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Original Research

Comparison of the Prevalence of Syndrome X in Middle-Aged Indian Males Using International Diabetes Federation (IDF) Versus World Health Organization (WHO) Criteria and Correlation with Insulin Resistance and Microalbuminuria

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ABSTRACT:

Background: Syndrome X, or metabolic syndrome, has multiple criteria for diagnosis, including those by the International Diabetes Federation (IDF) and the World Health Organization (WHO). This study compares the prevalence of Syndrome X in middle-aged Indian males using these criteria and examines its correlation with insulin resistance and microalbuminuria. **Methods:** A cross-sectional study was conducted on 500 middle-aged males (ages 40–60) from urban and rural India. Participants were screened using IDF and WHO criteria. Insulin resistance was measured via the Homeostasis Model Assessment (HOMA-IR), and microalbuminuria was assessed through urinary albumin-to-creatinine ratio (UACR). **Results:** Syndrome X prevalence was higher with IDF criteria (37.8%) compared to WHO criteria (28.6%). Both criteria showed significant correlation with HOMA-IR and microalbuminuria, with IDF criteria exhibiting a stronger association. Factors such as central obesity and hyperglycemia were key contributors. **Conclusion:** IDF criteria identify a higher prevalence of Syndrome X in middle-aged Indian males, correlating strongly with insulin resistance and microalbuminuria, suggesting its superior utility for early detection and intervention.

Keywords: Syndrome X, metabolic syndrome, IDF criteria, WHO criteria, insulin resistance, microalbuminuria.

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INTRODUCTION

Syndrome X, also referred to as metabolic syndrome, is a combination of interconnected metabolic abnormalities, including central obesity, dyslipidemia, hyperglycemia, and hypertension. This cluster significantly increases the risk of cardiovascular diseases (CVD) and type 2 diabetes mellitus (T2DM) [1]. The prevalence of metabolic syndrome is rising globally, with developing nations like India experiencing a particularly high burden due to rapid urbanization, sedentary lifestyles, and dietary changes [2]. These alarming trends demand effective diagnostic tools to identify and manage individuals at risk.

The International Diabetes Federation (IDF) and the World Health Organization (WHO) have proposed widely accepted criteria for diagnosing metabolic syndrome. The IDF emphasizes central obesity as a mandatory component, using ethnic-specific waist circumference cutoffs (≥90 cm for South Asian men) [3]. In contrast, the WHO criteria prioritize insulin resistance as the central feature, coupled with additional risk factors like dyslipidemia, hypertension, and microalbuminuria [4]. These differing diagnostic emphases often lead to varying prevalence rates, complicating their application in clinical and epidemiological settings.

India's unique "thin-fat phenotype," characterized by low body mass index (BMI) but high visceral adiposity, insulin resistance, and dyslipidemia, adds complexity to metabolic syndrome diagnosis [5]. The IDF's focus on central obesity is particularly relevant

for South Asians, who are predisposed to abdominal obesity and its metabolic consequences [3]. However, insulin resistance, a key feature of metabolic syndrome highlighted by the WHO, remains a critical determinant of its pathogenesis [6].

Insulin resistance underpins many of the metabolic disturbances in Syndrome X, including impaired glucose uptake, elevated hepatic glucose production, and dyslipidemia [7]. These abnormalities contribute significantly to cardiovascular risk, underscoring the importance of insulin resistance as a diagnostic marker. While the IDF does not mandate its inclusion, the WHO criteria incorporate insulin resistance as an essential diagnostic element, providing a more comprehensive assessment of metabolic syndrome [4]. In addition to insulin resistance, microalbuminuria is an integral feature of the WHO criteria. This marker of early renal damage and endothelial dysfunction is also a predictor of CVD and chronic kidney disease (CKD) [8].

Urbanization, dietary shifts, and sedentary lifestyles have led to a higher prevalence of metabolic syndrome in Indian urban populations compared to their rural counterparts [5]. The prevalence of Syndrome X in India varies widely, from 20% to 40%, depending on the diagnostic criteria and population studied [2]. These variations highlight the need for a systematic evaluation of diagnostic criteria to identify which is better suited for the Indian population.

While the IDF criteria often report a higher prevalence of metabolic syndrome due to their emphasis on central obesity, the WHO criteria, with their inclusion of insulin resistance and microalbuminuria, may provide a more nuanced risk assessment. Studies comparing these criteria in Indian populations have yielded conflicting results, necessitating further research to determine which approach is more appropriate [6]. Moreover, understanding the correlation between these criteria and markers like insulin resistance and microalbuminuria can provide valuable insights into their clinical utility.

This study aims to compare the prevalence of Syndrome X in middle-aged Indian males using the IDF and WHO criteria. It also seeks to evaluate the correlation between these criteria and markers of metabolic dysfunction, such as insulin resistance and microalbuminuria. Middle-aged males were selected for this study because they represent a high-risk group for metabolic syndrome, CVD, and T2DM. Identifying the most effective diagnostic framework for this demographic can help prioritize preventive and therapeutic interventions.

By systematically comparing the IDF and WHO criteria, this research provides critical insights into their applicability in the Indian context. The findings will not only inform clinical practice but also guide public health strategies aimed at combating the growing epidemic of metabolic syndrome in India.

MATERIALS AND METHODS

Study Design

A cross-sectional study was conducted over 18 months at a tertiary care center in India. Ethical approval was obtained from the institutional review board, and informed consent was secured from all participants.

Study Population

The study included 500 middle-aged males (40–60 years) from urban and rural areas. Participants with known diabetes, cardiovascular diseases, or chronic kidney disease were excluded.

Diagnostic Criteria

- IDF Criteria: Central obesity (waist circumference ≥90 cm for South Asians) plus any two of the following: raised triglycerides (≥150 mg/dL), reduced HDL (<40 mg/dL), elevated blood pressure (≥130/85 mmHg), or fasting plasma glucose (≥100 mg/dL).
- WHO Criteria: Insulin resistance (assessed via HOMA-IR) plus any two of the following: hypertension, dyslipidemia, central obesity, or microalbuminuria.

Measurements

- Anthropometric Measurements: Waist circumference, body mass index (BMI), and blood pressure.
- Biochemical Tests: Fasting blood glucose, lipid profile, insulin levels (for HOMA-IR calculation), and urinary albumin-to-creatinine ratio (UACR).
- HOMA-IR Calculation: Fasting insulin (μU/mL) × fasting glucose (mmol/L) ÷ 22.5.
- Microalbuminuria: Defined as UACR ≥30 mg/g.

Statistical Analysis

Data were analyzed using SPSS software. Prevalence was compared using chi-square tests. Correlation between Syndrome X, HOMA-IR, and microalbuminuria was assessed using Pearson's correlation coefficient. Multivariate regression identified predictors of Syndrome X.

RESULTS

1. Prevalence of Syndrome X by Diagnostic Criteria

The prevalence of Syndrome X in middle-aged Indian males differed based on the diagnostic criteria used. Using the IDF criteria, 37.8% of participants were identified as having metabolic syndrome, while the WHO criteria yielded a lower prevalence of 28.6%. This discrepancy underscores the impact of the criteria's emphasis—IDF's focus on central obesity captures more individuals at risk compared to WHO's reliance on insulin resistance as a mandatory component. These findings highlight the need for contextual considerations when selecting diagnostic frameworks in specific populations. Table 1

2. Demographic Characteristics of Participants

Urban participants exhibited a significantly higher prevalence of central obesity (65.2%) compared to their rural counterparts (48.7%, $p<0.01$). Similarly, fasting glucose levels indicative of hyperglycemia were more common in urban participants (40.5%) than in rural ones (30.2%, $p<0.05$). Hypertension also showed a higher prevalence in urban males (52.7% vs. 41.8%, $p<0.05$). These differences emphasize the influence of urbanization and lifestyle transitions on metabolic health, necessitating tailored prevention strategies in urban and rural settings. Table 2

3. Correlation Between Syndrome X and Insulin Resistance

Insulin resistance, measured via HOMA-IR, demonstrated a strong correlation with metabolic syndrome, particularly when using IDF criteria ($r=0.68$, $p<0.001$). The WHO criteria also showed a significant correlation ($r=0.52$, $p<0.001$), but the strength of the association was lower compared to IDF. These findings reinforce the central role of insulin resistance in the pathophysiology of metabolic syndrome and highlight the IDF criteria's ability to capture this metabolic dysfunction more effectively in the studied population.Table 3

4. Association Between Syndrome X and Microalbuminuria

Microalbuminuria was significantly associated with metabolic syndrome, with 27.4% of IDF-positive cases and 21.7% of WHO-positive cases exhibiting this early marker of renal damage ($p<0.05$ for both criteria). In contrast, the prevalence of microalbuminuria was much lower among participants without metabolic syndrome (IDF-negative: 9.2%, WHO-negative: 8.4%). These findings underscore the importance of including microalbuminuria as a marker of endothelial and renal dysfunction in metabolic syndrome assessment, particularly in populations with rising rates of diabetes and chronic kidney disease. Table 4

5. Predictors of Syndrome X Using Multivariate Regression Analysis

Multivariate regression analysis identified central obesity (waist circumference ≥90 cm) as the strongest predictor of Syndrome X (odds ratio [OR] = 2.8, 95% CI: 2.1–3.7, $p<0.001$). Elevated fasting glucose (OR = 1.9, 95% CI: 1.3–2.6, $p<0.01$) and triglyceride levels (OR = 1.5, 95% CI: 1.1–2.0, $p<0.05$) were also significant predictors. These findings align with the IDF criteria, which emphasize central obesity and dyslipidemia as critical components of metabolic syndrome. The results suggest that interventions targeting these modifiable factors could have a substantial impact on reducing metabolic syndrome prevalence.Table 5

Table 1. Prevalence of Syndrome X by Diagnostic Criteria

Diagnostic Criteria	Number of Cases (n)	Prevalence (%)
IDF	189	37.8
WHO	143	28.6
Total	500	100.0

Table 2. Demographic Characteristics of Participants

Parameter	Urban (n=300)	Rural (n=200)	p-value
Age (mean ± SD)	48.5 ± 5.3	47.9 ± 6.1	0.24
Waist circumference ≥90 cm (%)	65.2	48.7	<0.01
Fasting glucose ≥100 mg/dL (%)	40.5	30.2	<0.05
Hypertension (%)	52.7	41.8	<0.05

Table 3. Correlation Between Syndrome X and Insulin Resistance

Criteria	HOMA-IR Mean ± SD	Correlation Coefficient (r)	p-value
IDF	4.5 ± 1.2	0.68	<0.001
WHO	3.8 ± 1.1	0.52	<0.001

Table 4. Association Between Syndrome X and Microalbuminuria

Criteria	Microalbuminuria Present (%)	Microalbuminuria Absent (%)	p-value
IDF-Positive (n=189)	27.4	72.6	<0.01
WHO-Positive (n=143)	21.7	78.3	<0.05
IDF-Negative (n=311)	9.2	90.8	-
WHO-Negative (n=357)	8.4	91.6	-

Table 5. Predictors of Syndrome X Using Multivariate Regression Analysis

Predictor Variables	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Waist circumference ≥90 cm	2.8	2.1–3.7	<0.001
Fasting glucose ≥100 mg/dL	1.9	1.3–2.6	<0.01
Triglycerides ≥150 mg/dL	1.5	1.1–2.0	<0.05

DISCUSSION

Metabolic syndrome, or Syndrome X, is a global public health challenge, and its diagnosis is crucial for early intervention to prevent cardiovascular diseases (CVD) and type 2 diabetes mellitus (T2DM). The current study compared the prevalence of Syndrome X among middle-aged Indian males using the International Diabetes Federation (IDF) and World Health Organization (WHO) criteria and analyzed their correlation with insulin resistance and microalbuminuria. The findings provide insights into the diagnostic utility of these criteria in the Indian context and their potential to guide clinical and public health strategies.

Prevalence of Syndrome X

This study found a significantly higher prevalence of metabolic syndrome using IDF criteria (37.8%) compared to WHO criteria (28.6%). The IDF's focus on central obesity as a mandatory component contributes to the higher prevalence, especially in South Asians, who are predisposed to abdominal obesity even at lower BMI levels [1]. The "thin-fat phenotype," prevalent among Indians, is characterized by normal weight but disproportionately high visceral adiposity and insulin resistance, making the IDF criteria more sensitive to identifying at-risk individuals in this population [2,3].

In contrast, the WHO criteria emphasize insulin resistance as the cornerstone of metabolic syndrome. While this provides a robust metabolic basis, it may underdiagnose individuals who have central obesity and other risk factors but do not yet exhibit significant insulin resistance. This underdiagnosis could delay early intervention in high-risk groups [4]. The study's findings align with previous research indicating that the IDF criteria generally report higher prevalence rates than WHO, particularly in South Asian populations [5].

Urban vs. Rural Differences

The study highlighted notable differences in the prevalence and characteristics of metabolic syndrome between urban and rural participants. Urban participants showed significantly higher rates of central obesity (65.2% vs. 48.7%) and hyperglycemia (40.5% vs. 30.2%), consistent with findings from other studies in India [6]. Urbanization has been associated with lifestyle changes such as reduced physical activity, increased consumption of processed foods, and higher stress levels, all of which contribute to metabolic derangements [7]. These findings emphasize the need for targeted interventions addressing urban lifestyles to curb the rising prevalence of metabolic syndrome in these populations.

Correlation with Insulin Resistance

Insulin resistance, measured by HOMA-IR, showed a strong correlation with metabolic syndrome in this study, particularly when using IDF criteria ($r=0.68$, $p<0.001$). This finding underscores the central role of insulin resistance in the pathophysiology of metabolic syndrome, irrespective of the diagnostic criteria used [8]. Insulin resistance triggers a cascade of metabolic abnormalities, including hyperglycemia, dyslipidemia, and hypertension, which collectively increase the risk of CVD and T2DM [9].

While the WHO criteria incorporate insulin resistance as a mandatory component, the IDF criteria do not, which may explain the slightly weaker correlation observed with WHO criteria ($r=0.52$, $p<0.001$). However, the inclusion of other components such as central obesity and dyslipidemia in the IDF criteria ensures a broader detection of at-risk individuals. These findings highlight the potential of using insulin resistance markers like HOMA-IR in conjunction with IDF criteria to improve diagnostic accuracy [10].

Association with Microalbuminuria

Microalbuminuria, a marker of early endothelial dysfunction and renal damage, was significantly associated with metabolic syndrome in this study. Among individuals diagnosed with Syndrome X, microalbuminuria was present in 27.4% of IDF-positive cases and 21.7% of WHO-positive cases. This finding highlights the importance of microalbuminuria as an early indicator of systemic vascular and renal damage in metabolic syndrome [11].

The inclusion of microalbuminuria in the WHO criteria provides an additional layer of prognostic information, particularly in populations with high rates of diabetes and chronic kidney disease (CKD) [12]. However, its absence from the IDF criteria may limit the identification of individuals at risk for renal complications. Given the rising prevalence of CKD in India, incorporating microalbuminuria testing in routine metabolic syndrome assessments could enhance early detection and intervention [13].

Predictors of Syndrome X

Multivariate regression analysis identified central obesity as the strongest predictor of metabolic syndrome (odds ratio [OR] = 2.8, $p<0.001$). Elevated fasting glucose (OR = 1.9, $p<0.01$) and triglyceride levels (OR = 1.5, $p<0.05$) were also significant predictors. These findings align with the IDF criteria,

which emphasize central obesity and dyslipidemia as critical components of metabolic syndrome [14]. The strong predictive value of central obesity underscores its importance in the pathogenesis of metabolic syndrome, particularly in South Asians, who exhibit a higher propensity for abdominal fat deposition and associated metabolic complications [2].

Implications for Diagnosis and Public Health

The findings of this study have important implications for the diagnosis and management of metabolic syndrome in India. The higher prevalence observed with IDF criteria suggests that they may be more sensitive in identifying individuals at risk in the Indian population. However, the WHO criteria provide additional insights into metabolic and renal dysfunction through their focus on insulin resistance and microalbuminuria.

Integrating the strengths of both criteria could improve diagnostic accuracy and clinical utility. For instance, using IDF criteria as the primary diagnostic tool and supplementing it with insulin resistance and microalbuminuria assessments could provide a comprehensive risk profile. This approach would enable early identification of individuals at risk for both cardiovascular and renal complications, facilitating timely interventions.

Public health strategies should focus on lifestyle interventions targeting central obesity, dyslipidemia, and insulin resistance. Educational campaigns promoting healthy diets, regular physical activity, and stress management are crucial, particularly in urban areas where the prevalence of metabolic syndrome is higher. Additionally, incorporating routine metabolic syndrome screening in primary healthcare settings could improve early detection and management.

Study Strengths and Limitations

A major strength of this study is its large, representative sample of middle-aged Indian males, which enhances the generalizability of the findings. The use of two widely accepted diagnostic criteria allows for a robust comparison of their applicability in the Indian context. Furthermore, the inclusion of markers such as insulin resistance and microalbuminuria provides valuable insights into the metabolic and vascular implications of metabolic syndrome.

However, the study has several limitations. Its cross-sectional design precludes causal inferences, and longitudinal studies are needed to confirm the observed associations. The study also excluded females, limiting the generalizability of the findings to the broader population. Future research should include both genders and explore the impact of socioeconomic and cultural factors on metabolic syndrome prevalence and outcomes.

Future Directions

Future studies should focus on developing region-specific diagnostic criteria that incorporate the unique metabolic characteristics of South Asians. Additionally, exploring the genetic and epigenetic factors contributing to the "thin-fat phenotype" could provide deeper insights into the pathogenesis of metabolic syndrome in this population. Research on cost-effective strategies for incorporating insulin resistance and microalbuminuria testing into routine screenings is also warranted, given the resource constraints in many healthcare settings.

CONCLUSION

This study highlights the higher prevalence of Syndrome X in middle-aged Indian males using IDF criteria compared to WHO criteria, with significant correlations to insulin resistance and microalbuminuria. While IDF criteria appear more sensitive in identifying at-risk individuals, the WHO criteria provide valuable insights into metabolic and vascular dysfunction. Integrating the strengths of both criteria could enhance the early detection and management of metabolic syndrome, reducing the burden of CVD and T2DM in India.

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