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Review

Prevalence of metabolic syndrome in Nepal: A systematic review of all published studies

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Abstract. *Background and aim:* Metabolic syndrome (MetS) encompasses a cluster of medical conditions that significantly increase the risk of type 2 diabetes mellitus (T2DM), cardiovascular disease (CVD), cancer, and stroke. The global prevalence of MetS is rising, with a notable increase across South Asian countries. Multiple studies from diverse regions of Nepal, examining both general and clinical populations, have documented high MetS prevalence rates. This systematic review aims to determine the comprehensive prevalence of MetS in Nepal. *Methods:* We conducted systematic searches across PubMed, Web of Science, Scopus, and EMBASE databases. Our review included all studies reporting MetS prevalence in Nepal among individuals aged 15 years and older, regardless of the study setting. We calculated the weighted mean prevalence and assessed study quality using the Joanna Briggs Institute (JBI) critical appraisal tool for prevalence studies. *Results:* In the general population (n=6,065; males:34%, females:66%), the weighted mean prevalence of MetS ranged from 17.11% to 18.41%, varying by diagnostic criteria. MetS prevalence was higher among females (females:17.73-20.78%: males: 14.93-16.64%), older adults, and individuals with lower educational attainment. Among populations with existing medical conditions, MetS prevalence was highest in patients with T2DM (90.36%, n=1710; males:54%, females:46%) and lowest in those with Psoriasis (20.83%, n=72). *Conclusions:* Our findings demonstrate the substantial prevalence of MetS; interpretation must consider the variability in diagnostic criteria across studies and the predominant focus on major urban centres. Authorities should focus on interventions addressing modifiable risk factors such as alcohol consumption, smoking, and physical inactivity to reduce the overall disease burden. (www.actabiomedica.it)

Key words: metabolic syndrome, Nepal, prevalence, systematic review, type 2 diabetes mellitus

Introduction

Metabolic syndrome (MetS) is characterized by a constellation of conditions, including dyslipidemia, elevated fasting plasma glucose (FPG), central obesity, and hypertension. Individuals with MetS face substantially increased risks of type 2 diabetes mellitus (T2DM) and cardiovascular disease (CVD) (1). The pathogenesis of MetS involves insulin resistance (IR), chronic inflammation, and neurohormonal activation, which contribute to its progression toward CVD and T2DM (2). The global obesity epidemic has elevated

MetS to a major public health concern (3). Moreover, recent evidence demonstrates that MetS, accompanied by obesity, substantially increases the risk of non-alcoholic fatty liver disease (NAFLD), a chronic liver condition affecting approximately 25% of the global adult population (4,5). Current prevalence estimates indicate that 41.8% of adults in the United States have MetS, with rising rates worldwide (6). In China, a recent meta-analysis by R Li and colleagues found that 24.5% of the population aged 15 years and older meets MetS criteria (7). Among South Asian nations, MetS affects approximately 30% of the population in India (8) and Bangladesh (9). This prevalence has been attributed to increasing urbanization, sedentary behaviours, and poor dietary patterns (10–12). Nepal, a lower-middle-income country in South Asia (13), faces particular challenges in this context. Moreover, public hospitals in Nepal face severe shortages of basic facilities and medical staff, including doctors, paramedics, and nursing professionals. The primary healthcare system is hampered by limited access to free medications and inadequate funding to address the growing burden of non-communicable diseases (14). Additionally, Nepal lacks routine health surveillance and disease registration systems, making it difficult to manage MetS (11). The World Health Organization's (WHO) 2023 report highlights that low and middle-income countries bear a disproportionate burden of non-communicable disease mortality (15). Understanding its current burden in Nepal is crucial, given the established links between MetS and various non-communicable diseases. Studies examining MetS prevalence across different Nepalese populations, including general communities (11) and specific patient groups such as T2DM (16), have reported varying rates depending on the diagnostic criteria employed. This variability may result in misinformation regarding the accurate prevalence rates of MetS and hinder the effective implementation of public health interventions. To our knowledge, no systematic review has examined MetS prevalence in Nepal's population. This review aims to provide comprehensive data on the MetS burden across Nepal's general and clinical populations. Early identification of MetS is vital for recognizing individuals at elevated risk for CVD, T2DM, and associated comorbidities.

Materials and methods

This systematic review followed the PRISMA 2020 guidelines and was prepared based on the PRISMA 2020 checklist (17). The protocol PROSPERO registration number is CRD42023476479. The checklist is available in Table S1.

Eligibility criteria

We included observational studies that reported MetS prevalence among individuals aged 15 years and older from both urban and rural populations in Nepal, irrespective of the study setting. Studies were excluded if they were not published in English, conducted outside Nepal, or were reviews, unpublished works, editorial letters, randomized controlled trials, case studies, commentaries, or conference abstracts.

Search strategy and information sources

Two authors (RR and SUK) independently conducted systematic searches in PubMed, Scopus, Web of Science, and EMBASE databases from their inception until October 2023. The search strategy was implemented in two stages. First, we used the key search terms: 'metabolic syndrome,' OR 'metabolic syndrome X,' OR 'insulin resistance syndrome,' AND 'prevalence,' OR 'epidemiology,' AND 'Nepal.' Second, we restricted results to English-language studies conducted in humans. We reviewed reference lists of included articles to identify potentially missed publications. Additionally, we searched the National Journal of Nepal for relevant articles. Our detailed screening methodology is outlined in (Table S2).

Study selection

The identified articles were imported into Mendeley, and duplicates were removed. Two authors (RR and SUK) independently screened all titles and abstracts for eligibility. Subsequently, they conducted independent full-text screenings to exclude articles that did not meet the inclusion criteria. Any disagreements during the screening process were resolved by a third author (UK).

Data extraction

Studies were classified into three categories: 1) prevalence in healthy populations, 2) prevalence among disease populations (such as T2DM and hypertension), and 3) prevalence in specific population groups (such as students). An Excel spreadsheet was developed to extract relevant information for analysis. The extracted data included first author, publication date, MetS diagnostic criteria, study location, population source, urban/rural setting, age, sex, and MetS prevalence. Two authors (RR and SUK) independently performed data extraction. Any disagreements were resolved by a third author (UK or BAS).

Quality assessment

The JBI Critical Appraisal Checklist for Prevalence Studies was used to assess potential bias in the included studies (18). Two researchers (RR and SUK) independently conducted quality evaluations. The checklist comprises nine questions assessing: inclusion criteria eligibility, sample description, participant recruitment suitability, sample size appropriateness through participant and setting descriptions, sample representativeness, diagnostic criteria standardization, result reliability and validity, statistical methodology, and response rate adequacy. Each question could be answered as 'Yes,' 'No,' 'Unclear,' or 'Not Applicable.' Studies were classified as having high risk of bias if any question was answered 'No' or 'Unclear,' while studies with all 'Yes' responses were considered to have low risk of bias. Results were expressed as frequencies and were not used as study eligibility criteria.

Results

Study selection

The literature selection process is illustrated in Figure 1. Initial database searches identified 149 articles. After duplicate removal, 82 articles underwent title and abstract screening. Sixty-one articles were excluded for not meeting the inclusion criteria. The remaining 21 articles underwent full-text evaluation, leading to two additional exclusions. Nineteen studies were ultimately included in this review. The weighted mean prevalence was calculated using the formula: "sum of cases across all studies divided by the total number of participants across all studies*100"(19).

Study characteristics

Table 1 summarizes the key characteristics of the included studies. Of the 19 studies, 14 examined disease populations, three investigated the general population, and two focused on specific populations (college students and hospital staff). Fifteen studies were hospital-based, while four were community-based. More than half of the studies were conducted in Kathmandu. With the exception of one nationally representative study, no studies were reported from Nepal's mid- and far-western regions.

Metabolic syndrome definition and sampling technique

The definitions of MetS used across various studies are shown in Table 2. Most studies adopted the National Cholesterol Education Program-Adult Treatment Panel (NCEP ATP) III definition, followed by the International Diabetes Federation (IDF) and WHO definitions. Regarding sampling techniques, six researchers employed random sampling strategies (11,20–24), while ten studies used non-random sampling strategies (16,25–33). Three researchers did not disclose their sampling strategies (34–36).

Risk of bias

The study quality was evaluated using criteria defined by JBI guidelines (18), and the results are summarized in Figure 2, and Table S3. In 57.89% of studies, an appropriate sample frame was used to address the target population. However, only 26.31% of studies employed appropriate sampling techniques. The sample size was adequate in 47.37% of studies. In 94.73% of the articles, the study setting and participants were described in detail. Adequate sample coverage for data analysis was achieved in 84.21% of studies. All investigations used appropriate methods to determine the condition and adopted reliable, standardized methods

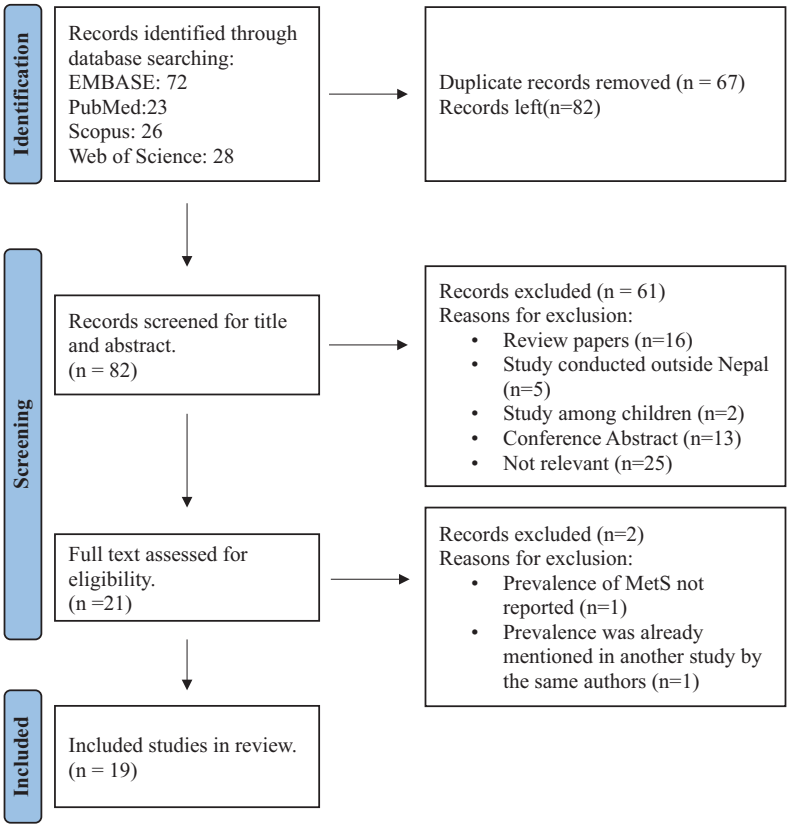

Figure 1. PRISMA flow diagram of the systematic review process and selection of eligible articles

for assessing participants. Appropriate statistical analysis was employed in 42.10% of studies. The response rate was adequately managed in 52.63% of studies.

Prevalence

General population

Three studies were conducted in the general population, comprising 6,065 subjects: 34% males and 66% females. The prevalence of MetS was reported using various guidelines (Table 2). MetS prevalence varied based on the guidelines used to define it. Two studies (11,20) used NCEP ATP III and IDF criteria, while one study (22) used the American Heart Association and National Heart, Lung, and Blood Institute (AHA/NHLBI) criteria with Asian cut-off points for waist circumference. The weighted mean prevalence of MetS was 17.11% (NCEP ATP III) (range: 15%-20.7%) and 18.41% (IDF) (range: 16%-22.5%). In contrast, the prevalence was only 12.4% using AHA/NHLBI criteria in one study (22). When comparing males and females using NCEP ATP III and IDF criteria (11,20), the weighted mean prevalence in males was 16.64% (NCEP ATP III) (range: 15.30%-18.6%) and 14.93% (IDF) (range: 13.42%-17.1%). In females, it was 17.73% (NCEP ATP III) (range: 15.43%-21.9%) and 20.78% (IDF) (range: 18.10%-25.7%). In contrast, in the study using AHA/NHLBI criteria (22), the prevalence was higher among males (16.9%) compared to females (8.75%). Two studies reported prevalence by age (11,20), showing increasing prevalence with age using NCEP ATP III criteria. In one study, the prevalence was higher among those aged 41-60 years than those aged 61-80 using IDF criteria. Additionally, the prevalence was higher among participants with lower

Table 1. Study population

SN	Studies	N	Study characteristics
1	General population	3	n=6065, 18-90 years, 66% Females
2	Type 2 diabetes mellitus (T2DM)	4	n=1710, ≥ 20 years, 54% Males
3	Chronic Obstructive Pulmonary Disease (COPD)	2	n=141, >18 years (NR)
4	Polycystic Ovarian Syndrome (PCOS)	1	n=106, 15-40 years
5	Chronic Kidney Disease (CKD)	1	n=160, Age (NR), 50% Males, 50% Females
6	Acute Myocardial Infarction (AMI)	1	n=84, Age (NR), 65.5% Males
7	Central Obesity	1	n=378, 18-80 years,51% Females
8	Hypertension	1	n=150, 30-74 years, 53% Females
9	Gout	1	n= 523, >18 years, 97% Males
10	Non-alcoholic fatty liver disease (NAFLD)	1	n= 219, 30-60 years, (NR)
11	Psoriasis	1	n=72, >18 years, (NR)
12	Hospital staffs	1	n=118, Age (NR), 83% Males
13	Students	1	n=739, 18-25 years, 63% Females

Abbreviations: NR= Not Reported, N: number of studies done in that group of population, n: sample size

levels of education. The MetS component prevalence was reported in two studies: one study (13) reported prevalence in the whole population, where low high-density lipoprotein-cholesterol (HDL-C) was the most prevalent component (70.72%), while FPG was the least prevalent (17.59%). In males, central obesity was the least prevalent component (18.03%), while in females, it was FPG (13.71%). In the study by Sharma D et al. (22), which reported component prevalence among MetS cases only, triglycerides were the most prevalent component (94.44%), while low HDL-C and increased FPG were the least prevalent (61.11%). The prevalence of MetS among students is shown in Table 2, with the highest rate reported using Harmonize criteria (7.1%) and the lowest using the WHO definition (3.6%) (29). Low HDL-C was found in 78% of students, while hypertension was present in 4.2%. Among hospital staff Table 2, 39% had MetS according to NCEP ATP III criteria, with prevalence rates of 33.89% in males and 5.08% in females (24).

Among disease population

In T2DM patients (Table 2) (16,30,34,35), the weighted mean prevalence of MetS was 76.02% (IDF), 77.30% (NCEP ATP III), 77.28% (WHO), and 90.36% (Harmonized). In one study (35) using NCEP ATP III criteria with Asian cut-off points for waist circumference (WC), the prevalence of MetS was 76.9%. The gender-wise weighted mean prevalence of MetS in males was 67.69% (IDF), 70.53% (NCEP ATP III), 86.63% (Harmonized), and 80.78% (WHO), while in females it was 85.98% (IDF), 85.39% (NCEP ATP III), 95.06% (Harmonized), and 82.35% (WHO). Using the NCEP ATP III definition with Asian WC cut-off points (35), the prevalence was 70% in males and 85.3% in females. We used NCEP ATP III criteria to calculate the weighted mean prevalence of each MetS component in T2DM. Low HDL-C (70.05%) was the most frequent component, followed by triglycerides (62.34%), hypertension (55.96%), and central obesity (44.05%). In HK Tamang et al. study (35), which used Asian cut-off points for waist circumference, the prevalence was 63.5%. Two studies were conducted among chronic obstructive pulmonary disease (COPD) patients (Table 2) (25,27). The weighted mean prevalence of MetS was 36.87% (IDF), with one study reporting a gender-specific prevalence of 40.0% in males and 32.65% in females (27). Across different COPD stages, the weighted mean prevalence was highest in GOLD stage II (21.98%), followed by stage III (6.38%),

Table 2. Metabolic Syndrome Studies in Nepal

Author and Year	Location	Study Population	Sample Size	Definition of MetS	Prevalence of MetS (%)		
					All	Males	Females
D R Pokharel et al. (2014) (34)	Hospital	T2DM	1061	WHO, NCEP ATP III, IDF, JSS	81.1, 83, 80.5,91.6	80, 78.4, 69.6, 87.9	82.6, 89.4, 94.1, 96.2
Sharma K et al. (2023) (16)	Hospital	T2DM	296	Modified NCEP ATP III, IDF	58.4, 66.2	40.7, 66.9	75.5, 65.6
HK Tamang et al. (2013) (35)	Hospital	T2DM	221	Modified NCEP ATP III	76.9	70	85.3
Tamrakar R et al. (2019) (30)	Hospital	T2DM	132	WHO, NCEP ATP III, IDF, JSS	84.1, 80.3, 71.2, 62.1	87, 66.2, 54.5, 76.6	80, 78.2, 72.7, 85.5
Santosh B et al. (2023) (25)	Hospital	COPD	57	IDF	38.59	NR	NR
Singh NK et al. (2021) (27)	Hospital	COPD	84	IDF	35.71	40	32.65
Giri A et al. (2022) (26)	Hospital	PCOS	106	NCEP ATP III	47.1	-	-
Jha BK et al. (2020) (21)	Community	Central Obesity	378	IDF	74.9	77.70	72.20
Vaidya V et al. (2021) (28)	Hospital	Gout	523	NCEP ATP III	30.6	NR	NR
Pardhe BD et al. (2018) (31)	Hospital	NAFLD	219	NCEP ATP II, IDF	13.6, 30.1	NR	NR
Poudel B et al. (2013) (36)	Hospital	CKD	160	NCEP ATP III	37.50	32.50	42.50
Shrestha R et al (2011) (23)	Hospital	Hypertension	150	NCEP ATP III, WHO, IDF	54.7,18.7, 42	49.3, 16.9, 45	59.5, 20.3, 39.2
Pandey S et al. (2009) (32)	Hospital	AMI	89	NCEP ATP III	26.19	NR	NR
Thapa P et al. (2023) (33)	Hospital	Psoriasis	72	NCEP ATP III	20.83	NR	NR
Mehata S et al. (2018) (11)	Community	General Population	3729	NCEP ATP III, IDF	15,16	15.30, 13.42	15.43, 18.10
Sharma SK et al. (2011) (20)	Community	General Population	2191	Modified NCEP ATP III, IDF	20.7, 22.5	18.6, 17.1	21.9, 25.7
Sharma D et al. (2017) (22)	Community	General Population	150	AHA	12.40	16.90	8.75
Sapkota M et al. (2020) (29)	College	Students	739	Modified NCEP ATP III, IDF, AACE, WHO, JSS	4, 5.8, 2.3, 3.6, 7.1	NR	NR
Shrestha S et al. (2010) (24)	Hospital	Staff	118	NCEP ATP III	39	NR	NR

Abbreviations: NR = not reported; IDF = International Diabetes Federation; WHO = World Health Organization; NCEP ATP III = National Cholesterol Education Program Adult Treatment Panel III; JSS= Joint Scientific Statement (Harmonized) AACE= American Association of Clinical Endocrinologists, AHA= American Heart Association, JSS= Joint Scientific Statement (Harmonized)

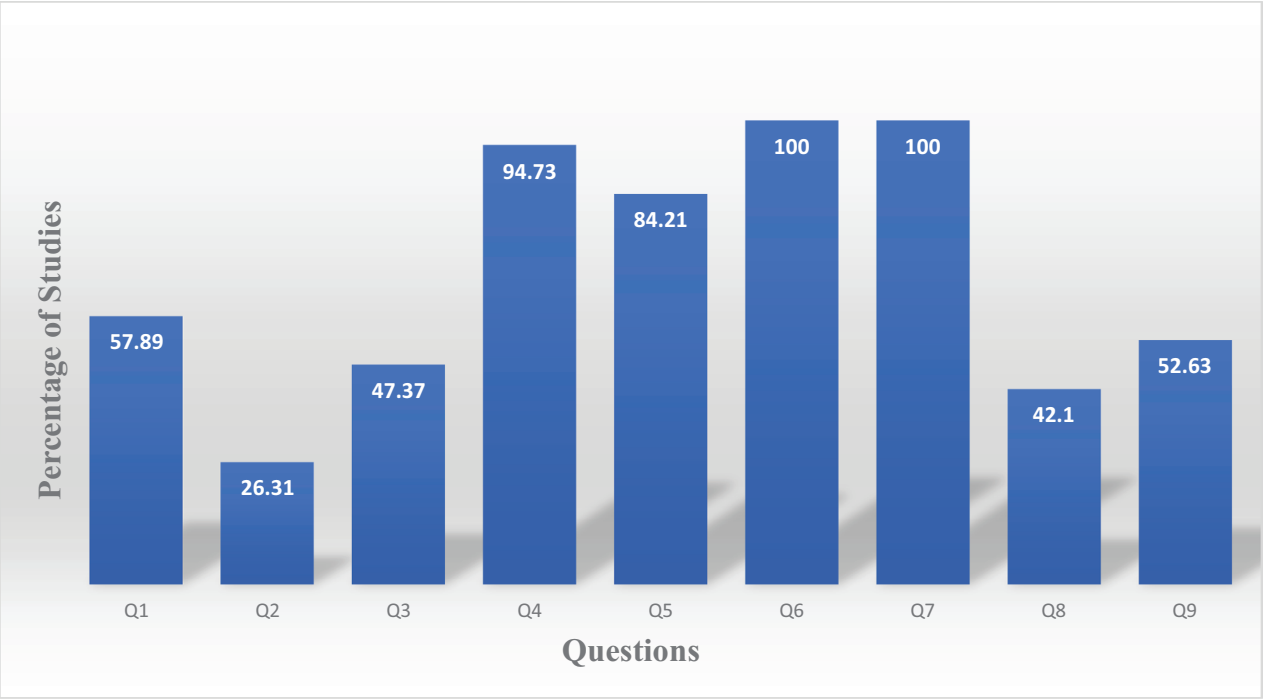

Figure 2. Percentage of studies meeting each JBI quality assessment criterion.

Q1. Was the sample frame appropriate to address the target population? Q2. Were study participants sampled in an appropriate way? Q3. Was the sample size adequate? Q4. Were the study subjects and the setting described in detail? Q5. Was the data analysis conducted with sufficient coverage of the identified sample? Q6. Were valid methods used for the identification of the condition? Q7. Was the condition measured in a standard, reliable way for all participants? Q8. Was there appropriate statistical analysis? Q9. Was the response rate adequate, and if not, was the low response rate managed appropriately? Yes, No, Unclear, and Not Applicable.

stage I (4.96%), and stage IV (3.45%). One study (25) reported component prevalence, with hypertension being the most prevalent (90.90%) and triglycerides the least prevalent (31.80%).

Only one study was conducted for each of the other diseases (Table 2). The prevalence of MetS was: 26.19% in acute myocardial infarction (AMI) patients (32); 18.7% to 54.7% in hypertension patients (23); 37.5% in chronic kidney disease (CKD) patients (36); 13.6% to 30.1% in NAFLD patients (31); 30.6% in gout patients (28); 74.9% in patients with central obesity (21); 47.1% in polycystic ovary syndrome (PCOS) patients (26); and 20.83% in psoriasis patients (33). Among hypertensive patients, the prevalence was higher in females (20.3%-59.5%) than in males (16.9%-49.3%). Similarly, in CKD patients, females showed a higher prevalence (56.67%) compared to males (43.33%). In patients with central obesity, MetS was present in 77.7% of males and 72.2% of females. Several studies reported component-specific prevalence. Low HDL-C was the most prevalent component in NAFLD (69.8%), PCOS (84.9%), and central obesity (84.1%) patients. In gout patients, elevated triglycerides (68%) were the most common component, while in CKD patients, it was hypertension (70%).

Discussion

This review analysed findings from 19 studies published between 2000 and 2023 examining MetS in the Nepalese population. The studies included both general population samples and specific demographic groups. We included all available studies reporting MetS prevalence in Nepal, regardless of study setting or population characteristics. The analysis evaluated gender distribution, MetS diagnostic definitions used, and the

components of MetS assessed in each study. Among the general Nepalese population, the weighted mean prevalence of MetS was 17.11% using NCEP ATP III criteria and 18.41% using IDF criteria. One study (22) that applied NCEP ATP III criteria with Asian-specific waist circumference cutoffs found a prevalence of 12.4%. However, this lower figure may be attributed to the study's smaller sample size. Reviews from other South Asian countries, the Middle East, and Africa indicate that nearly one-third of their populations are affected by MetS (8,9,37,38), a prevalence higher than that observed in our review. The prevalence in America is substantially higher at 41.8%, in contrast to the findings from our review (4). A recent meta-analysis of the Chinese population (7) showed a MetS prevalence of 24.5%, which more closely aligns with our findings from Nepal. The lower prevalence of MetS in Nepal compared to other regions may be attributed to its predominantly rural population distribution and lower socioeconomic status. Urban residents were found to have a high prevalence of MetS due to unhealthy lifestyles compared to their rural counterparts, and higher socioeconomic status was associated with increased MetS prevalence (8,9,11). This pattern likely reflects occupational differences, with much of Nepal's population engaged in physical labour rather than sedentary office work, the latter being more strongly associated with MetS development (39). Consistent with previously mentioned studies, our review found that MetS prevalence was higher among females and individuals with lower literacy rates, with one notable exception where males showed higher prevalence than females (20). The elevated prevalence of MetS among women may be attributed to several factors: their predominant engagement in household activities, post-menopausal physiological changes (particularly the development of central obesity and insulin resistance), PCOS, and hormonal contraceptive use. Understanding these sex-specific differences is crucial for developing targeted and effective prevention and treatment strategies (7-9). In our review of the general Nepalese population, elevated triglycerides and decreased HDL-C emerged as the most prevalent MetS components. The global variation in MetS prevalence likely stems from cultural differences that directly influence lifestyle choices and dietary patterns (7). In comparing MetS prevalence among college students, our findings aligned closely with Kenya (1.9%) (40) but differed markedly from Bangladesh's higher rate (27.7%) (41). Similarly, MetS prevalence among hospital staff in Nepal paralleled that of Bangladesh (47.7%) (41) but exceeded Malaysia's rate (20.6%) (42). These variations may be attributed to differences in diagnostic guidelines and geographical factors (43). T2DM patients showed the highest MetS prevalence among disease groups at 90.36% using harmonized criteria. This was followed by patients with central obesity (74.9% using IDF criteria) and hypertension (54.7% using NCEP ATP III criteria). Psoriasis patients demonstrated the lowest prevalence at 20.83%. The elevated MetS prevalence among T2DM patients is noteworthy but not unexpected, as individuals with MetS are predisposed to developing T2DM and cardiovascular disease (44). The MetS prevalence among T2DM patients in Nepal exceeded rates reported in other countries: Ethiopia (64.49%) and Ghana (68.6%) (45,46). Similarly, Nepal showed a higher MetS prevalence among patients with PCOS at 47.1% compared to India (38.5%) (47) and 30% in a systematic review by A. Khorshidi et al. (48). CKD patients in Nepal also showed higher MetS prevalence (37.5%) compared to Sudan (19%) (49). For hypertensive patients, Nepal's MetS prevalence aligned with rates from other countries, including Ethiopia (48.7% using NCEP ATP III criteria) and Ghana (58.4% using IDF criteria) (50,51). Similarly, the MetS prevalence among COPD patients in Nepal (36.87% using IDF criteria) was comparable to rates found in a systematic review by N. C. Lipovic et al. (34%) and the Thai population (37.4% using IDF criteria) (52,53). Among patients with central obesity, Nepal's MetS prevalence (74.9% using IDF criteria) closely matched findings from a Palestine refugee camp study by B. Damiri et al. (69.4% using IDF criteria) (54). AMI patients in Nepal showed a lower MetS prevalence (26.9%) compared to rates in India (40%) and Vietnam (68.3%) (55,56). Nepal also reported lower MetS prevalence among gout patients (30.6%) compared to Sub-Saharan Africa (54.6%) (57). Similarly, NAFLD patients in Nepal showed lower MetS prevalence (13.6% using NCEP ATP III criteria) compared to Iran (65.9%) (58). Psoriasis patients in Nepal also demonstrated lower MetS prevalence (20.83%)

compared to both global estimates (32%) and the Indian population (32.6%) (59,60). These lower rates in Nepal may be attributed to smaller sample sizes in the studies. The varying diagnostic criteria used in Nepalese prevalence studies pose challenges in determining the exact burden of MetS across general and disease-specific populations. Future studies in Nepal should adopt diagnostic criteria specific to Asian populations or establish standardized criteria for the country. This review also highlights an epidemic of MetS among T2DM patients in Nepal, necessitating government action to implement systematic screening programs for this population. Emerging technologies, particularly artificial intelligence models, could facilitate early detection of MetS and support the development of non-invasive markers in Nepal's resource-limited settings. These technologies could help identify asymptomatic individuals at increased risk and monitor lifestyle factors such as dietary habits, food consumption, and physical activity. Furthermore, wearable devices and mobile applications could be integrated into comprehensive MetS management strategies (61,62). Our review's strengths include the systematic search across four databases and the independent screening of articles by two authors. To our knowledge, this is the first systematic review examining MetS prevalence in the Nepalese population. However, several limitations warrant consideration. The inclusion of studies, regardless of setting, may have affected prevalence estimates. Limited available studies prevented us from calculating mean prevalence rates for various study groups. Additionally, most studies were conducted in major Nepalese cities, potentially limiting the generalizability of disease group findings to the broader population. Most studies were conducted in urban areas, which may limit the generalizability of findings to rural populations. The exclusion of non-English publications may have also limited our findings.

Conclusion

This systematic review reveals substantial MetS prevalence across both general and clinical populations in Nepal, irrespective of diagnostic criteria. Our findings indicate an urgent need for relevant authorities to intervene in public health. Since most studies were conducted in major urban centres, a national screening program is needed to comprehensively assess the MetS burden across diverse populations. The implementation of primary prevention strategies is crucial to curtail rising MetS prevalence and reduce associated morbidity and mortality. Additionally, targeted interventions addressing modifiable risk factors, including alcohol consumption, smoking, and physical inactivity, are essential to reduce the overall disease burden.

Ethic Approval: Not applicable.

Registration: PROSPERO (CRD42023476479).

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

Authors Contribution: RR: Concept, Methodology, formal analysis, writing original draft, and development of search strategy; SUK: Conceptualization, methodology, writing review, development of search and editing; BAS: Supervision, writing review and editing; SU: Supervision, writing review and editing, GAM: Supervision, writing review and editing; UK: Conceptualization, methodology, writing review and editing; RRS: Supervision, writing review and editing; PA: Concept, Methodology, formal analysis, writing the original draft. All authors read, provided feedback, and approved the final manuscript.

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Abbreviations:

PRISMA: Preferred Reporting Items for Systematic Review and Meta-Analysis

PROSPERO: The International Prospective Register of Systematic Review
JBI: Joanna Briggs Institute
PCOS: polycystic ovary syndrome
NAFLD: non-alcoholic fatty liver disease.
CKD: chronic kidney disease
AMI: acute myocardial infarction
IDF: International Diabetes Federation
WHO: World Health Organization
NCEP ATP III: National Cholesterol Education Program Adult Treatment Panel III
JSS: Joint Scientific Statement (Harmonized)

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ANNEX

Table S1. PRISMA Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	

Table S1. (*Continued*)

Section and Topic	Item #	Checklist item	Location where item is reported
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	
Study characteristics	17	Cite each included study and present its characteristics.	
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	

Section and Topic	Item #	Checklist item	Location where item is reported
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	
	23b	Discuss any limitations of the evidence included in the review.	
	23c	Discuss any limitations of the review processes used.	
	23d	Discuss implications of the results for practice, policy, and future research.	
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	
Competing interests	26	Declare any competing interests of review authors.	
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

Table S2. Details of the Search Strategy

PubMed	("epidemiology"[MeSH Subheading] OR "epidemiology"[All Fields] OR "prevalence"[All Fields] OR "prevalence"[MeSH Terms] OR "prevalence"[All Fields] OR "prevalences"[All Fields] OR "prevalence s"[All Fields] OR "prevalent"[All Fields] OR "prevalently"[All Fields] OR "prevalents"[All Fields] AND ("metabolic syndrome"[MeSH Terms] OR ("metabolic" [All Fields] AND "syndrome" [All Fields] OR "metabolic syndrome" [All Fields] OR "metabolic syndrome x"[All Fields] AND " syndrome"[All Fields]) OR "metabolic syndrome"[All Fields] OR "insulin resistance syndrome x"[All Fields]) OR ("metabolic syndrome"[MeSH Terms] OR ("metabolic"[All Fields] AND "Syndrome"[All Fields] OR "metabolic syndrome"[All Fields] AND ("humans"[MeSH Terms] AND ("female"[MeSH Terms] OR "male"[MeSH Terms]) AND "english" [Language]))
Web of Science	(ALL=(prevalence)) AND ALL=("metabolic syndrome" OR "metabolic syndrome X" OR "Insulin resistance X") AND Article (DocumentTypes) AND English(Languages) AND Nepal(Countries/Regions)
Embase	('metabolic syndrome X'/exp OR 'insulin resistance syndrome' OR 'metabolic syndrome' OR 'metabolic syndrome X' OR 'syndrome X, metabolic') AND ('prevalence'/exp OR 'prevalence' OR 'prevalence study') AND [english]/lim AND ('nepal'/exp OR nepal)
Scopus	(TITLE-ABS-KEY (prevalence) AND TITLE-ABS-KEY ("metabolic syndrome") OR TITLE-ABS-KEY ("metabolic syndrome X") OR TITLE-ABS-KEY ("Insulin resistance syndrome X")) AND (LIMIT-TO (AFFILCOUNTRY, "Nepal")) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (EXACTKEYWORD, "Human")) AND (LIMIT-TO (LANGUAGE, "English"))

In the above results, we used a filter Species: Humans, Language: English, Date inception until 31st October 2023, and results were further narrowed down by putting Country Name: Nepal

Table S3. Quality assessment of studies using JBI critical appraisal tools for prevalence studies.

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Score
Mehata S et al (2018) (11)	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	7
Sharma D et al (2017) (22)	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	7
Sharma SK et al (2011) (20)	Un/ clear	No	No	Yes	Yes	Yes	Yes	No	Yes	5
Sapkota M et al (2020) (29)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Shrestha S et al (2010) (24)	Unclear	Unclear	Unclear	Yes	Yes	Yes	Yes	No	No	4
Sharma K et al (2023) (16)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Tamrakar R et al (2019) (30)	No	Unclear	No	Yes	Yes	Yes	Yes	No	Unclear	4
Pokharel DR et al (2014) (34)	No	No	No	Yes	Yes	Yes	Yes	Yes	Unclear	5
HK Tamang et al (2013) (35)	Yes	No	Unclear	Yes	Yes	Yes	Yes	No	Unclear	5
Santosh B et al (2023) (25)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	7
Singh NK et al (2021) (27)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Jha BK et al (2020) (21)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Shrestha R et al (2011) (23)	No	No	No	Yes	Yes	Yes	Yes	Yes	Unclear	5
Pandey S et al (2009) (32)	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Unclear	6
Pardhe et al (2018) (31)	No	No	No	Yes	Yes	Yes	Yes	Yes	Unclear	5
Thapa P et al (2023) (33)	Unclear	No	Yes	No	No	Yes	Yes	No	Unclear	3
Giri A et al (2022) (26)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Vaidya V et al (2021) (28)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	7
Poudel B et al (2013) (36)	Unclear	No	No	Yes	No	Yes	Yes	No	Unclear	3