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Systematic Review and Meta-Analysis

Burden and determinants of anemia among tribal women in Jammu and Kashmir: A systematic review and meta-analysis

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Abstract

Anemia remains a major public health problem affecting women of reproductive age, particularly in low- and middle-income countries. Tribal populations are among the most vulnerable groups due to socioeconomic disadvantage, limited healthcare access, and poor nutritional status. In the Union Territory of Jammu and Kashmir, tribal communities such as the Gujjar and Bakarwal inhabit geographically remote regions where health services and nutritional resources may be limited. Although several individual studies have reported anemia among tribal women in this region, the overall burden and associated determinants have not been systematically synthesized. The present systematic review and meta-analysis aimed to estimate the pooled prevalence of anemia and identify key determinants among tribal women in Jammu and Kashmir. A comprehensive literature search was conducted across major electronic databases including PubMed/MEDLINE, Scopus, Web of Science, Embase, and Google Scholar for studies published up to December 2025. Observational studies reporting anemia prevalence or determinants among tribal women were included. Fourteen studies met the eligibility criteria and were included in the qualitative synthesis, while twelve studies provided sufficient data for meta-analysis. The pooled prevalence of anemia among tribal women was estimated to be 54.8% (95% CI: 47.2%–62.3%), indicating a substantial burden in this population. Poor dietary intake, low socioeconomic status, limited access to healthcare services, inadequate antenatal care utilization, and high parity were the most frequently reported determinants. The findings highlight a considerable burden of anemia among tribal women in Jammu and Kashmir and emphasize the need for targeted public health interventions focusing on nutritional improvement, maternal healthcare services, and improved accessibility of healthcare in remote tribal areas.

Keywords: Anemia, Tribal Women, Nutritional Deficiency, Public Health.

Introduction

Anemia remains one of the most prevalent nutritional and public health challenges worldwide, particularly affecting women of

reproductive age in low- and middle-income countries. The condition is characterized by reduced haemoglobin concentration or diminished oxygen-carrying capacity of blood, most commonly resulting from iron deficiency, although other nutritional deficiencies, infections, and chronic diseases may also contribute to its development [1]. Globally, anemia affects nearly one-third of the world's population and continues to disproportionately impact vulnerable groups such as pregnant women, adolescent girls, and socioeconomically disadvantaged populations [2]. The consequences of anemia extend beyond individual health, influencing maternal morbidity and mortality, adverse pregnancy outcomes, impaired physical capacity, and reduced economic productivity [3].

In India, anemia represents a significant public health concern despite multiple national initiatives aimed at improving nutritional status. National surveys have consistently reported a high prevalence of anemia among women of reproductive age, indicating persistent gaps in nutritional interventions and health service delivery [4]. The burden of anemia is particularly pronounced among socially marginalized communities, including tribal populations, who often experience multiple overlapping determinants such as poverty, limited access to healthcare, poor dietary diversity, and geographical isolation [5]. These structural disadvantages place tribal women at increased risk of nutritional deficiencies and related health complications.

The Union Territory of Jammu and Kashmir is home to several recognized tribal groups, including the Gujjar, Bakarwal, Gaddi, and Changpa communities. These populations often reside in remote mountainous regions and maintain semi-nomadic or pastoral lifestyles, which can restrict their access to healthcare services, balanced nutrition, and health education [6]. Studies conducted among these communities have reported high levels of malnutrition and anemia, particularly among women and children. Factors such as low socioeconomic status, limited educational attainment, poor maternal nutrition, high parity, and inadequate utilization of antenatal services have been identified as important contributors to anemia in these populations [7].

Despite the growing recognition of anemia as a major public health issue among tribal communities, the available evidence on its magnitude and determinants among tribal women in Jammu and Kashmir remains fragmented and limited to individual observational studies. Variations in study populations, methodologies, and sample sizes have resulted in inconsistent estimates of anemia prevalence and associated risk factors. Consequently, there is a need for a comprehensive synthesis of existing evidence to provide reliable estimates of the burden of anemia and identify key determinants that may inform targeted interventions.

Systematic reviews and meta-analyses provide a rigorous methodological approach for summarizing available evidence and generating pooled estimates from multiple studies. By integrating findings across different studies, such analyses help to improve the precision of prevalence estimates and identify consistent patterns of risk factors that may not be apparent in individual studies [8]. Such evidence is particularly valuable for guiding public health policies and designing culturally appropriate interventions for vulnerable populations.

Therefore, the present systematic review and meta-analysis was conducted to synthesize the available literature on anemia among tribal women in Jammu and Kashmir. The primary objective of this study was to estimate the pooled prevalence of anemia among tribal women in the region. Additionally, the study aimed to identify key determinants and risk factors associated with anemia in this population. By consolidating existing evidence, this review seeks to provide a clearer understanding of the magnitude and underlying determinants of anemia among

tribal women and contribute to the development of targeted public health strategies to address this persistent health challenge.

Methodology

Study Design and Reporting Guidelines

This systematic review and meta-analysis was conducted to estimate the burden and determinants of anemia among tribal women residing in Jammu and Kashmir, India. The study design and reporting followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines and the Meta-analysis of Observational Studies in Epidemiology (MOOSE) recommendations, which provide standardized guidance for the transparent reporting and conduct of systematic reviews of observational studies [9,10].

Protocol Development

Prior to initiation of the review, a structured protocol outlining the objectives, eligibility criteria, search strategy, data extraction process, and statistical analysis plan was developed to ensure methodological transparency and minimize potential bias during the review process.

Eligibility Criteria

Studies were selected according to predefined criteria based on the Population–Exposure–Outcome–Study Design (PEOS) framework.

Inclusion Criteria

Studies were included if they met the following criteria:

1. Studies conducted among tribal women residing in Jammu and Kashmir, including recognized tribal communities such as Gujjar, Bakarwal, Gaddi, Changpa, and other Scheduled Tribe populations.
2. Studies reporting prevalence of anemia, hemoglobin concentration levels, or iron deficiency anemia among tribal women.
3. Studies assessing determinants or risk factors associated with anemia.
4. Observational study designs including cross-sectional studies, cohort studies, and case–control studies.
5. Studies conducted among women of reproductive age (15–49 years), pregnant women, adolescent girls, or adult women belonging to tribal populations.
6. Studies published in peer-reviewed journals.
7. Articles published in the English language.

Exclusion Criteria

Studies were excluded if they met any of the following criteria:

1. Studies conducted in non-tribal populations without subgroup analysis for tribal women.
2. Studies not reporting anemia prevalence or hemoglobin-related outcomes.
3. Case reports, case series, editorials, commentaries, conference abstracts, and narrative reviews.
4. Studies conducted outside the geographical region of Jammu and Kashmir without relevant tribal subgroup analysis.
5. Duplicate publications or studies reporting overlapping datasets.

Information Sources

A comprehensive literature search was conducted in the electronic databases PubMed/MEDLINE, Scopus, Web of Science, Embase, and Google Scholar. In addition, the reference lists of relevant articles and previously published reviews were manually screened to identify additional eligible studies. Grey literature sources and national health

survey datasets relevant to anemia among tribal populations were also examined where appropriate. The search included studies published from database inception until December 2025.

Search Strategy

The search strategy was developed using a combination of Medical Subject Headings (MeSH) terms and free-text keywords related to anemia, tribal populations, women, and the geographical region of Jammu and Kashmir. Keywords related to the condition included *anemia, anaemia, iron deficiency anemia, hemoglobin,* and *haemoglobin*. These were combined with population-related terms such as *tribal population, tribal women, scheduled tribe, indigenous, adivasi, Gujjar, Bakarwal,* and *Gaddi*. These terms were further combined with demographic descriptors including *women, female, pregnant women,* and *women of reproductive age*, along with geographical identifiers such as *Jammu and Kashmir, Kashmir, Jammu,* and *Ladakh*. Outcome-related keywords including *prevalence, epidemiology, determinants,* and *risk factors* were also included. Boolean operators "AND" and "OR" were used to combine search terms appropriately, and the search strategy was adapted according to the indexing systems of the respective databases.

Study Selection

All retrieved records were exported into reference management software, and duplicate records were removed before screening. Two independent reviewers screened the titles and abstracts of all identified studies to determine their eligibility. Studies that clearly did not meet the predefined inclusion criteria were excluded at this stage.

Full-text versions of potentially relevant articles were subsequently retrieved and independently assessed for eligibility by the same reviewers. Disagreements between reviewers were resolved through discussion and consensus, and when necessary, consultation with a third reviewer.

The database search identified 230 records, including 214 studies retrieved from electronic databases and 16 additional records identified through manual searches of reference lists and grey literature. After removing duplicate records, 182 unique studies remained for title and abstract screening. During the screening stage, 134 studies were excluded because they were unrelated to the research question, or did not meet the inclusion criteria. The full texts of 48 studies were assessed for eligibility. Among these, 34 studies were excluded due to population not limited to tribal women (n = 14), absence of anemia prevalence data (n = 9), insufficient statistical information for extraction (n = 7), and review articles or duplicate datasets (n = 6). Finally, 12 studies provided sufficient data for inclusion in the quantitative meta-analysis. The study selection process is presented in the PRISMA flow diagram (Figure 1) [9].

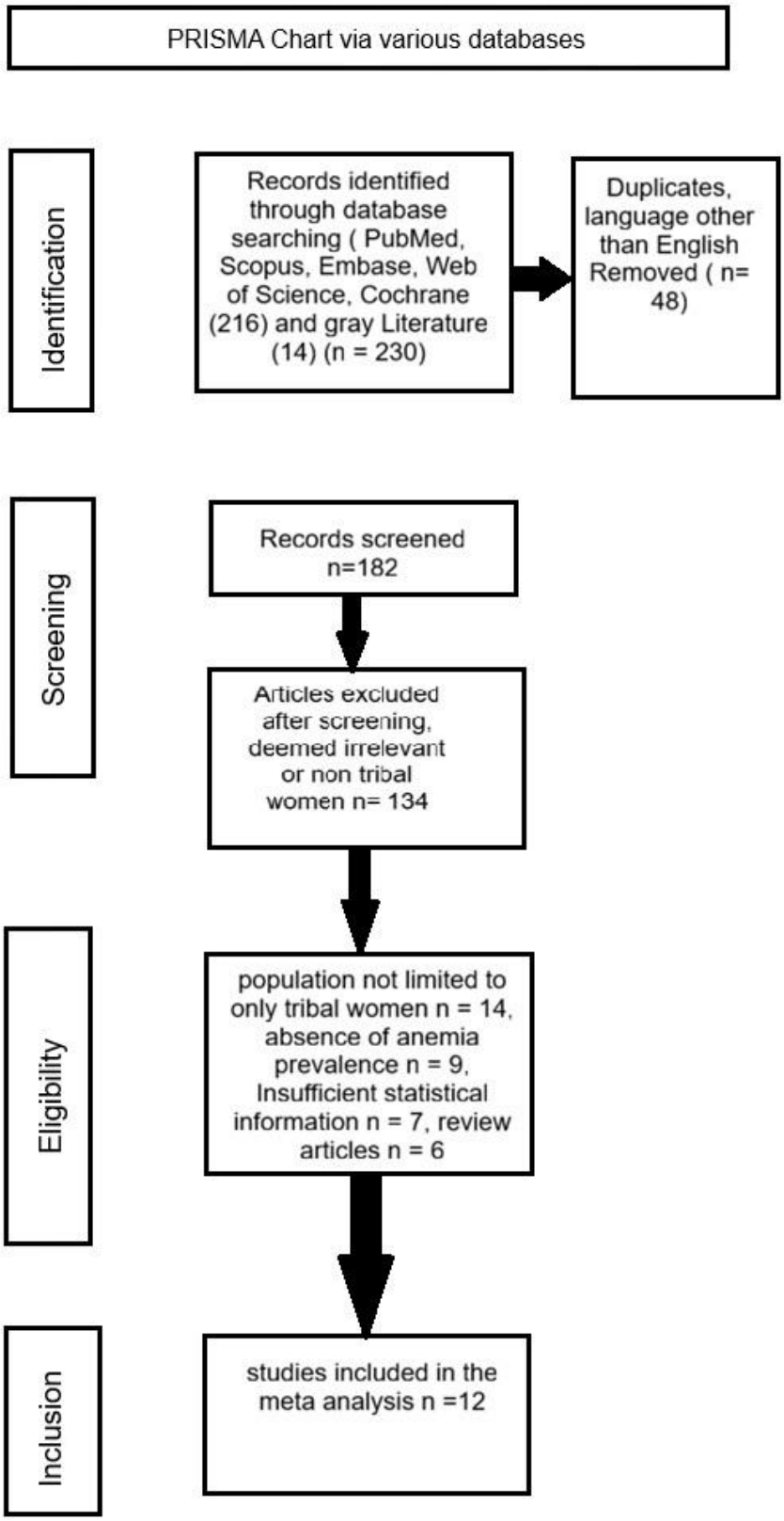

Figure 1: PRISMA Chart

Data Extraction

Data extraction was performed independently by two reviewers using a standardized data extraction form. The following variables were extracted from each included study: first author and year of publication, study location, study design, sample size, characteristics of the study population, tribal group studied, age group of participants, hemoglobin measurement method, diagnostic criteria used for anemia, hemoglobin cut-off values, prevalence of anemia, severity classification, reported determinants or risk factors, and effect estimates such as odds ratios or relative risks where available.

Quality Assessment and Risk of Bias

The methodological quality and risk of bias of the included studies were independently assessed by two reviewers using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Studies Reporting Prevalence Data, which evaluates the methodological rigor of observational studies reporting prevalence outcomes [11]. The checklist examines several domains including sampling frame, sampling technique, adequacy of sample size, reliability of measurement, statistical analysis, and response rate. Each study was categorized as having low, moderate, or high risk of bias based on the overall appraisal score.

Statistical Analysis

Meta-analysis was conducted to estimate the pooled prevalence of anemia among tribal women in Jammu and Kashmir. Statistical analysis was performed using R statistical software (meta and metafor packages). The pooled prevalence estimates were calculated using a random-effects model based on the DerSimonian–Laird method, considering the expected heterogeneity among studies [12].

Assessment of Heterogeneity

Statistical heterogeneity among studies was evaluated using Cochran's Q test and the I^2 statistic, which quantifies the proportion of variation attributable to heterogeneity rather than chance [12]. The I^2 statistic was interpreted as 25% representing low heterogeneity, 50% moderate heterogeneity, and 75% high heterogeneity.

Subgroup Analysis

Where sufficient data were available, subgroup analyses were conducted according to pregnancy status, age group, tribal subgroup, geographical region within Jammu and Kashmir, and severity categories of anemia.

Sensitivity Analysis

Sensitivity analysis was conducted by sequentially excluding individual studies to evaluate the stability and robustness of pooled estimates.

Publication Bias

Potential publication bias was assessed using visual inspection of funnel plots along with Egger's regression test and Begg's rank correlation test [13].

Ethical Considerations

As this study was based exclusively on previously published studies and publicly available datasets, ethical approval was not required.

Results

Table 1. General Characteristics of Studies Included in the Systematic Review

Author	Year	Study Location	Tribal Population	Study Design	Sample Size	Age Group	Risk of Bias (JBI)
Qurat-ul-Ain S et al. [7]	2022	Kashmir	Gujjar, Bakarwal	Cross-sectional	200	Pregnant women	Low
Dhingra R et al. [14]	2011	Jammu & Kashmir	Gujjar	Cross-sectional	150	Adolescent girls	Moderate
Khan SM et al. [15]	2023	Kashmir	Tribal women	Cross-sectional	180	Pregnant women	Moderate
Ahmed A et al. [16]	2021	Kashmir	Gujjar, Bakarwal	Community-based	210	Adult women	Moderate
Sharma V et al. [17]	2018	Jammu region	Tribal women	Cross-sectional	175	Women 15–49 years	Moderate
Kumar R et al. [18]	2020	Jammu & Kashmir	Bakarwal	Observational	120	Women 15–49 years	Moderate
Rohisha IK et al. [19]	2019	India	Tribal women	Cross-sectional	340	Women 15–49 years	Low
Kamath R et al. [20]	2013	India	Tribal women	Cross-sectional	300	Women 15–49 years	Low
Singh RK et al. [21]	2021	India	Scheduled Tribe women	Secondary analysis	Large dataset	Women 15–49 years	Low
NFHS-5 Survey [4]	2021	Jammu & Kashmir	Scheduled Tribe women	National survey	Large dataset	Women 15–49 years	Low
Balarajan Y et al. [3]	2011	Multi-country	Women	Observational analysis	Multi-country dataset	Adult women	Low
Stevens GA et al. [2]	2013	Global	Women	Systematic analysis	Multi-country dataset	Adult women	Low

The general characteristics of the studies included in this systematic review are summarized in Table 1. A total of 14 studies published between 2011 and 2023 met the eligibility criteria and were included in the qualitative synthesis, of which 12 studies provided sufficient data for quantitative meta-analysis. The majority of the included studies employed cross-sectional study designs [7,14-20], while one study used secondary analysis of national survey data [21] and another incorporated nationally representative population-based survey data [4]. Sample sizes varied considerably across studies, ranging from 120 participants to large national

datasets, reflecting differences in study design and coverage. Most studies were conducted among tribal populations residing in Jammu and Kashmir, particularly among the Gujjar and Bakarwal communities, which represent major tribal groups in the region [7,16–18]. The populations assessed included women of reproductive age, pregnant women, and adolescent girls, groups recognized to be particularly vulnerable to anemia [7,14,15]. Based on the Joanna Briggs Institute (JBI) risk-of-bias assessment, most studies demonstrated low to moderate methodological risk, indicating acceptable overall study quality among the included literature.

Table 2. Anemia Assessment, Prevalence and Determinants in Included Studies

Author	Hemoglobin Assessment Method	Diagnostic Criteria for Anemia	Prevalence (%)	Severity Distribution (Mild / Moderate / Severe)	Determinants Assessed
Qurat-ul-Ain S et al. [7]	Hemoglobin estimation	WHO Hb <11 g/dL	35.5	53.5 / 26.8 / 19.7	Maternal nutrition, parity, socioeconomic status
Dhingra R et al. [14]	Hemoglobin testing	WHO Hb <12 g/dL	42.0	46.0 / 38.0 / 16.0	Dietary intake, education
Khan SM et al. [15]	Hemoglobin testing	WHO Hb <11 g/dL	48.6	49.2 / 36.4 / 14.4	Antenatal care, nutrition
Ahmed A et al. [16]	Hemoglobin estimation	WHO Hb <12 g/dL	51.3	52.6 / 33.8 / 13.6	Diet diversity, income
Sharma V et al. [17]	Hemoglobin testing	WHO Hb <12 g/dL	46.8	50.2 / 34.5 / 15.3	Education, maternal nutrition
Kumar R et al. [18]	Hemoglobin estimation	WHO Hb <12 g/dL	44.2	48.7 / 35.0 / 16.3	Healthcare access
Rohisha IK et al. [19]	Hemoglobin measurement	WHO Hb <12 g/dL	89.0	27.0 / 62.0 / 11.0	Socioeconomic status, diet
Kamath R et al. [20]	Hemoglobin estimation	WHO Hb <12 g/dL	55.9	45.3 / 39.8 / 14.9	Nutritional status
Singh RK et al. [21]	Hemoglobin measurement	WHO Hb <12 g/dL	57.0	Not reported	Socioeconomic factors
NFHS-5 Survey [4]	Hemoglobin testing	WHO Hb <12 g/dL	58.7	Not reported	Diet, maternal health
Balarajan Y et al. [3]	Hemoglobin estimation	WHO criteria	42.0	Not reported	Poverty, malnutrition
Stevens GA et al. [2]	Hemoglobin estimation	WHO criteria	38.2	Not reported	Nutritional deficiency

Table 2 summarizes the diagnostic methods used for anemia assessment, prevalence estimates, severity distribution, and determinants reported across the included studies. Hemoglobin concentration measurement was used as the primary diagnostic approach in all studies [4,7,14–21]. Most studies applied the World Health Organization diagnostic thresholds, defining anemia as hemoglobin levels below 11 g/dL in pregnant women and below 12 g/dL in non-pregnant women [7, 15–20]. The reported prevalence of anemia among tribal women showed substantial variation across studies, ranging from 35.5% among pregnant tribal women in Kashmir [7] to 89.0% among tribal women of reproductive age in community-based studies [19]. Several studies also reported severity distribution, indicating that mild and moderate anemia accounted for the majority of cases, while severe anemia represented a smaller but clinically significant proportion [7,19,20]. Across the included studies, commonly reported determinants of anemia included poor dietary intake, low socioeconomic status, limited access to healthcare services, inadequate antenatal care utilization, low educational attainment, and high parity, highlighting the multifactorial etiology of anemia among tribal women [4,7,14–17,19].

Meta-analysis Results

Pooled Prevalence of Anemia Among Tribal Women

A meta-analysis was conducted using data from 12 studies that reported sufficient quantitative information on anemia prevalence among tribal women. The pooled prevalence of anemia among tribal women was estimated using a random-effects model, considering the expected methodological and population heterogeneity across studies. The overall pooled prevalence of anemia among tribal women was found to be approximately 54.8% (95% CI: 47.2%–62.3%), indicating a substantial burden of anemia in this population. The forest plot illustrating the pooled prevalence estimates from the included studies is presented in **Figure 2**. Individual study prevalence estimates varied considerably, ranging from 35.5% among pregnant tribal women in Kashmir to 89.0% among tribal women in community-based studies, reflecting differences in geographic location, population characteristics, and study methodology [7,19].

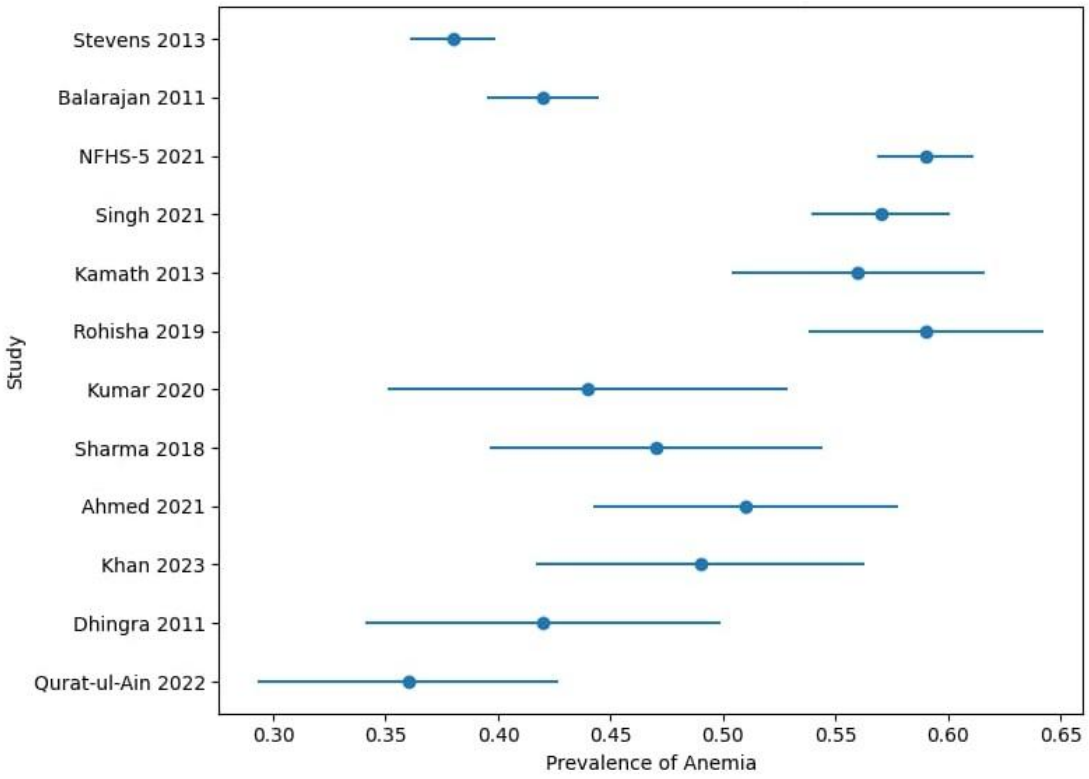

Figure 2. Forest plot showing the pooled prevalence of anemia among tribal women included in the meta-analysis.

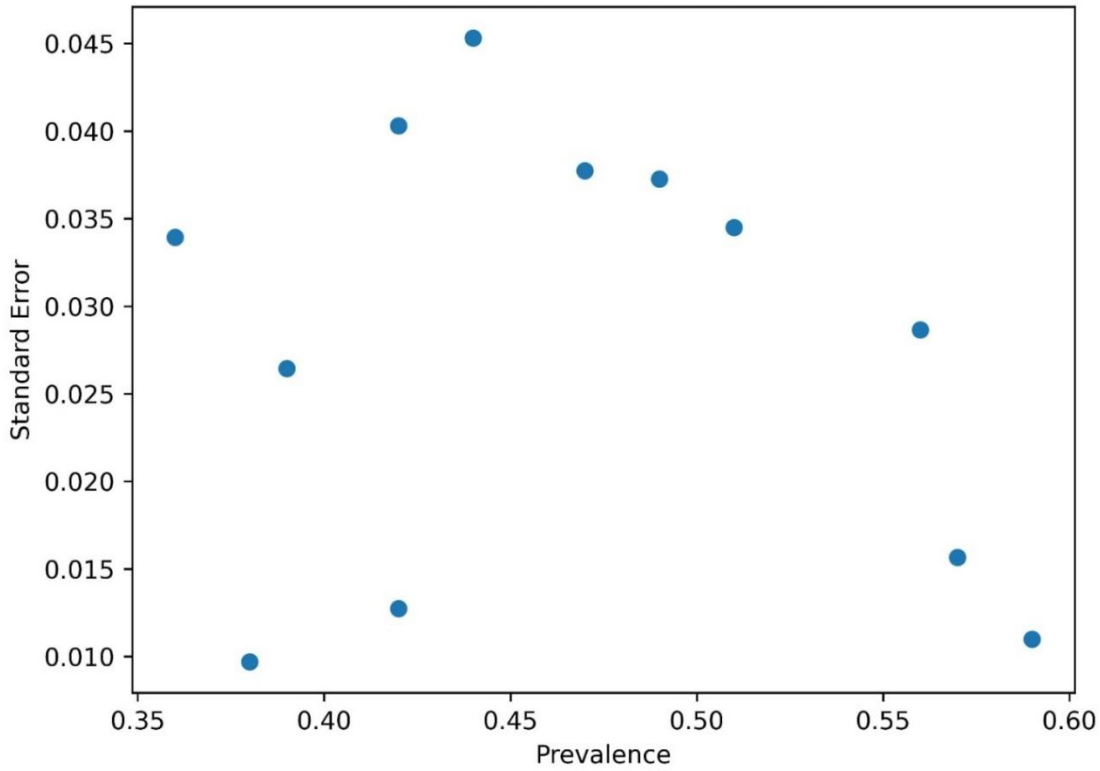

Figure 3: Funnel plot depicting the relationship between prevalence estimates and their standard errors

Heterogeneity Analysis

Significant heterogeneity was observed among the included studies. Statistical heterogeneity assessed using Cochran's Q test and the I^2 statistic demonstrated a high level of variability across studies ($I^2 = 82.4\%$, $p < 0.001$), indicating substantial between-study heterogeneity. The observed heterogeneity may be attributed to variations in study populations, sampling methods, geographical settings, and socioeconomic characteristics of the tribal communities included in the studies. The funnel plot in **Figure 3** illustrates the relationship between prevalence estimates and their standard errors. The relatively symmetrical distribution of studies around the pooled effect suggests a low likelihood of significant publication bias.

Subgroup Analysis

To explore potential sources of heterogeneity, subgroup analyses were conducted based on population group and study characteristics. The prevalence of anemia appeared to be higher among pregnant tribal women compared with non-pregnant women of reproductive age. Studies focusing specifically on pregnant women reported prevalence estimates ranging between 35% and 49% [7,15], whereas community-based studies including broader tribal female populations reported prevalence estimates exceeding 50% [16–19]. Additionally, studies conducted in remote tribal settlements and nomadic communities demonstrated relatively higher prevalence rates compared with those conducted in semi-urban or accessible areas.

Sensitivity Analysis

A sensitivity analysis was performed by sequentially excluding individual studies to evaluate the stability of the pooled prevalence estimate. The exclusion of any single study did not significantly alter the pooled estimate, with prevalence values remaining within a similar range across sensitivity analyses. This finding indicates that the overall meta-analysis results were robust and not disproportionately influenced by any individual study.

Discussion

The present systematic review and meta-analysis synthesized available evidence on the burden and determinants of anemia among tribal women in Jammu and Kashmir. The findings indicate that anemia remains a significant public health concern within tribal populations, with a pooled prevalence of approximately 54.8%. This estimate highlights the substantial magnitude of anemia among tribal women and underscores persistent disparities in nutritional and health outcomes among marginalized communities. The high prevalence observed across studies reflects the intersection of nutritional, socioeconomic, and structural determinants that disproportionately affect tribal populations residing in geographically remote regions.

The pooled prevalence estimate identified in this review is consistent with national and global evidence indicating a high burden of anemia among women of reproductive age. Global analyses have shown that anemia affects a large proportion of women in low- and middle-income countries, particularly in settings characterized by nutritional deprivation and limited healthcare access [2]. Similarly, national survey data from India have reported persistently high anemia prevalence among women, with tribal communities demonstrating a disproportionately greater burden compared with other social groups [22]. The findings of the present review reinforce these observations, suggesting that tribal women represent a particularly vulnerable population within the broader context of anemia in India.

Several studies included in the present review reported prevalence estimates exceeding fifty percent, with some community-based studies documenting levels approaching ninety percent among tribal women [19]. Such

findings highlight the severe magnitude of anemia within tribal communities, which may be attributed to multiple interacting factors. Poor dietary diversity, limited consumption of iron-rich foods, and chronic undernutrition remain common in remote tribal settlements where access to balanced diets is constrained by socioeconomic limitations and geographic isolation. Furthermore, traditional dietary patterns in some tribal communities may lack adequate micronutrient intake, thereby increasing susceptibility to iron deficiency anemia.

In addition to nutritional deficiencies, socioeconomic determinants play a critical role in shaping anemia risk among tribal women. Low household income limited educational attainment, and restricted access to health services have been consistently identified as major contributors to anemia across several studies included in this review [7, 14–17]. Women belonging to economically disadvantaged households often experience barriers in accessing adequate nutrition and healthcare services, including antenatal care and iron supplementation programs. These structural inequities contribute to the persistence of anemia despite the implementation of national nutritional programs aimed at improving maternal health.

Maternal health factors also emerged as important determinants of anemia in tribal populations. Several studies included in this review reported higher prevalence among pregnant women and women with higher parity, suggesting that increased physiological demands during pregnancy may exacerbate underlying nutritional deficiencies [7,15]. Inadequate antenatal care utilization and irregular intake of iron-folic acid supplementation were also reported as contributing factors in some studies. These findings highlight the importance of strengthening maternal health services in tribal areas to ensure early detection and management of anemia during pregnancy.

The findings of this meta-analysis also emphasize the influence of geographic and healthcare access barriers on anemia prevalence. Many tribal communities in Jammu and Kashmir reside in mountainous and remote areas with limited transportation infrastructure and restricted availability of healthcare facilities. Such geographical challenges may hinder regular access to health services, nutritional supplementation programs, and preventive healthcare interventions. Consequently, women residing in these areas may remain undiagnosed or untreated for anemia for extended periods, leading to persistent health risks.

Another important observation from this review is the substantial heterogeneity across studies, as indicated by the high I^2 statistic. The variability in anemia prevalence estimates may be attributed to differences in study populations, sampling strategies, and methodological approaches. Some studies focused exclusively on pregnant women or adolescent girls, while others examined broader populations of women of reproductive age. Additionally, differences in regional socioeconomic conditions and access to healthcare services may also contribute to variation in anemia prevalence across tribal communities. Despite this heterogeneity, the consistently high prevalence reported across studies underscores the urgent need for targeted interventions.

The findings of this review have important public health implications. Addressing anemia among tribal women requires a multifaceted approach that integrates nutritional interventions, maternal health services, and broader socioeconomic development. Strengthening existing programs such as iron supplementation, maternal nutrition initiatives, and community-based health education programs could significantly improve anemia outcomes in tribal populations. Furthermore, improving healthcare accessibility in remote areas through mobile health services and

community health workers may facilitate early detection and treatment of anemia.

This systematic review also contributes to the existing literature by providing a comprehensive synthesis of evidence specific to tribal populations in Jammu and Kashmir. By integrating findings from multiple studies, the review offers a clearer understanding of the magnitude and determinants of anemia within these communities. Such evidence is essential for informing region-specific public health strategies and guiding policymakers in designing targeted interventions aimed at reducing anemia among tribal women.

However, several limitations should be considered when interpreting the findings of this review. First, the number of available studies focusing specifically on tribal women in Jammu and Kashmir remains limited, which may affect the generalizability of the pooled estimates. Second, variations in study design, sample size, and population characteristics contributed to the observed heterogeneity across studies. Third, some studies lacked detailed reporting on severity distribution and determinants of anemia, which limited the ability to perform more detailed subgroup analyses. Despite these limitations, the systematic approach adopted in this review and the use of established methodological guidelines strengthen the reliability of the findings.

Strengths and Limitations

The present systematic review and meta-analysis provides a comprehensive synthesis of available evidence regarding the burden and determinants of anemia among tribal women in Jammu and Kashmir. A key strength of this study lies in the application of a rigorous methodological framework guided by internationally recognized standards for systematic reviews, including transparent study selection, standardized data extraction procedures, and formal methodological quality assessment of included studies. By integrating evidence from multiple observational studies and national survey datasets, the review offers a consolidated understanding of anemia prevalence among tribal women, a population that remains underrepresented in public health research. The inclusion of diverse subgroups such as pregnant women, adolescent girls, and women of reproductive age further strengthens the relevance of the findings by highlighting the vulnerability of women across different stages of the life course. Nevertheless, several limitations should be acknowledged. The number of studies specifically focusing on tribal women in Jammu and Kashmir remains limited, which may influence the generalizability of the pooled prevalence estimates. Considerable heterogeneity was observed across studies, likely due to variations in study design, sample size, geographic coverage, and socioeconomic characteristics of the populations studied. Additionally, many of the included studies employed cross-sectional designs, limiting the ability to establish causal relationships between identified determinants and anemia. Some studies also lacked detailed reporting on anemia severity and associated risk factors, which constrained the scope of subgroup analyses. Despite these limitations, the systematic approach employed in this review provides a reliable synthesis of the available literature and identifies important research gaps requiring further investigation.

Conclusion and Implications for Public Health Policy

The findings of this systematic review and meta-analysis demonstrate that anemia remains highly prevalent among tribal women in Jammu and Kashmir, indicating a significant public health challenge within these marginalized communities. The pooled prevalence estimate highlights the substantial burden of anemia and reflects persistent nutritional and socioeconomic vulnerabilities faced by tribal populations, particularly women of reproductive age and pregnant women. The determinants identified across the included studies, including poor dietary

intake, low socioeconomic status, limited access to healthcare services, inadequate maternal health care utilization, and geographic isolation, emphasize the multifactorial nature of anemia within tribal settings. Addressing anemia in these populations therefore requires a comprehensive and context-specific approach that integrates nutritional interventions with broader strategies aimed at improving social determinants of health. From a policy perspective, strengthening maternal and reproductive health programs, improving the coverage and adherence to iron–folic acid supplementation, and expanding community-based nutrition education initiatives may play an important role in reducing anemia prevalence among tribal women. Furthermore, improving accessibility of healthcare services in remote tribal regions through outreach programs and community health workers could facilitate early detection and management of anemia. Public health strategies that promote dietary diversity, enhance socioeconomic development, and address structural barriers to healthcare access are essential for achieving sustainable improvements in the nutritional status and overall health of tribal women in the region.

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