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THE EPIDEMIOLOGICAL STUDY ON THE HEALTH STATUS OF PATIENTS AFFECTING WITH DIABETES AND OBESITY

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Abstract

Introduction: *Diabetes and obesity are global health concerns that significantly burden both individuals and healthcare systems. The disease arises due to either inadequate insulin assembly or body's incapability to consume insulin efficiently, causes elevated blood sugar levels and vascular problems.* ***Objectives:*** *This study aims to evaluate how socioeconomic status influences the incidence of Type 1& 2 diabetes mellitus and obesity among patients attending healthcare facilities.* ***Methods:*** *About 2,000 participants participated from five locations across Arifwala, Pakistan, including government hospitals, non-government hospitals, and private clinics. The sampling strategy was designed to ensure diverse representation across various healthcare settings.* ***Results:*** *From hospitals and clinics, 906 individuals had normal weight, 621 overweight, and 473 classified as obese. The diabetes and obesity prevalence trends across different demographics, geographic areas, and socioeconomic groups, utilizing epidemiological data from national surveys, research publications, and health organization reports. It highlights several diseases associated with diabetes and obesity, like cardiovascular disease, neuropathy, and mental health disorders. This suggests the urgent need for preventive measures and effective treatment strategies. This provides comprehensive overview of multifaceted nature of diabetes and obesity, aiming to inform policymakers, healthcare providers, and general public about growing scale of issues and need for coordinated interventions.* ***Conclusion:*** *In summary, among patients with Type 2 diabetes, BMI, overweight, and obese show variations. The study population included individuals from both rural and urban (areas, emphasizing the critical need for targeted strategies in diabetes and weight management across diverse communities.*

INTRODUCTION

Diabetes Mellitus is long-lasting metabolic disorder categorized by consistently increased blood glucose level, which can results in damage and dysfunction across different organs, i.e., kidney, retina, heart, nerves, and blood vessels (1, 2). It is among the oldest recorded diseases in human history, with references dating back nearly 3,000 years in ancient Egyptian writings (3). Over time, especially by the mid-twentieth century, multiple types of diabetes mellitus were identified. Today, millions of people

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around the world are affected by diabetes and its related complications (4). The disease arises due to either inadequate insulin assembly or body's failure to use insulin successfully, leading to raised blood sugar level and vascular problems (5). Type 1 diabetes mellitus (T1DM), typically begins in childhood and requires insulin treatment. It is a less common form in which immune system attack insulin-producing cell in pancreas, results in insulin shortage (6). It is caused by many genetic and environment related factors i.e., viral infection or toxins (7, 8). Type 2 (T2DM), usually adult-onset and may not require immediate insulin therapy; and gestational diabetes, which generally resolves after childbirth (9). It is typically diagnosed after the age of 45, its incidence is increasing among younger populations due to unhealthy diets, physical inactivity, and obesity (10). Globally, new cases of T2DM rose from 8.4 million [7.8–9.1m] in 1990 to 21.7m [20.0–23.5m] in 2019. Death due to T2DM also, increasing from 606,407 [573,069 to 637,508] in 1990 to 1.5 million [1.4 to1.6 m] in 2019. The World Health Organization WHO has referred to growing prevalence of diabetes and obesity as a "21st Century epidemic" (11). More than 50% of the global population is now classified as obese, which significantly raises the risk of developing T2DM and other health issues (12). Obesity and diabetes are closely linked, with 60–90% of T2DM patients either currently obese or having a history of obesity (13). In fact, 88.6% of T2DM cases are attributed to obesity (14).

Socioeconomic status SES plays a vital role in glycemic control (15). It is defined by an individual's economic and social position, also plays a role (16-18). SES-related variables such as gender, age, marital status, education, income, occupation, region, place of residence, debt, and liabilities are important indicators (19, 20). These factors help to identify disparities in diabetes prevalence related to socioeconomic status. Low SES and limited education levels have been associated with higher rates of diabetes (21), although the exact relationship remains debated (22). Economic conditions have a significant impact on health outcomes, with individuals living in poverty facing a higher risk of complications related to diabetes. The study investigates diabetes, prediabetes, and undiagnosed cases in Pakistan, emphasizing the challenges brought on by socioeconomic factors (23). Unlike wealthier countries, Pakistan faces substantial obstacles in effective diabetes management (24). According to the WHO, developing countries have experienced a 170% rise in diabetes cases, with 228 million people roughly 75% of the global total affected (25). Risk factors for diabetes are diverse and include behavioral factors such as smoking, physical inactivity, consumption of saturated fats, and sugar-sweetened beverages (26).

The link in vascular diseases and socioeconomic status is well-established (27-30). Several risk factors related with onset of diabetes i.e., obesity, inactivity, smoking, and low birth weight are also tied to SES. In Western societies, these risk factors are commonly observed in populations with lower socioeconomic status (31). Therefore, an inverse relationship is generally expected in the occurrence of T2DM and SES. However, few studies have directly investigated this correlation. The Whitehall study reported a significant inverse relation IN glucose intolerance and employment grade. An ecological study across 9 English towns also found inverse relation in prevalence of T2DM and the towns' relative affluence (32). Conversely, a study conducted in Bangladesh revealed a higher prevalence of T2DM in more affluent populations, even after adjusting for major diabetes risk factors (33). Research examining the relationship between T1DM and SES has generally found little to no association. The study aimed to assess the influence of socioeconomic status on incidence of both Type 1 and Type 2 diabetes mellitus, as well as obesity, by focusing on populations visiting healthcare facilities in the Arfwala district of Pakistan.

Materials and methods

The study was targeted to assess the socioeconomic status and the effect of biochemical tests i.e., blood sugar level among diabetes mellitus patients.

Site and patients selection

The diabetic outpatient departments of both hospitals were considered in the study. The private diabetic clinics were strategically placed to cover various geographical areas of Arifwala, encompassing Goraya Nagar, Cattle Mandi, Ghalla Mandi, Chak

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63 EB, and Green Town to ensure comprehensive coverage across the city.

About 2000 patients were targeted to collect data under this study. The study duration spanned 2 years after starting.

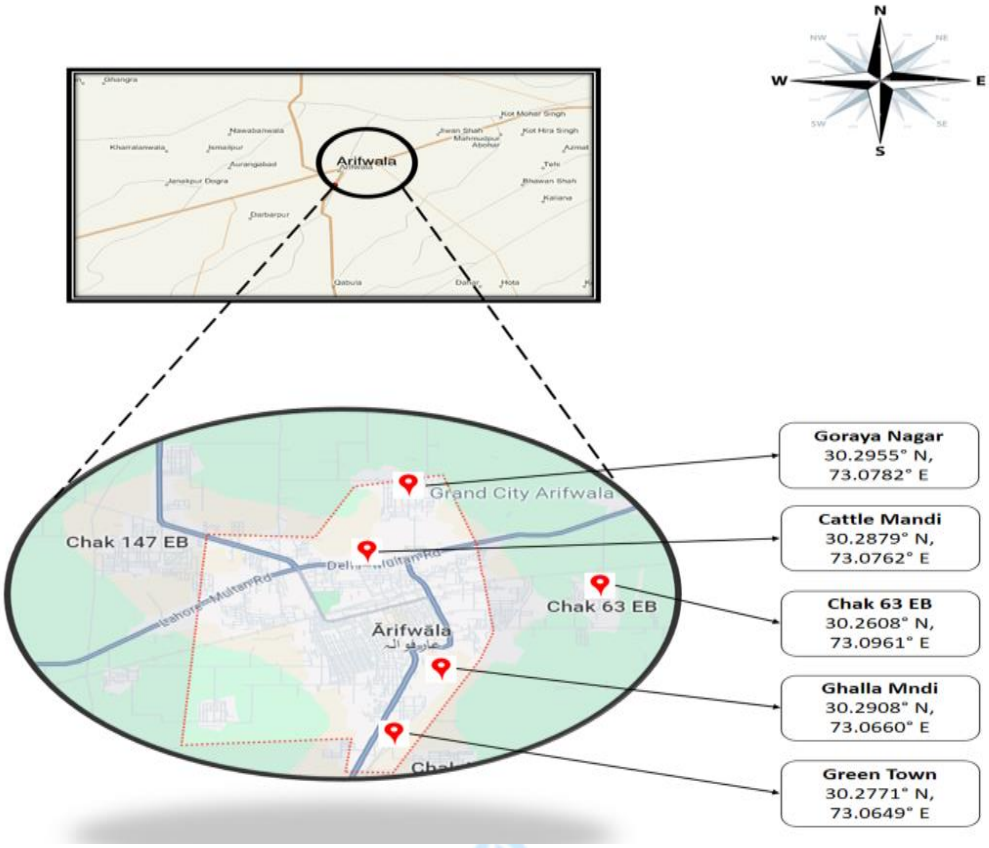

Figure 1: Map showing location of selected study area from the District Arifwala, Pakistan

Ethical review certificate

The ethical review certificate with reference no: UO/DOZ/IE/2023/26 was obtained from the university before starting the study dated 16-06-2023.

Consent of participation and publication

The informed consent was obtained from both patients and healthcare providers to collect the data and publish accordingly. The data was collected by following the declarations of Helsinki. .

Collection of Data

The questionnaire was designed to collect the data from secondary care hospital and a tertiary care hospital, as well as at non-government hospitals and various private diabetic clinics across diverse territories within Arifwala, located in Punjab, Pakistan. About 800 patient's data was collected from Government hospitals, 600 from non-government hospital and 600 from Private clinics.

Inclusion and exclusion criteria of study

The study included participants of both genders diagnosed with Type II Diabetes, aged 30 years and above, who visited the study site and were willing to provide their consent. The decision to set the minimum age at 30 was based on International Diabetes guidelines, which indicate that a significant proportion of Type II diabetic patients fall within this age range. While the study did not include individuals with Type I Diabetes, those without diabetes, individuals aged over 80 years, unconscious patients reliant on others for medication administration, individuals with Gestational Diabetes, pediatric patients, pregnant women, and mentally compromised individuals.

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Biochemical analysis

Fasting Blood Sugar (FBS)

The glucose level was measured by drawing blood after a fasting night. Diabetic symptoms may be present if FBS levels are more than 126 mg/dL on two independent times (34, 35).

HbA1c test

The HbA1c test provides insight into chronic glycaemia rather than capturing a single moment in time. It offers a comprehensive measure of glycemic control over the entire 120-day lifespan of red blood cells. Notably, recent glycemic levels exert the greatest influence on HbA1c, with 50% of the value reflecting the past month and an additional 25% from the month preceding that. This rationale supports its suitability for diagnosing conditions marked by sustained hyperglycemia and a gradual progression to complications. Moreover, the HbA1c test is convenient, eliminating the need for fasting and requiring only a single blood sample. This convenience is significant as it may enhance testing accessibility and contribute to the improved detection of diabetes, a crucial aspect given the considerable number of undiagnosed diabetes cases (35).

Body Mass Index and Obesity

Body Mass Index (BMI) is a widely used screening tool that assesses weight relative to height using the formula: BMI = weight (kg) / height (m^2). It classifies individuals into weight categories: underweight (BMI < 18.5), normal weight (18.5–24.9), overweight (25–29.9), and obesity, which is further divided into Class I (30–34.9), Class II (35–39.9), and Class III (≥40, also called morbid obesity). While useful, BMI does not directly measure body fat or its distribution and may misclassify highly muscular people as obese in spite of low body fat levels (36).

Biochemical tests to assess cholesterol

Blood tests are commonly used to assess metabolic health in individuals with obesity, focusing on markers like cholesterol, triglycerides, and glucose, which help evaluate the threat of cardiovascular diseases and diabetes. Cholesterol is measured in milligram per deciliter (mg/dL) and includes different types i.e., LDL (low-density of lipoprotein), HDL (high-density of lipoprotein), and total cholesterol. LDL (bad cholesteol), is best kept below 100 mg/dL, with level above 160 mg/dL measured high. HDL (good cholesterol) should be 40 mg/dL for males and 50 mg/dL for females, with 60 mg/dL or more offering the most protection. Total cholesterol is considered effective if under 200 mg/dL, borderline high between 200–239 mg/dL, and high at 240 mg/dL or above. Triglycerides, another key lipid, are borderline high between 150–199 mg/dL, high between 200–499 mg/dL, and extremely high at 500 mg/dL or more. These measurements provide valuable insights into the metabolic risks associated with obesity (37).

Statistical analysis

Statistical analysis was done by Chi-square tests in MS Excel 2010. The $P>0.05$ was considered non-significant (38).

Results

The study of 2000 participants reveals a mean age of 43 years with an age range from 18-81 years. The gender distribution showed that 60% were males, while 40% were females. The participants were categorized into age groups, with approximately one-third falling into the 41 to 50 years and 51 to 60 years categories, and 17.52% belonging to the 31 to 40 years age group.

Hospital wise Patient Distribution

The distribution of patients was conducted by selecting individuals from government hospitals and clinics. To assess the Knowledge, Attitudes, and Practices (KAP) of diabetic patients, an equivalent number of participants were chosen, comprising 800 patients from government hospitals, 600 from non-government hospitals, and 600 from private clinics. The figure 2 shows the percentage of patient's data collection sites.

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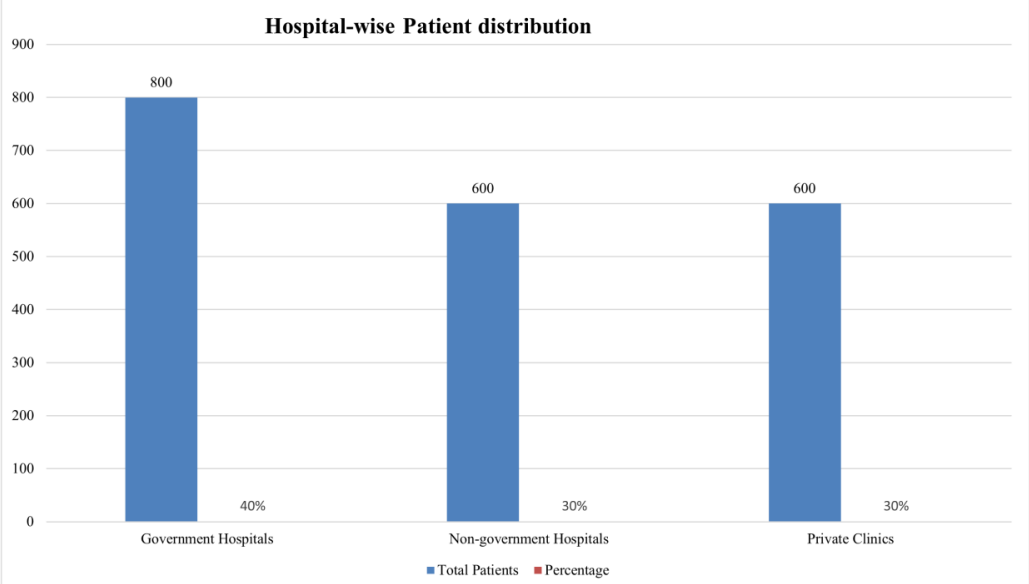

Figure 2: Distribution of patients in Hospitals

Patient's residence and area wise distribution

Patients were categorized according to their residential areas in both groups. In hospitals, 360 patients belong to rural areas, and 640 patients belong to urban areas. Meanwhile, in clinics, 394 patients resided in rural areas, while 606 patients belonged to urban locales. The distribution of patients was organized according to their respective locations at different clinics. Goraya Nagar accounted for 459 patients, Cattle Mandi had 367 patients, Ghalla Mandi saw 442 patients, Chak 63 EB accommodated 338 patients, and Green Town had 394 patients. The patients residence and area wise distribution is described in table 1.

Table 1: Residence and area-wise distribution of patients

Sr. No	Location	Government Hospital	Non- Government Hospital	Clinics
1	Rural	369	239	242
2	Urban	431	361	358
		800	600	600
Sr. No	**Area**			
1	Goraya Nagar	213	112	134
2	Cattle Mandi	124	125	118
3	Ghalla Mndi	196	134	112
4	Chak 63 EB	129	111	98
5	Green Town	138	118	138
	Total	800	600	600

Fasting Plasma Glucose (FPG) and Hemoglobin A1c Test

The diagnosis of diabetes involves various tests that measure blood glucose levels.

After an overnight fast (often 8 hours), the FPG test checks the levels of glucose in the blood. A fasting glucose level below 100 mg/dL is considered normal. Diabetic symptoms include two distinct fasting glucose readings of 126 mg/dL or above. The Hemoglobin A1c analysis takes a blood glucose reading from the patient over the course of two to three months. Diabetes is diagnosed when the A1c result is 6.5% or above. (table 2) No fasting is necessary for this test.

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Table 2: Indicated the results of fasting plasma glucose and hemoglobin A1c test

Test	Specimen	Reference range	Age	Gender	Result
Blood Glucose	Na Fluoride containing Blood	Reference range For Fasting	55	Male	192
		60-100mg/dl	56	Male	177
		Reference range For	53	Female	138
		Random	38	Female	141
		80-160mg/dl	35	Male	176
			37	Female	135
			22	Male	146
			30	Female	129
			53	Male	118
			60	Female	172
			56	Female	163
			36	Male	175
HbA1C	EDTA-Whole Blood	4.2-6.2	55	Male	9.3
			56	Male	7.8
			53	Female	6.3
			38	Female	7.7
			35	Male	8.3
			37	Female	9.2
			22	Male	8.2
			30	Female	8.5
			53	Male	7.9
			60	Female	7.7
			56	Female	6.9
			36	Male	8.9

Body Mass Index and obesity

In the table 3 patients were distributed on the basis of their BMI. In hospitals and in clinics 906 patients were having normal weight, 621 patients over weight and 473 patients were obese.

Table 3: Body Mass Index (BMI) used to check the Obesity in Patients

Sr. No	BMI (Kg/m^2)	Government Hospital	Non- Government Hospital	Clinics
1	Normal Weight (18.5-24.9)	368	274	264
2	Overweight (25.0-29.9)	284	179	158
3	Obese (30.9-39.9)	148	147	178
4	Total	800	600	600
Summary				
Groups	**Count**	**Sum**	**Average**	**Variance**
368	3	1232	410.6667	118309.3
274	3	926	308.6667	63912.33
264	3	936	312	62308

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ANOVA				
Source of Variation	SS	df	MS	F
Between Groups	20150.22	2	10075.11	0.123606
Within Groups	489059.3	6	81509.89	
Total	509209.6	8		

Cholesterol analysis among patients

The table 4 explains the cholesterol test results from blood samples across individuals of varying ages and genders, compared against a reference range of 50–200 mg/dL. All recorded cholesterol values exceed the upper limit, indicating hypercholesterolemia. Specifically, male participants, aged 22 to 56, show cholesterol levels ranging from 269 to 430 mg/dL, while female participants, aged 30 to 60, display even higher levels, between 274 and 456 mg/dL. Notably, several individuals (both male and female) have cholesterol readings well above 400 mg/dL, indicating a very high cardiovascular risk. The data reveals consistently elevated cholesterol levels across all age and gender groups, highlights the need for urgent clinical evaluation and intervention to manage lipid levels and reduce associated health risks.

Table 4: Cholesterol Level in Patients

Test	Specimen	Reference range	Age	Gender	Result
Cholesterol level	Blood	50-200	55	Male	295
			56	Male	430
			53	Female	389
			38	Female	421
			35	Male	386
			37	Female	274
			22	Male	269
			30	Female	421
			53	Male	389
			60	Female	395
			56	Female	456
			36	Male	298

Discussion

A cross-sectional interventional study was conducted among individuals diagnosed with type II diabetes mellitus in Arifwala, Punjab. The investigation encompassed patients from government hospitals, non-government hospitals, and various private diabetic clinics. The primary objective was to evaluate the Knowledge, Attitude, and Practice (KAP) of diabetic patients, with a specific focus on comparing these aspects between patients at government hospitals and those attending different private diabetic clinics in Arifwala. Factors influencing the KAP of type II diabetic patients include education, socioeconomic status, locality, and beliefs regarding the disease and its management. Addressing these factors is crucial for improving the KAP scores among individuals coping with type II diabetes mellitus. Furthermore, several other factors play role in management of T2DM, including the regulation of obesity, consistent engagement in physical activity, and adherence to a balanced diet. These measures contribute to the enhancement of glycemic levels and serve as preventive measures against both microvascular and macrovascular complications related with type 2 diabetes.

The present research was conducted on 2000 individuals diagnosed with T2DM. These participants were stratified into three distinct groups: 800 were selected from government hospitals, 600 from non-government hospitals, and the remaining 600 from various private clinics. In a parallel

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investigation, (39) undertook a study involving 100 DM-II patients to evaluate their Knowledge, Attitude, and Practice (KAP). Similarly, (40) conducted a study with 64 DM-II patients to assess the KAP scores. (41) also conducted a comparative study on KAP between diabetic and non-diabetic patients, involving participants. Furthermore, (42) assessed 238 DM-II patients to observe and measure their conditions, emphasizing the significance of the ongoing research.

Bay and Bay, in another study conducted in Iran, reported combined intervention comprising acupressure at spleen, liver, and lung points, transcendental meditation (TM), and hypnotherapy had a positive effect on reducing blood glucose level of T2DM patients (43). They concluded that this integrative approach was more effective than placebo in lowering blood sugar. However, due to the use of convenience sampling, the presence of a nonequivalent control group, and the use of a combined intervention, the observed effects cannot be attributed to acupressure alone.

To isolate the impact of acupressure, a study from Indonesia demonstrated that acupressure at ST-36 points alone significantly reduced blood glucose levels in diabetic patients (44). Other studies employing similar mechanisms have also supported the potential of acupressure in managing diabetes-related complications. For instance, acupressure applied to auricular points was shown to decrease the concentration of oxidative stress markers in high-risk diabetic individuals (45). Collectively, these studies demonstrated the short-term efficacy of acupressure in controlling blood glucose levels in both diabetic and non-diabetic populations, using varied study designs. Regarding its long-term benefits, a longitudinal study spanning three years revealed that sustained acupressure intervention significantly lowered levels of (LDL-C), triglycerides (TG), and total cholesterol (TC), while increasing (HDL-C). This study also highlighted the intervention's potential to prevent hyperlipidemia and neuropathy and improve renal function in patients with T2DM (46). Moreover, another study reported that bilateral acupressure at points LI-4, HT-7, ST-36, ST-44, and SP-6 led to a reduction in insulin levels among obese female participants (47).

Geographical distribution was also examined as a relevant factor. Among the study population, 850 participants (42.5%) resided in rural areas, while 1,150 individuals (57.5%) were from urban areas. This finding aligns with a study by (41) which found that 53% of patients with type 2 diabetes lived in rural areas, whereas 47% were from urban settings. In contrast, a study by (42) reported that a majority of diabetic patients (80.27%) were from urban areas, with only 19.32% living in rural regions.

Our multivariate analysis revealed that females exhibited a higher prevalence of diabetes mellitus (DM) than males in both years under study. This finding is consistent with several previous studies reporting a greater prevalence of DM among women compared to men (48, 49). Earlier research has shown that impaired glucose tolerance is generally more prevalent in women than in men (50, 51). One explanation may be physiological differences; women typically have lower muscle mass than men, limiting their capacity to absorb the standard 75 g glucose load used in oral glucose tolerance tests (51). Additionally, elevated levels of estrogen and progesterone in women are known to reduce whole-body insulin sensitivity (52). Physical inactivity, a known risk factor for DM, also differs by gender. A global study by WHO found that physical inactivity was more common among women (27%) than men (20% (53). A similar trend was observed in Thailand, where 16.4% of women and 12.8% of men were reported to be physically inactive. Moreover, statin use among postmenopausal women has been associated with an increased risk of developing DM (54).

Our analysis also indicated that individuals aged 65–74 had significantly higher odds of having DM. Nearly half of all deaths attributable to high blood glucose occur before the age of 70 (55). In countries with middle-income, the ratio of such deaths is highest after age 50 for both sexes, whereas in high-income countries, the highest mortality by high blood glucose is observed in 60–79 age group (55). Aging itself is a key factor for metabolic disorders, i.e., obesity, impaired glucose tolerance, and T2DM (56, 57). Numerous studies have documented that frequency of T2DM increases with age, with older adults being nearly twice as likely as middle-aged adults to develop the disease. The highest prevalence

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is observed in the 60–74-year age group (58, 59). Age-related endocrine decline is believed to contribute significantly to disturbances in metabolic homeostasis (60, 61) and impaired glucose tolerance is widely recognized as a common consequence of aging in both humans and animal models. Furthermore, our findings demonstrated a significant association between educational attainment and DM. Individuals with lower levels of education showed the highest prevalence of DM, recorded at 8.38% in 2010 and 8.44% in 2012. These results align with prior studies that have identified an inverse relationship between educational level and DM prevalence (62). Evidence from both developing and developed countries has shown that lower educational and SES is associated with a higher risk of DM, likely due to differences in health literacy and health-conscious behaviors among more educated individuals (63).

This study is consistent with early research highlights the association in (SES) and the occurrence of (T2DM). Comparable results have been reported in studies from Italy and France, where poverty indices were used to show that individuals with lower SES were more likely to develop diabetic complications such as retinopathy and nephropathy (64). Similarly, research conducted in the United Kingdom and Germany reported a higher incidence of retinopathy among residents of socioeconomically disadvantaged areas (65). However, not all studies support this association. A UK-based study involving general practice patients found no significant link between local poverty levels and the prevalence of either retinopathy or nephropathy. Another UK study also failed to identify a correlation between poverty indices and retinopathy (66). In Japan, only a limited number of studies have examined the association between SES and T2DM. One such study, focusing on public servants, reported a higher prevalence of T2DM among individuals with lower educational attainment and lower job rankings. Another study among white-collar workers found a higher incidence of T2DM, particularly among those employed in sales positions (67)

In the present study, fasting blood glucose (FBG) levels were significantly higher among females than males within the diabetic cohort. This gender difference may be attributed to hormonal changes associated with menopause, which are known to impact glucose and insulin metabolism. Additionally, nutritional factors, including higher average body mass index (BMI) among females, may contribute to elevated glucose levels (68). DM is long lasting disease categorized by chronic hyperglycemia due to impaired insulin secretion, insulin action, or both. A rare form, permanent neonatal diabetes, results from glucokinase deficiency and exemplifies a genetic defect in the glucose-insulin regulatory pathway. Globally, the prevalence of diabetes among adults was estimated at 285 million (6.4%) in 2010 and is projected to rise to 439 million (7.7%) by 2030 (69). In this study, the mean random blood glucose level was alarmingly high, recorded at 468.1 ± 39.894 mg/dL, suggesting poorly managed diabetes or severe hyperglycemia. Additionally, the average sodium level was elevated at 151.8 ± 7.76 mmol/L, indicating potential hypernatremia, which may be due to dehydration or an underlying endocrine disorder (1).

Furthermore, a significant inverse association was observed between SES and the prevalence of T2DM, particularly among individuals aged 40–69 years (70). In terms of body composition, 45.3% of patients in the current study had a normal BMI, 31.05% were overweight, and 23.65% were classified as obese. These results are in agreement with prior findings by (41) which reported that 5% of patients were underweight, 39% had normal BMI, 36% were overweight, and 20% were obese. Similarly, a study by (71) found that 30% of diabetic patients had a normal BMI, 53% were overweight, and 17% were obese.

Conclusion

In conclusion, this descriptive study on patients with type 2 diabetes mellitus, provides valuable insights into current patterns of diabetes and obesity in the region. Participants were engaged from a range of healthcare settings, including government hospitals (800), non-government hospitals (600), and private clinics (600), with 42.5% residing in rural areas and 57.5% in urban locations. Body mass index (BMI) analysis revealed that 45.3% of patients had a normal weight, 31.05% were overweight, and 23.65% were classified as obese. These findings show the growing burden of diabetes and associated weight

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issues and highlight the urgent need for targeted, context-specific interventions aimed at improving diabetes management and promoting healthier lifestyles in this population. This study also establishes a foundation for future research in similar socio-demographic settings.

Author's contribution

All authors contributed equally in the manuscript.

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Conflict of interest

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