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The Relationship Between Physical Activity and Blood Sugar Levels in Type 2 Diabetes Mellitus Patients

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ABSTRACT

Type II diabetes mellitus is one of the non-communicable diseases with a continuously increasing prevalence, significantly impacting quality of life and healthcare costs. The demographic transition in Indonesia, which has shifted from a developing population to an industrial society, has brought new tendencies within the community. The disease pattern, which was previously dominated by infectious diseases, is now dominated by non-communicable diseases, including diabetes mellitus. This study aims to analyze the relationship between physical activity and blood sugar levels in patients with type 2 diabetes mellitus within the working area of the Dau Public Health Center in Malang Regency. This study employs a quantitative research type with a correlational analytic design using a cross-sectional data collection method. The sample in this study consisted of 51 respondents selected through purposive sampling based on inclusion criteria, and data were collected using the Global Physical Activity Questionnaire (GPAQ) and observations of blood sugar level examinations using a glucometer. The study results showed that the majority of respondents had low physical activity levels, with 21 respondents (41.2%), and high blood sugar levels, with 28 respondents (54.9%). Bivariate analysis using the Spearman Rank test produced a strong negative correlation value (r = -0.747), indicating that the higher the physical activity, the lower the blood sugar levels. The relationship between these two variables was found to be significant, with a p-value (0.01) < α (0.05). Thus, it can be concluded that there is a relationship between physical activity and blood sugar levels in patients with type II diabetes mellitus. These findings are expected to serve as a reference for health promotion programs, especially in managing the physical activity of DM patients to control their blood sugar levels.

Keyword: Blood sugar, Diabetes melitus, Physical activity

ABSTRAK

Diabetes melitus tipe II merupakan salah satu penyakit tidak menular dengan prevalensi yang terus meningkat, yang berdampak signifikan terhadap kualitas hidup dan biaya perawatan kesehatan. Transisi demografi di Indonesia, yang telah bergeser dari populasi berkembang menjadi masyarakat industri, telah membawa tren baru dalam masyarakat. Pola penyakit yang sebelumnya didominasi oleh penyakit menular, kini didominasi oleh penyakit tidak menular, termasuk diabetes melitus. Penelitian ini bertujuan untuk menganalisis hubungan antara aktivitas fisik dengan kadar gula darah pada penderita diabetes melitus tipe 2 di wilayah kerja Puskesmas Dau Kabupaten Malang. Penelitian ini menggunakan jenis penelitian kuantitatif dengan rancangan analitik korelasional menggunakan metode pengumpulan data potong lintang. Sampel dalam penelitian ini sebanyak 51 responden yang dipilih secara purposive sampling berdasarkan kriteria inklusi, dan pengumpulan data menggunakan Global Physical Activity Questionnaire (GPAQ) dan observasi pemeriksaan kadar gula darah menggunakan glukometer. Hasil penelitian menunjukkan bahwa sebagian besar responden memiliki tingkat aktivitas fisik rendah yaitu sebanyak 21 responden (41,2%), dan kadar gula darah tinggi yaitu sebanyak 28 responden (54,9%). Analisis bivariat menggunakan uji Spearman Rank menghasilkan nilai korelasi negatif yang kuat (r = -0,747) yang menunjukkan bahwa semakin tinggi aktivitas fisik maka kadar gula darah akan semakin rendah. Hubungan antara kedua variabel ini ditemukan signifikan, dengan nilai p (0,01) < α (0,05). Dengan demikian, dapat disimpulkan bahwa terdapat hubungan antara aktivitas fisik dan kadar gula darah pada pasien diabetes melitus tipe II. Temuan ini diharapkan dapat menjadi referensi bagi program promosi kesehatan, khususnya dalam mengelola aktivitas fisik pasien DM untuk mengendalikan kadar gula darahnya.

Kata Kunci: *Glukosa Darah; Diabetes Mellitus ; Aktivitas Fisik*

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Introduction:

The prevalence of non-communicable diseases (NCDs), including diabetes mellitus, continues to rise globally. According to the International Diabetes Federation (IDF, 2025), approximately 589 million adults worldwide representing 11.1% of the global population are living with diabetes. Each year, diabetes is responsible for more than 6.7 million deaths, with nearly 80% of these occurring in low- and middle-income countries (WHO, 2024; IDF, 2025). According to the 2023 Indonesian Health Survey (SKI 2023), the prevalence of diabetes mellitus based on blood glucose examination among individuals aged 15 years and older has increased to 11.7%, compared to 10.9% in 2018. This trend indicates a continued rise in diabetes prevalence in Indonesia, reflecting lifestyle changes and increasing urbanization (Ministry of Health Republic of Indonesia, 2023). Data from the International Diabetes Federation (IDF) in 2019 ranked Indonesia as the sixth country globally in terms of the number of diabetes mellitus patients, which reached 10.3 million individuals (PERKENI, 2021). The World Health Organization (WHO) estimates that more than 180 million people worldwide currently suffer from diabetes mellitus, a number expected to more than double by 2030 (WHO & IAHO, 2019). This trend highlights the ongoing shift in disease patterns globally.

Demographic changes in Indonesia, from a developing population to an industrial society, have introduced new trends in disease patterns. Currently, the disease profile in Indonesia shows a significant shift, with communicable diseases that previously dominated now being replaced by non-communicable diseases, including diabetes mellitus (Siregar et al., 2023). The number of diabetes mellitus cases is rapidly increasing, posing a concerning public health phenomenon due to its substantial impact on the productivity of affected individuals.

The high prevalence of diabetes mellitus significantly impacts healthcare financing, with approximately 11.5% of global health expenditure equivalent to USD 966 billion in 2021 spent on diabetes and its complications (International Diabetes Federation, 2021; World Health Organization, 2024). Diabetes care costs present a substantial burden on patients, their families, and the global economy. Globally, the cost of diabetes treatment in 2015 was estimated at 673 billion US dollars, projected to increase to 802 billion US dollars by 2040 (Tiawati & Febrianti, 2022). Additionally, diabetes mellitus physically affects patients, causing fatigue, frequent urination, weakness, and weight loss. Furthermore, complications such as heart damage, vascular issues, eye and kidney problems, nerve damage, and even death are serious concerns (IDF, 2017).

Diabetes mellitus patients face challenges in controlling their blood glucose levels for several reasons. One primary cause is the insufficient production of insulin or the body's inability to effectively use the insulin produced. Insulin regulates blood glucose levels; when it malfunctions, blood glucose levels rise excessively. Other contributing factors include an imbalanced lifestyle, lack of physical activity, and stress, which can exacerbate the difficulty of controlling blood glucose levels (American Diabetes Association, 2024; International Diabetes Federation, 2021; Chatterjee et al., 2017).

Limited physical activity among diabetes mellitus patients often results from their health condition. Consequently, controlling risk factors becomes paramount in diabetes mellitus management (Melati & Herlina, 2022). One of the four pillars of diabetes management is physical activity. Engaging in regular physical activity 2–3 times per week for approximately 30 minutes can enhance insulin efficiency, facilitating the uptake of blood glucose into cells for energy conversion. During exercise, muscles utilize stored glucose, and as reserves deplete, glucose is drawn from the bloodstream. This process lowers blood glucose levels and improves glycemic control. Regular physical activity, such as exercise, also aids in improving blood glucose regulation, maintaining or reducing body weight, and increasing high-density lipoprotein (HDL) cholesterol levels (Siti, 2021). Diabetes prevalence is notably lower in individuals who routinely engage in physical activity, with the risk

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decreasing as overall physical activity levels increase (Li et al., 2023).

The high prevalence of diabetes mellitus in Indonesia, its profound impacts, the significant number of cases among individuals in their productive years, and the lack of awareness regarding preventive measures underscore the urgency of this research topic. Suboptimal blood glucose control and unresolved issues related to physical activity form the basis for this study. Unlike previous studies that primarily focused on general correlations between physical activity and glycemic control, this research provides a more localized analysis by examining the relationship between physical activity levels and blood glucose among patients enrolled in the Prolanis program at a primary healthcare center in Malang Regency. The novelty of this study lies in its community-based approach, emphasizing how structured physical activity interventions within Indonesia's public health system can influence glycemic outcomes. Furthermore, this study identifies practical gaps in implementing physical activity monitoring in primary care, offering evidence-based recommendations for strengthening local diabetes management programs. Therefore, this study aims to analyze the relationship between physical activity and blood glucose levels among patients with Type 2 Diabetes Mellitus in the working area of the Dau Public Health Center, Malang Regency.

Methods:

This study employed a descriptive correlational observational design with a cross-sectional approach. The study population consisted of patients with Type 2 Diabetes Mellitus (DM) enrolled in the Prolanis program at Dau Public Health Center, Malang Regency, East Java, Indonesia, totaling 58 patients. A total of 51 participants were recruited from 58 eligible patients through purposive sampling according to the defined inclusion and exclusion criteria.

The inclusion criteria for the study were patients diagnosed with Type 2 DM for at least six months, aged 18 years or older, who provided informed consent. Participants needed to be capable of performing physical activities independently and have complete medical records, including recent blood glucose data. Exclusion criteria applied to patients with severe diabetes complications, such as advanced cardiovascular disease, renal failure, or neuropathy that limited physical activity. Patients with physical or mental disabilities preventing participation, those undergoing treatments affecting blood glucose levels (e.g., corticosteroid therapy), pregnant or lactating patients, and those who did not complete the study or withdrew consent during the research period were also excluded.

Data collection was conducted from November to December 2024. Physical activity was measured using the Global Physical Activity Questionnaire (GPAQ) developed by the World Health Organization (WHO). This instrument evaluates the frequency and duration of physical activity in three domains work-related, transport-related, and recreational activities during a typical week. The total activity score is expressed in Metabolic Equivalent of Task (MET) minutes per week, and respondents are classified into low, moderate, or high physical activity levels according to WHO (2020) guidelines. Blood glucose data were collected from Prolanis program medical records, based on the results of routine blood glucose examinations. The data were analyzed using the Spearman Rank correlation test with a significance level of $\alpha = 0.01$. This study was reviewed and approved by the Research Ethics Committee of the Faculty of Health Sciences, Universitas Brawijaya, with approval number 12992/UN10.F17.10.4/TU/2024.

Results :

Table 1. Respondent Characteristics

Demographic	Category	Frequency (f)	Percentage (%)
Age	20–30 years	4	7.8
	31–40 years	7	13.7
	41–50 years	14	27.5
	> 50 years	26	51.0
Gender	Male	8	15.7
	Female	43	84.3
Education	No formal education	1	2.0

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Demographic	Category	Frequency (f)	Percentage (%)
	Elementary to High School	10	19.6
	Higher education	40	78.4
Occupation	Housewife/Unemployed	16	31.4
	Private employee	17	33.3
	Office employee	18	35.3

Based on the analysis of Table 1, the majority of respondents were aged 50 years or older, comprising 26 individuals, or 51% of the total. Regarding gender, the majority of respondents were female, totaling 43 individuals, which accounted for 84.3%. In terms of educational background, most respondents had attained higher education, with 40 individuals (78.4%). Lastly, regarding occupation, the majority of respondents were office employees, with 18 individuals, representing 35.3%.

Table 2. Distribution of Respondents Based on Physical Activity

Category	Number (f)	Percentage (%)
Light Activity	21	41.2
Moderate Activity	18	35.3
Heavy Activity	12	23.5
Total	51	100

Based on the analysis of Table 2, it shows that out of 51 respondents, the majority had light physical activity, with 21 respondents. This was followed by respondents with moderate physical activity, totaling 18 respondents, while the least number of respondents reported heavy physical activity, with only 12 respondents.

Table 3. Distribution of Respondents Based on Blood Sugar Levels

Category	Number (f)	Percentage (%)
Normal	23	45.1
High	28	54.9
Total	51	100

Based on the analysis of Table 3, it shows that out of 51 respondents, the majority had high blood glucose levels, with 28 respondents. This was followed by 23 respondents who had normal blood glucose levels, while none of the respondents had low blood glucose levels.

Table 4. Relationship Between Physical Activity and Blood Sugar Levels

Physical Activity	Blood Sugar Level				p-value	Correlation Coefficient (r)
	Normal		High		0.001	-0.747
	(f)	(%)	(f)	(%)		
Light	2	3.9	19	37.7		
Moderate	9	17.6	9	17.6		
Heavy	12	23.5	0	0		

Based on the results from Table 4, it is shown that the majority of respondents engage in light physical activity, with 21 respondents (41.2%), and have high blood sugar levels, with 28 respondents (54.9%). The bivariate analysis using the Spearman Rank test yielded a strong negative correlation (r = -0.747), indicating that the higher the physical activity, the lower the blood sugar levels. The relationship between these two variables is significant, with a p-value of (0.01) < α(0.05). It can be concluded that there is a relationship between physical activity and blood sugar levels in patients with Type 2 Diabetes Mellitus in the working area of Puskesmas Dau.

Discussion:

The present study examined the relationship between physical activity and blood glucose levels among patients with Type 2 Diabetes Mellitus (T2DM) in the working area of the Dau Public Health Center, Malang Regency. The findings revealed a statistically significant negative correlation between physical activity and blood glucose levels ($r = -0.747$; $p < 0.05$), indicating that higher physical activity was associated with lower blood glucose levels. This result aligns with the growing body of evidence emphasizing the crucial role of physical activity in glycemic control among individuals with T2DM.

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The majority of participants in this study were over 50 years old and predominantly female. Most respondents demonstrated low levels of physical activity and correspondingly high blood glucose levels. These findings are consistent with global patterns reported by the International Diabetes Federation (IDF, 2021), which indicate that the prevalence of T2DM increases with age and sedentary behavior. As individuals age, physiological processes such as reduced insulin sensitivity, impaired β-cell function, and decreased muscle mass contribute to the deterioration of glucose metabolism (DeFronzo et al., 2021). Additionally, women, particularly those in postmenopausal age, often experience metabolic changes due to hormonal decline, increasing their risk for insulin resistance (Clegg et al., 2017).

The results of this study corroborate findings from Li et al. (2023) and Siregar et al. (2023), who reported that low physical activity levels are associated with higher fasting blood glucose and HbA1c concentrations among T2DM patients. According to the American Diabetes Association (ADA, 2024), regular physical activity of at least 150 minutes per week of moderate-intensity aerobic exercise significantly improves insulin sensitivity and facilitates glucose uptake in skeletal muscles. During exercise, muscle contraction promotes non–insulin-mediated glucose transport into muscle cells through the translocation of GLUT4 receptors to the cell membrane, resulting in reduced circulating glucose levels (Sylow et al., 2017). This mechanism explains why participants who engaged in moderate to vigorous activity in the current study demonstrated better glycemic profiles compared to those with low activity levels.

In addition to the physiological effects, behavioral and occupational factors also contribute to differences in blood glucose control. The majority of respondents in this study were office employees and housewives occupations typically associated with prolonged sedentary time. Prolonged sitting and limited movement reduce energy expenditure, leading to increased adiposity and insulin resistance (Lange et al., 2022). A study by Setyoadi et al. (2016) on sedentary behavior among Indonesian adults found that low physical activity was strongly linked to obesity and glucose intolerance, highlighting the importance of workplace-based interventions to reduce sedentary time.

Age was another significant factor observed in this study. More than half of the respondents were aged 51 years or older. This pattern is consistent with Mufida et al. (2024), who found that T2DM predominantly affects adults over 50 due to age related metabolic decline. Aging is associated with reduced mitochondrial efficiency, altered lipid metabolism, and chronic low-grade inflammation, all of which impair insulin action (Zhang et al., 2025). Furthermore, the cumulative exposure to unhealthy lifestyles, including physical inactivity and poor dietary patterns, exacerbates hyperglycemia risk among older adults.

Gender differences in diabetes prevalence and outcomes have also been reported in numerous studies. In this study, 84.3% of respondents were female. Similar results were observed by Melati and Herlina (2022), who reported that female patients with diabetes in Indonesia often show higher blood glucose levels due to lower physical activity participation and cultural factors that limit time for exercise. Biological differences, such as variations in fat distribution and hormonal profiles, further contribute to this disparity (Zhao et al., 2020).

From a pathophysiological perspective, physical activity enhances glucose homeostasis by increasing muscle glucose uptake, improving insulin sensitivity, and promoting lipid oxidation (Hawley et al., 2021). Exercise also modulates inflammatory pathways and oxidative stress, which are central to the pathogenesis of insulin resistance. Chronic physical inactivity, conversely, leads to mitochondrial dysfunction and increased intramyocellular fat accumulation, impairing insulin signaling (Sylow et al., 2017). These biological mechanisms strengthen the explanation for the observed negative correlation between activity level and blood glucose concentration in this study.

The results have important implications for public health and diabetes management programs. The Prolanis program implemented in

Indonesian primary care settings emphasizes patient education, regular monitoring, and lifestyle modification. However, the present findings suggest that more targeted interventions focusing on structured physical activity are needed. Incorporating community-based exercise programs, peer support, and digital health monitoring could enhance adherence to physical activity regimens and improve long-term glycemic control (Setyoadi et al., 2023).

Moreover, integrating culturally tailored health promotion strategies is essential, considering that most participants were middle-aged women balancing household responsibilities. Family involvement and social support have been shown to increase motivation for lifestyle change and sustain physical activity among women with T2DM (Kristaningrum et al., 2021).

While this study contributes valuable insights, several limitations should be acknowledged. The cross-sectional design limits causal inference between physical activity and blood glucose levels. Additionally, the use of self-reported GPAQ data may introduce recall bias, and the absence of dietary and medication adherence variables restricts comprehensive analysis. Future studies should adopt longitudinal or experimental designs to evaluate the causal effect of physical activity interventions on glycemic outcomes, incorporating objective measures such as accelerometers and HbA1c levels.

In summary, this study confirms a significant inverse relationship between physical activity and blood glucose levels in patients with T2DM. Age, gender, and occupational factors also play influential roles in determining physical activity levels and glycemic status. Promoting regular physical activity remains a cornerstone of diabetes management, as supported by international evidence. Primary health centers should integrate structured exercise programs and individualized counseling into routine diabetes care to achieve optimal glycemic control and reduce the long-term burden of diabetes complications.

Conclusion:

This study demonstrated a significant negative correlation between physical activity and blood glucose levels among patients with Type 2 Diabetes Mellitus (T2DM) in the working area of the Dau Public Health Center, Malang Regency. Patients who engaged in higher levels of physical activity had lower blood glucose concentrations, emphasizing that physical activity plays a crucial role in maintaining glycemic control and preventing diabetes-related complications. From a community nursing perspective, these findings highlight the importance of empowering patients to adopt active lifestyles as part of routine diabetes management. Nurses at the primary healthcare level should integrate physical activity education, individualized counseling, and family involvement to enhance motivation and self-care compliance. Culturally appropriate community-based exercise programs such as walking groups or family-centered activity sessions should also be encouraged to increase participation and sustainability among older adults and women with limited mobility. Further studies are needed using longitudinal or interventional designs to establish causality between physical activity and blood glucose levels. Incorporating objective measures such as accelerometers and HbA1c testing would strengthen the validity of the findings. Additionally, qualitative studies exploring patients' perceptions, barriers, and facilitators of physical activity within the Prolanis program context could provide deeper insights for developing tailored interventions. In conclusion, strengthening community nursing roles in promoting regular physical activity is essential for improving diabetes self-management, achieving optimal glycemic control, and reducing the overall burden of T2DM in Indonesia's primary healthcare system.

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