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HbA1c and Blood Pressure Correlation in Patients with Uncontrolled Type 2 Diabetes Mellitus

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A B S T R A C T

The primary metabolic symptom of diabetes mellitus is hyperglycemia. Analysing HbA1c levels can help determine blood glucose management. Elevations in blood pressure can be caused by abnormalities in the metabolism of glucose. Patients with uncontrolled diabetes mellitus may experience elevated blood pressure. To ascertain whether blood pressure and HbA1c levels are correlated in patients with uncontrolled DM. There were 90 subjects aged between 31-65 years consisting of 48 men and 42 women. HbA1c levels were checked using the boronate affinity method and blood pressure was measured using a sphygmomanometer. Data analysis used the independent difference t-test and Mann-Whitney U test as well as the Spearman correlation test with a significance level of α=0.05. Research subjects had an average HbA1c level of 10 ± 2.08% (7.1-15). Mean systolic blood pressure was 132.75 ± 18.04 mmHg (90-180). The average diastolic blood pressure was 83.28 ± 10.38 mmHg (60-120). Subjects who experienced hypertension were 36.66%. There were no differences in blood pressure between men and women (systolic p=0.70 and diastolic p=0.58). There was no correlation between HbA1c levels and blood pressure (systolic: r=0.022, p=0.81 and diastolic: r=0.022, p=0.81). There was no correlation between duration of DM and blood pressure (systolic: r=.093 and p=0.38 and diastolic: r= -.032 and p=0.76). There was no correlation between HbA1c levels and blood pressure

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INTRODUCTION

Hyperglycemia, a metabolic disorder caused by abnormalities in insulin action, secretion, or both, is the hallmark of diabetes mellitus. It has been established that the pathophysiology of central damage in Type 2 diabetes is due to insulin resistance, which affects the liver, muscles, and pancreatic beta cells (PERKENI, 2021).

If blood pressure, nutritional status, and HbA1c all achieve predetermined thresholds and blood glucose, lipid, and HbA1c levels reach the expected ranges, diabetes mellitus is considered well controlled(American Diabetes Association, 2020). HbA1c levels have significant prognostic value in DM patients (Sherwani et al., 2016). Clinical HbA1c evaluations should be performed on a regular basis to guarantee effective glycaemic management and to inform therapeutic modifications (American Diabetes Association, 2020; Almutairi et al., 2022)

Haemoglobin with glucose linked is known as haemoglobin A1c. The HbA1c test measures the percentage of glycated haemoglobin to assess the average blood glucose level over the previous two to three months. Haemoglobin A1c is a sign of effective type 2 diabetes patient care (American Diabetes Association, 2020).

One of the leading causes of premature death worldwide is hypertension. According to estimates from the World Health Organisation (WHO), 22% of people worldwide suffer from hypertension. Less than 20% of people with hypertension, however, try to lower their blood pressure. prevalence in Southeast Asia, which accounts for 25% of the world's population. WHO estimates that 1 in 5 women globally have hypertension, and 1 in 4 males (WHO, 2023).

Over two thirds of individuals with type 2 diabetes mellitus have hypertension. Hyperglycemia and the onset of hypertension are compatible. The mechanisms behind hypertension include insulin resistance, hyperinsulinemia, and the excitatory consequences of hyperglycemia itself (Song et al., 2020). In those without type 2 diabetes, elevated and normal HbA1c levels are significantly linked to an increased risk of arterial stiffness (Lee et al., 2016). The development of hypertension is significantly influenced by the activation of the sympathetic nervous system (SNS) and renin-angiotensin-aldosterone system (RAAS) in situations including obesity, insulin resistance, or hyperglycemia (Jia & Sowers, 2021).

HbA1c has prognostic importance because it is used to predict cardiovascular complications associated with metabolic syndrome (Pan et al., 2019). There is a significant difference in HbA1c levels in Type 2 Diabetes Mellitus Patients with and without hypertension (Haryati & Tyas, 2022). Omar et al., (2022) found that there was an increase in HbA1c with the incidence of hypertension. Diabetes Mellitus with hypertension is a dangerous disease, because the presence of this condition will facilitate complications of other diseases, such as coronary heart disease, stroke, and blood vessel disease. (Khorasani et al., 2019; Hardianto, 2021; Zeng et al., 2023).

LITERATURE REVIEW

Numerous investigations have been carried out to examine the connection between HbA1c and the likelihood of hypertension; nevertheless, the results show mixed results. Research has to be carried out about the correlation between HbA1c levels and blood pressure in uncontrolled type 2 DM patients.

METHODOLOGY

This type of research is analytical observational research with a cross-sectional design. The variables studied included HbA1c levels and systolic and diastolic blood pressure. The subjects used in this study were patients with uncontrolled type 2 diabetes mellitus (HbA1c more than 7%) who were outpatients at the Polyclinic at PKU Muhammadiyah Gamping Hospital. The minimum number of research subjects was calculated using the Slovin formula as 45. The inclusion criteria used included: 1) Patients diagnosed with type 2 diabetes mellitus, 2) HbA1c levels > 7%, 3) aged 31 – 65 years. Exclusion criteria include: 1) experiencing acute complications 2) having a history of chronic renal failure 3) having a history of hyperthyroidism. The sampling technique used was purposive sampling. This research was carried out August 2022 – October 2022. HbA1c levels were examined using the Boronic Affinity method (HPLC). Blood pressure was measured using a mercury sphymomanometer in a sitting position. Determination of blood pressure categories (classifications) is based on the criteria of the Joint National Committee (JNC) High Blood Pressure. Data processing used the SPSS 25 computer application. Statistical analysis was used to test differences using the independent T-test and Mann-Whitney U methods as well as the Spearman test to test for correlation. The level of significance used is α=0.05. The research carried out has received ethical clearance (Ref No. 072/EC/KEPK FKIK UMY/III/2021) and permission from the RSU PKU Muhammadiyah Gamping institution. All subjects have provided written informed consent.

RESEARCH RESULT

The research subjects were 90 patients suffering from uncontrolled type 2 DM who met the study inclusion and exclusion criteria. Subjects aged between 31-65 years consisted of 48 men (53.33%) and 42 women (46.67%). Demographic data can be seen in table 1.

Table 1. Respondents' Characteristic

Respondents' characteristic	Respondent	
	Frequency	Percentage
Gender		
Male	48	53.33%
Female	42	46.67%
Total	90	100%

Age		
31-35 year	2	2.22%
36-40 year	6	6.67%
41-45 year	9	10.00%
46-50 year	18	20.00%
51-55 year	15	16.67%
56-60 year	24	26.67%
61-65 year	16	17.78%
Total	90	100%
Time Spent Affected by DM		
0-5 year	58	64.44%
6-10 year	16	17.78%
11-15 year	11	12.22%
16-20 year	4	4.44%
>20 year	1	1.11%
Total	90	100%

The HbA1c level of the research subjects ranged from 7.1% at the lowest to 15.0% at the highest, with a mean of 10 ± 2.08%. The mean systolic blood pressure was 132.75 ±18.04 mmHg, with a minimum of 90 mmHg and a maximum of 180 mmHg. With a mean of 83.28 ±10.38 mmHg, the diastolic blood pressure ranges from 60 mmHg at the minimum to 120 mmHg at the maximum. Table 2 displays the results of the blood pressure test in detai.

Table 2. Profile of HbA1c Levels and Blood Pressure

	Minimum	**Maximum**	**Mean**	**SD**
HbA1c (%)	7.1	15,0	10	2.08
Systolic Blood Pressure (mmHg)	90	180	132.75	18.04
Diastolic Blood Pressure (mmHg)	60	120	83.28	10.38

The systolic blood pressure of the study participants was classified into four groups: normal (14.44%), hypertension level II (13.33%), pre-hypertension (48.89%), and hypertension level I (23.33%). Meanwhile, the comparable diastolic blood pressure classifications are pre-hypertension (42.22%), hypertension level I (25.56%), normal (21.11%), and hypertension level II (11.11%). Hypertension (level I and II) was present in 36.66% of the participants (see table 3).

Table 3. Subject Blood Pressure Categories

	Frequency	**Percentage**
Systolic		
Normal	13	14.44%
Pre-Hypertension	44	48.89%
Hypertension level 1	21	23.33%
Hypertension level II	12	13.33%
Total	90	100%

Diastolic	19	21.11%
Normal	38	42.22%
Pre-Hypertension	23	25.56%
Hypertension level 1	10	11.11%
Hypertension level II	90	100%
Total		

The average systolic blood pressure for male subjects ranged from 100 to 170 mmHg, whereas the average for female subjects was 133.9 ± 19.4 mmHg (90-180). These results were based on gender. The difference test utilising the Mann-Whitney U test did not disclose a significant difference between the two (p=0.70) (see table 4).

Male respondents had an average diastolic blood pressure of 82.72 ± 9.9 mmHg (60-100), whereas female subjects had an average of 83.9 ± 10.9 mmHg (90-180). There was no discernible difference between the two (p=0.58) according to the Mann-Whitney U test difference test (see table 5).

Table 4. Systolic Blood Pressure by Gender Group

Gender	Amount	Minimum (mmHg)	Maximum (mmHg)	Mean (mmHg)	SD	*p*
Male	48	100	170	131.7	16.9	
Female	42	90	180	133.9	19.4	0.70
Total	90					

Table 5. Diastolic Blood Pressure by Gender Group

Gender	Amount	Minimum (mmHg)	Maximum (mmHg)	Mean (mmHg)	SD	*p*
Male	48	60	100	82,7	9,9	
Female	42	60	120,00	83,9	10,9	0,58
Total	90					

Based on control criteria, DM patients can be divided into good, moderate and poor control groups. Uncontrolled DM patients have two criteria, namely moderate and poor. The moderate control group had HbA1c levels between 7-8%, while the poor control group had HbA1c levels of more than 8%.

Of the 90 subjects, 18 patients (31.2%) had moderate control and 72 patients (68.8%) had poor control. The moderate DM control group had a mean systolic blood pressure of 130.2 ± 16.5 mmHg (100-160) while the poor control group had a mean of 133.3 ± 18.4 mmHg (90-180). Analysis of different tests using the independent T-test in the two groups did not reveal a significant difference (p= 0.50) (see table 6)

The moderate DM control group had a mean diastolic blood pressure of 84.3 ± 12 mmHg (70-120) while the poor control group had a mean of 83.0 ± 10.0 mmHg (60-100). Analysis of different tests using the Mann-Whitney U Test in the two groups did not reveal a significant difference (p= 0.93) (see table 7).

Table 6. Systolic Blood Pressure Levels Based on Control Group

Control group	Minimum (mmHg)	Maksimum (mmHg)	Mean (mmHg)	SD	*p*
Medium(18)	100,0	160,0	130,2	16,5	0,51
Poor (72)	90,0	180,0	133,3	18,4	

Table 7. Diastolic Blood Pressure Levels Based on Control Group

Control group	Minimum (mmHg)	Maksimum (mmHg)	Mean (mmHg)	SD	*p*
Medium (18)	70,0	120,0	84,3	12,0	0,93
Poor (72)	60,0	100,0	83,0	10,0	

Moderate Correlation Between HbA1 Levels and Duration of DM on Blood Pressure

From the Spearman correlation test, no significant correlation was found between HbA1c levels and systolic blood pressure (r=0.07, p=0.47). There was no significant correlation between HbA1c levels and diastolic blood pressure (r=0.00, p=0.99).

From the results of the Spearman correlation test, there was no correlation between the duration of DM and systolic blood pressure (r=.09 and p=0.38). There was no correlation between duration of DM and diastolic blood pressure (r= -0.03 and p=0.76) (see table 8).

Table 8. Correlation of HbA1c Levels and Duration of DM on Blood Pressure

	Systolic blood pressure	Diastolic blood pressure
HbA1c	*r*=0,07 dan *p*=0,47	*r*=0,00 dan *p*=0,99
Time spent	*r*=0,09 dan *p*=0,38	*r*= -0,03 dan *p*=0,76

DISCUSSION

In this study, all participants with uncontrolled diabetes mellitus (DM) exhibited pre-hypertension of 48.89% and hypertension of 36.66%. According to Lumban et al., (2015), 38.7% of DM patients had hypertension. Naseri et al., (2022) found that the prevalence of hypertension in people with DM was 70.5%. A systematic review and meta-analysis research conducted by Nawi et al., (2021) found that the incidence of hypertension in people with diabetes mellitus was 33.82%. A systematic review study conducted by Haile et al., (2023) found that the prevalence of hypertension in type 2 DM sufferers was higher at 55%.

In this study, there were no differences in blood pressure, both systolic and diastolic, between men and women. Research conducted by Mohanty et al., (2022) states that men have a higher prevalence of hypertension up to the age of 50 years but after that, women have an increased incidence of hypertension. Research conducted by Salsabila et al., (2024) found that the risk factor age influences the incidence of hypertension, men are more likely to be under 45 to 55 years old than women, and as age increases the risk factor of gender does not influence the incidence of hypertension.

In this study, there was no difference in systolic-diastolic blood pressure between the moderate and poor control category groups and there was also no correlation between the duration of DM and blood pressure. This is different from research conducted by Ramanathan, (2017) who found a correlation between the duration of DM and the incidence of hypertension. Akalu & Belsti, (2020) also found a correlation between the duration of DM and hypertension. This difference in results is possible because HbA1c reflects the stability of glycemic control within 8-12 weeks so it has the potential to fluctuate within the observation period(American Diabetes Association, 2020; Hardianto, 2021).

In this study, there was no correlation between HbA1c levels and blood pressure. This is in line with research conducted by Khorasani et al., (2019). Research conducted by Arania et al., (2021) also found that there was no significant relationship between HbA1c levels and blood pressure. In contrast to survey research conducted by Song et al., (2020) stated that increasing HbA1c is a risk factor for hypertension. Furthermore, a prospective cohort study conducted by Huang et al., (2023) found a positive relationship between HbA1c levels and blood pressure.

The lack of statistical significance in this study could be attributed to risk factors for hypertension that were not thoroughly examined, including education level, socioeconomic status, dietary status, physical activity, smoking history, and dyslipidaemia (Nawi et al., 2021). Potential confounding variables have been identified by exclusion criteria, albeit clinically.

The study's shortcomings stem from its neglect of the impact of confounding variables on laboratory and clinical blood pressure readings. This study's cross-sectional methodology also permits numerous restrictions on extrapolating the correlations between the research variables.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Patients with uncontrolled type 2 diabetes have a 36.66% prevalence of hypertension, with the majority having pre-hypertensive conditions. There was no difference in prevalence between males and women. There was no relationship seen between blood pressure and HbA1c levels. Blood pressure and the length of diabetes mellitus did not correlate. The intermediate control group's blood pressure did not differ from that of the poor control group.

Recommendation

There is substantial confusion in the determination of HbA1c, as evidenced by the inconsistent connection between the two. What is more crucial, though, is that co-existence—the coexistence of diabetes mellitus and hypertension—has the potential to worsen coronary artery disease, which raises the risk of cardiovascular death and morbidity. Due to the strong correlation between the two phenomena and macro- and microvascular problems, patients who have both disorders may be at higher risk of vascular-related adverse outcomes than those who only have one. Consequently, it is crucial and critical for DM patients to have appropriate blood pressure regulation.

FURTHER STUDY

This study still has limitations, so further research is needed related to the topic of HbA1c and Blood Pressure Correlation in Patients with Uncontrolled Type 2 Diabetes Mellitus in order to perfect this study and increase insight for readers.

REFERENCES

Akalu, Y., & Belsti, Y. (2020). Hypertension and Its Associated Factors Among Type 2 Diabetes Mellitus Patients at Debre Tabor General Hospital, Northwest Ethiopia. Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy, Volume 13, 1621–1631. https://doi.org/10.2147/DMSO.S254537

Almutairi, J. S., Almigbal, T. H., Alruhaim, H. Y., Mujammami, M. H., AlMogbel, T. A., Alshahrani, A. M., Al Zahrani, A. M., Batais, M. A., & Shaik, S. A. (2022). Self-awareness of HbA1c and its association with glycemic control among patients with type 2 diabetes: A multicenter study. Saudi Medical Journal, 43(3), 291–300. https://doi.org/10.15537/smj.2022.43.3.20210536

American Diabetes Association. (2020). Standards of Medical Care in Diabetes—2020 Abridged for Primary Care Providers. Clinical Diabetes, 38(1), 10–38. https://doi.org/10.2337/cd20-as01

Arania, R., Esfandiari, F., Triwahyuni, T., & Hafizhdillah, A. R. (2021). Hubungan Antara Tekanan Darah Sistolik Dengan Kadar HbA1c Pada Pasien Diabetes Melitus Tipe 2 Di Klinik Arafah Lampung Tengah. Jurnal Medika Malahayati, 5(2), 124–131. https://doi.org/10.33024/jmm.v5i2.4151

Haile, T. G., Mariye, T., Tadesse, D. B., Gebremeskel, G. G., Asefa, G. G., & Getachew, T. (2023). Prevalence of hypertension among type 2 diabetes mellitus patients in Ethiopia: A systematic review and meta-analysis. International Health, 15(3), 235–241. https://doi.org/10.1093/inthealth/ihac060

Hardianto, D. (2021). Telaah Komprehensif Diabetes Melitus: Klasifikasi, Gejala, Diagnosis, Pencegahan, Dan Pengobatan: A Comprehensive Review of Diabetes Mellitus: Classification, Symptoms, Diagnosis, Prevention, and Treatment. Jurnal Bioteknologi & Biosains Indonesia (JBBI), 7(2), 304–317. https://doi.org/10.29122/jbbi.v7i2.4209

Haryati, A. I., & Tyas, T. A. W. (2022). Perbandingan Kadar HbA1c pada Pasien Diabetes Melitus Tipe 2 yang Disertai Hipertensi dan Tanpa Hipertensi di Rumah Sakit Umum Daerah Duri, Mandau, Bengkalis, Riau. Jurnal Kedokteran dan Kesehatan, 18(1), 33. https://doi.org/10.24853/jkk.18.1.33-40

Huang, X., Qin, C., Guo, X., Cao, F., & Tang, C. (2023). Association of hemoglobin A1c with the incidence of hypertension: A large prospective study. Frontiers in Endocrinology, 13, 1098012. https://doi.org/10.3389/fendo.2022.1098012

Jia, G., & Sowers, J. R. (2021). Hypertension in Diabetes: An Update of Basic Mechanisms and Clinical Disease. Hypertension, 78(5), 1197–1205. https://doi.org/10.1161/HYPERTENSIONAHA.121.17981

Khorasani, S. H., Masoumi, M., Nakhaei, M., & Masoumi, A. (2019). Relationship Between the Hypertension Stage and Hemoglobin A1c in Patients With Type 2 Diabetes. Iranian Heart Journal;, 20(3).

Lee, Y.-H., Shin, M.-H., Choi, J.-S., Rhee, J.-A., Nam, H.-S., Jeong, S.-K., Park, K.-S., Ryu, S.-Y., Choi, S.-W., Kim, B.-H., Oh, G.-J., & Kweon, S.-S. (2016). HbA1c is significantly associated with arterial stiffness but not with carotid atherosclerosis in a community-based population without type 2 diabetes: The Dong-gu study. Atherosclerosis, 247, 1–6. https://doi.org/10.1016/j.atherosclerosis.2016.01.032

Lumban, R., Hiswani, & Ashar, T. (2015). Karakteristik Penderita Diabetes Mellitus Dengan Komplikasi Yang Dirawat Inap Di Rumah Sakit Martha Friska Tahun 2014. Jurnal Gizi, Kesehatan Reproduksi Dan Epidemiologi, 1(4). http://portalgaruda.fti.unissula.ac.id/index.php?ref=browse&mod=viewarticle&article=438113

Mohanty, P., Patnaik, L., Nayak, G., & Dutta, A. (2022). Gender difference in prevalence of hypertension among Indians across various age-groups: A report from multiple nationally representative samples. BMC Public Health, 22(1), 1524. https://doi.org/10.1186/s12889-022-13949-5

Naseri, M. W., Esmat, H. A., & Bahee, M. D. (2022). Prevalence of hypertension in Type-2 diabetes mellitus. Annals of Medicine & Surgery, 78. https://doi.org/10.1016/j.amsu.2022.103758

Nawi, M. A., Mohammad, Z., Jetly, K., Abd Razak, M. A., Ramli, N. S., Wan Ibadullah, W. A. H., & Ahmad, N. (2021). The Prevalence and Risk Factors of Hypertension among the Urban Population in Southeast Asian Countries: A Systematic Review and Meta-Analysis. International Journal of Hypertension, 2021, 1–14. https://doi.org/10.1155/2021/6657003

Omar, S. M., Musa, I. R., Abdelbagi, O., Sharif, M. E., & Adam, I. (2022). The association between glycosylated haemoglobin and newly diagnosed hypertension in a non-diabetic Sudanese population: A cross-sectional study. BMC Cardiovascular Disorders, 22(1), 208. https://doi.org/10.1186/s12872-022-02649-y

Pan, W., Lu, H., Lian, B., Liao, P., Guo, L., & Zhang, M. (2019). Prognostic value of HbA1c for in-hospital and short-term mortality in patients with acute coronary syndrome: A systematic review and meta-analysis. Cardiovascular Diabetology, 18(1), 169. https://doi.org/10.1186/s12933-019-0970-6

PERKENI. (2021). Pedoman pengelolaan dan pencegahan diabetes melitus tipe 2 dewasa di INDONESIA - 2021.

Ramanathan, A. S. (2017). Correlation of duration, hypertension and glycemic control with microvascular complications of diabetes mellitus at a tertiary care hospital. Integrative Molecular Medicine, 4(1). https://doi.org/10.15761/IMM.1000272

Salsabila, E., Utami, S. L., & Sahadewa, S. (2024). Faktor Risiko Usia dan Jenis Kelamin dengan Kejadian Hipertensi di Klinik Paradise Surabaya Oktober 2023.

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. Biomarker Insights, 11, BMI.S38440. https://doi.org/10.4137/BMI.S38440

Song, J., Wei, N., Zhao, Y., Jiang, Y., Wu, X., & Gao, H. (2020). Elevated glycosylated hemoglobin levels and their interactive effects on hypertension risk in nondiabetic Chinese population: A cross-sectional survey. BMC Cardiovascular Disorders, 20(1), 218. https://doi.org/10.1186/s12872-020-01501-5

WHO. (2023, March 16). Hypertension. https://www.who.int/news-room/fact-sheets/detail/hypertension

Zeng, R., Zhang, Y., Xu, J., Kong, Y., Tan, J., Guo, L., & Zhang, M. (2023). Relationship of Glycated Hemoglobin A1c with All-Cause and Cardiovascular Mortality among Patients with Hypertension. Journal of Clinical Medicine, 12(7), 2615. https://doi.org/10.3390/jcm12072615