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Original Research Article

Clinical Features of Diabetes Mellitus Type 2 in association with Treatment Modalities: an observational study

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Abstract: ***Objective***: Diabetes mellitus is a chronic metabolic disorder requiring effective management strategies to achieve optimal glycemic control and prevent complications. Treatment options include oral hypoglycemic drugs, insulin therapy, dietary modifications, and their combinations, each with varying efficacy. Consequently, this study assessed how various therapy modalities differed in terms of clinical symptoms. ***Methodology:*** This cross-sectional study at a secondary care hospital was conducted on 375 people with type 2 diabetes (T2DM) via non-probability convenient sampling from the duration of Jan 2025 till July 2025. Each participant was split up into five groups based on treatment modalities, and clinical evaluations assessed glycemic control, diabetic symptoms, and cardiovascular metrics. Statistical analysis was conducted using IBM SPSS version 20.0, one-way ANOVA and chi-square test to identify group differences and relationships, with $p < 0.05$ being considered statistically significant. ***Results:*** The findings of this investigation demonstrate that Group C (54.04±14.25 years) and Group D (50.48±14.36 years) had lower mean ages, while Group D (64.69±15.28 kg) and Group E (65.09±14.71 kg) had lower weights ($p<0.001$). Dyslipidemia (88.0%), fatigue (100.0%), and mood changes (92.0%) were highest in Group D. Frequent urination (60.0%) and smoking (49.3%) were most common in Groups A and B, respectively. Blurry vision (50.7%) and tingling (86.7%) were prevalent in Groups D and E. Gender, socioeconomic status, and RBS levels also varied significantly across groups ($p<0.05$). ***Conclusion:*** This study concluded that groups receiving oral hypoglycemic drugs and insulin with diet (Group D and E) exhibited higher prevalence of fatigue, mood changes, and severe edema, while renal and ocular symptoms were more common in other groups. Dyslipidemia and smoking were also significantly associated with specific treatment groups.

Keywords: Oral hypoglycemic drugs, Insulin, diet, Diabetes mellitus type 2.

INTRODUCTION

Diabetes mellitus type 2 (T2DM) includes a collection of long-lasting and diverse conditions characterized via metabolic dysregulation of carbohydrates, fats, and proteins [1]. As a multisystem disorder, T2DM adversely impacts various body tissues, leading to a wide range of complications [2]. These include an increased risk of atherosclerosis [3], kidney failure [4], and vision loss [5], all of which significantly elevate the disease's mortality rate. At the moment, type 2 diabetes is the ninth most common cause of mortality worldwide [6]. The most recent data from both the International Diabetes Federation and the World

Health Organization, T2DM is a major global health issue, contributing to significant ecnomic burdens and affecting an estimated 350–400 million individuals worldwide [7, 8].

Healthy eating has been found to be an important component in preventing the onset of T2D [9]. However, the best nutritional strategies are not well supported by the available data for managing hyperglycemia in T2DM patients [10]. Dietary strategies include low-carb, low-glycemic index/load, high-protein, vegetarian, and Mediterranean diets can successfully lower HbA1c levels, according to meta-analyses [11].

Poor glycemic control in patients with diabetes mellitus type 2 (T2DM) is a serious risk factor for developing complications associated with diabetes [12]. Because of this, clinical practice recommendations for type 2 diabetes always emphasize how important it is to keep blood glucose levels within the advised range in order to decrease the disease's progression and avoid complications. For example, the American Diabetes Association (ADA) establishes a HbA1c threshold of 7% as the top limit for establishing adequate glycemic control in their guidelines [13]. Research from various regions has identified a range of factors contributing to inadequate glycemic control. These include delayed insulin initiation, poor adherence to prescribed treatments, inadequate nutrition and activity, early age, high blood pressure, disregard for diabetes self-management, lack of formal schooling, and jobs such as farming are important independent factors linked to poor glycemic control [14].

Diabetes is an important health issue in Pakistan due to its high incidence and also limited access to healthcare resources in many areas. Effective management strategies are crucial to reduce the disease burden and prevent complications. However, there is limited local data comparing the effectiveness of oral hypoglycemic medications, insulin, dietary modifications, along with combination therapies. Therefore, this study compared the clinical features of diabetes mellitus type 2 based on glycemic control across different treatment modalities.

METHODOLOGY

This cross-sectional study was performed in a secondary care hospital using a non-probability convenient sampling method. The ethical approval was obtained by the Ethical Review Board of the concerned hospital. The duration of the study was about six months from Jan 2025 till July 2025. This study included 375 patients with type 2 diabetes mellitus (T2DM) who were divided equally into five groups based on their treatment modalities: Group A: Patients receiving oral hypoglycemic drugs; Group B: Patients on insulin therapy. Group C: Patients following a diet-only regimen. Group D: Patients on a diet combined with oral hypoglycemic drugs. Group E: Patients on a diet combined with insulin therapy. The study excluded participants with Type 1 diabetes, those experiencing hypoglycemia, individuals who had undergone surgical procedures, and those who had received chemotherapy.

Patients attending outpatient clinics were enrolled in the study after providing written informed consent. Clinical evaluations were conducted to assess glycemic control and identify potential complications related to T2DM. Glycemic control was primarily determined using glycosylated hemoglobin (HbA1c) levels and postprandial glucose levels. T2DM diagnosis was based on recent HbA1c levels, reflecting long-term glycemic control. Random blood sugar levels were measured two hours after a standard meal to provide a detailed assessment of glucose metabolism. Diabetic complications were thoroughly evaluated. Cardiovascular assessments included physical exams such as blood pressure and heart rate measurements, and lipid profile analyses, were assessed. Demographic information such as age, sex, physical activity, diet, and smoking status was gathered using structured questionnaires. Body mass index (BMI) was calculated based on height and weight. A questionnaire also captured medical history and sleep issues, including insomnia, abnormal sleep behaviors, and difficulties sleeping at preferred times. Symptoms of dry eyes were identified through a history of ocular discomfort, such as grittiness, irritation, inflammation, blurred vision relieved by blinking, and increased tear production.

Data was analyzed using IBM SSPS Statistics version 20.0 (IBM, Armonk, NY). The socio-demographic information and signs and symptoms related to T2DM were presented in frequencies and percentages. Quantitative variables were documented as means with standard deviations. A chi-square test was applied to examine the association of clinical symptoms in T2DM. Additionally, one-way ANOVA was employed to analyze the relationship between the means of demographic variables. A p-value < 0.05 was considered statistically significant.

RESULTS

This study included 375 patients with T2DM who were divided equally into five groups based on their treatment modalities. The mean age was significantly lower in group C (54.04±14.25 years) and group D (50.48±14.36 years) compared to the other groups, which had mean ages around 60 years ($p<0.001$). Weight was also significantly lower in group D (64.69±15.28 kg) and group E (65.09±14.71 kg), compared to group A (72.22±13.06 kg) and group C

(72.96±13.61 kg, p<0.001). Although there were no significant differences in height across the groups (p=0.073), heart rate varied significantly, with the highest rate observed in the group E (92.10±9.16 beats/min) and the lowest in the group D (78.10±11.03 beats/min, p<0.001). Random blood sugar (RBS) levels were also significantly different, with the E group showing the lowest mean RBS (268.86±94.21 mg/dL), while the highest was recorded in group D (344.90±121.34 mg/dL, p<0.001), as presented in Table I.

The association of gender, comorbidities, and socioeconomic status with T2DM varied significantly across the treatment groups. Gender distribution showed, with all patients in Groups A and B being male, while Group D consisted entirely of females. Females were predominant in both C and E groups (p<0.001). Socioeconomic status showed significant variation, with the middle socioeconomic class being the most prevalent across all groups, particularly in Group E 56(74.7%). The low socioeconomic status was least common in Group E 6(8.0%) but relatively more frequent in Group D 17(22.7%). High socioeconomic status was most common in Group A 27(36.0%) and least in Group E 13(17.3%), (p=0.031). The prevalence of hypertension was consistent across groups, with no significant difference observed (p=0.340). However, dyslipidemia varied significantly, being most prevalent in Group D 66(88.0%) and least in Group E 39(52.0%), (p<0.001). Smoking history also demonstrated significant variation, with the highest prevalence in Group A 37(49.3%) and Group B 36(48.0%), while it was least common in Group D 3(4.0%), (p<0.001), as presented in Table II.

The association of renal, ocular, and respiratory symptoms in T2DM patients revealed significant differences across treatment groups. Frequent urination was most common in Group A and least in Group E (p<0.001), while night urination was highest in Group E (p=0.004). Blurry vision was significantly more prevalent in Groups C and D (p=0.006). Edema patterns differed, with bilateral edema common in Group D and unilateral edema in Group E (p=0.009). Mild bilateral edema predominated in Groups A and B, whereas moderate edema was highest in Group D (p<0.001). Shortness of breath was more frequent in Groups A and B compared to D (p=0.019). Dyspnea severity varied, with climbing-stairs difficulty most common in Group E, and walking-related dyspnea least severe in Group D (p=0.035). Breathing difficulty was significantly more severe in Group E (p<0.001), while chest tightness was most frequent in Group D and least in Group E (p=0.013), as presented in Table III.

The association of psychological and gastrointestinal symptoms in T2DM patients showed significant variation across groups. Tingling or numbness in the extremities was most prevalent in Group E 65(86.7%) and least in Group C 36(48.0%), (p<0.001). Burning pain in the legs or feet was highest in Group D, 58(77.3%), (p=0.015), while sensitivity to touch was most frequent in Group D as well, 35(46.7%), ((p=0.013). Muscular pain or cramps were universally present in Group D 75(100.0%) and less common in other groups (p=0.003). Increased thirst was significantly higher in Group D 57(76.0%), (p<0.001). Fatigue was most prevalent in Group D 75(100.0%), followed by Group C 68(90.7%), (p<0.001). Mood changes were also predominantly observed in Group D 69(92.0%) compared to other groups (p=0.001). Loss of appetite and insomnia showed no statistically significant differences across groups, as presented in Table IV.

Table I: Demographic details of the patients with type 2 Diabetes Mellitus with different treatment modalities (n=375).

Variable	Group A Mean±SD	Group B Mean±SD	Group C Mean±SD	Group D Mean±SD	Group E Mean±SD	p-value
Age (Years)	60.50±15.51	60.38±16.35	54.04±14.25	50.48±14.36	60.88±13.80	<0.001
Weight (kg)	72.22±13.06	72.96±13.61	68.40±15.01	64.69±15.28	65.09±14.71	<0.001
Height (Inch)	68.51±11.33	67.48±10.57	65.13±9.06	64.80±6.51	66.99±8.25	0.073
Heart rate beats min	88.13±10.31	87.81±10.35	83.17±11.19	78.10±11.03	92.10±9.16	<0.001
RBS	334.45±94.78	335.38±98.48	320.18±102.10	344.90±121.34	268.86±94.21	<0.001

Table II: The association of gender, comorbidities, and socioeconomic status in T2DM patients with different treatment modalities.

Variables		Group A n(%)	Group B n(%)	Group C n(%)	Group D n(%)	Group E n(%)	P-value
Gender	Male	75(100.0%)	75(100.0%)	36(48.0%)	0(0.0%)	33(44.0)	<0.001
	Female	0(0.0%)	0(0.0%)	39(52.0%)	75(100.0%)	42(56.0%)	
Socioeconomic Status	Low	12(16.0%)	12(16.0%)	14(18.7%)	17(22.7%)	6(8.0%)	0.031
	Middle	36(48.0%)	41(54.7%)	45(60.0%)	41(54.7%)	56(74.7%)	
	High	27(36.0%)	22(29.3%)	16(21.3%)	17(22.7%)	13(17.3%)	
History of Hypertension	Yes	53(70.7%)	51(68.0%)	51(68.0%)	53(70.7%)	61(81.3%)	0.340
	No	22(29.3%)	24(32.0%)	24(32.0%)	22(29.3%)	14(18.7%)	
History of Dyslipidemia	Yes	57(76.0%)	55(73.3%)	60(80.0%)	66(88.0%)	39(52.0%)	<0.001
	No	18(24.0%)	20(26.7%)	15(20.0%)	9(12.0%)	36(48.0%)	
History of Smoking	Yes	37(49.3%)	36(48.0%)	18(24.0%)	3(4.0%)	16(21.3%)	<0.001
	No	38(50.7%)	39(52.0%)	57(76.0%)	72(96.0%)	59(78.7%)	

Table III: The association of renal, ocular, and respiratory symptoms among T2DM patients with different treatment modalities.

Variables		Group A n(%)	Group B n(%)	Group C n(%)	Group D n(%)	Group E n(%)	P-value
Frequent urination	Yes	45(60.0%)	44(58.7%)	32(42.7%)	22(29.3%)	6(8.0%)	<0.001
	No	30(40.0%)	31(41.3%)	43(57.3%)	53(70.7%)	69(92.0%)	
Urination at night	Three times at night	34(45.3%)	37(49.3%)	41(54.7%)	50(66.7%)	58(77.3%)	0.004
	Two times at night	37(49.3%)	34(45.3%)	30(40.0%)	22(29.3%)	17(22.7%)	
	Every night	4(5.3%)	4(5.3%)	4(5.3%)	3(4.0%)	0(0.0%)	
Blurry vision	Yes	20(26.7%)	21(28.0%)	32(42.7%)	38(50.7%)	34(45.3%)	0.006
	No	55(73.3%)	54(72.0%)	43(57.3%)	37(49.3%)	41(54.7%)	
Poor night vision	Yes	26(34.7%)	28(37.3%)	26(34.7%)	28(37.3%)	26(34.7%)	0.991
	No	49(65.3%)	47(62.7%)	49(65.3%)	47(62.7%)	49(65.3%)	
Edema if yes then	Bilateral	37(49.3%)	35(46.7%)	31(41.3%)	48(64.0%)	27(36.0%)	0.009
	Unilateral	38(50.7%)	40(53.3%)	44(58.7%)	27(36.0%)	48(64.0%)	
If bilateral then	1+ Mild (Both ankles/feet)	45(60.0%)	43(57.3%)	23(30.7%)	3(4.0%)	23(30.7%)	<0.001
	2+ Moderate (Both feet, hands, lower arms and lower legs)	24(32.0%)	26(34.7%)	43(57.3%)	63(84.0%)	44(58.7%)	
	3+ Severe (Generalized bilateral pitting edema, including both legs, arms feet and face)"	6(8.0%)	6(8.0%)	9(12.0%)	9(12.0%)	8(10.7%)	
Confusion or trouble in concentrating	Yes	32(42.7%)	34(45.3%)	33(44.0%)	26(34.7%)	33(44.0%)	0.689
	No	43(57.3%)	41(54.7%)	42(56.0%)	49(65.3%)	42(56.0%)	

Shortness of breath	**Yes**	53(70.7%)	51(68.0%)	52(69.3%)	36(48.0%)	51(68.0%)	0.019
	No	22(29.3%)	24(32.0%)	23(30.7%)	39(52.0%)	24(32.0%)	
Dyspnea grading	**While climbing stairs**	41(54.7%)	39(52.0%)	40(53.3%)	35(46.7%)	44(58.7%)	0.035
	While walking for more than 6 hours in a day	20(26.7%)	22(29.3%)	26(34.7%)	37(49.3%)	24(32.0%)	
	While walking for less than 6 hours in a day"	8(10.7%)	8(10.7%)	6(8.0%)	3(4.0%)	1(1.3%)	
	While at rest	6(8.0%)	6(8.0%)	3(4.0%)	0(0.0%)	6(8.0%)	
Difficulty in breathing If Yes	**Mild**	22(29.3%)	22(29.3%)	36(48.0%)	53(70.7%)	21(28.0%)	<0.001
	Moderate	41(54.7%)	39(52.0%)	30(40.0%)	17(22.7%)	39(52.0%)	
	Severe	12(16.0%)	14(18.7%)	9(12.0%)	5(6.7%)	15(20.0%)	
Chest tightness or pressure	**Yes**	53(70.7%)	51(68.0%)	55(73.3%)	66(88.0%)	48(64.0%)	0.013
	No	22(29.3%)	24(32.0%)	20(26.7%)	9(12.0%)	27(36.0%)	

Table IV: The association of psychological and gastrointestinal symptoms in T2DM patients with different treatment modalities.

Variables		Group A n(%)	Group B n(%)	Group C n(%)	Group D n(%)	Group E n(%)	P-value
Tingling or numbness in the hands or feet	**Yes**	47(62.7%)	45(60.0%)	36(48.0%)	38(50.7%)	65(86.7%)	<0.001
	No	28(37.3%)	30(40.0%)	39(52.0%)	37(49.3%)	10(13.3%)	
Burning pain in your legs or feet	**Yes**	40(53.3%)	41(54.7%)	49(65.3%)	58(77.3%)	44(58.7%)	0.015
	No	35(46.7%)	34(45.3%)	26(34.7%)	17(22.7%)	31(41.3%)	
Too sensitive feet on touch	**Yes**	20(26.7%)	23(30.7%)	22(29.3%)	35(46.7%)	16(21.3%)	0.013
	No	55(73.3%)	52(69.3%)	53(70.7%)	40(53.3%)	59(78.7%)	
Muscular pain or cramps in your legs or feet	**Yes**	63(84.0%)	62(82.7%)	69(92.0%)	75(100.0%)	68(90.7%)	0.003
	No	12(16.0%)	13(17.3%)	6(8.0%)	0(0.0%)	7(9.3%)	
Loss of appetite	**Yes**	49(65.3%)	45(60.0%)	49(65.3%)	39(52.0%)	50(66.7%)	0.319
	No	26(34.7%)	30(40.0%)	26(34.7%)	36(48.0%)	25(33.3%)	
Insomnia	**Yes**	36(48.0%)	40(53.3%)	36(48.0%)	30(40.0%)	41(54.7%)	0.404
	No	39(52.0%)	35(46.7%)	39(52.0%)	45(60.0%)	34(45.3%)	
Increased thirst	**Yes**	28(37.3%)	29(38.7%)	38(50.7%)	57(76.0%)	37(49.3%)	<0.001
	No	47(62.7%)	46(61.3%)	37(49.3%)	18(24.0%)	38(50.7%)	
Fatigue	**Yes**	63(84.0%)	63(84.0%)	68(90.7%)	75(100.0%)	57(76.0%)	<0.001
	No	12(16.0%)	12(16.0%)	7(9.3%)	0(0.0%)	18(24.0%)	
Feel tired and weak	**Yes**	53(70.7%)	52(69.3%)	59(78.7%)	70(93.3%)	54(72.0%)	0.002
	No	22(29.3%)	23(30.7%)	16(21.3%)	5(6.7%)	21(28.0%)	
Mood changes	**Yes**	52(69.3%)	54(72.0%)	64(85.3%)	69(92.0%)	53(70.7%)	0.001
	No	23(30.7%)	21(28.0%)	11(14.7%)	6(8.0%)	22(29.3%)	

DISCUSSION

Adhering to prescribed medication is linked to improved glycemic control, reduced hospitalization and mortality rates, and decreased healthcare costs. However, adherence rates remain suboptimal, with approximately 68% of patients following oral medication regimens and only 59% adhering to insulin therapy [15]. Therefore, this study demonstrated the clinical features associated with T2DM patients with different treatment modalities.

This case-control study evaluated glycemic control in patients with T2DM treated with either insulin therapy (IT) or oral hypoglycemic agents (OHA) and

examined the associations between treatment modalities. No significant differences were observed between the IT and OHA groups in terms of gender, age, diabetes duration, BMI, fasting plasma glucose (FPG), systolic blood pressure (SBP), serum lipid levels, or smoking history ($p > 0.05$). Among patients with a diabetes duration of ≥5 years, HbA1c levels did not differ significantly between the two groups. Additionally, in those with a shorter diabetes duration (<5 years), insulin therapy did not significantly improve glycemic control ($p = 0.071$, OR = 0.577). However, in patients with a shorter diabetes duration (<5 years), oral hypoglycemic therapy demonstrated better glycemic control compared to insulin therapy [16]. These findings were inconsistent with the present study and indicated that significant difference was observed among patients receiving insulin, oral hypoglycemic drugs, diet, and combined therapy to reduce glucose levels with respect to age, weight, gender, RB, history of dyslipidemia and smoking ($p<0.05$).

Fatigue is recognized as the most common and burdensome symptom experienced by individuals with type 2 diabetes [17]. It is particularly severe in those with lower well-being. Individuals with low mood scores report fatigue levels approximately 33 points higher on a 0–100 scale compared to those with normal well-being, while those likely experiencing depression score about 46 points higher relative to those with normal well-being [18]. As far as the present study is concerned, Fatigue was most prevalent in diabetic patients who controlled their glucose level by diet 75(100.0%), followed by diet combined with hypoglycemic drugs 68(90.7%), ($p<0.001$).

The effects of treatment on weight varied significantly. SGLT2 inhibitors consistently resulted in weight loss, with average reductions of 2–3 kg over 6–12 months [19], attributed to caloric loss through glucosuria and increased lipid oxidation. DPP-4 inhibitors generally had a neutral effect on weight [20]. In contrast, insulin therapy was frequently associated with weight gain, a concern for many patients managing T2DM. [21]. The present study showed consistency with the above-reported studies and revealed that weight was significantly lower in group D (diet with oral hypoglycemic drugs) (64.69±15.28 kg) and group E (drug with insulin) (65.09±14.71 kg), compared to group A (72.22±13.06 kg) and group C (72.96±13.61 kg, $p<0.001$).

The risk of hypoglycemia differed across treatments, carrying significant implications for patient safety and quality of life. SGLT2 inhibitors and DPP-4 inhibitors were associated with a low risk of hypoglycemia, whether used alone or in combination with metformin [22]. Similarly, metformin itself posed a minimal risk of hypoglycemia [23]. The present study was in accordance with the above-reported study and showed that Random blood sugar (RBS) levels were also significantly different, with the group E (diet with insulin) showing the lowest mean RBS (268.86±94.21 mg/dL), while the highest was recorded in the group D (diet with oral hypoglycemic drugs) (344.90±121.34 mg/dL, $p<0.001$).

Diabetes is a common cause of nocturia, with a meta-analysis of 197,809 participants showing that diabetes roughly doubled the incidence of nocturia. The condition was more prevalent in both males ($p<0.00001$) and females ($p<0.0001$), with a stronger association in males compared to females [24]. In the present study, night urination frequency varied significantly, with Group E having the highest proportion of patients urinating three times at night 58(77.3%), ($p=0.004$).

This study is limited by its cross-sectional design, which precludes causal inferences. The reliance on self-reported data for some symptoms may introduce recall bias. Additionally, the study population was restricted to a single center, limiting the generalizability of findings. Future studies should employ a longitudinal design to better assess causal relationships between treatment modalities and symptom profiles. Multicenter studies with larger, more diverse populations are recommended to enhance generalizability.

CONCLUSION

This study concluded that significant variations in clinical symptoms, comorbidities, and socioeconomic factors among T2DM patients across different treatment modalities were observed. Groups receiving oral hypoglycemic drugs and insulin with diet (Groups D and E) exhibited higher prevalence of fatigue, mood changes, and severe edema, while renal and ocular symptoms were more common in non-insulin groups. Dyslipidemia and smoking were also significantly associated with specific treatment groups.

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