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Effectiveness of physical activity and prolanis treatment on random blood sugar in type 2 DM patients: An urban-rural study

Efektivitas aktivitas fisik dan pengobatan prolanis terhadap kadar gula darah acak pada pasien DM tipe 2: Studi perbandingan perkotaan-pedesaan

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Abstract

Persistent differences in diabetes control between urban and rural communities suggest that program-based management should consider not only clinical treatment but also patients' adherence to lifestyle recommendations and continuity of care. This study aimed to examine the relationship between adherence to physical activity, medication compliance, sociodemographic characteristics, and average random blood sugar levels among type 2 diabetes mellitus patients participating in PROLANIS in urban and rural areas of Bone Regency. A quantitative cross-sectional study was conducted using purposive sampling among 111 respondents from five community health centers. Data were collected on physical activity adherence, medication adherence, employment status, duration of PROLANIS participation, and random blood sugar levels, then analysed to identify variables associated with blood sugar control in urban and rural groups. The findings showed that normal random blood sugar levels were more common in urban areas, reaching 97.2%, compared with 85.0% in rural areas. In urban areas, adherence to physical activity and medication was associated with average random blood sugar levels, whereas employment status and duration of PROLANIS participation were not significantly related. In rural areas, adherence to physical activity, medication, and duration of PROLANIS participation were associated with average random blood sugar levels, while employment status showed no significant relationship. These findings highlight the importance of strengthening physical activity adherence, medication compliance, and sustained PROLANIS engagement to improve diabetes control across urban and rural primary care settings.

Abstrak

Perbedaan yang terus-menerus dalam pengendalian diabetes antara masyarakat perkotaan dan pedesaan menunjukkan bahwa pengelolaan berbasis program seharusnya tidak hanya mempertimbangkan pengobatan klinis, tetapi juga kepatuhan pasien terhadap rekomendasi gaya hidup serta kelangsungan perawatan. Penelitian ini bertujuan untuk mengkaji hubungan antara kepatuhan terhadap aktivitas fisik, kepatuhan minum obat, karakteristik sosiodemografis, dan kadar gula darah acak rata-rata di antara pasien diabetes mellitus tipe 2 yang berpartisipasi dalam program PROLANIS di wilayah perkotaan dan pedesaan Kabupaten Bone. Penelitian potong lintang kuantitatif dilakukan dengan menggunakan teknik pengambilan sampel purposif terhadap 111 responden dari lima puskesmas. Data yang dikumpulkan meliputi kepatuhan terhadap aktivitas fisik, kepatuhan minum obat, status pekerjaan, lamanya partisipasi dalam program PROLANIS, dan kadar glukosa darah acak, kemudian dianalisis untuk mengidentifikasi variabel-variabel yang terkait dengan pengendalian glukosa darah pada kelompok perkotaan dan pedesaan. Hasil penelitian menunjukkan bahwa kadar gula darah acak yang normal lebih umum ditemukan di daerah perkotaan, yaitu mencapai 97,2%, dibandingkan dengan 85,0% di daerah pedesaan. Di daerah perkotaan, kepatuhan terhadap aktivitas fisik dan pengobatan berhubungan dengan kadar gula darah acak rata-rata, sedangkan status pekerjaan dan lamanya partisipasi dalam program PROLANIS tidak memiliki hubungan yang signifikan. Di daerah pedesaan, kepatuhan terhadap aktivitas fisik, pengobatan, dan lamanya partisipasi dalam PROLANIS berhubungan dengan kadar gula darah acak rata-rata, sementara status pekerjaan tidak menunjukkan hubungan yang signifikan. Temuan ini menyoroti pentingnya memperkuat kepatuhan terhadap aktivitas fisik, kepatuhan terhadap pengobatan, dan keterlibatan berkelanjutan dalam PROLANIS untuk meningkatkan pengendalian diabetes di fasilitas pelayanan kesehatan primer baik di daerah perkotaan maupun pedesaan.

Keywords :

blood sugar; diabetes mellitus; medical adherence; physical activity; rural

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INTRODUCTION

A Type 2 diabetes mellitus (DM) is a chronic metabolic disease with a high and increasing global prevalence, making it a major public health concern across diverse population groups (Ong et al., 2023). The disease is characterized by hyperglycemia caused by insulin resistance and/or impaired pancreatic beta-cell function, resulting in inadequate insulin secretion and poor blood glucose regulation. Clinically, type 2 DM develops progressively and may lead to serious complications, including neuropathy, nephropathy, cardiovascular disease, disability, and reduced quality of life (American Diabetes Association, 2021). Effective glycemic control is therefore essential to prevent complications and reduce the long-term burden of disease. This issue is also closely aligned with the Sustainable Development Goals, particularly SDG 3 on good health and well-being, because diabetes prevention and management contribute to reducing premature mortality from non-communicable diseases.

The burden of type 2 DM is not evenly distributed across populations. Differences between urban and rural communities may influence risk factors, lifestyle practices, access to health services, treatment adherence, and disease management outcomes (Bujawati et al., 2021). Urban populations may have better access to health facilities and structured chronic disease programs, whereas rural communities may face barriers related to distance, health literacy, socioeconomic conditions, and local cultural practices. These differences may affect adherence to physical activity, medication use, and participation in chronic disease management programs. Therefore, understanding how diabetes management operates across urban and rural settings is important for designing context-sensitive interventions that improve blood glucose control among patients with type 2 DM.

The main research problem is that blood glucose control among patients with type 2 DM remains influenced by multiple behavioural, treatment-related, and contextual factors, yet the relationship between physical activity adherence, medication adherence, sociodemographic characteristics, and random blood sugar levels in urban and rural PROLANIS participants has not been sufficiently examined. Physical activity is a core component of diabetes management because regular exercise can improve insulin sensitivity, support weight control, enhance metabolic function, and stabilize blood glucose levels (Ino Ischak et al., 2024). Medication adherence is equally important because consistent treatment helps maintain glycemic stability and prevent complications. The general solution is to strengthen integrated diabetes management through PROLANIS by combining structured physical activity, routine medication monitoring, health education, and regular blood sugar assessment, while adapting implementation strategies to the needs of urban and rural patients.

Scientific evidence emphasizes that physical activity should be incorporated into routine care for patients with type 2 DM. Appropriate and regular activities, such as diabetes exercise, brisk walking, and other structured movement programs, can improve glucose uptake, enhance insulin sensitivity, reduce insulin resistance, and support more stable random blood sugar levels (Ino Ischak et al., 2024). Physical activity also contributes to weight management, which is an important factor in type 2 DM prevention and control. However, adherence to physical activity may vary across communities because of differences in occupation, environment, health knowledge, motivation, and access to organized exercise programs. These differences are particularly relevant when comparing urban and rural areas, where opportunities and barriers to regular physical activity may not be the same.

In addition to physical activity, the Chronic Disease Management Program or PROLANIS represents an integrated strategy for improving type 2 DM management through self-management support, health education, routine monitoring, and programmed physical activity (Syahid, 2021). Participation in PROLANIS activities, including educational sessions, regular health checks, blood sugar monitoring, medication evaluation, and group exercise, has been reported to improve adherence and support better glycemic control (BPJS Kesehatan, 2021). Nevertheless, the effectiveness of PROLANIS may differ between urban and rural settings because of variations in health service availability, patient accessibility, socioeconomic conditions, and community support. Therefore, evaluating PROLANIS outcomes in both settings is necessary to identify whether the program functions equally across geographic contexts or requires local adaptation.

Previous studies have shown that type 2 DM management is strongly influenced by physical activity, medication adherence, self-management practices, and access to health services (American Diabetes Association, 2021; Ino Ischak et al., 2024; Syahid, 2021). Other evidence indicates that urban and rural differences may affect diabetes risk, health behaviour, and healthcare utilization, creating disparities in disease control and program effectiveness (Bujawati et al., 2021). However, comparative

Table 1
The characteristic of respondents

Respondent Characteristics	Frequency (n= 111)	Percentage (%)
Gender		
Famale	94	84.7
Male	17	15.3
Age		
38 – 42	4	3.6
43 – 47	3	2.7
48 – 52	12	10.8
53 - 57	14	12.6
58 – 62	16	14.4
63 – 67	23	20.7
68 – 73	19	17.1
74 – 79	20	18
Employment Status		
Not working	102	91.9
Working	9	8.1
Duration of Type 2 Diabetes		
≤ 1 year	13	11.7
2 years	23	20.7
3 years	25	22.5
4 years	25	22.5
5 years	9	8.1
6 years	11	9.9
7 years	4	3.6
8 years	1	0.9
Duration of participating in PROLANIS		
3 – 12 months	78	70.3
13 - 22 months	1	0.9
23 - 32 months	20	18
33 – 42 months	8	7.2
43 – 52 months	1	0.9
53 – 62 months	2	1.8
63 – 72 months	0	0
73 – 84 months	1	0.9

studies examining the relationship between adherence to physical activity, medication adherence, sociodemographic characteristics, and random blood sugar levels among PROLANIS participants in urban and rural areas remain limited and difficult to find (Karin, 2024). This creates an important research gap, particularly in understanding whether diabetes management strategies produce similar outcomes across different geographic and sociocultural contexts.

The novelty of this study lies in its urban-rural comparison of type 2 DM management among PROLANIS participants in Bone Regency. Rather than examining physical activity or medication adherence separately, this study considers both adherence factors alongside sociodemographic characteristics and average random blood sugar levels. This approach provides a more comprehensive understanding of how behavioural and program-related factors are associated with glycemic control in different geographic settings. Therefore, this study aimed to determine the relationship between adherence to physical activity and medication, as well as the sociodemographic characteristics of PROLANIS participants, with average random blood sugar levels among patients with type 2 diabetes mellitus in urban and rural areas of Bone Regency.

METHODS

This study used a quantitative method with a cross-sectional design to analyze the relationship between adherence to physical activity and medication and average random blood sugar levels (GDS) in patients with type 2 diabetes mellitus. The study involved five variables, consisting of one dependent variable and four independent

Table 2
Distribution of respondents based on univariate test results

Variable Type	Study Area				Total
	Urban		Rural		
	n= 71	%	n=40	%	
Average GDS					
Not normal	2	25	6	75	8
Normal	69	67	34	33	103
Physical Activity Compliance					
Low	4	29	10	71	14
Height	67	69	30	31	97
Treatment Compliance					
Low	10	63	6	37	16
Height	61	64	34	36	95
Employment Status					
Not working	65	64	37	36	102
Working	6	67	3	33	9
Duration of Perticipating in PROLANIS					
≤ 1 year	71	90	8	10	79
> 1 years	0	0	32	100	32

variables. The study lasted two months, from January 23 to March 30, 2025, at five community health centers (Puskesmas) in Bone Regency. Bajoe Community Health Center was designated as a representative urban area, while the other four community health centers—Ulaweng, Usa, Lappariaja, and Sibulue—represented rural areas.

The study population included 152 PROLANIS participants for type 2 diabetes mellitus registered at the five community health centers. Based on the inclusion criteria, 111 eligible respondents participated in the study. The sampling technique used was purposive sampling, namely the selection of respondents based on criteria that are in accordance with the research objectives, including active participation in PROLANIS (having a medical record of checking random blood sugar levels at least twice in three months), health conditions that allow, and willingness to participate in the research.

The research process began with initial data collection and obtaining ethical clearance from the Health Research Ethics Committee of the Faculty of Medicine and Health Sciences, UIN Alauddin Makassar. After obtaining ethical approval, researchers collected secondary data from the Community Health Center (Puskesmas) and primary data using research instruments administered directly to respondents. Primary data collection was conducted after respondents signed an informed consent form, indicating their understanding of the purpose, benefits, and rights of participating in the study.

This study used several instruments as data collection tools. GDS levels and physical activity compliance were obtained through routine examination result sheets and participant attendance checklists for PROLANIS exercise activities. The calculation of the average GDS refers to the average results of random or random plasma glucose examinations of respondents over three examinations or three months with the average GDS categorized as normal (<200 mg/dL or <11.1 mmol/L) and abnormal (≥200 mg/dL or ≥11.1 mmol/L). GDS level data in both types of regions showed normally distributed data with a p-value (>0.05). Meanwhile, physical activity compliance was assessed based on the number of respondents' attendance at exercise activities over three months (6-12 meetings). Because the data were not normally distributed, compliance was categorized using the median value, namely high (≥5 times) and low (<5 times). Meanwhile, medication compliance was measured using a modified MMAS-8 (Morisky Medication Adherence Scale) questionnaire and through validation tests. Respondents' sociodemographic data, including employment status and length of time participating in PROLANIS, were collected using a special checklist.

Data analysis in this study was conducted in two stages: univariate and bivariate analysis. Univariate analysis was used to describe the frequency distribution of each variable, such as adherence level and GDS levels. Meanwhile, bivariate analysis aims to identify the relationship between two variables, specifically adherence

Table 3
Results of the bivariate compliance test with average random blood sugar levels

Variable Type	Average GDS Level				Total	p-value
	Not Normal		Normal			
	n	%	n	%		
Physical Activity Compliance						
Urban						
Low	2	50	2	50	4	0.002
Height	0	0	67	100	67	
Rural						
Low	6	60	4	40	10	0.000
Height	0	0	30	100	30	
Treatment Compliance						
Urban						
Low	2	20	8	80	10	0.018
Height	0	0	61	100	61	
Rural						
Low	5	83.3	1	16.7	6	0.000
Height	1	2.9	33	97.1	34	

to physical activity and medication, and average random blood sugar levels (GDS). The statistical test used in bivariate analysis was the Chi-Square. The results of the analysis are presented in the form of frequency tables, percentages, and p-values as a basis for drawing conclusions.

RESULTS

Table 1 presents the distribution of respondents based on the demographic characteristics of PROLANIS participants. Of the 111 respondents, the majority were female, 94 (84.7%). The largest age group was 63–67 years old, with 23 (20.7%). Most respondents were unemployed, 102 (91.9%). The majority of respondents had suffered from type 2 diabetes mellitus for 3 and 4 years, respectively, with 25 (22.5%) participants. The most frequent duration of PROLANIS participation was 3–12 months, with 78 (70.3%).

Table 2 presents the results of univariate analysis related to the mean GDS, adherence, and demographic characteristics of PROLANIS participants. The average random blood sugar (GDS) level was normal in 69 respondents (97.2%) in urban areas and 34 respondents (85%) in rural areas. In contrast, abnormal GDS levels or those categorized as diabetes were found in 2 respondents (2.8%) in urban areas and 6 respondents (15%) in rural areas. The majority of physical activity compliance levels were in the high category, namely 67 respondents (94.4%) in urban areas and 30 respondents (75%) in rural areas, while low compliance was recorded in 4 respondents (5.6%) in urban areas and 10 respondents (25%) in rural areas. For medication compliance, respondents with high compliance levels were recorded as many as 61 people (85.9%) in urban areas and 34 people (85%) in rural areas, while respondents with low compliance were 10 people (14.1%) in urban areas and 6 people (15%) in rural areas. As for the employment status variable, the majority of respondents were in the unemployed category, namely 65 people (91.5%) in urban areas and 37 people (92.5%) in rural areas, while respondents with working status were only recorded as 6 people (8.5%) in urban areas and 3 people (7.5%) in rural areas. When viewed from the length of PROLANIS participation, a significant difference is observed between urban and rural areas. All 71 respondents in urban areas (100%) had a participation duration of ≤1 year, while only 8 (20%) in rural areas fell into this category. Conversely, respondents with a participation duration of >1 year were absent in urban areas (0%), but were quite prevalent in rural areas, with 32 (80%).

Table 3 shows the results of a bivariate analysis of the relationship between adherence to physical activity and PROLANIS treatment and average random blood glucose (GDS) levels. Chi-square test results in the urban area of Bone Regency indicate that physical activity adherence and medication adherence are significantly associated with average GDS levels in PROLANIS participants with type 2 diabetes, with p-values of 0.002 and 0.018, respectively ($p < 0.05$). Similarly, in rural areas, these two variables also had a significant relationship with the average GDS level, indicated by a p-value of 0.000 ($p < 0.05$).

Table 4 displays the results of a bivariate analysis of the relationship between employment status and duration of PROLANIS participation and average Random Blood Sugar (GDS) levels. A chi-square test showed that employment status was not significantly associated with the average GDS in either urban or rural areas, with p-values of 1.000 and 0.394, respectively ($p > 0.05$). Statistical analysis of the variable duration of PROLANIS participation was not performed in urban areas because all respondents were in the ≤1-year category. However, in rural areas, this variable showed a significant relationship with the average GDS level, indicated by a p-value of 0.000 ($p < 0.05$).

DISCUSSION

Effectiveness of physical activity compliance on average blood sugar levels in type 2 diabetes mellitus patients

This study demonstrates a relationship between adherence to physical activity (exercise) and average Random Blood Sugar (GDS) levels, both in urban and rural areas. PROLANIS exercise is an intervention in a chronic disease management program aimed at helping patients control blood sugar levels through regular physical activity. The results showed that patients who consistently participated in PROLANIS exercise experienced a significant reduction in blood sugar levels. The statistical analysis revealed that, despite respondents in urban areas with low levels of physical activity adherence, GDS levels in this group remained within normal limits. This is thought to be influenced by other factors that contribute to blood sugar control, such as regular independent physical activity outside of exercise sessions or differences in individual biological responses to body metabolism.

The analysis showed that all respondents in urban areas with high levels of physical activity adherence had random blood sugar (GDS) levels within the normal range. This finding aligns with research by Handayani et al (2023), which states that regular implementation of PROLANIS exercises plays a significant role in reducing blood sugar levels in diabetes mellitus sufferers in Nangsri Village, Kebakkramat. Previous research also revealed that although PROLANIS exercises have been proven effective in lowering blood sugar levels, some patients with low compliance are still able to maintain their blood sugar levels within normal limits. This is influenced by a combination of other factors, such as dietary management and good medication adherence (Handayani et al., 2023). Therefore, optimal blood sugar control is not solely determined by the frequency of PROLANIS exercise participation but also by comprehensive diabetes self-management.

In this study, respondents in urban areas demonstrated high levels of physical activity adherence, even though all respondents had only been participating in PROLANIS for ≤ 1 year. This condition is thought to be influenced by other factors that play a role in blood sugar control, such as the regularity of independent physical activity outside of exercise sessions and differences in individual biological responses to body metabolism. Respondents in rural areas also demonstrated high levels of physical activity adherence, even though most had been

Table 4
Results of bivariate tests of demographic characteristics with average random blood sugar levels

Variable	Average GDS Level				Total	p-value
	Not Normal		Normal			
	n	%	n	%		
Employment Status						
Urban						
Not working	2	3.1	63	96.9	65	1.000
Working	0	0	6	100	6	
Rural						
Not working	5	13.5	32	86.5	37	
Working	1	33.3	2	66.7	3	0.394
Duration in prolanis						
Urban						
≤ 1 year	2	2.8	69	97.2	71	N/A
> 1 years	0	0	0	0	0	
Rural						
≤ 1 year	5	62.5	3	37.5	8	0.000
> 1 years	1	3.1	31	96.9	32	

participating in PROLANIS for > 1 year. The findings in this study indicate that the length of participation in PROLANIS was not significantly associated with physical activity adherence. These results are in line with research by Adi Vernanda et al (2024), there are significant differences in physical activity levels between urban and rural communities. Type 2 DM patients living in rural areas demonstrated higher levels of physical activity compared to those living in urban areas, with a p-value of 0.001 and a mean difference of -2.261. Meanwhile, Nketia (2022) suggested that low physical activity scores in urban communities are due to the dominance of a sedentary lifestyle due to technological developments, such as prolonged sitting while working, studying, or enjoying entertainment. On the other hand, rural communities still maintain high levels of physical activity despite technological advancements, because the majority (60.8%) work as farmers and laborers, which requires a lot of physical activity.

Other research has shown that patients who regularly participate in PROLANIS exercise routines have a greater chance of achieving controlled blood sugar levels compared to patients who are less compliant. For example, at the Koja District Community Health Center, patients who adhered to exercise routines were 16.25 times more likely to achieve controlled blood sugar levels than those who were non-compliant (p = 0.000). These results indicate that consistent exercise routines not only lower blood sugar levels but also improve the quality of life of patients with type 2 diabetes mellitus through optimal disease management. Therefore, the role of healthcare professionals is crucial in providing motivation and support to keep patients actively participating in these activities (Hafizhah & Fadhillah, 2020).

A study also reported that PROLANIS exercise intervention had a significant effect on reducing random blood sugar levels in patients with type 2 diabetes mellitus. At the Cibaliung Community Health Center, Pandeglang Regency, PROLANIS exercise was proven to contribute to reducing random blood sugar levels with a p value of 0.023, where the average decrease reached 49.35 mg/dl (Herni et al., 2023). Similar results were obtained at the Lempuing Community Health Center, Bengkulu City, which showed an average decrease in random blood sugar levels of 57 mg/dl after the exercise intervention with a p value of 0.004 (Nadinda & Dewa, 2023). These findings confirm that exercise implementation plays an important role in helping reduce random blood sugar levels in patients with type 2 diabetes mellitus.

Effectiveness of treatment compliance on average blood sugar levels of type 2 diabetes mellitus patients

The results of this study indicate a relationship between medication adherence and average Random Blood Sugar (GDS) levels, both in urban and rural areas. One important factor in blood sugar control is patient consistency in taking antidiabetic medications. However, the statistical analysis table shows that some respondents in urban areas with low adherence rates still had normal RBS levels. This condition may be influenced by non-pharmacological factors that support blood sugar stability, such as a relatively short disease duration or good insulin sensitivity, allowing glucose levels to be maintained even if medication adherence is not optimal (American Diabetes Association, 2022).

One study reported that type 2 diabetes patients in urban areas had higher medication adherence rates than patients in rural areas, with a 3.7 times greater likelihood. This difference is influenced by various factors, such as access to healthcare facilities, medication availability, lifestyle, and type of employment. Patients in urban areas have relatively easy access to healthcare, while those in rural areas tend to be accustomed to healthier, traditional diets (Nketia, 2022). Similar results were found in a study at the Disease Polyclinic at Panti Rini Hospital in Yogyakarta, where a Spearman correlation test showed a p-value of 0.003 ($p < 0.05$) with a correlation coefficient of -0.406. This finding confirms a significant relationship between medication adherence and random blood glucose levels in patients with type 2 diabetes mellitus. Patients with low adherence tend to have higher random blood glucose levels, while the better the patient's adherence, the lower the random blood glucose levels (Ageng et al., 2024).

Research shows that patient adherence to treatment can be influenced by good knowledge about diabetes, with patients with adequate understanding tending to be more compliant (Rosalinda & Nugraheni, 2023). Furthermore, social support from family and healthcare professionals also plays a role in improving adherence, for example through providing motivation and reminders to take medication regularly, which is crucial for maintaining stable blood sugar levels (Wibowo et al., 2021). Medication adherence directly contributes to clinical outcomes. Higher adherence results in better clinical control, while lower adherence results in more difficult outcomes (Alfiza & Oktadiana, 2022). This finding aligns with research that found a significant correlation between adherence to antidiabetic medication and blood glucose levels in controlled type 2 DM patients. The Pearson Chi-Square test

showed a p-value of 0.004 ($p < 0.05$), indicating a statistically significant relationship (Daryanti et al., 2022).

Effectiveness of employment status on the average blood sugar level of type 2 diabetes mellitus patients

In this study, respondents' employment status was not significantly associated with average Random Blood Sugar (GDS) levels in either urban or rural areas. In urban areas, almost all respondents, both employed and unemployed, showed normal RBS levels, with abnormal RBS levels found only in the unemployed group. Meanwhile, in rural areas, some unemployed respondents had abnormal RBS levels, although the majority of respondents in both groups remained within the normal range. This uneven distribution pattern between employed and unemployed respondents was influenced by the predominance of respondents over 40 years of age, who tended to be unemployed. The inconsistent distribution between groups and the high proportion of normal RBS levels in both groups suggests that employment status was not a significant factor influencing RBS levels in this study.

The relationship between employment status and blood sugar levels in patients with type 2 diabetes mellitus was examined using a multidimensional approach. Research at the Mardi Walujo Clinic in Central Lampung (2020) showed that employment status had a weak correlation with an increased risk of diabetes mellitus through the mechanism of body fat accumulation ($r = -0.273$; $p = 0.002$). Furthermore, the type of employment also influences the level of diabetes risk, where jobs with low physical activity tend to reduce energy expenditure, thus contributing to weight gain and increasing the risk of diabetes mellitus (Arania et al., 2021).

A multinational study involving 36 states in the United States from 2014–2018 reported that the highest prevalence of type 2 diabetes mellitus was found among workers in the protective services sector (8.9%), agriculture (8.8%), and community and social services (8.4%). The high prevalence of diabetes among these workers is primarily influenced by irregular shift work patterns and stress from long working hours, which impact diet, physical activity levels, and metabolic balance (Shockey et al., 2021). Furthermore, a meta-analysis from the European Prospective Investigation into Cancer and Nutrition (EPIC) study revealed that job stress increases the risk of type 2 diabetes mellitus by 15% (HR = 1.15; 95% CI 1.06–1.25). This mechanism is related to increased levels of the hormone cortisol due to stress, which can reduce insulin sensitivity in the body (Nyberg et al., 2014).

However, research findings on the effect of employment status on type 2 diabetes mellitus are still mixed. A 2020 study at the Pisang Baru Community Health Center reported no significant association between employment status and the incidence of type 2 diabetes mellitus ($p = 0.711$). This is likely related to the heterogeneity of informal workers' characteristics, which are often not recorded in surveillance systems, thus affecting the accuracy of analyses in this group (Yulia & Cahyati, 2022).

Effectiveness of prolanis on the average blood sugar levels of type 2 diabetes mellitus patients

This study shows that the length of participation in the PROLANIS program influences the average Random Blood Sugar (GDS) levels of respondents in rural areas. However, statistical analysis of this variable could not be conducted in urban areas because all respondents in urban community health centers had participated in PROLANIS for the same duration, namely ≤ 1 year. The Chronic Disease Management Program (PROLANIS) has been shown to play a significant role in helping control blood glucose levels in patients with diabetes mellitus (Rohmah et al., 2023). A recent study in 2024 also showed that patients who participated in the program for ≥ 40 months experienced significant improvements in HbA1c ($p < 0.05$) compared to those who participated for a shorter period. This mechanism occurs through increased cell sensitivity to insulin and optimization of glucose metabolism, which are achieved through involvement in structured and sustained physical activity (Fadillah et al., 2024).

The length of participation in PROLANIS is positively associated with stable blood glucose levels. A study at the Azzahra Clinic in Palembang reported that 84% of participants who consistently followed the program for two years achieved random blood glucose levels below 126 mg/dl, according to WHO standards (Syakurah et al., 2024). A systematic analysis also showed that participants who underwent PROLANIS for less than 40 months had a 1.8-fold greater risk of developing hyperglycemia than those who followed the program long-term. These findings confirm that continued participation in PROLANIS plays a crucial role in controlling blood sugar levels (Fadillah et al., 2024).

CONCLUSION

This study concludes that random blood sugar control among patients with type 2 diabetes mellitus participating in PROLANIS was generally favorable in both

urban and rural areas. In urban areas, most patients had normal random blood sugar levels, with significant associations found for adherence to physical activity and medication. Employment status and duration of PROLANIS participation were not significantly related to blood sugar levels in this setting. In rural areas, most patients also had normal random blood sugar levels; however, associated factors included adherence to physical activity, medication adherence, and duration of PROLANIS participation, while employment status remained unrelated.

These findings indicate that physical activity and medication adherence are essential factors in maintaining glycemic control among type 2 diabetes mellitus patients, regardless of geographic setting. The additional association between PROLANIS duration and blood sugar control in rural areas suggests that sustained program participation may be particularly important where access to health information and routine monitoring may be more limited. Community health centers should further optimize PROLANIS by strengthening participant adherence to physical activity and medication, ensuring continuity of follow-up, and adapting implementation strategies to urban and rural contexts. Future studies should examine the long-term effectiveness of PROLANIS and identify barriers to adherence among patients with type 2 diabetes mellitus in different community settings.

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AUTHORS' CONTRIBUTIONS

Elva Elfira contributed to the conceptualisation of the study, study design, data analysis, and manuscript drafting. Dian Ihwana Ansyar contributed to data collection, data acquisition, fieldwork implementation, and manuscript preparation. Dian Rezki Wijaya contributed to methodological guidance, interpretation of findings. Nildawati contributed to manuscript review, and critical revision All authors read and approved the final version of the manuscript.

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COMPETING INTERESTS

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