



Utilization of Oral Hyperglycemic Drugs Among Type 2 Diabetes Patients in Indonesia's Major Maize-Producing Region

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Abstract

Diabetes Mellitus (Diabetes) is a degenerative and chronic disease caused by impaired carbohydrate metabolism due to insulin hormone insufficiency. Data from the Gorontalo Provincial Health Department in 2023 showed that there were 18,299 cases of diabetes mellitus diagnosed. The study aimed to analyze the use of oral hyperglycemic drugs in patients with type 2 diabetes mellitus in Bone Bolango Regency, Gorontalo Province. This research is a quantitative study with an observational analytical approach using a cross-sectional design. The population of this study was diabetic patients who were using oral hyperglycemic drugs in the Kabila Health Center area, with 126 people selected using the total sampling method. The data on gender, age, income, health worker support, and family support were analyzed using binary logistic regression. The results showed a significant difference between income ($P = 0.013$) and health worker support ($P = 0.022$) with compliance. In contrast, the gender ($P = 0.333$) and family support ($P = 0.070$) did not significantly differ in compliance. Each category that had significant differences was subjected to multivariate analysis. The results showed no difference in compliance based on gender ($P = 0.235$), 2). However, there was a difference in compliance based on age ($P = 0.022$) and income level ($P = 0.020$). The variable explaining the dependent variable was only 19.5%, and the rest was described by other variables outside the research model (80.5%). The statistical analysis concluded that 1) gender variables (Sig 0.333) and family support (0.070) did not have a significant effect on compliance, 2) income variables (0.013) and health worker support (0.022) had a significant effect on compliance.

Introduction

Diabetes Mellitus (Diabetes) is a degenerative and chronic disease caused by impaired carbohydrate metabolism due to insulin hormone insufficiency. The World Health Organization (WHO) predicted that more than 346 million people worldwide have diabetes. Without interventions, it could increase by more than a hundred percent or double by 2030. Approximately 366 million adults will have diabetes by 2030, and by 2040, it is predicted to reach 642 million sufferers, of which most (75%) are in developing countries (International Diabetes Federation, 2015; Sosa-rubí & López-ridaura, 2009). According

to the Indonesian Ministry of Health (2020), Indonesia was ranked 3rd at the Asian level, with a diabetes prevalence of 11.3%. Data from the Gorontalo Provincial Health Department in 2023 showed 18,299 cases of diabetes mellitus diagnosed. The prevalence of diabetes cases in Gorontalo has increased significantly in Bone Bolango Regency, especially in the Kabila Health Center area. The Kabila Health Center data in 2022 reported that 447 patients had diabetes, and it increased to 644 patients in 2023 (Dinas Kesehatan Kabupaten Bone Bolango, 2024).

Nearly 80% of deaths from Diabetes occur in low- and middle-income countries (Tiong *et al.*, 2019). Diabetes is classified as a

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chronic illness and is, therefore, a significant burden on the healthcare system. The losses caused by Diabetes related to Gross Domestic Product (GDP) in the world from 2010 to 2030 are estimated to be around 1.7 trillion dollars. Treatment of sufferers is carried out throughout life, thus increasing the economic burden on the family and leading to worsening symptoms and complications of sufferers (Patil *et al.*, 2017; Tol *et al.*, 2013). Most people of Bone Bolango Regency earn mainly from agriculture, fisheries, and forestry, where Gorontalo Province is one of the largest corn producers in Indonesia.

Factors that cause a high rate of complications and mortality in people with diabetes include the presence of early comorbidities (such as chronic kidney disease and chronic obstructive pulmonary disease) and poor medication adherence and persistence (Gibson *et al.*, 2020; Tang *et al.*, 2020). Treatment adherence is fundamental to the successful management of chronic disease treatment, including in people with diabetes mellitus. Previous studies have reported that medication adherence and self-care behavior, such as diet control, regular physical activity, and medication compliance, are essential components of diabetes management to prevent complications and maintain glycemic control (Balgis *et al.*, 2023; Febrinasari *et al.*, 2022). Factors associated with non-compliance in people with type 2 diabetes are education level, social security coverage, therapeutic education or knowledge of the disease and treatment, cost of therapy, socioeconomic level, duration of diabetes, polypharmacy, gender, age, and family support, as well as health care professionals (health worker support, community pharmacy services) (Achouri *et al.*, 2021; Jaam *et al.*, 2017; Newman *et al.*, 2020; Studer *et al.*, 2023). Beliefs about treatment vary among individuals, family roles, and racial- and ethnic-related cultural factors, which can be related to medication adherence to various health conditions (Isroin, 2019; Jaam *et al.*, 2017; McQuaid & Landier, 2018; Studer *et al.*, 2023). The results of other studies stated that education is an essential predictor of treatment adherence (Mamoon *et al.*, 2022). Demographic and socioeconomic factors and low utilization of health services are also determinants of medication adherence

(Alhazami *et al.*, 2020).

A preliminary study conducted in September 2024 at the Kabila Health Center, Bone Bolango Regency, identified 126 Diabetic patients using oral hyperglycemic drugs and undergoing health checks as part of the Prolanis-compliant group. Of the seven respondents who were interviewed, three respondents consumed medication regularly because their families often reminded them. The three other respondents said they forgot occasionally due to the old age factor, and one respondent stated that they only took medication when they were sick. The purpose of the study was to analyze the use of oral hyperglycemic drugs in patients with Type 2 Diabetes Mellitus in Bone Bolango Regency, Gorontalo Province, which is a historic old city and one of the largest corn-farming-producing cities in Indonesia.

Method

This research is a quantitative study with an observational analytical approach using a cross-sectional design. The population consisted of diabetic patients using oral hyperglycemic drugs in the Kabila Health Center area, with 126 respondents who were included in this study, who used the total sampling method. The instruments used were demographic, health worker support, family support, and compliance questionnaires (MMAS-8). The variables of this study were gender, age, income, support for health workers, and family support. Gender was categorized into 2, namely male and female. The age group was classified into two groups, the productive age (19-59 years old) and older people (≥ 60 years old). The revenue was divided into two, namely the < Provincial Minimum Wage (PMW) group (Rp. 3,025,100) and > PMW group (Rp. 3,025,100). Health worker support and family support consisted of bad and good categories. The level of compliance was categorized into non-compliant groups and compliant groups.

The statistical analysis of the data used in this study was binary logistic regression analysis, with the test of determination coefficient to assess the variability of independent variables in explaining dependent variables measured using the determination coefficient that can be seen from the value of

Nagelkerke R Square, Wald test (Partial t-test) to test whether each independent variables were able to influence the dependent variables of compliance, Omnibus Tests of Model Coefficients (Simultant test f) to test whether all independent variables simultaneously affect compliance, and Chi-Square Test to assess the difference in compliance in each category in the independent variables. This study received an *ethical exemption* from the Health Research Ethics Committee, Faculty of Medicine, Universitas Negeri Semarang (Approval No. 1055/KEPK/FK/KLE/2024). The research protocol was declared ethically appropriate in accordance with the seven WHO (2011) standards and the CIOMS (2016) Guidelines.

Result And Discussion

Table 1 shows the results of regression analysis; the value of the determination coefficient, as seen from the value of Nagelkerke R Square, is 0.195. This indicates that the ability of independent variables, namely gender, income, family support, and health worker support, to explain the dependent variable, namely compliance, is only 19.5%, while the rest is explained by other variables outside this research model, which is 80.5%.

Table 2 shows the result of the analysis of logistic regression; the logistic regression equation can be formulated as follows:

$$Kp = -5.457 - 0.474 \text{ Gender} + 1.497 \text{ Income} + 1.718 \text{ D_Health Worker} + 0.881 \text{ D_Family},$$

The results of **Table 2**. It can be concluded that 1) the gender variable did not have a significant effect on compliance, 2) the income variable had a significant effect on compliance, 3) the variable of health worker support had a significant effect on compliance, and 4) the variable of family support did not have a significant effect on compliance. Which means: (1) The value of the constant (α) is -5.457, meaning that if the independent variable has a constant value, then the compliance is -5.457; (2) The gender variable has a negative coefficient value of 0.474, meaning that if the gender increases the number of males assuming the value of other variables is constant (constant), the coefficient of gender (-0.474) indicates that male respondents tend to have lower odds of medication adherence compared with females, although the relationship was not statistically significant.; (3) The income variable has a positive coefficient value of 1.497, meaning that if the income increases by one

Table 1. Model Summary

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
153.310	0.145	0.195

Source: Primary Data Analysis, 2024

Table 2. Results of Logistic Regression Analysis

Variables	B	S.E	Wald	Sig.
Gender	-0.474	0.490	0.936	0.333
Income	1.497	0.602	6.174	0.013
Health Worker Support	1.718	0.748	5.275	0.022
Family Support	0.881	0.487	3.275	0.070
Constant	-5.457	1.993	7.495	0.006

*Significance Level = 0.05

Source: Primary Data Analysis, 2024

Table 3. Omnibus Test of Model Coefficients (Simultaneous Test f)

	Chi-Square	df	Sig.
Step	19.804	4	0.001
Block	19.804	4	0.001
Model	19.804	4	0.001

Source: Primary Data Analysis, 2024

Table 4. Differences in Compliance of Each Category on Independent Variables

	Compliance						Sig.
	Low	Percentage	High	Percentage	Total	Percentage	
Gender							
Male	9	7.1%	16	12.7%	25	19.8%	0.235
Female	47	37.3%	54	42.9%	101	80.2%	
Total	56	44.4%	70	55.6%	126	100.0%	
Age							
26-35 years old	1	0.8%	0	0.0%	1	0.8%	0.022
36-45 years old	9	7.1%	3	2.4%	12	9.5%	
46-55 years old	20	15.9%	18	14.3%	38	30.2%	
56-65 years old	20	15.9%	30	23.8%	50	39.7%	
> 65 years old	6	4.8%	19	15.1%	25	19.8%	
Total	56	44.4%	70	55.6%	126	100.0%	
Education							
No Education	1	0.8%	0	0.0%	1	0.8%	0.024
Elementary School	26	20.6%	19	15.1%	45	35.7%	
Junior High School	17	13.5%	17	13.5%	34	27.0%	
High School	10	7.9%	27	21.4%	37	29.4%	
College	2	1.6%	7	5.6%	9	7.1%	
Total	56	44.4%	70	55.6%	126	100.0%	
< PMW	51	40.5%	53	42.1%	104	82.5%	0.020
> PMW	5	4.0%	17	13.5%	22	17.5%	
Total	56	44.4%	70	55.6%	126	100.0%	

Source: Primary Data Analysis, 2024

percent, assuming the value of other variables is fixed (constant), then compliance will increase by 1.497 percent; (4) The variable of health worker support has a positive coefficient value of 1.718, meaning that if health worker support increases by one percent, assuming the value of other variables is fixed (constant), then compliance will increase by 1.718 percent and vice versa; and (5) The family support variable has a negative coefficient value of 0.881, meaning that if family support increases by one percent, assuming the value of other

variables is fixed (constant), then compliance will increase by 0.881 percent.

Table 3 shows a significant value of 0.001 (< 0.05) can be obtained, and it can be concluded that gender, income, health worker support, and family support simultaneously affect compliance.

The results of the chi-square test: 1) based on gender, a significant value of 0.235 > 0.05 was obtained, so it was concluded that there was no difference in compliance based on gender. 2) Based on age, a GIS value of

0.022 < 0.05 was obtained, so it was concluded that there was a difference in compliance based on age differences. 3) Based on education, a GIS value of 0.024 < 0.05 was obtained, so it was concluded that there was a difference in compliance based on differences in education levels. 4) Income obtained a GIS value of 0.020 < 0.05, so it was concluded that there was a difference in compliance based on the difference in income level.

The results of the statistical analysis concluded that 1) gender variables had no significant effect on compliance (Sig 0.333), 2) income variables had a significant effect on compliance (Sig 0.013), 3) variables of Health Worker Support had a significant effect on compliance (Sig 0.022), and 4) The variable of family support had no significant effect on compliance (Sig 0.070). Income will affect compliance because income is a fundamental factor related to education, knowledge, and access to health services provided by the family. Individuals with higher socioeconomic status generally have better access to healthcare services and health information, which can improve treatment adherence and health outcomes among patients with chronic diseases (Febrinasari *et al.*, 2022). Families with adequate income will find it easier to achieve higher education, which will then have broader knowledge and insight that will affect their healthy attitudes and behaviors, including adherence to taking medicine. Family income makes it possible to provide good and complete health service facilities according to the needs of their family members. This aligns with the results of the study, which states that knowledge needs attention; therefore, education is a crucial predictor of treatment adherence (Mamoon *et al.*, 2022). Low socioeconomic factors and low utilization of health services are also determinants of medication adherence (Alhazami *et al.*, 2020).

Bone Bolango Regency is known as one of the major maize-producing areas in Gorontalo Province. The dominance of agricultural livelihoods, particularly maize farming, influences the socioeconomic conditions of the community. Most households depend on seasonal agricultural income, which may fluctuate depending on harvest yields

and market prices. This condition potentially implicates the financial capability of families to access health services and maintain regular treatment. Farmers' income instability may contribute to lower medication adherence among patients with diabetes, particularly in households with income below the Provincial Minimum Wage. Limited financial resources can affect transportation to health facilities, routine medical check-ups, and access to medication. Previous studies also indicate that socioeconomic conditions in agricultural communities significantly direct health-seeking behavior and adherence to long-term treatment among patients with chronic diseases.

Support from health workers in the form of counseling, health education, and quality health services can increase patient comfort and trust in the treatment process. Patient empowerment and satisfaction with health services have been shown to improve adherence to treatment and clinical outcomes among patients with diabetes mellitu (Tjiptabudi & Antonio, 2025) Managing diabetes is not merely about treating a disease; it is about empowering patients with the knowledge, skills, and confidence to become the primary managers of their own health (Tanamas *et al.*, 2025). Positively associated factors included knowledge about the disease and treatment, regular follow-up visits, and patients' positive beliefs about effectiveness and motivation about treatment, while negatively associated factors included forgetfulness, side effects, and polypharmacy (Jaam *et al.*, 2017). Support for health workers can come from doctors, nurses, health promotion workers, and others to pharmaceutical services. The results of the study stated that community pharmacy services can improve treatment adherence and clinical outcomes in a variety of chronic diseases, including diabetes mellitus (Newman *et al.*, 2020). The results of other studies have shown that the comprehensive impact of telepharmacy on the delivery of healthcare to individuals living with chronic diseases is proven to lead to improved treatment adherence and overall health outcomes (Hussain *et al.*, 2024).

In addition, the result of the Coefficient of Determination (*Nagelkerke's R Square*), indicates that the ability of independent

variables, namely gender, income, family support, and health worker support to explain the dependent variable, namely compliance, was only 19.5%, while the rest was explained by other variables outside of this research model, which was 80.5% (including cultural factors, polypharmacy, social security coverage, therapeutic education or knowledge about disease and treatment, medical costs, duration of diabetes, severity, and marital status) (Achouri *et al.*, 2021; Gibson *et al.*, 2020; Jaam *et al.*, 2017; Li *et al.*, 2023; Newman *et al.*, 2020; Studer *et al.*, 2023). But in conclusion, also that gender, income, health worker support, and family support are simultaneously influential to compliance (Sig 0.001 < 0.005).

If we look at the difference in compliance of each category on the independent variables, then we can conclude that: 1) there was no difference in compliance based on gender (Sig 0.235), where most respondents were female (80.2%). 2) There is a difference in compliance based on age difference (Sig 0.022). The age in this study is mostly in the age group of 56 – 65 years (39.7%), or if divided into 2 age groups, namely productive age and the elderly, then, the most in the productive age group (19 – 59 years) as much as 54.8% and the elderly age (≥ 60 years) as much as 45.2%. Most elderly respondents were obedient in consuming oral hyperglycemic drugs, while the level of medication adherence at a productive age was lower. This can be because elderly patients have higher awareness and more experience related to the disease they suffer from, which will greatly affect the level of health and complaints that will occur, as well as complications that can occur. The results of this study are in line with research conducted on other chronic diseases (antidepressant treatment), where older age and polypharmacy are significant predictors of medication adherence. The study also found that individuals living in urban areas were more likely to adhere to treatment, but the difference was not statistically significant (Muhammad *et al.*, 2023). Other studies found that patients of younger ages and shorter duration of treatment may be at risk of lower adherence (Kibbons *et al.*, 2024). 3) There are differences in compliance based on differences in education levels (Sig 0.024).

The respondents with an elementary school education level were 35.7%, and only 7.1% had a tertiary education. Low adherence was associated with lower education, income, and awareness of diabetes management. Effective diabetes control requires continuous disease management through appropriate health education and self-care practices in order to reduce the risk of complications (Yuliastuti *et al.*, 2019), while high adherence was associated with improved glycemic control and reduced complications (Al-chawishli *et al.*, 2024). 4) There is a difference in compliance based on differences in income levels (Sig 0.020). Most respondents in this study are groups with income < UMP (Provincial Minimum Wage), which is 82.5%.

The specificity of the research area, which is a corn producer (*Zea mays*) in Indonesia, will have an impact on the picture of public employment, income levels, and education. The study from Halid *et al.* (Halid *et al.*, 2016) showed that maize processing and production development has a good prospect as an economically driven activity in Gorontalo. Gorontalo is also a historic old city, which is one of the entrances to Islam in Indonesia, where the culture of the local community is still widely adhered to. This is reinforced by the results of Handayani's research, which states that in Gorontalo (which represents the area outside Java), there are still quite a large number of families who choose health services in traditional medicine, such as treatment for smart people and the like, cultural factors, in this case, may be still quite influential, including customs and traditional stakeholders who are in the role model (Pakaya *et al.*, 2024), this conclusion can affect medication adherence. This conclusion is also strengthened by the results of the study, which states that cultural factors related to habits, community environment, and existing values can also determine healthy parenting (including medication compliance) and health services chosen (Al-sejari, 2017; Handayani *et al.*, 2020; Handayani & Rahayu, 2019; Silva, 2012).

Conclusion

The results of the statistical analysis concluded that 1) gender variables (Sig 0.333)

and family support (0.070) did not have a significant effect on compliance, 2) income variables (0.013) and health worker support (0.022) had a significant effect on compliance. In addition, the variables of gender, income, family support, and support of health workers in explaining the dependent variable, namely compliance, were only 19.5%, while the rest were explained by other variables outside of this research model, which was 80.5%. The difference in compliance of each category in the independent variable, it was concluded that: 1) there was no difference in compliance based on gender (Sig 0.235), 2) there was a difference in compliance based on age difference (Sig 0.022). 3) there are differences in compliance based on differences in education levels (Sig 0.024). 4) there is a difference in compliance based on differences in income levels (Sig 0.020).

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