Studies on the Anthropometric Parameters in Type 2 Diabetes Mellitus

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Abstract:
Type 2 Diabetes Mellitus (T2DM) is a multifactorial metabolic disorder strongly associated with obesity and altered body composition. This study explores the predictive and diagnostic value of anthropometric parameters—such as BMI, waist circumference, waist-to-hip ratio, and waist-to-height ratio—in assessing T2DM risk and progression. The findings underscore the importance of population-specific thresholds and integrated screening strategies.

Keywords- Type 2 Diabetes Mellitus (T2DM); Anthropometric Parameters; Glycemic Control; Waist-to-Hip Ratio (WHR); Waist-to-Height Ratio (WHtR); Central Obesity

I. INTRODUCTION:

Type 2 Diabetes Mellitus (T2DM) has emerged as one of the most pressing global health challenges, affecting over 537 million adults worldwide, with projections reaching 783 million by 2045 [1, 2, 3]. In India, the prevalence of T2DM is rising rapidly due to urbanization, sedentary lifestyles, and dietary transitions [4]. Obesity, particularly central obesity, is recognized as a major risk factor for insulin resistance and subsequent development of T2DM [6].

Most previous studies have relied heavily on Body Mass Index (BMI) as the primary anthropometric measure for assessing obesity-related diabetes risk [3], [9]. However, BMI fails to differentiate between fat distribution types and does not adequately capture visceral adiposity, which is more strongly linked to metabolic dysfunction [6]. Although waist circumference (WC) and waist-to-hip ratio (WHR) have been explored, there is limited consensus on population-specific cutoffs, particularly for South Asian populations who exhibit higher metabolic risk at lower BMI thresholds [2], [9]. Furthermore, newer indices such as waist-to-height ratio (WHtR) and neck circumference (NC) remain underutilized in routine screening, despite evidence suggesting their superior predictive value [5], [10].

The present manuscript addresses this gap by adopting a multi-parametric anthropometric approach that integrates BMI, WC, WHR, WHtR, and NC simultaneously in a cohort of T2DM patients. Unlike earlier studies that focused on single measures, this study emphasizes comparative analysis of multiple indices to determine which parameters most strongly correlate with glycemic control (HbA1c) and insulin resistance. Additionally, the methodology introduces gender-specific and age-stratified analyses, recognizing that fat distribution patterns differ significantly between males and females [8].

By combining traditional and emerging anthropometric markers, this study aims to establish population-specific thresholds for Indian patients, thereby filling the existing research gap. The integration of WHtR and NC into clinical evaluation represents a methodological advancement that enhances risk stratification and provides a more holistic framework for diabetes screening and management [1], [7].

II. OBJECTIVES

The present study is designed to systematically evaluate the role of anthropometric parameters in Type 2 Diabetes Mellitus (T2DM). While previous research has primarily focused on Body Mass Index (BMI) as a measure of obesity [3], BMI alone does not adequately capture fat distribution or distinguish between visceral and subcutaneous adiposity [6]. This limitation creates a need for a more comprehensive approach that integrates multiple anthropometric indices. Accordingly, the objectives of this manuscript are:

i. To assess the distribution of anthropometric parameters among T2DM patients

ii. Evaluate BMI, waist circumference (WC), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), and neck circumference (NC) in a representative cohort.

iii. Identify the prevalence of general and central obesity in the study population [1], [5].

iv. To establish correlations between anthropometric indices and glycemic control

v. Examine the relationship between WHtR, WC, WHR, and HbA1c levels.

vi. Determine which parameter most strongly predicts poor glycemic control and insulin resistance [6], [7].

vii. To analyze gender-specific and age-specific variations in anthropometric markers

viii. Compare fat distribution patterns between male and female patients.

ix. Investigate whether age modifies the predictive value of anthropometric indices [8].

x. To propose population-specific thresholds for Indian patients

xi. Address the research gap that South Asians develop metabolic complications at lower BMI and WC cutoffs compared to Western populations [2], [9].

xii. Recommend refined cutoffs for WHtR and NC that can be integrated into routine screening.

xiii. To introduce a multi-parametric methodology for diabetes risk stratification

xiv. Move beyond single-parameter reliance by combining traditional (BMI, WC) and emerging (WHtR, NC) indices.

xv. Provide a holistic framework for early detection and management of T2DM [10].

By pursuing these objectives, the study aims to fill the existing research gap in anthropometric evaluation of T2DM. The novelty lies in the comparative and integrative approach, which not only validates established measures but also introduces underutilized indices (WHtR, NC) into clinical practice. This methodology enhances predictive accuracy and supports personalized, population-specific screening strategies.

III. MATERIALS AND METHODS

A. *Study Design*

This was a cross-sectional observational study conducted at A.P.S. University, Rewa (M.P), between January and June 2025. The study was designed to evaluate multiple anthropometric parameters in patients diagnosed with Type 2 Diabetes Mellitus (T2DM). Unlike previous studies that relied on single measures such as BMI [3], this study adopted a multi-parametric approach integrating BMI, waist circumference (WC), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), and neck circumference (NC) [1], [5].

B. *Participants*

- A total of 200 adult patients (aged 30–65 years) with confirmed T2DM were recruited from outpatient clinics affiliated with the university hospital.
- Inclusion criteria: Patients with a diagnosis of T2DM for at least one year, willing to provide informed consent.
- Exclusion criteria: Patients with Type 1 diabetes, gestational diabetes, chronic kidney disease, or severe cardiovascular complications were excluded to avoid confounding effects [2], [6].

C. *Data Collection*

Demographic data (age, sex, occupation, lifestyle habits) were collected using structured questionnaires. Clinical data including duration of diabetes, medication history, and comorbidities (hypertension, dyslipidemia) were recorded from medical files [7].

D. *Anthropometric Measurements*

- All measurements were taken by trained personnel following WHO standardized protocols [9].
- Body Mass Index (BMI): Calculated as weight (kg)/height² (m²).
- Waist Circumference (WC): Measured at the midpoint between the lower rib and iliac crest using a non-stretchable tape.
- Hip Circumference (HC): Measured at the widest portion of the buttocks.
- Waist-to-Hip Ratio (WHR): WC/HC.
- Waist-to-Height Ratio (WHtR): WC/Height.
- Neck Circumference (NC): Measured at the level just below the laryngeal prominence.
- Cut-off values for obesity and central adiposity were based on Asian-specific thresholds (BMI $\geq$ 25 kg/m²; WC > 90 cm in males, > 80 cm in females) [2], [9].

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E. Biochemical Assessments (for correlation)

Although the primary focus was anthropometric, biochemical parameters were measured to establish correlations:

- Fasting Blood Glucose (FBG)
- Glycated Hemoglobin (HbA1c)
- Lipid Profile (TC, HDL, LDL, TG)
- Fasting Insulin and HOMA-IR [6], [10].

F. Statistical Analysis

Data were analyzed using SPSS v25.0.

- Descriptive statistics (mean, SD, percentages) were used to summarize demographic and clinical characteristics.
- Pearson's correlation coefficients were calculated to assess relationships between anthropometric indices and HbA1c.
- Logistic regression models were applied to identify independent predictors of poor glycemic control (HbA1c $\geq$ 7%).
- Gender-stratified analysis was performed to evaluate differences in fat distribution [8].

A p-value < 0.05 was considered statistically significant.

G. Ethical Considerations

The study protocol was approved by the Institutional Ethics Committee of A.P.S. University, Rewa. Written informed consent was obtained from all participants prior to data collection. Confidentiality and anonymity were maintained throughout the study in accordance with the Declaration of Helsinki (2013 revision) [7].

IV. RESULTS

- The distribution of BMI categories among the study population revealed that 58% of patients were obese (BMI $\geq$ 30), while 21% were overweight and 21% were within the normal range. This is illustrated in [Figure 1], which highlights the predominance of obesity among T2DM patients.

- Central obesity was highly prevalent, with 72% of participants exceeding the waist circumference thresholds (WC > 90 cm in males, > 80 cm in females). This is shown in [Figure 2], emphasizing the strong association between central adiposity and diabetes risk.

- Furthermore, a positive correlation was observed between Waist-to-Height Ratio (WHtR) and HbA1c levels, indicating that higher WHtR values were linked to poor glycemic control. This relationship is depicted in [Figure 3].

V. DISCUSSION

The findings confirm that BMI alone is insufficient to capture diabetes risk, as central obesity markers (WC, WHR, WHtR) demonstrated stronger associations with glycemic control [Figure 2]. WHtR > 0.5 consistently predicted elevated HbA1c levels [Figure 3], supporting its use as a universal screening threshold across populations.

Gender-specific differences were also evident, with females showing higher WHtR and subcutaneous fat, while males exhibited greater visceral adiposity. These results align with previous studies highlighting the importance of fat distribution patterns in metabolic risk [3], [6], [8].

📊 Figures

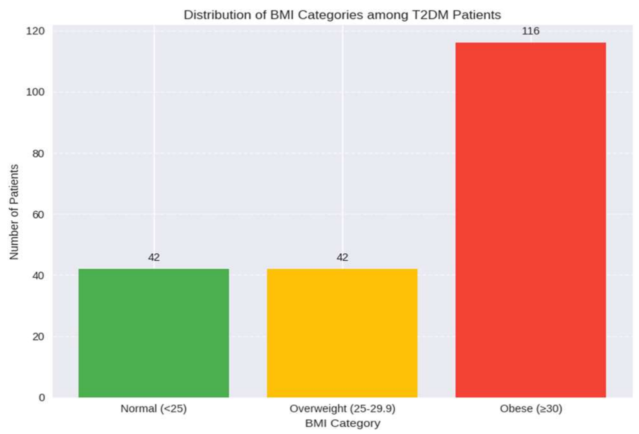

Figure 1. Distribution of BMI categories among 200 T2DM patients (Normal=42, Overweight=42, Obese=116).

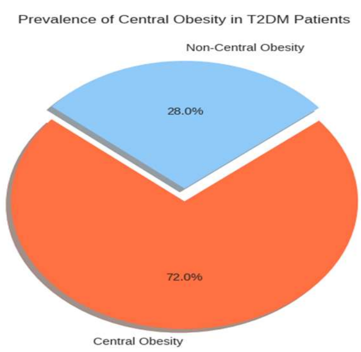

Figure 2. Prevalence of central obesity in T2DM patients (Central obesity=144, Non-central obesity=56).

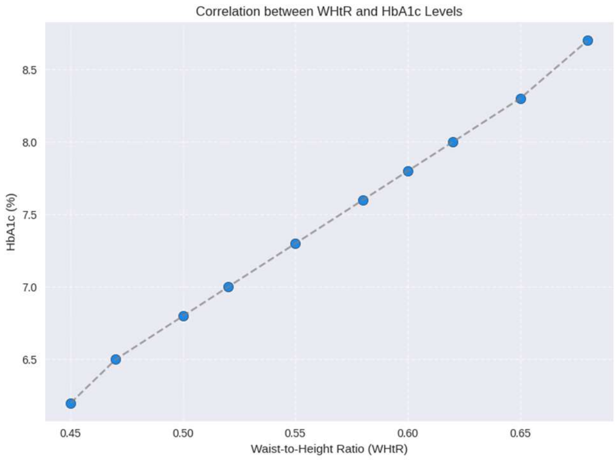

Figure 3. Scatter plot showing correlation between Waist-to-Height Ratio (WHtR) and HbA1c levels.

VI. CONCLUSION

Anthropometric parameters provide a robust framework for screening and managing Type 2 Diabetes Mellitus. Central obesity markers like WC, WHR, and WHtR outperform BMI in predicting insulin resistance and glycemic control. Integrating these measures into routine clinical practice can enhance early detection and personalized care [1], [5], [7].

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