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The Role of Physical Activity in Controlling Blood Glucose Levels in Patients with Type 2 Diabetes Mellitus

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Abstract: Diabetes mellitus is a chronic metabolic disorder characterized by elevated blood glucose levels and is an incurable disease, one way to control blood sugar levels is by doing physical activity because it can reduce insulin resistance. This study aims to summarize the results of clinical trials examining the role of physical activity in controlling blood sugar levels in patients with type 2 diabetes mellitus. This study uses a Systematic Literature Review design conducted on the Google Scholar site, obtained 7 journals to be reviewed literature, with the results of the 7 journals studied as many as 6 studies showing a relationship between physical activity and blood glucose levels in Diabetes Mellitus patients, and one article that does not show a relationship between physical activity and blood glucose levels in Diabetes Mellitus patients. Most of the physical activities carried out by respondents are divided into 3 categories, namely: light activities, such as sleeping, watching television, eating, and doing general household chores. Moderate activities, such as walking, driving, or using public transportation. For, heavy activities carried out, such as gardening, jogging, and intense sports such as sit ups, push ups, or cycling. Thus, physical activity can increase insulin sensitivity and help the process of glucose absorption into cells can lower blood sugar levels and physical activity also helps reduce the risk of complications such as diabetic neuropathy in people with diabetes mellitus.
Keywords: Physical Activity, Blood Glucose, Patients, Type 2 Diabetes Mellitus

Introduction

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistently elevated blood glucose levels. This condition can occur due to impaired insulin production, cellular resistance to insulin action, or a combination of both (Goyal R, 2023). Generally, diabetes is classified as type 1 diabetes mellitus (T1DM), type 2 diabetes mellitus (T2DM), gestational diabetes, and other specific types of diabetes. The causes of diabetes are genetic and environmental (Hardianto, 2020). According to data from the International Diabetes Federation (IDF), in 2019, approximately 463 million people aged 20 to 79 worldwide were living with diabetes, equivalent to 9.3% of the global population in that age range. In Southeast Asia, including Indonesia, the prevalence of diabetes reached 11.3%, placing this region in the third highest position.

Globally, Indonesia ranks seventh out of the ten countries with the highest number of diabetes sufferers, with an estimated 10.7 million sufferers (Ministry of Health of the Republic of Indonesia, 2020). According to the 2018 Basic Health Research (Riskesdas), the number of diabetes sufferers in Indonesia reached 10.9% of the total population. Among the elderly (over 60 years old), 6.5% were diagnosed with diabetes mellitus. Of these, 6.06% were undergoing treatment, 5.46% were following medical advice, and only 4.12% regularly visited healthcare facilities (Ministry of Health of the Republic of Indonesia, 2018).

The prevalence of type 2 diabetes mellitus is increasing in both sexes, but men are typically diagnosed at a younger age and have lower body fat mass than women. Worldwide, an estimated 17.7 million more men than women suffer from diabetes mellitus (Kautzky et al., 2023). Risk factors for type 2 diabetes mellitus include lack of physical activity (less than 3 times a week), obesity, age over 45, and genetics (CDC, 2024). Long-term hyperglycemia, along with other metabolic disorders, can damage various organs in the body. This can lead to serious and life-threatening complications, particularly microvascular complications such as retinopathy, nephropathy, and neuropathy, as well as macrovascular complications that significantly increase the risk of cardiovascular disease by two to four times. Therefore, managing this disease is crucial (Goyal R, 2023).

To date, diabetes remains an incurable disease, but blood glucose levels must be continuously maintained. To live a healthy life, people with diabetes mellitus need to understand how to manage blood sugar levels through four main pillars. These four pillars include education, dietary management, physical activity, and pharmacological therapy (Marbun et al., 2022). Physical activity has been scientifically proven to be an effective therapy, with numerous studies supporting its benefits. For many years, exercise has been specifically utilized to provide positive effects for people with diabetes, with an increasingly protective role through improved body composition, blood glucose control, blood pressure, and reduced insulin resistance (Cai et al., 2017). Based on the background description, this literature review aims to summarize the results of clinical trials examining the role of physical activity in controlling blood sugar levels in people with type 2 diabetes mellitus.

Method

This research employed the Systematic Literature Review method. This method involves the identification, review, evaluation, and interpretation of all relevant and available research. A Systematic Literature Review is used as a research design that aims to systematically synthesize evidence from previous studies to answer a research question (Dhamayanti, 2022).

A Systematic Literature Review also provides an approach to evaluating the quality and strength of available evidence related to a specific question or topic. This approach offers a more comprehensive and accurate understanding than a conventional literature review. Systematic reviews follow standardized procedures and guidelines for systematically searching, selecting, reviewing, critically appraising, interpreting, synthesizing, and reporting results from various relevant published sources (MacDonald, 2014). In a Systematic Literature Review, authors need to conduct critical evaluations because this positively contributes to reader understanding. Therefore, authors develop evaluations that focus on establishing inclusion and exclusion criteria (Karim & Hambali, 2024).

Guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), systematic literature reviews are ensured with methodological accuracy and quality. The PRISMA guidelines include an evidence-based checklist and

flowchart designed to provide a practical guide for authors in preparing systematic reviews and meta-analyses (Booth et al., 2021). PRISMA offers three main benefits: helping formulate research questions systematically and clearly, establishing structured inclusion and exclusion criteria, and facilitating the search for scientific literature sources within a specific timeframe (Shaffril et al., 2018).

The target population for this study was articles from scientific journals reporting on physical activity in type 2 diabetes mellitus. The accessible population for this study was identified using the Google Scholar search engine. The sampling technique used in this study was total sampling with a search query using the keywords "Physical activity" AND "Diabetes Mellitus" AND "Blood sugar levels".

Table 1. Search Process for Collecting Data

Data Retrieval	Keywords
Google Schoolar	All Tittle “Physical activity” AND “Diabetes Mellitus” AND “Blood sugar levels”

This study uses several criteria to search for articles to be reviewed, including: 1) Using articles for a maximum of the last 10 years, meaning from 2015 to 2025, so that articles that are not included in this time frame will be excluded or not used in this study. 2) Indonesian, the articles used in this study use Indonesian, so that articles or journals that use languages other than Indonesian are not used in this study. 3) Sinta Indexed, researchers use articles that have been published on Google Scholar that have been indexed by Sinta, so that the quality standards of the articles are maintained. 4) Documents, documents used in this study must contain empirical data. Secondary sources such as literature review articles, books, and conference papers will not be included in the analysis.

Table 2. Article Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Year	Last 10 years (2015-2025)	More than 10 years
Language	Indonesian	Besides Indonesian
Index	SINTA	Not indexed by SINTA
Document	Research Articles	Besides Research Articles

The following is a PRISMA flow chart which serves as a guide in this literature review research;

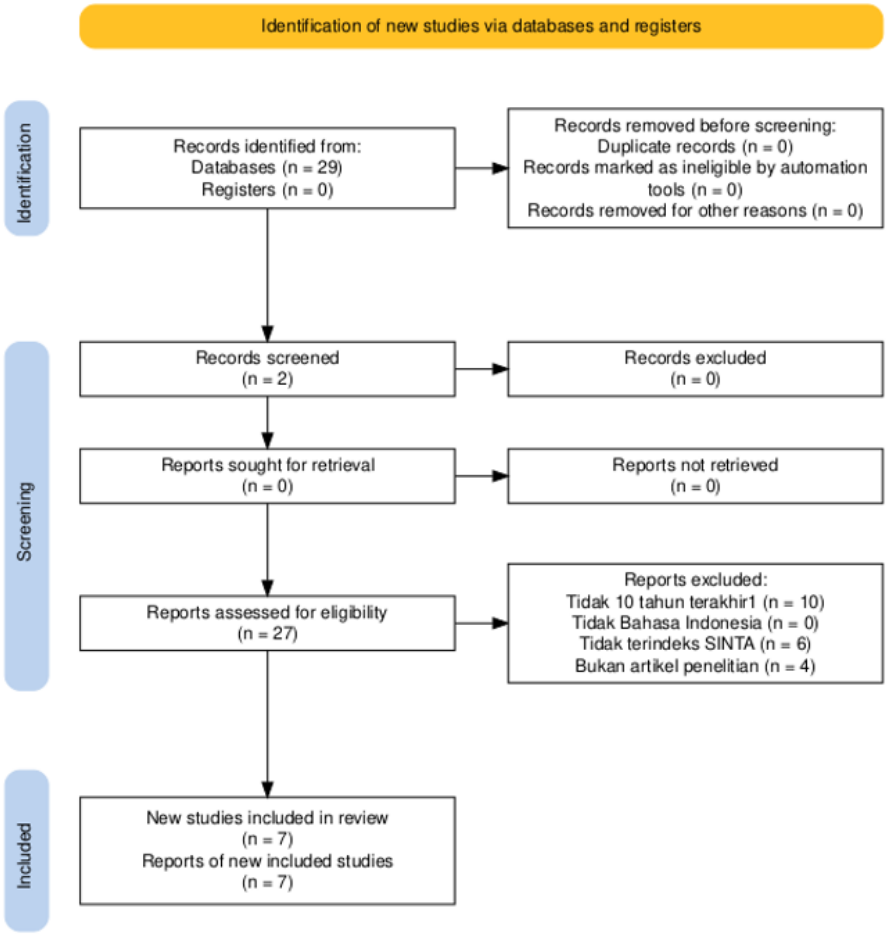

Figure 1. PRISMA Diagram

The article selection process was carried out through a search in the Google Scholar database with the keywords Alltitle “Physical activity” AND “Diabetes Mellitus” AND “Blood sugar levels”, which resulted in 29 articles. Next, filtering was carried out based on the year of publication between 2015 and 2025, which eliminated 10 articles outside that year range, leaving 19 articles. The articles were then selected based on population suitability, leaving 17 (2 articles were irrelevant). After filtering based on outcome suitability, by removing articles that were not indexed by SINTA and only taking research, the number was reduced to 10 articles, and after considering the research design, 7 articles remained. so that 7 articles were obtained which were used in this research literature review.

Results & Discussion

Results

The results of the literature review obtained through a search using Google Scholar with the keywords All Title "Physical activity" AND "Diabetes Mellitus" AND "Blood sugar levels", produced 29 articles and after going through the screening criteria of the articles to be studied until the final stage produced 7 articles to be reviewed. The following are the titles, researchers, years, methods and results of the articles selected after screening.

Table 3. Selected Articles

No.	Title	Author	Year	Method	Results
1	The Effect of Diet Compliance, Physical Activity, and Medication on Changes in Blood Sugar Levels in Rejang Tribe Diabetes Mellitus Patients	Almaini, A. & Heriyanto, H.	2019	Cross Sectional	There is a significant relationship between diet compliance, medication adherence and current blood sugar levels in DM patients
2	Physical Activity, Disease Duration, and Blood Sugar Levels in Type 2 Diabetes Mellitus (DM) Patients	Yessi, A. Yulian, A. Yessi, M. Marlina, Lidya, N. & Niken Dwi, A.	2020	Observation with a Cross-Sectional Approach	The results of the study showed a picture of the level of physical activity in respondents suffering from DM of 66.7% with a light level of physical activity, and 33.3% with a moderate level of physical activity
3	The relationship between physical activity and the incidence of diabetic neuropathy in patients with type 2 diabetes mellitus	Badrujamaludin, A. Santoso, M. B. & Nastrya, D.	2021	Correlation Analysis with Cross Sectional Approach	There is a relationship between physical activity and the occurrence of diabetic neuropathy in type 2 DM sufferers
4	The Relationship Between Lifestyle (Dietary Patterns and Physical Activity) and the Incidence of Diabetes Mellitus at the NTB Provincial General Hospital	Hariawan, H. Fathoni, A. & Purnamawati, D.	2019	Analytical Observational with Retrospective Study	There is a relationship between lifestyle (diet and physical activity) and the incidence of DM. With the Chi-Square Test with the incidence of DM ($p=0.02 <\alpha=0.05$) and there is a relationship between physical activity and the incidence of DM ($p=0.009 <\alpha=0.05$)
5	The Relationship Between Physical Activity and Fasting Blood Sugar Levels in Type 2 Diabetes Mellitus Patients	Nurayati, L. & Adriani, M.	2017	Cross Sectional	The study results showed that 62.9% of respondents had low physical activity and 58.0% had high fasting blood sugar levels. The results showed a relationship between physical activity and fasting blood sugar levels in type 2 diabetes mellitus patients (p=0.000)
6	Physical Activity and Its Relationship to the Incidence of Diabetes Mellitus	Purnama, A. & Sari, N.	2019	Descriptive Analytical with Cross Sectional Approach	There is a relationship between physical activity and the incidence of diabetes mellitus (P value = 0.009 with OR = 11,000)
7	The Relationship Between Physical Activity and Blood Glucose Levels in Diabetes Mellitus Patients in the Internal Medicine Ward of Koja Regional Hospital, Jakarta	Henrianto, K.S. Samsinar, B.B. Santa, M.P. Sri, W.S. & Khairunnisa, B.	2023	Analytical Survey with Cross Sectional Approach	There is a relationship between physical activity and blood glucose levels in diabetic patients. The Chi-square test results show a p-value of ($0.000 < \alpha$ 0.05)

After the eligibility stage was completed, the documents were thoroughly analyzed and evaluated. The results of this evaluation were then used to answer the research questions and conduct an in-depth analysis, starting with identifying the title, reading the

abstract, and reviewing the entire content to uncover the main themes and findings of each document or article selected for this study.

Discussion

A study (Nurayati and Adriani, 2017) found that most respondents with type 2 diabetes mellitus in the Mulyorejo Community Health Center (Puskesmas) area in Surabaya City had low levels of physical activity accompanied by high fasting blood sugar levels, representing 30 individuals (76.9%). Based on statistical tests using Spearman's rho, the p-value was 0.000, which is smaller than the alpha value (0.01). Therefore, it can be concluded that there is a significant relationship between physical activity and fasting blood sugar levels in respondents with type 2 diabetes mellitus.

This is due to the ability of physical activity to increase insulin receptor sensitivity, making blood glucose more easily metabolized into energy. One of the benefits of physical activity is its ability to lower blood sugar levels in individuals with diabetes mellitus, as described in research (Dewi et al., 2022). Various diabetes prevention programs have shown that behavioral changes, such as consuming nutritious foods and increasing physical activity, can reduce the risk of developing type 2 diabetes. In recent years, the International Diabetes Federation (IDF) has supported several initiatives for primary prevention of diabetes by integrating these programs into national healthcare systems. However, to prevent the surge in diabetes cases by 2025, comprehensive lifestyle changes are needed at the population level, including improved diet and increased physical activity (IDF, 2017).

A study (Siregar et al., 2023) conducted at Koja Regional Hospital in Jakarta in 2022 showed a relationship between physical activity and blood glucose levels in diabetes mellitus patients. This was demonstrated by a chi-square test, which yielded a significance value (p-value) of 0.000, less than the α value (0.05). This study involved a total of 255 respondents, the majority of whom were diabetes mellitus patients aged 45 and over. The results showed that 23 (37.7%) experienced elevated blood glucose levels (>200 mg/dL), 20 (32.8%) experienced decreased blood glucose levels (<70 mg/dL), and 18 (29.5%) experienced normal blood glucose levels.

These findings align with those of Rohmatulloh et al., 2024, who stated that with aging, the body's physiological function declines due to decreased insulin production or resistance, reducing the body's ability to handle high blood glucose levels. This can lead to complications such as diabetes and cardiovascular disease. In general, the rate of physiological change slows significantly after the age of 40. However, the results of the study stated that age is not the only aspect that causes the occurrence of Diabetes Mellitus, because this disease is also a result of a bad lifestyle in the sense of eating patterns and lack of physical activity so that this disease can attack individuals of various ages, especially those with a bad lifestyle pattern.

In a study (Hariawan et al., 2019), which examined the relationship between diet and activity and the incidence of diabetes mellitus, the study found a relationship between diet and the incidence of diabetes mellitus, and physical activity and the incidence of diabetes mellitus at the NTB Provincial General Hospital in 2013. In addition to poor diet, lack of physical activity is also a factor that triggers diabetes mellitus. Muscles that are inactive due to lack of movement have a very low level of permeability to glucose, unless stimulated by insulin. Low physical activity can increase the risk of diabetes because reduced muscle contractions cause the body's cells to be less able to absorb glucose. This interferes with the process of glucose absorption into cells and decreases the response to insulin, which can then cause insulin resistance and trigger the onset of diabetes mellitus. According to the Directorate of Prevention and Control of Non-Communicable Diseases (2017), type 2 diabetes is a condition where the pancreas does not produce enough insulin, or the body is unable to use the available insulin. This condition, called insulin resistance, often occurs in people with obesity and lack of

physical activity (Ministry of Health of the Republic of Indonesia, 2016). In a study (Sari and Purnama, 2019), most respondents had a light level of physical activity, namely 16 people (66.77%), while 8 people (33.3%) were in the moderate physical activity category. Based on interviews during the research process, light activities commonly carried out by respondents included bathing, dressing, eating, washing dishes, watching television, praying, resting, sitting, and sleeping. Meanwhile, moderate activities included walking, cooking, sweeping or cleaning the house, ironing, washing clothes, and other similar activities.

The results of the bivariate analysis using the Chi-Square test obtained a p-value of 0.009, which means $p < 0.05$, so there is a relationship between physical activity and the incidence of Diabetes Mellitus. Lack of physical activity is one of the main risk factors for various chronic diseases and globally contributes to mortality. Physical activity or exercise has a direct relationship with increasing the ability of muscles to absorb glucose from the bloodstream. During exercise, muscles utilize stored glucose reserves, and when these reserves are depleted, muscles will draw glucose from the blood to replenish their energy needs. This process contributes to lowering blood glucose levels, thus supporting better glycemic management. Physical activity is recommended for patients with Diabetes Mellitus. Physical activity plays an important role in the management of diabetes mellitus, especially in controlling blood sugar levels and improving various cardiovascular risk factors, such as reducing hyperinsulinemia, increasing insulin sensitivity, reducing body fat levels, and stabilizing blood pressure. Regular moderate-intensity physical exercise has been shown to be associated with a 45–70% reduction in mortality rates in people with type 2 diabetes mellitus and helps lower HbA1c levels to levels that can prevent complications (Sari and Purnama, 2019).

Research (Yessi et al., 2020) explains that most respondents reported light to moderate levels of physical activity, likely due to their advanced age. Light exercise for the elderly, such as regular gymnastics, walking, or jogging 3–4 times per week for approximately 30 minutes, can help maintain physical fitness and promote weight loss (Setiyorini & Wulandari, 2018). Furthermore, this exercise also contributes to increased insulin sensitivity, which ultimately helps control blood glucose levels. The study found that respondents with light physical activity tended to have uncontrolled fasting blood sugar levels, while those with moderate physical activity showed more stable fasting blood sugar levels. Recommended physical activity for people with type 2 Diabetes Mellitus is recommended to be regular physical activity and in accordance with CRIPE (continuous, rhythmic, interval, progressive, endurance training) and strive to achieve 75-85% of maximum heart rate (Fatimah, 2015).

A study (Badrujamaludin et al., 2021) examining the relationship between physical activity and diabetic neuropathy, a complication of diabetes mellitus, showed that most respondents engaged in light physical activity, and a significant proportion experienced diabetic neuropathy. Most of the respondents' physical activity fell into the light category, such as sleeping, watching television, grooming, eating, and general household chores. Moderate-intensity activities included walking, driving, or using public transportation. Meanwhile, vigorous activities included gardening, jogging, and intense exercise such as sit-ups, push-ups, or cycling.

Uncontrolled blood glucose levels can damage the walls of capillary blood vessels, which directly supply nutrients to nerves, potentially leading to nerve damage or neuropathy (Purnama & Sari, 2019). Therefore, maintaining healthy blood vessels is crucial to protect the nerves they supply. Hyperglycemia in diabetes mellitus can cause nerve and microvascular damage, reduce perfusion and increase the risk of complications such as peripheral neuropathy. Therefore, regular physical activity or exercise is essential to maintain optimal nervous system function (Oktavianti et al., 2023). Rahmawati (2018) also stated that aerobic activities such as walking, cycling,

jogging, and swimming at appropriate intensity can help reduce the risk of complications from diabetes mellitus.

In contrast, a study (Almaini and Heriyanto, 2019) involving 46 respondents showed that 19 respondents (41.3%) complied with recommendations for physical activity. The average random blood glucose level in the group that complied with physical activity was 268 mg/dL, which was higher than the average random blood glucose level in the diet-compliant group (196 mg/dL) and the medication-compliant group (212 mg/dL). Analysis showed no statistically significant relationship between adherence to physical activity and random blood glucose levels. This means that adherence to physical activity does not significantly affect random blood glucose levels.

Although research results do not show a significant relationship between physical activity and blood sugar levels, regular physical exercise is still recommended. The risk of developing diabetes mellitus can increase by 2-4 times in inactive individuals compared to those who are physically active. In other words, the lower a person's physical activity level, the greater the likelihood of developing diabetes. Physical activity or exercise helps control weight and encourages the burning of glucose for energy, ultimately increasing the body's cell sensitivity to insulin. Furthermore, consistent physical activity can also improve blood circulation and reduce various risk factors associated with diabetes mellitus (Perkeni, 2019).

Some physical activities that can be performed by people with type 2 diabetes include light-intensity physical activity (light walking) and moderate-intensity physical activity (prolanis exercise, elderly fitness exercise, and brisk walking for 30 minutes). The goal of diabetes mellitus management is to achieve and control optimal blood sugar levels and prevent or slow down complications caused by diabetes mellitus. To achieve this goal, DM management is focused on 4 pillars of management, namely education, medical nutrition therapy, physical activity and pharmacological intervention (Putra and Berawi, 2015).

Conclusion

An analysis of seven research articles concluded that regular physical activity has a very strong therapeutic effect in controlling blood glucose levels in patients with type 2 diabetes mellitus. Most of the literature (six of the seven articles) significantly demonstrated that moderate-intensity physical activity performed routinely 3 to 4 times per week for at least 30 minutes can improve insulin sensitivity, maintain fitness, and aid weight loss. Although one article did not show statistical significance, the findings still support the role of physical activity as an important pillar in establishing a healthy lifestyle. Therefore, physical activity tailored to the individual's condition and abilities should be one of the main interventions in a comprehensive and sustainable diabetes management program. To optimize the success of this program, healthcare professionals play a crucial role in providing appropriate education and consistent motivation to patients to commit to carrying out this routine for a better quality of life.

References

Almaini, A. and Heriyanto, H. (2019). ‘Pengaruh Kepatuhan Diet, Aktivitas Fisik dan Pengobatan dengan Perubahan Kadar Gula Darah pada Pasien Diabetes Mellitus Suku Rejang’, Jurnal Keperawatan Raflesia, 1(1), pp. 55–66. doi: 10.33088/jkr.v1i1.393

Alza, Y. et al. (2020). ‘Aktivitas Fisik, Durasi Penyakit Dan Kadar Gula Darah Pada Penderita Diabetes Mellitus (Dm) Tipe 2’, Jurnal GIZIDO, 12(1), pp. 18–26. doi: 10.47718/gizi.v12i1.907.

Badrujamaludin, A., Santoso, M. B. and Nastrya, D. (2021). 'Hubungan aktivitas fisik dengan kejadian neuropati diabetik pada penderita diabetes mellitus Tipe 2', Holistik Jurnal Kesehatan, 15(2), pp. 176–186. doi: 10.33024/hjk.v15i2.3624.

Booth, A., Martyn-St James, M., Clowes, M., & Sutton, A. (2021). Systematic approaches to a successful literature review.

Direktorat Jenderal Pencegahan dan Pengendalian Penyakit. (2019) Buku Pedoman Penyakit Tidak Menular. Kementerian Kesehatan RI [Internet]. Available from: http://p2ptm.kemkes.go.id/uploads/VHcrbkVobjRzUDN3UCs4eUJ0dVBndz09/2019/03

Cai, H., Li, G., Zhang, P., Xu, D., & Chen, L. (2017). Effect of exercise on the quality of life in type 2 diabetes mellitus: a systematic review. Quality of Life Research, 26(3), 515–530. https://doi.org/10.1007/s11136-016-1481-5

CDC. (2024). Diabetes Risk Factors. Available at : https://www.cdc.gov/diabetes/risk-factors/index.html

Dewi, P. A. C., Andayani, N. W. R., & Pratiwi, N. M. S. (2022). Hubungan Aktivitas Fisik Dengan Kadar GDS Pada Penderita Dm Tipe II. Journal of Midwifery and Health Administration Research, 2(1), 19-26.

Dhamayanti, P. V. (2022). Systematic literature review: Pengaruh strategi pembelajaran inkuiri terhadap kemampuan berpikir kritis peserta didik. Indonesian Journal of Educational Development (IJED), 3(2), 209-219.

Fatimah, R. N. (2015). Diabetes melitus tipe 2. Jurnal majority, 4(5), 93-101.

Goyal R, Singhal M, Jialal I. (2023). Type 2 Diabetes. In: StatPearls [Internet]. Treasure Island (FL): StatPearls . Available from: https://www.ncbi.nlm.nih.gov/books/NBK513253/

Hardianto, D. (2020) Telaah komprehensif diabetes melitus: klasifikasi, gejala, diagnosis, pencegahan, dan pengobatan. Jurnal bioteknologi dan biosains Indonesia, 7(2), 304-317.

Hariawan, H., Fathoni, A. and Purnamawati, D. (2019). 'Hubungan Gaya Hidup (Pola Makan dan Aktivitas Fisik) Dengan Kejadian Diabetes Melitus di Rumah Sakit Umum Provinsi NTB', Jurnal Keperawatan Terpadu (Integrated Nursing Journal), 1(1), p. 1. doi: 10.32807/jkt.v1i1.16.

IDF. (2017). IDF Diabetes Atlas Eighth edition 2017. International Diabetes Federation (IDF). https://diabetesatlas.org/atlas/eighth-edition/

Karim, N. N. F., & Hambali, B. (2024). Systematic Literature Review: Peningkatan Kesehatan Mental Melalui Olahraga. Jurnal Olahraga dan Kesehatan Indonesia (JOKI), 4(2), 110-120.

Kautzky-Willer A, Leutner M, Harreiter J. (2023). Sex differences in type 2 diabetes. Diabetologia. Jun;66(6):986-1002. doi: 10.1007/s00125-023-05891-x. Epub 2023 Mar 10. Erratum in: Diabetologia. 2023 Jun;66(6):1165. doi: 10.1007/s00125-023-05913-8. PMID: 36897358; PMCID: PMC10163139.

Kementrian Kesehatan RI. (2016). Diabetes Tanya-Jawab seputar. Jakarta: Kementrian Kesehatan RI.

Kementerian Kesehatan RI. (2018). Hasil Riset Kesehatan Dasar (RISKESDAS) 2018. Hasil Utama Riskesdas. Jakarta.

Kementrian Kesehatan RI. (2020). Tetap Produktif, Cegah, dan Atasi Diabetes Melitus. InfoDatin : Pusat Data dan Informasi Kementrian Kesehatan Republik Indonesia

MacDonald, J. (2014). Systematic Approaches to a Successful Literature Review, Journal of the Canadian Health Libraries Association / Journal de l'Association des bibliothèques de la santé du Canada. doi: 10.5596/c13-009.

Marbun, A. S., Brahmana, N., Sipayung, N. P., Sinaga, C., Marbun, K. L. U., & Halianja, R. (2022). Pelaksanaan empat pilar pada penderita diabetes melitus. Jurnal Abdimas Mutiara, 3(1), 366-371.

Nurayati, L. and Adriani, M. (2017). 'Hubungan Aktifitas Fisik dengan Kadar Gula Darah Puasa Penderita Diabetes Melitus Tipe 2', Amerta Nutrition, 1(2), p. 80. doi: 10.20473/amnt.v1i2.6229.

Oktavianti, D. S., Ramadhan, G. E., Wigati, W.W., Alfonsa, R.O. (2023). 'Penerapan Buerger Allen Dan Foot Exercise Terhadap Sirkulasi Darah Kaki Penderita Diabetes Melitus', Jurnal Vokasi Kesehatan.

Perkeni. (2019). Konsensus pengelolaan dan pencegahan diabetes melitus tipe 2 di indonesia. Jakarta. Diunduh dari https://www.scribd.com/doc/310474800/ Perkeni-Diabetes-Mellitus.

Purnama, A. and Sari, N. (2019). 'Aktivitas Fisik dan Hubungannya dengan Kejadian Diabetes Mellitus', Window of Health : Jurnal Kesehatan, 2(4), pp. 368–381. doi: 10.33368/woh.v0i0.213.

Putra, I. W. A., & Berawi, K. N. (2015). Empat pilar penatalaksanaan pasien diabetes mellitus tipe 2. Jurnal Majority, 4(9), 8-12.

Rahmawati, A. (2018). Pengaruh Keteraturan Berobat Dan Aktivitas Fisik Terhadap Kejadian Neuropati Diabetik Tipe 2. Jurnal Wiyata: Penelitian Sains dan Kesehatan, 4(2), 157-164.

Rohmatulloh, V. R., Riskiyah, R., Pardjianto, B., & Kinasih, L. S. (2024). Hubungan usia dan jenis kelamin terhadap angka kejadian diabetes melitus tipe 2 berdasarkan 4 kriteria diagnosis di Poliklinik Penyakit Dalam RSUD Karsa Husada Kota Batu. PREPOTIF: Jurnal Kesehatan Masyarakat, 8(1), 2528-2543.

Setiyorini, E & Wulandari, N. A., (2018) Asuhan keperawatan lanjut usia dengan penyakit degeneratif (Vol. 1). Media Nusa Creative (MNC Publishing).

Shaffril, H. A. M., Krauss, S. E., & Samsuddin, S. F. (2018). A systematic review on Asian's farmers' adaptation practices towards climate change. Science of the total Environment, 644, 683-695.

Siregar, H. K. et al. (2023).'Hubungan Aktivitas Fisik Dengan Kadar Glukosa Darah Pada Pasien Diabetes Mellitus di Ruang Penyakit Dalam RSUD Koja Jakarta', Jurnal Keperawatan Cikini, 4(1), pp. 32–39.