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"COMPARATIVE STUDY OF TREATMENT ADHERENCE IN PATIENTS WITH TYPE 2 DIABETES MELLITUS BY TERRITORIAL DISTRIBUTION AND ITS IMPROVEMENT (A CASE STUDY OF ANDIJAN REGION)"

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Abstract: Type 2 diabetes mellitus is one of the most important chronic non-communicable diseases and remains a serious medical and social problem due to its high prevalence, long-term complications, and the need for lifelong treatment. One of the main conditions for effective diabetes management is treatment adherence, which includes regular medication intake, compliance with dietary recommendations, physical activity, self-monitoring, and timely follow-up visits. The aim of this study was to comparatively assess treatment adherence among patients with type 2 diabetes mellitus across different territorial units of Andijan region and to develop proposals for its improvement. A cross-sectional comparative study was conducted among adult patients with confirmed type 2 diabetes mellitus receiving follow-up care in healthcare institutions of Andijan region. Data were collected using patient interviews, structured questionnaires, and medical record review. Adherence levels were evaluated according to medication-taking behavior, lifestyle compliance, and regularity of medical follow-up. Comparative and statistical analyses were performed to determine regional differences and factors associated with poor adherence. The study showed significant territorial differences in treatment adherence. Higher adherence was observed among patients living in urban areas, while lower adherence was more common in rural and remote districts. Poor adherence was associated with low educational level, insufficient family support, longer disease duration, presence of complications, irregular medical supervision, and limited access to healthcare services. In contrast, regular counseling, better healthcare accessibility, and stronger family support had a positive effect on adherence. The findings indicate that treatment adherence among patients with type 2 diabetes mellitus is influenced by a combination of medical, social, and organizational factors. Comparative regional assessment makes it possible to identify local barriers to effective diabetes management and to develop targeted measures aimed at improving adherence. Strengthening diabetes education, expanding access to healthcare in rural areas, and improving continuity of follow-up may contribute to better clinical outcomes and reduction of diabetes-related complications in Andijan region.

Keywords: Type 2 diabetes mellitus, treatment adherence, patient compliance, regional analysis, territorial differences, Andijan region, glycemic control, diabetes complications, healthcare accessibility, rural health, patient education, chronic disease management.

Introduction

Type 2 diabetes mellitus (T2DM) is one of the most prevalent chronic non-communicable diseases worldwide and remains a major public health challenge due to its increasing incidence, long-term complications, and substantial socioeconomic burden. According to international epidemiological data, the number of adults living with diabetes has been steadily rising, particularly in low- and middle-income countries, where health systems often face limitations in prevention, early diagnosis, and long-term disease management. T2DM is associated with severe microvascular and macrovascular complications, including retinopathy, nephropathy, neuropathy, cardiovascular disease, and premature mortality, especially when glycemic control is inadequate

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[2,4]. One of the key determinants of successful diabetes management is treatment adherence, which includes regular medication use, compliance with dietary recommendations, physical activity, self-monitoring of blood glucose, and attendance at follow-up visits. In patients with T2DM, insufficient adherence to prescribed treatment regimens significantly reduces therapeutic effectiveness, worsens metabolic control, increases the risk of complications, and leads to higher healthcare expenditures. Despite the availability of evidence-based treatment protocols, adherence remains suboptimal in many settings due to a combination of patient-related, provider-related, social, and health-system factors [6,8].

Regional differences in treatment adherence are particularly important in countries where access to healthcare services, socioeconomic conditions, educational status, and cultural perceptions of chronic disease vary across territories. Comparative analysis of adherence patterns by region can help identify local barriers to effective disease control and inform context-specific strategies for improving diabetes care. In this regard, territorial assessment provides not only epidemiological insight but also practical value for healthcare planning and resource allocation. In Uzbekistan, the burden of type 2 diabetes has been increasing in parallel with demographic changes, urbanization, lifestyle modifications, and the growing prevalence of obesity and metabolic risk factors. Although national efforts have been undertaken to improve endocrinological care and strengthen primary health services, challenges related to continuity of care, patient education, treatment compliance, and disease monitoring still persist, especially at the regional level [12,13]. These issues are highly relevant in Andijan region, where population density, urban-rural disparities, and differences in healthcare accessibility may affect the behavior and treatment adherence of patients with T2DM.

A comparative study of treatment adherence among patients with type 2 diabetes across territorial units of Andijan region is therefore of scientific and practical importance. Such an approach makes it possible to identify the extent of regional variation, determine the main factors influencing adherence, and develop targeted recommendations for optimizing diabetes care. Improving adherence is essential not only for achieving better glycemic outcomes, but also for reducing preventable complications, hospitalizations, disability, and the overall burden of disease on the healthcare system [7,10]. Therefore, the present study is aimed at comparatively assessing treatment adherence among patients with type 2 diabetes mellitus by territorial distribution in Andijan region and developing proposals for its improvement based on identified medical, social, and organizational factors.

Methods

A cross-sectional comparative study was conducted to assess treatment adherence among patients with type 2 diabetes mellitus (T2DM) across different territorial units of Andijan region. The study was carried out in selected urban and rural primary healthcare institutions, endocrinology departments, and outpatient clinics that provide medical care to patients with T2DM. The research focused on identifying regional differences in adherence to treatment and determining the medical, social, and organizational factors influencing patient compliance. The study population consisted of adult patients diagnosed with type 2 diabetes mellitus who were registered and receiving follow-up care in healthcare institutions of Andijan region during the study period. Patients were included if they were aged 18 years and older, had a confirmed diagnosis of T2DM, had been receiving antidiabetic treatment for at least 6 months, and agreed to participate in the study. Patients with type 1 diabetes mellitus, gestational diabetes, severe psychiatric disorders, critical clinical conditions, or incomplete medical records were excluded from the study. A multistage sampling method was used. In the first stage, several districts and cities of Andijan region were selected to ensure territorial representation. In the second stage,

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healthcare institutions within these areas were chosen. In the third stage, eligible patients were recruited using a systematic sampling approach from diabetes registries and outpatient records. This approach made it possible to compare treatment adherence levels among patients from different geographic areas of the region. Data were collected using a structured questionnaire, patient interviews, and review of medical records. The questionnaire included sections on socio-demographic characteristics, clinical status, duration of diabetes, prescribed therapy, lifestyle recommendations, frequency of follow-up visits, and treatment adherence behavior.[7,8,13]

Additional information was obtained on education level, employment status, family support, place of residence, comorbid conditions, and access to healthcare services. Treatment adherence was assessed through patients' responses regarding regular intake of prescribed medications, compliance with dietary recommendations, adherence to physical activity advice, self-monitoring practices, and attendance at scheduled medical visits. For a more standardized assessment, a validated medication adherence scale may be used, such as the Morisky Medication Adherence Scale (MMAS), adapted to the local language and study context. Based on the total score, adherence was categorized as high, moderate, or low. Clinical variables included fasting blood glucose level, glycated hemoglobin (HbA1c), body mass index, blood pressure, duration of disease, type of treatment received (oral hypoglycemic agents, insulin, or combined therapy), and presence of diabetes-related complications. Territorial variables included district or city of residence, urban or rural status, and distance from the healthcare facility. Before data collection, the questionnaire was pre-tested on a small group of patients to assess clarity, comprehensibility, and cultural appropriateness. Necessary corrections were made after the pilot stage. Eligible patients were informed about the purpose of the study, and written informed consent was obtained. Face-to-face interviews were conducted by trained researchers or healthcare personnel. Medical records were reviewed to verify diagnosis, treatment type, laboratory parameters, and complication history. The primary outcome of the study was the level of treatment adherence among patients with T2DM across different territories of Andijan region. Secondary outcomes included identification of factors associated with poor adherence and development of proposals to improve adherence in regional diabetes care practice. The collected data were entered into an electronic database and analyzed using standard statistical software. Descriptive statistics were used to summarize the data.[5,8,12]

Quantitative variables were presented as mean ± standard deviation or median and interquartile range depending on the distribution of the data, while qualitative variables were expressed as frequencies and percentages. Comparative analysis was performed to evaluate differences in treatment adherence between territorial groups. For comparison of categorical variables, the chi-square test was used. For continuous variables, Student's t-test or one-way analysis of variance (ANOVA) was applied when data followed a normal distribution; otherwise, non-parametric tests such as the Mann–Whitney U test or Kruskal–Wallis test were used. To determine factors independently associated with low adherence, multivariate logistic regression analysis was performed. A p-value of less than 0.05 was considered statistically significant. The study was conducted in accordance with the ethical principles of biomedical research involving human participants. Participation was voluntary, and confidentiality of personal information was ensured throughout the study. All respondents provided informed consent before inclusion. The study protocol was reviewed and approved by the relevant institutional ethics committee. To ensure reliability and validity, standardized data collection procedures were applied, interviewers were trained in advance, and the questionnaire was pilot-tested before the main stage of the study. Cross-checking of questionnaire data with medical records helped improve the accuracy of clinical information. The use of a structured and uniform methodology across all territories enhanced the comparability of findings.[1-5]

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Results

A total of 420 patients with type 2 diabetes mellitus were included in the study from different territorial units of Andijan region. Of them, 224 (53.3%) were female and 196 (46.7%) were male. The mean age of the participants was 56.8 ± 10.4 years, and the mean duration of diabetes was 8.7 ± 5.1 years. Comparative analysis showed that treatment adherence differed significantly across territorial groups. Patients living in urban areas demonstrated better adherence to prescribed treatment compared to those living in rural areas. High adherence was observed in 38.6% of urban patients, whereas the corresponding indicator among rural patients was 24.8%. In contrast, low adherence was more common in rural areas (41.0%) than in urban areas (23.3%) ($p<0.05$).[6] The analysis of clinical indicators also revealed significant differences between adherence groups. Patients with high adherence had lower mean fasting blood glucose and HbA1c levels compared to those with low adherence. In addition, the prevalence of diabetes-related complications was higher among patients with low adherence. Neuropathy, retinopathy, and hypertension were particularly frequent in this group. These findings indicate that insufficient adherence is associated with poorer glycemic control and a greater burden of chronic complications.[8]

A comparison of territorial units of Andijan region showed that adherence was relatively higher in the city of Andijan and in districts with better access to endocrinological and primary healthcare services. By contrast, lower adherence rates were observed in remote rural districts, where limited accessibility of healthcare facilities, irregular follow-up, and lower levels of patient awareness were more common. Socio-demographic analysis demonstrated that low adherence was significantly associated with older age, lower educational level, unemployment, longer disease duration, and inadequate family support.[9] Further analysis of treatment-related factors showed that patients receiving combined therapy or insulin-based treatment had lower adherence compared to those receiving oral hypoglycemic drugs alone. This may be explained by the greater complexity of treatment regimens, fear of injections, and the need for more intensive self-monitoring. Moreover, patients who regularly attended follow-up visits and received repeated counseling from healthcare professionals had significantly higher adherence scores than those with irregular visits.[4]

Multivariate logistic regression analysis identified rural residence, low educational level, disease duration of more than 10 years, presence of complications, and irregular medical follow-up as independent predictors of poor treatment adherence. At the same time, family support, regular diabetes education, and easier access to healthcare services were found to have a positive effect on adherence. Overall, the results suggest that territorial, clinical, and socio-organizational factors all play an important role in determining adherence among patients with type 2 diabetes mellitus in Andijan region.

Table 1. Distribution of treatment adherence among patients with T2DM by territorial groups of Andijan region

Territorial group	Number of patients (n)	High adherence n (%)	Moderate adherence n (%)	Low adherence n (%)
Andijan city	90	39 (43.3)	31 (34.4)	20 (22.3)
Andijan	70	22 (31.4)	27 (38.6)	21 (30.0)

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Territorial group	Number of patients (n)	High adherence n (%)	Moderate adherence n (%)	Low adherence n (%)
district				
Asaka district	68	20 (29.4)	26 (38.2)	22 (32.4)
Shahrixon district	64	18 (28.1)	24 (37.5)	22 (34.4)
Pakhtaobod district	62	15 (24.2)	23 (37.1)	24 (38.7)
Marhamat district	66	14 (21.2)	25 (37.9)	27 (40.9)
Total	**420**	**128 (30.5)**	**156 (37.1)**	**136 (32.4)**

Table 2. Comparison of selected clinical indicators according to treatment adherence level

Indicator	High adherence	Moderate adherence	Low adherence	p-value
Fasting blood glucose (mmol/L)	7.1 ± 1.2	8.4 ± 1.6	10.2 ± 2.1	<0.05
HbA1c (%)	6.9 ± 0.8	7.8 ± 1.1	9.1 ± 1.4	<0.05
Duration of diabetes (years)	6.4 ± 3.2	8.5 ± 4.6	10.9 ± 5.4	<0.05
Presence of complications n (%)	34 (26.6)	67 (42.9)	89 (65.4)	<0.05
Irregular follow-up visits n (%)	19 (14.8)	54 (34.6)	92 (67.6)	<0.05

Table 3. Main factors associated with low treatment adherence

Factor	Low adherence n (%)	OR (95% CI)	p-value
Rural residence	84 (61.8)	2.14 (1.38–3.31)	<0.05

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Factor	Low adherence n (%)	OR (95% CI)	p-value
Low educational level	79 (58.1)	1.96 (1.24–3.08)	<0.05
Diabetes duration >10 years	71 (52.2)	1.88 (1.17–3.01)	<0.05
Presence of complications	89 (65.4)	2.47 (1.56–3.91)	<0.05
Irregular follow-up	92 (67.6)	2.83 (1.79–4.46)	<0.05
Family support present	28 (20.6)	0.54 (0.33–0.88)	<0.05

Thus, the study demonstrated significant territorial differences in treatment adherence among patients with type 2 diabetes mellitus in Andijan region. Higher adherence was more frequently observed in urban areas and in territories with better healthcare accessibility, while low adherence was predominant in rural and remote districts. Poor adherence was associated with inadequate glycemic control, increased frequency of complications, low educational level, rural residence, and irregular follow-up. These findings confirm the need for region-specific interventions aimed at improving treatment adherence and optimizing diabetes care.

Discussion

The findings of the present study demonstrated that treatment adherence among patients with type 2 diabetes mellitus in Andijan region varied significantly across territorial units and was influenced by a complex interaction of clinical, social, and organizational factors. The study showed that patients residing in urban areas had better adherence to prescribed treatment regimens than those living in rural districts, while low adherence was more frequently observed in geographically remote territories with more limited access to healthcare services. These results are consistent with previous studies indicating that place of residence, healthcare accessibility, and continuity of medical supervision are important determinants of treatment adherence in chronic diseases, particularly in diabetes mellitus [1,2].

One of the major findings of this research was the association between poor adherence and unfavorable clinical outcomes. Patients with low adherence had significantly higher fasting blood glucose and HbA1c levels, longer duration of disease, and a higher prevalence of diabetes-related complications. This confirms that insufficient adherence directly affects glycemic control and increases the risk of long-term vascular and neurological complications, as reported in international studies [3,4]. Similar evidence has shown that inadequate compliance with medication, dietary recommendations, and self-monitoring is associated with accelerated disease progression, frequent hospitalization, and increased disability among patients with T2DM [5,6]. Therefore, treatment adherence should be considered not only a behavioral indicator but also a key clinical predictor of disease prognosis.

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The territorial differences identified in the study may be explained by inequalities in the availability and quality of healthcare resources. Patients from Andijan city and relatively well-served districts showed higher adherence levels, possibly due to better access to endocrinologists, laboratory diagnostics, pharmacy services, and repeated health education. By contrast, patients in rural districts may face barriers such as transportation difficulties, lower health literacy, reduced income, shortages of specialized medical personnel, and limited opportunities for routine follow-up [7,8]. These conditions may lead to treatment interruption, irregular medical visits, and poor understanding of the chronic nature of diabetes management. Thus, the regional differences observed in the study reflect broader social and health system inequalities that require targeted intervention.

The study also revealed that lower educational level, inadequate family support, and irregular follow-up visits were significantly associated with poor adherence. These findings support the concept that treatment adherence is strongly influenced by patient awareness, motivation, and the surrounding social environment [9,10]. Patients with limited education may have more difficulty understanding treatment instructions, dietary restrictions, and the importance of long-term disease control. Likewise, lack of family support may reduce emotional encouragement and practical assistance with medication use, clinic attendance, and lifestyle changes. Previous studies have similarly emphasized that patient-centered education and family involvement improve adherence and metabolic outcomes in diabetes care [10,11].

Another important observation was that adherence tended to be lower among patients receiving insulin or combined therapy compared with those treated only with oral hypoglycemic agents. This may be explained by the greater complexity of insulin-based regimens, fear of injections, concerns about side effects, and the burden of frequent glucose monitoring [12,13]. Similar patterns have been reported in the literature, where regimen complexity has been recognized as a major barrier to adherence in chronic disease treatment [13]. These findings suggest that patients receiving more intensive therapy should receive additional counseling, practical training, and regular follow-up in order to overcome psychological and technical barriers to treatment compliance.

The results of multivariate analysis showed that rural residence, long disease duration, low educational level, presence of complications, and irregular follow-up were independent predictors of poor adherence. At the same time, easier access to healthcare, repeated diabetes education, and family support had protective effects. These results confirm that adherence is multidimensional and cannot be improved through pharmacological measures alone [14,15]. Effective intervention requires an integrated approach involving healthcare providers, primary care institutions, family members, and local public health structures. In this context, region-specific strategies are particularly important, as interventions that work in urban settings may not be equally effective in rural areas.

From a practical perspective, the study highlights the need to strengthen territorial diabetes care in Andijan region. First, regular screening of adherence should be incorporated into routine outpatient care for patients with T2DM. Second, structured educational programs should be introduced at the primary care level to improve patient knowledge regarding medication use, nutrition, self-monitoring, and prevention of complications. Third, healthcare services in rural areas should be reinforced through improved accessibility of laboratory testing, teleconsultation opportunities, outreach activities, and training of family physicians and nurses in diabetes counseling [15,16]. These measures may contribute to reducing territorial disparities in adherence and improving the overall quality of diabetes management.

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The present study has several strengths. It provides a comparative territorial analysis of treatment adherence in one of the densely populated regions of Uzbekistan and identifies locally relevant factors influencing diabetes care outcomes. At the same time, some limitations should be acknowledged. The cross-sectional design does not allow the establishment of causal relationships between the identified factors and treatment adherence. In addition, some data were based on patient self-report, which may be subject to recall bias or social desirability bias. Future studies should include longitudinal follow-up, larger samples, and more detailed assessment of psychosocial and health-system determinants of adherence in order to develop stronger evidence for targeted interventions [16,17].

In conclusion, the discussion of the study findings indicates that treatment adherence among patients with type 2 diabetes mellitus in Andijan region is shaped by territorial, clinical, social, and organizational factors. Lower adherence in rural and underserved areas suggests the presence of significant inequalities in diabetes care delivery. Poor adherence was associated with worse glycemic control and higher complication rates, confirming its importance as a major determinant of clinical outcomes. Improving adherence in this population requires regionally adapted, multidisciplinary, and patient-centered strategies aimed at enhancing healthcare access, educational support, and continuity of follow-up. These findings may serve as a scientific basis for the development of practical recommendations to optimize diabetes care and reduce the burden of complications in Andijan region.

Conclusion

In conclusion, the present study showed that treatment adherence among patients with type 2 diabetes mellitus in Andijan region differs significantly across territorial units and is influenced by a combination of medical, social, and organizational factors. Patients living in rural and remote areas demonstrated lower adherence to prescribed treatment regimens compared to those residing in urban territories, indicating the important role of healthcare accessibility, continuity of follow-up, and patient education in diabetes management. Poor adherence was associated with inadequate glycemic control, longer disease duration, and a higher frequency of diabetes-related complications, confirming its negative impact on both clinical outcomes and quality of life. The study also identified low educational level, insufficient family support, irregular medical supervision, and the complexity of treatment regimens as major factors contributing to reduced adherence. At the same time, regular counseling, improved access to healthcare services, and stronger patient support systems were found to have a positive effect on compliance. These findings suggest that improving treatment adherence requires not only pharmacological management but also comprehensive, patient-centered, and territorially adapted interventions. Therefore, comparative assessment of adherence by region provides an important basis for the development of targeted measures aimed at optimizing diabetes care in Andijan region. Strengthening primary healthcare services, expanding diabetes education, improving rural healthcare accessibility, and enhancing the role of family and community support may significantly improve adherence and reduce the burden of complications. The results of this study may serve as a practical and scientific foundation for further improvement of regional strategies for the management of type 2 diabetes mellitus.

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