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Prevalence and Determinants of Anaemia in Pregnancy in Low-Middle Income Countries

Pegah Naghizadeh
Northumbria University, Newcastle, United Kingdom.
Corresponding Author: pegahnghz@gmail.com
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Abstract

The systematic review analysed anaemia prevalence together with its determinants throughout pregnancy in countries categorised as low and middle income. The PRISMA guidelines guided the selection of ten cross-sectional studies which demonstrated wide-ranging anaemia prevalence rates from 20.9% in Ethiopia to 95.1% in Nigeria. The review revealed various linked factors which produce anaemia during pregnancy throughout these regions. The main factors underlying anaemia risk during pregnancy were socioeconomic variables since lower income levels combined with less education and rural locations created increased susceptibility to anaemia. The limited consumption of iron-rich foods together with restricted access to supplements made pregnant women more susceptible to anaemia. Health-related factors such as hookworm infections and malaria history together with excessive menstrual blood loss significantly impacted the development of anaemia in pregnant women. The connexion between anaemia prevalence and geographic location produced conflicting results because researchers discovered higher prevalence in both urban and rural areas. The research demonstrates how multiple factors from different settings in LMICs influence pregnancy-related anaemia and shows why specific intervention approaches are needed. The author recommend implementing maternal nutrition programmes with supplementation and developing healthcare detection services alongside socioeconomic empowerment programmes for mothers.

Keywords: Prevalence, Determinants, Anaemia, Pregnancy, Low-Middle Income Countries.

Introduction

Anaemia stands as a prominent contributor to adverse pregnancy outcomes, putting pressure on maternal mortality and morbidity rates. The consequences of anaemia during pregnancy include a heightened risk of postpartum haemorrhage, small-for-gestational-age infants, postnatal sepsis, pregnancy-induced hypertension, and low birth weight newborns, among other perinatal adversities (Ali et al., 2019; Obai et al., 2016). The burdens of this condition are felt acutely in developing countries, which grapple with fragile healthcare systems and the considerable economic and social costs associated with anaemia during pregnancy and its repercussions. The Southeast Asian and Sub-Saharan African regions, in particular, bear the brunt of these implications. Although there exist low-cost and highly effective therapeutic interventions in these nations, the problem of anaemia during pregnancy remains stubbornly persistent (Gebreweld and Tsegaye, 2018).

Globally, the issue of anaemia during pregnancy continues to be a significant concern in the realm of public health, with an even more critical impact on low and middle-income countries (Hailu et al., 2019; Olatunbosun et al., 2014). A study by Obai et al. (2016) shed light on the staggering fact that over 1.62 billion individuals worldwide grapple with anaemia, underscoring its profound implications for public health. This condition transcends age boundaries, yet pregnant women find themselves disproportionately affected. Africa stands out with a worrisome prevalence rate, boasting the highest percentage of child-bearing women afflicted by anaemia. A growing body of research suggests that economically disadvantaged women are particularly susceptible to iron deficiency anaemia (Gebreweld and Tsegaye, 2018). Olatunbosun et al. (2014) released a report that provided a global estimate, indicating that around 38% of pregnant women worldwide grapple with anaemia (Olatunbosun et al., 2014). Numerous studies investigating anaemia during pregnancy, particularly in developing countries, have primarily concentrated on three key areas: the prevalence of the condition, the factors contributing to its occurrence, and the interventions implemented by both governmental and non-governmental health organisations to combat this issue (Gebreweld and Tsegaye, 2018). The WHO's estimates suggest that approximately 50% of pregnant women in underdeveloped nations are afflicted by anaemia (Hailu et al., 2019; Obai et al., 2016). Notably, the prevalence of anaemia varies from country to country, making it imperative to conduct comprehensive studies for a deeper comprehension of this issue and its extensive consequences.

The prevalence of anaemia during pregnancy constitutes a significant global health challenge with a pronounced impact on Low and Middle-Income Countries (LMICs). In Southeast Asia, anaemia stands as the second most significant cause of maternal mortality, with over 80% of these unfortunate deaths occurring in India (Obai et al., 2016). Worldwide, it is estimated that more than 32.4 million pregnant women are affected by anaemia, with Southeast Asia and Africa bearing the brunt, accounting for

approximately 48.7% and 46.3% of the global anaemia burden, respectively (WHO, 2015). Anaemia prevalence in the country has been more than 40% since the late '90s to date. The presence of anaemia among pregnant women is more than 40%. Hence, it constitutes a serious threat to the health of society.

Moreover, anaemia in pregnancy contributes significantly to the welfare as well as economic development and the health system of LMICs. Anaemia is prevalent in many developing or low-income countries (LMICs) because many people here cannot afford nutrient-rich foods vital to avoiding this condition. It is also because they do not have hospitals where they can go. Anaemia is a common complication experienced by pregnant women living in LMICs who may be subjected to additional risk factors like parasitic infections and high fertility levels, leading to increased susceptibility. As a result, anaemia during pregnancy can be associated with a broad array of poor maternal outcomes, ranging from maternal mortality and morbidity to perinatal outcomes like low birth weight and neonatal death. Such effects have economic consequences as more people suffer from the high costs of treating chronic anaemia-associated diseases and lost workforce productivity. The reason behind this research is that LMICs face deep consequences associated with non-communicable diseases, especially cardiovascular disease.

Anaemia during pregnancy, prevalent in these regions, not only jeopardises the well-being of expectant mothers but also poses significant risks to future generations and the socio-economic development of these nations. The urgency of this study arises from the harsh reality that a substantial percentage of pregnant women in LMICs suffer from anaemia, and the consequences are dire. Maternal mortality, infant mortality, and a myriad of adverse perinatal outcomes are inextricably linked to anaemia during pregnancy. These issues cause immeasurable human suffering and impose a substantial economic burden on already resource-constrained healthcare systems in LMICs. Hence, this study examined the Prevalence and Determinant of Anaemia in Pregnancy in Low-Middle Income Countries

Study Aim and Objectives

The study aims to examine the prevalence and determinants of anaemia in Pregnancy in Low-Middle Income Countries. The study objectives:

1. To identify, appraise and synthesise existing evidence on the anaemia prevalence among pregnant women in low and middle-income countries (LMIC).
2. To explore the biological, cultural, social, and economic determinants of anaemia in pregnancy, particularly in Low-middle-income countries.

Research Question

The systematic review examined the prevalence and determinants of Anaemia in Pregnancy in Low-Middle Income Countries.

Significance of the Study

This systematic review addresses several issues related to a study on the prevalence and determinants of anaemia in pregnancy among LMICs. Secondly, anaemia during pregnancy is a very serious problem for a country with a low middle income. It may result in worse outcomes for the mother as well as the foetus, such as high maternal mortality rates, low birth weights, preterm labour and cognitive dysfunction in the offspring (Obai et al., 2016). Examining the prevalence and risk factors of anaemia in these settings is crucial to addressing this significant public health concern and improving maternal and child health outcomes.

Also, the impact of this research is far-reaching, even for the global health community. It should be noted that anaemia is a global challenge whose consequences go beyond LMICs. Globally, it impacts on maternal and child health. The findings could help formulate global strategies for fighting anaemia in low-resource settings by understanding the determinants in LMICs where anaemia is common. The study also adds to the global movement towards Sustainable Development Goal 3, which addresses maternal survival rates and child mortality (United Nations SDG, 2015).

This study can also help policymakers in LMICs to implement interventions and programs based on particular determinants of anaemia in their respective settings. It could show where intervention is needed in food supplements, health care availability, and cultural factors affecting anaemia. To be effective, tailoring interventions targeting determinants per region is important.

Research Framework

The study's question is centred on the PEO framework facilitates specificity, clarity, and precision in research queries, enhancing the search strategy and structuring research problems effectively (Munn et al., 2014). Conversely, while the PICO framework yields detailed outcomes, it might not universally suit all research questions, especially those focusing on diagnosis, aetiology, or prognosis (Eriksen and Frandsen, 2018). However, there are various frameworks aid in crafting research questions, including PICO (Population, Intervention, Control, Outcome), SPIDER (Sample, Phenomenon of Interest, Design, Evaluation, Research type), and PEO (Population, Exposure, Outcome) frameworks.

Given the need for a framework adaptable to the research question the incidence and determinant of anaemia among expected mothers, the PEO framework was preferred over the PICO framework. Consequently, utilising the PEO framework, the Population of interest encompasses expected mother and anaemic patients,' the Exposure involves anaemia,' and the Outcome concerns the management of anaemia (Haider *et al*., 2013). In addition, it is essential to recognize the adaptability and value of the Population, Exposure, Outcome (PEO) framework in structuring research across diverse fields. This systematic breakdown simplifies complex topics, offering researchers a versatile tool. The framework's precision aids in crafting well-defined research questions, ensuring targeted and comprehensive inquiries, optimizing literature searches, and guiding study design. Within systematic reviews, PEO's structured approach facilitates coherent evidence synthesis, categorizing findings for thorough

analysis, bolstering review reliability, and enabling informed conclusions. This table outlines the framework's pivotal role in structuring research and enhancing evidence-based insights across various disciplines.

Table 1: PEO Framework

P (Population)	E (Exposure)	O (Outcome)
Pregnant women residing in LMICs	Factors influencing anemia in pregnancy such as inadequate nutrition, socio-economic disparities, limited healthcare access, and prevalent cultural practices	Prevalence or incidence of anemia in pregnancy, complications during pregnancy or childbirth, maternal and fetal health outcomes, long-term health implications

Search Strategy

A search strategy for a systematic review on the prevalence and determinants of anemia in pregnancy in low-middle income countries involves a structured approach to identify all relevant literature. According to the Cochrane protocol which values collaborative team efforts over individual contributions (Cooper *et al*., 2018). This is against a single author review discouraged due to concerns about reliability, because the reviewer is a postgraduate student under supervisor's guidance, following academic guidelines (Boland et al., 2017). Also, the reviewer adhere to PRISMA guideline to enhances methodological rigor (O'Dea et al., 2021), and comprehensive search strategies across databases minimize biases, strengthening review validity by incorporating diverse evidence. Therefore, the search strategy involve examining relevant articles such as observational studies such as cross-sectional, cohort, and case-control studies that report prevalence rates and research or analyses that investigate determinants of anemia in pregnant women in low-middle income countries. In addition, key concepts such as "anemia," "pregnancy," "prevalence," "determinants," and "low-middle income countries." Were employed in searching in relevant databases such as CINAHL, PubMed and Embase, which cover a wide range of public health peer reviewed articles. Also, record of all search terms used, the number of hits for each term, and the combinations of terms, along with the dates of the search. For PubMed, MeSH terms such as "Anemia," "Pregnancy," and "Prevalence was used" For Embase, use Emtree terms such as "Anemia," "Pregnant woman," and "Incidence." Was employed. In addition, include synonyms and related terms like "iron deficiency," "gestation," and "occurrence." Account for plural forms, different spellings, and acronyms. Construct a search string using Boolean operators (AND, OR) and parentheses for nesting concepts, e.g., (anemia OR "iron deficiency") AND pregnancy AND ("low-middle income countries" OR LMIC). However, the reviewer employed filters such as language, publication date, and study type to refine the results, review titles and abstracts for relevance, and adjust search terms as necessary to ensure that there were no mistakes in spelling or syntax that could affect the search results. Therefore, the syntax and indexing of other databases like Scopus or Web of Science were adapted and

to refine the results and feedback from initial searches. The essence of this comprehensive strategy was enhance rigour and reduce bias. However, the details of the process will be provided in subsequent subheadings.

Electronic Database Search

The search strategy begins with the selection of appropriate databases that are likely to contain relevant studies and stands as a cornerstone in evidence-based research, relying on meticulous and systematic searches facilitated by primary tools like databases (Mallett et al., 2012). However, it's crucial to note that no single database encompasses all essential information required for comprehensive analysis (Gopalakrishnan and Ganeshkumar, 2013). In this study, the employment of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) facilitated the identification of primary papers relevant to the review's focal inquiry (Snyder, 2019). Therefore, the selection of databases for the systematic review encompassed PubMed, Embase, Web of Science, and the Cochrane Library, each chosen for its distinct offerings. PubMed, renowned for biomedical literature, grants access to diverse articles in medicine, nursing, dentistry, and more, utilizing Medical Subject Headings (MeSH) for focused searches. Conversely, Embase, with extensive international coverage, excels in drug research and pharmacology, employing Emtree for precise article indexing. Web of Science, an interdisciplinary platform, extends beyond life sciences, delving into fields like chemistry and social sciences. Lastly, the Cochrane Library, a hub for systematic reviews and clinical trials, is pivotal for evidence-based medicine, offering comprehensive insights into healthcare interventions. This strategic use of databases ensured a broad and thorough exploration of the research landscape across various disciplines.

Search Terms

The study employed the PEO (Population, Exposure, Outcome) framework, the search terms for examining the prevalence and determinants of anemia in pregnancy in low-middle income countries are meticulously selected to encapsulate the core aspects of the research question. The population of interest is pregnant women residing in low-middle income countries. Therefore, search terms will include "pregnant women," "expectant mothers," and specific names of low-middle income countries or the term "developing countries" to capture the relevant geographic context. The exposure in this case refers to the determinants or risk factors associated with anemia in pregnancy. Search terms will encompass "determinants," "risk factors," "nutritional status," "iron deficiency," "folic acid deficiency," "malaria," "parasitic infections," and "socioeconomic factors." The outcome is the prevalence of anemia in pregnancy. This will be represented by search terms such as "prevalence," "incidence," "epidemiology," and "anemia," which may also be specified further with terms like "mild," "moderate," or "severe" anemia.

Similarly, index terms were standardized vocabularies utilized by databases to organize and retrieve information. In PubMed, Medical Subject Headings (MeSH) indexed articles, aiding in locating articles discussing similar topics under controlled vocabularies. Embase utilized

Emtree terms for indexing. The utilization of these index terms in conjunction with free-text terms, representing words and phrases used in titles and abstracts by authors, ensured a comprehensive search. Free-text terms accommodated the diverse expressions used by different authors for similar concepts. The Web of Science database proved valuable for interdisciplinary research, encompassing various scientific disciplines and enabling researchers to trace citations, exploring both backward references and forward citations. The Cochrane Library served as a specialized database focusing on systematic reviews and clinical trials, renowned for its stringent standards in evidence synthesis. Particularly beneficial for identifying healthcare-related systematic reviews and meta-analyses, it contributed significantly to robust search strategies. Combining these resources facilitated the construction of thorough search strategies, enhancing the identification of pertinent literature for systematic reviews or research projects.

In addition, the search terms involve combining these terms using Boolean operators to ensure a comprehensive search. For example: ("pregnant women" OR "expectant mothers") AND ("developing countries" OR specific country names) AND ("determinants" OR "risk factors" OR "nutritional status" OR "iron deficiency" OR "folic acid deficiency" OR "malaria" OR "parasitic infections" OR "socioeconomic factors") AND ("prevalence" OR "incidence" OR "epidemiology" OR "anemia") This approach ensures that the search captures a wide range of studies that address the specified population, the various exposures or determinants under investigation, and the particular outcome of interest, which in this case is the prevalence of anemia in pregnancy. Therefore, the search terms are carefully chosen to reflect the nuances of the research question while being broad enough to include all relevant literature.

Inclusion and Exclusion Criteria

The criteria was subjected to the PRISMA guidelines which required a clear articulation of inclusion and exclusion criteria. These criteria ensured the systematic identification, selection, and appraisal of studies. In addition, the PEO (Population, Exposure, Outcome) framework was particularly suited for qualitative research and guided the development of the criteria. This is presented in Table

Table 2: Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Population	Pregnant individuals in low-middle income countries	Non-pregnant individuals, high-income country populations
Exposure	Factors associated with anemia in pregnancy	Studies not examining anemia determinants or non-pregnancy focus
Outcomes	Anemia prevalence, qualitative analysis of determinants	Studies reporting only quantitative prevalence data
Study Design	Mixed studies which include Qualitative and quantitative studies.	Systematic review and any other review were excluded
Language and Time Frame	English studies in the last 10 years	Non-English studies without translations, studies >10 years old

Data Extraction

The data extraction process was meticulously conducted in alignment with the PRISMA guidelines to ensure a systematic and unbiased collection of relevant information from each included study. A standardized data extraction form was developed and pilot-tested on several studies to confirm its adequacy in capturing all necessary details. However, a single reviewer conducted the extraction process to minimize errors and enhance the reliability of the data. They extracted key study characteristics, including author details, year of publication, study location, study design, sample size, participant demographics, results and conclusion. This rigorous data extraction process laid a solid foundation for the subsequent synthesis and analysis, allowing for a comprehensive understanding of the prevalence and determinants of anemia in pregnancy within low-middle income countries.

Quality Assessment Tool

The quality assessment of the included qualitative studies was rigorously performed using the Critical Appraisal Skills Programme (CASP) Qualitative Research Checklist. Each study was meticulously evaluated on ten criteria encompassing the research's aim, methodology, design, recruitment strategy, data collection, relationship between researcher and participants, ethical considerations, data analysis, findings, and research value. The reviewer assessed the studies, ensuring a thorough and unbiased appraisal. The CASP tool enabled a comprehensive examination of the studies' trustworthiness, relevance, and implications. Therefore, this process ensured that only high-quality, methodologically sound studies contributed to the final synthesis, providing a reliable foundation for conclusions drawn about the prevalence and determinants of anemia in pregnancy in low-middle income countries.

Data Synthesis

The data synthesis was conducted through a narrative approach, integrating findings from the selected qualitative studies to construct a comprehensive understanding of the prevalence and determinants of anemia in pregnancy within low-middle income countries. The researcher carefully examined each study's results for themes and patterns regarding the risk factors and consequences of anemia during pregnancy and ensure similar findings were grouped to identify common determinants, such as nutritional deficiencies, socioeconomic status, and access to healthcare services. Divergent themes were also explored to understand the variability in experiences and risk factors across different settings. The narrative synthesis provided a textured interpretation of the data, highlighting the complex interplay of individual, cultural, and systemic factors contributing to anemia in pregnancy. This method facilitated the identification of gaps in the literature and informed recommendations for future research and policy interventions.

PRISMA Diagram

The 2019 version of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement is a detailed guideline designed to assist systematic reviewers in

transparently communicating their research's rationale, methodology, and findings (Vu-Ngoc et al., 2018; Page et al., 2021). The PRISMA flow diagram, characterized by its use of numerical data, concise language, and directional cues, offers a succinct visual representation of the search process, presenting readers with an accessible summary (Haddaway *et al*., 2022; Page, 2021).

Initially, 203 studies were identified from various databases (PubMed: 72, Cochrane Library: 38, EMBASE: 61, Web of Science: 32). Following exclusion of 74 irrelevant or duplicate studies, 129 articles remained. 34 articles were removed after abstract review, 62 articles didn't meet the study's objectives, leaving 33 for full-text assessment. 18 were excluded (systematic reviews, reports, proceedings), resulting in 15 studies. Subsequently, five studies were excluded, aligning with the study's goals, culminating in a final selection of 10 studies for a thorough systematic evaluation.

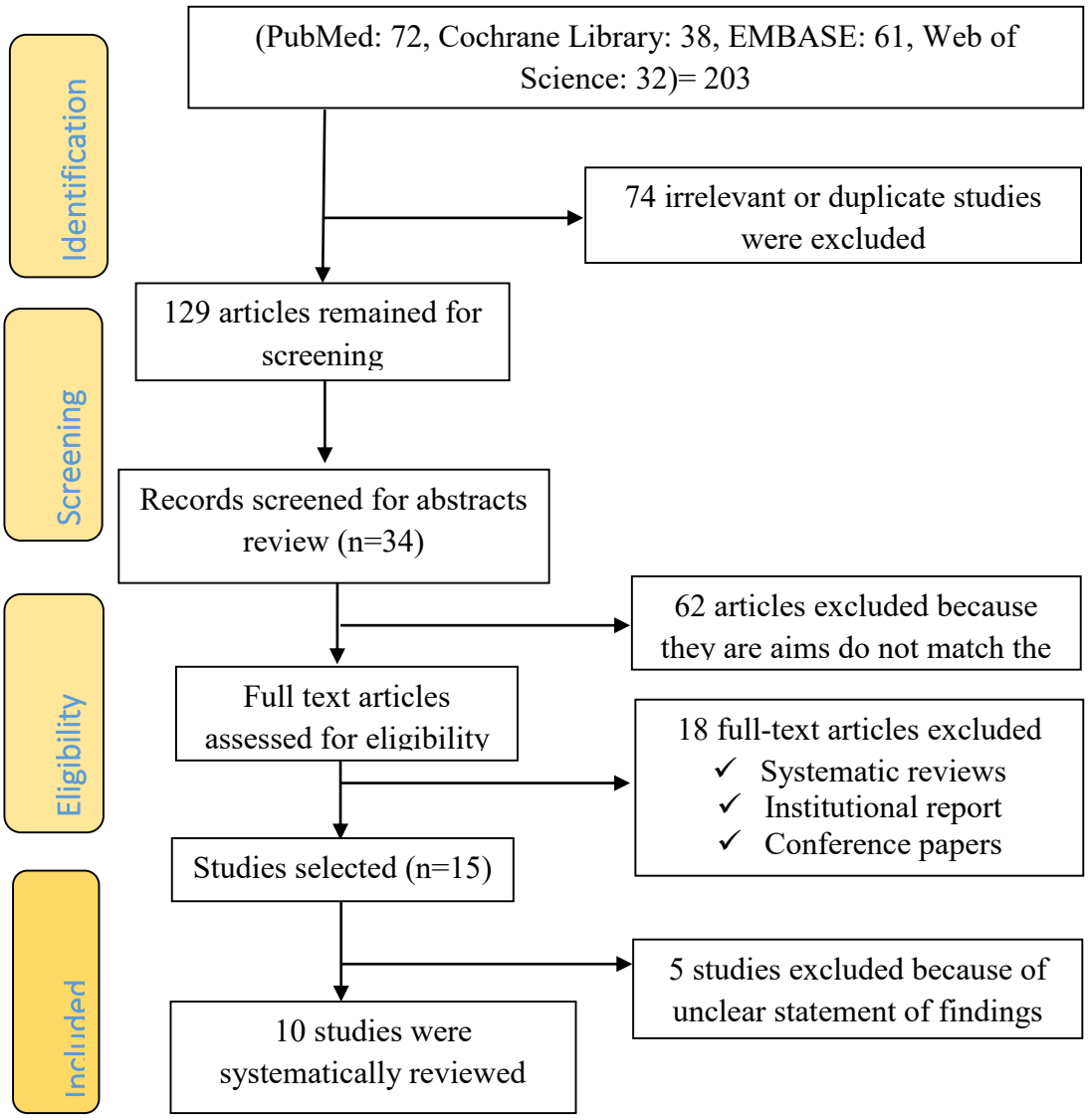


Figure 1: PRISMA Framework

Quality Assessment

The JBI checklist was applied for methodological appraisal of cross-sectional studies, ensuring rigorous evaluation. Studies underwent meticulous assessment of inclusion criteria relevance and participant selection justification. Sampling techniques were scrutinized for their representation of the target population, with high-quality studies employing suitable strategies. Evaluations of study settings and participant recruitment methods ensured alignment with research objectives. Validity and reliability of data collection methods were pivotal, favoring studies utilizing validated measures and standardized collection procedures. Adequacy and appropriateness of statistical analyses were reviewed for alignment with study design and data nature. Reporting clarity, including precise results and variability measures provision, determined the study's quality, ensuring replicability and comprehensive findings dissemination. (See Appendix).

Table 3: Data Extraction

Author/Year	Study Aim/Objectives	Study Design	Population	Country	Primary Outcome/Result (Statistical)	Conclusion
Dodzo et al. (2022)	Determine prevalence and risks associated with anemia in pregnant women	Cross-sectional study	Pregnant women (550)	Eswatini	Anemia prevalence: 43.1%; Factors: Urban residence, past anemia, trimester of pregnancy	Eswatini's pregnant women face significant anemia prevalence, particularly among urban residents, those with past anemia, and in certain trimesters of pregnancy.
Abdallah et al. (2022)	Assess prevalence and factors associated with anemia in pregnant women	Cross-sectional study	Pregnant women (420)	Tanzania	Anemia prevalence: 25.5%; Factors: Socio-economic status, dietary factors	In Tanzania, anemia prevalence is notable among pregnant women with lower socio-economic status and inadequate dietary habits.
Nuru-Yesuf and Agegniche (2020)	Evaluate prevalence and factors associated with anemia in pregnant women	Hospital-based cross-sectional study	Pregnant women (286)	Ethiopia	Anemia prevalence: 20.9%; Factors: Hookworm, rural residence, malaria history	Ethiopia's pregnant women experience moderate anemia prevalence, particularly affected by hookworm, rural residence, malaria history, and dietary factors.
Al-Aini et al. (2020)	Determine prevalence and factors of anemia in pregnant women	Cross-sectional study	Pregnant women (384)	Yemen	Anemia prevalence: 25.0%; Factors: Socio-economic, dietary, and health factors	Yemeni pregnant women encounter anemia prevalence linked to socio-economic status, dietary habits, and specific health conditions.

Author/Year	Study Aim/Objectives	Study Design	Population	Country	Primary Outcome/Result (Statistical)	Conclusion
Gonaid et al. (2022)	Assess prevalence and determinants of anemia in pregnant women	Cross-sectional study	Pregnant women (500)	Yemen	Anemia prevalence: 55.0%; Factors: Socio-economic, nutritional, health factors	High anemia prevalence among pregnant women in Yemen is associated with socio-economic status, nutritional aspects, and health factors.
Yang et al. (2023)	Describe prevalence and influencing factors of anemia in expectant mothers	Cross-sectional survey	Expectant mothers (586)	China	Anemia prevalence: 34.8%; Influence: Prenatal healthcare attendance	Rural Northwestern China sees considerable anemia prevalence among expectant mothers; regular prenatal healthcare attendance plays a significant role in reducing this prevalence.
Bansal et al. (2020)	Determine prevalence and associated factors of anemia in pregnant women	Cross-sectional study	Pregnant women (500)	India	Anemia prevalence: 81.8%; Factors: Socio-demographic, dietary factors	In India, pregnant women experience high anemia prevalence, influenced by socio-demographic factors and dietary habits.
Nair et al. (2022)	Estimate prevalence and factors associated with anemia in pregnant women	Cross-sectional study	Antenatal women (295)	India	Anemia prevalence: 40.0%; Factors: Menstrual blood loss, parity, trimester	Rural Indian antenatal women encounter moderate anemia prevalence, correlated with menstrual blood loss, parity, and specific trimesters of pregnancy.
Azhar et al. (2021)	Determine prevalence and risk factors of anemia in pregnant women	Cross-sectional study	Pregnant women (424)	Bangladesh	Anemia prevalence: 62.5%; Factors: Age, income, parity, iron supplementation	Bangladeshi pregnant women have notable anemia prevalence, linked to age, income, parity, and iron supplementation.
Anenga (2022)	Determine anaemia prevalence among pregnant women in BSUTH ANC	Cross-sectional	299 pregnant women	Nigeria	Prevalence: 95.1% mild anaemia, 4.9% moderate anaemia; No severe cases	High prevalence in 20-24 age group, lower education; Parity, fever, haematinics, diet linked to anaemia; Interventions needed

Prevalence of Aneamia among Pregnant Women in LMIC

The synthesis of the prevalence of anemia among pregnant women across various studies shows considerable variation from one country to another in LMIC. In Eswatini, the prevalence is reported at 43.1%, while Tanzania has a lower rate of 25.5%. Ethiopia's

prevalence stands at 20.9%, indicating a moderate level of anemia among pregnant women. In Yemen, two different studies report varying rates, with one study showing a 25.0% prevalence and another indicating a much higher prevalence at 55.0%. This suggests significant within-country variation. China's reported prevalence among expectant mothers is 34.8%, which reflects a substantial portion of the pregnant population. In India, there is a stark contrast in reported rates, with one study indicating a very high prevalence of 81.8% and another reporting 40.0%. Similarly, Bangladesh shows a prevalence of 62.5%, which is among the higher rates reported. Lastly, Nigeria presents a notably high prevalence of mild anemia at 95.1%, with a smaller percentage (4.9%) of moderate anemia cases. This synthesis indicates that anemia remains a common and significant health issue among pregnant women LMIC, with prevalence rates ranging from moderate to very high across the different countries studied.

Determinants of Aneamia among Pregnant Women in LMIC

The determinants of anemia among pregnant women in low- and middle-income countries (LMICs) are multifaceted, with themes emerging around socio-economic factors, dietary and nutritional intake, health-related issues, and accessibility to healthcare services.

Socio-economic Factors:

All the studies showed that socio-economic factor is major determinant of aneamia in pregnancy in LMIC. Abdallah et al. (2022) revealed a significant correlation between lower socio-economic status and anemia, displaying an Adjusted Odds Ratio (AOR) of 2.40 (95% CI: 1.05-5.48) for this factor. Similarly, Gonaid et al. (2022) outlined the significance of socio-economic elements, citing husband and mother education, mother's health knowledge, and family socioeconomic level as determinants. Al-Aini et al. (2020) identified low family income as a risk factor, indicating an Odds Ratio (OR) of 0.357 (95% CI: 0.215–0.590). Anenga (2022) highlighted a distinct association between rural residence and higher prevalence of anemia (P=0.000) during pregnancy. Additionally, Azhar et al. (2021) detailed associations between anemia and maternal age, monthly family income, and antenatal care (ANC) in government hospitals, displaying adjusted odds ratios ranging from 1.9 to 2.37. Dodzo et al. (2022) further suggested that living in urban areas could be associated with anemia, with an Odds Ratio (OR) of 1.8 (CI: 1.19–2.72). Nair et al. (2022) pinpointed excess menstrual blood loss, early age at first delivery, trimester, and parity as factors correlated with anemia, particularly emphasizing excess menstrual blood loss and trimester. Bansal et al. (2020) echoed the influence of residence, educational status, monthly family income, and occupation on anemia. Finally, Nuru-Yesuf and Agegniche (2020) reiterated the role of rural residence, lack of green leafy vegetables, and lower socioeconomic status, underscoring Adjusted Odds Ratios (AOR) of 6.26 for rural residence, 7.94 for lack of green leafy vegetables, and notably 22.9 for lower socioeconomic status associated with hookworm infection. This array of studies collectively illustrates the diverse and interconnected factors

contributing to the prevalence of anemia, emphasizing the intricate interplay between socio-economic, geographical, nutritional, and healthcare-related elements in its occurrence.

Dietary and Nutritional Intake

Seven studies out of the included studies showed that there is a relationship between dietary and nutritional intake and the prevalence of anemia among pregnant women (Abdallah et al., 2022; Nuru-Yesuf and Agegniche, 2020; Al-Aini et al., 2020; Anenga, 2022; Bansal et al., 2020; Azhar et al., 2021; Gonaid et al., 2022). Statistical analyses across these studies reveal compelling associations between specific dietary habits and anemia risk. Consuming green leafy vegetables and vegetable liquid cooking oil emerges as protective factors against anemia, as highlighted by adjusted odds ratios (AORs) of 0.53 (95% CI: 0.30-0.94) and 0.56 (95% CI: 0.34-0.98) in Abdallah et al. (2022). Conversely, studies indicate that the absence of crucial dietary components exacerbates anemia risk; lack of green leafy vegetables results in an AOR of 7.94 (95% CI: 1.1-56.4) for increased anemia prevalence (Nuru-Yesuf and Agegniche, 2020). Moreover, never consuming liver (Al-Aini et al., 2020), non-consumption of meat, poultry, or fish (Anenga, 2022), and dietary habits excluding green leafy vegetables, meat, and animal products (Bansal et al., 2020) are associated with heightened anemia risks. Encouragingly, the intake of iron supplements is linked to reduced anemia risk, with an AOR of 0.64 (95% CI: 0.64-0.98) (Azhar et al., 2021). Collectively, these findings underscore the pivotal role of dietary diversity, including the consumption of specific food items and nutritional supplements, in mitigating anemia risk among pregnant women, advocating for targeted nutritional interventions to combat anemia during pregnancy.

Health-Related Issues:

Six studies out of the included studies highlighted the intricate relationship between health issues and anemia, shedding light on diverse contributing factors (Abdallah et al., 2022; Nuru-Yesuf and Agegniche, 2020; Al-Aini et al., 2020; Anenga, 2022; Azhar et al., 2021; Gonaid et al., 2022). Abdallah et al. (2022) reported a significant association between the presence of health problems and anemia, revealing an Odds Ratio (OR) of 2.260 (95% CI: 1.342–3.806). Similarly, Nuru-Yesuf and Agegniche (2020) emphasized the impact of factors like hookworm infection, rural residence, and a history of malarial attacks on anemia, demonstrating substantial Adjusted Odds Ratios (AOR) of 22.9, 6.26, and 19.62, respectively. Al-Aini et al. (2020) echoed the significance of health problems in relation to anemia, presenting similar statistical outcomes with an Odds Ratio (OR) of 2.260 (95% CI: 1.342–3.806). Anenga's (2022) study pinpointed specific clinical features like fever, albeit without a specified odds ratio, as significantly linked to anemia. Additionally, Azhar et al. (2021) underscored the correlation between health problems and anemia, mirroring the odds ratio of 2.260 (95% CI: 1.342–3.806). Furthermore, Gonaid et al. (2022) identified factors such as suffering from excessive menses, mother's health knowledge, and health concerns as significantly associated with anemia, underscoring the intricate interplay between health conditions, awareness, and their impact on the prevalence of anemia. These collective findings accentuate the pivotal role

of health-related factors and clinical aspects in understanding and addressing the complex dynamics of anemia within diverse populations.

Geographical Location

The influence of geographical location, particularly urban versus rural residence, on anemia prevalence among pregnant women presents conflicting findings across several studies. Abdallah et al. (2022) reported a statistically significant association between urban residence and higher anemia prevalence among pregnant women, with an odds ratio (OR) of 1.8 (CI: 1.19–2.72), indicating an increased risk of anemia in urban areas. Similarly, Azhar et al. (2021) highlighted a significantly higher prevalence of anemia in pregnant women attending government hospitals in urban settings, with an adjusted odds ratio (AOR) of 2.02 (CI: unspecified). In contrast, Nuru-Yesuf and Agegniche (2020) and Anenga (2022) revealed a higher prevalence of anemia among pregnant women in rural areas. Nuru-Yesuf and Agegniche (2020) reported a rural residence with an AOR of 6.26 (CI: 1.90–20.71), indicating a substantially increased risk of anemia among rural-dwelling pregnant women. Similarly, Anenga (2022) found statistically significant determinants of anemia prevalence linked to rural residence (P=0.000). These divergent statistical outcomes underscore the complexity of regional disparities in anemia prevalence among pregnant women, necessitating a comprehensive understanding of contextual factors for targeted intervention strategies.

Discussion

Anaemia occurs at different levels of prevalence among pregnant women throughout LMICs from moderate to very high. Socio-economic conditions together with dietary patterns and geographical features and health-related aspects combine to explain this wide range of anaemia prevalence among pregnant women. Research findings confirm that anaemia affects large populations across LMICs and social conditions along with healthcare services both contribute to this situation (World Health Organisation, 2021). Local conditions such as healthcare infrastructure and dietary patterns appear to determine the differences in anaemia prevalence rates between Nigeria (95.1%) and Ethiopia (20.9%).

The review demonstrates that socio-economic status produces a significant impact on anaemia prevalence levels. Multiple research studies show that people from poor backgrounds who live in rural areas with limited educational opportunities develop more anaemia (Ahmed, 2021); Gupta *et al*., 2021). Ahmed (2021) confirmed these findings when they established that economic barriers block access to prenatal care and iron-rich diets which intensifies maternal anaemia. The results from different studies show economic poverty and educational deficits as primary risk elements that support previous research about maternal health inequalities in developing nations.

Nutritional and dietary patterns significantly influence the occurrence of anaemia among the population. Randhawa (2015) shows that consuming green leafy vegetables together with meat and iron supplements helps protect against maternal anaemia. Health-related factors such as

hookworm infections and excessive menstrual blood loss have been shown to raise anaemia risks according to previous studies (WHO, 2021).

Finally, geographical disparities underscore the need for region-specific policies. While some studies indicate higher anemia rates in urban areas due to dietary deficiencies, others highlight rural areas' vulnerability due to inadequate healthcare access (Kinshella *et al*., 2025). This duality, which suggest that both urban and rural settings pose unique challenges in addressing anemia. These findings collectively emphasize the necessity for integrated, context-specific interventions to mitigate anemia among pregnant women in LMICs.

Recommendation

i. Improve Maternal Nutrition Through Supplementation and Diet Diversification

Anemia among pregnant women in low- and middle-income countries (LMICs) is primarily caused by inadequate iron intake and poor dietary diversity. To address this, improving maternal nutrition through supplementation and diet diversification is essential. A key intervention is iron and folic acid (IFA) supplementation, which has been widely recommended by the World Health Organization (WHO) as a standard prenatal care practice.

ii. Strengthen Healthcare Services for Early Detection and Treatment

Anemia in pregnancy often remains undiagnosed due to inadequate healthcare services and lack of routine screening in LMICs. Strengthening healthcare services for early detection and treatment is crucial to reducing anemia-related complications. Antenatal care (ANC) services should be expanded to ensure pregnant women undergo routine anemia screening. Regular hemoglobin tests should be integrated into standard prenatal checkups, allowing healthcare providers to detect and manage anemia promptly. Many women in LMICs face challenges in accessing ANC due to geographical and financial barriers. Governments should implement mobile health clinics and community outreach programs to bridge this gap, ensuring that even women in remote areas receive essential prenatal services.

iii. Address Socioeconomic Barriers and Improve Women's Education

Socioeconomic factors play a major role in the high prevalence of anemia among pregnant women in LMICs. Poverty, low levels of education, and gender inequality prevent women from accessing proper nutrition and healthcare services. Addressing these barriers through economic empowerment and education is essential.

Women with low educational levels often lack awareness of anemia prevention and treatment. Governments and non-governmental organizations (NGOs) should implement community-based educational programs that focus on maternal health and nutrition. Health education should be integrated into school curricula to raise awareness from an early age.

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