RESEARCH PAPER

Unravelling Obesity and Diabetes Connection: Insights into Diabetic Complications

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Abstract

Background: Obesity and type 2 diabetes mellitus are closely linked metabolic disorders that share common mechanisms, including insulin resistance, adipose tissue inflammation, lipotoxicity, endothelial dysfunction and chronic low-grade systemic inflammation. The coexistence of obesity and diabetes may accelerate the development of microvascular and macrovascular complications.

Objective: To determine the frequency of obesity among patients with type 2 diabetes mellitus and assess its association with diabetic complications.

Methods: This cross-sectional analytical study included 158 adult patients with type 2 diabetes mellitus attending a Tertiary care hospital of Pakistan. Demographic profile, body mass index, waist circumference, duration of diabetes, glycaemic control, hypertension, dyslipidaemia and diabetic complications were recorded. Patients were categorized as non-obese and obese using body mass index criteria. Diabetic complications assessed included peripheral neuropathy, diabetic nephropathy, diabetic retinopathy, macrovascular disease and diabetic foot disease. Data were analyzed using descriptive statistics, chi-square test and logistic regression. A p-value <0.05 was considered statistically significant.

Results: Among 158 patients, 103 (65.2%) were obese and 55 (34.8%) were non-obese. Mean age was 52.7 +/- 10.0 years and mean duration of diabetes was 8.5 +/- 5.8 years. At least one diabetic complication was observed in 91 (57.6%) patients. The frequency of any diabetic complication was significantly higher in obese patients compared with non-obese patients, 69 (67.0%) versus 22 (40.0%), respectively (OR 3.04, 95% CI 1.55-6.00; p=0.001). Peripheral neuropathy was the most frequent complication, followed by nephropathy, retinopathy and macrovascular disease. On multivariable analysis, obesity, duration of diabetes >=10 years, HbA1c >=8.0% and hypertension were independent predictors of diabetic complications.

Conclusion: Obesity was highly prevalent among patients with type 2 diabetes mellitus and was significantly associated with a greater burden of diabetic complications, particularly neuropathy, nephropathy and macrovascular disease. Integrated management of obesity, glycaemic control, blood pressure and lipid abnormalities should be prioritized to reduce complication risk.

Keywords: Obesity; type 2 diabetes mellitus; diabetic complications; neuropathy; nephropathy; retinopathy; body mass index; insulin resistance.

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Introduction

Obesity has emerged as one of the most important public health challenges worldwide. The World Health Organization defines overweight as body mass index (BMI) >=25 kg/m2 and obesity as BMI >=30 kg/m2 in adults [1]. The global rise in obesity has occurred alongside a parallel increase in type 2 diabetes mellitus, making these two disorders central contributors to the burden of non-communicable diseases [1,2].

Type 2 diabetes mellitus is a chronic metabolic disorder characterized by insulin resistance, progressive pancreatic beta-cell dysfunction and persistent hyperglycaemia [3]. Obesity, especially central or visceral obesity, promotes insulin resistance through increased free fatty acid flux, adipokine imbalance, mitochondrial dysfunction, oxidative stress and activation of inflammatory pathways [4-6]. These changes impair insulin signalling in skeletal muscle, liver and adipose tissue, increasing the risk of diabetes and worsening glycaemic control in those already diagnosed [5-7].

The relationship between obesity and diabetes is not merely epidemiological but pathophysiological. Adipose tissue acts as an endocrine and immune organ, secreting leptin, adiponectin, resistin, tumour necrosis factor-alpha, interleukin-6 and other mediators involved in metabolic regulation [6,8]. In obesity, adipose tissue expansion becomes dysfunctional and contributes to chronic low-grade inflammation, endothelial injury and accelerated atherosclerosis [6,8].

Diabetic complications are traditionally classified into microvascular complications, including retinopathy, nephropathy and neuropathy, and macrovascular complications, including coronary artery disease, cerebrovascular disease and peripheral arterial disease [9-11]. Poor glycaemic control, longer disease duration, hypertension and dyslipidaemia are established predictors of these complications [11-13]. However, increasing evidence suggests that obesity itself may contribute independently to complication development, particularly kidney disease, neuropathy and cardiovascular events [10,14].

Understanding the link between obesity and diabetic complications is clinically important because obesity is modifiable. Weight reduction, dietary intervention, physical activity, pharmacotherapy and metabolic surgery have shown benefits in glycaemic control and cardiometabolic risk reduction [3,15]. This study was conducted to assess the frequency of obesity among patients with type 2 diabetes mellitus and to determine its association with diabetic complications.

Methodology

Study design and setting

This was a cross-sectional analytical study conducted in the Department of Medicine/Endocrinology of a tertiary care hospital. The study included 158 adult patients diagnosed with type 2 diabetes mellitus.

Study duration

The study was conducted over a period of six months. From Oct 2025 to March 2026

Inclusion criteria

Patients were included if they were aged 30 years or above, had established type 2 diabetes mellitus for at least one year and provided informed consent for participation.

Exclusion criteria

Patients with type 1 diabetes mellitus, gestational diabetes, chronic steroid use, malignancy, acute infection, end-stage renal disease on dialysis, pregnancy or incomplete clinical records were excluded.

Data collection

A structured proforma was used to record age, sex, duration of diabetes, treatment history, smoking status, blood pressure, BMI, waist circumference, HbA1c, fasting blood glucose, lipid profile and serum creatinine. BMI was calculated as weight in kilograms divided by height in meters squared. Patients were classified as non-obese if BMI was <30 kg/m2 and obese if BMI was >=30 kg/m2.

Assessment of diabetic complications

Peripheral neuropathy was assessed by history, clinical examination and monofilament testing where available. Diabetic nephropathy was defined by microalbuminuria, reduced estimated glomerular filtration rate or documented diabetic kidney disease. Diabetic retinopathy was diagnosed by ophthalmological examination or documented fundus findings. Macrovascular disease included ischemic heart disease, stroke or peripheral arterial disease documented clinically or by medical record. Diabetic foot disease included ulceration, infection, deformity or previous amputation related to diabetes.

Statistical analysis

Data were analyzed using statistical software. Quantitative variables were expressed as mean +/- standard deviation. Qualitative variables were expressed as frequency and percentage. Chi-square test was used to compare categorical variables. Odds ratios with 95% confidence intervals were calculated. Logistic regression analysis was performed to identify independent predictors of diabetic complications. A p-value <0.05 was considered statistically significant.

Ethical consideration

Ethical approval was obtained from the institutional review board. Patient confidentiality was maintained and data were used only for research purposes.

Results

A total of 158 patients with type 2 diabetes mellitus were included. The mean age was 52.7 +/- 10.0 years. There were 84 (53.2%) males and 74 (46.8%) females. The mean duration of diabetes was 8.5 +/- 5.8 years. Obesity was present in 103 (65.2%) patients, while 55 (34.8%) were non-obese.

Table 1. Baseline characteristics of included patients

Variable	Total, n=158	Non-obese, n=55	Obese, n=103	p-value
Age, years	52.7 +/- 10.0	53.4 +/- 10.4	52.4 +/- 9.8	0.548
Male sex	84 (53.2%)	34 (61.8%)	50 (48.5%)	0.112
Female sex	74 (46.8%)	21 (38.2%)	53 (51.5%)	0.112
Duration of diabetes, years	8.5 +/- 5.8	7.3 +/- 5.1	9.2 +/- 6.0	0.050
BMI, kg/m2	32.4 +/- 5.0	26.2 +/- 2.3	35.7 +/- 4.2	<0.001
Waist circumference, cm	104.6 +/- 11.8	92.1 +/- 8.3	111.3 +/- 9.0	<0.001
HbA1c, %	8.3 +/- 1.6	7.8 +/- 1.3	8.6 +/- 1.7	0.002
Hypertension	94 (59.5%)	23 (41.8%)	71 (68.9%)	0.001
Dyslipidaemia	88 (55.7%)	21 (38.2%)	67 (65.0%)	0.001
Smoking history	27 (17.1%)	12 (21.8%)	15 (14.6%)	0.253

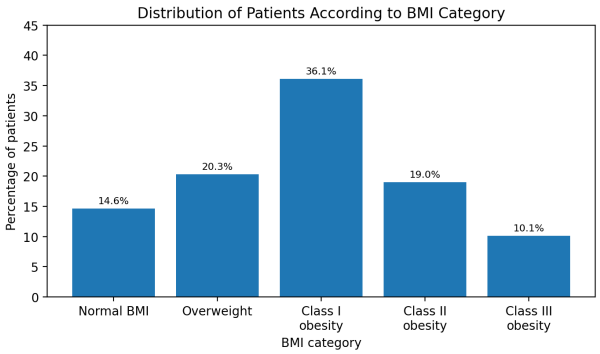

Figure 1. Distribution of patients according to BMI category.

Table 2. Frequency of diabetic complications according to BMI category

Complication	Normal BMI, n=23	Overweight, n=32	Class I obesity, n=57	Class II obesity, n=30	Class III obesity, n=16	Total, n=158
Any complication	8 (34.8%)	14 (43.8%)	34 (59.6%)	22 (73.3%)	13 (81.3%)	91 (57.6%)
Peripheral neuropathy	5 (21.7%)	8 (25.0%)	24 (42.1%)	15 (50.0%)	8 (50.0%)	60 (38.0%)
Nephropathy	4 (17.4%)	8 (25.0%)	21 (36.8%)	13 (43.3%)	8 (50.0%)	54 (34.2%)
Retinopathy	4 (17.4%)	7 (21.9%)	16 (28.1%)	9 (30.0%)	6 (37.5%)	42 (26.6%)
Macrovascular disease	3 (13.0%)	4 (12.5%)	13 (22.8%)	9 (30.0%)	7 (43.8%)	36 (22.8%)
Diabetic foot disease	1 (4.3%)	3 (9.4%)	8 (14.0%)	4 (13.3%)	3 (18.8%)	19 (12.0%)

Table 3. Association of obesity with diabetic complications

Complication	Non-obese, n=55	Obese, n=103	Odds ratio	95% CI	p-value
Any complication	22 (40.0%)	69 (67.0%)	3.04	1.55 - 6.00	0.001
Peripheral neuropathy	13 (23.6%)	47 (45.6%)	2.71	1.30 - 5.64	0.007
Nephropathy	12 (21.8%)	42 (40.8%)	2.47	1.16 - 5.23	0.017
Retinopathy	11 (20.0%)	31 (30.1%)	1.72	0.79 - 3.77	0.171
Macrovascular disease	7 (12.7%)	29 (28.2%)	2.69	1.09 - 6.62	0.028
Diabetic foot disease	4 (7.3%)	15 (14.6%)	2.17	0.68 - 6.90	0.180

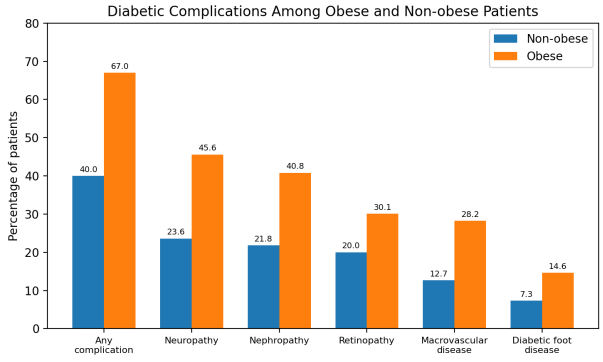

Figure 2. Diabetic complications among obese and non-obese patients.

On multivariable logistic regression, obesity remained independently associated with diabetic complications

after adjustment for age, duration of diabetes, HbA1c, hypertension and dyslipidaemia.

Table 4. Multivariable predictors of any diabetic complication

Predictor	Adjusted odds ratio	95% CI	p-value
Obesity, BMI >=30 kg/m2	2.58	1.24-5.36	0.011
Diabetes duration >=10 years	2.97	1.51-5.84	0.002
HbA1c >=8.0%	2.43	1.21-4.89	0.013
Hypertension	2.16	1.04-4.48	0.039
Dyslipidaemia	1.72	0.84-3.51	0.136
Age >=55 years	1.48	0.75-2.92	0.257

Discussion

This study demonstrated a high frequency of obesity among patients with type 2 diabetes mellitus, with nearly two-thirds of the included patients having BMI >=30 kg/m2. Obesity was significantly associated with a higher overall burden of diabetic complications. Patients with obesity had approximately three times higher odds of having at least one diabetic complication compared with non-obese patients. This finding supports the concept that obesity and diabetes represent overlapping metabolic disorders rather than separate clinical entities [3-8].

The observed association between obesity and diabetic complications can be explained by multiple biological mechanisms. Obesity induces insulin resistance through ectopic fat deposition, increased circulating free fatty acids and impaired insulin signalling in liver, skeletal muscle and adipose tissue [5,7]. In addition, dysfunctional adipose tissue releases inflammatory mediators that contribute to endothelial dysfunction, oxidative stress and vascular injury [6,8]. These processes are central to the development of both microvascular and macrovascular complications in diabetes [9-13].

Peripheral neuropathy was the most common complication in the present study and was significantly more frequent in obese patients. This is consistent with previous evidence showing that adiposity is associated with neuropathy and other microvascular outcomes in type 2 diabetes [10,14]. Obesity may contribute to neuropathy through metabolic inflammation, dyslipidaemia, microvascular ischemia and increased oxidative stress affecting peripheral nerves [10,16].

Diabetic nephropathy was also significantly more common among obese patients. Obesity may worsen kidney disease through glomerular hyperfiltration, activation of the renin-angiotensin-aldosterone system, hypertension, inflammation and lipid-mediated renal injury [10,14]. Previous studies have shown that obesity indices are associated with diabetic kidney disease, supporting the need for early renal screening in diabetic patients with excess adiposity [14].

Although retinopathy was more frequent in obese patients, the association did not reach statistical significance in this study. This may be due to the modest sample size or the complex relationship between BMI and retinopathy. Retinopathy is strongly linked with duration of diabetes, glycaemic exposure and hypertension [11-13,16]. Some studies have reported inconsistent associations between obesity and diabetic retinopathy, suggesting that central adiposity and metabolic profile may be more informative than BMI alone [14,16].

Macrovascular disease was significantly associated with obesity in the present study. This finding is clinically important because cardiovascular disease remains a major cause of morbidity and mortality among patients with type 2 diabetes [17-19]. Obesity promotes atherosclerosis through dyslipidaemia, hypertension, endothelial dysfunction, inflammation and prothrombotic changes [6,8,17]. The higher frequency of hypertension and dyslipidaemia among obese patients in this study further supports the clustering of cardiometabolic risk factors.

In multivariable analysis, obesity, diabetes duration >=10 years, HbA1c >=8.0% and hypertension were independent predictors of diabetic complications. These findings are consistent with landmark studies showing that chronic hyperglycaemia and longer diabetes duration increase microvascular complication risk [11-13]. The UKPDS demonstrated that improved glycaemic control reduces microvascular endpoints, while long-term follow-up confirmed sustained benefits of early intensive control [11,12]. Similarly, multifactorial risk reduction targeting glucose, blood pressure, lipids and lifestyle factors has shown substantial benefit in reducing vascular outcomes [18,19].

The findings of this study also support the growing emphasis on obesity management as a primary therapeutic target in type 2 diabetes. Current diabetes care increasingly recognizes that weight reduction can improve glycaemic control, insulin resistance, blood pressure, lipid profile and quality of life [3,15,20]. The DiRECT trial showed that structured weight management in primary care can induce remission of type 2 diabetes in a significant proportion of patients [21]. The Look AHEAD trial demonstrated that intensive lifestyle intervention produced weight loss and improvements in several cardiometabolic risk factors, although it did not significantly reduce major cardiovascular events in the overall cohort [20].

Pharmacological and surgical approaches to obesity management have further strengthened the role of weight-centred diabetes care. Metabolic surgery has been associated with improvement in glycaemic control and reduction in some microvascular outcomes among

patients with obesity and type 2 diabetes [22]. Contemporary diabetes guidelines recommend individualized weight management strategies including nutrition therapy, physical activity, behavioural therapy, pharmacotherapy and metabolic surgery when appropriate [3,23].

This study has several limitations. First, it was cross-sectional, so causal relationships cannot be established. Second, it was conducted at a single centre with a relatively modest sample size. Third, BMI was used as the primary obesity measure, although waist circumference, visceral fat assessment and body composition analysis may better reflect metabolic risk. Fourth, some complications were identified through available clinical documentation, which may underestimate true prevalence. Despite these limitations, the study highlights the important relationship between obesity and diabetic complications in routine clinical practice.

The clinical implication is clear: diabetic care should not focus only on glucose values. Comprehensive care must include weight assessment, waist circumference measurement, blood pressure control, lipid management, renal screening, foot examination and retinal evaluation. Early identification of obese diabetic patients at high risk of complications may allow targeted intervention and improved long-term outcomes [3,15,23-25].

Conclusion

Obesity was highly prevalent among patients with type 2 diabetes mellitus and was significantly associated with diabetic complications. Obese diabetic patients had higher frequencies of peripheral neuropathy, nephropathy and macrovascular disease compared with non-obese patients. Obesity remained an independent predictor of diabetic complications after adjustment for glycaemic control, duration of diabetes, hypertension and dyslipidaemia. Integrated management targeting obesity, hyperglycaemia, hypertension and dyslipidaemia is essential to reduce the burden of diabetic complications.

Recommendations

1. BMI and waist circumference should be routinely measured in all patients with type 2 diabetes mellitus.
2. Obese diabetic patients should undergo regular screening for neuropathy, nephropathy, retinopathy and cardiovascular disease.
3. Weight management should be included as a major treatment target along with glycaemic control.
4. Lifestyle modification, medical nutrition therapy, physical activity and pharmacological weight management should be individualized.
5. Larger multicentre prospective studies are recommended to determine causal relationships between obesity and diabetic complications.

Conflict of Interest

The authors declare no conflict of interest.

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