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AKTIVITAS FISIK PENTING DALAM MANAJEMEN KADAR GULA DARAH LANSIA DENGAN DIABETES MELLITUS

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ABSTRACT

Aktivitas fisik yang rendah pada lansia penderita diabetes melitus berkontribusi pada tingginya kadar gula darah. Kadar gula darah yang tinggi dapat menyebabkan komplikasi kesehatan yang lebih besar. Salah satu tata laksana dalam diabetes melitus adalah aktivitas fisik. Aktivitas fisik yang dilakukan berkesinambungan membantu menurunkan kadar gula darah. Tujuan dari penelitian ini untuk mengetahui hubungan antara aktivitas fisik dengan kadar gula darah pada lansia penderita diabetes mellitus Puskesmas Silir. Penelitian ini merupakan penelitian kuantitatif dengan metode observasional dengan pendekatan *cross-sectional study*. Pengambilan sampel dengan Accidental Sampling dengan sampel sebanyak 96 responden dari sampel sejumlah 408, dengan instrumen GPAQ (Global Physical Activity Questionnaire). Analisis data menggunakan uji Spearman. Hasil penelitian menunjukkan sebesar 60.4% partisipan memiliki aktivitas fisik kategori Inaktif, serta 53.1% kadar gula dari partisipan masuk dalam kategori Tinggi. Hasil uji Spearman menunjukkan ρ-value = 0,000 < 0,05 dengan koefisien korelasi -0,830 yang menunjukkan arah negatif dengan kekuatan hubungan sangat kuat. Penelitian ini menunjukkan bahwa aktivitas fisik memiliki hubungan yang sangat kuat dengan kadar gula darah lansia dengan Diabetes Mellitus. Hal ini bermakna bahwa aktivitas fisik menjadi tatalaksana yang penting dalam perawatan lansia dengan Diabetes Mellitus.

Keywords : Aktivitas Fisik, Diabetes Melitus, Kadar Gula Darah, Lansia

ABSTRACT

Low levels of physical activity among elderly individuals with diabetes mellitus are associated with increased blood glucose levels, which may further exacerbate health complications. Physical activity is recognized as a fundamental component in diabetes management. Engaging in consistent and routine physical activity has been shown to effectively lower blood glucose levels. This study investigates the correlation between physical activity and blood glucose levels in elderly patients diagnosed with diabetes mellitus at the Silir Community Health Center. Utilizing a quantitative approach, the research employed an observational method with a cross-sectional design. Participants were selected through accidental sampling, resulting in a total of 96 respondents. Data collection involved the Global Physical Activity Questionnaire (GPAQ), and analysis was performed using the Spearman correlation test. Findings revealed that 60.4% of the elderly participants had low levels of physical activity, while 53.1% exhibited elevated blood glucose levels. The Spearman correlation analysis indicated a p-value of 0.000 (< 0.05) and a correlation coefficient of -0.763, signifying a strong inverse relationship. In conclusion, this study highlights a significant negative correlation between physical activity and blood glucose levels among elderly individuals with diabetes mellitus. These results reinforce the importance of regular physical activity as a key strategy in managing diabetes in older populations..

Keywords: *Blood Glucose Level ; Diabetes Mellitus; Elder People; Physical Activity,*

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INTRODUCTION

In elderly individuals with diabetes, insufficient physical activity plays a critical role in the elevation of blood glucose levels. Persistently high blood glucose can lead to severe and potentially life-threatening complications. Among the various approaches to managing diabetes, regular physical activity remains a cornerstone. Evidence consistently supports that engaging in sustained and routine physical exercise can significantly reduce blood glucose levels, thereby improving overall health outcomes in diabetic patients (Hasnita et al., 2020). Still, there are few studies with the elderly as the subject of this research. This research was about blood sugar levels and physical activity in the elderly connectivity.

A recent study by Geladis et al. (2024), which examined diabetic patients aged 30 to 85, highlighted the significant role of physical activity in regulating blood glucose levels. Nonetheless, the majority of existing research has predominantly focused on populations under the age of 60 (Geladis et al., 2024). This presents a critical gap in the literature, as older adults—particularly those aged 60 and above—experience physiological changes such as reduced metabolic rate and increased adiposity. Consequently, further investigation targeting this demographic is essential to better understand the relationship between aging, physical activity, and glycemic control (Palmer & Jensen, 2022).
Furthermore, in many studies, the term physical activity tends to refer narrowly to structured exercise. However, physical activity should be broadly defined as any bodily movement produced by skeletal muscles that requires energy expenditure (Amrullah, 2020). Hence, this study views physical activity as encompassing daily life activities, not just formal exercise routines.

Based on the 2023 Indonesian Health Survey (SKI) published by the Ministry of Health or Kementerian Kesehatan Republik Indonesia (Kemenkes), only 40.4% of individuals in East Java Province reported participating in physical activity or exercise as part of their diabetes management regimen. This percentage falls significantly short of the expected 50% benchmark, indicating a persistent gap in the adoption of recommended lifestyle interventions among diabetic patients (Kemenkes, 2023). Meanwhile, East Java ranked second nationally for the highest number of diabetes mellitus (DM) cases in 2023, recording a total of 130,683 cases—just behind West Java, which held the top position. This represents a notable escalation compared to 2018, when East Java was ranked sixth in terms of DM prevalence across Indonesia.

Karwati (2022) introduced a holistic framework for diabetes management encompassing five fundamental pillars: patient education, nutritional therapy, pharmacological treatment, physical activity, and self-monitoring of blood glucose. Within this framework, the present study places particular emphasis on physical activity as a critical non-pharmacological intervention recommended for individuals with diabetes (Karwati, 2022). According to Lestari et al. (2021), physical activity—particularly structured exercise—serves a vital function in managing blood glucose levels, preventing obesity, and reducing the risk of atherogenic complications, hypertension, and dyslipidemia. This underscores its importance as a preventive and therapeutic strategy in diabetes care (Lestari et al., 2021).

Moreover, physical activity extends beyond structured exercise to encompass everyday movements that engage skeletal muscles and result in energy expenditure. Activities such as walking around the neighborhood, performed for approximately 30 to 40 minutes per session, are recommended. These

forms of activity contribute to lowering the risk of diabetes, promoting weight loss, and enhancing insulin sensitivity—all of which are essential for maintaining optimal blood glucose control in elderly.

RESEARCH METHODS

A quantitative research design utilizing an observational analytic method was implemented in this study, taking the form of a cross-sectional correlational investigation. The population under study comprised elderly individuals with a diagnosis of diabetes mellitus who were registered at the Silir Public Health Center (Puskesmas Silir) located in Wates, Kediri. The research was conducted in October 2023, and a total of 96 participants were recruited through accidental sampling techniques. Physical activity data were gathered using the Global Physical Activity Questionnaire (GPAQ), a validated 16-question tool developed by the World Health Organization (WHO). This instrument assesses various facets of physical activity, including its intensity, duration, and frequency, across three primary areas: work-related, transportation-related, and leisure-time activities. Concurrently, random blood glucose levels were measured using a glucometer (World Health Organization (WHO), 2025).

Blood glucose levels in the diabetic participants were measured using an Autocheck glucometer. This device is recognized for its high accuracy and adherence to the International Organization for Standardization (ISO) 15197:2013 standards. As per these guidelines, for self-monitored blood glucose readings exceeding 100 mg/dL, 95% of the results can deviate by no more than ±15% from laboratory values. For readings below 100 mg/dL, the allowable variance is ±15 mg/dL. Furthermore, the Autocheck glucometer requires a minimal blood sample of 0.5 mL to deliver immediate blood glucose readings. This study employed a cross-sectional design, with data collected at a single time point. During this period, participants completed the Global Physical Activity Questionnaire (GPAQ) with the assistance of the researchers and their team. This was immediately followed by blood glucose level testing using the aforementioned glucometer. Physical activity levels were dichotomized into two categories: Active and Inactive. Following the World Health Organization (WHO) criteria (2025), participants with a GPAQ score of 600 MET-minutes or higher were classified as Active, while those scoring below this threshold were considered Inactive. The Blood Glucose Level variable was categorized into three groups based on the Random Blood Glucose test results: Low (less than 97 mg/dL), Normal (ranging from 97 to 131 mg/dL), and High (greater than 131 mg/dL). These cut-off points were derived from the Indonesian Endocrinology Association (Perkeni) guidelines as cited in Nurfalah (2022) (Rima Nurfalah, 2022). The study received ethical approval from the Ethics Committee of the Bhakti Wiyata Institute of Health Sciences, Kediri, under Approval Number: 404/FIK/Ep/III/2024.

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RESULTS AND DISCUSSION

Results

Table 1. Distribution of Respondents' General Characteristics, 2024 (n=96)

No	Characteristics of Respondents	Frequency	Percentage (%)
	Gender		
1	Male	19	19.8
2	Female	77	80.2
	Age		
1	60-74 yo	96	100
2	75-90 yo	0	0
3	>90 yo	0	0
	Respondents' Educational Level		
1	Below Primary School Level	0	0
2	Elementary School Graduate	44	45.8
3	Junior Secondary Education	21	21.9
4	Senior Secondary Education	31	32.3
5	College	0	0
	Type of Occupation		
1	Housewives/Jobless	44	45.8
2	Farmer	26	27.1
3	Others	26	27.1
	Total	**96**	**100**

Table 1 shows that none of the respondents are over 74 years old, and most are female (80.2%). We also found that all respondents attend formal education, and most are elementary graduates (45.8%), but none had a college level.

Table 2. Distribution of Respondents' Random Blood Sugar, 2024 (n=96)

No	Blood Sugar Levels	Frequency	Percentage (%)
1	Low	8	8.3
2	Normal	37	38.6
3	High	51	53.1
	Total	**96**	**100**

We found that 51% of the respondents had High Random Blood Sugar and only a few Low levels. Meanwhile, 38.6% of respondents had Normal blood sugar. It indicates that there are more respondents with High Blood Sugar Levels than those with normal or low blood sugar levels.

Table 3. Distribution of Respondents' Physical Activity Category, 2024 (n=96)

No	Physical Activity Category	Frequency	Percentage (%)
1	Active	38	39.6
2	Inactive	58	60.4
	Total	**96**	**100**

The Physical Activities of respondents are explained in Table 3. It shows that there are more Inactive Respondents than Active ones. Active means the respondent achieves at least 600MET minutes/week, and Inactive is below those.

Table 4. Cross Tabulation of Respondents' Physical Activity and Blood Sugar Levels, 2024 (n=96)

No	Physical Activity	Blood Sugar						Total	Sig.	Correlation Coefficient
		Low		Normal		High				
		Freq	%	Freq	%		%			
1	Active	7	7.3	31	32.3	0	0	39.6	0.000	-0.830
2	Inactive	1	1.1	6	6.2	51	53.1	60.4		
Total		**8**	**8.4**	**37**	**38.5**	**51**	**53.1**	**100**		

Table 4 explains the cross-tabulation between respondents' physical activity and blood sugar levels. None of the 'Active' respondents had a High blood sugar level. Most of them had Normal blood sugar. Of the 'Inactive' respondents, most were categorized as High blood sugar levels. We also found the significance value by the Spearman-rho is below 0.05 with a correlation coefficient of -0.830.

Discussion

Physical Activity

The classification of more than half of the study respondents as physically inactive is a notable finding. This observation is closely correlated with the age profile of the participants, all of whom were older adults aged 60 years and above. The influence of age is substantial, as older individuals typically encounter a decline in physical capacity and an increased vulnerability to health conditions that impede physical activity levels (Rahayuningsih et al., 2023). Furthermore, a lack of awareness and understanding regarding the health benefits of physical activity can diminish the motivation to engage in more active behaviors. Research by Siregar et al. (2023) indicates that vigorous physical activity demands significant commitment, discipline, and sufficient physical fitness, qualities not universally present. These factors, encompassing lifestyle, age, health status, and awareness, provide a scientific basis for the considerable differences observed in physical activity levels among the study participants (Siregar et al., 2023).

The higher proportion of physically inactive respondents can also be attributed to their occupational status. In this study of elderly individuals with diabetes mellitus, a larger number were housewives or unemployed compared to those who were employed. While housewives perform domestic tasks, the majority of non-working participants had considerable free time, with daily activities mainly consisting of limited market shopping and cooking. Shopping was often done with assistance and using motorized transport, and they tended to choose markets with closely spaced vendors, further reducing physical movement. Cooking was primarily a sedentary activity. Their leisure time was

typically spent sitting or lying down, resulting in minimal use of major muscle groups and low energy expenditure (Guthold et al., 2018; World Health Organization (WHO), 2024)

Blood Glucose Level

In this study, the majority of respondents were found to have high blood glucose levels, although a smaller number also exhibited low blood glucose levels. Several factors may influence the respondents' blood glucose levels, one of which is age. Although all respondents in this study were below 74 years old, there was still an observable age distribution that helps explain the variation in blood glucose levels found. Further data revealed that there were 64 respondents aged 60–63 years, 22 respondents aged 64–67 years, and 10 respondents within the age range of 68–74 years.

Individuals aged 45 and above tend to experience a decline in insulin sensitivity, making them more susceptible to elevated blood glucose levels (Sihite et al., 2022). With advancing age, some individuals progressively lose the ability to regulate glucose as efficiently as when they were younger (Chia et al., 2018). In older adults, glucose metabolism undergoes significant changes. According to Chia et al. (2018), in non-diabetic individuals, fasting plasma glucose (FPG) levels increase by approximately 0.7–1.1 mg/dL per decade of age, while 2-hour glucose (2hG) levels increase by 5.6–6.6 mg/dL per decade (Chia et al., 2018). Furthermore, Hummel & Hummel (2025) state that low blood sugar levels are more common in the elderly due to a decreased perception threshold for hypoglycemia after long-term diabetes, along with delayed counter-regulatory responses to low blood sugar levels in older age (Hummel & Hummel, 2025).

Colberg et al. (2016) suggest that behavior-change strategies can be effective in promoting both the initiation and sustained practice of physical activity among individuals with diabetes. They recommend that all adults, particularly those with type 2 diabetes, minimize their daily sedentary time. Extended periods of inactivity in individuals with or at risk for type 2 diabetes are linked to poorer blood sugar management and a higher risk of multiple metabolic issues. For adults with type 2 diabetes, breaking up prolonged sitting with either 15 minutes of walking after meals or 3 minutes of light walking and simple bodyweight exercises every 30 minutes has demonstrated improvements in glycemic control (Colberg et al., 2016).

Gender is another factor that can affect blood glucose levels in individuals with diabetes. Several studies suggest that women tend to have less effective blood glucose management compared to men. Research by Ciarambino, Crispino, and Leto (2022) indicates a higher occurrence of diabetes in males before puberty, while females are more frequently affected after menopause and in older age (Ciarambino et al., 2022). According to Kasriani (2021), women are at a higher risk of experiencing weight gain, which in turn increases the likelihood of elevated blood glucose levels (Kasriani & Widaryati, 2021). Women tend to gain weight in midlife because their metabolism slows down, they are less physically active, and their bodies change, meaning they lose muscle and accumulate more fat (Hurtado et al., 2024).

Education also appears to significantly influence blood glucose control in individuals with diabetes mellitus. Lower educational attainment has been linked to poorer blood glucose management in diabetic patients. This is consistent with Kurniawati's research, which demonstrated that education

level affects the occurrence of type 2 diabetes mellitus. Individuals with higher education typically have greater health knowledge, leading to increased awareness and improved self-management practices for their health (Kurniawati, 2023) .

The Relationship Between Physical Activity and Blood Glucose Levels in Elderly Patients with Diabetes Mellitus

Statistical analysis revealed a significant strong negative correlation between physical activity and random blood glucose levels in elderly individuals with diabetes mellitus. This suggests that sufficient physical activity (being active) can effectively help manage blood glucose by lowering it through increased energy expenditure. The decrease in blood glucose levels observed in type 2 diabetes patients after physical activity is supported by mechanisms that enhance glycemic control. During exercise, muscle contractions trigger the release of GLUT-4 (glucose transporters), which facilitate glucose uptake into muscle cells without requiring insulin. Additionally, muscle contraction increases blood flow, causing more capillaries to dilate. This expansion in capillaries leads to a greater number of active insulin receptors, thereby promoting glucose uptake and naturally lowering blood glucose levels (Barus et al., 2021).

Fundamentally, physical activity has a significant impact on glucose and insulin metabolism. When a person engages in physical activity, their muscles require energy, which is derived from glucose in the bloodstream. This process helps reduce blood glucose levels directly. In addition, physical activity enhances the sensitivity of body cells to insulin, meaning that cells become more responsive to insulin and more efficient in absorbing glucose from the blood for energy use (Safitri et al., 2022).

In the elderly, physical activity in the form of resistance training can reduce HOMA-IR, especially if done continuously for at least 12 weeks. HbA1c levels also showed a significant decrease in the elderly with moderate intensity physical activity.(Jiahao et al., 2021). Light physical activity carried out by the elderly in their daily sedentary activities for 3 minutes every 30 minutes can reduce iAUC *for 24-h glucose* (*incremental area under the curve for glucose levels over a 24-hour period*) and decreased HOMA-IR which is an indication of insulin resistance. Light physical activities that can be done include walking, going up and down stairs, squats, or other movements. (Leon et al., 2022).

The group that underwent an intensive lifestyle intervention incorporating physical activity demonstrated markedly greater and more sustained improvements in weight reduction, cardiovascular fitness, blood glucose regulation, blood pressure, and lipid levels, all while depending on fewer medications. Participants also showed decreased incidences of sleep apnea, advanced diabetic nephropathy and retinopathy, depression, sexual dysfunction, urinary incontinence, and knee discomfort. Furthermore, they maintained better physical mobility and overall quality of life, accompanied by a reduction in total healthcare expenditures (Colberg et al., 2016).

Engaging in physical activity that meets at least the World Health Organization's (WHO) minimum recommendations is crucial for preventing a sedentary lifestyle, which is typically defined by low levels of physical movement. Sedentary behavior encompasses any waking activity with minimal energy expenditure, such as sitting, reclining, or lying down. The growing dependence on

motorized transport and increased screen time for work, education, and leisure has significantly contributed to the rise of sedentary habits in contemporary society. Numerous studies have consistently linked prolonged inactivity to adverse health outcomes, including type 2 diabetes mellitus and cardiovascular diseases (World Health Organization (WHO), 2024).

For individuals with diabetes mellitus, several physical activity recommendations exist. Daily exercise, or at least ensuring no more than two consecutive days without physical activity, is advised to enhance insulin sensitivity. To achieve optimal blood sugar control and overall health, adultsand older adults with type 2 diabetes are encouraged to participate in both aerobic and resistance training. Additionally, structured lifestyle interventions that include a minimum of 150 minutes of physical activity per week, along with dietary changes resulting in a 5%–7% weight loss, are recommended to prevent or delay the development of type 2 diabetes in high-risk individuals or those with prediabetes (World Health Organization (WHO), 2022)

CONCLUSION

There exists a significant association between physical activity and blood glucose levels in older adults with diabetes mellitus. This finding underscores the importance of incorporating physical activity as a fundamental element in the effective management of diabetes among the elderly population.

SUGGESTIONS

Elderly individuals with diabetes mellitus need to engage in physical activity in accordance with WHO recommendations as part of their daily routine. In addition, community health centers or Pusat Kesehatan Masyarakat (Puskesmas), as primary healthcare providers, should consistently offer motivation and support to encourage physical activity among elderly patients with diabetes mellitus.

REFERENCES

Amrullah, J. F. (2020). Hubungan Aktivitas Fisik dengan Kadar Gula Darah Sewaktu pada Lansia Penderita Diabetes Melitus di Wilayah Kerja UPT Puskesmas Babakan Sari Kota Bandung. *Jurnal Sehat Masada*, *14*(1), 42–50. https://doi.org/https://doi.org/10.38037/jsm.v14i1.124

Barus, S., Anwar, M., & Kustini, L. (2021). Pengaruh Senam Kaki Dm Terhadap Penurunan Kadar Gula Darah Pada Pasien Diabetes Mellitus Tipe Ii Di Persadia Cabang Cimahi. *Jurnal Kesehatan Budi Luhur*, *15*(2), 474–480. https://doi.org/https://doi.org/10.62817/jkbl.v14i2.144

Chia, C. W., Egan, osephine M., & Ferrucci, L. (2018). Age-Related Changes in Glucose Metabolism, Hyperglycemia, and Cardiovascular Risk. *Circulation Research of American Heart Association Journal*, *123*(7), 886–904. https://doi.org/10.1161/CIRCRESAHA.118.312806

Ciarambino, T., Crispino, P., Leto, G., Mastrolorenzo, E., Para, O., & Giordano, M. (2022). Influence of Gender in Diabetes Mellitus and Its Complication. *International Journal of Molecular Science*, *23*(16). https://doi.org/https://doi.org/10.3390/ijms23168850

Colberg, S. R., Sigal, R. J., Yardley, J. E., Riddell, M. C., Dunstan, D. W., Dempsey, P. C., Horton, E. S., Castorino, K., & Tate, D. F. (2016). Physical Activity/Exercise and Diabetes: A Position Statement of the American Diabetes Association. *Diabetes Care*, *39*(11), 2065–2079. https://doi.org/10.2337/dc16-1728

Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2018). Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1·9 million participants. *The Lancet Global Health*, *6*(10), e1077–e1086. https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(18)30357-7/fulltext

Hasnita, A.Z, R., & Astuti, A. (2020). Hubungan Durasi Penyakit dan Kadar Gula Darah Dengan

Keluhan Subyektif Pada Penderita Diabetes Mellitus Tipe II di Puskesmas Putri Ayu Kota Jambi. *Jurnal Medika Cendekia*, *7*(1), 6–13. https://doi.org/https://doi.org/10.33482/medika.v7i1.119

Hummel, S., & Hummel, M. (2025). *Diabetes in Old Age*. https://www.diabinfo.de/en/living-with-diabetes/diabetes-in-everyday-life/old-age-and-care.html

Hurtado, M. D., Saadedine, M., Kapoor, E., Shufelt, C., & Faubion, S. S. (2024). Weight Gain in Midlife Women. *Current Obesity Reports Journal*, *13*(2), 352–363. https://doi.org/10.1007/s13679-024-00555-2 Weight Gain in Midlife Women

Jiahao, L., Jiajin, L., & Yifan, L. (2021). Effects of resistance training on insulin sensitivity in the elderly: A meta-analysis of randomized controlled trials. *Journal of Exercise Science & Fitness*, *19*(4), 241–251. https://doi.org///doi.org/10.1016/j.jesf.2021.08.002

Karwati. (2022). Hubungan Aktivitas Fisik Dengan Kadar Gula Darah Pada Lansia Penderita Diabetes Melitus Tipe 2 Di Wilayah Kerja Puskesmas Situ. *Jurnal Ilmu Keperawatan Sebelas April*, *4*(1), 11–17.

Kasriani, & Widaryati. (2021). *Faktor – Faktor Yang Mempengaruhi Kontrol Gula Darah Pasien Diabetes Melitus Tipe II* [Universitas Aisyiyah Yogyakarta]. https://digilib.unisayogya.ac.id/5957/1/NASKAH_PUBLIKASI_KASRIANI_1910201211_25-02-2021%5B1%5D.pdf

Kemenkes. (2023). *Survey Kesehatan Indonesia (SKI) 2023*.

Kurniawati, P. (2023). Pengaruh Pendidikan Kesehatan Terhadap Motivasi Mengontrol Kadar Gula Darah pada Penderita Diabetes Mellitus Tipe 2. *Jurnal Surya Medika (JSM)*, *9*(3), 117–123. https://doi.org/https://doi.org/10.33084/jsm.v9i3.6491

Leon, D. G., Gittermann, L. M. T., Island, N. S., Boratovic, S. R. V., & Giacoman, A. von O. (2022). Effects of break in sedentary behaviour on blood glucose control in diabetic patients. Systematic review. *Endocrinología, Diabetes y Nutrición (English Ed.) Journal*, *69*(10), 888–896. https://doi.org/10.1016/j.endien.2022.11.027

Lestari, Zulkarnain, & Sijid, S. A. (2021). Diabetes Melitus: Review etiologi, patofisiologi, gejala, penyebab, cara pemeriksaan, cara pengobatan dan cara pencegahan. *Prosiding Biologi Achieving the Sustainable Development Goals with Biodiversity in Confronting Climate Change*, *7*(1). https://doi.org/https://doi.org/10.24252/psb.v7i1.24229

Palmer, A. K., & Jensen, M. D. (2022). Metabolic changes in aging humans: current evidence and therapeutic strategies. *The Journal of Clinical Investigation*, *132*(16). https://doi.org/https://doi.org/10.1172/JCI158451

Rahayuningsih, M. S., Juniarsana, I. W., & Wiardani, N. K. (2023). Hubungan Aktivitas Fisik dan Kepatuhan Diet dengan Kadar Glukosa Darah Pasien DM Tipe 2. *Jurnal Ilmu Gizi*, *12*(3), 155–165. https://doi.org/https://doi.org/10.33992/jig.v12i3.2122

Rima Nurfalah. (2022). *Hubungan Konsumsi Makanan Glikemik Dengan Kadar Gula Darah Pada Pralansia Di Posbindu Wilayah Kerja Puskesmas Darma Kabupaten Kuningan* [Universitas Siliwangi]. ttp://repositori.unsil.ac.id/id/eprint/6110

Safitri, Y. E., Rachmawati, D., & Martiningsih, W. (2022). The Effect Of Physical Activity To Reduce Blood Glucose Levels In Patients With Type 2 Diabetes Mellitus (Literature Review). *Jurnal Keperawatan Malang (JKM)*, *7*(2), 206–216. https://doi.org/https://doi.org/10.36916/jkm.v7i2.178

Sihite, R., Silitonga, H. A., & Tarigan, J. (2022). Hubungan Diabetes Melitus Tipe 2 Berdasarkan Usia dan Jenis Kelamin Dengan Kejadian Covid-19 di RSUD Dr. Pirngadi Kota Medan. *Jurnal Kedokteran Methodist*, *16*(2). https://ejurnal.methodist.ac.id/index.php/jkm/article/view/1662

Siregar, H. K., Pangaribuan, S. M., Batubara, K., Butar, S. B., & Siregar, S. W. (2023). Hubungan

Aktivitas Fisik Dengan Kadar Glokosa Darah Pada Pasien Diabetes Mellitus di Ruang Penyakit Dalam RSUD Koja Jakarta. *Jurnal Keperawatan Cikini*, *4*(1), 32–39. https://doi.org/https://doi.org/10.55644/jkc.v4i1.97

World Health Organization (WHO). (2022). *Physical Activity and Sedentary Behaviour: A brief to support people living with type 2 diabetes*. Department of Health Promotion World Health Organization. https://iris.who.int/bitstream/handle/10665/364452/9789240062740-eng.pdf

World Health Organization (WHO). (2024). *Physical Activity*. https://www.who.int/news-room/fact-sheets/detail/physical-activity

World Health Organization (WHO). (2025). *Noncommunicable Disease Surveillance, Monitoring and Reporting. Physical activity surveillance.* https://www.who.int/teams/noncommunicable-diseases/surveillance/systems-tools/physical-activity-surveillance