STUDENTS' CORNER
RESEARCH ARTICLE

The association between maternal anaemia in the third trimester and low birth weight neonates: a cross-sectional study

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Abstract

Objective: To explore the association between maternal anaemia during the third trimester and low birthweight babies.

Method: The prospective, cross-sectional study was conducted from August to October 2024 at Lyari General Hospital, Karachi, and comprised women with singleton, term pregnancies. Using a structured questionnaire, sociodemographic data and haemoglobin levels of the mothers in the 3rd trimester were recorded. Maternal anaemia's potential association with body mass index, maternal age, child birthweight, gestational age at delivery, and nulliparity was explored. Data was analysed using SPSS 26.

Results: Of 314 pregnant women with mean age 27±5.88 years, 241(76.8%) were anaemic. Low birthweight (<2.5kg) was observed in 45(14.3%) neonates. A significant association (p<0.01) was found between maternal anaemia in the 3rd trimester and low birthweight in neonates.

Conclusion: Low haemoglobin levels in the third trimester were found to be significantly associated with low birthweight of the neonate, with severe anaemia posing the highest risk.

Key Words: Anaemia, Low birthweight, Gestational age, Body mass index, Parity.
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Introduction

Anaemia is a pathophysiological state characterised by reduced haemoglobin (Hb) and/or red blood cells (RBCs), resulting in compromised oxygen delivery to tissues.[1] Anaemia during pregnancy constitutes a significant public health concern, particularly in developing nations, due to its association with increased morbidity in pregnancy-related complications.[2] According to the World Health Organisation (WHO), anaemia in pregnancy is characterised by an Hb concentration of <11gm/dl.[3] Population-based studies have consistently identified the prevalence of anaemia being ≥40% as a major public health threat.[4] Globally, 38% of pregnant women are affected by anaemia, impacting approximately 32 million individuals.[5] In Southeast Asia, 48% of pregnant women suffer from anaemia. The Indian National Family Health Survey-4 (NFHS-2015-16) reported a concerning prevalence of 50.4% anaemic pregnant women aged 15-49 years.[6] Anaemia may lead to low birthweight (LBW) and small for gestational age (SGA) babies, preterm labour and intrauterine growth restriction (IUGR) or intrauterine death.[7] In females of reproductive age, factors that may contribute to causing anaemia include dietary deficiencies, poor socioeconomic status (SES), multi-parity or some disease conditions. Maternal nutritional deficiencies during pregnancy can significantly impact foetal growth and development. Insufficient intake of essential nutrients can result in adverse birth outcomes, such as LBW, which can have long-lasting health consequences for the newborn.[8,9]

The physiological expansion of plasma volume during the second trimester leads to a decrease in Hb levels. Consequently, measurements of Hb levels after this period can potentially mask the true prevalence of anaemia in pregnant women.[10,11] According to the WHO guidelines, Hb values 10-10.9gm/dl are considered mild anaemia, 7-9.9gm/dl for moderate anaemia, and <7gm/dl for severe anaemia,[12] Birth weight of neonates <2.5kg is measured as LBW; (normal birth weight: 2.5-4.0kg).[7] GA is defined as the neonatal weight being below the 10th percentile, and it is associated with increased neonatal morbidity and mortality.[13] Foetal iron requirements increase in the third trimester, and foetal growth increases in this period. In the presence of maternal iron

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deficiency anaemia in the early third trimester, foetal growth restriction, owing to insufficient circulation and oxygenation, is possible.[14] Another reason for IUGR is an increased production of norepinephrine in iron-deficient states, stimulating the production of corticotropin-releasing hormone. This in turn increases cortisol production which may possibly restrict foetal growth.[15]

The current study was planned to find an association between maternal anaemia in the last trimester and clinically diagnosed LBW in neonates.

Subjects and Methods

The prospective, cross-sectional study was conducted from August 1 to October 31, 2024, at the Paediatrics Department and Obstetrics and Gynaecology Department of Lyari General Hospital, Karachi. The sample size was calculated using OpenEpi[16], based on an assumed LBW prevalence of 78% among anaemic mothers.[17] To enhance precision, the sample size was inflated by <20%. The sample was raised using convenience sampling technique. Those included were women with singleton pregnancy having full-term newborn babies. Pregnant women with multiple gestation births, pre-term delivery <37 weeks of gestation, history of tobacco, alcohol and drug abuse during pregnancy, pregnancies with complications other than anaemia, mothers with co-morbid conditions existing prior to pregnancy, babies with chromosomal and congenital anomalies, and newborns with any haemoglobinopathy were excluded.

After taking informed consent from the mothers, data was collected using a structured questionnaire that covered antenatal or obstetric history and maternal socio demographic characteristics, including age, ethnicity, residency, dietary and smoking habits, education, occupation and economic class, through in-person interviews.[15] The covariates in the presence of anaemia during pregnancy, gestational age, mode of delivery (spontaneous vaginal delivery [SVD] or Caesarean section [CS]), number of foetuses and pregnancy outcomes, were obtained from the medical records, and and were used to explore the relationship between maternal body mass index (BMI) and neonatal birthweight.

All neonates were assessed for their growth parameters within 48 hours of birth. Birthweight was measured using digital weight scale and categorised as LBW (<2.5kg) or normal (2.5-4.0kg).[18] Maternal BMI was classified using the Paediatrics and Pregnancy Nutrition Surveillance System (PNSS) as underweight (<18.5kg/m2), normal (18.5-24.9kg/m2), overweight (25.0-29.9kg/m2) and obese (≥30kg/m2) [19,20]. Last menstrual period was used to determine the gestational week. In cases where last menstrual period was not known, gestational age was calculated on the basis of ultrasound done in the first trimester. LBW was defined as weight <2.5kg at term.[21] Population was divided into different SES groups as per the World Bank Report for Pakistan[22], according to which, the lower income class in Pakistan is the one earning 78.1 Pakistani rupee (PKR) or less per day per capita, lower middle-income class earning PKR132.5, and upper middle-income class earning PKR248.7 per day per capita. IUGR was defined as foetal growth, measured by ultrasound, less than 10th centile for that gestational age.[23] Hb 10-10.9gm/dl was considered mild anaemia, 7-9.9gm/dl moderate anaemia, and <7gm/dl severe anaemia.[12] SGA was identified when the neonatal weight was below the 10th percentile.[13]

Data was analysed using SPSS 26. Quantitative variables were reported as mean +/- standard deviation or median with interquartile range (IQR) depending on data normality which was assessed using the Kolmogorov-Smirnov test. Qualitative variable were reported as frequencies and percentages. Effect modifiers, like maternal age, parity, education, employment status and monthly income, were addressed through cross-tabulation. Chi-square test and Fischer-exact test were applied, as appropriate. P<0.05 was considered significant.

Results

There were 314 pregnant women with mean age 27±5.88 years. The predominant ethnic group was Baloch 83(26.4%). Majority of the subjects were from the lower

Table-1: Sociodemographic characteristics of the participants (n=314).

Variables	Frequency (n)	Percent (%)
Age Group		
< 19 years	25	8.0
20-25 years	131	41.7
26-30 years	104	33.1
> 30 years	54	17.2
Religion		
Christian	6	1.9
Hindu	14	4.5
Muslim	294	93.6
Ethnicity		
Baloch	83	26.4
Brohi	1	0.3
Farsi	1	0.3
Hazara	2	0.6
Marwaari	1	0.3
Mianwali	1	0.3

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Pathan	55	17.5
Punjabi	44	14.0
Saraiki	1	0.3
Sindhi	69	22.0
Soomro	1	0.3
Urdu	55	17.5
Dietary Habits		
Non- Vegetarian	297	94.6
Vegetarian	17	5.4
Smoking Habits		
Non- Smoker	303	96.5
Smoker	11	3.5
Education		
Elementary	57	18.2
Secondary	53	16.9
Intermediate	40	12.7
Graduate/ Postgraduate	14	4.5
None	150	47.8
Occupation		
Housewife	288	91.7
Working	26	8.3
Socioeconomic Class		
Lower class	138	43.9
Lower middle class	156	49.7
Upper middle class	20	6.4

middle-class background 156(49.7%), Muslim 294(93.6%), non-vegetarian 294(93.6%), non-smokers 303(96.5%), and housewives 288(91.7%), while 150(47.8%) were illiterate (Table 1).

Of the 314 live-birth cases, 115(37%) mothers were mildly anaemic, 111(35%) were moderately anaemic, 15(5%) were severely anaemic and 73(23%) were not anaemic (Figure 1). Overall, the prevalence of LBW was 53(16.9%), whereas 261(83.1%) newborns had birth weight ≥2.5kg.

A significant association was found between anaemia status and LBW, with 45(18.7%) LBW cases among 241(76.8%) anaemic mothers compared to 8(11%) among 73(23.2%) non-anaemic mothers ($p<0.01$). A more pronounced gradient showed that the LBW rates were (12)10.4%, (21)18.9% and (12)80% in the mild, moderate and severe anaemic groups, respectively. A large proportion of anaemic mothers 196(62.4%) had babies weighing >2.5kg babies (Figure 2). Severe anaemia (Hb<7mg/dl) was present in 15(4.7%) cases, and 12(80%) of them had LBW babies.

Maternal anaemia was predominantly observed among those aged 20-25 years 95(30.25%). Majority of females

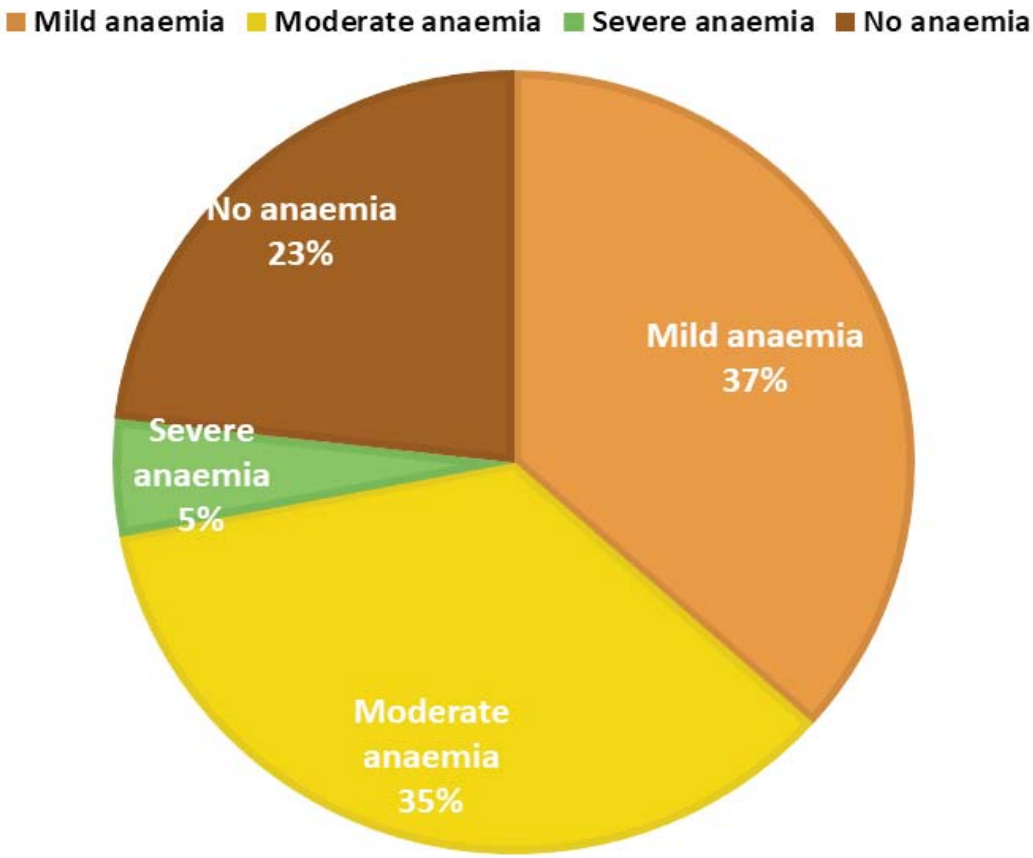

Figure-1: Anaemia severity among the participants.

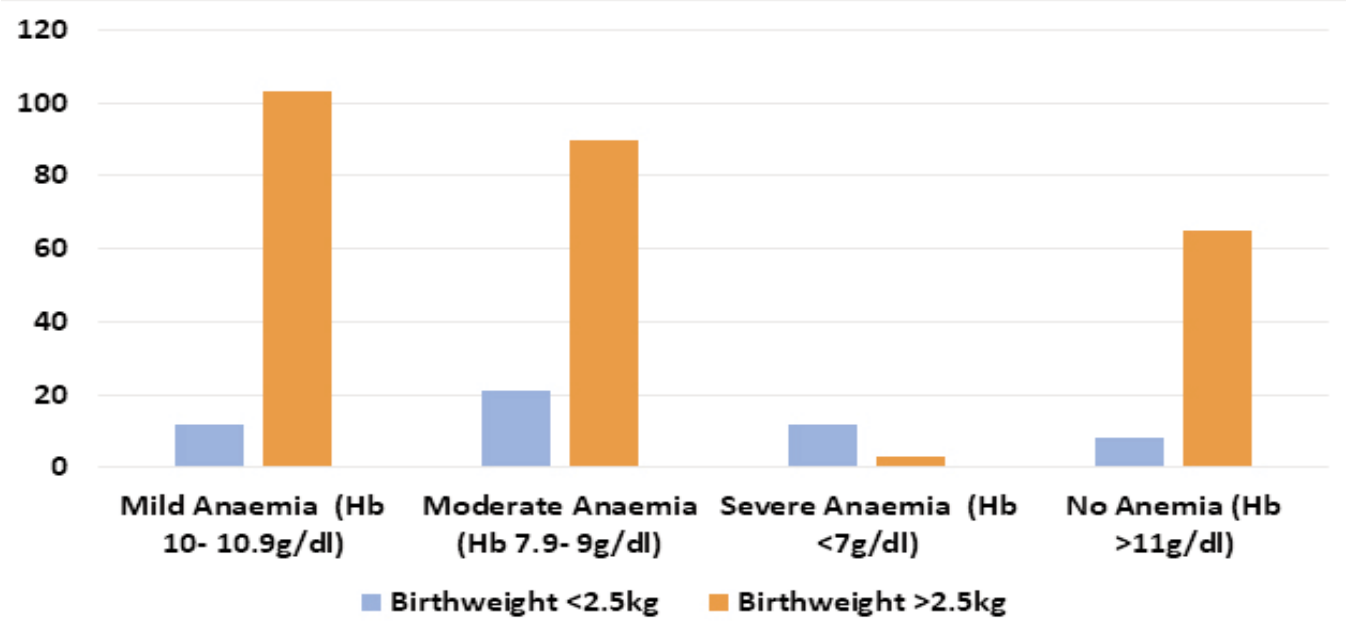

Figure-2: Prevalence of clinically diagnosed cases of low birthweight (LBW) babies in association with maternal anaemia.

Table-2: Distribution of maternal characteristics and complications by anaemia status.

		Mild anaemia (Hb 10-10.9) (N = 115) n (%)	Moderate anaemia (Hb 7-9.9) (N = 111) n (%)	Severe anaemia (Hb<7) (N = 15) n (%)	No anaemia (Hb>11) (N = 73) n (%)	P-value
BMI is less than 30 kg/m^2:						
	No	46 (40)	31 (27.9)	26 (35.6)	26 (35.6)	0.250
	Yes	69 (60)	80 (72.07)	47 (64.3)	47 (64.3)	
Maternal Age						
	<19 years	5 (4.3)	8 (7.2)	5 (33.3)	7 (9.58)	0.005
	20-25 years	48 (41.7)	42 (37.8)	5 (33.3)	36 (49.3)	
	26-30 years	42 (36.5)	42 (37.8)	5 (33.3)	15 (20.5)	
	>30 years	20 (17.3)	19 (17.1)	0	15 (20.5)	
Child Birth weight:						
	<2.5 kgs	12 (10.4)	21 (18.9)	12 (80)	8 (10.9)	0.000
	>2.5 kgs	103 (89.5)	90 (81.08)	3 (20)	65 (89.04)	
Gestational age at delivery (weeks):						
	37	47 (40.8)	63 (56.7)	15 (100)	28 (38.3)	0.000
	38	33 (28.6)	32 (28.8)	0	17 (23.2)	
	39	19 (16.5)	14 (12.6)	0	10 (13.6)	
	40	15 (13.04)	1 (0.90)	0	15 (20.5)	
	41	1 (0.86)	1 (0.90)	0	3 (4.1)	
Nulliparity:						
	No	99 (86.08)	95 (85.5)	12 (80)	64 (87.6)	0.889
	Yes	16 (13.9)	16 (14.4)	3 (20)	9 (12.3)	
Socioeconomic Class:						
	Lower	43 (37.39)	53 (47.74)	12 (80)	30 (41.09)	0.001
	Lower Middle	62 (53.91)	55 (49.54)	3 (20)	36 (49.31)	
	Upper Middle	10 (8.69)	3 (2.70)	0	7 (9.58)	

Hb: Haemoglobin.

with maternal anaemia delivered babies at 37 weeks of gestation (mild 47[40.8%], moderate 63[56.7%], and severe 15[100%]). Additionally, mothers with mild anaemia 62(53.91%) and moderate anaemia 55(49.54%)

predominantly belonged to the lower-middle socioeconomic class. In contrast, mothers with severe anaemia were reported to be primarily from the lower socioeconomic class 12(80%). Severe anaemia was significantly associated with younger maternal age, lower socioeconomic class, earlier gestational age at delivery and LBW (p<0.01) (Table2).

Discussion

Anaemia in pregnancy is a major global health concern, particularly in developing countries, with a prevalence as high as 36.8%.[24] An adequate amount of Hb is required by the body during pregnancy to meet increased maternal metabolic demands as well as to provide sufficient nutrients and gaseous exchange to the developing foetus. A decreased Hb compromises the uteroplacental circulation, posing a significant threat to foetal organogenesis and leading to malformations, foetal LBW or foetal demise. Various studies have found maternal anaemia to be one of the leading causes of foetal complications, including low vascular perfusion which is one of the causes of stillbirth.[25]

Although pregnancy is associated with physiological anaemia mainly due to volume expansion, in developing countries, gestational anaemia is majorly due to nutritional deficiencies.[26] In developing parts of the world, families with financial constraints have difficulty accessing supplements or dietary modifications for pregnant women. In the current study, women with severe anaemia primarily had low SES.

Existing literature has reported inconsistent associations between anaemia during pregnancy and adverse neonatal outcomes, including preterm birth, LBW, and SGA.[27-28] This might be due to various studies defining anaemia during pregnancy with different cut-off thresholds. Additionally, the specific timing for Hb measurement during pregnancy significantly impacts the strength of the association between maternal anaemia and adverse neonatal outcomes.[29]

The current findings help reconcile previous inconsistent reports, demonstrating that when anaemia is categorised by severity, the associations with LBW becomes clear and strong, particularly for severe anaemia (Hb <7g/dl). This suggests that earlier studies using a binary (yes/no) anaemia definition may have underestimated the risk posed by severe deficiency.[7,14]

Using the WHO criteria[30] for the division of anaemia, the current study found that 76.75% of the sample was affected by anaemia, and 18.67% of the anaemic pregnancies led to LBW babies. Similar results were found in studies from India[31], Ethiopia[32] and some South Asian countries.[33]

The current study also found a significant association between Hb levels during pregnancy and maternal age. Similarly, a cross-sectional study in Bangladesh reported a significant association of maternal anaemia with maternal age.[34] Investigating anaemia and monitoring Hb levels during pregnancy can be a hidden clue to expected delivery date for the foetus.[35]

The current study has limitations of being a single-centre research using convenience sampling, which may have introduced selection bias and limited the generalisability of the findings. Additionally, effect modifiers, like maternal age, BMI, ethnicity and classes, may have affected the findings.

Future studies should be large-scale and multicentre. Additionally, implementation of programmes, such as maternal health camps targeting outreach across rural populations, and the spread of antenatal multiple micronutrient supplementation (MMS) by such camps should be encouraged in combination with implementation research from which issues facing utilisation, acceptability, compliance and sustainability can be identified and addressed.[36]

Conclusion

Mild and moderate anaemia in mother was found to be less likely to result in LBW babies compared to severe maternal anaemia. Gestational anaemia and LBW in neonates can be caused by multiple factors, but their interconnection is undeniable.

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References

1. Balarajan Y, Ramakrishnan U, Ozaltin E, Shankar AH, Subramanian SV. Anaemia in low-income and middle-income countries. Lancet 2011;378:2123-35. doi: 10.1016/S0140-6736(10)62304-5.
2. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet 2013;382:427-51. doi: 10.1016/S0140-6736(13)60937-X.
3. World Health Organization (WHO). Worldwide prevalence of anaemia 1993-2005: WHO global database on anaemia. [Online] 2008 [Cited 2025 June 03]. Available from URL: https://www.who.int/publications/i/item/9789241596657
4. Challa S, Amirapu P. Surveillance of anaemia: mapping and grading the high risk territories and populations. J Clin Diagn Res 2016;10:LC01-6. doi: 10.7860/JCDR/2016/18107.7915.
5. Tan J, He G, Qi Y, Yang H, Xiong Y, Liu C, et al. Prevalence of anaemia and iron deficiency anaemia in Chinese pregnant

women (IRON WOMEN): a national cross-sectional survey. BMC Pregnancy Childbirth 2020;20:670. doi: 10.1186/s12884-020-03359-z.
6. International Institute for Population Sciences (IIPS), The International Coaching Federation (ICF). National Family Health Survey (NFHS-4), 2015-16. Mumbai, India: IIPS and ICF; 2017.
7. Shah T, Khaskheli MS, Ansari S, Lakhan H, Shaikh F, Zardari AA, et al. Gestational anaemia and its effects on neonatal outcome in the population of Hyderabad, Sindh, Pakistan. Saudi J Biol Sci 2022;29:83-87. doi: 10.1016/j.sjbs.2021.08.053.
8. Esmaillzadeh A, Samareh S, Azadbakht L. Dietary patterns among pregnant women in the west-north of Iran. Pak J Biol Sci 2008;11:793-6. doi: 10.3923/pjbs.2008.793.796.
9. Abedini Z, Gaini M. Dietary food intake of pregnant women based on food guide pyramid and its related factors. Iran J Nurs 2011;24:36-46.
10. Menon KC, Ferguson EL, Thomson CD, Gray AR, Zodpey S, Saraf A, et al. Effects of anaemia at different stages of gestation on infant outcomes. Nutrition 2016;32:61-5. doi: 10.1016/j.nut.2015.07.009.
11. de Haas S, Ghossein-Doha C, van Kuijk SM, van Drongelen J, Spaanderman ME. Physiological adaptation of maternal plasma volume during pregnancy: a systematic review and meta-analysis. Ultrasound Obstet Gynecol 2017;49:177-87. doi: 10.1002/uog.17360.
12. World Health Organization (WHO). Assessing the iron status of populations: including literature reviews. [Online] 2004 [Cited 2025 June 03]. Available from URL: https://www.who.int/publications/i/item/9789241596107
13. American College of Obstetricians and Gynecologists (ACOG). ACOG Practice Bulletin No. 134: fetal growth restriction. Obstet Gynecol 2013;121:1122-33. doi: 10.1097/01.AOG.0000429658.85846.f9.
14. Madendag IC, Eraslan Sahin M, Madendag Y, Sahin E, Demir MB, Acmaz B, et al. The effect of iron deficiency anaemia early in the third trimester on small for gestational age and birth weight: a retrospective cohort study on iron deficiency anaemia and fetal weight. Biomed Res Int 2019;2019:7613868. doi: 10.1155/2019/7613868.
15. Ganju S. Maternal anaemia, intra uterine growth restriction and neonatal outcomes. Int J Clin Obstet Gynaecol 2020;4:152-55. doi: 10.33545/gynae.2020.v4.i4c.638.
16. Dean AG, Sullivan KM, Soe MM. OpenEpi: Open Source Epidemiologic Statistics for Public Health, Version 3.01. [Online] 2013 [Cited 2025 June 03]. Available from URL: https://www.openepi.com/Menu/OE_Menu.htm
17. Iltaf G, Shahid B, Khan MI. Incidence and associated risk factors of low birth weight babies born in Shaikh Khalifa Bin Zayad Al-Nayan Hospital Muzaffarabad, Azad Jammu and Kashmir. Pak J Med Sci 2017;33:626-30. doi: 10.12669/pjms.333.12413.
18. World Health Organization. Child growth standards: weight-for-age. [Online] 2006 [Cited 2025 June 03]. Available from URL: https://www.who.int/tools/child-growth-standards/standards
19. Yip R, Parvanta I, Scanlon K, Borland EW, Russell CM, Trowbridge FL. Pediatric nutrition surveillance system—United States, 1980-1991. MMWR CDC Surveill Summ 1992;41:1-24.
20. Kim I, Hungerford DW, Yip R, Kuester SA, Zyrkowski C, Trowbridge FL. Pregnancy nutrition surveillance system—United States, 1979-1990. MMWR CDC Surveill Summ 1992;41:25-41.
21. World Health Organization (WHO). UNICEF-WHO low birthweight estimates: levels and trends 2000-2015. [Online] 2019 [Cited 2025 June 03]. Available from URL: https://www.who.int/publications/i/item/WHO-NMH-NHD-19.21
22. Metreau E, Young KE, Eapen SG. Understanding country income: World Bank Group income classifications for FY26 (July 1, 2025-June 30, 2026). [Online] 2025 [Cited 2025 June 03]. Available from URL: https://blogs.worldbank.org/en/opendata/understanding-country-income--world-bank-group-income-classifica
23. Salomon LJ, Alfirevic Z, Da Silva Costa F, Deter RL, Figueras F, Ghi T, et al. ISUOG Practice Guidelines: ultrasound assessment of fetal biometry and growth. Ultrasound Obstet Gynecol 2019;53:715-23. doi: 10.1002/uog.20272.
24. Karami M, Chaleshgar M, Salari N, Akbari H, Mohammadi M. Global prevalence of anaemia in pregnant women: a comprehensive systematic review and meta-analysis. Matern Child Health J 2022;26:1473-87. doi: 10.1007/s10995-022-03450-1.
25. Goldenberg RL, Saleem S, Goudar SS, Moore J, Guruprasad G, Kulkarni V, et al. The PURPOSe cause of death study in stillbirths and neonatal deaths in India and Pakistan: a review. BJOG 2023;130(Suppl 3):s26-35. doi: 10.1111/1471-0528.17635.
26. Means RT. Iron deficiency and iron deficiency anaemia: implications and impact in pregnancy, fetal development, and early childhood parameters. Nutrients 2020;12:447. doi: 10.3390/nu12020447.
27. Zhang X, Xu Q, Yang Y, Wang L, Liu F, Li Q, et al. Preconception Hb concentration and risk of preterm birth in over 2.7 million Chinese women aged 20-49 years: a population-based cohort study. Br J Nutr 2018;120:508-16. doi: 10.1017/S0007114518001721.
28. Ronkainen J, Lowry E, Heiskala A, Uusitalo I, Koivunen P, Kajantie E, et al. Maternal hemoglobin associates with preterm delivery and small for gestational age in two Finnish birth cohorts. Eur J Obstet Gynecol Reprod Biol 2019;238:44-48. doi: 10.1016/j.ejogrb.2019.04.045.
29. Liu D, Li S, Zhang B, Kang Y, Cheng Y, Zeng L, et al. Maternal haemoglobin concentrations and birth weight, low birth weight, and small for gestational age: findings from a prospective study in Northwest China. Nutrients 2022;14:858. doi: 10.3390/nu14040858.
30. World Health Organization (WHO). Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. [Online] 2011 [Cited 2025 June 03]. Available from URL: https://www.who.int/publications/i/item/WHO-NMH-NHD-MNM-11.1
31. Gnanasekaran S, V J, R RR. Study on the effect of maternal anaemia on birth weight of term neonates among rural population India. Int J Contemp Pediatr 2019;6:1255-58. doi: 10.18203/2349-3291.ijcp20192023.
32. Engidaw MT, Eyayu T, Tiruneh T. The effect of maternal anaemia on low birth weight among newborns in Northwest Ethiopia. Sci Rep 2022;12:15280. doi: 10.1038/s41598-022-19726-z.
33. Rahman MA, Khan MN, Rahman MM. Maternal anaemia and risk of adverse obstetric and neonatal outcomes in South Asian countries: a systematic review and meta-analysis. Public Health Pract (Oxf) 2020;1:100021. doi: 10.1016/j.puhip.2020.100021.
34. Chowdhury HA, Ahmed KR, Jebunessa F, Akter J, Hossain S, Shahjahan M. Factors associated with maternal anaemia among pregnant women in Dhaka city. BMC Womens Health 2015;15:77. doi: 10.1186/s12905-015-0234-x.
35. Vural T, Toz E, Ozcan A, Biler A, Ileri A, Inan AH. Can anaemia predict perinatal outcomes in different stages of pregnancy? Pak J Med Sci 2016;32:1354-59. doi: 10.12669/pjms.326.11199.
36. Nutrition International (NI). Voices from the field: A look at multiple micronutrient supplementation implementation research in Swabi, Pakistan. [Online] 2023 [Cited 2025 June 03]. Available from URL: https://nutritionintl.org/news/all-field-stories/photos-multiple-micronutrient-supplementation-implementation-research-pakistan/

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MQ, BAK, VK, MA, MS, & KA: Concept, design, data acquisition, analysis, interpretation, drafting, revision, final approval and agreement to be accountable for all aspects of the work.