JURNAL UPI

Jurnal Pendidikan Jasmani dan Olahraga

Journal homepage: http://ejournal.upi.edu/index.php/penjas/index

JPJO

Relationship between Physical Activity and HbA1c Levels at Made Health Center

Nazwa Syahlimar Alkatiri, Rahajoe Imam Santosa,, Raden Roro Shinta Arisanti, Natalia Yuwono*

School of Medicine, Universitas Ciputra, Surabaya, Indonesia

*Correspondence: E-mail: nanasyhh@gmail.com

ABSTRACT

One of the non-communicable diseases that has become a global concern is diabetes mellitus, a metabolic disease characterized by hyperglycemia. An accurate examination to measure blood glucose levels is HbA1c test, which measures blood glucose levels in the last three months. The Global Physical Activity Questionnaire is a tool to measure the intensity of physical activity. Physical activity, in moderate and vigorous intensity, is an important management to control blood glucose levels. This research aimed to determine the relationship between physical activity and HbA1c levels in the general medicine unit at the Made Public Health Center in Surabaya City. This research used an analytical observational study with a cross-sectional design. The population of this study was an eligible population with 30 samples. The examination of HbA1c levels used venous blood samples of respondents, while the examination of physical activity used the global physical activity questionnaire. Based on univariate analysis, most of the respondents, namely 21 respondents (70,0%), had mild physical activity and 24 respondents (80,0%) had uncontrolled HbA1c levels. Fisher's Exact Test analysis showed a p-value of 0.049 <p-value (0.05). It concludes that there is a relationship between physical activity and HbA1c levels in the general medicine unit at the Made Public Health Center in Surabaya City.

ARTICLE INFO

Article History:

Submitted/Received December 2024

First Revised December 2024

Accepted January 2025

Publication Date April 2025

Keyword:

Diabetes Mellitus, HbA1c, Physical Activity

INTRODUCTION

The metabolic disease with most patients is diabetes mellitus (DM) is a non-communicable diseases characterized by increased blood glucose levels (hyperglycemia) due to insulin damage. Insulin-dependent diabetes mellitus or T2DM is caused by genetic or environmental factors such as the patient's unhealthy lifestyle which includes not maintaining a diet and lack of physical activity (Loscalzo, 2022).

Diabetes mellitus is becoming a problem for the whole world as it is expected to increase every year. In 2021, every 5 seconds 6.7 million deaths are caused by DM. The International Diabetes Federation (IDF) reports that 537 million adults aged 20-79 suffer from DM. By 2024, it is predicted that 783 million sufferers will be present, and the number is predicted to increase to 643 million sufferers in 2030. Indonesia is one of the top ten DM sufferers worldwide with 19.5 million sufferers and by 2024 the prevalence will increase to 28.6 million sufferers (IDF, 2021). In East Java DM is estimated at 854,454 patients aged 15 years and over. Estimates of DM sufferers in first-level health facilities in 38 districts/cities are estimated to reach 859,187 cases (100.6%) of the total number of DM sufferers (DINKES JATIM, 2024). A total of 642 patients with T2DM were served at Made Health Center in 2024. Every two times a week, several patients receive wound care due to diabetic ulcers, a complication that can arise due to lack of physical activity. Every person with T2DM at the made health center must obtain health services according to standards and promotive efforts including T2DM management and HbA1c testing (primary data from made health center).

Type 2 diabetes mellitus has the highest prevalence of DM at around 90% and is mainly preventable (WHO, 2024). The risk factors for a person suffering from T2DM are obesity, age >45 years, family history of T2DM, lack of physical activity, and history of gestational diabetes mellitus (GDM) (CDC, 2024). Previous research shows most risk factors are age> 45 years, female, obese, and not working (Lasari et al., 2021). Symptoms that will be experienced by patients can include polyuria, polyphagia, polydipsia, and weight loss of unknown cause. There are three examinations that can be taken, such as random blood glucose levels, fasting blood glucose levels, oral glucose tolerance test, and HbA1c. HbA1c examination is the most accurate diagnostic criteria in T2DM because it can observe the effect of therapy 8-12 weeks earlier, this examination can be repeated every 3 months (Scobie, 2007). To check blood glucose levels, patients can check independently at home by checking random blood glucose levels or control to the doctor every one month to monitor blood glucose levels (Logan, Jones, & Kuritzky, 2020).

The main purpose of T2DM management is to achieve controlled blood glucose levels (Davies et al., 2022). Causes of complications in T2DM due to uncontrolled blood glucose levels that are prolonged, untreated complications can lead to death. Type 2 diabetes mellitus can be prevented by non-pharmacological diabetes management, including managing diet and increasing physical activity. The risk factor for T2DM is low intensity physical activity, because physical activity increases insulin sensitivity to absorb glucose into muscle cells, thus preventing obesity. Physical activity is an important non-pharmacological management for people with T2DM (PERKENI, 2021).

Physical activity is body movements that occur due to skeletal muscle contractions that cause an increase in caloric needs or skeletal muscles that cause an increase in calorie demand or use of body calories in excess of energy needs in resting state. Physical activity divided into three intensity categories are mild, moderate, and vigorous (Wicaksono & Handoko, 2020). During moderate and vigorous intensity physical activity, the skeletal muscle uses more fat

DOI: https://doi.org/10.17509/jpjo.v10i1.77142
p- 2085-6180 e- ISSN 2580-071X

and carbohydrates to meet the increased demand for metabolic fuel. The body also needs to secrete more glucose as active muscle fuel (Bouchard et al., 2007).

Adult and elderly patients with T2DM are recommended to do 150 to 300 minutes of moderate or vigorous intensity physical activity per week, or at least 75 to 150 minutes of vigorous intensity physical activity per week, or a combination of moderate and vigorous intensity physical activity to achieve substantial health benefits. If additional benefits are wanted, on two or more days per week T2DM patients can engage in muscle-strengthening at moderate or vigorous intensity physical activity that involves all major muscles of the body (WHO, 2022). Type 2 diabetes mellitus patients are recommended to do moderate and vigorous intensity physical activities that expend energy to reduce blood glucose levels in the body and achieve controlled blood glucose levels.

Based on Olesen et al. (2022), moderate intensity physical activity shows a long-term positive effect on blood glucose levels. Research conducted by Azhari & Septimar (2022) proves that if a person routinely does physical activity, their blood glucose levels can be controlled, and the results show that blood glucose levels can be reduce with physical activity. This indicates that physical activity is proven to be an important management for patients with T2DM to controlling blood glucose levels.

Previous researchers proved that people with T2DM who did light physical activity (21 respondents/50.0%) had high blood glucose levels (29 respondents/80.95%) (Faswita, 2024). Based on the background, researchers want to clarify the relationship between physical activity can reduce blood glucose levels in patients with T2DM in the General Poly of Made Surabaya City Health Center.

METHODS

The type of study was analytical observational with a cross-sectional research design. Researchers wanted to analyze the relationship between physical activity and HbA1c levels in patients with T2DM in the general clinic of Made Surabaya City Health Center in July-August 2024.

Participants

The population used in this study is an eligible population, which is patients with T2DM who can do physical activity. According to the formula calculated, the sample used was 30 patients. The formula used is the unpaired categorical analysis hypothesis formula.

$$n = \frac{(Z_\alpha\sqrt{2PQ} + Z_\beta\sqrt{P_1Q_1 + P_2Q_2})^2}{(P_1 - P_2)^2}$$

$$n = \frac{(1{,}96\sqrt{2(0{,}0889)(0{,}5555)} + 0{,}84\sqrt{(0{,}81\ x\ 0{,}19 + 0{,}079\ x\ 0{,}921)^2}}{(0{,}81 - 0{,}079)^2}$$

$$n = \frac{1\ 594\ 390\ 376}{0{,}534\ 361}$$

n = 29,8 rounded to 30

DOI: https://doi.org/10.17509/jpjo.v10i1.77142
p- 2085-6180 e- ISSN 2580-071X

Sampling Procedures

Patients were taken according to the inclusion criteria which are respondents age> 15 years, willing to fill out informed consent and Global Physical Activity Questionnaire instrument (GPAQ), and ability to do physical activity independently. This study's exclusion criteria are patients with bone or joint disorders that interfere with physical activity.

Materials and Procedures

This study has two variables, which are physical activity and HbA1c levels (controlled <6,7%). Researchers took blood from the patient's mediana cubiti vein to measure HbA1c levels using an HbA1c kit and then analyzed it using an HbA1c tool. Controlled HbA1c levels <6,5% and uncontrolled HbA1c levels >6,5% (Liong, 2024). The intensity of the patient's physical activity was measured using the GPAQ, which contains three main domains (activity at work, travel (walking) to and from places, and recreational activities) and added with sedentary behavior. The GPAQ results were then calculated using the Metabolic equivalent score (METs) formula and categorized according to minutes/METs. The formula equation: total physical activity METs-minutes/week = [(P2*P3*8) + (P5*P6*4) + (P8*P9*4) + (P11*P12*8) + (P14*P15*4)]. The categories of METs values based on the intensity of physical activity are vigorous intensity METs ≥ 3000, moderate intensity METs 600 to 3000, and mild intensity <600 (World Health Organization, 2021).

Design or Data Analysis

This study used univariate and bivariate analyses to obtain data on the characteristics of the patients studied in the form of gender, age, body mass index (BMI), HbA1c levels and physical activity. Bivariate analysis to see relationship between the variables studied, namely physical activity and HbA1c levels. Researchers want to compare physical activity levels with controlled or uncontrolled HbA1c levels so researchers use the chi-square hypothesis test to analyze patient data. If the chi-square hypothesis test does not qualify for the requirements, another alternative test will be used, which is Fisher's exact hypothesis test. The data collected were analyzed using SPSS 29 software for window versions.

RESULTS

The univariate analysis results to see the characteristics of patients with T2DM who have taken blood and filled out the GPAQ at the General Clinic of Made Surabaya City Health Center. The data obtained is attached in table 1.

Tabel 1. Patient Characteristics

Patien Characteristics	F	%
Gender		
Male	13	44.4
Famale	17	56.7
Age (Years old)		
26-45	4	13.3
46-59	16	53.3
>60	10	33.3
BMI		
Normal	20	66.7
Overweigh	1	3.3
Obese	9	33.3
HbA1c		

DOI: https://doi.org/10.17509/jpjo.v10i1.77142
p- 2085-6180 e- ISSN 2580-071X

Controlled	6	20.0
Uncontrolled	24	80.0
Physical activity		
Mild	21	70.0
Moderate + Vigorous	9	30.0

The bivariate analysis results was used to compare physical activity levels and HbA1c levels. Table 2 contains the results that were obtained.

Tabel 2. Results of Cross Tabulation of Physical Activity and HbA1c Levels

Physical Activity	HbA1c Levels				Total
	Uncontrolled		Controlled		
	F	%	F	%	(%)
Mild	19	79.2	2	33.3	21 (70.0)
Moderate + Vigorous	5	20.8	4	66.7	9 (30.0)
Total	24	100	6	100	30 (100)

Table 3. Analysis Results of Physical Activity and HbA1c Levels

	Exact Sig. (2-sided)	Exact Sig. (1-sided
Fisher's Exact Test	0.049	0.049

Tabel 4. Analysis Result of Physical Activity and HbA1c Levels Using Chi-Square Test

	value	df	Asymp Sig (2-Sided)
Pearson Chi-Square	4.802[a]	1	0.028
Continuity Corection[b]	2.867	1	0.090
Likelihood Ratio	4.450	1	0.035
Linear-by Linear Association	4.624	1	0.031

The Chi-Square hypothesis test analysis did not qualify because 2 cells 50.0% have expected count less than 5 is more than 20%, so other alternative tests were used using the Fisher's Exact hypothesis test, which obtained in a significant value Exact Sig (2-sided) is 0.049 where the value of $\alpha < 0.05$. The hypothesis can be accepted, meaning that there is a relationship between physical activity and HbA1c levels in patients with T2DM at the General Clinic of Made Surabaya City Health Center.

DISCUSSION

Based on gender characteristics, most respondents were female as much as 56.7%. Worldwide,17.7 million males are thought to have T2DM, which affects more men than woman. Obesity in women is a more significant risk factor when diagnosed with T2DM. In addition, the risk of DM in women is more signifantly influenced by psychological stress (Kautzky-Willer, A., Leutner, M., & Harreiter, J., 2023).. According to other sources, T2DM can affect both sexes at various age ranges (Watkins, 2003). Males suffer more from T2DM before puberty, while females suffer more from T2DM after menopausal age. In premenopausal

DOI: https://doi.org/10.17509/jpjo.v10i1.77142
p- 2085-6180 e- ISSN 2580-071X

women, estrogen protects T2DM by increasing insulin sensitivity and glucose-stimulated insulin secretion, and reducing beta cell apoptosis (Ciarambino et al., 2022).

Age is one of the non-modifiable risk factors for T2DM. The most frequent respondent characteristic was age range of 46-59 years. Type 2 diabetes mellitus most often affects the elderly and occurs at 50-70 years (Watkins, 2003). Research conducted by (Azhari & Septimar, 2022) shows that the early elderly patients aged 46 to 55 years are more from T2DM than adults. The results show that patients aged >45 years have a greater risk of suffering from T2DM than patients aged <45 years.

The body mass index of the patients was found that most patients had normal BMI. Unexplain weigh loss is one of the classic symptoms of T2DM. Many researchers have suggested that obesity is a common cause of insulin resistance. T2DM is a progressive disease, insulin secretion decreases over several years, resulting in decreased glycemic control (Watkins, 2003).

In this study, a higher normal BMI number can be caused by the body becoming resistant to insulin. Glucose does not absorb properly into muscle cells, so the body will look for other energy sources from protein and fat as a result of a decrease in body weight due to burning fat and body protein to meet energy needs (Sulastri, 2022).Previous research showed that out of 87 patients suffering from T2DM 39 patients had abnormal BMI (Anggraini et al., 2024).

Physical activity is an important non-pharmacological treatments for controlling glucose levels. An increased risk of T2DM is associated to a lack of physical activity. Moderate and vigorous physical activity is important in managing T2DM because it influences blood glucose levels and other risks. According to research, physical activity can reduce HbA1c by about 0.66%, a clinically significant amount in the long term. Physical activity does not have to reduce body weight to affect glucose control positively (Nagi, 2006). Previous research found that out of 105 patients, 37 patients who did medium intensity physical activity had not normal blood glucose levels, the chi-square results the p value is 0.020 less than 0.05, indicating a significant relationship between physical activity and blood glucose levels. (Rooiqoh et al., 2023)

Plasma insulin levels will decrease during physical activity, especially vigorous physical activity. Insulin-independent or insulin action on muscle increases muscle glucose uptake. During physical activity, the concentration of the major glucose transport protein, or glucose transporter (GLUT) 4, which is not dependent on insulin, on the muscle membrane increases. The increased concentration of GLUT 4 on the cell surface causes more glucose to be taken up into the muscle cell, resulting in a decrease in glucose levels (Poretsky, 2010). Previous research showed that out of 51 samples, 20 respondents who did not regularly doing physical activity had uncontrolled blood glucose levels, and 14 respondents who often did physical activity could reduce blood glucose levels or achieve controlled blood glucose levels (Syaftriani et al, 2023).

The main important factors to decreasing blood glucose levels is physical activity, uncontrolled blood glucose levels can be caused by individuals not doing the recommended physical activity. Low physical activity has an impact on increasing blood glucose levels. If it lasts long, it will trigger complications from DM (Siregar et al., 2023). Accordance to research conducted by Martafari & Julinar (2021)which shows that 40 respondents (76.9%) did not do regular physical activity have uncontrolled blood glucose levels. According on the statistical analysis results, the p value is 0.014, which means there is a relations between physical activity and HbA1c levels.

Adult and elderly patients with T2DM are recommended to do at least 150-300 minutes per week of moderate or vigorous-intensity physical activity, or at least 75-150 minutes per

DOI: https://doi.org/10.17509/jpjo.v10i1.77142
p- 2085-6180 e- ISSN 2580-071X

week of vigorous-intensity physical activity, or a combination of moderate and vigorous physical activity to achieve substantial health benefits. If additional benefits are desired, T2DM patients can engage in muscle-strengthening at moderate or vigorous-intensity physical activity that involves all major muscles of the body on two or more days per week (WHO, 2022). Type 2 diabetes mellitus patients are recommended to do moderate or vigorous-intensity physical activities that expend energy to reduce blood glucose levels in the body and achieve controlled blood glucose levels.

This study's results showed that most patients were female and aged >45 years. The percentage of respondents doing mild physical activity and showing uncontrolled HbA1c levels. The age, gender, and occupation of the patient can be the main factors of the patient's non-routine or lack of activity. The patient's unawareness the importance of physical activity in regulating blood glucose levels makes the patient indifferent to physical activity. Most patients prefer time to relax at home rather than do physical activity. If individuals adhere to the therapy given, it will result in controlled blood glucose levels. Individuals who perform low levels of physical activity can produce uncontrolled HbA1c levels and are categorized as hyperglycemia.

CONCLUSION

According to the results of the analysis conducted by patients with T2DM at the General Poly of Made Surabaya City Health Center, the results showed that uncontrolled HbA1c levels were held by patients who had mild physical activity. Fisher's Exact hypothesis test analysis obtained an Asymp.Sig (2-sided) value of 0.049 α value <0.05%. This proves that there is a relationship between physical activity and HbA1c levels. If the patient does mild physical activity, the blood glucose level will be uncontrolled, and if the patient does moderate and heavy physical activity, the blood glucose level can be controlled. Most of respondents do not do physical activity because patients do not understand how important physical activity is in controlling blood glucose levels, the average age of patients above 45 years is a factor in patients not doing physical activity because patients feel tired as they get older the body becomes easily tired when doing activities. With this study, hopefully, patients who have been given education can do physical activity in accordance with WHO recommendations to achieve controlled blood glucose levels and prevent complications of T2DM.

AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

REFERENCES

Anggraini, M.B., & Purwanti, O.S. (2024). The Relationship Between Body Mass Index and Diabetic Neuropathy in Patients With Diabetes Mellitus at the Regional General Hospital dr.Soehadi Prijonegoro Sragen District. *Contagion: scientific periodical of public health and coastal health,* 6(1), p.453-464.

Azhari, R., & Septimar, Z. M. (2022). Relationship between physical activity and blood glucose levels in type 2 diabetes mellitus in Buges Housing Area, Mas Indah RW 009. *Nusantara Hasana Journal*, *2*(7), 86–90.

Bouchard, Claude., Blair, S. N. ., & Haskell, W. L. . (2007). *Physical activity and health*. United States: Human Kinetics.

DOI: https://doi.org/10.17509/jpjo.v10i1.77142
p- 2085-6180 e- ISSN 2580-071X

Centers for disease and prevetion. (2024). Diabetes risk factors. Retrieved 7 December 2024, from https://www.cdc.gov/diabetes/risk-factors/index.html

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 sciences, 23(16), 8850.

Davies, M. J., Aroda, V. R., Collins, B. S., Gabbay, R. A., Green, J., Maruthur, N. M., ... & Buse, J. B. (2022). Management of hyperglycaemia in type 2 diabetes, 2022. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetologia, 65(12), 1925-1966.

Dinas Kesehatan Provinsi Jawa Timur. (2024). Profil Kesehatan Provinsi Jawa Timur Tahun 2023. Retrieved from https://dinkes.jatimprov.go.id/userfile/dokumen/PROFIL%20KESEHATAN%20JATIM%202022.pdf

Faswita, W. (2024). Hubungan Aktivitas Fisik Dengan Kadar Gula Darah Pada Pasien Diabetes Mellitus Tipe 2 Di Puskesmas Binjai Estate. *Jurnal Ilmiah Keperawatan Imelda*, *10*(1), 110-116.

IDF. (2021). IDF Diabetes Atlas 10th edition. Retrieved 7 December 2024, from https://diabetesatlas.org/atlas/tenth-edition/

Kautzky-Willer, A., Leutner, M., & Harreiter, J. (2023). Sex differences in type 2 diabetes. *Diabetologia*, *66*(6), 986-1002.

Kurniawan, L. B. (2024). HbA1c As Diabetes Mellitus Biomarker and Its Methods Evolution. *Indonesian Journal of Clinical Pathology and Medical Laboratory*, *30*(2), 198-203.

Lasari, H. H., Afifah, N. L., Mutmainnah, Y., & Fitriyanti, J. (2021). Spatial analysis and risk factors for diabetes mellitus type II in Banjarbaru City.

Logan, A. D., Jones, J., & Kuritzky, L. (2020). Structured blood glucose monitoring in primary care: a practical, evidence-based approach. *Clinical Diabetes*, *38*(5), 421-428.

Loscalzo, J., Fauci, A. S., Kasper, D. L., Hauser, S. L., Longo, D. L., & Jameson, J. L. (2022). *Harrison's principles of internal medicine (-2022)*. McGraw Hill.

Martafari, C. A., & Julinar, J. (2021). Hubungan Aktivitas Fisik Dan Diet Terhadap Kadar Gula Darah Pada Penderita Diabetes Mellitus Tipe-Ii Di Rsud Meuraxa Kota Banda Aceh. *Jurnal Sains Riset*, *11*(3), 670-676.

Nagi, D. (Ed.). (2006). *Exercise and sport in diabetes*. John Wiley & Sons.

PERKENI. (2021). *Pedoman pengelolaan dan pencegahan diabetes melitus tipe 2 dewasa di indonesia*. Jakarta: PB PERKENI.

Poretsky, L. (2010). *Principles of diabetes mellitus* (Vol. 21). L. Poretsky (Ed.). New York: Springer.

Rooiqoh, Q. F., Tamtomo, D. G., & Cilmiaty, R. (2023). The Relationship of Carbohydrate, Vitamin D, Zinc Consumption and Physical Activity with Fasting Blood Glucose Level in Type 2 Diabetes Mellitus Patients during COVID-19 Pandemic. *International Journal of Nutrition Sciences*, *8*(1), 20-26.

Schubert-Olesen, O., Kröger, J., Siegmund, T., Thurm, U., & Halle, M. (2022). Continuous glucose monitoring and physical activity. *International Journal of Environmental Research and Public Health*, *19*(19), 12296.

Scobie, I. N. (2007). Atlas of Diabetes Mellitus UK: Informa healthcare.

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

DOI: https://doi.org/10.17509/jpjo.v10i1.77142
p- 2085-6180 e- ISSN 2580-071X

Sulastri. (2022). *Buku pintar perawatan diabetes melitus*. Jakarta: Trans info medika.

Syaftriani, A. M., Lubis, H. H., Butar-Butar, M. H., & Eviana, L. (2023). The Relationship Of Physical Activity With Blood Glucose Levels In Patients With Type Ii Diabetes Mellitus In The Hospital General Mitra Medika Medan In 2021. *Jurnal Ilmu Keperawatan Medikal Bedah*, *6*(1), 11-21.

Watkins, P. J. (2003). *ABC of Diabetes*. London: BMJ publishing group.

Wicaksono, A., & Handoko, W. (2020). *Buku Aktivitas Fisik dan Kesehatan*. Pontianak: IAIN Pontianak Press.

World Health Organization. (2021). Global physical activity questionnaire (GPAQ) analysis guide. Retrieved 2 January 2025, from https://www.who.int/docs/default-source/ncds/ncd-surveillance/gpaq-analysis-guide.pdf

World health organization. (2022). WHO guidelines on physical activity and sedentary behavior. Retrieved 7 December 2024, from https://iris.who.int/bitstream/handle/10665/364452/9789240062740-eng.pdf

World health organization. (2024). Diabetes. Retrieved 7 December 2024, from https://www.who.int/europe/news-room/fact-sheets/item/diabetes

DOI: https://doi.org/10.17509/jpjo.v10i1.77142
p- 2085-6180 e- ISSN 2580-071X