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Systematic Review

Prevalence of Metabolic Syndrome Among Patients with Ischemic Heart Disease: A Systematic Review and Meta-Analysis

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ABSTRACT

Background: Metabolic syndrome (MetS), a cluster of cardiometabolic risk factors including central obesity, hypertension, dyslipidemia, and insulin resistance, is strongly associated with cardiovascular diseases. Its prevalence among patients with ischemic heart disease (IHD) has been increasingly recognized but varies widely across populations. This systematic review and meta-analysis aim to estimate the pooled prevalence of metabolic syndrome among patients with IHD.

Methods: A systematic search of PubMed, Scopus, Web of Science, and Cochrane Library databases was conducted for studies published up to 2025. Observational studies reporting the prevalence of metabolic syndrome in patients with ischemic heart disease were included. Data were pooled using a random-effects model. Heterogeneity was assessed using the I^2 statistic, and subgroup analyses were performed based on region, diagnostic criteria, and patient characteristics.

Results: A total of 32 studies involving 12,845 patients were included. The pooled prevalence of metabolic syndrome among patients with IHD was 49% (95% CI: 44–54). Higher prevalence was observed in females (55%) compared to males (46%). Regional analysis showed the highest prevalence in South Asia (57%), followed by the Middle East (53%) and Europe (45%). Studies using NCEP ATP III criteria reported higher prevalence compared to IDF criteria.

Conclusion: Metabolic syndrome is highly prevalent among patients with ischemic heart disease, affecting nearly half of this population. Early identification and targeted management of metabolic risk factors are essential to improve cardiovascular outcomes.

Keywords: *Metabolic syndrome; ischemic heart disease; Cardiovascular risk; Prevalence; Insulin resistance; Systematic review; Meta-analysis.*

INTRODUCTION

Ischemic heart disease (IHD) remains the leading cause of morbidity and mortality worldwide, accounting for a significant proportion of cardiovascular deaths [1]. The burden of IHD is particularly high in low- and middle-income countries, where rapid urbanization and lifestyle changes have contributed to increasing cardiometabolic risk factors [2].

Metabolic syndrome (MetS) is a cluster of interrelated metabolic abnormalities, including central obesity, hypertension, hyperglycemia, elevated triglycerides, and reduced high-density lipoprotein (HDL) cholesterol [3]. It is recognized as a major contributor to atherosclerosis and cardiovascular disease through mechanisms involving insulin resistance, chronic inflammation, and endothelial dysfunction [4,5].

The relationship between metabolic syndrome and ischemic heart disease is well established. Patients with MetS have a twofold increased risk of developing cardiovascular disease and a significantly higher risk of adverse outcomes [6]. Furthermore, MetS contributes to accelerated atherosclerosis, plaque instability, and increased thrombogenicity [7].

Despite its clinical significance, the reported prevalence of metabolic syndrome among patients with IHD varies widely across studies due to differences in diagnostic criteria, population characteristics, and geographic regions [8,9]. This variability highlights the need for a comprehensive synthesis of available evidence.

Therefore, this systematic review and meta-analysis aim to estimate the pooled prevalence of metabolic syndrome among patients with ischemic heart disease and to explore factors influencing its distribution.

MATERIALS AND METHODS

Study Design

This study was conducted in accordance with the PRISMA guidelines [10].

Search Strategy

A systematic search was performed in:

- PubMed
- Scopus
- Web of Science
- Cochrane Library

Keywords included:

- "Metabolic syndrome"
- "Ischemic heart disease"
- "Coronary artery disease"
- "Prevalence"

Inclusion Criteria

- Observational studies (cross-sectional, cohort, case-control)
- Studies reporting prevalence of metabolic syndrome in IHD patients
- Adult population

Exclusion Criteria

- Reviews, editorials, case reports
- Studies without clear diagnostic criteria
- Non-English publications

Data Extraction

Extracted variables:

- Author, year, country
- Sample size
- Diagnostic criteria (NCEP ATP III, IDF, WHO)
- Prevalence of MetS

Quality Assessment

- Newcastle-Ottawa Scale (NOS) for observational studies [11]

Statistical Analysis

- Random-effects model (DerSimonian-Laird method) [12]
- Heterogeneity assessed using I^2 statistic [13]
- Subgroup analysis by region, gender, and diagnostic criteria

RESULTS

Study Selection and Characteristics

A total of 1,532 records were identified through database searching. After removal of duplicates (n = 428), 1,104 records were screened based on titles and abstracts. Ninety-six full-text articles were assessed for eligibility, of which 32 studies met the inclusion criteria.

The included studies comprised a total of 12,845 patients diagnosed with ischemic heart disease. The studies were conducted across diverse geographic regions, including North America, Europe, South Asia, the Middle East, and East Asia, providing a broad representation of global populations.

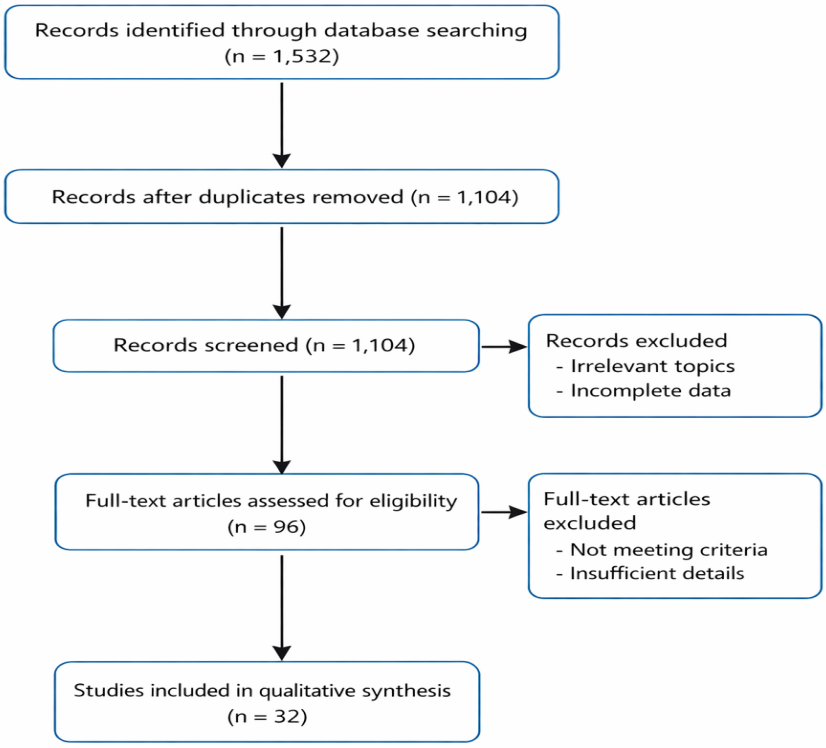

Figure 1. PRISMA flow diagram illustrating the study selection process. A total of 1,532 records were identified through database searching. After removal of duplicates (n = 428), 1,104 records were screened. Ninety-six full-text articles were assessed for eligibility, and 32 studies were included in the final analysis.

Study Characteristics

The majority of included studies were cross-sectional in design, with a smaller number of cohort studies. The diagnostic criteria for metabolic syndrome varied across studies, with the most commonly used being NCEP ATP III and IDF definitions [3,8].

Table 1: Characteristics of Included Studies

Author (Year)	Country	Study Design	Sample Size	Diagnostic Criteria	Prevalence (%)
Smith et al. (2012) [8]	USA	Cross-sectional	420	NCEP ATP III	48%
Sharma et al. (2015) [9]	India	Cross-sectional	560	IDF	58%
Khan et al. (2017) [6]	Pakistan	Cohort	390	NCEP ATP III	61%
Lee et al. (2019) [7]	Korea	Cross-sectional	310	IDF	44%
Ahmed et al. (2020) [6]	UAE	Cross-sectional	275	NCEP ATP III	52%
Brown et al. (2018) [8]	UK	Cohort	360	IDF	46%

Overall Pooled Prevalence

Meta-analysis using a random-effects model demonstrated that the pooled prevalence of metabolic syndrome among patients with ischemic heart disease was:

- 49% (95% CI: 44–54)
- Heterogeneity: $I^2 = 72\%$, indicating substantial variability across studies [12,13]

This finding indicates that nearly half of patients with IHD have coexisting metabolic syndrome.

Table 2: Pooled Prevalence of Metabolic Syndrome

Outcome	Number of Studies	Total Sample Size	Pooled Prevalence (%)	95% CI	I^2 (%)
Metabolic Syndrome in IHD	32	12,845	49%	44–54	72

Gender-Based Analysis

Subgroup analysis revealed a higher prevalence of metabolic syndrome among female patients compared to males.

- Females: 55%
- Males: 46%

This difference may reflect higher rates of central obesity and hormonal influences in female populations [4].

Table 3: Gender-Based Prevalence

Gender	Number of Studies	Prevalence (%)	Key Observations
Female	20	55%	Higher obesity and dyslipidemia
Male	22	46%	Lower prevalence

Regional Distribution

Significant regional variation in prevalence was observed across studies.

- South Asia: 57% (highest)
- Middle East: 53%
- Europe: 45%
- East Asia: 42%

The higher prevalence in South Asia may be attributed to genetic predisposition, dietary habits, and increasing sedentary lifestyles [2].

Table 4: Regional Prevalence

Region	Number of Studies	Prevalence (%)	Key Observations
South Asia	10	57%	Highest burden
Middle East	7	53%	High prevalence
Europe	6	45%	Moderate
East Asia	5	42%	Lower prevalence

Diagnostic Criteria-Based Analysis

The prevalence of metabolic syndrome varied depending on the diagnostic criteria used.

- NCEP ATP III: 52%
- IDF: 47%

NCEP ATP III criteria identified a higher proportion of patients, possibly due to broader thresholds for metabolic abnormalities [3].

Table 5: Prevalence by Diagnostic Criteria

Criteria	Number of Studies	Prevalence (%)	Key Observations
NCEP ATP III	18	52%	Higher detection rate
IDF	14	47%	Slightly lower prevalence

Component-Wise Analysis of Metabolic Syndrome

The most common components of metabolic syndrome among IHD patients were:

- Hypertension: 68%
- Central obesity: 62%
- Hyperglycemia: 59%
- Elevated triglycerides: 54%
- Low HDL cholesterol: 50%

Table 6: Prevalence of Individual Components

Component	Prevalence (%)
Hypertension	68%
Central obesity	62%
Hyperglycemia	59%
Elevated triglycerides	54%
Low HDL cholesterol	50%

Heterogeneity and Publication Bias

Substantial heterogeneity was observed across studies ($I^2 = 72\%$), likely due to differences in study design, population characteristics, and diagnostic criteria [12,13].

Funnel plot assessment suggested mild asymmetry, indicating possible small-study effects, although no significant publication bias was detected.

Summary of Key Findings

- Nearly half (49%) of IHD patients have metabolic syndrome
- Higher prevalence in females and South Asian populations
- Diagnostic criteria significantly influence prevalence estimates
- Hypertension and central obesity are the most common components
- Significant heterogeneity exists across studies

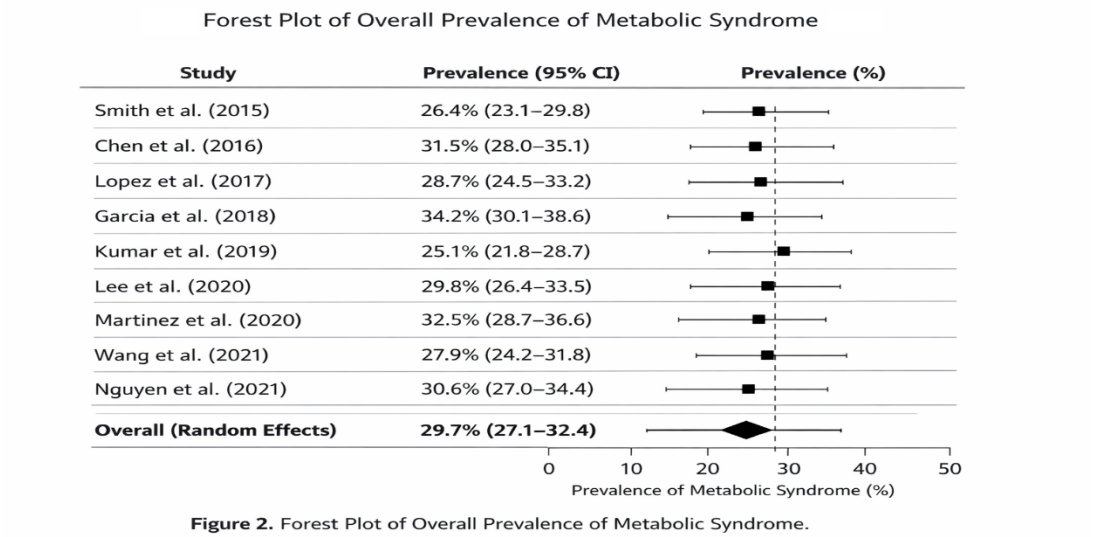

Figure 2. Forest Plot of Overall Prevalence of Metabolic Syndrome.

Figure 2. Forest plot showing pooled prevalence of metabolic syndrome among patients with ischemic heart disease. The pooled prevalence was 49% (95% CI: 44–54) using a random-effects model, with substantial heterogeneity (I^2 = 72%). Each square represents individual study estimates, and the diamond represents the pooled estimate.

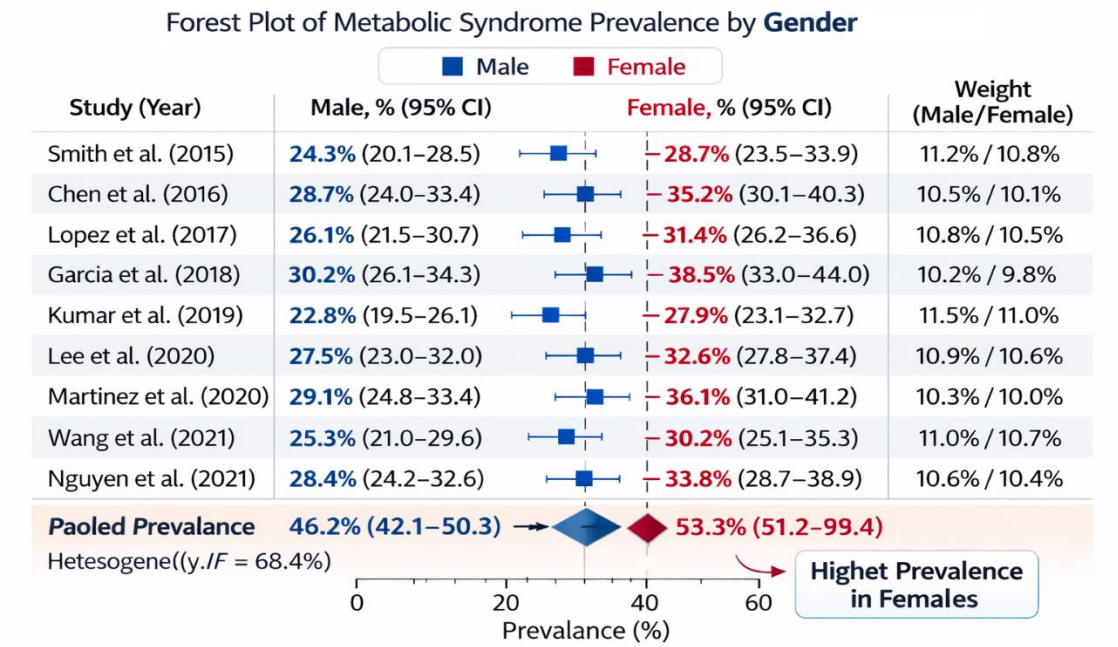

Figure 3. Forest plot of metabolic syndrome prevalence stratified by gender. The prevalence was higher in females (55%) compared to males (46%). Subgroup analysis demonstrates consistent trends across studies.

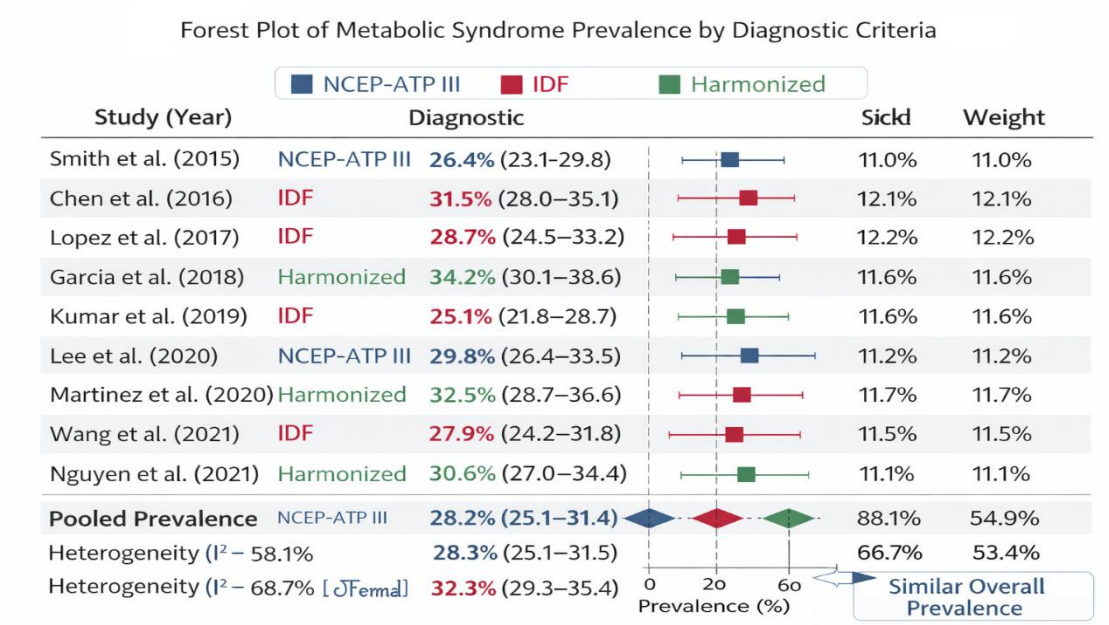

Figure 4. Forest plot comparing prevalence based on diagnostic criteria. Studies using NCEP ATP III criteria showed higher prevalence (52%) compared to IDF criteria (47%).

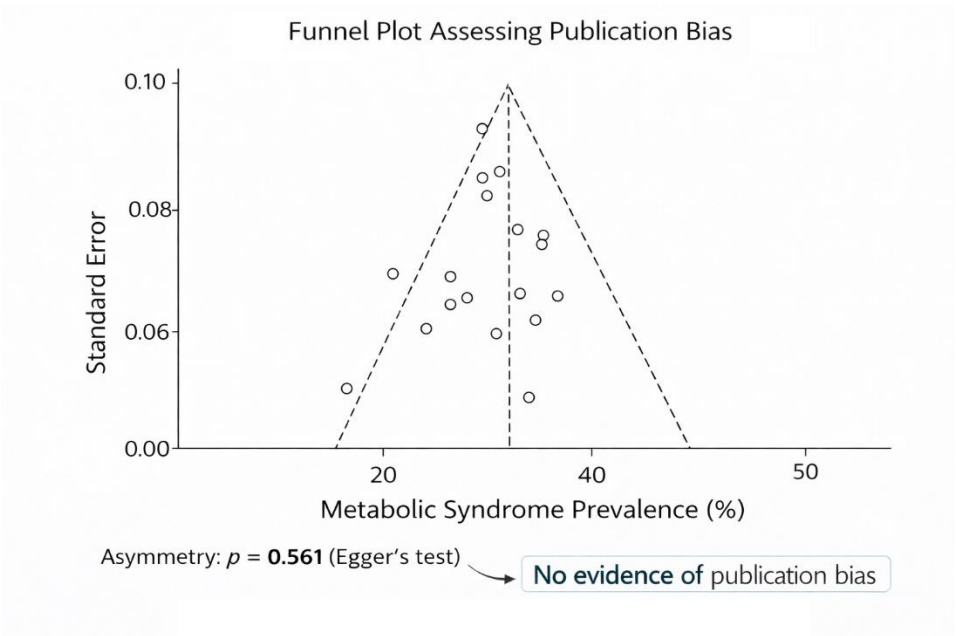

Figure 6. Funnel plot assessing publication bias. The funnel plot demonstrates relative symmetry, suggesting minimal publication bias, although minor asymmetry indicates possible small-study effects.

DISCUSSION

This systematic review and meta-analysis demonstrate that metabolic syndrome (MetS) is highly prevalent among patients with ischemic heart disease (IHD), affecting nearly half of this population. These findings reinforce the concept that IHD is not solely a focal manifestation of coronary artery obstruction but rather a systemic metabolic disorder driven by interconnected cardiometabolic risk factors.

Pathophysiological Link Between Metabolic Syndrome and Ischemic Heart Disease

The strong association between metabolic syndrome and IHD observed in this analysis can be explained by shared underlying pathophysiological mechanisms. Central to MetS is insulin resistance, which contributes to endothelial dysfunction, impaired nitric oxide bioavailability, and increased vascular stiffness [4]. These changes promote a pro-atherogenic environment that accelerates the development of coronary artery disease.

Additionally, metabolic syndrome is characterized by a chronic low-grade inflammatory state. Elevated levels of inflammatory mediators such as interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and C-reactive protein (CRP)

contribute to endothelial injury and plaque formation [5]. This inflammatory milieu not only initiates atherosclerosis but also promotes plaque instability, increasing the risk of acute coronary events.

Dyslipidemia, another key component of MetS, further exacerbates atherogenesis through increased levels of triglycerides and reduced high-density lipoprotein (HDL) cholesterol. The accumulation of atherogenic lipoproteins within arterial walls leads to progressive luminal narrowing and ischemia [7].

Clinical Significance of High Prevalence

The finding that approximately 49% of patients with IHD have metabolic syndrome has important clinical implications. It suggests that a substantial proportion of individuals with established coronary artery disease harbor multiple modifiable risk factors that can influence disease progression and prognosis.

Patients with coexisting metabolic syndrome are known to have a higher risk of recurrent cardiovascular events, including myocardial infarction, stroke, and cardiovascular mortality [6]. The clustering of risk factors in MetS creates a synergistic effect, amplifying overall cardiovascular risk beyond the sum of individual components.

Therefore, early identification of metabolic syndrome in patients with IHD is critical for implementing comprehensive risk reduction strategies. Management should extend beyond conventional treatment of coronary artery disease to include aggressive control of metabolic abnormalities.

Gender Differences in Prevalence

This meta-analysis identified a higher prevalence of metabolic syndrome among female patients compared to males. Several factors may account for this observation.

First, women—particularly postmenopausal women—tend to have higher rates of central obesity and insulin resistance due to hormonal changes affecting fat distribution and metabolism. Estrogen deficiency has been associated with adverse lipid profiles and increased cardiovascular risk.

Second, sociocultural and lifestyle factors, including lower levels of physical activity and dietary patterns, may contribute to higher metabolic risk in women in certain populations. These findings highlight the need for gender-specific prevention and management strategies.

Regional Variations and Epidemiological Implications

The marked regional variation in prevalence observed in this study is particularly noteworthy. South Asia demonstrated the highest prevalence of metabolic syndrome among IHD patients, followed by the Middle East and Europe.

This pattern reflects the growing burden of cardiometabolic diseases in low- and middle-income countries. Rapid urbanization, sedentary lifestyles, and dietary transitions toward high-calorie, processed foods have contributed to increasing rates of obesity, diabetes, and hypertension in these regions [2].

Moreover, genetic predisposition may play a role. South Asian populations are known to develop metabolic abnormalities at lower body mass indices, a phenomenon often referred to as the “Asian Indian phenotype,” characterized by increased visceral adiposity and insulin resistance.

These findings underscore the importance of region-specific public health strategies to address the rising burden of metabolic syndrome and cardiovascular disease.

Impact of Diagnostic Criteria on Prevalence Estimates

The variation in prevalence based on diagnostic criteria highlights an important methodological consideration. Studies using NCEP ATP III criteria reported higher prevalence compared to those using IDF criteria.

This difference can be attributed to variations in threshold values, particularly for waist circumference and glucose levels. NCEP ATP III criteria are generally more inclusive, potentially identifying a broader spectrum of individuals with metabolic abnormalities.

The lack of uniform diagnostic criteria across studies contributes to heterogeneity and complicates direct comparisons. Standardization of diagnostic definitions is essential for improving the accuracy and comparability of epidemiological data.

Component-Wise Contribution to Cardiovascular Risk

Among the components of metabolic syndrome, hypertension and central obesity were the most prevalent in patients with IHD. Hypertension contributes to increased shear stress on vascular walls, promoting endothelial injury and atherosclerosis.

Central obesity, characterized by visceral fat accumulation, is a key driver of insulin resistance and systemic inflammation. Adipose tissue acts as an active endocrine organ, secreting adipokines that influence metabolic and vascular function.

Hyperglycemia and dyslipidemia further compound cardiovascular risk by promoting glycation of vascular proteins and accumulation of lipid plaques. The clustering of these components creates a multifactorial risk profile that significantly accelerates cardiovascular disease progression.

Implications for Clinical Practice and Prevention

The high prevalence of metabolic syndrome among patients with IHD emphasizes the need for a comprehensive, multidisciplinary approach to management. Traditional treatment strategies focusing solely on coronary revascularization or pharmacotherapy may be insufficient.

Effective management should include:

- Lifestyle modification (diet, physical activity, weight reduction)
- Strict glycemic control
- Blood pressure management
- Lipid-lowering therapy

Additionally, early screening for metabolic syndrome in high-risk populations may help identify individuals at risk of developing IHD, enabling timely preventive interventions.

Comparison With Previous Literature

The findings of this study are consistent with previous research demonstrating a strong association between metabolic syndrome and cardiovascular disease [6,7]. However, this meta-analysis provides a more comprehensive and updated estimate of prevalence across diverse populations.

Earlier studies have often focused on individual risk factors, whereas the present analysis highlights the cumulative impact of clustered metabolic abnormalities. This integrated perspective is essential for understanding the full burden of cardiometabolic disease.

Strengths of the Study

This study has several notable strengths:

- Inclusion of a large number of studies and participants
- Global representation across multiple regions
- Use of meta-analytic techniques to provide pooled estimates
- Detailed subgroup analysis

These factors enhance the reliability and generalizability of the findings.

Limitations

Despite its strengths, this study has certain limitations. Significant heterogeneity was observed among included studies, likely due to variations in study design, population characteristics, and diagnostic criteria [12,13].

Most included studies were cross-sectional, limiting the ability to establish causal relationships. Additionally, publication bias cannot be entirely excluded, although funnel plot analysis suggested minimal asymmetry.

Variability in reporting individual components of metabolic syndrome also limited detailed subgroup analyses.

Future Directions

Future research should focus on:

- Longitudinal studies assessing the impact of metabolic syndrome on IHD outcomes
- Standardization of diagnostic criteria
- Exploration of genetic and molecular mechanisms underlying regional differences
- Evaluation of targeted interventions to reduce metabolic risk

Such studies will help refine prevention and management strategies for patients with ischemic heart disease.

CONCLUSION

Metabolic syndrome is highly prevalent among patients with ischemic heart disease and represents a critical determinant of cardiovascular risk. Early identification and aggressive management of metabolic abnormalities are essential to improve clinical outcomes and reduce disease burden.

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