

Original Research Article

EXPLORING THE LINK BETWEEN DIABETES DURATION AND BMI AMONG TYPE 2 DIABETICS

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Received : 05/09/2025
Received in revised form : 29/10/2025
Accepted : 17/11/2025

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DOI: 10.70034/ijmedph.2025.4.265

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (4); 1481-1485

ABSTRACT

Background: The objective is to explore the relationship between the duration of type 2 diabetes mellitus and body mass index (BMI) among diagnosed patients in comparison with age and BMI matched healthy controls.

Materials and Methods: This cross-sectional study investigated the relationship between duration of type 2 diabetes mellitus (T2DM) and body mass index (BMI) in 60 patients compared with 60 age- and BMI-matched healthy controls at Dr. S.N. Medical College, Jodhpur, after ethical approval and informed consent. T2DM was diagnosed using American Diabetes Association criteria¹. Patients were stratified by diabetes duration: <5 years (n=20), 6–10 years (n=21), and >10 years (n=19). Anthropometric measurements included weight (nearest 0.1 kg) and height (nearest 0.5 cm); BMI was calculated as weight (kg)/[height (m)]². Data were analyzed using descriptive statistics and Student's t-test; p <0.05 was considered significant.

Results: Mean BMI was 23.81±2.30 kg/m² in controls, 24.99±3.75 kg/m² (<5 years), 26.59±4.13 kg/m² (6–10 years), and 23.90±2.64 kg/m² (>10 years). No significant differences existed between controls and <5-year (p=0.306) or <5-year and 6–10-year groups (p=0.679). However, BMI differed significantly between 6–10-year and >10-year groups (p=0.05).

Conclusion: BMI follows a biphasic pattern in T2DM—rising during mid-duration (6–10 years) likely due to insulin resistance and therapy effects, then declining after a decade, approaching control levels, possibly due to catabolic states and complications. These trajectories align with prior cohorts showing pre-diagnosis BMI gain and post-diagnosis stabilization or loss (2-5). Duration-specific BMI monitoring is essential for personalized management.

Keywords: Type 2 diabetes mellitus, BMI, disease duration, insulin resistance, weight change.

INTRODUCTION

Body mass index (BMI) is a major risk factor for the development of type 2 diabetes mellitus and influences glycemic control and complications after diagnosis.

According to international diabetes federation, approximately 589 million adults (20-79 years) are living with diabetes worldwide in 2024.^[1] Type 2 diabetes mellitus remains a leading global health challenge, characterized by chronic hyperglycemia resulting from insulin resistance and progressive β -cell dysfunction. The duration of diabetes significantly influences the risk for complications

that impact patient outcomes. Body mass index (BMI), an established measure of body fat, is a well-known modifiable factor associated with the development, progression, and prognosis of Type 2 diabetes mellitus.

However, the pattern of the relationship between duration of type 2 diabetes mellitus and BMI is complex: obesity often precedes diagnosis, but weight trajectories frequently change after diagnosis due to lifestyle modification, disease progression, and treatment effects. Understanding how BMI relates to diabetes duration helps clarify prognosis, management needs, and risk stratification.

Review of literature

Type 2 diabetes mellitus (T2DM) is a major global health problem characterized by chronic hyperglycaemia resulting from insulin resistance and β -cell dysfunction. Its prevalence has been rising sharply in both developed and developing countries, largely due to lifestyle changes, obesity, and aging populations. According to the International Diabetes Federation (IDF), more than 500 million adults worldwide are living with diabetes, with T2DM accounting for over 90% of cases.

Obesity, typically assessed through body mass index (BMI), is one of the strongest risk factors for the onset of T2DM. Elevated BMI increases insulin resistance, alters glucose metabolism, and accelerates the onset of diabetes. However, once diabetes is diagnosed, the relationship between BMI and disease progression becomes more complex.

Moreover, pharmacological management of T2DM—such as insulin therapy, sulfonylureas, GLP-1 receptor agonists, and SGLT2 inhibitors—has variable effects on weight, further modifying the association between disease duration and BMI. These dynamics are important to understand, as BMI not only affects glycemic control but also influences the risk of diabetes-related complications, cardiovascular outcomes, and overall prognosis.

Feldstein AC et.al study shows that a weight-loss pattern after new diagnosis of type 2 diabetes predicted improved glycemic and blood pressure control despite weight regain. The initial period postdiagnosis may be a critical time to apply weight-loss treatments to improve risk factor control.^[2]

Repeated-measure cohort studies by Donnelly LA et.al shows, on average, BMI rises before diagnosis and falls or stabilizes after diagnosis, but subgroups (younger vs older patients; higher vs lower baseline BMI) show different trajectories.^[3]

Deng L and co-researcher studied BMI and outcomes in established diabetes and found that BMI associates with glycemic control and complication risk in complex ways (e.g., U-shaped mortality relationships), meaning BMI's prognostic effect may change with disease duration and comorbidity burden.^[4]

Polemiti E, et al. (2021) studied from the EPIC-Potsdam cohort investigated how pre- and post-diagnosis BMI, and annual changes in BMI, impact the long-term risk of complications in type 2 diabetes. The research emphasizes that BMI changes post-diagnosis influence outcomes differently depending on the type and duration of diabetes complications.^[5]

MATERIALS AND METHODS

The study was conducted after approval from the institutional ethics committee of Dr. S.N. Medical College, Jodhpur. A written informed consent was taken from the subject before enrolment in study. The participants were thoroughly informed about the objectives and procedure of the study. A detail history

including personal history, family history, socioeconomic history, drug history and past medical history was taken and was recorded in a prefixed proforma. A thorough clinical examination was done. Height and weight of the subjects was recorded and BMI was calculated.

Subjects were divided into 2 groups –

Group 1 – Diagnosed type 2 diabetes mellitus Cases.

Group 2 – Age and BMI matched Healthy Controls.

Subjects with type 2 Diabetes Mellitus were diagnosed on the basis of-

American Diabetes Association Criteria for diagnosis of diabetes,^[6]

1. HbA1C $\geq 6.5\%$. The test should be performed in a laboratory using a method that is NGSP certified and standardized to the DCCT assay.
2. FBG ≥ 126 mg/dl (7mmol/L). Fasting is defined as no caloric intake for at least 8 hours.
3. 2-hour plasma glucose ≥ 200 mg/dl (11.1 mmol/L) during an OGTT. The test should be performed as described by WHO, using a glucose load containing the equivalent of 75g anhydrous glucose dissolved in water.
4. In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose ≥ 200 mg/dl (11.1 mmol/L).

Based on the duration of diabetes, diabetic patients will be divided into groups

Group A – Duration of diabetes < 5 years.

Group B – Duration of diabetes 6 – 10 years.

Group C – Duration of diabetes >10 years.

Following parameters will be assessed in all subjects:

a) Anthropometric Parameters- Following anthropometric parameters assessment will be recorded.

1. Weight (kg) was measured nearest to 0.1 Kg by calibrated weighing balance (Krup's Weighing Scale) after removal of shoes with light clothing only. Subjects were instructed to stand with erect posture with both feet together without any support, looking straight forward, without bending the head downwards towards scale. The scale was readjusted to zero after weighing each subject.
2. Height (cm) was measured to nearest 0.5cm against the wall without shoes using Stadiometer, which consists of a ruler and a sliding horizontal head piece which is adjusted to rest on the top of the head.
3. BMI was calculated by dividing the weight taken in Kg by the square of height taken in meters.

$BMI = [Wt. \text{ in Kg}] / [Ht.in meter]^2$

RESULTS

[Table 1] shows age distribution in type 2 diabetes mellitus patients and control subjects. The mean age of diabetic patients was 53.32 ± 8.19 years and that of control was 47.78 ± 6.80 years. On statistical analysis by student t test the result obtained was non-significant ($p > 0.05$), hence the groups were comparable.

Table 1: Distribution of age in type 2 diabetic patients and healthy controls

Characteristic	Type 2 diabetic Mean $\pm$ SD (n = 60)	Healthy control Mean $\pm$ SD (n = 60)	P-value
Age	53.32 $\pm$ 8.19	47.78 $\pm$ 6.80	0.15

Table 2: Anthropometric parameters in type 2 diabetic patients and healthy controls

Characteristics	Type 2 diabetic Mean $\pm$ SD (n=60)	Healthy control Mean $\pm$ SD (n=60)	P value
Height in meter	1.63 $\pm$ 0.06	1.64 $\pm$ 0.05	0.16
Weight in kgs	66.52 $\pm$ 2.12	65.80 $\pm$ 2.30	0.5
BMI in kg/m2	25.21 $\pm$ 2.38	23.81 $\pm$ 2.30	0.7

BMI – Body Mass Index.

[Table 2] shows height, weight, BMI in type 2 diabetic patients and control subjects. The mean height in diabetic patients was 1.63 $\pm$ 0.06 mts and mean height in control subjects was 1.64 $\pm$ 0.05 mts. The mean weight in diabetics was 66.52 $\pm$ 2.12 kgs and mean weight in control subjects was 65.80 $\pm$ 2.30

kgs. The mean BMI in diabetic was 25.21 $\pm$ 2.38 kg/m2 and the mean BMI in controls was 23.81 $\pm$ 2.30 kg/m2. All the values were statistically non-significant ($p > 0.05$). This shows that the groups were comparable.

Table 3.a Descriptives of BMI

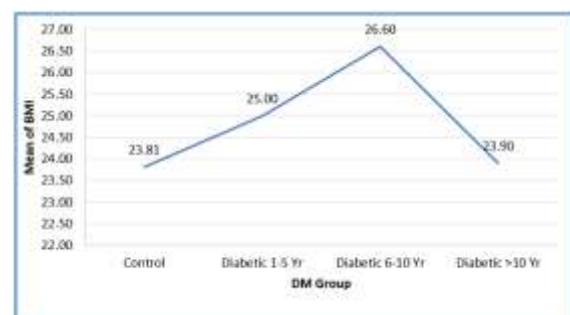
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control	60	23.81	2.298	0.296	23.2177	24.4053	19.05	34.42
Diabetic 1-5 Year	20	24.99	3.746	0.837	23.2431	26.7501	18.37	33.64
Diabetic 6-10 Year	21	26.59	4.125	0.900	24.7194	28.4749	19.38	34.89
Diabetic >10 Year	19	23.90	2.643	0.606	22.6271	25.1749	19.72	29.69
Total	120	24.51	3.145	0.287	23.9422	25.0792	18.37	34.89

BMI – Body Mass Index

Table 3. b Descriptives of BMI

	N	Mean	Std. Deviation	P value
Diabetic 6-10 Year	21	26.59	4.125	0.05
Diabetic >10 Year	19	23.90	2.643	

[Table 3.a] show descriptive of BMI. The mean of BMI in controls, 1–5-year diabetic, 6–10 year diabetic and > 10-year diabetic were 23.81 $\pm$ 2.29, 24.10 $\pm$ 3.74, 26.59 $\pm$ 4.12, 23.90 $\pm$ 2.64 respectively. The comparison between the Control group and Diabetes Mellitus (DM) group with 1–5 years of disease duration yielded a p-value of 0.306, indicating no statistically significant difference between these two groups.

**Figure 3: graph showing mean of BMI**

Similarly, the comparison between DM patients with 1–5 years and those with 6–10 years of duration showed a p-value of 0.679, suggesting no significant difference between these groups as well.

However, [Table 3.b] the comparison between DM patients with 6–10 years and those with more than 10 years of disease duration produced a p-value of 0.05,

which is at the threshold of statistical significance. This finding indicates a potentially significant difference between these two groups, suggesting that disease duration beyond 10 years may be associated with measurable changes in the studied parameter.

DISCUSSION

The control group had a mean BMI of 23.81 $\pm$ 2.29, ranging from 19.05 to 34.42. Participants with diabetes duration of 1–5 years showed a slightly higher mean BMI of 24.99 $\pm$ 3.74, while those with 6–10 years of diabetes had the highest mean BMI (26.59 $\pm$ 4.12), indicating an increase in BMI with disease duration. This progressive rise in BMI during the initial years of diabetes may be attributed to factors such as insulin resistance, excessive caloric intake, sedentary lifestyle, and the anabolic effects of exogenous insulin or oral hypoglycemic agents.

However, in participants with more than 10 years of diabetes, the mean BMI decreased to 23.90 $\pm$ 2.64, closer to that of the control group. Interestingly, individuals with a diabetes duration of more than 10 years demonstrated a decline in mean BMI, reaching values comparable to those of the control group. This reduction in BMI among long-standing diabetics could be linked to multiple factors including chronic hyperglycemia leading to catabolic changes, poor glycemic control, or the presence of diabetes-related

complications such as nephropathy or neuropathy, which may contribute to weight loss. Additionally, loss of glucose through urine, reduced appetite from complications, and a general catabolic state further contribute to the decline in BMI. Similar patterns have been observed in previous studies, where long-term diabetes was associated with a decline in body weight due to progressive beta-cell dysfunction and impaired metabolic regulation.

Al Jarad FAS and co-investigators studied, The overall prevalence of obesity among type 2 diabetic participants in Abha, Saudi Arabia, was found to be 46.0%, with 28.5% classified as Obesity Grade I, 10.8% as Obesity Grade II, and 6.8% as Obesity Grade III.^[7]

A study in Abha by Sachithananthan V noted that obesity grades prevalence in the diabetes mellitus subjects Grade I (31.1%) and Grade II (29.8%) and around 8.6% of the subjects had morbid obesity (≥ 40 BMI).^[8] Another study in Bisha reported an even higher combined prevalence of overweight and obesity at 85.8%, with 27.9% of participants being overweight, 57.8% being obese, and only 13.2% having normal weight.^[9] A study by Abdulsalam reported a high prevalence of overweight and obesity among type 2 diabetics (55.6%).^[10]

Helen C. Looker and co-investigators noted that before diagnosis of diabetes, there were steady gains in weight: mean BMI climbed between 0.43 and 0.71 kg/m² per year. After diagnosis, the weight gain declined, and weight loss was generally seen; the mean rate of change of BMI ranged between -0.61 and +0.22 kg/m² per year.^[11]

A report from another American Indian population showed that over a 4-year period, there was an average individual weight loss of 3.7 kg in a group on various medical therapies for diabetes.^[12] In Irish people with symptomatic, newly diagnosed type 2 diabetes, most individuals underwent weight loss that was sustained for 10 years of follow-up.^[13] Individuals on oral hypoglycemic therapy showed less marked weight loss than those treated with diet alone. In a U.S. population study, weight loss was more likely to occur in those with diabetes than in those without.^[14] The most extensive clinical trial to study changes in weight was the U.K. Prospective Diabetes Study. They examined weight changes for various intention-to-treat groups. Over 10 years of follow-up, people in all treatment groups generally gained weight. Weight gain was most pronounced in those on intensive therapy with sulfonylureas or insulin.^[15] It is possible that the effects of dietary management on BMI were not seen fully, because those who achieved fasting blood glucose < 6 mmol/l after the 3-month run-in period were excluded. There were many differences between the population examined in our study and that in U.K. Prospective Diabetes Study, including ethnicity, gender mix, baseline BMI, and, in our study, inclusion of all subjects regardless of initial glycemic control.

Maryam Mousavi and co-investigator studied Impact of adiposity indices changes across the

lifespan on risk of diabetes in women: trajectory modeling approach. Three distinct body mass index (BMI) trajectories and 2 distinct trajectories of other adiposity indices (waist circumference (WC), conicity index (C-index), and body roundness index (BRI)) were chosen as the best fitting of the latent class growth mixture model. In the adjusted model, total participants [HR (CI 95%): 2.83 (2.05, 3.91); $p < 0.001$], and menopause [1.35 (1.10, 2.11); $p = 0.001$] and reproductive-age women [2.93 (1.80, 4.78); $p = 0.003$] of the high BMI trajectory compared to the ones in the low trajectory of BMI were more likely to develop DM. The high BRI in menopause had a significantly higher risk of DM compared to the low trajectory. In menopause (1.80 (1.26, 2.58)) and reproductive-age women (4.32 (2.49, 7.47)) with high trajectory of C-index, the DM risk decreased after adjustment.^[16]

Lorna S Aucott et al studied Patterns of weight change after the diagnosis of type 2 diabetes in Scotland and their relationship with glycaemic control, mortality and cardiovascular outcomes: a retrospective cohort study, found that by 2 years, 36% of patients had lost $\geq 2.5\%$ of their weight. Increasing age, being female and a higher body mass index at diagnosis were associated with larger proportions of weight lost ($p < 0.001$). Multivariable modelling showed that inadequate glycaemic control at 2 years was associated with being younger at baseline, being male, having lower levels of obesity at diagnosis, gaining weight or being weight stable with weight change variability, and starting antidiabetic medication.^[17]

Baibing Mi et al study found four patterns of the trajectories of change in BMI were identified among Chinese adults, 42.7% of participants had stable BMI change, 40.8% for moderate BMI gain, 8.9% for substantial BMI gain and 7.7% for weight loss. During the follow-up with mean 11.2 years (158 637 person-years contributed by 14 185 participants), 498 people with type 2 diabetes (3.7%) occurred. Risk of type 2 diabetes was increased by 47% among people who gained BMI more substantially and rapidly (HR: 1.47, 95% CI 1.08 to 2.02, $p = 0.016$) and increased by 20% among those in people with the moderate BMI gain (HR: 1.20, 95% CI 0.98 to 1.48, $p = 0.078$), compared with those with stable BMI change.^[18]

Abdullah et al. conducted a prospective cohort study using the Framingham Heart Study cohort to show that the duration of obesity is a significant, independent risk factor for developing type 2 diabetes, regardless of the exact BMI value, emphasizing that the longer an individual remains obese, the greater their risk for developing diabetes.^[19]

Deng et al. examined the relationship between BMI and glycemic control, finding a significant positive correlation between higher BMI and poorer glycemic control (higher HbA1c) in T2DM patients. The study highlights the importance of weight management in optimizing clinical outcomes for those with type 2 diabetes.^[20]

The American Diabetes Association (ADA) guidelines recommend weight loss of at least 5–10% of body weight for overweight and obese T2DM patients to achieve clinically significant improvements in glycemic control and reduce the risk of cardiovascular complications.^[21]

These findings suggest that BMI does not remain constant throughout the course of diabetes but varies depending on disease duration and metabolic adaptations. The initial years are often characterized by weight gain and insulin resistance, while later years may show weight loss due to deteriorating metabolic control. This emphasizes the importance of individualized lifestyle interventions, dietary counselling, and regular weight monitoring in diabetic patients to maintain optimal BMI and minimize the risk of complications.

CONCLUSION

We conclude from the above study that BMI declines in patients with diabetes of >10 years duration and is almost equal to the BMI of control groups. This reduction is linked to catabolic changes, poor glycemic control or presence of Diabetes Mellitus related complications like neuropathy or nephropathy. Therefore it is important to closely monitor the weight and adapt lifestyle and dietary changes to prevent the further complications.

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