk due to their tendency toward unhealthy lifestyle habits (Al-Shudifat et al., 2017). Research has shown a growing number of diabetes cases among children and adolescents across various countries, although the rates are still lower than in adults and the elderly (Qifti et al., 2020). In Indonesia, medical diagnoses indicate that 159,014 individuals aged 15–24 years have diabetes mellitus (Ministry of Health RI, 2018). Globally, adolescents represent a significant demographic, with an estimated 1.2 billion individuals, accounting for approximately 16% of the total population (UNICEF, 2019). The adolescent stage, defined as ages 10–19 years, is marked by rapid mental, physical, emotional, and social development (WHO, 2018). During this period, adolescents are particularly vulnerable to diabetes due to unhealthy behaviors such as poor dietary intake, low fruit and vegetable consumption, frequent intake of sugary drinks, smoking, and insufficient physical activity (Yuningrum et al., 2021).

According to the 2018 Basic Health Research, one of the notable risk factors for diabetes mellitus among adolescents is insufficient physical activity, reported at 33.5% (RISKESDAS, 2019). Currently, many teenagers spend their leisure time engaging in sedentary behaviors such as playing online games, watching television, using computers, and browsing on mobile phones (Qifti et al., 2020). In contrast, adolescents can maintain their health through simple physical activities like sweeping, gardening, mopping, making the bed, and exercising (Darti et al., 2021). If no preventive actions are taken, diabetes mellitus may develop within the next decade, particularly among adolescents at moderate to high risk. While lifestyle changes play a crucial role in prevention, other factors such as body mass index—especially obesity—must also be considered (Opara et al., 2020). Additional risk factors include a family history of diabetes, the presence of hypertension, and low levels of physical activity, all of which significantly contribute to the likelihood of developing diabetes mellitus (Al-Shudifat et al., 2017).

Physical activity refers to any movement that increases energy expenditure and plays a vital role in maintaining overall health, improving quality of life, boosting the immune system, and preventing obesity (Romadhoni et al., 2022). It also has a significant impact on blood glucose regulation. During physical activity, muscles require more glucose for energy. If the body cannot supply enough glucose to meet this increased demand—particularly during intense exercise—blood sugar levels may decrease. On the other hand, limited physical activity can impair glucose regulation, resulting in elevated blood sugar levels (Lubis & Kanzasabilla, 2021). Engaging in physical activity helps lower blood glucose levels by enhancing glucose uptake by muscle cells (Ega Safitri et al., 2022). Exercise, in particular, can contribute to energy expenditure ranging from 20% to 50% (Yuningrum et al., 2021). Several types of physical activity are particularly suitable for adolescents, including walking, cycling, jogging, and gymnastics (Mustofa et al., 2022). Aerobic exercise, in particular, has been shown to

effectively reduce blood sugar levels in individuals with diabetes (Siregar, 2019). It is considered one of the most accessible, enjoyable, and popular forms of exercise (Lubis & Kanzanabilla, 2021). In addition to helping regulate blood glucose, aerobic exercise also offers benefits such as supporting weight loss and alleviating symptoms of anxiety (Sari & Effendi, 2020).

Research conducted by Nababan & Nababan (2022) demonstrated that aerobic exercise significantly reduces blood glucose levels in individuals with type 2 diabetes. In their study, participants in the intervention group had an average blood glucose level of 192.73 mg/dl before the intervention, which decreased to 153.80 mg/dl afterward. Similarly, Almeida et al. (2020) reported a reduction of 29.53 mg/dl (20.52%) in the experimental group, while the control group showed a smaller decrease of 14.52 mg/dl (11.41%). These findings highlight the positive impact of aerobic exercise in lowering blood sugar levels among patients with type 2 diabetes mellitus. However, there is still a lack of research investigating the effects of aerobic exercise on blood glucose levels in adolescents who are at risk for diabetes mellitus. To identify adolescents at risk, the FRIDEM application can be used as a screening tool.

## **Method**

The study was Quasi Experiment with a pre-test and post-test two group design. This research was conducted on January 13 -31, 2025. The study population consisted of adolescents from SMPN 2 Katapang. A purposive sampling method was applied. The sample size was calculated using G\*Power version 3.1.9.4 with the following specifications: statistical analysis based on an F-test with ANCOVA (fixed effect, main effects, and interactions), effect size  $f = 0.4$ , significance level ( $\alpha$ ) = 0.05, statistical power ( $1 - \beta$ ) = 0.8, numerator degrees of freedom = 1, two groups, and one covariate. The inclusion criterion was enrollment in the eighth grade, while the exclusion criterion was being identified as having a high risk of type 2 diabetes mellitus according to the E-FRIDEM application. The total sample consisted of 60 participants, evenly divided into an intervention group ( $n = 30$ ) and a control group ( $n = 30$ ). Blood glucose levels were assessed using a digital glucometer. Measurements were taken both before and after the aerobic exercise intervention. The equipment and materials used included a GCU (Glucose, Cholesterol, and Uric Acid) device, glucose test strips, alcohol swabs, gloves, an observation sheet for recording glucose results, and a pen. The intervention provided was a physical activity in the form of aerobic exercise, conducted two times a week with a duration of 30 minutes per session. The stages of aerobic exercise were divided into three parts, namely: warm-up, main movements, and cool-down, in accordance with standard aerobic exercise procedures. Statistical tests using Paired Sample T-Tests and ANCOVA.

## Results

Table 1. Demographic data: of the Respondents (N=60)

Variables	Intervention (n=30)		Control (n=30)		P-value
	Mean±SD	Min-Max	Mean±SD	Min-Max	
Age	13.82 ± .531	13-15	13.80 ± .407	13-14	0.278
Height	159.37 ±10.785	141-185	155.70 ± 8.470	133-177	0.675
Boby Weight	49.53 ± 13.607	32-105	48.20 ± 10.772	32-72	0.148
DM risk score	2.67±1.093	1-6	2.53±1.532	1-7	0.707

Based on Table 1, the mean age of adolescents in both the intervention and control groups was 13 years. The average height was 159 cm in the intervention group and 155 cm in the control group. The mean body weight was 49 kg for the intervention group and 48 kg for the control group. The average diabetes mellitus risk score was 2.67 in the intervention group and 2.53 in the control group.

Table 2. Demographic data: gender in the intervention and control groups (N=60)

Variables	Intervention Group		Control Group		P-value
	(n=30)		(n=30)		
	F	%	F	%	
Gender					
Female	17	(51 %)	17	(51 %)	0.134
Male	13	(49 %)	13	(49 %)	

Based on table 2, the gender in the intervention and control groups was the same, more than half of the respondents were female (51%).

Table 3. Blood sugar before and after intervention (n=60)

Variables	Intervention Group (n=30)		Control Group (n=30)	
	Mean± SD	Min-Max	Mean±SD	Min-Max
Pretest	123.00 ± 15.704	97-172	110.77 ± 14.123	80-142
Posttest	100.97 ± 10.804	80-124	115.70 ± 17.554	85-157

Based on Table 3, the intervention group had a mean blood sugar level of 123 mg/dL at pretest and 100 mg/dL at post-test. In the control group, the mean blood sugar level was 110 mg/dL at pretest and 115 mg/dL at post-test.

Table 4. Analysis of differences in the value of blood sugar levels before and after aerobic exercise in the intervention group and control group.

Variables	t	P-value
Intervention group pretest and posttest (n=30)	8.921	0.000
Control group pretest and posttest (n=30)	-1.834	0.077

Based on table 4. the results of the paired sample t-test in the intervention group p-value = 0.000, and the control group with a p-value of 0.077

Table 5. Analysis of the effect aerobic exercise toward blood sugar levels

Source	Type III Sum of Squares	df	Mean Square	F	Sig
Corrected Model	14970.111 <sup>a</sup>	35	427.717	3.085	0.003
Intercept	20977.062	1	20977.062	151.298	0.000
Group	2398.294	1	2398.294	17.298	0.000
GDS_PRE	10055.961	34	295.764	2.133	0.028
Error	3327.539	24	138.647		
Total	700751.000	60			
Corrected Total	18297.650	59			

Based on Table 5, the ANCOVA test showed a significance value of  $p = 0.000$  when comparing blood sugar levels between the intervention and control groups. This finding indicates that aerobic exercise had a significant effect on reducing blood sugar levels among adolescents at risk of diabetes mellitus.

## Discussion

The results showed a decrease in blood sugar levels in the intervention group, while an increase was observed in the control group that did not receive aerobic exercise. This finding aligns with the study by Nababan and Nababan (2022). Risk factors for diabetes include unhealthy lifestyles, insufficient physical activity, and obesity; therefore, the primary step in managing diabetes risk is prevention through regular physical activity (Ega Safitri et al., 2022). Adolescents aged 13–15 years undergo significant growth and development, during which poor dietary habits and lack of exercise can increase the likelihood of developing diabetes mellitus (Suha & Rosyada, 2022). Research by Cahyani et al. (2024) also highlights that female adolescents are at greater risk, as women tend to have a higher likelihood of weight gain or increased body mass index, coupled with hormonal factors that may contribute to the development of diabetes mellitus (Imelda, 2019). Aerobic exercise is a form of physical activity involving movements that engage large muscle groups of the body. This type of exercise enhances muscle glucose utilization, meaning that during physical activity, muscles draw upon glucose stores in the body. Conversely, insufficient physical activity can lead to elevated insulin levels, as nutrients from food are not adequately burned but instead stored as sugar and fat (Purnama & Sari, 2019). The findings of this study are consistent with those of Dewi and Susilawaty (2019), who reported that aerobic exercise positively influences blood sugar control. In the present study, the intervention consisted of aerobic exercise conducted three times for 30 minutes, integrated into the scheduled sports lessons. The results confirm that aerobic exercise significantly impacts blood sugar levels in adolescents at risk of diabetes mellitus. This aligns with the findings of Fitriani and Fadilla (2020), who reported a significant effect of aerobic exercise on blood sugar levels ( $p = 0.00$ ). By increasing glucose uptake by the muscles, aerobic exercise contributes to lowering blood sugar levels in adolescents at risk of diabetes mellitus.

## Conclusion

This study demonstrates that aerobic exercise significantly reduces blood glucose levels in adolescents at risk of type 2 diabetes mellitus. Contributing risk factors such as poor diet, physical inactivity, obesity, and gender-specific physiological characteristics further support the importance of early lifestyle interventions among adolescents. Health promotion programs in schools should integrate regular aerobic exercise sessions into the physical education curriculum, particularly targeting adolescents at risk of diabetes mellitus. Structured aerobic activities can serve as a preventive strategy to manage blood glucose levels and reduce the long-term risk of type 2 diabetes.

## References

- Al-Shudifat, A. E., Al-Shdaifat, A., Al-Abdouh, A. A., Aburoman, M. I., Otoum, S. M., Sweedan, A. G., Khrais, I., Abdel-Hafez, I. H., & Johannessen, A. (2017). Diabetes Risk Score in a Young Student Population in Jordan: A Cross-Sectional Study. *Journal of Diabetes Research* [revista en Internet] 2017 [acceso 9 de agosto de 2020]; 1(1):1-5. Hindawi, 2017, 5. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5429959/>
- Amidos Pardede, J., Simanjuntak, G. V., Simamora, M., & Parapat, M. (2022). Self-Efficacy, Self-Compassion, and Dietary Compliance of Diabetes Mellitus Patients. *Tour Health Journal*, 1(1), 14–24.
- Arini, L. A., & Wijana, I. K. (2020). Korelasi Antara Body Mass Index (BMI) Dengan Blood Pressure (BP) Berdasarkan Ukuran Antropometri Pada Atlet. *JURNAL KESEHATAN PERINTIS (Perintis's Health Journal)*, 7(1), 32–40. <https://doi.org/10.33653/jkp.v7i1.390>

- Cahyani, A. R., Abdullah, A., & Santi, T. D. (2024). Faktor-Faktor yang berhubungan dengan Kejadian Diabetes Melitus pada Usia Produktif di Wilayah Kerja Puskesmas Kuta Alam Kota Banda Aceh Tahun 2023. *Jurnal Kesehatan Tambusai*, 5(1), 1429–1439.
- Darti, J., Wahyuningsih, R., Abdi, L., & Irianto. (2021). Aktivitas Fisik Remaja Pada Masa Pandemi Covid-19. *Jurnal Gizi Prima (Prime Nutrition Journal)*, 6(2), 91–96.
- Dewi, R., & Susilawaty, S. A. (2019). Efektivitas Senam Aerobik Terhadap Kontrol Glukosa Darah Pasien DM Tipe 2. *Jurnal Ilmiah Keperawatan Imelda* <http://jurnal.uimedan.ac.id/index.php/JurnalKeperawatan> Vol., 5(2), 91–95.
- Ega Safitri, Y., Rachmawati, D., Martiningsih, W., Studi Keperawatan Blitar, P., Keperawatan, J., & Kemenkes Malang, P. (2022). Pengaruh Aktivitas Fisik Dalam Menurunkan Kadar Glukosa Darah Pada Pasien Diabetes Melitus Tipe 2. *Jurnal Keperawatan Malang*, 7(2), 94–105. <https://jurnal.stikespantiwaluya.ac.id/index.php/JPW>
- Fitriani, F., & Fadilla, R. (2020). Pengaruh Senam Diabetes Terhadap Penurunan Kadar Gula Darah Pada Pasien Diabetes Mellitus. *Jurnal Kesehatan dan Pengembangan*, 10(19), 114–122.
- Imelda, S. I. (2019). Faktor-Faktor Yang Mempengaruhi Terjadinya diabetes Melitus di Puskesmas Harapan Raya Tahun 2018. *Scientia Journal*, 8(1), 28–39. <https://doi.org/10.35141/scj.v8i1.406>
- Kabosu, R. A. S., Adu, A. A., & Hinga, I. A. T. (2019). Faktor Risiko Kejadian Diabetes Melitus Tipe Dua di RS Bhayangkara Kota Kupang. *Timorese Journal of Public Health*, 1(1), 11–20. <https://doi.org/10.35508/tjph.v1i1.2122>
- Lubis, R. F., & Kanzanabilla, R. (2021). Latihan Senam Dapat Menurunkan Kadar Glukosa Darah pada Penderita Diabetes Melitus Tipe II. *Jurnal Biostatistik, Kependudukan, dan Informatika Kesehatan*, 1(3), 177. <https://doi.org/10.51181/bikfokes.v1i3.4649>
- Miftahurrahmah, Ayudia, E. I., Harahap, H., Siregar, M. I., & Annissa, D. (2024). Diabetes Melitus Pada Remaja Di Kota Jambi. 7, 77–81.
- Mustofa, E. E., Purwono, J., & Ludiana. (2022). Penerapan Senam Kaki Terhadap Kadar Glukosa Darah Pada Pasien Diabetes Melitus Di Wilayah Kerja Puskesmas Purwosari Kec. Metro Utara. *Jurnal Cendikia Muda*, 2(1), 78–86.
- Nababan, N. C., & Nababan, D. (2022). Pengaruh Senam Aerobik Terhadap Penurunan Kadar Glukosa Darah Sewaktu Pada Penderita Diabetes Mellitus Tipe 2 Di Puskesmas Poriaha. *Journal of Innovation Research and Knowledge*, 20(1), 105–123.
- Opara, B. C., Ijeh, I. I., Ejike, C. E. C. C., & Nnamudi, A. C. (2020). Diabetes risk score assessment and some adiposity indices in a young adult population in Umudike, Nigeria. *African Journal of Diabetes Medicine*, 28(1), 7–13. <https://www.embase.com/search/results?subaction=viewrecord&id=L2017763423&from=export>
- Panjaitan, R. S., Mailintina, Y., Yesayas, F., Meilawati, I., Rizqi, M., Rasyid, A., Valerina, A. A., & Rahayu, F. I. (2024). Edukasi Diabetes untuk Remaja Dipanti Aisyiyah : Meningkatkan Kesadaran dan Pencegahan Diabetes Education For Teenagers at Aisyiyah ' s Parenting : Increasing Awareness and Prevention Secara global , prevalensi diabetes melitus tipe 2 semakin meningkat ., *Jurnal Pengabdian dan Kesejahteraan Masyarakat*, 1(4).
- Purnama, A., & Sari, N. (2019). Aktivitas Fisik dan Hubungannya dengan Kejadian Diabetes Mellitus. *Window of Health : Jurnal Kesehatan*, 2(4), 368–381. <https://doi.org/10.33368/woh.v0i0.213>

- Puspasari, S., Nambiar, N., Said, F. B. M., Hayati, S. N., Supriatin, E., & Putri, T. A. R. K. (2022). E-FRIDEM Learnability as Type 2 Diabetes Mellitus Screening Tools In Indonesia. *Malaysian Journal of Medicine and Health Sciences*, 18(4), 1–6.
- Putri, D., Harahap, N., Manullang, S., Meyliana, D., & Chosya, C. (2023). Sebagai Bahan Alami Embuatan. 4(4), 8942–8946.
- Qifti, F., Malini, H., & Yetti, H. (2020). Karakteristik Remaja SMA dengan Faktor Risiko Diabetes Melitus di Kota Padang. *Jurnal Ilmiah Universitas Batanghari Jambi*, 20(2), 560. <https://doi.org/10.33087/jiubj.v20i2.950>
- Rahmala, G. U., Marfuah, D., & Noviyanti, R. D. (2023). Hubungan Aktivitas Fisik dan Kepatuhan Diet dengan Kadar Gula Darah Pasien Diabetes Mellitus Tipe II di RSUD Ibu Fatmawati Soekarno Surakarta. *Prosiding University Research Colloquium*, 684–692.
- RISKESDAS. (2019). Kementerian Kesehatan Republik Indonesia. In Kementerian Kesehatan RI (Vol. 1, Nomor 1). <https://www.kemkes.go.id/article/view/19093000001/penyakit-jantung-penyebab-kematian-terbanyak-ke-2-di-indonesia.html>
- Romadhoni, W. N., Nasuka, N., Candra, A. R. D., & Priambodo, E. N. (2022). Aktivitas Fisik Mahasiswa Pendidikan Kepelatihan Olahraga selama Pandemi COVID-19. *Gelombang Olahraga: Jurnal Pendidikan Jasmani dan Olahraga (JPJO)*, 5(2), 200–207. <https://doi.org/10.31539/jpjo.v5i2.3470>
- Sari, I. P., & Effendi, M. (2020). Efektifitas Senam Diabetes Terhadap Kadar Gula Darah Pada Pasien Diabetes Mellitus Di Lamongan. *Indonesian Journal for Health Sciences*, 4(1), 45. <https://doi.org/10.24269/ijhs.v4i1.2345>
- Suha GR, & Rosyada A. (2022). Faktor-Faktor yang Berhubungan dengan Kejadian Obesitas pada Remaja Umur 13-15 Tahun di Indonesia (Analisis Lanjut Data Riskesdas 2018). *Ilmu Gizi Indonesia*, 6(1), 43–56.
- Yuningrum, H., Trisnowati, H., & Rosdewi, N. N. (2021). Faktor Risiko Penyakit Tidak Menular (PTM) pada Remaja: Studi Kasus pada SMA Negeri dan Swasta di Kota Yogyakarta. *Jurnal Formil (Forum Ilmiah) Kesmas Respasi*, 6(1), 41. <https://doi.org/10.35842/formil.v6i1.343>