ORIGINAL ARTICLE

A Cross-sectional Analysis on Anemia, Hemoglobin Level, and Erythrocyte Sedimentation Rate in Pregnant Women in Gilgit–Baltistan, Pakistan

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ABSTRACT

Objective: The present study was designed to study the prevalence of anemia, hemoglobin level, gestational age, and erythrocyte sedimentation rate in pregnant women of Gilgit-Baltistan, to determine the factors, and recommend intervention strategies to reduce this health problem in the female population of reproductive age in Gilgit-Baltistan and in similar conditions.

Study Design: Cross-sectional analytical study.

Place and Duration of Study: The study was conducted in Gilgit-Baltistan (GB), Pakistan from March 2021 to March 2022.

Methods: A total of 330 pregnant women from various parts of the region, including Gilgit city, Juglot, Naltar, Nomal, and Hunza, were enrolled. Hemoglobin level was measured with an automated cell counter (Sysmex K-21), and the erythrocyte sedimentation rate was determined by the Westergren method. The gestational age was determined from the last menstrual period, later confirmed by ultrasonography.

Results: A significant proportion of pregnant women who presented with anemia were in their third trimester. The prevalence of anemia was found to vary across age groups. The highest prevalence (30%) was observed in the 37-40 years age group. In contrast, a lower prevalence (10.25%) was recorded among women aged 32-36 years. A positive correlation between gestational age and ESR and an inverse relationship between hemoglobin concentration and ESR were observed.

Conclusion: Anemia was identified as a moderate public health problem among pregnant women in the Gilgit-Baltistan region, with a prevalence of 30% among those aged 37–40 years.

Keywords: *Anemia, Erythrocyte Sedimentation Rate, Gestational Age, Hemoglobin, Pregnancy.*

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Introduction

Anemia is characterized by a decreased hemoglobin (Hb) concentration, which may result from a reduced red blood cell count or an expanded plasma volume.[1] For men, a low Hb (at sea level) is < 13.5 g/dl; for women, it is < 11.5 g/dl.[2] Anemia may be due to reduced production or increased loss of red blood cells. Reduced hemoglobin levels and anemia pose significant risks to women's health and overall development.[3] Anemia is classified as a serious public health issue when it affects 40% or more of the population.[4] The World Health Organization (WHO) defines anemia in pregnancy as a Hb concentration below 11 g/dl.[5] Pregnancy-related anemia is more common in South Asia (75%) than in developed countries (18%).[6]

Approximately 50% (1,000 ml) of the blood volume and 25% (300 ml) of the total cell mass increase during pregnancy, increasing iron requirement.[7] In a recent study it was observed that the primary factors

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contributing to anemia were insufficient consumption of iron-rich foods (36%) and low intake of oral iron supplements (25%).[8] The primary determinants of anemia in the general population are socioeconomic status and inadequate knowledge regarding health maintenance during pregnancy.[9] To counter the lower oxygen levels at high altitudes, the body adapts by elevating hemoglobin concentration.[10] Accurately assessing iron deficiency anemia in pregnant women living above 3600 m is challenging, as existing hemoglobin correction factors are inadequate, even though nearly 20 million people live at such altitudes worldwide.[11] Normal Erythrocyte Sedimentation Rate (ESR) is 0–10 mm/hr for children, 0–20 mm/hr for women, and 0–15 mm/hr for men.[12] However, ESR can be affected by various inflammatory conditions; for instance, it is increased during rheumatoid arthritis and pregnancy, while it is decreased in sickle cell anemia, polycythemia, congestive heart failure, and hereditary spherocytosis.[13] The ESR is marginally higher in females. Age also influences the ESR, which may exhibit an elevation in both males and females beyond the age of 50.[14] The increase is particularly pronounced in postmenopausal women, with ESR values reaching 0–30 mm/hr.[15] Additionally, Hb concentration and gestational age can have a significant effect on the ESR during pregnancy.[16] The ESR ranges from 0 to 20 mm/hr in non-pregnant women, but in pregnant women, it ranges from 4 to 57 mm/hr during the first trimester, 7 to 47 mm/hr in the second trimester, and from 13 to 70 mm/hr in the third trimester.[17] The hypothesis of the study was to determine the prevalence of anemia, which is significantly influenced by gestational age and associated with increased erythrocyte sedimentation rates in the female population of reproductive age in Gilgit-Baltistan.

Methods

The study was conducted in Gilgit-Baltistan (GB), Pakistan, from March 2021 to March 2022 after taking permission from the Research and Ethics Review Committee, Department of Health, Gilgit-Baltistan vide letter no: R&ERC/15/21, dated: 09th January 2021. The study comprised 330 pregnant women who visited the hospital for regular outpatient antenatal check-ups. Pregnant women were included in the analysis regardless of their age or gestational stage while the non-pregnant women were excluded.

The women included in the study were from various parts of the province, including Gilgit city (the Capital of Gilgit Baltistan province), Juglot, Naltar, Nomal, and Hunza (Upper and lower) areas. Participants provided written informed consent (in their native language) before being included in the study. The study protocol was approved by the ethical committee of the Karakoram International University, Gilgit-Baltistan.

Hemoglobin levels were analyzed using the Sysmex K-21 automated cell counter after venous blood was drawn from the pregnant women. The erythrocyte sedimentation rate (ESR) was assessed using the Westergren method with the remaining portion of the sample WHO criteria were used to establish the cutoff values for hemoglobin. Anemia was identified in individuals with Hb levels lower than 11 g/dL. Ultrasonography was used to verify the gestational age, which was first estimated based on the last menstrual period. The Statistical Package for Social Sciences (version 26) was used to perform the data analysis.

Results

The participants were divided into five groups based on their age. A higher prevalence of anemia (30%) was recorded in the final age group (37–40 years) compared to the remaining four age groups. The prevalence of anemia among pregnant women by age group is presented in Table 1. The incidence of anemia was comparatively lower (10.25%) among women aged 32–36 years as compared to the younger and older age groups. However, the underlying reason for this observation remains unclear.

Prevalence of anemia among women residing in five districts of Gilgit-Baltistan: Gilgit, Ghezir, Hunza-Nagar, Diamer, and Astore is displayed in Table 2. Women from district Astore exhibited the highest prevalence of anemia (30%) followed by women from Hunza (24.32%), whereas Ghizer women had the lowest prevalence of anemia (13.04%).

Table 3 presents the prevalence of anemia by

Table 1: No of pregnant women were observed to be anemic or non-anemic according to their age groups

Age groups	No of observations	No anemic women	%	No of non-anemic women	%
17-21	33	8	24.24	25	75.75
22-26	167	42	25.14	125	74.85
27-31	76	15	19.73	61	80.26
32-36	39	4	10.25	35	89.74
37-40	10	3	30.00	7	70.00
Total	325	72	22.15	253	77.85

Table 2: Distribution of anemic and non-anemic pregnant women in five districts of Gilgit Baltistan

Districts	No of observation	Anemic Women	%	Non-anemic women	%
Gilgit	218	51	23.39	167	76.6
Ghizer	46	6	13.04	40	86.96
Hunza	37	9	24.32	28	75.67
Diamer	14	3	21.40	11	78.50
Astore	10	3	30.00	7	70.00
Total	325	72	22.15	253	77.85

Table 3: Distribution of anemic and non-anemic pregnant women across different trimesters

Trimesters	No of observations	Anemic women	%	Non-anemic women	%
0-12 weeks	70	7	10.00	63	90.00
13-24 weeks	112	21	18.75	91	81.25
25-36 weeks	143	44	30.6	99	69.3
Total	325	72	22.5	253	77.5

Table 4: Evaluation of erythrocyte sedimentation rate (ESR) about age groups of pregnant women in Gilgit-Baltistan using one-way ANOVA

Age Groups	No. of Observations	Mean+ SD of ESR
17-21	25	62.16 ± 26.30
22-26	25	51.5200 ± 18.85
27-31	25	62.7600 ± 25.70
32-40	32	52.2188 ± 24.48
Total	107	56.841 ± 24.29

Table 5: Analysis of the relationship between erythrocyte sedimentation rate (ESR) and gestational age in pregnant women from Gilgit-Baltistan

Gestation age	No. of Observations	Mean + Std. of ESR
0-12 weeks	45	40.08 ± 21.17
13-24 weeks	45	55.48 ± 23.34
27-36 weeks	45	66.00 ± 22.71
F-value	-	15.191
P-value	-	< 0.001
Total	135	53.85±24.69

Table 6: Assessment of hemoglobin variations across different gestational ages in pregnant women of Gilgit-Baltistan using ANOVA

Gestation age	No. of observations	Mean + SD of Hb
0-12 weeks	66	13.97±13.05
13-24 weeks	70	11.69±1.26
27-36 weeks (above)	69	11.46±1.43
F Value	-	2.302
P Value	-	0.103
Total	135	12.35±7.53

gestational age or trimester. It was observed that the preponderance of anemic women occurred in their third trimester (44, 30.76%) of pregnancy; 18.75% of pregnant women were anemic in the second trimester, and 7% of pregnant women were anemic in the first trimester.

Table 4 Displays the comparison of erythrocyte sedimentation rate among four age-based groups. The sample included 25 randomly selected cases from each of the first three age groups, defined by 5-year intervals, and 32 cases from the last age group, which covered an 8-year interval. The table also represents the mean + standard error of ESR for different age groups of pregnant women, i.e. 62.16 ± 26.30 for those aged 17–21 years, 51.52±18.85 for those aged 22-26 years, 62.76±25.70 for those aged 27-31 years, and 52.21±24.48 for those aged 32-40 years, respectively. One-way ANOVA was applied to evaluate the differences between the four age groups. The data obtained were not statistically significant.

The correlation of gestational age with erythrocyte sedimentation rate is presented in Table 5. In the first trimester, the mean ESR was 40.08 $\pm$ 21.17, whereas in the second trimester, it was 55.48 $\pm$ 23.34, and in the last trimester, 53.85 $\pm$ 24.69. One-way ANOVA revealed statistically significant differences between different gestational age groups ($P < 0.05$). The F value was 1.714, and the *P*-value was 0.169 in the current study.

Table 6 shows the mean + SD of hemoglobin levels in the three trimesters of pregnant women. There were 66 observations selected at random during the first trimester, and the mean hemoglobin was 13.97 ± 13.05. During the second trimester, the mean Hb value of blood samples collected from 70 participants was 11.69 ± 1.26. The mean Hb level during the third trimester was 11.46 ±1.43. The results showed a difference in the mean hemoglobin levels among women of different gestational ages; however, statistically, there was no significant difference ($P < 0.05\%$). The F value was 15.191, and the *P* value was 0.001 in the ESR vs gestational age.

A positive relationship was observed between ESR and Hb level. The degree of association depicted a positive correlation (i.e., $r^2 = 0.184$) as shown in Figure. 1. The plotted data points show a clustering pattern around the linear regression line, indicating a relationship between the dependent and independent variables. The $R^2 = 0.184$ demonstrates that the independent variable explains 27.94% of the variability in the dependent variable.

The results indicated a negative correlation between ESR and hemoglobin levels. The degree of

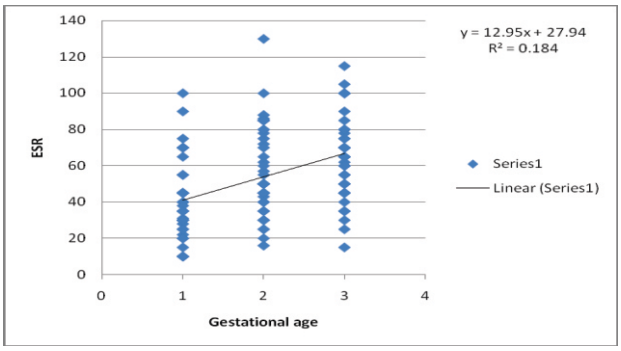

Fig.1: Correlation between erythrocyte sedimentation rate (ESR) and gestational age in pregnant women of Gilgit-Baltistan

association was negative (i.e., $r^2 = 0.85$) as depicted in Figure. 2. The plotted values of the dependent and independent variables are concentrated near the linear regression line, as illustrated in the scatter plot. The independent and dependent variables exhibit minimal variation between them. The R^2 value of 0.132 suggests that the independent variable explains 13.2% of the variation in the dependent variable, implying that a one-unit increase in Hb level results in a 0.132-unit reduction in ESR.

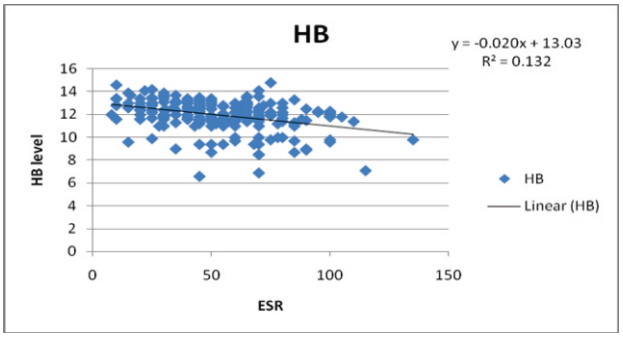

Fig.2: Correlation between hemoglobin levels and erythrocyte sedimentation rate (ESR) in pregnant women of Gilgit-Baltistan

Discussion

Globally, anemia during pregnancy poses a serious public health challenge, with nearly two-thirds of pregnant women in developing countries being affected. The current study was conducted on the prevalence of anemia in pregnant women from Gilgit-Baltistan, Pakistan, which has scarce resources and few quality healthcare service providers, and remote regions of the country bordering Afghanistan, China, and India.[18] There are no standardized, appropriate preventative and therapeutic measures implemented in Pakistan.[19] Various studies in Kolar District, Southern region of India, have reported that the prevalence of anemia during pregnancy ranges between 48.2% and 90.5%.[20]

A cross-sectional study carried out in the Gilgit-Baltistan region revealed that anemia and associated risk variables among different age groups and genders. The prevalence of anemia was higher in females (56.7%) than in males (32.40%). However, 22.15% of pregnant women were anemic, classifying anemia as a moderate public health problem.[21] A study was conducted in 8 provinces of Peoples Republic of China (PRC) between 2016 and 2020, which indicated that 43.59% of the women had anemia at any point during pregnancy.[22] It was also lower than the prevalence reported from other parts of the country in earlier as 69.9%, 90.5%, and 48.2 %, respectively. This may be because the present research (Gilgit-Baltistan) is situated at a higher altitude, and this may have resulted in increased Hb levels, and could potentially conceal anemia. The other reason could be improved nutritional values, or due to high awareness towards the importance of improving the family health system in the GB. However, Stevens GA et al. also reported that the prevalence of mild anemia remained little changed.[23] In contrast, moderate and severe anemia declined in most populations and geographical locations at the Global level, indicating a shift towards mild anemia. In another recent study from the Kingdom of Saudi Arabia (KSA), it was observed that the main determinants for anemia were lack of intake of iron-rich food (36%) followed by inadequate intake of oral iron (25%).[24] Zhang Y et al. documented 26.2% prevalence of anemia among pregnant women in China. It was reported to be 27.1% in Turkey, 4.7% in Iran, whereas in Nigeria it was reported to be 23%.[25] The prevalence of anemia increases with increasing gestational age.[26] The current study showed that 9.72% of pregnant women were anemic during the first trimester, 29.16% during the second trimester, and 61.1 % during the third trimester.[27] This steady upward trend may be due to increased body requirements of both the pregnant woman and the developing fetus. It may also have developed from the excessive domestic and field labor performed by

the female workforce in Gilgit-Baltistan; however, this does not justify devoting the entire labor force to the third trimester. Nevertheless, increased nutritional requirements of developing babies and overwork may potentially contribute to a decline in Hb level. The mean Hb during the first, second, and third trimesters was 13.97, 11.7, and 11.4, respectively. In the present study, 84.72% of anemic women had mild anemia, 11.11% had moderate anemia, and 4.16% had severe anemia. Similar results were reported from Iran, indicating the severity of anemia; showing 79.8% had mild anemia, 15.4% had moderate anemia, and 4.8% had severe anemia.[4] Similarly, a study reported that in urban areas of Pakistan, 14.8% had moderate anemia, 75% had mild anemia, and 0.7% were severely anemic.[28] According to a study on a Pakistani cohort found that 36% from mild anemia, 12% from severe anemia, and 52% of women suffered from moderate anemia.[29] In a small study from Multan, Awan et al. reported that 44 % of women had mild anemia, 48% moderate anemia, and 8% severe anemia. Thus, we conclude that anemia severely affects Pakistan's women, especially during pregnancy, so further research is necessary to identify the precise factors that cause anemia in women residing in the mountain region of Gilgit–Baltistan, Pakistan, before, during, and after pregnancy.[30]

Conclusion

Anemia was identified as a moderate public health problem among pregnant women in the Gilgit-Baltistan region, with a prevalence of 30% among those aged 37–40 years. Both hemoglobin concentration and gestational age were found to be important factors that correlate with an elevated erythrocyte sedimentation rate.

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Author Contributions

ZA: Conception and design of the work, manuscript writing for methodology design and investigation
AK: Data acquisition, curation, and statistical analysis
ZA: Validation of data, interpretation, and write-up of results
MR: Revising, editing, and supervising for intellectual content
NAL: Writing the original draft, proofreading, and approval for final submission