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ORIGINAL RESEARCH

IDENTIFICATION OF THE RELATIONSHIP BETWEEN BODY MASS INDEX AND HbA1c IN TYPE 2 DM PATIENTS

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ABSTRACT

People with DM (diabetics) will generally experience obesity as a manifestation of metabolic changes in insulin and leptin hormones. The high variation in body weight and height and the many problems of controlling blood sugar levels in people with diabetes mellitus, researchers want to identify the relationship between Body Mass Index and HbA1c in Type 2 Diabetes Mellitus Patients at Bangil Hospital. This study uses correlation analytics with a cross-sectional approach to determine the relationship between body mass index and HbA1c levels in patients with type 2 diabetes mellitus at Bangil Hospital using consecutive non-random sampling techniques totalling 80 respondents. Data collection was carried out by means of laboratory examinations to see HbA1c data and blood glucose levels, while data regarding the patient's Body Mass Index (BMI) was taken by measuring body weight and height. The results of bivariate analysis conducted with the Chi-Square test approach showed that there was a significant relationship between body mass index and HbA1c (p-value = 0.000; $\alpha < 0.05$). HbA1c is the gold standard for assessing blood glucose homeostasis. HbA1c is a single accurate test to assess long-term glycaemic status and is useful in all types of DM. One of the efforts that can be done to reduce blood glucose levels is by achieving good nutritional status through BMI.

Keywords

Body Mass Index, HbA1c, Diabetes Mellitus

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic syndrome disease caused by the pancreas not producing or being unable to use insulin effectively. According to the International Diabetes Federation (IDF), the number of people with diabetes in Indonesia could reach 28.57 million by 2045. This number is 47% greater than the number of 19.47 million in 2021. The number of people with diabetes in 2021 has increased rapidly in the last ten years. (International Diabetes Federation, 2022).

People with DM (diabetics) will generally experience obesity as a manifestation of metabolic changes in insulin and leptin hormones which have an impact on hyperphagia (Suci Wulandari et al., n.d.). DM and obesity will lead to complications. It is known that DM with obesity will increase the risk of mortality. The high mortality and morbidity in diabetics is a manifestation of macro and micro complications. Overweight is associated with poor diet and low physical activity. Excessive energy intake and not balanced with balanced energy expenditure (low physical activity) will cause an increase in

body weight that leads to obesity. It is necessary to check blood glucose levels to diagnose someone with DM. One of the easiest and most commonly used blood glucose level test is the intermittent blood glucose level. However, this test has a disadvantage when compared to fasting and 2-hour postpandrial blood glucose level tests. Currently, HbA1c level is often used because it is more accurate in assessing blood glucose levels over the last two to three months. HbA1c is the gold standard for assessing blood glucose homeostasis. HbA1c is a single accurate test to assess long-term glycaemic status and is useful in all types of DM. Compared with fasting and 2-hour postprandial blood glucose tests, HbA1c has advantages such as: HbA1c has a better overall glucose exposure index and can assess long-term complications, is relatively unaffected by acute conditions, can be used for therapy guidance and adjustment, can be performed at any time and does not require fasting or special tests, and is a single test that can be used for diagnosis and assessment of glycaemic control (Liu et al., 2019).

One of the efforts that can be made to reduce blood glucose levels is by achieving good nutritional status. Anthropometry is one way of determining nutritional status to determine the number of DM diet calories. The determination of nutritional status used is the ratio of body weight in kg to height in metres squared expressed in body mass index or BMI. BMI is related to the blood glucose level of diabetics. In addition, it is also possible that information on central obesity status (LP) can be used as an easy and inexpensive screening tool to prevent complications such as lipid profile and blood pressure problems in diabetes (Sina et al., n.d.). Central obesity, measured by waist circumference (LP), is a strong predictor of heart disease which is a manifestation of macro complications of diabetes. However, there is no limit on BMI or LP for diabetics, which is necessary because diabetics are at higher risk of overweight, obesity dyslipidaemia, and hypertension than non-diabetics.

The number of people with diabetes has skyrocketed 167% compared to the number of people with diabetes in 2011, which reached 7.29 million. The increase was much higher than the increase between 2000 and 2011. In that period, the number of people with diabetes increased by 29% from 5.65 million in 2000. In 2021, the number of deaths caused by diabetes in Indonesia reached 236,711. This number increased by 58% when compared to 149,872 in 2011. In general, IDF estimates that the number of people with diabetes in the world could reach 783.7 million by 2045. This number increased by 46% compared to the number of 536.6 million in 2021 (Reza Pahlevi, 2021). Indonesia ranks 7th out of 10 countries with the highest number of people with DM, with 10.7 million people suffering from DM (infodatin, n.d.). Based on (Badan Pusat Statistik Kota Pasuruan, 2018) shows that there are 1,759 people with DM. This shows that DM sufferers in the Pasuruan area are still relatively high.

The high variation in body weight and height and the many problems of controlling blood sugar levels in patients with diabetes mellitus, researchers want to identify the relationship between Body Mass Index and HbA1c in Patients with Type 2 Diabetes Mellitus at Bangil Hospital.

METHOD

This study uses correlation analytics with a cross-sectional approach. Correlation analytic study is a technique used to analyse the relationship between independent variables and dependent variables. While cross-sectional is a study to study the correlation between risk factors by approaching or collecting data at one time only. This research design studies the relationship between body mass index and HbA1c levels in type 2 DM patients. The independent variable in this study was body mass index, and the dependent variable was HbA1c. The population in this study were all patients with diabetes mellitus in the period December 2022 at Bangil Hospital which is the place of this research. The population in this study was 93 people. The number and method of sampling uses consecutive non-random sampling with subjects who meet the inclusion and exclusion criteria. The inclusion criteria for subjects were type 2 DM patients of male and female gender, age range 40-60 years, willing to be used as research subjects and in a conscious condition and can be interviewed. Subjects as

active smokers, pregnant women and experiencing problems in communication are included in the exclusion criteria. Based on these criteria, the total sample size of this study was 80 respondents. Data collection in this study is primary data. Primary data sources are age, gender and duration of DM which are obtained directly from respondents using a questionnaire. Then the results of laboratory examinations were used to see HbA1c data and blood glucose levels, while data regarding the patient's body mass index (BMI) was taken by measuring body weight and height.

RESULTS

1. Characteristics of Respondents

Table 1 Frequency Distribution of Respondents Based on Gender at Bangil Hospital in 2023

Type of Gender	(n)	Percentage (%)
Male	39	48.8
Female	41	51.3
Total	80	100

The results based on table 4.1 show that most of the respondents' gender is female as many as 41 respondents (51.3%).

Table 2 Mean Age and Duration of DM Suffering at Bangil Hospital in 2023

Variabel	Mean	Median	SD	Min-Max	95% CI
Age	59.31	58.00	11.74	44.00-92.00	56.70-61.92
Duration of Suffering	4.76	5.00	2.34	1.00-11.00	4.24-5.28

* Normally Distributed Data

The results based on table 4.2 show that the median age was 58.00 years with the youngest age of 44.00 years and the oldest age of 92.00 years. The median length of DM was 4.76 years with the minimum length of DM being 1.00 years and the longest length of DM being 11.00 years.

2. Body Mass Index

Table 3 Frequency Distribution of Respondents Based on Body Mass Index at Bangil Hospital in 2023

Body Mass Index	(n)	Percentage (%)
Very Thin	0	0.0
Skinny	0	0.0
Normal	20	25.0
Overweight	8	8.0
Obesitas	52	65.0
Total	80	100

The results based on table 4.3 show that most of the respondents' body mass index is obese as many as 52 respondents (65.0%).

3. HbA1c

Tabel 4 Distribusi Frekuensi Responden Berdasarkan HbA1c Table 4.4 Frequency Distribution of Respondents Based on HbA1c at Bangil Hospital in 2023

HbA1c	(n)	Percentage (%)
Normal	11	13.8
Diabetes	69	86.3
Total	80	100

The results based on table 4.4 show that most of the respondents' HbA1c is diabetes as many as 69 respondents (86.3%).

4. Relationship between Body Mass Index and HbA1c

Tabel 5 Relationship between Body Mass Index and HbA1c at Bangil Hospital in 2023

Variable		HbA1c				p-value
		Normal		Diabetes		
		n	%	n	%	
Body Mass Index	Very Thin	0	0.0	0	0.0	0.000*
	Skinny	0	0.0	0	0.0	
	Normal	7	8.8	13	16.3	
	Overweight	4	5.0	4	5.0	
	Obesitas	0	0.0	52	65.0	

Total		11	13.8 69	86.3

* Significant at $\alpha < 0.05$

The results based on table 4.5 show that most respondents with normal body mass index have normal HbA1c values as many as 7 respondents (8.8%), while respondents with diabetic HbA1c are mostly respondents with obese body mass index. Further analysis shows that there is a significant relationship between body mass index and HbA1c (p-value = 0.000; $\alpha < 0.05$).

DISCUSSION

1. Identifying Body Mass Index in patients with Type 2 DM at Bangil Hospital (n=80)

Based on the results of the study, it is known that of the 80 respondents studied, it was seen that most of them had BMI in the obese category as many as 52 people (65.0%) while the rest were obtained in the normal category, namely 20 people (25.0%), and 8 people were categorised as fat. BMI is a simple tool or way to monitor the nutritional status of adults, especially those related to underweight and overweight. Being underweight can increase the risk of infectious diseases, while being overweight will increase the risk of developing degenerative diseases, so maintaining a normal body weight allows a person to achieve a longer life expectancy. BMI results that fall into the overweight category need to be watched out for. Excess weight is a risk factor that plays an important role in diabetes mellitus. Overweight people have excessive calorie input. The beta cells of the pancreas gland will be exhausted and unable to produce enough insulin to compensate for the excess calorie input. As a result, blood glucose levels will be high which will eventually become DM (irman saputra, 2020)

Overweight and obesity, which are both defined as being overweight, are generally a state of obesity with different levels, namely mild overweight and obesity, which are distinguished according to the criteria for obesity based on the measurement of body mass index (BMI). Overweight is a condition that is almost close to obesity, someone can be declared overweight if that person has a BMI = 23. In addition, overweight conditions are also commonly referred to as pre-obese conditions (WHO, 2010). Diabetes mellitus occurs in people who have obese or non-obese nutritional status. However, most T2DM occurs in obese/overweight people. The relationship between obesity and T2DM has been recognised since decades ago, with visceral obesity often found in the majority of patients. Insulin resistance is found even in simple obesity that is not followed by hyperglycaemia, suggesting a fundamental abnormality in insulin signalling in the fat-overloaded state. The term metabolic syndrome has been used for a group of findings dominated by visceral obesity, followed by insulin resistance, glucose intolerance, and risk factors such as high blood pressure and abnormal lipid profile (Perkeni, 2015).

Excessive fat deposits in the body of obese patients can lead to insulin resistance which affects blood sugar levels in patients with diabetes mellitus. BMI more than equal to 25 kg/m2 in adults with obesity causes insulin receptors on target cells throughout the body to be less sensitive and reduced in number so that insulin in the blood cannot be utilised which has an impact on reducing blood sugar absorption in tissues so that blood sugar levels increase (Ilyas dalam Soegondo, 2007).

According to D'adamo (2008) people who are overweight, leptin levels in the body will increase. Leptin is a hormone associated with the obesity gene. Leptin acts in the hypothalamus to regulate body fat levels, the ability to burn fat for energy, and satiety. Plasma levels of leptin increase with increasing body weight. Leptin acts on both the peripheral and central nervous system. The role of leptin on the occurrence of resistance is that leptin inhibits the phosphorylation of insulin receptor substrate-1 (IRS) which can consequently inhibit glucose uptake. So that there is an increase in blood sugar levels. In the absence of weight loss and lifestyle modification, people with metabolic syndrome have a significant risk of developing T2DM, emphasising the importance of obesity in this disease. The risk of diabetes increases as body mass index (a measurement of body fat content) increases,

assuming a dose-related relationship between body fat and insulin resistance (Kumar, 2015). According to the researchers, the results of this study indicate that excessive BMI affects the occurrence of diabetes, so to prevent and control BMI can be done by controlling life style. Among them is by conducting periodic anthropometric measurements on every diabetic patient on outpatient treatment so that the patient's weight can be monitored and evaluated to determine the follow-up programme and weighing his body so that optimal nutritional status can be achieved and blood sugar levels can be controlled properly.

2. Identifying HbA1c levels in patients with Type 2 DM at Bangil Regional Hospital (n=80).

Based on the results of the study, it is known that of the 80 respondents studied, it was seen that most of the respondents' HbA1c was diabetes as many as 69 respondents (86.3%). About 50% of undiagnosed diabetics are undergoing treatment. Of those who underwent treatment. Of those undergoing treatment, only one third are well controlled. Evidence suggests that complications can be prevented with optimal glycaemic control. HbA1c (Glycolised Haemoglobin) is one of the parameters used to assess glycaemic control (patient compliance). Good glycaemic control is associated with reduced DM complications, however, in Indonesia, the target for achieving glycaemic control, the average HbA1c is still 8%, which is still above the desired target of 7%. Therefore, a treatment guideline is needed that can be a reference for the management of diabetes mellitus. (PERKENI, 2011). HbA1c (Glycolised Haemoglobin) is a test to measure the level of sugar associated with haemoglobin A, the lifespan of red blood cells. The higher the HbA1c in people with diabetes mellitus, the more at risk of complications. In patients with diabetes mellitus, it should be maintained below 8%. Every 1% decrease in HbA1c will reduce the risk of vascular disorders by 35%, other diabetes mellitus complications by 21%, and reduce the risk of death by 21% (United Kingdom Prospective Diabetes study results). HbA1c normality describes the patient's adherence to diet, exercise and medication so that there is control of blood sugar levels during the last 3 months (Sutedjo, 2010).

Based on the results of the analysis, poor glucose metabolism control can be seen by increasing blood sugar levels / hyperglycaemia. Uncontrolled hbA1c levels reflect that diabetic patients are not compliant in undergoing therapy for their disease.

3. Analysing the relationship between body mass index and HbA1c levels in type 2 DM patients at Bangil Hospital (n=80).

The results based on table 4.5 show that most respondents with normal body mass index have normal HbA1c values as many as 7 respondents (8.8%), while respondents with diabetic HbA1c are mostly respondents with obese body mass index. Further analysis showed that there was a significant relationship between body mass index and HbA1c (p-value = 0.000; $\alpha < 0.05$). The higher the amount of HbA1c means that more haemoglobin binds to glucose. This is a sign that blood sugar is high. If the amount of HbA1c exceeds 8%, there is a risk of uncontrolled diabetes and the risk of complications (Bella, 2022). Hba1c is also known as glycated haemoglobin. This is something that is produced when glucose in the body attaches to red blood cells. When glucose enters the blood, it binds to a red blood cell protein called haemoglobin. This protein plays an important role in carrying oxygen around the body. The higher the blood glucose level, the more haemoglobin it binds to. Red blood cells can live for about 4 months. So, Hba1c reflects long-term blood glucose levels. Many studies have shown that lowering Hba1c levels can help slow the progression of diabetes and reduce the risk of complications, such as nerve damage and cardiovascular disease, in both type 1 and type 2 diabetes. Even small changes in Hba1c can have a significant effect. The American Diabetes Association (ADA) recommends people to keep Hba1c levels below 7 per cent. However, in people with diabetes, the ideal Hba1c level is 6.5 per cent or lower. (Fadli, 2021)

The HbA1c test and blood sugar test have the same function and purpose. Both are for people with diabetes and people at risk of

developing diabetes. Both tests also function to assess blood sugar levels. The results of the examination are in line, in the sense that if the HbA1c level is high, the blood sugar level will also be high. However, there is a slight difference between the two tests. The HbA1c test is not affected by temporary changes in blood sugar levels, such as after eating sweet foods. This is why there is no need to fast before the HbA1c test. However, this test cannot be used to diagnose all types or certain conditions of diabetes, such as gestational diabetes and diabetes symptoms that have lasted for less than 2 months. (Bella, 2022)

According to the researchers, efforts to keep Hb-A1c levels normal include achieving good nutritional status through diet, exercise, monitoring, therapy (if needed), and education. Treatment throughout the course of diabetes mellitus will vary following advances in therapeutic methods resulting from research, changes in lifestyle, physical, and mental conditions of people with diabetes mellitus themselves. So it is expected to control Hb-A1c levels regularly so that preventive measures can be taken as early as possible. In the absence of weight loss and lifestyle modifications, people with metabolic syndrome have a significant risk of developing significant T2DM, emphasising the importance of obesity in this disease. The risk of diabetes increases as body mass index (a measurement of body fat content) increases, assuming a dose-related relationship between body fat and insulin resistance (Kumar, 2015). According to the researcher, the results of this study indicate that excessive BMI affects the occurrence of diabetes, so to prevent and control this disease the community in the Independent Practice of Doctor K. Hakikiyah is equipped with quite complete health facilities, public awareness to check health is good, especially checking laboratory examinations supported by the state of checking the laboratory every 3 months.

CONCLUSIONS

Based on the results of research that has been conducted on body mass index and HbA1c on Blood Sugar Levels in patients with Type 2 DM, it shows that there is a significant relationship between body mass index and HbA1c (p-value = 0.000; $\alpha < 0.05$). advice that can be done for medical personnel is to educate patients about the importance of periodic HbA1c checks in order to know the average picture of blood sugar levels in the last 3 months which provides benefits to control the quality of long-term blood sugar control and assess the effectiveness of drugs that have been programmed. In other words, to monitor the compliance of diabetics taking medication and adherence to a healthy lifestyle.

REFERENCES

Andayaningsih, T. (2021, July 4). *PERAN PEMERIKSAAN HbA1c DALAM PENENTUAN DAN PEMANTAUAN PENYAKIT DIABETES*. RSUD BANJARNEGARA.

antropometriindonesia.com. (2013). *DEFINISI ANTROPOMETRI*.

Arfianti, A., Deyana, F., Rosdiana, D., Ardin, N. Y., Armi, W., & Kesumah, D. I. S. (2018). Akurasi Indeks Antropometri Obesitas dalam Mempediksi Kontrol Glicemic Pasien Diabetes Mellitus Tipe 2 di Puskesmas Kota Pekanbaru. *Majalah Kedokteran Bandung*, *50*(3), 140–146. https://doi.org/10.15395/mkb.v50n3.1361

Bella, d. A. (Januari 2022). Hämtat från https://www.alodokter.com/pemeriksaan-hba1c-untuk-mendeteksi-dan-mengontrol-diabetes

Fadli, d. R. (den 25 november 2021). Ini Cara yang Efektif untuk Menurunkan Kadar Hba1c dalam Tubuh. Hämtat från https://www.halodoc.com/artikel/ini-cara-yang-efektif-untuk-menurunkan-kadar-hba1c-dalam-tubuh

irman saputra, d. (Desember 2020). Indeks Massa Tubuh dengan Kadar Hb-A1c pada Pasien Diabetes Melitus Tipe-II.

Jurnal Ilmiah Kesehatan Sandi Husada, *9*(2), 597-603. doi:10.35816/jiskh.v10i2.360

Badan Pusat Statistik Kota Pasuruan. (2018, March 13). *Jumlah Kasus 10 Penyakit Terbanyak di Kota Pasuruan*.

Fajrunni'mah, R., & Purwanti, A. (2021). PEMERIKSAAN GLUKOSA DARAH PADA PENDERITA DIABETES MELITUS (STUDI FENOMENOLOGI). *Jurnal Riset Kesehatan Poltekkes Depkes Bandung*, *13*(2), 495–506. https://doi.org/10.34011/juriskesbdg.v13i2.1975

Hyo-Kyoung Nam, 1 Won Kyoung Cho, 2, * Jae Hyun Kim, corresponding author3, * Young-Jun Rhie, 4 Sochung Chung, 5 Kee-Hyoung Lee, 6 and Byung-Kyu Suh2. (2018). HbA1c Cutoff for Prediabetes and Diabetes Based on Oral Glucose Tolerance Test in Obese Children and Adolescents. *J Korean Med Sci.*, *33*(12).

infodatin. (n.d.). *Infodatin 2020 Diabetes Melitus*.

International Diabetes Federation. (2022, July 7). *What is diabetes*. https://www.idf.org/aboutdiabetes/what-is-diabetes.html

Joanne B Cole, & Jose C Florez. (2020). Genetics of diabetes mellitus and diabetes complications. *Nature Reviews Nephrology*, *16*, 377–390.

Jürgen Harreiter 1, M. R. 2. (2019). Diabetes mellitus-Definition, classification, diagnosis, screening and prevention. *Wiener Klinische Wochenschrift The Central European Journal of Medicine*, 6–15.

Liu, Y., Ye, W., Chen, Q., Zhang, Y., Kuo, C. H., & Korivi, M. (2019). Resistance exercise intensity is correlated with attenuation of HbA1c and insulin in patients with type 2 diabetes: A systematic review and meta-analysis. In *International Journal of Environmental Research and Public Health* (Vol. 16, Issue 1). MDPI AG. https://doi.org/10.3390/ijerph16010140

Makarim, dr. F. R. (2022, May 12). *Kadar Gula Darah Normal Menurut Usia*. Halodoc.

P2PTM Kemenkes RI. (2018, November 7). *Klasifikasi Pengukuran IMT*. KemenkesRI.

R. Keith Campbell, Pharm. B. , M. C. F. (2007). Etiology and effect on outcomes of hyperglycemia in hospitalized patients. *American Journal of Health-System Pharmacy*, , *64*(10), 4–8.

Reza Pahlevi. (2021). jumlah-penderita-diabetes-indonesia-terbesar-kelima-di-dunia. *Katadata Media Network*. https://databoks.katadata.co.id/datapublish/2021/11/24/jumlah-penderita-diabetes-di-indonesia-diproyeksikan-capai-2857-juta-pada-2045

Sherwani, S. I., Khan, H. A., Ekhzaimy, A., Masood, A., & Sakharkar, M. K. (2016). Significance of HbA1c test in diagnosis and prognosis of diabetic patients. In *Biomarker Insights* (Vol. 11, pp. 95–104). Libertas Academica Ltd. https://doi.org/10.4137/Bmi.s38440

Sina, I., Kedokteran, J., Kedokteran, K.-F., Islam, U., Utara, S., Penelitian, A., Harahap, A. M., Ariati, A., Siregar, Z. A., & Artikel, H. (n.d.). *Aprian Muliadin Harahap 81 HUBUNGAN INDEKS MASSA TUBUH DENGAN KADAR GULA DARAH PADA PENDERITA DIABETES MELLITUS DI DESA SISUMUT, KECAMATAN KOTAPINANG CORRELATION BETWEEN BODY MASS INDEX AND BLOOD GLUCOSE LEVELS AMONG DIABETES MELLITUS*

PATIENTS IN DESA SISUMUT, KECAMATAN KOTAPINANG. http://bit.ly/OJSIbnuSina

Suci Wulandari, D., Adelina, R., Kesehatan Kemenkes Malang, P., & Studi Sarjana Terapan Gizi dan Dietetika, P. (n.d.). HUBUNGAN STATUS ANTHROPOMETRI DENGAN KADAR GLUKOSA DARAH, KADAR HBA1C DAN POLA MAKAN PADA PENDERITA DIABETES MELITUS TIPE 2 DI PUSKESMAS TARIK KABUPATEN SIDOARJO. In *Media Gizi Pangan* (Vol. 27).

the global diabetes community. (2022, June 10). *Blood Sugar Level Ranges*.