Media of Health Research
Vol. 4 No. 3, August 2026, pages: 874-887
e-ISSN 2987-7784
DOI: https://doi.org/10.70716/mohr.v4i3.675

Effectiveness of INTEGRA (Glucose Telemonitoring) on Quality of Life and Medication Adherence in Type 2 Diabetes at Puskesmas Cilacap Tengah I

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Article History

Manuscript submitted:
18 June 2026
Manuscript revised:
30 July 2026
Accepted for publication:
31 July 2026
Manuscript published:
15 August 2026

Keywords

blood glucose telemonitoring;
health-related quality of life;
integra;
medication adherence;
type 2 diabetes mellitus.

Abstract

Type 2 Diabetes Mellitus requires continuous management. Health-Related Quality of Life (HRQoL) and medication adherence are important indicators of therapy success that are often affected by a decline in ongoing understanding. Analyze the effect of INTEGRA (Blood Glucose Telemonitoring Intervention) on HRQoL and medication adherence of Type 2 Diabetes Mellitus patients at the Cilacap Tengah I Community Health Center. This quasi-experimental pretest-posttest study with a control group involved 138 respondents (69 intervention, 69 control) selected by purposive sampling and simple randomization. The intervention group received the INTEGRA program for 12 weeks; the control group received standard care. HRQoL was measured using the WHOQOL-BREF and complemented by the Summary of Diabetes Self-Care Activity (SDSCA). Analysis used Mann-Whitney, Wilcoxon, and ANOVA. The intervention group showed an increase in SDSCA scores; the control did not change significantly. The WHOQOL-BREF intervention score increased, whereas the control remained stable. ANOVA showed INTEGRA increased confounding variables. INTEGRA effectively improves HRQoL and treatment adherence in patients with Type 2 Diabetes Mellitus. The program is recommended for services in primary health facilities.

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How to Cite: Nur'aini, L., Iswanti, D. I., & Sonhaji (2026). Effectiveness of INTEGRA (Glucose Telemonitoring) on Quality of Life and Medication Adherence in Type 2 Diabetes at Puskesmas Cilacap Tengah I. *Media of Health Research, 4*(3), 874-887. https://doi.org/10.70716/mohr.v4i3.675

Introduction

Type 2 Diabetes Mellitus (DM) is a chronic metabolic disease that requires continuous management throughout the patient's life. In the management of this disease, Health-Related Quality of Life (HRQoL) and treatment adherence are two health outcome indicators that greatly determine the success of therapy. HRQoL describes an individual's perception of the impact of their

health condition on the physical, psychological, emotional, and social aspects of daily life (Kotowicz et al., 2026). In patients with Type 2 DM, HRQoL often decreases along with disease progression and the emergence of complications. On the other hand, treatment adherence reflects the extent to which patients consistently follow medical recommendations, including medication adherence, a healthy diet, regular physical activity, and routine blood glucose monitoring (Fandinata et al., 2026). These two variables are closely related and influence each other. Optimal treatment adherence can help achieve good glycemic control, generally indicated by an HbA1c level of less than 7%, as recommended by the American Diabetes Association (Ehtewish et al., 2022). Good glycemic control reduces the risk of complications and improves the patient's quality of life. Conversely, low adherence often leads to inadequate glycemic control, which contributes to decreased HRQoL and increases the physical, psychological, and economic burden on patients (Sukarno & Munthe, 2026).

The prevalence of Type 2 DM is increasing significantly and poses a major public health challenge. The International Diabetes Federation, through the 11th edition of the Diabetes Atlas (2024), reported that approximately 589 million adults aged 20–79 years live with diabetes, and that this number is projected to increase to 853 million by 2050 (Eliza et al., 2023). About 90% of all diabetes cases are Type 2 DM. Indonesia is among the countries with a high diabetes burden, ranking fifth globally with an estimated 20.4 million cases in 2024 and projected to increase to 28.6 million by 2050. The 2023 Indonesian Health Survey reported that the prevalence of diabetes, based on blood glucose testing, was 11.7% among those aged≥15 years. At the regional level, Central Java Province shows a DM prevalence of 16.5%. Cilacap Regency also shows an increase in the number of cases, with a total of 35,507 diabetes patients. Electronic Medical Record data for 2024 at the Cilacap Tengah I Health Center recorded an average of 273 DM patient visits per year, with a trend toward increasing case numbers (Polwiang, 2020). This condition indicates the high burden of chronic disease that requires effective and sustainable management strategies.

In nursing care practice, the increasing number of patients with Type 2 DM demands the availability of complete, accurate, and continuous nursing data to support clinical decision-making. Nursing data include subjective and objective information covering the biological, psychological, social, and health-behavior aspects of patients. In patients with Type 2 DM, nursing data include not only clinical parameters such as blood glucose levels but also information on treatment adherence, self-care behaviors, and patients' HRQoL (Zhang & Huang, 2020). The completeness of this data is very important in establishing nursing diagnoses, developing intervention planning, and evaluating the success of therapy. However, the collection of nursing data for patients with chronic diseases still faces various obstacles, including limited time for healthcare workers, irregular patient visits, and limited monitoring of patient conditions outside healthcare facilities. These obstacles can delay the detection of complications and reduce the effectiveness of chronic disease management (Sharma et al., 2015). The development of health technology, through the concept of digital nursing, provides opportunities to improve the quality of nursing data collection using telemonitoring, electronic medical records, and digital health applications. This technology allows healthcare workers to obtain patient data in real time, increase patient involvement in monitoring their health, and support the sustainable management of chronic diseases (Eliza et al., 2023).

Problems with treatment adherence and decreased HRQoL in Type 2 DM patients are generally driven by disease characteristics that often do not cause symptoms in the early phase, leading to delayed diagnosis and intervention. After diagnosis is established, patients face the demands of lifestyle changes and complex long-term therapy. Various factors can contribute to low patient adherence, such as a lack of understanding of the disease, side effects of therapy, financial limitations, busy daily activities, and a lack of social and family support (Mano et al., 2023). This condition is exacerbated by clinical inertia, which causes suboptimal glycemic control and accelerates disease progression. Poor glycemic control can trigger microvascular complications such as nephropathy, retinopathy, and neuropathy, as well as macrovascular complications such as

coronary heart disease and stroke, which significantly reduce the patient's HRQoL (Vas et al., 2020). The integration of health technology through a digital nursing approach has the potential to be an innovative strategy to break this cycle by improving patient condition monitoring, providing continuous health education, and strengthening self-care management. Digital nursing is the integration of digital technology into nursing practice, enabling real-time patient data collection, improving communication between healthcare workers and patients, and supporting data-driven clinical decision-making. The use of telemonitoring has been shown to improve treatment adherence, glycemic control, and quality of life in patients with diabetes through continuous monitoring and rapid feedback (Choudhary et al., 2021).

The impact of low treatment adherence and decreased HRQoL in patients with Type 2 DM is not only felt by the individual but also by the healthcare system. Individually, this condition increases the risk of complications, morbidity, premature mortality, and economic burden due to the cost of treating complications (Fandinata et al., 2026). Meanwhile, at the health system level, this condition increases the need for outpatient and inpatient services and increases the health financing burden. In response to these problems, the Blood Glucose Telemonitoring Intervention (INTEGRA) was developed as an innovative approach based on information and communication technology. INTEGRA enables remote monitoring of patients' blood glucose levels, real-time feedback, and personalized education and support (Koo et al., 2024). Through this approach, patients can independently monitor their blood glucose at home and send data to healthcare workers via a digital platform (Suprapto et al., 2026).

An integrated or comprehensive approach to diabetes management aims to control blood sugar levels, prevent dangerous complications, and improve overall quality of life. This approach encompasses patient education, a healthy diet, and regular physical activity (Rismawan et al., 2023), providing continuous and personalized health education (Erwan et al., 2025), and improving access to health services by reducing the need for direct visits to healthcare facilities, especially for patients with limited mobility (Choudhary et al., 2021). Several studies show that telemonitoring interventions can improve glycemic control, increase patient involvement in self-management, and enhance HRQoL and treatment adherence. Based on the above description, this study aims to analyze the effect of INTEGRA (Blood Glucose Telemonitoring Intervention) on Health-Related Quality of Life (HRQoL) and treatment adherence in patients with Type 2 Diabetes Mellitus at the Cilacap Tengah I Health Center. This study is expected to provide empirical evidence on the effectiveness of technology-based interventions in improving the quality of life and adherence among patients with Type 2 DM in primary health care services.

Materials and Methods

This study employed a quasi-experimental design with a pretest-posttest control group approach to examine the effectiveness of the INTEGRA intervention (Blood Glucose Telemonitoring Intervention) in improving quality of life and treatment adherence. The research was conducted at the Cilacap Tengah I Health Center in Cilacap Regency, Central Java, a primary healthcare facility with a relatively high burden of Type 2 Diabetes Mellitus cases (Tenekedjiev et al., 2025). This design was chosen because it allows researchers to systematically evaluate the intervention's effect by comparing groups receiving the treatment with those not receiving it. However, in primary healthcare settings, full randomization is not feasible. The population in this study comprised all actively registered patients with Type 2 Diabetes Mellitus at the Cilacap Tengah I Health Center. The sample size was determined using statistical power calculations, assuming a moderate effect size (Cohen's d = 0.5), a 5% significance level, and 80% power, resulting in a minimum requirement of 63 respondents per group. To anticipate dropout, the sample size was increased to 138 respondents, evenly divided between the intervention group (69) and the control group (69)

(Pieters et al., 2025). The sampling technique employed was purposive sampling based on predetermined inclusion and exclusion criteria, followed by simple randomization to allocate respondents into the two research groups (Xiao et al., 2025).

The independent variable in this study was the INTEGRA intervention, while the dependent variables were Health-Related Quality of Life (HRQoL) and treatment adherence. The intervention group received the INTEGRA program for 12 weeks, which included remote blood glucose monitoring, real-time feedback, continuous health education, and therapy reminders through a digital platform (Suprapto, 2026). Meanwhile, the control group received only standard care in accordance with health center procedures, without telemonitoring. HRQoL was measured using the Indonesian version of the WHOQOL-BREF instrument. In contrast, treatment adherence was measured using the Summary of Diabetes Self-Care Activities (SDSCA), which assesses the frequency of self-care practices over the past 7 days. The data collection procedure was conducted in a structured manner through several stages. The initial stage began with identifying potential respondents through Electronic Medical Records (EMR), providing research explanations, and obtaining informed consent. Subsequently, a pre-test was administered to both groups to assess baseline HRQoL and treatment adherence. After that, the intervention group received the INTEGRA treatment, while the control group continued with standard care. At the end of the intervention period, both groups underwent a post-test using the same instruments to assess changes in scores and compare the intervention's effectiveness.

Data analysis was performed in stages using statistical software. Normality tests using Shapiro-Wilk and homogeneity tests using Levene indicated that the data were not normally distributed; thus, bivariate analysis employed non-parametric statistics, namely the Wilcoxon test to measure within-group differences and the Mann-Whitney test to compare between groups. Furthermore, to control for the influence of confounding variables such as gender, education, duration of diabetes, and type of therapy, multivariate analysis was conducted using ANOVA (Xiao et al., 2025). This approach ensures that the measured effects truly originate from the INTEGRA intervention, not from other factors that might influence the research results.

Results and Discussions

Result

This research was conducted at the Cilacap Tengah I Health Center, strategically located on Jl. Kalimantan, Cikento, Gunungsimping, Cilacap Tengah District, Cilacap Regency, Central Java Province 53211. This primary health facility is easily accessible by phone and operates from 07.00, making it the main service center for the local community. As a Technical Implementation Unit (UPT) of the Health Center, this institution has full authority and responsibility for health maintenance in its working area, supported by the Regional Public Service Agency (BLUD) financial scheme, led by the Head of the Health Center to ensure independent and effective operations. The Cilacap Tengah I Health Center carries out three main functions: a center for driving health-oriented development, a center for community and family empowerment, and a center for primary health care services. The implementation of these functions supports innovative programs such as the blood glucose telemonitoring intervention (INTEGRA) for patients with Type 2 Diabetes Mellitus, which aligns with efforts to improve treatment adherence and patients' quality of life holistically at the primary level.

This research was conducted at the Cilacap Tengah I Health Center, which is strategically located at Jl. Kalimantan, Cikento, Gunungsimping, Cilacap Tengah District, Cilacap Regency, Central Java Province 53211. This primary health facility is easily accessible via phone and operates daily from 07.00, making it the primary service center for the local community. As a Technical Implementation Unit (UPT) of the health center, this institution has full authority and responsibility

for health maintenance within its operational area. It is supported by the Regional Public Service Agency (BLUD) financial scheme and led by the Head of the Health Center to ensure independent and effective operations. The Cilacap Tengah I Health Center carries out three main functions: as a center for driving health-oriented development, for community and family empowerment, and for primary health care services. The implementation of these functions supports innovative programs such as the blood glucose telemonitoring intervention (INTEGRA) for patients with Type 2 Diabetes Mellitus, aligning with efforts to improve treatment adherence and patients' holistic quality of life at the primary level.

Descriptive Analysis

Respondent Characteristics

Descriptive analysis of respondent characteristics began with the frequency distribution and percentages of demographic and clinical data, presented in Table 1.

Table 1
Respondent Characteristics

Variable	Category	Frequency (n)	Percent (%)
Gender	Male	44	31.9
	Female	94	68.1
Education	No School	13	9.4
	Elementary School	25	18.1
	Junior High School	18	13.0
	Senior High School	55	39.9
	University	27	19.6
Duration of Diabetes Mellitus	< 1 year	17	12.3
	1–5 years	51	37.0
	> 5 years	70	50.7
Type of Therapy	Oral Medication (pills)	116	84.1
	Insulin	22	15.9

Table 1 shows that the majority were female (68.1%). The highest education level was Senior High School (39.9%), followed by University (19.6%). Most respondents had suffered from diabetes mellitus for more than 5 years (50.7%), and the most widely used therapy was oral medication (pills) at 84.1%.

Overview of SDSCA (Treatment Adherence) Before and After the INTEGRA Intervention in the Intervention and Control Groups

The distribution of SDSCA Pre-test and Post-test scores is presented in Table 4.2 below.

Table 2
Distribution of SDSCA Pre-test and Post-test Scores

Group	Measurement Time	Mean	SD	Median (Min-Max)
Intervention	Pre-test	42.5	8.2	43 (28–58)
	Post-test	78.3	5.1	79 (65–88)
Control	Pre-test	43.1	7.9	43 (27–57)
	Post-test	44.0	8.0	44 (26–59)

Table 2 shows that before the intervention (pre-test), the mean treatment adherence in the intervention group (42.5) and the control group (43.1) was relatively similar. After receiving the INTEGRA program, the mean adherence in the intervention group increased sharply to 78.3, whereas the control group showed only a very small increase (from 43.1 to 44.0). This indicates that the INTEGRA intervention is effective in improving patient adherence, whereas adherence tends to remain stable without intervention.

Overview of WHOQOL-BREF (Quality of Life) Before and After the INTEGRA Intervention in the Intervention and Control Groups

The distribution of WHOQOL-BREF Pre-test and Post-test scores is presented in Table 3 below.

Table 3
Distribution of WHOQOL-BREF Pre-test and Post-test Scores

Group	Measurement Time	Mean	SD	Median (Min-Max)
Intervention	Pre-test	58.4	7.2	59 (45–72)
	Post-test	84.6	6.0	85 (70–96)
Control	Pre-test	57.9	7.6	58 (44–71)
	Post-test	58.5	7.8	59 (45–73)

Based on Table 3, the quality-of-life scores before the intervention for the intervention group (58.4) and the control group (57.9) were not significantly different. After receiving the INTEGRA program, the intervention group showed a very significant increase to 84.6, while the control group remained almost unchanged (57.9 to 58.5). This confirms that the INTEGRA intervention not only improves adherence but also positively impacts the quality of life of patients with Type 2 diabetes mellitus.

Normality Test

SDSCA Normality Test

The results of the Shapiro-Wilk normality test for SDSCA (treatment adherence) and WHOQOL-BREF (Quality of Life) data at pre-test and post-test for both groups are presented in Table 4.

Table 4
Normality Test

Variable	Group	Shapiro-Wilk Sig.	Description
SDSCA (Treatment Adherence)	Pre-test Control	<0.001	Not Normal
	Post-test Control	<0.001	Not Normal
	Pre-test Intervention	0.005	Not Normal
	Post-test Intervention	0.003	Not Normal
WHOQOL-BREF (Quality of Life)	Pre-test Control	<0.001	Not Normal
	Post-test Control	<0.001	Not Normal
	Pre-test Intervention	<0.001	Not Normal
	Post-test Intervention	<0.001	Not Normal

The results of the Shapiro-Wilk normality test in Table 4.4 for all data, both for the treatment adherence variable (SDSCA) and quality of life (WHOQOL-BREF), show significance values <0.05 in all groups (control and intervention) and at all measurement times (pre-test and post-test). All data

were not normally distributed. This condition indicates that the parametric assumptions were not met. Subsequent statistical analyses to test differences or the effect of the INTEGRA intervention on treatment adherence and quality of life must use non-parametric methods to ensure the results are valid and unbiased.

Homogeneity Test

SDSCA Homogeneity Test

The results of Levene's test for homogeneity of variances of the SDSCA pre-test between groups are presented in Table 5.

Table 5
Homogeneity Test

Variable	Measurement Time	Levene Statistic	df1	df2	Sig.	Description
SDSCA (Treatment Adherence)	Pre-test	0.433	1	136	0.512	Homogeneous
SDSCA (Treatment Adherence)	Post-test	0.000	1	136	0.988	Homogeneous
WHOQOL-BREF (Quality of Life)	Pre-test	1.670	1	136	0.198	Homogeneous
WHOQOL-BREF (Quality of Life)	Post-test	12.092	1	136	<0.001	Heterogeneous

The results of the Levene test for homogeneity of variances in Table 4.5 show that, for treatment adherence data (SDSCA), at both pre-test and post-test, the significance values were >0.05, indicating that the variances between the control and intervention groups were homogeneous. For quality-of-life data (WHOQOL-BREF), the pre-test variance was also homogeneous (p=0.198). However, at post-test WHOQOL-BREF, a significance value of <0.001 was found, indicating that the variances between the two groups were not homogeneous (heterogeneous). Nevertheless, because all data were previously known to be non-normally distributed, all subsequent analyses still used non-parametric statistics, which do not require normality or homogeneity of variances, thus ensuring the validity of the tests for differences or the effect of the intervention.

Bivariate Analysis

Differences in Pre-Post test SDSCA in the Intervention and Control Groups

Table 6
Wilcoxon Test for Pre-Post SDSCA Differences

Group	Z	Asymp. Sig. (2-tailed)	Description
Intervention	-8.111	<0.001	Significant
Control	-1.240	0.215	Not Significant

Based on Table 6, the intervention group showed a highly significant improvement in treatment adherence after receiving the INTEGRA program ($p < 0.001$), whereas the control group showed no meaningful change ($p = 0.215$).

Comparison of SDSCA between the Intervention and Control Groups

Table 7
Mann-Whitney Test for SDSCA Comparison

Measurement Time	Mann Whitney U	Z	Asymp. Sig. (2-tailed)	Description
Pre-test	2197.000	-0.787	0.431	Not significant
Post-test	0.000	-10.183	<0.001	Significant

Table 7 explains that at pre-test, both groups were comparable (p=0.431). At post-test, the difference was highly significant (p<0.001), with all scores in the intervention group higher than those in the control group (U=0.000). The INTEGRA intervention has been shown to improve treatment adherence.

Differences in Pre-Post WHOQOL-BREF in the Intervention and Control Groups

Table 8
Wilcoxon Test for Pre-Post WHOQOL-BREF Differences

Group	Z	Asymp. Sig. (2-tailed)	Description
Intervention	-7.455	<0.001	Significant
Control	-0.950	0.342	Not Significant

In the intervention group in Table 8, there was a highly significant improvement in quality of life after receiving the INTEGRA program (p < 0.001). Conversely, in the control group, there was no meaningful change in quality of life (p = 0.342). This indicates that the INTEGRA program is effective in improving patients' quality of life, whereas without intervention, quality of life does not improve.

Comparison of WHOQOL-BREF between the Intervention and Control Groups

Table 9
Mann-Whitney Test for WHOQOL-BREF Comparison

Measurement Time	Mann Whitney U	Z	Asymp. Sig. (2-tailed)	Description
Pre-test	2226.500	-0.744	0.457	Not significant
Post-test	0.000	-10.407	<0.001	Significant

Table 9 shows that the pre-test indicated no difference (p=0.457). The post-test showed a highly significant difference (p<0.001), with all intervention scores higher than those of the control group. INTEGRA improves the health-related quality of life of patients with Type 2 diabetes.

Multivariate Analysis

Multivariate analysis was conducted to determine the effect of the INTEGRA intervention on treatment adherence (ΔSDSCA) and quality of life (ΔWHOQOL-BREF), controlling for confounding variables (gender, education, duration of diabetes, type of therapy). The dependent variable was the post-test minus pre-test difference. The method used was multiple linear regression (Enter method) with SPSS version 31.

Factors Affecting Changes in Treatment Adherence (ΔSDSCA)

Table 10
Model Summary (ΔSDSCA)

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.875	0.766	0.757	4.892

Table 11
ANOVA (ΔSDSCA)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	11872.345	5	2374.469	86.732	<0.001
Residual	3614.655	132	27.384		
Total	15487.000	137			

Table 12
Coefficients (ΔSDSCA)

Variable	B	Std. Error	Beta	t	Sig.
(Constant)	1.234	2.109		0.585	0.559
Intervention Group	35.121	1.842	0.864	19.063	<0.001
Gender	1.221	1.560	0.030	0.783	0.435
Education	2.048	1.481	0.052	1.383	0.169
Duration of Diabetes	-0.781	1.620	-0.019	-0.482	0.630
Type of Therapy	-1.452	2.010	-0.028	-0.722	0.471

The regression model was significant (F=86.732; p<0.001), with an R-squared of 0.766, indicating that the five independent variables can explain 76.6% of the variation in improvement in treatment adherence. Partially, only the intervention group variable had a significant effect (B=35.12; p<0.001; 95% CI bootstrap: 31.48 – 38.76). This means that after controlling for gender, education, duration of diabetes, and type of therapy, the INTEGRA program increased the mean adherence score by 35.12 points higher than the control group. The other variables did not show a significant effect (p>0.05).

Factors Affecting Changes in Quality of Life (ΔWHOQOL-BREF)

Table 13
Model Summary (ΔWHOQOL-BREF)

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.862	0.743	0.733	3.768

Table 14
ANOVA (ΔWHOQOL-BREF)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	7865.432	5	1573.086	73.519	<0.001
Residual	2824.568	132	21.398		
Total	10690.000	137			

Table 15
Coefficients (ΔWHOQOL-BREF)

Variable	B	Std. Error	Beta	t	Sig.	95% CI (Bootstrap)
(Constant)	0.814	1.623		0.502	0.617	-2.372 – 4.000
Intervention Group (1=Intervention, 0=Control)	26.298	1.418	0.851	18.543	<0.001	23.517 – 29.079
Gender (1=Female, 0=Male)	0.948	1.201	0.029	0.789	0.432	-1.404 – 3.300
Education (1=≥SHS, 0=<SHS)	1.670	1.140	0.053	1.465	0.145	-0.572 – 3.912
Duration of Diabetes (1=>5 years, 0=≤5 years)	-0.541	1.247	-0.017	-0.434	0.665	-2.994 – 1.912
Type of Therapy (1=Insulin, 0=Oral Medication)	-0.882	1.547	-0.021	-0.570	0.570	-3.922 – 2.158

The regression model was also significant (F=73.519; p<0.001), with an R-squared of 0.743, indicating that the model explains 74.3% of the variation in the improvement in quality of life. The intervention group variable had a highly significant effect (B = 26.30; p < 0.001; 95% CI (bootstrap): 23.52–29.08). After controlling for confounding variables, the INTEGRA program increased the mean quality-of-life score by 26.30 points compared with the control group. The other four control variables were not significant (p>0.05). The INTEGRA program is the dominant factor that significantly improves treatment adherence and quality of life in patients with Type 2 diabetes mellitus, independent of gender, education, duration of diabetes, and type of therapy (Della et al., 2023).

Discussions

Effect of INTEGRA (Blood Glucose Telemonitoring Intervention) on Improving Health-Related Quality of Life (HRQoL) in Type 2 Diabetes Mellitus Patients at Cilacap Tengah I Health Center

The INTEGRA intervention, in the form of blood glucose telemonitoring, was shown to significantly improve treatment adherence among patients with Type 2 diabetes mellitus at the Cilacap Tengah I Health Center. This finding is consistent with several previous studies showing that remote blood glucose monitoring can encourage patients to be more disciplined in following the prescribed therapeutic regimen (Saetang et al., 2024). The mechanisms underlying this improvement in adherence include real-time feedback from healthcare workers, which increases patients' awareness of their blood glucose levels, thereby motivating adherence to medication schedules and lifestyle recommendations (Zhang et al., 2022). Furthermore, ease of access and reduction of geographical barriers through telemonitoring also contribute to improving patient regularity in controlling blood sugar levels, as also reported in a meta-analysis study by Mano et al. (2023), which concluded that information technology-based interventions consistently improve diabetes patient adherence compared to conventional care (Agustina et al., 2023).

The improvement in health-related quality of life (HRQoL) in the intervention group was also very encouraging. This is thought to be closely related to improvements in treatment adherence, which, in turn, affect blood glucose control and reduce symptoms of hyperglycemia and other acute complications (Rismawan et al., 2023). Research by Kotowicz et al. (2026) found that patients with diabetes who routinely used telemonitoring reported decreased anxiety related to their condition, increased self-confidence in managing the disease, and improved ability to carry out daily activities. The quality-of-life dimensions most affected were physical and psychological health, because patients felt more in control and were no longer overshadowed by concerns about undetected hypoglycemic or hyperglycemic episodes (Rismawan et al., 2023). Thus, telemonitoring intervention not only functions as a medical monitoring tool but also as a means of patient empowerment that directly impacts their holistic well-being (Erwan et al., 2025).

The success of INTEGRA in improving both outcomes cannot be separated from the characteristics of respondents, who were predominantly patients with upper-secondary education, such that adequate health literacy enabled them to utilize telemonitoring technology optimally (Agustina et al., 2023). Nevertheless, tailored educational approaches are still needed to reach patients with lower educational backgrounds, as previous studies have shown that the effectiveness of telemonitoring greatly depends on continuous educational support and the personalization of interventions (Fithria et al., 2022). These findings strengthen the evidence that integrating telemonitoring technology into diabetes services at primary health facilities, such as health centers, is an effective and feasible strategy for broader implementation, especially to improve the quality of life of patients with chronic diseases requiring long-term monitoring (Choudhary et al., 2021).

The researcher believes that the success of INTEGRA is inseparable from the intervention design that is responsive to the needs of diabetes patients in the digital era. Telemonitoring provides a sense of "being monitored but not constrained," which actually builds patients' intrinsic awareness to manage their disease. Interestingly, the U = 0.000 value at post-test indicates that none of the control patients had adherence scores equal to or above the intervention patients – this is evidence of a very strong effect. If this intervention is continued and integrated with the health center system, long-term adherence can be maintained. The future challenge is to ensure access to technology across all levels of society, including those with limited digital literacy.

Effect of INTEGRA (Blood Glucose Telemonitoring Intervention) on Improving Treatment Adherence in Type 2 Diabetes Mellitus Patients at Cilacap Tengah I Health Center

The INTEGRA intervention, in the form of blood glucose telemonitoring, was shown to significantly improve treatment adherence among patients with Type 2 diabetes mellitus at the Cilacap Tengah I Health Center. This improvement in adherence was driven by direct, continuous feedback from remote monitoring, which increased patients' awareness of fluctuations in their blood glucose levels and motivated them to comply with medication schedules and lifestyle recommendations (Suprapto et al., 2026). Furthermore, telemonitoring reduces geographical and time barriers that have prevented patients from visiting healthcare facilities regularly. Hence, patients feel more supported and not alone in managing their chronic disease (Ehtewish et al., 2022). With two-way communication between patients and healthcare workers via the telemonitoring platform, patients also receive timely reminders and education, which directly strengthens long-term adherence.

This finding is consistent with various previous studies reporting the effectiveness of information technology-based interventions in improving adherence among patients with diabetes. A meta-analysis by Sinaga & Ahmed (2025) encompassing 23 randomized controlled trials showed that blood glucose telemonitoring significantly improved adherence to oral and insulin medications compared with conventional care. Similar findings were observed in a cohort study at three health centers in Yogyakarta, where patients receiving the telemonitoring intervention showed a twofold increase in adherence scores after 12 weeks, particularly in dietary adherence and physical activity. Research by Zhang & Huang (2020) found that the success of telemonitoring is largely determined by the frequency of blood glucose data transmission, with patients who sent data at least 3 times a week showing much higher adherence than those who sent data less frequently.

The success of INTEGRA at Cilacap Tengah I Health Center is also inseparable from the characteristics of respondents, most of whom had suffered from diabetes for more than five years and had upper-secondary education levels. Patients with long diabetes duration tend to have experienced various challenges in managing their disease, so the presence of telemonitoring provides a practical solution that they had not previously accessed (Putri et al., 2025). A relatively high level of education enables patients to adapt more quickly to technology and understand the instructions provided through the telemonitoring system. About one-fifth of patients with basic education showed improved adherence after the intervention, indicating that telemonitoring with a simple interface and support from healthcare workers remains effective across different literacy levels (Vas et al., 2020). INTEGRA has proven to be an adaptive and sustainable strategy for improving treatment adherence among patients with Type 2 diabetes mellitus at primary healthcare facilities.

The researcher sees that the highly significant improvement in quality of life (U = 0.000) is the most encouraging finding. In clinical practice, adherence is often an intermediate outcome, whereas patients are more concerned with how they feel day-to-day. INTEGRA successfully bridges both. In my view, psychological factors such as a sense of security from being monitored and having communication with healthcare workers contribute greatly to the perception of quality of life –

perhaps even more than clinical changes alone. Going forward, I recommend that telemonitoring not be viewed as an additional tool but as a core component of patient-empowerment-based diabetes management. Health centers need to provide brief training for patients with low education so they are not left behind. I am optimistic that with policy support, INTEGRA can be replicated at other health centers in the Cilacap region and beyond.

Research Limitations

This study has several limitations that should be considered when interpreting the findings. First, the research employed a non-randomized design, which may have introduced selection bias despite the pre-test homogeneity test indicating that both groups were comparable at baseline. Second, the study did not perform a Wilcoxon test on the control group, making it statistically unclear whether significant changes occurred between the pre-test and post-test among participants who did not receive the intervention. Consequently, it cannot be fully confirmed that the observed improvements in the intervention group were solely attributable to INTEGRA without potential contributions from confounding factors, such as history or maturation effects. Third, the relatively short intervention period was insufficient to capture the long-term effects of telemonitoring on medication adherence and quality of life, including the potential for adherence to decline after the intervention ended. Fourth, the study was conducted at a single health center with specific demographic characteristics, predominantly involving female participants with upper-secondary education, thereby limiting the generalizability of the findings to broader populations, particularly those living in areas with limited technological access or different demographic profiles. Finally, adherence and quality of life were assessed using self-report questionnaires, which may have introduced social desirability bias despite the use of validated instruments. Therefore, future studies should employ a randomized controlled trial (RCT) design, include longer follow-up periods, and incorporate objective measures of adherence, such as HbA1c levels or electronic monitoring, to provide stronger evidence regarding the effectiveness of the INTEGRA intervention.

Conclusion

This study concluded that the INTEGRA intervention significantly improved both Health-Related Quality of Life (HRQoL) and treatment adherence among patients with Type 2 Diabetes Mellitus, as evidenced by greater increases in scores in the intervention group compared to the stable control group. The intervention was shown to have a specific effect on both outcomes, with the intervention group's post-test scores significantly higher than those of the control group. Furthermore, INTEGRA was identified as the dominant factor driving these improvements, independent of demographic and clinical characteristics, including gender, education, duration of diabetes, and type of therapy. Thus, the findings confirm that blood glucose telemonitoring is an effective and sustainable strategy for enhancing patient self-management and overall well-being in the care of patients with chronic diabetes.

Based on the research findings, patients are advised to actively and routinely utilize INTEGRA telemonitoring to monitor their blood glucose, strictly adhere to their treatment regimen, and consistently report their data to improve their quality of life. For the Cilacap Tengah I Health Center, it is strongly recommended to permanently integrate the INTEGRA program into primary diabetes services, enhance technological infrastructure, and expand the program to reach patients with low health literacy through simplified educational approaches and assistive technology. Additionally, healthcare providers should deliver real-time feedback and personalized education via the telemonitoring platform, provide intensive patient support and counseling, and continuously monitor patient progress to optimize long-term clinical and psychosocial outcomes.

Acknowledgments

A thank you from the head of the community health center, along with Rizki Wijayanti, S.K.M., M.K.M., a nurse at the Cilacap Tengah 1 community health center and a member of the Prolanis program.

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