Int. j. adv. multidisc. res. stud. 2026; 6(1):801-806

Received: 27-11-2025
Accepted: 07-01-2026

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Maternal Anemia Prevalence and Neonatal Mortality: Evidence from Ecological Cross-National Regression Analysis

[1] Jegede Tovia, [2] Okpanachi Favour Ojoanemile, [3] Otioro Jane Godwin, [4] Jimoh Sherifat Olamide, [5] Kamara Marie, [6] Saccoh Abdul

[1] Department of Medicine, Ignatius Ajuru University, Nigeria
[2] Department of Medicine, Ahmadu Bello University, Nigeria
[3] Department of Public Health, St. Monica University
[4] Department of Medical Laboratory Science, St. Ambrose Alli University, Nigeria
[5] Department of Nursing, University of Sierra Leone, Sierra Leone
[6] Department of Pharmaceutical Sciences, Southwest University, China

Corresponding Author: **Jegede Tovia**

Abstract

This study uses cross-national ecological data to examine the relationship between maternal anemia prevalence and neonatal mortality rates. Our regression analysis isolates the independent effect of anemia while controlling for the proportion of skilled health workers and neural tube defects (NTDs). After adjusting for NTDs (β = 0.037) and skilled health workers (β = -0.014), the multiple linear regression model revealed a statistically significant and positive correlation between maternal anemia and neonatal mortality rate (β = 0.448). The inclusion of control variables for NTDs further clarified that anemia extends beyond folate-related congenital anomalies, including a direct association with neonatal resilience and fetal growth. The negative coefficient for skilled health workers affirms their role in mitigating mortality risks. The findings in our study align with biological mechanisms linking anemia to preterm birth, intrauterine hypoxia, and immune compromise, which are consistent with prior epidemiological evidence. Additionally, the persistence of the association between the variables across robustness checks underscores the non-proximal status of maternal anemia, while confirming its independent risk factor position. The study presents a significant policy implication on the subject, advocating for scaled-up interventions and antenatal care expansion, particularly in low-and middle-income countries where anemia prevalence is highest.

Keywords: Maternal Anemia, Neonatal Mortality, Neural Tube Defects, Skilled Birth Attendance

1. Introduction

Maternal anemia, a condition of abnormally low red blood cells or hemoglobin in pregnant women, and neonatal mortality, the death of a newborn within the first 0-27 days of birth 28, are conditions resulting from reduced oxygen delivery to the fetus in pregnant women. Maternal anemia and neonatal mortality are an intricate and multifaceted relationship that is responsible for the two most pressing global public health concerns, with their far-reaching implications on the general health of mothers and infants, particularly in low and middle-income countries. According to the World Health Organization [1] approximately 40% of pregnant women are affected by anemia globally, with prevalence rates rising to over 50% in some sub-Saharan Africa and South Asia regions. Maternal anemia–hemoglobin concentration of less than 11g/dL during pregnancy is also regarded as the most common hematological disorder found among pregnant women [2]. According to [3] about 2.4 million neonates succumb to various causes arising from this disorder. The combined strain of maternal anemia and neonatal mortality not only negatively influences the affected families but also has a significant negative impact on the social and economic development of nations, as epidemiological studies have demonstrated a rigid association between maternal anemia and neonatal mortality.

From the large-scale prospective cohort study conducted in China, they attributed low birth weight and preterm birth to anemia in pregnant women, a study by HYPERLINK \l "Shi03" [5], linked the presence of a severe maternal anemia with higher risks of neonatal outcomes. A systematic cohort review and meta-analysis conducted from the search of the Chinese

database also revealed that maternal anemia is associated with an increased risk of neonatal mortality, as well as several other adverse pregnancy outcomes such as postpartum hemorrhage, preterm delivery, low birth weight (LBW), cesarean section, gestational hypertension, PROM, and neonatal asphyxia [6]. Furthermore, an early cohort study in India [7], also found 40-90% of pregnancy complications were found to be related to the presence of anemia, and a regional meta-analysis in sub-Saharan Africa [8], also indicated that women with anemia during pregnancy have a higher risk of giving birth to low-weight babies compared to women without anemia (AOR = 3.37; 95% CI: 2.66-4.27; I2: 96.71%).

The correlation between maternal anemia and neonatal mortality has a non-uniformity across countries, and is shaped by contextual factors that require rigorous analysis to disentangle [9]. However, despite growing evidence and research, critical gaps undermine our understanding of the anemia-neonatal mortality relationship, as existing cross-national analyses rely on bivariate correlations rather than regression models, thereby failing to control for confounders like proportion of skilled healthcare professionals, and medical defects such as neural tube defects (NTDs), a serious congenital malformations affecting the development of the fetus brain, spinal cord, and their protective coverings during the critical embryonic period (21–28 days post-conception) [10, 11], thereby making it impossible to isolate anemia's independent effect. This study addresses these gaps by utilizing cross-national regression analysis to quantify the direct relationship between maternal anemia prevalence and neonatal mortality through controlling for key confounders. Hence, provides a statistically robust evidence of anemia's independent contribution to neonatal mortality, and further addresses the limitations of correlational studies in the field. The finding from this study also has a high policy relevance capable of informing targeted policies, and underscoring the need for context-specific strategies between low middle-income countries (LMICs) and high-income countries, achieving sustainable development goal 3, which is reducing neonatal mortality to <12 per 1,000 live births by the year 2030 (United Nations Report 2025), and prioritizing anemia reduction as a cost-effective strategy for saving neonatal lives.

This research is grounded in three vital lines of evidence. First, biological studies consistently show that anemia directly disrupts fetal development [12], and also demonstrates that intrauterine hypoxia from low hemoglobin enhances risks of LBW, immune compromise, and preterm birth, all strong predictors of neonatal death [13]. Second, a meta-analysis [14], cross-national analyses [15], have observed correlations between anemia and neonatal mortality, but none have controlled for NTDs, thereby creating ambiguity about causality. Third, healthcare systems studies have shown that skilled workers can reduce neonatal mortality even in anemia-dominated populations [16]. Hence, a residual negative coefficient relationship is expected after adjustment of the variable. Therefore, this research put up a hypothesis that "there is a positive correlation between maternal anemia prevalence and neonatal mortality rates across countries". This hypothesis is testable, specific, and grounded in prior evidence, making it a robust foundation for analyzing and testing cross-national data.

2. Literature Review

Exploring the relationship between maternal anemia prevalence and the need to control for confounding factors is a significant approach towards a better understanding of the subject. The study of [17], Anemia prevalence among pregnant women in Sub-Saharan Africa related anemia prevalence to iron-folic acid supplementation and diversified dietary intake. Similarly, [18], linked severe anemia in the same region to the type of contraceptive and method of usage (PAF = 53.11%), and the lack of health insurance coverage (PAF = 37.92%). According to [19], the rising cases of anemia in rural areas are often due to limited healthcare access, dietary deficiencies, and poverty, in contrast to urban areas, while the study by [20], revealed level of education is the most influential factor contributing to anemia prevalence in Iran's Kurdish population. In South Asia, [15], surveyed the percentage of pregnant women with anemia, their research found a 23.2% mild anemia, 24.3% moderate anemia, and 2.0% severe anemia cases, resulting in an overall 2.5% neonatal and 3.5% infant deaths. Similarly, [21] studied the trend in East Asia, where their survey showed a 11.9% overall decline in anemia prevalence from 1990 to 2021, emphasizing profound regional and socio-economic imbalance in anemia burden.

[22] also studied the role of iron in neurodevelopment as an important factor towards avoiding neonatal mortality, emphasizing the dynamics of fetal iron metabolism to mother and child postnatal well-being. Over the years, iron deficiency anemia (IDA) in pregnant women has also been linked with neurological complications and congenital heart defects in fetuses, leading to neonatal mortality. Consequently, [23, 24] examined the components and effectiveness of increased use of skilled birth attendants in sub-Saharan Africa as a measure to curb neonatal mortality, suggesting a community-level initiative, free health care, and medication incentives as a measure of reducing IDA in pregnant women and neonatal mortality [16], also compared the neonatal mortality among births delivered by skilled to unskilled birth attendants in sub-Saharan Africa, their result showed a significant difference in risk of death on the first day of birth between newborns, which agrees with an early study by [25] relating high neonatal death within the first day of birth in Sub-Saharan Africa to the presence of unskilled birth attendants, which is in contrast to the result found in Asia and Latin America/Caribbean [26], also attributed the increase in neonatal mortality in Brazil to the unequal spatial distribution of health workers between the rural and the urban areas, while [27, 28], in their studies, emphasized the importance of an improved neonatal nursing workforce, as neonatal outcomes are directly linked to adequate access to trained health professionals within the medical and nursing sector.

3. Theoretical Framework

The relationship between maternal anemia prevalence and neonatal mortality can be best explained through a biosocial theoretical framework [29]. By integrating biological mechanisms such as the healthcare system and social determinants, the link between anemia prevalence and higher mortality risk across nations can be properly understood [30]. The research framework suggests that maternal anemia functions as a proximal biological stressor,

where structural and social factors such as the availability of skilled health workers modify its impact through timely screenings and interventions during antenatal care (ANC), treating underlying infections, prescribing iron-folate supplements, and managing neonatal complications. While neural tube defects (NTDs) and iron deficiency, which, through impairing the fetus's lymphocyte and cytokine production, weaken both maternal and fetal immune function, and reduce the neonate's ability to fight infections, act as a critical cofounder due to their shared etiological roots [31]. Together, this biosocial model describes the base of cross-national variation in maternal anemia prevalence correlation with neonatal mortality, as biological mechanisms are considered risk-driven, while social and structural factors are risk determinants, enabling an anemia's independent rigorous test contribution to mortality across diverse contexts Fig 1.

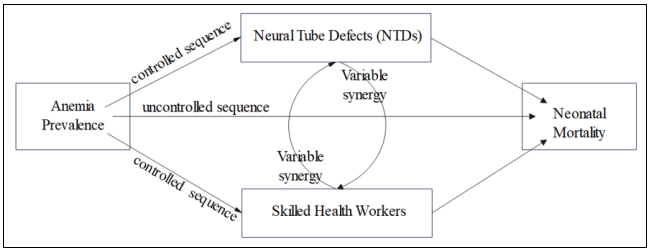

Fig 1: Anemia prevalence and the neonatal mortality pathway

4. Research Design

4.1 Sample Selection and Data Sources

Data for this research were extracted from the World Health Organization database, which ensures great comparability, consistency, and global representativeness. The sample includes a complete dataset 2023 of 98 countries, with variables of interest selected based on three criteria such as availability of annual estimate for maternal anemia prevalence (women aged 15–49 years), reported neonatal mortality rates (0–27 days; per 1,000 live births) across all estimated countries, data on neural tube defect (NTDs) incidence (per 10,000 live births), proportions of skilled health workers (per 10,000 birth). and malaria burden for instrumental variable estimation. The combination of these variables provides our study with a scientifically robust result for analysis with great policy relevance.

4.2 Model Construction

The study adopts a cross-national multiple linear regression model in testing for the relationship between maternal anemia prevalence and neonatal mortality rate, adjusting for incidence of NTD, and skilled health worker proportions. Detailed model is specified below:

$$\text{Anemia}_i = \beta_0 + \beta_1 \text{Neonatal Mortality}_i + \beta_2 \text{NTD}_i + \beta_3 \text{Skilled Workers}_i + \varepsilon_i \quad (1)$$

β_0 signifies the intercept of predicted anemia prevalence when all variables equal 0: β_1 signifies the coefficient for neonatal mortality: β_2 signifies the coefficient for NTD incidence, which controls for shared folate deficiency pathways: β_3 signifies the coefficient for skilled health workers: ε_is signifies error term of unobserved factors influencing anemia prevalence in country i. table 1.

Table 1: Descriptive statistics

Variable	Obs	Unit	Mean	Std. Dev.	Min	Max
Neonatal	98	death per 1,000 births	11.808	9.737	0.6	40.2
Anemia	98	percentage	27.676	10.509	10.5	59.9
NTDs	98	per 10,000 live births	74.607	52.316	1	166
Skilled	98	per 10,000 birth	86.373	21.183	0	100

Table 2 reports the variance inflation factor VIF for each variable to detect the presence of multicollinearity between independent variables, where all the variable values are less than 10, and the probability of severe multicollinearity is low according to the rule of thumb; therefore, the data can be modeled for analysis.

Table 2: Variance inflation factor

Variable	VIF	1/VIF
NTD1	1.033	0.968
Anemia	1.032	0.969
Skilled health	1.008	0.992

5. Results and Analysis

5.1 Basic Regression Result Analysis

A basic regression test was conducted to investigate the relationship between anemia and neonatal mortality, as well as to assess its correlation with our hypothesis. From our results, as shown in Table 3, column (1) does not include control variables, while column (2) includes all control variables. The regression results show that the coefficient of anemia on neonatal mortality is significantly positive, with the coefficient value of 0.448, indicating that neonatal mortality increases by 0.448 units for every unit increase of maternal anemia. The coefficient of NTD is significantly positive with the value 0.037, indicating that neonatal mortality increases by 0.037 units for every unit increase of NTD, and the coefficient of skilled health workers is significantly negative with the value -0.014, which indicates that neonatal mortality decreases by 0.014 units for every unit increase of skilled workers. This situation demonstrates that the regression results are consistent, and our model is reasonable. These findings support our hypothesis, confirming there is a positive correlation between maternal anemia prevalence and neonatal mortality rates across countries.

Table 3: Maternal anemia and neonatal mortality regression result

	(1) Neonatal	(2) Neonatal
Anemia	0.476***	0.448***
	(8.450)	(7.999)
NTDs		0.037***
		(3.247)
Skilled		-0.014***
		(-0.507)
_cons	-1.369	-2.106
	(-0.821)	(-0.725)
Year effect	Yes	Yes
Number of observations/countries	98	98

Note: t Statistics in parentheses, * signify significance level * p < 0.1, ** p < 0.05, *** p < 0.01. value without parentheses signifies the coefficient value.

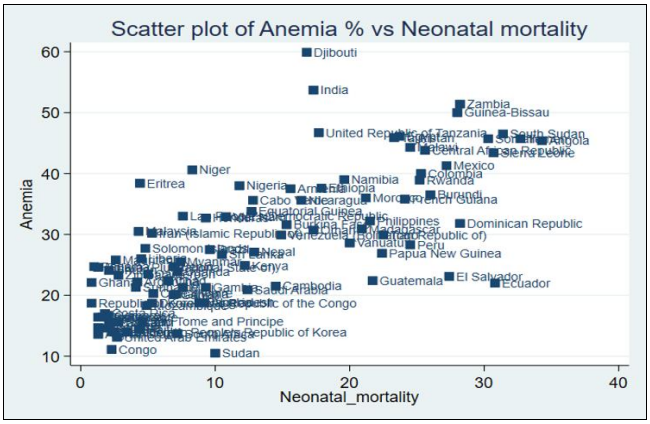

Fig 2: Scatter plot of anemia vs neonatal mortality

5.2 Robustness Test and Analysis

Endogeneity issues, such as measurement error resulting from omitted variables, are potential problems that can arise during empirical analysis. To reduce these measurement errors, address potential endogeneity issues, and further test the consistency of our regression results, this study employs the instrumental variable (IV) method, using malaria burden as an IV, which will help correct for unmeasured confounding variables and establish a causal relationship. Malaria burden, a parasitic infection that can lead to anemia prevalence through mechanisms such as the destruction of infected red blood cells and the body's impaired ability to produce new red blood cells, which can cause anemia prevalence. and the results are presented in Table 4. The results demonstrate that after accounting for the endogeneity issue, the conclusion that there is a positive correlation between maternal anemia prevalence and neonatal mortality rates across countries remained robust, thereby supporting our main result and hypothesis.

Table 4: Instrumental Variables Regression result

	(1) Neonatal	(2) Neonatal
Malaria burden	1.303***	1.215***
	(8.753)	(7.965)
NTD		0.005***
		(3.504)
Skilled		-0.003***
		(-0.927)
_cons	-2.194***	-2.001***
	(-4.456)	(-3.873)
Year effect	Yes	Yes
Number of observations/countries	98	98

Note: t Statistics in parentheses, * signify significance level * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Value without parentheses signifies the coefficient value.

6. Discussion

The core finding of this research maintains that higher maternal anemia prevalence is significantly correlated with increased neonatal mortality, even after adjusting for skilled health workers and neural tube defects (NTDs). Our result aligns with a robust body of epidemiological and biological evidence. This result, also reinforced by our instrumental variable robustness checks, further confirms that maternal anemia is not merely an associated factor of neonatal mortality but an independent risk driver across diverse national contexts. Cross-nationally, our research findings conform to the work by [32], who observed a correlation between anemia and neonatal mortality, especially in sub-Saharan Africa, with a 95% confidence interval. This suggests that anemic mothers are more likely to give birth to preterm or low-birth-weight infants, which are all strong predictors of neonatal mortality. Our result also aligns with the study by [33], which associated anemia with preterm birth, neonatal death, and perinatal death. However, their study fails to control for confounders; our analysis, therefore, advances this by demonstrating that the association between these variables persists after adjusting for confounders such as NTDs, with a pooled coefficient of $\beta = 0.037$ across 98 countries. The inclusion of NTDs as a control variable is critical to our study, as folate deficiency is an NTD and anemia common etiological factor. By adjusting for NTD incidence, we successfully isolated the independent effect of anemia on neonatal mortality and separated it from its indirect impact through congenital anomalies [34], which contributes about 10–15% of neonatal deaths globally.

On skilled health professionals, the interaction between anemia and skilled health workers was significantly negative ($\beta = -0.014$), indicating that the strength of the maternal anemia neonatal mortality association varies systematically with healthcare capacity, where an increase in the proportion of skilled health workers covaries with neonatal mortality. This situation conforms to [35], which argued that many maternal deaths can be reduced or prevented if a pregnant mother receives care from skilled health personnel. Our result also aligns with [36], which emphasized the importance of improved health care access for rural residents in LMICs by expanding health facilities and focusing on socio-cultural context-specific barriers to encompass marginalized populations, as can be observed in the scatter plot above Figure 2. However, while skilled health workers reduce the risk of anemia-mortality, they do not eliminate it, suggesting that healthcare capacity acts as a buffer to the problem, not a sole solution, as addressing the anemia dilemma and related situations requires upstream interventions alongside skilled care delivery. Furthermore, our result also agrees with the findings of [37], that compared during antenatal and postnatal period community health educational strategy by skilled health professionals versus non-skilled health workers strategy on maternal and newborn care in LMICs, aimed at improving neonatal health and survival across Africa, Central and South America, arguing that community health educational and interventions by skilled health workers had significant impact on inhibiting the overall neonatal mortality risk ratio (RR) 0.87, 95% confidence interval in those region.

7. Conclusion

This study was conducted to examine the relationship between maternal anemia prevalence and neonatal mortality. From the conducted cross-national regression analysis, our result confirms that maternal anemia is a significant independent predictor of neonatal mortality, with a robust association that lingers across various contexts. The biological mechanisms, immune impairment, hypoxia, shared nutritional pathways, and the global scope of the data emphasize the assertion that anemia reduction is a feasible and cost-effective strategy to advance progress toward the WHO Sustainable Development Goal 3, aimed at reducing neonatal mortality to <12/1000 live births by 2030. Also, by prioritizing iron-folate supplementation, strengthening (ANC), and addressing root causes of anemia, countries can

substantially lower neonatal mortality, improve maternal and child health equity, as even after accounting for the proportion of skilled health workers and neural tube defects, the relationship between our dependent and independent variables remains consistent across robustness checks. These results further underscore the urgency of prioritizing maternal anemia reduction and its inclusion in global health agendas, especially in low-and middle-income countries.

8. Recommendation

(1) Based on the robust evidence of the positive correlation between maternal anemia prevalence and neonatal mortality, this study stresses the urgent need for targeted multi-sectoral policies as a critical lever to address maternal anemia for the reduction of neonatal deaths. First, national and global health authorities must prioritize scaling up programs and awareness on universal iron-folate supplementation for women of reproductive age, especially in (LMICs) where anemia prevalence exceeds 50%. The WHO daily iron and folic acid supplementation recommendation during pregnancy is (30–60 mg) and (400µg) respectively, but coverage remains below 50% in most sub-Saharan Africa and South Asia countries. Therefore, related policies should prioritize and integrate supplementation into routine (ANC) visits, with community health workers tasked with holistic supervision and distribution to rural and marginalized populations.

(2) Policy interventions must address the root causes of maternal anemia, including food insecurity and parasitic infections, particularly in sub-Saharan Africa, as malaria and hookworm infestations aggravate anemia by causing nutrient loss and chronic hemolysis. Additionally, anemia-targeted programs and policies should incorporate malaria prophylaxis and deworming campaigns, as co-interventions can reduce anemia prevalence by 25% in endemic regions [38]. Furthermore, fortifying staple foods with iron and folate should be mandated in countries with high anemia rates, and ensuring this approach reaches populations beyond ANC coverage.

(3) Substantial investments and budgetary allocation into the healthcare sector should also be prioritized, as such is critical for translating anemia reduction into lower mortality. Therefore, health policies should expand training for nurses and midwives in identifying anemia, providing neonatal resuscitation, and managing preterm labor, as these skills present great potential for the reduction of neonatal mortality. Efforts and modalities aimed at increasing ANC coverage to >80%, ensuring timely detection and treatment of anemia, should be cautiously implemented, while creating a feedback loop where reduced anemia can strengthen the effectiveness of healthcare interventions.

(4) In sub-Saharan Africa, where anemia mortality is strongest [39]. Policies prioritizing emergency obstetric care, supplementation, and tracking anemia prevalence should be implemented. These policies, combined with biological interventions such as fortification and supplementation, infection control, strengthening of the healthcare workforce, and equity-focused strategies, can break the anemia-neonatal mortality cycle and enhance progress toward achieving global health targets.

9. Study Limitations and Suggestions for Future Research

Our study employed an ecological cross-national research approach, comparing different countries at a single point in time. A research method that is highly prone to ecological fallacy and confounding bias. We strongly encourage future research to combine the ecological approach with the longitudinal dynamics approach, whereby a particular participant is followed over an extended period, which helps to reveal how and why changes occur, rather than simply offering a snapshot in time. This method allows for deeper exploration of causality and trends.

Declaration of Conflicting Interests

The authors declared no conflicts of interest

Funding

The authors received no funding for this research.

Data Availability statement

The data used in this research can be obtained online through the WHO website
https://data.who.int/indicators/i/E3CAF2B/A4C49D3
https://data.who.int/indicators/i/41D099F/8D58801
https://data.who.int/indicators/i/F835E3B/1772666
https://www.who.int/data/gho/data/indicators/indicator-details/GHO/reported-number-of-people-requiring-interventions-against-ntds
https://www.who.int/data/gho/data/indicators/indicator-details/GHO/malaria-incidence-(per-1-000-population-at-risk)

10. References

1. World Health Organization. Guideline on haemoglobin cutoffs to define anaemia in individuals and populations. Geneva: 2024. Licence: CC BY-NC-SA 3.0 IGO.
2. Mahtab S, Madhi SA, Baillie VL, *et al*. Causes of death identified in neonates enrolled through Child Health and Mortality Prevention Surveillance (CHAMPS). PloS Global Public Health. 2023; 3(3):e0001612.
3. Fançony C, Soares Â, Lavinha J, *et al*. Efficacy of Nutrition and WASH/Malaria Educational Community-Based Interventions in Reducing Anemia in Preschool Children from Bengo, Angola: Study Protocol of a Randomized Controlled Trial. Int. J. Environ. Res. Public Health. 2019; 16:466.
4. Chu F, Shen-Wen S, Liang-Minga L, *et al*. Association between maternal anemia at admission for delivery and adverse perinatal outcomes. Journal of the Chinese Medical Association. 2020; 83(4):402-407.
5. Shi H, Chen L, Wang Y, *et al*. Severity of Anemia During Pregnancy and Adverse Maternal and Fetal Outcomes. JAMA Netw Open. 2022; 5(2):e2147046.
6. Wang R, Xu S, Hao X, *et al*. Anemia during pregnancy and adverse pregnancy outcomes: A systematic review and meta-analysis of cohort studies. Front. Glob. Womens Health. 2025; 6:1502585.
7. Sangeeta V, Pushpalatha S. Severe Maternal Anemia and Neonatal Outcome. Scholars Journal of Applied Medical Sciences. 2014; 2(1C):303-309.
8. Belete NK, Belete AG, Assefa DT, *et al*. Effects of maternal anemia on low-birth-weight in Sub-Sahara African countries: Systematic review and meta-analysis. PLoS One. 2025; 20(6):e0325450.
9. Zhao B, Sun M, Wu T. The association between maternal anemia and neonatal anemia: A systematic

review and meta-analysis. BMC Pregnancy Childbirth. 2024; 24(1):677.
10. Estevez-Ordonez D, Davis MC, Hopson B. Reducing inequities in preventable neural tube defects: The critical and underutilized role of neurosurgical advocacy for folate fortification. Neurosurgical Focus. 2018; 45(4):E20.
11. Manimekalai R, Rahana A, Shruti S. Neural Tube Defects: Etiology, Epidemiology, Risk Factors, and Advances in Prevention and Treatment. Int. J. of Allied Med. Sci. and Clin. Res. 2024; 12(3):320-324.
12. Shi H, Chen L, Wang Y, *et al*. Severity of Anemia During Pregnancy and Adverse Maternal and Fetal Outcomes. JAMA Netw Open. 2022; 5(2):e2147046.
13. Mustafa S, Baris K, Acar-Sahan S, *et al*. Functional and Histological Changes in Umbilical Artery and Myometrium Isolated from IUGR Complicated Pregnancies. Fetal and Pediatric Pathology. 2023; 42(6):845-859.
14. Sanni OB, Chambers T, Li JH, *et al*. A systematic review and meta-analysis of the correlation between maternal and neonatal iron status and haematologic indices. EClinical Medicine. 2020; 27:100555.
15. Fite MB, Assefa N, Mengiste B. Prevalence and determinants of Anemia among pregnant women in sub-Saharan Africa: A systematic review and Meta-analysis. Arch Public Health. 2021; 79(1):219.
16. Seifu BL, Negussie YM, Asnake AA, *et al*. Modifiable risk factors for anemia among women of childbearing age in sub-saharan. Africa BMC Public Health. 2015-2023; 25:267.
17. Ifeanyi OE. Comparing Anemia Prevalence in Rural vs. Urban Pregnant Populations: A Review. International Research in Medical and Health Sciences. 2025; 7(6):31-38.
18. Moradi Y, Moradkhani A, Shokri A, *et al*. Socioeconomic inequality in the prevalence of anemia: Decomposing analysis among Kurdish people. BMC Public Health. 2025; 25:1392.
19. Tsamantioti E, Tobias A, Muhammad ZH, *et al*. Maternal anaemia and risk of neonatal and infant mortality in low- and middle-income countries: A secondary analysis of 45 national datasets. BMJ Glob Health. 2025; 10:e014654.
20. Sharif N, Neyazi A, Khatib MN, *et al*. Anemia in Asian children: Trends in the prevalence, etiology and analysis of geographic inequalities. World J Pediatr. 2025; 21(4):396-405.
21. Vaishali J, Rajendra A. Iron Homeostasis and Metabolism During Pregnancy: Exploring Innovative Drug Delivery Approaches for Treating Iron Deficiency Anemia in Pregnant Women, Archiv der Pharmazie. 2025; 358:5.
22. Zych-Krekora K, Sylwestrzak O, Krekora M. The Critical Role of Iron in Pregnancy, Puerperium, and Fetal Development. Journal of Clinical Medicine. 2025; 14(10):3482.
23. Zuñiga JA, García A, Kyololo OM, *et al*. Increasing utilisation of skilled attendants at birth in sub-Saharan Africa: A systematic review of interventions. Int J Nurs Stud. 2021; 120:103977.
24. Amouzou A, Ziqi M, Carvajal-Aguirre L, *et al*. Skilled attendant at birth and newborn survival in Sub-Saharan Africa. Journal of Global Health. 2017; 7(2):020504.
25. Singh K, Brodish P, Suchindran CA. Regional Multilevel Analysis: Can Skilled Birth Attendants Uniformly Decrease Neonatal Mortality? Matern Child Health J. 2014; 18:242-249.
26. Sousa A, Dal Poz MR, Boschi-Pinto C. Reducing Inequities in Neonatal Mortality through Adequate Supply of Health Workers: Evidence from Newborn Health in Brazil. PLoS One. 2013; 8(9):e74772.
27. Carole K, Faan RN. Neonatal Nursing Workforce: A Global Challenge and Opportunity. Newborn and Infant Nursing Reviews. 2015; 15(4):165-166.
28. Miranda MM, Matthew L, Nancy C. Neonatal nursing research in low-and middle-income countries: A scoping review. Journal of Neonatal Nursing. 2024; 30(6):583-600.
29. Cui Y. Digital pathways connecting social and biological factors to health outcomes and equity. Npj Digit. Med. 2025; 8:172.
30. Diez Roux AV. Integrating Social and Biologic Factors in Health Research: A Systems View. Annals of Epidemiology. 2007; 17(7):569-557.
31. Arabzadeh H, Jenabi E, Masoumi SZ. Maternal factors for neural tube defects in offspring: An umbrella review. Open Medicine (Warsaw, Poland). 2024; 19(1):20241061.
32. Rahman M, Abe SK, Rahman S, *et al*. Shibuya Kenji 3Maternal anemia and risk of adverse birth and health outcomes in low- and middle-income countries: Systematic review and meta-analysis. The American Journal of Clinical Nutrition. 2016; 103(2):495-504.
33. Catherine S, Flora T, Emma B, *et al*. Maternal and Perinatal Morbidity and Mortality Associated with Anemia in Pregnancy. Obstet Gynecol. 2019; 134(6):1234-1244.
34. Kim J, Kim R. Problems in accessing health care and child survival in 49 low- and middle-income countries. The European Journal of Public Health. 2023; 33(2):160.
35. Black RE, Victora CG, Walker SP, *et al*. Maternal and Child Nutrition Study Group: Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet. 2013; 382(9890):427-451.
36. Nelson JR, Ess RH, Dickerson TT, *et al*. Strategies to increase rural maternal utilization of skilled health personnel for childbirth delivery in low- and middle-income countries: A narrative review. Global Health Action. 2022; 15(1):2058170.
37. Lassi ZS, Kedzior SG, Bhutta ZA. Community-based maternal and newborn educational care packages for improving neonatal health and survival in low- and middle-income countries. Cochrane Database Syst Rev. 2019; 11:7647.
38. Anil C, Kaur K, Malik V, *et al*. Effectiveness of Deworming Strategy in Reducing Anemia in Children: An Overview of Reviews. Indian Journal of Community Medicine. 2025; 50:1-14.
39. Martin NM, Glory M, Ernest M. Iron deficiency anemia in sub-Saharan Africa: A review of current evidence and primary care recommendations for high-risk groups. The Lancet Haematology. 2021; 8(10):e732-e743.