Jurnal Ilmiah Multidisiplin Indonesia (JIM-ID)
Volume 4 , Number 05, 2025, DOI 10.58471/esaprom.v4i05
ESSN 2828-9463 (Online)
https://ejournal.seaninstitute.or.id/index.php/esaprom

Social Support and Technology Use Technology as a Predictor of Diabetes Mellitus Patient Medication Adherence

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Article Info

Keywords:
Diabetes Mellitus,
Social Support,
Treatment Adherence,
Technology Use

ABSTRACT

Treatment adherence is a key factor in managing Type 2 Diabetes Mellitus . yet patient adherence remains low in various regions. including Langsa City. This study aimed to determine the extent to which social support and health technology use contribute to patient adherence to treatment. A quantitative approach with an analytic survey method was employed. A sample of 200 T2DM patients was obtained through area sampling from five sub-districts in Langsa City. Research instruments included a structured questionnaire based on the Social Support Questionnaire (SSQ). health technology use indicators. and a modified Morisky Medication Adherence Scale (MMAS-8). Data were analyzed using multiple linear regression. with classical assumption tests to validate the model. Results revealed that social support significantly influenced treatment adherence (40.3%). while technology use contributed 27.1%. These findings suggest that interventions integrating social and digital components could enhance patient adherence. In conclusion, social support and technology use are critical predictors of improved treatment adherence in diabetes patients. Strengthening family-based and technology-driven interventions in healthcare services is recommended.

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INTRODUCTION

Diabetes mellitus encompasses a heterogeneous group of metabolic disorders characterized by impaired carbohydrate utilization, wherein glucose is inadequately absorbed as an energy source. This dysregulation is primarily driven by excessive hepatic glucose production via aberrant gluconeogenesis and glycogenolysis, culminating in chronic hyperglycemia[1]. Among these disorders, Type 2 Diabetes Mellitus stands as a major non-communicable disease with alarmingly high prevalence in Indonesia. According to the International Diabetes Federation (IDF). Indonesia ranked seventh globally in 2019 for the highest number of Type 2 Diabetes Mellitus cases, with approximately 10.7 million individuals affected[2]. Treatment adherence remains a critical determinant of effective Type 2 Diabetes Mellitus management, as it directly influences the prevention of debilitating complications and improves long-term patient outcomes and quality of life.

Globally, the peak age of diagnosis for Type 2 Diabetes Mellitus typically occurs in middle-aged to elderly populations (40–65 years). However, disparities exist between developed and developing nations. In high-income countries, diagnosis peaks later (55–65 years), whereas in developing regions particularly across Asia individuals are often diagnosed at younger ages (~45–55 years)[1], [3]. This study focused on respondents aged 40 years and above diagnosed with Type 2 Diabetes Mellitus in Langsa City, aligning with the broader trend observed in developing regions where earlier onset necessitates proactive public health interventions.

Treatment adherence in Type 2 Diabetes Mellitus patients is shaped by multiple determinants, with social support systems and technology-integrated disease management emerging as pivotal factors. Empirical evidence highlights that structured social support from familial networks, peers, and community groups demonstrates a measurable impact on adherence behaviors. A study conducted by Priscayanti (2023) demonstrated a statistically significant positive association between social support and medication adherence among patients with Type 2 Diabetes Mellitus at the Mengwi II Community Health Center[4]. Similarly, Ramadhanty's research identified social support as a critical predictor of dietary compliance in individuals managing Type 2 Diabetes Mellitus[5], [6], [7], [8], [9].

Additionally. technology integration such as diabetes management applications and medication reminder systems has gained traction in clinical practice. These tools empower patients by facilitating real-time tracking of blood glucose levels, automating treatment schedules, and delivering personalized health education[10], [11], [12]. Despite their growing adoption, evidence on the efficacy of technology-driven interventions in improving treatment adherence remains sparse, particularly in understudied regions like Langsa City. This gap underscores the need for localized research to evaluate context-specific barriers and opportunities in leveraging digital health solutions for Type 2 Diabetes Mellitus management.

While existing studies have investigated the relationship between social support and treatment adherence, as well as technology utilization in Type 2 Diabetes Mellitus management, no research has explicitly examined the combined role of these variables as predictors of treatment adherence in Langsa City. This gap underscores the need for localized studies to identify context-specific determinants of adherence among Type 2 Diabetes Mellitus patients in this region.

Table 1. Healthcare Services for Diabetes Mellitus Patients at Community Health Centers in Langsa City Sub-Districts (2022)

No.	Community Health Center (Sub-District)	Total Patients	Patients Receiving Standard-Compliant Care	
			Patients	%
1	Langsa Barat	6.146	5.785	94.1
2	Langsa Baro	6.403	5.948	92.9
3	Langsa Lama	6.047	5.532	91.5
4	Langsa Kota	6.171	5.704	92.4
5	Langsa Timur	5.787	5.446	94.1

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No.	Community Health Center (Sub-District)	Total Patients	Patients Receiving Standard-Compliant Care	
			Patients	%
	Total	30.554	28.415	
			Average	93.0

Source: Langsa City Health Office. 2024.

According to the Langsa City in Figures 2025 report published by the Central Statistics Agency (BPS) of Langsa City (28 February 2025), the city's population in 2024 was 192,630. with 96,788 males and 95,842 females[13]. Table 1 further reveals a significant burden of Diabetes Mellitus among residents, with an estimated 15.86% of the population affected by the disease.

This study aims to:

1. Examine the individual and combined effects of social support and technology utilization on treatment adherence among Type 2 Diabetes Mellitus patients in Langsa City.
2. Determine the dominant predictor (social support or technology use) influencing treatment adherence through multiple linear regression analysis.

Conceptual Framework

This study investigates the influence of social support and technology utilization on treatment adherence among diabetes mellitus patients. As illustrated in Figure 1, the conceptual framework posits two independent variables (social support and technology use) and one dependent variable (treatment adherence). Below is a detailed breakdown:

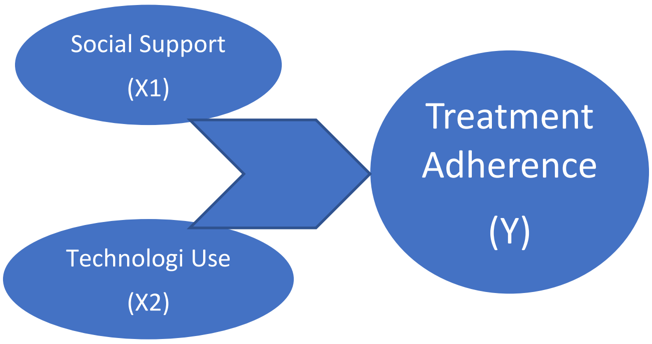

Figure 1. Conceptual Framework

Hypothesized Relationships

1. Social support and technology use are theorized to directly and positively influence treatment adherence.
2. A potential synergistic effect may exist when both variables are combined.

Social support (X1) is defined as assistance or care provided by individuals or groups to alleviate stress and enhance the well-being of recipients. For patients with Type 2 Diabetes Mellitus, social support plays a critical role in improving treatment adherence and overall disease management. It is categorized into three types: Emotional support: encouragement, empathy, and reassurance. Instrumental support: tangible aid (e.g..

reminders for medication. assistance with daily tasks). Informational support: sharing knowledge about diabetes care and resources[14].

In the context of Type 2 Diabetes Mellitus. support from family and friends helps mitigate feelings of loneliness and anxiety, which are common among patients. Studies indicate that individuals with robust social support systems are more likely to follow medical advice and adhere to treatment plans consistently[15]. House (2021) further emphasizes that social support strengthens patients' psychological resilience, enabling them to better cope with the challenges of chronic illnesses like diabetes[16].

Technology Utilization (X2). Technology has emerged as a critical component in managing chronic diseases such as Type 2 Diabetes Mellitus. This encompasses mHealth applications. wearable devices (e.g.. glucose monitors), and digital medication reminder systems, which assist patients in tracking blood glucose levels and adhering to treatment schedules. Venkatesh et al. (2023) highlight technology's role in facilitating patient-provider communication and enabling closer monitoring of patient health outcomes[17].

Furthermore, Leiva et al. (2024) demonstrate that mobile health (mHealth) technologies enhance patient engagement in diabetes self-management. These tools not only streamline health monitoring but also improve treatment adherence through automated reminders. personalized education, and digital record-keeping of medical histories[18]. The Unified Theory of Acceptance and Use of Technology (UTAUT) proposed by Venkatesh (2023), identifies key determinants of technology adoption. including ease of use and performance expectancy[17].

Treatment adherence (Y) in Type 2 Diabetes Mellitus refers to the extent to which patients follow medical instructions, including medication intake, dietary modifications, and adoption of healthy lifestyle practices. Adherence is critical in diabetes management, as it reduces the risk of severe complications such as cardiovascular disease, vision loss, and kidney dysfunction[19]. The Morisky Medication Adherence Scale (MMAS-8), developed by Morisky et al. (2021), is a validated tool widely used to measure adherence levels in chronic disease patients. including those with diabetes[20]. Gunawan (2024) underscores that patients with strong self-management practices and robust social support systems exhibit higher adherence rates[21].

Factors Influencing Treatment Adherence

a. Social and Economic Determinants

   Social and economic determinants, including educational attainment. income level. social support. and access to healthcare services, play a crucial role in influencing patients' adherence to treatment. Individuals who benefit from strong social support networks are significantly more likely to comply with their prescribed therapeutic regimens[16], [19].

b. Healthcare System Factors

   The quality of interactions between patients and healthcare providers. medication affordability and continuity of care significantly influence adherence. Poor communication can substantially reduce a patient's compliance with treatment[21].

c. Disease-Related Factors

The complexity, duration, and symptomatic nature of a disease shape patients' attitudes toward treatment. Chronic illnesses that lack acute symptoms, such as diabetes, often lead patients to underestimate the need for consistent medication use[20], [21].

d. Treatment-Related Factors

The number of medications prescribed, frequency of intake potential side effects, and duration of therapy can impact adherence. The more complex a treatment regimen is, the lower the likelihood of patient adherence[18].

e. Patient-Related Factors

These include knowledge, attitudes, beliefs about treatment, and intrinsic motivation. A limited understanding of the importance of medication can result in reduced adherence[15], [17].

f. Technological Factors

Technological interventions such as mHealth applications, SMS reminders. and telemedicine platforms assist patients in remembering medication schedules, monitoring their health conditions, and maintaining easier communication with healthcare providers[17], [18], [21].

METHOD

Research Design

This study employed a quantitative approach with a descriptive-analytic research design using a survey method.

Population and Sample

The population of this study consisted of all patients with type 2 diabetes mellitus who attended follow-up (control) visits at five public health centers (Puskesmas) located across five districts in Langsa City: Langsa Kota, Langsa Barat, Langsa Timur, Langsa Lama, and Langsa Baro.

A total of 200 respondents were selected as the sample. with participants drawn equally from each of the five health centers. This sample size satisfies the minimum requirement for statistical analysis, which is at least 30 respondents per group. According to Sugiyono (2024), "for statistical analysis, the minimum sample size should be 30 in order to allow for limited generalization of the research findings"[22].

A non-probability sampling technique was employed. in which not all members of the population had an equal chance of being selected. As noted by Riyanto (2025), "non-probability sampling is a sampling technique where not every element or member of the population has an equal opportunity to be selected as a sample, but is chosen based on specific research objectives"[23].

In this study, area sampling (also known as cluster sampling) was used. Area sampling involves selecting samples based on specific geographic areas that are part of the population. According to Hadi (2025), "area sampling is a technique in which samples are drawn from defined geographic regions or clusters. such as districts, villages, or sub-districts, which are deliberately chosen as data collection sites"[24].

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The selection of five health centers from five districts was made to represent the geographic distribution of diabetes patients in Langsa City and to facilitate focused data collection based on healthcare service clusters.

Research Instrument

The research instrument used in this study was a structured questionnaire consisting of three main sections:

Independent Variables (Predictors):

a. Social Support (X1): Refers to the assistance received by patients from family members, friends, or healthcare professionals. This support may include emotional, informational, or instrumental aid that helps patients manage their treatment and overall health condition. Measured using a modified version of the Social Support Questionnaire (SSQ)[25], consisting of 10 statement items.
b. Technology Use (X2): Refers to the utilization of digital tools such as health applications, telemedicine services, and online medical information platforms by patients to support or monitor their adherence to treatment. Measured using indicators such as the use of health apps, access to medical information, and patients' digital engagement[26], assessed through a modified questionnaire containing 10 statement items.

Dependent Variable:

a. Medication Adherence: Refers to the extent to which patients follow medical advice, including taking medications on schedule, attending routine check-ups, and maintaining a healthy lifestyle as directed by healthcare providers. Measured using a modified version of the Morisky Medication Adherence Scale (MMAS-8). adapted to include 10 statement items[27].

All questionnaire items were rated using a five-point Likert scale: (SD = 1) Strongly Disagree – (D = 2) Disagree – (N = 3) Neutral – (A = 4) Agree – (SA = 5) Strongly Agree [22].

Data Analysis

The collected data were subjected to validity and reliability testing before being analyzed using multiple linear regression to examine the effects of social support and technology use on medication adherence among patients with type 2 diabetes mellitus. Classical assumption tests, including tests for normality. Multicollinearity, and heteroscedasticity, were also conducted to ensure the validity and robustness of the regression model.

RESULT AND DISCUSSION

Result

Based on the questionnaire responses from 200 participants. the following demographic and clinical characteristics were identified:

Table 2. Respondent Characteristics

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Male	89	44.5

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Characteristic	Category	Frequency (n)	Percentage (%)
	Female	111	55.5
	Total	200	100.0
Age	< 40 years	19	9.5
	40–49 years	61	30.5
	50–59 years	79	39.5
	≥ 60 years	41	20.5
	Total	200	100.0
Educational Background	No formal education	11	5.5
	Primary school	31	15.5
	Junior high school	35	17.5
	Senior high school	69	34.5
	Diploma	25	12.5
	Bachelor's degree	29	14.5
	Total	200	100.0
Occupation	Unemployed	23	11.5
	Farmer	21	10.5
	Trader	45	22.5
	Civil servant (PNS)	33	16.5
	Private sector	49	24.5
	Others	29	14.5
	Total	200	100.0
Marital Status	Single	21	10.5
	Married	149	74.5
	Widowed/Divorced	30	15.0
	Total	200	100.0
Duration of Diabetes	< 1 year	27	13.5
	1–5 years	89	44.5
	6–10 years	55	27.5
	> 10 years	29	14.5
	Total	200	100.0
Family History of Diabetes	Yes	141	70.5
	No	59	29.5
	Total	200	100.0
Health Insurance (BPJS/KIS)	Yes	159	79.5
	No	41	20.5
	Total	200	100.0
Frequency of Medical Visits	Once	89	44.5
	Twice	69	34.5
	More than twice	41	20.5
	Total	200	100.0

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Characteristic	Category	Frequency (n)	Percentage (%)
Sources of Health Information	Health professionals	101	50.5
	Internet	43	21.5
	Family/Friends	41	20.5
	Others	15	7.5
	Total	200	100.0

Source: Processed Primary Data (2025)

Validity and Reliability Test Results

Validity refers to the extent to which an instrument accurately measures what it is intended to measure. The validity test in this study was conducted on 30 respondents outside the main sample, using Pearson's correlation between each item score and the total score. Based on the sample size (n = 30) and significance level (α = 0.05). the critical value of the correlation coefficient (r-table) is ±0.361. Thus: If r-calculated ≥ 0.361. the item is considered valid. If r-calculated < 0.361. the item is considered invalid[23]. Reliability refers to the consistency of the measurement instrument. An instrument is considered reliable if the Cronbach's Alpha value is ≥ 0.70[24].

Based on the data analysis using SPSS Version 23.0, all measurement items for each variable in this study were found to be valid, as each item's r-value exceeded 0.361. Furthermore, all variables passed the reliability test, with Cronbach's Alpha coefficients greater than 0.70, indicating high internal consistency.

Table 3. Validity and Reliability Test Results of the Social Support Variable

No	Item Code	Validity Result	Reliability (Cronbach Alpha)
1	My social supports my medical treatment.	0.712	0.801
2	I feel emotionally supported.	0.684	0.801
3	My friends help remind me to take my medication.	0.754	0.801
4	Health professionals provide clear information.	0.731	0.801
5	My family accompanies me during health check-ups at the community health center (Puskesmas).	0.690	0.801
6	I receive assistance in maintaining a healthy diet.	0.710	0.801
7	My friends share information about diabetes with me.	0.722	0.801
8	I feel cared for when receiving treatment.	0.703	0.801
9	My family helps me schedule and manage my medication routine.	0.747	0.801
10	There is a community that supports me in managing my condition.	0.768	0.801

Source: Processed Primary Data (2025).

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Table 4. Validity and Reliability Test Results of the Technology Utilization Variable

No	Item Code	Validity Result	Reliability (Cronbach Alpha)
1	I use health-related mobile applications.	0.701	0.812
2	I have used telemedicine services.	0.687	0.812
3	I regularly access health information online.	0.723	0.812
4	I participate in health education content on social media.	0.735	0.812
5	Mobile applications help me remember my medication schedule.	0.698	0.812
6	I read online articles about diabetes management.	0.720	0.812
7	I learn about diabetes through YouTube or other video platforms.	0.745	0.812
8	I use digital applications to monitor my blood glucose levels.	0.766	0.812
9	I actively participate in online diabetes support forums.	0.702	0.812
10	Online information improves my treatment adherence	0.729	0.812

Source: Processed Primary Data (2025).

Table 5. Validity and Reliability Test Results of Medication Adherence Variable

No	Item Code	Validity Result	Reliability (Cronbach Alpha)
1	I take my medication according to the prescribed schedule.	0.693	0.825
2	I regularly attend follow-up visits at the community health center (Puskesmas).	0.721	0.825
3	I follow my doctor's dietary recommendations.	0.710	0.825
4	I avoid foods that my doctor has advised against.	0.708	0.825
5	I never forget to take my medication.	0.741	0.825
6	I regularly check my blood sugar levels.	0.730	0.825
7	I follow medical instructions carefully.	0.749	0.825
8	I never discontinue my treatment without medical advice.	0.762	0.825
9	I maintain a healthy lifestyle.	0.773	0.825
10	I take full responsibility for adhering to my treatment plan.	0.788	0.825

Source: Processed Primary Data (2025).

Classical Assumption Tests

Normality Test

The normality test aims to determine whether the residuals from the regression model are normally distributed. This study employed the Kolmogorov-Smirnov (K-S) test. The result showed a significance value (Sig.) of 0.063, which is greater than 0.05, indicating that the residuals follow a normal distribution. Therefore, the assumption of normality is fulfilled.

Multicollinearity Test

The multicollinearity test was conducted to assess whether there is a high correlation between the independent variables (social support and technology use). The analysis used Variance Inflation Factor (VIF) and Tolerance values as indicators. The results are presented in the following table:

Table 6. Multicollinearity Test Results

Independeny Variable	Tolerance	VIF
Social Support	0.782	1.278
Technology Use	0.782	1.278

Source: Processed Primary Data (2025)

Based on the table, all independent variables have Tolerance values greater than 0.10 and VIF values less than 10. These results indicate that multicollinearity is not present in the regression model, and therefore, the assumption of no multicollinearity is satisfied.

Heteroscedasticity Test

The heteroscedasticity test is conducted to determine whether the residuals have constant variance (homoscedasticity) or varying variance (heteroscedasticity). In this study, the Glejser test was employed. The significance values (Sig.) for each independent variable are shown below:

Table 7. Heteroscedasticity Test Results (Glejser Test)

Independent Variable	Sig. (p-value)
Social Support	0.172
Technology Use	0.210

Source: Processed Primary Data (2025)

Since all p-values are greater than 0.05. it can be concluded that no heteroscedasticity is present in the model. Therefore. the assumption of homoscedasticity is fulfilled. Based on the results of the normality test, multicollinearity test. and heteroscedasticity test. all classical assumptions for multiple linear regression have been met. This indicates that the regression model is valid and appropriate for further analysis. The multiple linear regression analysis was conducted to determine the partial effect of each independent variable on the dependent variable. The results of the t-test are presented in the table below:

Table 8. Results of t-Test Analysis (Partial Test)

Model	Unstandardized Coefficients (Beta)	Std. Error	Standardized Coefficients (Beta)	t value	Sig.
Constant (a)	21.187	2.482		8.536	0.000

Model	Unstandardized Coefficients (Beta)	Std. Error	Standardized Coefficients (Beta)	t value	Sig.
Social Support	0.403	0.057	0.497	7.070	0.000
Technology Use	0.271	0.062	0.318	4.371	0.000

a. Dependent Variable: Kepatuhan
b. Predictors: (Constant), Social Support, Technologi Use

Source: Processed Primary Data (2025)

Based on the regression results. the following equation was obtained:

General Regression Model:

$$Y = a + b_1X_1 + b_2X_2 + e$$

Regression Equation from the Study:

$$Y = 21.187 + 0.403X_1 + 0.271X_2$$

The constant value (a = 21.187) indicates that if both social support (X_1) and technology use (X_2) are equal to zero, the predicted level of medication adherence (Y) would be 21.187. Although such a situation is rarely found in real life, the constant plays a critical mathematical role in constructing the regression model. The coefficient of social support (X_1) is 0.403, with a t-value of 7.070 and a significance value (p) of 0.000. This means that for every one-unit increase in social support, medication adherence increases by 0.403 points. assuming the other variables are held constant. Since the p-value is less than 0.05, this effect is statistically significant. The standardized beta coefficient ($\beta = 0.497$) indicates that social support is the most dominant predictor, contributing the most to medication adherence compared to other variables.

The coefficient for technology use (X_2) is 0.271, with a t-value of 4.371 and a significance value (p) of 0.000. This implies that a one-unit increase in technology use leads to a 0.271-point increase in medication adherence, with other factors held constant. Since the p-value is also less than 0.05, technology use significantly influences medication adherence. However, its standardized beta ($\beta = 0.318$) is lower than that of social support, indicating a weaker but still significant contribution. In conclusion, both independent variables: social support and technology use significantly affect medication adherence among patients with type 2 diabetes mellitus. Social support exerts a greater influence than technology use, as evidenced by its higher standardized beta coefficient.

Table 9. ANOVA – F-Test for Overall Model Significance

Model	Sum of Square	df	Mean Square	F	Sig
1	710.104	2	355.052	33.214	0.00
	2.104.896	197	10.682		
	2.815.00	199			

a. Dependent Variable: Treatment Adherence
b. Predictors: (Constant), Social Support, Technology Use

Source: Processed Primary Data (2025)

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The F-test results indicate that the overall regression model is statistically significant, with F(2,197) = 33.214 and $p < 0.001$. This means that the independent variables—social support and technology use—jointly contribute significantly to explaining the variance in treatment adherence among patients with type 2 diabetes.

Table 10. Coefficient of Determination (R^2)

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
1	0.645	0.416	0.409	3.625

Source: Processed Primary Data (2025)

Based on the table above:

The correlation coefficient (R) value of 0.645 indicates a strong and positive relationship between the independent variables (social support and technology use) and the dependent variable (treatment adherence). According to Sugiyono, an R value within the range of 0.60–0.799 is categorized as strong[22].

The coefficient of determination (R^2) is 0.416, meaning that 41.6% of the variance in treatment adherence can be explained by the combined influence of social support and technology use. The remaining 58.4% is attributed to other variables outside the current model. The adjusted R^2 value is 0.409, which adjusts R^2 for the number of predictors and sample size. This relatively high adjusted value suggests that the model remains robust even when accounting for model complexity.

In summary, the regression model demonstrates a moderately strong and statistically significant capacity to explain treatment adherence. Social support and technology use together account for nearly half of the variability in treatment adherence among patients with type 2 diabetes.

Discussion

Multiple Linear Regression Analysis

The results of the multiple linear regression analysis indicate that social support has a statistically significant influence on medication adherence, with a regression coefficient of 0.403 ($p < 0.001$). Similarly, technology use also contributes positively, with a regression coefficient of 0.271 ($p < 0.001$). The standardized beta values suggest that social support ($\beta = 0.497$) is the dominant predictor compared to technology use ($\beta = 0.318$). Collectively, these two independent variables explain 41.6% of the variance in medication adherence ($R^2 = 0.416$), indicating a moderately strong predictive model.

These findings underscore the critical role of social support whether from family, peers, or healthcare providers in enhancing adherence to treatment regimens among patients with type 2 diabetes mellitus. Robust social support systems can foster emotional security, facilitate informed decision-making, and reinforce patients' belief in the long-term benefits of treatment. Prior studies, such as Asniar et al. (2021), have demonstrated that family support plays a pivotal role in dietary compliance among type 2 diabetes mellitus patients at the Malaka Community Health Center ($p < 0.001$)[28]. Similar results were reported by Suciati (2021), who found that strong familial support significantly enhances self-care behaviors in diabetic patients[12].

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Clinically, adequate social support has been shown to mitigate the risk of long-term complications associated with non-adherence, including diabetic nephropathy, retinopathy, and cardiovascular disease. It plays a vital role in improving adherence to both oral medications and insulin therapy, maintaining glycemic control, and enhancing overall quality of life[29].

Although the contribution of technology use was slightly lower than that of social support, it remains a statistically significant factor in promoting adherence. Digital health interventions, such as medication reminder apps, online educational platforms, and telemedicine services, provide patients with rapid access to reliable information, enhance health literacy, and facilitate self-monitoring. A study by Jang et al. (2023) in South Korea found that T2DM patients using mobile glucose-monitoring applications maintained more consistent glycemic control and achieved more stable HbA1c levels than those in the control group[30].

From a policy perspective, these findings suggest the need for strengthening community-based programs and integrating digital technologies into primary healthcare systems. Community health centers should adopt family-centered care approaches by actively involving caregivers in patient education and treatment monitoring. Concurrently, healthcare providers should advocate for the adoption of user-friendly, evidence-based digital tools, such as locally developed mobile applications with features for reminders, patient education, and glucose monitoring—ideally integrated into national health information systems.

This study provides empirical support for a biopsychosocial model in predicting medication adherence, aligning with recommendations from the American Diabetes Association[31]. The ADA emphasizes that effective diabetes management should encompass not only biomedical interventions but also address psychosocial and technological determinants relevant to patients' daily lives.

Analysis of Social Support and Medication Adherence

A growing body of evidence in Indonesia supports the significant association between social support and medication adherence among patients with type 2 diabetes mellitus. For instance, a study conducted at Suak Ribee Public Health Center (Puskesmas), West Aceh, reported a statistically significant correlation between family support and adherence to oral hypoglycemic agents ($p = 0.007$)[32]. Similarly, research by Jais et al. (2020) at Pancur Public Health Center, North Lingga, identified a strong association between family support and dietary adherence among patients with diabetes ($p < 0.001$) [33]. In another study conducted at Baiturrahman Public Health Center in Banda Aceh, Satria (2021) demonstrated that family support significantly influenced dietary adherence among Type 2 Diabetes Mellitus patients ($p = 0.031$)[34].

Although the majority of studies report positive associations, some inconsistencies have emerged in the literature. A study by Simorangkir et al. (2023) failed to find a statistically significant relationship between family support and medication adherence among diabetes patients ($p = 0.397$)[35]. These discrepancies suggest the presence of other influencing factors, such as patient knowledge, intrinsic motivation, health literacy, and socioeconomic status, which may mediate or moderate the effect of social support.

From a theoretical standpoint, social support plays a multifaceted role in enhancing adherence through emotional reassurance, practical assistance, and health-related communication. Patients who receive encouragement and reminders from family members are more likely to follow medication regimens and adopt healthier behaviors. This aligns with findings from a recent multinational study by López-Pineda et al. (2024), which highlighted that culturally sensitive family involvement improves glycemic control and medication adherence across diverse socioeconomic settings[36].

Furthermore, integrating family-based interventions into primary care may enhance adherence outcomes. This approach is consistent with recommendations from the American Diabetes Association (ADA, 2023), which emphasizes the importance of psychosocial factors and patient-centered care in diabetes management[31]. Given the chronic nature of diabetes, fostering sustained support networks becomes essential in ensuring treatment success and preventing long-term complications

Analysis of Technology Use and Medication Adherence

Technology use has been shown to contribute significantly to medication adherence among patients with Diabetes Mellitus. A study by Ghose et al. (2021) revealed that the use of mobile health (mHealth) platforms can enhance patients' health-related behaviors and effectively reduce blood glucose levels in individuals with diabetes[37]. These findings are consistent with research conducted by Odhiambo et al. (2021), who developed a smartwatch application capable of accurately monitoring medication adherence[38].

In the Indonesian context, a study by Suciati (2021) found that the use of health-related applications and telemedicine services had a positive impact on diabetes management and medication adherence among diabetic patients[12]. This is further supported by Adhanty et al. (2021), who emphasized the importance of integrating technology to enhance treatment compliance among diabetes patients in Indonesia[39].

However, not all studies fully support these conclusions. Research conducted by Faswita (2023) reported that although diabetic patients accessed health information through technology, their level of medication adherence remained low. This was attributed to other contributing factors such as limited awareness and inadequate comprehension of the digital information provided[40]. These findings suggest that while technology has potential, it may not be sufficiently effective unless complemented by adequate health education and patient understanding regarding their treatment regimen.

CONCLUSION

Social support. particularly from family. friends. and healthcare providers. plays a pivotal role in improving treatment adherence among Type 2 Diabetes Mellitus patients. accounting for 40.3% of adherence outcomes. Patients who receive consistent emotional encouragement. access to relevant health information. and practical assistance (e.g.. help with medication management) are more likely to follow prescribed treatments. Furthermore. health technology including apps. telemedicine. and digital platforms contributes meaningfully to adherence. though its impact (27.1%) is comparatively lower than social support. These tools assist patients in monitoring blood glucose levels. scheduling medication reminders. and accessing real-time medical guidance. However. adherence is not solely dependent on external support or technology; intrinsic factors such as patients' understanding of diabetes. their motivation to manage the condition. and their ability to navigate digital tools are equally critical. These findings corroborate existing research on the importance of social and technological interventions in diabetes care. though they also highlight limitations in technology's effectiveness. especially among populations with limited digital access or literacy. Further research is imperative to comprehensively investigate the socioeconomic. cultural. and systemic determinants influencing treatment adherence among Type 2 Diabetes Mellitus patients. Developing localized intervention models that synergize social support systems with contextually adapted health technologies could significantly enhance adherence rates in region-specific populations. Such interventions must account for community-specific barriers. such as economic constraints. health literacy gaps. and cultural beliefs. to ensure relevance and sustainability. Concurrently. governments and health institutions must prioritize the equitable implementation of health technologies at the community level. This includes expanding access to digital tools for underserved populations. subsidizing internet connectivity. and advocating for policies that institutionalize technology-driven diabetes management. By addressing disparities in access and fostering collaboration between policymakers. healthcare providers. and tech developers. these efforts can bridge gaps in care and empower patients to achieve long-term adherence.

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