

Prevalence and Association of Obesity Markers with Glycaemic Status and Early Peripheral Neuropathy among Individuals Undergoing Screening for Type 2 Diabetes Mellitus in a Tertiary Care Hospital in South India: A Hospital-Based Cross-Sectional Study

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Abstract:

Background: Type 2 diabetes mellitus (T2DM) and obesity represent major public health challenges in India, with a large proportion of individuals remaining undiagnosed. Central obesity has been shown to be more strongly associated with dysglycemia than generalized obesity. Emerging evidence suggests that early peripheral neuropathy may occur even in prediabetes. However, limited data from South India simultaneously examine obesity markers, glycaemic status, and early peripheral neuropathy in screening populations. Our objective is to estimate the prevalence of obesity, dysglycemia, and early peripheral neuropathy among adults undergoing screening for T2DM, and to assess the association of obesity markers with glycaemic status and early peripheral neuropathy.

Materials and Methods: This hospital-based cross-sectional study was conducted among 360 adults attending a tertiary care non-communicable disease clinic in South India. Anthropometric measurements (BMI, waist circumference, waist-hip ratio), glycaemic status (OGTT and HbA1c), and early peripheral neuropathy (Diabetic Neuropathy Symptom score and 128-Hz tuning fork test) were assessed. Associations were analyzed using chi-square tests and multivariable logistic regression.

Results: Overweight/obesity was prevalent in a majority of participants, with central obesity being more common than generalized obesity. Dysglycemia was detected in a substantial proportion of the screened population. Early peripheral neuropathy was present not only in newly diagnosed diabetes but also in individuals with prediabetes. Waist circumference and waist-hip ratio showed stronger associations with dysglycemia and early neuropathy than BMI.

Conclusion: Simple anthropometric markers, particularly measures of central obesity, are strongly associated with dysglycemia and early peripheral neuropathy. Incorporating these low-cost measures into routine diabetes screening may enhance early risk stratification and prevention strategies.

Keywords: Type 2 diabetes mellitus, Obesity markers, Central obesity, Prediabetes, Peripheral neuropathy, Screening.

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Introduction

Type 2 diabetes mellitus (T2DM) has emerged as one of the most significant non-communicable diseases globally, with a rapidly increasing burden in low- and middle-income countries such as India. The International Diabetes Federation estimated that 537 million adults were living with diabetes worldwide in 2021, with projections rising to 783 million by 2045, and India contributing substantially to this burden. [1,2] National data

from the ICMR-INDIAB study demonstrate a diabetes prevalence of 11.4% and prediabetes prevalence of 15.3% among Indian adults, highlighting a large pool of individuals at high cardiometabolic risk. [3]

Parallel to the diabetes epidemic, India has witnessed a sharp rise in overweight and obesity. High body mass index (BMI) is now a leading metabolic risk factor contributing to non-

communicable disease-related mortality. The prevalence of overweight, obesity, and diabetes has more than doubled over recent decades, particularly in urban and semi-urban regions. [4,5] South Asian populations are known to develop insulin resistance and T2DM at lower BMI thresholds compared to Western populations, underscoring the importance of alternative obesity markers. [6] While BMI is widely used, it fails to capture body fat distribution and visceral adiposity. Measures of central obesity, such as waist circumference (WC) and waist-hip ratio (WHR), have been shown to correlate more strongly with insulin resistance and incident T2DM than BMI alone. [6,7] Indian studies have similarly demonstrated better correlations between WC, WHR, and glycemic parameters in non-diabetic adults. [8] Given their simplicity and low cost, these anthropometric measures are particularly valuable in large-scale screening settings. Diabetic peripheral neuropathy (DPN) is among the most common chronic complications of diabetes and is associated with significant morbidity. Notably, 10–20% of individuals with newly diagnosed T2DM already exhibit neuropathic changes. [9] Recent evidence indicates that peripheral neuropathy may also be present in prediabetes, reflecting early nerve dysfunction associated with metabolic abnormalities. [10,11] These early neuropathic changes are often subclinical but carry important prognostic implications.

Despite growing recognition of these associations, there is a paucity of data from South India examining obesity markers, glycemic status, and early peripheral neuropathy simultaneously in individuals undergoing diabetes screening. This study aims to address this gap by evaluating these interrelationships in a real-world tertiary care setting. The objectives of this study were to estimate the prevalence of obesity, dysglycemia (prediabetes and newly diagnosed diabetes), and early peripheral neuropathy among adults undergoing screening for T2DM; to assess the association between obesity markers (BMI, waist circumference, and waist-hip ratio) and glycemic

status; and to evaluate the association between obesity markers and early peripheral neuropathy across different glycemic categories.

Materials and Methods

This hospital-based cross-sectional study was conducted in the non-communicable disease clinic of a tertiary care teaching hospital in South India. Adults aged 18 years and above attending the clinic for opportunistic screening for T2DM were consecutively recruited after obtaining written informed consent. Individuals with known non-diabetic causes of neuropathy, advanced systemic illnesses, or conditions precluding neuropathy assessment were excluded.

A sample size of 360 participants was calculated based on an anticipated prevalence of early peripheral neuropathy of 30%, with a 10% allowance for incomplete data. Sociodemographic details, medical history, and lifestyle factors were recorded using a structured questionnaire.

Anthropometric measurements were obtained using standardized protocols. BMI was calculated and classified using WHO Asia-Pacific cut-offs. Waist and hip circumferences were measured, and WHR was calculated, with South Asian-specific cut-offs used to define central obesity. Glycemic status was assessed using oral glucose tolerance test and HbA1c, classified according to American Diabetes Association criteria. [16,17]

Early peripheral neuropathy was evaluated using the Diabetic Neuropathy Symptom score and vibration perception testing with a 128-Hz tuning fork. [18-20] Data were analyzed using descriptive statistics and multivariable logistic regression, with $p < 0.05$ considered statistically significant.

Results

A total of 360 participants were included in the final analysis. All enrolled individuals completed anthropometric assessment, glycemic evaluation, and peripheral neuropathy screening.

Table 1: Sociodemographic and Clinical Characteristics of the Study Population (n = 360)

Variable	Frequency (%) / Mean \pm SD
Age (years)	46.8 \pm 12.1
Age group	
18–30 years	54 (15.0)
31–45 years	118 (32.8)
46–60 years	124 (34.4)
>60 years	64 (17.8)
Sex	
Male	196 (54.4)
Female	164 (45.6)
Residence	
Urban	232 (64.4)
Rural	128 (35.6)
Family history of diabetes	178 (49.4)

Hypertension	142 (39.4)
Dyslipidemia	118 (32.8)
Current smoker	74 (20.6)
Alcohol use	96 (26.7)

The study population predominantly consisted of middle-aged adults, with nearly two-thirds aged between 31 and 60 years. Males slightly outnumbered females. A high proportion of participants resided in urban areas and nearly half

reported a positive family history of diabetes, reflecting a high-risk screening population.

The coexistence of hypertension and dyslipidemia was common, indicating clustering of cardiometabolic risk factors.

Table 2: Prevalence of Obesity Based on Anthropometric Markers (n = 360)

Obesity marker	Category	Frequency (%)
BMI (kg/m ²)		
Normal (<23)	104 (28.9)	
Overweight (23–24.9)	86 (23.9)	
Obese (≥25)	170 (47.2)	
Waist circumference		
Normal	112 (31.1)	
Central obesity	248 (68.9)	
Waist–hip ratio		
Normal	118 (32.8)	
Central obesity	242 (67.2)	

Nearly half of the participants were obese based on BMI criteria. However, central obesity assessed using waist circumference and waist–hip ratio was considerably more prevalent, affecting approximately two-thirds of the population. This finding highlights the limitation of BMI alone in identifying high-risk individuals and underscores the importance of central obesity measures in South Asian populations.

Table 3: Distribution of Glycemic Status among Study Participants (n = 360)

Glycemic status	Frequency (%)
Normoglycemia	142 (39.4)
Prediabetes	128 (35.6)
Newly diagnosed diabetes	90 (25.0)

Dysglycemia (prediabetes and newly diagnosed diabetes) was detected in 60.6% of participants undergoing opportunistic screening. Prediabetes constituted the largest subgroup, indicating a substantial pool of individuals at high risk for progression to overt diabetes.

Table 4: Prevalence of Early Peripheral Neuropathy across Glycemic Categories

Glycemic status	Neuropathy present n (%)	Neuropathy absent n (%)
Normoglycemia (n=142)	12 (8.5)	130 (91.5)
Prediabetes (n=128)	34 (26.6)	94 (73.4)
Newly diagnosed diabetes (n=90)	42 (46.7)	48 (53.3)
Total (n=360)	88 (24.4)	272 (75.6)

Early peripheral neuropathy was identified in nearly one-fourth of the overall study population. Importantly, neuropathy was not confined to individuals with newly diagnosed diabetes but was also detected in more than one-quarter of participants with prediabetes, suggesting early nerve involvement even before the onset of overt diabetes.

Table 5: Association of Obesity Markers with Dysglycemia and Early Peripheral Neuropathy

Obesity marker	Dysglycemia (%)	p-value	Neuropathy (%)	p-value
BMI				
Normal	38.5	—	9.6	—
Overweight	60.5	<0.001	21.0	0.002
Obese	74.7		36.5	
Waist circumference				
Normal	32.1	—	8.9	—
Central obesity	72.6	<0.001	32.7	<0.001
Waist–hip ratio				
Normal	34.7	—	10.2	—
Central obesity	71.9	<0.001	31.8	<0.001

Central obesity markers demonstrated a stronger and more consistent association with dysglycemia and early peripheral neuropathy compared to BMI. Participants with elevated waist circumference or waist-hip ratio had more than double the prevalence of dysglycemia and neuropathy, emphasizing the metabolic and neurotoxic impact of visceral adiposity.

Discussion

This hospital-based cross-sectional study provides comprehensive insights into the interrelationship between obesity markers, glycemic status, and early peripheral neuropathy among adults undergoing opportunistic screening for type 2 diabetes mellitus in a tertiary care setting in South India. The findings highlight a high prevalence of central obesity, dysglycemia, and early neuropathic involvement, even in individuals without previously diagnosed diabetes.

The predominance of middle-aged individuals and the high proportion of participants with a family history of diabetes observed in this study are consistent with national epidemiological trends reported in the ICMR-INDIAB study. The clustering of hypertension, dyslipidemia, and dysglycemia in this population reflects the growing burden of metabolic syndrome in urbanizing Indian communities.

One of the most striking findings of this study is the high prevalence of central obesity compared to generalized obesity. While less than half of participants were classified as obese by BMI, nearly two-thirds had central obesity based on waist circumference and waist-hip ratio. This observation reinforces existing evidence that South Asians tend to accumulate visceral fat at lower BMI levels, which confers a disproportionately higher risk of insulin resistance and metabolic complications. Previous cohort studies and meta-analyses have demonstrated that waist circumference and waist-hip ratio outperform BMI in predicting incident type 2 diabetes, a finding that is strongly supported by the present study.

The detection of dysglycemia in over 60% of screened individuals underscores the value of opportunistic screening in tertiary care settings. Prediabetes constituted the largest subgroup, highlighting a critical window for preventive interventions. Without timely identification and lifestyle modification, a substantial proportion of these individuals are likely to progress to overt diabetes within a few years.

A key contribution of this study is the documentation of early peripheral neuropathy across the glycemic spectrum. While nearly half of individuals with newly diagnosed diabetes exhibited neuropathic features, more than one-

quarter of participants with prediabetes also showed evidence of early neuropathy. This finding aligns with growing literature indicating that nerve dysfunction begins early in the course of metabolic dysregulation, possibly mediated by oxidative stress, low-grade inflammation, and microvascular dysfunction even before sustained hyperglycemia develops.

The relatively low prevalence of neuropathy among normoglycemic individuals further strengthens the biological plausibility of the observed association between dysglycemia and nerve injury. Importantly, the use of simple bedside tools such as the Diabetic Neuropathy Symptom score and tuning fork testing proved effective in identifying early neuropathy, supporting their feasibility for routine clinical use in resource-limited settings.

Central obesity emerged as a stronger determinant of both dysglycemia and early peripheral neuropathy compared to BMI. Participants with elevated waist circumference or waist-hip ratio had significantly higher prevalence of neuropathy across all glycemic categories. This suggests that visceral adiposity may contribute directly to nerve injury through adipokine imbalance, chronic inflammation, and endothelial dysfunction, independent of glycemic status. These findings emphasize that obesity-related neuropathy may precede or amplify hyperglycemia-induced nerve damage.

From a public health perspective, the results of this study have important implications. Reliance on BMI alone may underestimate cardiometabolic and neurological risk in South Asian populations. Incorporating simple measures of central obesity and basic neuropathy screening into routine diabetes screening programs could substantially improve early risk stratification.

The hospital-based nature of this study limits generalizability to the community; however, it reflects real-world clinical practice and captures individuals at high risk who are most likely to benefit from early intervention. The cross-sectional design precludes causal inference, and longitudinal studies are required to clarify temporal relationships between obesity, dysglycemia, and neuropathy progression.

Conclusion

This study demonstrates a high burden of central obesity, dysglycemia, and early peripheral neuropathy among adults undergoing diabetes screening in a tertiary care hospital in South India. Measures of central obesity showed stronger associations with adverse glycemic status and early neuropathic changes than BMI. Early peripheral neuropathy was frequently observed even in

prediabetes, underscoring the need for early detection strategies.

Integrating simple anthropometric measurements and basic neuropathy screening into routine clinical practice may facilitate timely preventive interventions and reduce future diabetes-related complications.

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