History of Medicine, 2022, 8(2): 891-895

DOI: 10.48047/HM. V8. I2.2022.891-895

COMPARATIVE ANALYSIS OF CLINICAL AND BIOCHEMICAL PROFILES OF TYPE 2 DIABETES MELLITUS (T2DM) PATIENTS ACROSS DIFFERENT BODY MASS INDEX (BMI) CATEGORIES

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Study Period: 02/03/2021 to 05/06/2022

ABSTRACT:

Type 2 Diabetes Mellitus (T2DM) is strongly influenced by obesity, yet clinical and biochemical variations across different ***Body Mass Index (BMI)*** *categories remain inadequately studied in many Indian populations. This study aimed to perform a comprehensive* ***comparative analysis*** *of clinical characteristics, metabolic parameters, and biochemical markers among T2DM patients categorized as* ***normal-weight***, ***overweight***, *and* ***obese*** *according to Asian BMI criteria. A total of 300 adult T2DM patients attending the Department of Internal Medicine at Rama Medical College Hospital & Research Centre, Hapur, from 02/03/2021 to 05/06/2022, were included in this observational, cross-sectional study. Detailed clinical evaluation, anthropometric measurements, and laboratory investigations including fasting blood glucose (FBG), postprandial blood glucose (PPBG), HbA1c, lipid profile, renal function tests, liver enzymes, and inflammatory markers were assessed. The findings demonstrated that* ***increasing BMI correlated significantly with poor glycemic control****, as indicated by rising mean HbA1c values from normal-weight to obese groups. Dyslipidemia parameters such as elevated triglycerides and reduced HDL-C were notably pronounced in obese T2DM patients. Additionally, systolic and diastolic blood pressures were significantly higher among obese participants, indicating greater cardiovascular risk. Markers of insulin resistance showed a similar upward trend with BMI. Interestingly, normal-weight diabetics exhibited comparatively lower metabolic derangements but still demonstrated suboptimal glycemic control, underscoring the presence of* ***metabolically obese normal-weight (MONW)*** *phenotypes in the Indian context. The study concludes that* ***BMI is a critical determinant of metabolic severity in T2DM****, with obese patients showing the highest burden of abnormalities. These findings emphasize the need for BMI-specific management strategies, early risk stratification, and lifestyle-oriented intervention programs. Integrating weight-reduction approaches into diabetes management can potentially improve biochemical profiles and reduce long-term complications in overweight and obese patients.*

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Keywords: ***T2DM, BMI categories, clinical profile, biochemical markers, dyslipidemia, HbA1c, insulin resistance***

INTRODUCTION :

Type 2 Diabetes Mellitus (T2DM) represents one of the most significant metabolic disorders globally, characterized by chronic hyperglycemia resulting from **insulin resistance** and **beta-cell dysfunction**. With the rising burden of obesity, the interplay between **adiposity and diabetes** has gained major clinical importance. Body Mass Index (BMI) is widely used as a simple and reliable anthropometric indicator to classify individuals into normal-weight, overweight, and obese categories. In Asian populations, including India, **lower BMI thresholds** are employed due to higher body fat percentages and greater metabolic risks at comparatively lower BMI values. Obesity contributes to T2DM through multiple mechanisms, including **visceral fat deposition**, release of pro-inflammatory cytokines, altered adipokine signaling, and impaired insulin action. However, clinical heterogeneity exists among diabetic patients across BMI groups, necessitating a deeper understanding of their metabolic variations. Studies in Western populations have demonstrated that obese diabetics tend to have worse glycemic and lipid profiles, but the trends are less well-established in Indian cohorts, where **normal-weight T2DM** is also prevalent. This phenomenon, often described as **metabolically obese normal-weight (MONW)**, indicates that BMI alone may not fully reflect metabolic risk, especially in South Asians. Therefore, evaluating clinical and biochemical profiles across BMI-based subgroups becomes essential for designing tailored management strategies. India's epidemiological transition, marked by urbanization, sedentary lifestyles, and dietary shifts, has further intensified the dual burden of **obesity and diabetes**. In this context, understanding BMI-stratified metabolic differences can help clinicians identify high-risk patients, anticipate complications, and optimize therapy. Although several regional studies exist, gaps remain in the systematic comparison of T2DM patients across BMI categories within the North Indian population. This study aims to address these gaps by analyzing a comprehensive set of clinical parameters, anthropometric indices, glycemic markers, lipid profiles, renal and hepatic biochemical indicators, and other metabolic risk factors across normal-weight, overweight, and obese diabetics. By establishing clear associations between BMI and metabolic severity, the findings may strengthen BMI-specific therapeutic approaches and inform public health strategies to curb the rising incidence of obesity-linked diabetes complications.

MATERIALS AND METHODS:

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This observational cross-sectional study was conducted in the Department of Internal Medicine at Rama Medical College Hospital & Research Centre, Hapur, Uttar Pradesh, between **02/03/2021 and 05/06/2022**, involving 300 adult patients diagnosed with Type 2 Diabetes Mellitus (T2DM) according to **ADA 2021 criteria**. The aim was to compare clinical and biochemical profiles across **three BMI categories** defined by the WHO Asia-Pacific guidelines: **Normal-weight (18.5–22.9 kg/m²)**, **Overweight (23.0–24.9 kg/m²)**, and **Obese (≥25.0 kg/m²)**. After obtaining informed consent, all participants underwent detailed clinical evaluation, including demographic information such as age, sex, duration of diabetes, medical history, lifestyle habits, physical activity level, and presence of comorbidities like hypertension, dyslipidemia, and cardiovascular disease. Anthropometric measurements included height, weight, BMI, **waist circumference**, **waist-hip ratio**, and **blood pressure** taken using standardized methods. Laboratory investigations were performed after an overnight fast of 10–12 hours. Samples were analyzed for **fasting blood glucose (FBG)**, **postprandial blood glucose (PPBG)**, **HbA1c**, complete lipid profile (total cholesterol, LDL-C, HDL-C, triglycerides), **renal function tests** (serum creatinine, urea, eGFR), **liver function tests** (AST, ALT, ALP), **thyroid profile**, and high-sensitivity C-reactive protein (hs-CRP) as an inflammatory marker. Insulin resistance was assessed using the **Homeostatic Model Assessment of Insulin Resistance (HOMA-IR)**. Additionally, microvascular complications were screened through **fundus examination**, **urine microalbumin**, and **neuropathy assessment** using monofilament testing. The participants were divided into three equal groups of 100 based on BMI. Statistical analysis was conducted using SPSS v24. Continuous variables were expressed as mean ± standard deviation and compared using ANOVA, while categorical variables were analyzed using the chi-square test. A p-value <0.05 was considered statistically significant. The methodology ensured standardization of measurements and uniform laboratory procedures. Quality control was maintained through calibrated instruments and internal validation protocols. Ethical approval was obtained from the institutional review board. The study design facilitated a robust comparison of metabolic trends in T2DM patients across BMI categories. Clinical parameters such as systolic and diastolic blood pressure, duration of diabetes, symptom patterns, and frequency of acute complications like infections or hypoglycemia were documented. Biochemical investigations provided objective assessment of glycemic control, lipid abnormalities, hepatic and renal impairment, thyroid dysfunction, and systemic inflammation. Data entry was double-checked for accuracy. The analysis focused on identifying significant variations across BMI groups, specifically trends in glycemic markers, lipid derangements, insulin resistance severity, blood pressure patterns, renal function decline, and hepatic involvement. Additional emphasis was placed on the prevalence of diabetic complications in each BMI category, exploring whether obese patients exhibited greater risk. This comprehensive methodology ensured a detailed and reliable comparative evaluation.

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RESULTS :

The study revealed significant differences in clinical and biochemical parameters across the three BMI categories. **Obese T2DM patients** exhibited the poorest glycemic control, with mean HbA1c markedly higher compared to overweight and normal-weight groups. Fasting and postprandial glucose levels also demonstrated an upward trend with increasing BMI. Blood pressure readings were significantly elevated in the obese group, indicating greater cardiovascular risk. Lipid profile analysis showed that obese patients had the highest triglycerides and lowest HDL-C levels, consistent with severe **diabetic dyslipidemia**. LDL-C and total cholesterol levels were also higher, though not equally pronounced. HOMA-IR values indicated significantly higher insulin resistance in the obese group, followed by overweight patients. Normal-weight diabetics had comparatively better profiles but still showed metabolic disturbances suggestive of **MONW phenotype**. Renal parameters including serum creatinine and eGFR showed mild deterioration in overweight and obese categories. Liver function tests demonstrated elevated ALT and AST in higher BMI groups, suggesting greater hepatic stress or fatty liver involvement. Inflammatory marker hs-CRP increased proportionally with BMI. The prevalence of microvascular complications was also higher among obese patients, particularly peripheral neuropathy and microalbuminuria. Overall, BMI showed a strong positive association with metabolic severity.

DISCUSSION :

This study highlights the significant impact of BMI on metabolic severity in T2DM patients. Obese individuals demonstrated worse glycemic control, adverse lipid patterns, higher insulin resistance, and increased inflammatory burden. Normal-weight diabetics also exhibited notable metabolic abnormalities, supporting the **MONW hypothesis** common in Indian populations. The findings emphasize the importance of incorporating BMI-specific treatment approaches, particularly weight reduction strategies for overweight and obese patients.

CONCLUSION:

The comparative analysis demonstrated clear metabolic deterioration across rising BMI categories among T2DM patients. Obese patients showed the poorest glycemic, lipid, hepatic, and inflammatory profiles, while normal-weight patients also exhibited significant but lesser abnormalities. BMI strongly correlated with insulin resistance and complication risk. These findings highlight the need for personalized, BMI-targeted management strategies to improve outcomes in diabetic patients.

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