

ORIGINAL ARTICLE

Analysis of HbA1c levels in patients with type 2 diabetes: a study at dustira hospital, cimahi

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ABSTRACT

The HbA1c test has been recommended by the International Committee and the American Diabetes Association to diagnose and monitor the effectiveness of therapy in patients with diabetes mellitus. Pharmacological therapy for controlling blood sugar levels in patients with type 2 diabetes mellitus may include oral medications, insulin, or a combination of both. This study aimed to compare the average HbA1c levels of patients with type 2 diabetes mellitus using oral antidiabetic drugs (OAD), insulin, or a combination of OAD and insulin. This research utilized an observational analytic method with a cross-sectional design and employed a consecutive sampling technique, analyzing patients' medical records from January 2019 to June 2022 at Dustira Hospital. Bivariate analysis was performed using the Kruskal-Wallis test, followed by the Mann-Whitney test. The study concluded that among the 123 data samples, 41 patients using OAD had an average HbA1c of 11.77%, 41 patients undergoing insulin therapy had an average HbA1c of 9.68%, and 41 patients receiving a combination of OAD and insulin had an average HbA1c of 10.73%. The results indicated a significant difference in the average HbA1c levels between the OAD and insulin treatment groups ($p=0.002$; < 0.05) and no significant difference between the OAD and OAD-insulin combination groups ($p=0.092$; > 0.05). Although significant differences in average HbA1c levels were observed between the three types of management, the ideal HbA1c target had not been achieved. This suggests that other factors, such as patient adherence to medication, physical activity patterns, nutritional diet, and the duration of diabetes mellitus, may also play a role in influencing treatment outcomes.

Keyword: Average HbA1c, insulin, OAD, OAD-insulin combination, type 2 diabetes mellitus

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INTRODUCTION

Diabetes mellitus is a condition characterized by metabolic disturbances affecting insulin action, insulin secretion, or both.¹ Type 2 diabetes mellitus accounts for over 90% of diabetes cases globally.^{2,3} According to the International Diabetes Federation (IDF), Indonesia ranked fifth in the world in terms of diabetes mellitus prevalence in 2021.⁴ The 2018 Riskesdas (Basic Health Research) report indicated that West Java ranked seventeenth among Indonesian provinces with the highest incidence of diabetes mellitus.⁵ As of 2020, the number of diabetes mellitus cases in Cimahi City had reached 9,716, with the West Java Health Office reporting a total of 46,837 cases in 2021.^{6,7}

The HbA1c (Hemoglobin A1c) test is used to evaluate blood glucose control and assess the effectiveness of treatment in patients. HbA1c reflects the average plasma glucose levels over the past 8 to 12 weeks, providing insight into blood glucose levels over the previous 90 days.^{1,2} It is widely recognized as a key tool for assessing glycemic control in individuals with diabetes. Both the World Health Organization (WHO) and the American Diabetes Association (ADA) support diagnosing diabetes mellitus with an HbA1c level of $\geq 6.5\%$ (48 mmol/mol). For individuals with diabetes, an HbA1c level below 6.5% is considered well-controlled.^{1,8} Monitoring the therapeutic response in type 2 diabetes mellitus patients is crucial, as poor glycemic control can serve as a detrimental comorbidity, especially in patients with other underlying conditions.^{9,10} Effective diabetes management involves four key components: education, medical nutritional therapy, physical activity, and pharmacological intervention.¹¹ Current pharmacological treatments for blood glucose control include both oral medications and injectable therapies, such as insulin.¹²

The initial management of type 2 diabetes mellitus typically involves the use

of oral antidiabetic drugs (OADs). However, to enhance treatment effectiveness, especially when blood glucose levels remain uncontrolled with OADs, combination therapy may be considered. If blood glucose levels continue to be inadequately managed despite combination therapy, insulin therapy may be initiated.^{13,14} The objective of this study is to evaluate the effectiveness of various treatment approaches by analyzing the mean HbA1c levels of patients with type 2 diabetes mellitus. This study is conducted at RS TK.II Dustira, a referral hospital in Cimahi City, which was selected as the study site due to its role as a key healthcare center for diabetes management. This setting provides an opportunity to examine differences in mean HbA1c levels among patients treated with OADs, insulin, or a combination of OADs and insulin.

METHODS AND SUBJECT

This research utilized a retrospective cross-sectional study, leveraging secondary data from the medical records of patients diagnosed with type 2 diabetes mellitus at RS TK.II Dustira. The data collection period spanned from January 1, 2019, to June 30, 2022, and included only patients who met the predefined inclusion criteria. Ethical clearance for the study was obtained, as indicated by the ethics approval letter (No. Etik.RSD/127/X/2022), issued in October 2022.

A total of 123 medical records were identified for the study, comprising patients who underwent HbA1c laboratory assessments and received treatment with oral antidiabetic drugs (OADs), insulin, or a combination of both, with 41 records allocated to each treatment group. The sampling methodology used was consecutive sampling. Upon data acquisition, univariate analysis was performed to describe the characteristics of the subjects, including variables such as gender, age, and mean HbA1c levels in

patients with type 2 diabetes mellitus. This was followed by bivariate analysis using the Kruskal-Wallis test, with a significance level set at a p-value threshold of ≤ 0.05 . The analysis was further supplemented by the Mann-Whitney test to evaluate differences in mean HbA1c levels among patients treated with OADs, insulin, or a

combination of both.

RESULTS AND DISCUSSION

A total of 123 samples were evaluated based on medical record data that met the inclusion criteria. The research data examined included gender, age, and HbA1c test results, which were listed completely in the medical records.

Table 1. Characteristics of Respondents

Characteristic	N = 123	
	Frequency (n)	Percentage (%)
Gender		
Male	47	38.2
Female	76	61.8
Age		
26-35 years	2	1.6
36-45 years	8	6.5
46-55 years	22	17.9
56-65 years	39	31.7
>65 years	52	42.3

The results presented in Table 1 show that the majority of patients with type 2 diabetes mellitus at RS TK.II Dustira were female, accounting for 76 individuals (61.8%), while male patients comprised 47 individuals (38.2%). This finding is consistent with the research by Prasetyani D et al. (2017), which also demonstrated that most type 2 diabetes patients were female.¹⁵ Furthermore, the study aligns with data from the 2018 Riskesdas (Basic Health Research) report, which indicated a higher prevalence of type 2 diabetes among females compared to males over the past five years, with a slight increase in prevalence among females and a decrease among males.⁵ Additional support comes from Ghifari et al. (2022), who observed that the number of female patients exceeded that of male patients. They attributed this trend to the increased

likelihood of body mass elevation in females due to a higher body fat composition, which contributes to elevated blood glucose levels.¹⁶ Putra IWMM et al. (2022) further suggested that hormonal changes associated with the menstrual cycle in females lead to greater accumulation of body fat, which subsequently impacts blood glucose levels.¹⁷

In addition to gender, Table 1 presents the characteristics of patients with type 2 diabetes mellitus stratified by age according to the classification established by the Indonesian Ministry of Health (Depkes RI) in 2009. The data indicate that the age group most affected by type 2 diabetes mellitus was those over 65 years, comprising 52 individuals (42.3%). This age-related trend is influenced by declining physiological functions, particularly the

ability of pancreatic beta cells to metabolize glucose and produce insulin.¹⁸ This finding aligns with the research conducted by Dwi Prasetyani et al. (2017), which identified

age as a risk factor for the development of diabetes mellitus, correlating increased age with elevated blood glucose levels and heightened insulin resistance.¹⁵

Table 2. Mean HbA1c Levels in Patients Treated with OADs, Insulin, and Combination Therapy (OADs and Insulin)

	N	Mean (%)	Std. Dev	Min	Max
OAD	41	11.77	1.97	7.3	15
Insulin	41	9.68	3.21	5.4	15
Combination OAD-Insulin	41	10.73	2.92	4.8	15

The data analysis presented in Table 2 indicates that the mean HbA1c level for patients with type 2 diabetes mellitus receiving oral antidiabetic drugs (OADs) was $11.77\% \pm 1.97$. In comparison, the mean HbA1c level for patients treated with insulin was $9.68\% \pm 3.21$. For those receiving a combination of OADs and insulin, the mean HbA1c level was $10.73\% \pm 2.92$.

The target HbA1c level for patients with type 2 diabetes mellitus is established at $\leq 6.5\%$ (≤ 48 mmol/mol). According to the 2021 Perkeni (Indonesian Endocrine Society) guidelines, the criterion for diabetes mellitus control, as determined by HbA1c testing, is set at $< 7\%$.¹⁹ Based on the findings, it is evident that the HbA1c control targets for patients with type 2 diabetes mellitus had not been met, regardless of whether treatment involved OADs, insulin, or a combination of both, as the mean HbA1c levels for patients at RS TK.II Dustira remained above the control target. Additionally, research conducted by Sugandha PU et al. in 2015 indicated that elevated HbA1c levels can result from insufficient self-care practices, which may

lead to complications associated with diabetes mellitus, encompassing both macrovascular and microvascular complications.²⁰

In this study, a series of statistical tests were conducted to compare HbA1c levels in patients with type 2 diabetes mellitus treated with OAD, insulin, and combination of both. The analysis included tests for normality and homogeneity of the data, comparison of mean HbA1c levels among the three treatment groups, and pairwise comparisons between the treatment groups.

The analysis proceeded by first conducting normality and homogeneity tests on the data. The normality test yielded a p-value of 0.062 ($p > 0.05$), indicating that the data followed a normal distribution. In contrast, the homogeneity test produced a p-value of 0.000 ($p < 0.05$), suggesting that the data were not homogeneous. Subsequently, the Kruskal-Wallis test was employed to ascertain whether there were significant differences in HbA1c levels among patients with type 2 diabetes mellitus receiving OAD, insulin, and a combination of OAD-insulin treatments.

Table 3. Differences in Mean HbA1c Levels Among Patients Treated with OADs, Insulin, and Combination Therapy (OADs and Insulin)

Treatment	Mean (%) $\pm$ SD	<i>p</i>	Interpretation
OAD	11.77 $\pm$ 1.97	0.005	Significant Difference
Insulin	9.68 $\pm$ 3.21		
Combination OAD-Insulin	10.732.92		

*) Kruskal-Wallis test, $p \leq 0,05$

Based on the results presented in Table 3, there was a significant difference in the mean HbA1c levels among patients with type 2 diabetes mellitus. The lowest mean HbA1c level was observed in patients receiving insulin treatment, while the highest mean HbA1c level was found in those receiving oral antidiabetic drugs (OADs). The analysis revealed a

probability value (p-value) of 0.005, which was less than 0.05, indicating a statistically significant difference in HbA1c levels among the treatment groups ($p = 0.005 < 0.05$). Given the presence of this significant difference, the Mann-Whitney U test was subsequently conducted to further explore the differences in HbA1c levels between the treatment modalities.

Table 4. Comparison of HbA1c Levels Among Different Treatment Modalities

Comparison	<i>p</i> -Value	Interpretation
OAD vs. Combination OAD-Insulin	0.092	No Significant Difference
OAD vs. Insulin	0.002	Significant Difference
Combination OAD-Insulin vs. Insulin	0.072	No Significant Difference

*Mann-Whitney test, $p < 0,05$

Table 4 illustrates the results of the comparative analysis of HbA1c levels among the different treatment modalities. A significant difference was found between the OAD and insulin treatments ($p = 0.002 < 0.05$). Conversely, no statistically significant difference in HbA1c levels was observed between the OAD and combination OAD-insulin treatments ($p = 0.092 > 0.05$), nor between the insulin and combination OAD-insulin treatments ($p = 0.072 > 0.05$).

Supporting this study, research conducted by Arini NMA et al. in 2020 examined HbA1c levels in patients treated with oral antidiabetic medications and a combination of oral medications with

insulin. Their findings indicated that treatment with oral antidiabetic agents alone resulted in elevated HbA1c levels, while the combination of oral agents with insulin yielded more favorable reductions in HbA1c among patients with type 2 diabetes mellitus. This suggests that combining oral agents with insulin may provide superior HbA1c control compared to oral antidiabetic therapy alone.¹³ Additionally, a study by Hirsch IB et al. (2020) affirmed that insulin effectively reduces hyperglycemic burden promptly and efficiently, leading to an immediate decrease in metabolic risk and long-term complications. This ultimately reduces the prevalence of patients with HbA1c levels

exceeding 9.0%. Therefore, insulin should be strongly considered for patients with very high HbA1c levels (>9.0%) following treatment with oral antidiabetic medications (OADs).²¹

Furthermore, research conducted by Udayani NN et al. (2021) indicates that the use of rapid-acting insulin in conjunction with long-acting insulin can replicate the body's normal insulin secretion patterns. Medium- or long-acting insulin (basal insulin) is employed to achieve baseline blood glucose targets, while rapid-acting or short-acting insulin (prandial insulin) is administered to meet HbA1c objectives.²²

Insulin is a hypoglycemic agent that effectively controls blood glucose levels in both the short and long term. The rapid reduction of glucotoxicity can improve beta-cell function and preserve insulin secretory capacity, resulting in prolonged glycemic control.²³ Therefore, a longer duration of glycemic control is suspected to be one of the factors contributing to the lower mean of HbA1c in patients treated with insulin compared to those receiving oral therapy in this study.

In this study, the mean of HbA1c level in patients treated with a combination of OAD-insulin was lower than those treated with only OAD. Interestingly, patients receiving combination therapy had higher HbA1c levels compared to those treated with insulin alone. We suspect this relates to patient compliance. According to the study by Syah FZN et al., patients with type 2 diabetes in their research showed a high level of compliance to oral antidiabetic medications.²⁴ This is also supported by the study of Hasanah U et al., which demonstrated a relationship between compliance to oral antidiabetic medication and blood glucose levels, with the majority of the participants showing a high level of compliance.²⁵

In contrast, insulin treatment is perceived to have more barriers to administration. Alsaidan AA et al. reported several constraints to insulin use, including

weekly missed doses, embarrassment about administering insulin in public, and needle phobia.²⁶ In addition, patients treated with insulin experience greater emotional distress compared to those using oral antidiabetic medications.²⁷ Due to these factors, we suspect that when patients are prescribed combination therapy, there is a tendency to prefer oral medication over insulin, or perhaps insulin is used less consistently than oral antidiabetic drugs. Nevertheless, further research is needed to compare patients compliance between OAD therapy and combination OAD-insulin therapy.

A limitation of this study is that, despite identifying differences in HbA1c levels among the various treatment modalities, the research did not explore the underlying reasons why the HbA1c targets for patients with type 2 diabetes mellitus at RS TK.II Dustira remained unachieved.

CONCLUSION

Patients with type 2 diabetes mellitus at TK.II Dustira Hospital exhibited varying mean HbA1c levels, depending on the type of therapy administered. The lowest HbA1c level was observed in the group of patients treated with insulin (9.68 ± 3.21). Statistically, there was a significant difference between patients treated with OAD and those treated with insulin. Further research is warranted to investigate the reasons for the failure to achieve HbA1c targets among patients with type 2 diabetes mellitus. Factors to consider include medication adherence, patterns of physical activity, dietary nutrition, and the duration of diabetes mellitus.

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DECLARATION OF INTERESTS

The authors declare that there are no conflicts of interest associated with the writing of this article.

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