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HEMATOLOGICAL PROFILE IN PREGNANT WOMEN ATTENDING AL-FALAH GENERAL & EYE HOSPITAL IN BAHAWALPUR, PUNJAB, PAKISTAN

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ABSTRACT

Background: Pregnancy entails significant physiological changes, including alterations in hematological parameters. Understanding these changes is crucial for maternal and fetal health.
Objective: This cross-sectional study aimed to investigate the hematological characteristics of pregnant women, focusing on age distribution, blood group prevalence, and abnormal hematological parameters.
Methods: A total of 100 pregnant females aged 16 to 48 years with gestational periods ranging from 8 to 40 weeks were included in the study conducted at Al-Falah General & Eye Hospital in Bahawalpur, Pakistan. Blood samples were collected and analyzed for complete blood count using an automatic hematological analyzer.
Results: The majority of participants (40%) fell within the age range of 25 to 34 years, with B Positive being the most prevalent blood group. Anemia was observed in 51% of pregnant women, with varying levels of abnormality in parameters such as Hematocrit, Total Red Blood Cell Count, and Mean Cell Volume. However, Total Leukocyte Count and Platelets generally showed normal levels. Analysis of age distribution within each blood group revealed diverse patterns, suggesting potential age-related variations in hematological parameters.
Conclusion: Monitoring hematological parameters during pregnancy is essential for ensuring maternal health and well-being. Further research is warranted to explore underlying factors contributing to observed variations and their implications for maternal and fetal outcomes.

INTRODUCTION

Pregnancy has been described as a physiological phenomenon but needs careful antenatal care to have fit feto-maternal result. [1]Human pregnancy is not an illness, it is a physiological situation; pregnancy creates deep physiological differences that happen to be more important as pregnancy develops. The hormonal variation starts from the ovaries, and then later the placenta. The initial hormone to manifests after conception is human chorionic gonadotropin (HCG) then followed by hormones like; estrogen, progesterone, prolactin, renin and human placental lactogen .[2]

It is also important stating that sufficient degrees of circulating thyroid hormones are of main significance for normal reproductive role, all these alterations are followed by developing womb with steady mechanical effect. [2]Pregnancy is the period in which one or more child develops inside a woman's womb. In a pregnancy, there can be multiple pregnancies, as in the case of twins or triplets. Childbirth usually occurs approximately 38 weeks after conception. In case of women who have a menstrual cycle length of 4 weeks, this is approximately 40 weeks from the last normal menstrual.[3]

Pregnancy is influenced by a lot of variables, some of which include culture, environment, socioeconomic status, and access to medical care [4] Pregnancy is usually associated with many changes in a woman, which can be physiologic or pathologic. [5] These changes are often reflected in the maternal hematological profile. Hematological indices reflect the individual's state of health, and that of a pregnant woman has been proven to affect both the pregnancy and its outcome. [6]

During the first trimester, the performance of a maternal assessment through the review of the patient's medical history and characteristics, along with biochemical tests, can help in determining the risk for pregnancy-related complications such as macrosomia, intrauterine growth restriction (IUGR), fetal abnormalities, miscarriage, stillbirth, pre-eclampsia (PE), gestational diabetes mellitus (GDM) and preterm delivery. [7]

Low haemoglobin in the blood is widely identified as a haematological abnormality and it is associated with adverse pregnancy outcome. Physiologic anemia is the term often used to describe the fall in haemoglobin level that occurs during normal pregnancy outcomes from plasma volume amplifies above normal by the end of pregnancy although the erythrocyte masses itself amplify and still leads to a fall in haemoglobin level with a feature of normocytic and normochromic type of anaemia . [8] It is very hard to define a normal reference range for haemoglobin level during pregnancy. Anemia contributes to intrauterine growth limitation, preterm labour, abortions and it is also a main cause of low immunity of both the mother and the baby, which makes them prone for several life threatening infections. [9] The hematological parameter indicates the immunological, nutritional and hemostatic condition of a pregnant woman and is considered as major factors affecting the pregnancy. [10, 11]

These hematological parameters for a pregnant women include hematocrit (Hct), total red blood cell count (T-RBC), Total leukocytes count (TLC), total leucocyte count (TLC), mean cell volume (MCV), mean cell hemoglobin (MCH), mean cell hemoglobin concentration (MCHC), differential leucocytes count(DLC) and platelet count . [8]

During this stage of pregnancy there is physiological change in the circulatory system that the level of haemoglobin may be greatly downgraded below what is normal for an adult woman. This is regarded to as physiological anaemia which is due to haemodilution leading to the uneven increase in the plasma volume and erythrocyte mass in pregnancy. [12]

Anemia

Anemia is the most common hematological problem in pregnancy, followed by thrombocytopenia. Leukocytosis is almost always associated with pregnancy. [13]Anemia is defined as a condition in which there is less than the normal hemoglobin (Hb) level in the body, which decreases oxygen-carrying capacity of red blood cells to tissues. Anemia is a global public health problem affecting both developed and developing countries with major consequences for human health as well as social and economic development. It occurs at all stages of the life cycle. [14, 15]

It is a major public health problem affecting all ages of the population with its highest prevalence among children under five years of age and pregnant women. [16, 17]Globally, anemia affects 1.62 billion people (25%), among which 56 million are pregnant women. [18]It is estimated that anemia causes more than 115,000 maternal and 591,000 perinatal deaths globally per year

Anemia during pregnancy is considered severe when hemoglobin concentration is less than 7.0 g/dL, moderate when hemoglobin falls between 7.0–9.9 g/dL, and mild from 10.0-11 g/dL. [19]Anemia is a public health issue for developing countries, especially for child bearing age women . The worldwide prevalence of anemia in child bearing age group is quite high (30.2%). According to World Health Organization (WHO) report, 32.3% non-pregnant women of child bearing age are suffering from anemia in Saudi Arabia. [18]

Controversial results from long- and short-term intervention studies on the role of different food inhibitors (tea, coffee, bran, and egg yolk) and enhancers (meat, and dairy products, and ascorbic acid) on iron absorption and iron stores have raised questions regarding their effectiveness in reducing anemia. [20, 21]

Anemia is one of the most common nutritional deficiency diseases observed globally. Although nutritional anemia affects members of both sexes and all age groups, the problem is more prevalent among women and contributes to maternal morbidity and mortality, as well as to low birthweight it has been estimated that nutritional anemia affects almost two-

thirds of pregnant women in developing countries. However, many of these women were already anemic at the time of conception, with an estimated prevalence of anemia of almost 50% among nonpregnant women in developing countries. [22]
In Pakistan, the prevalence of anemia among ever-married women aged 15 to 44is reported to be 26% in urban areas and 47% in rural areas. The prevalence of anemia among pregnant women living in urban areas is similar, ranging from 29% to 50% among pregnant women attending antenatal clinics in a large private, tertiary hospital in Karachi .[23]

Materials and Methods

Aims

The aim of this study was to assess RBCs with haematological indices, neutrophils and platelets in pregnant women in a tertiary care centre. The changes in these parameters were be analysed to use as surrogate markers to identify impending danger to mother or/and fetus.

Study population

This cross sectional study was conducted in six months duration (November 2023-Januaray 2024) in the Al-Falah General & Eye Hospital of Bahawalpur, Bahawalpur (BWP) province. All pregnant female were included in current study within age of 16-48 years with 8th to 40th week's gestational period. During the study period between November 2023 and January 2024, all pregnant women who gave informed consent and satisfed the study inclusion criterion (normotensive blood pressure, 140/90 mmHg) were recruited into the study. Pregnant women with any of the following conditions were excluded from the study: bleeding disorders, splenomegaly, and connective tissue disease such as systemic lupus erythematosus, hypertension, human immunodeficiency virus (HIV), and hepatitis B infection. In addition, women on nonsteroidal anti-inflammatory drugs such as aspirin were also excluded.
Demographic data and information on drug history were collected directly from the recruited participants, and additional data – such as HIV/hepatitis B status – were extracted from clinical notes. All study participants were on routine ferrous sulfate (200 mg three times daily), folic acid (5 mg daily), and vitamin B complex (one taken three times daily) tablets.

Ethics

The research was approved by the ethics review committees of both the Lagos University Teaching Hospital and the Lagos State University Teaching Hospital.

Sample collection

A blood sample (4.5 mL) was withdrawn from each participant with minimal stasis from the antecubital vein using a dry, sterile disposable syringe and needle. The blood was dispensed into tubes containing the anticoagulant ethylenediaminetetraacetic acid (EDTA). The specimens were labeled with the subject's age, and identification number. The EDTA samples were kept at room temperature until processing, which occurred within 4 hours of collection.

Laboratory analysis

Full blood count was performed using a KN-21N Hematology Analyzer (Sysmex, Kobe, Japan), a three-part auto analyzer able to test 19 parameters per sample including Hb concentration, PCV, RBC concentration, MCH, MCV, MCHC, WBC count, and PLT count. Standardization, calibration of the instrument, and processing of the samples were done according to the manufacturer's instructions.

Procedures

Each blood sample was mixed well and then approximately 20 µL was aspirated by allowing the analyzer's sampling probe into the blood sample and depressing the start button. Results of the analysis were displayed after about 30 seconds, after which the analyzer generated a paper copy of the results on thermal printing paper.

Statistical analysis

Data were analyzed using SPSS (v 16; IBM, Armonk, NY, USA). The descriptive data are presented herein as means ± standard deviation (SD). Pearson's Chi-square test and one-way analysis of variance (ANOVA) were used for analytic assessment and the differences were considered statistically signifcant when the *P* value obtained was ,0.05.

Results

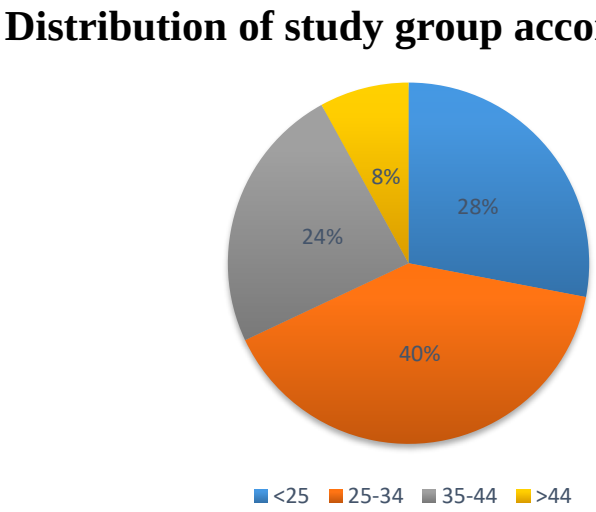
According to the age, the study group was divided into four groups first group (28%) between the age of less than 25, second group the highest percentage

(40%) of the pregnant women was between the age of 25 and 34, third group (24%) between 35 and 44, and finally the fourth group showed lowest percentage (8%) in the age above 44 years as shown in table no.1.

Table No.1 Distribution of study group according to age

Age				
Age groups	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
less 25	28	28.0	28.0	28.0
25-34	40	40.0	40.0	68.0
35-44	24	24.0	24.0	92.0
above 44	8	8.0	8.0	100.0
Total	100	100.0	100.0	

Figure No.1 Distribution of study group according to age



A total of 100 pregnant females were studied during the study duration in which 19.0% (n=19), 42.0% (n=42) , 6.0% (n=6) , 24.0% (n=24), 1.0% (n=1) , 6.0% (n=6) , 2.0% (n=2) , and 0.0% (n=0) were in A positive, B positive, AB positive, O positive, A negative, B negative, AB negative and O negative blood group respectively as shown in table no.2.

Table.No.2 Distribution of study group according to blood group

Blood Group				
BG Name	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
A Positive	19	19.0	19.0	19.0
B Positive	42	42.0	42.0	61.0
AB Positive	6	6.0	6.0	67.0
O Positive	24	24.0	24.0	91.0
A Negative	1	1.0	1.0	92.0
B Negative	6	6.0	6.0	98.0
AB Negative	2	2.0	2.0	100.0
O Negative	0	0.0	0.0	0.0
Total	100	100.0	100.0	

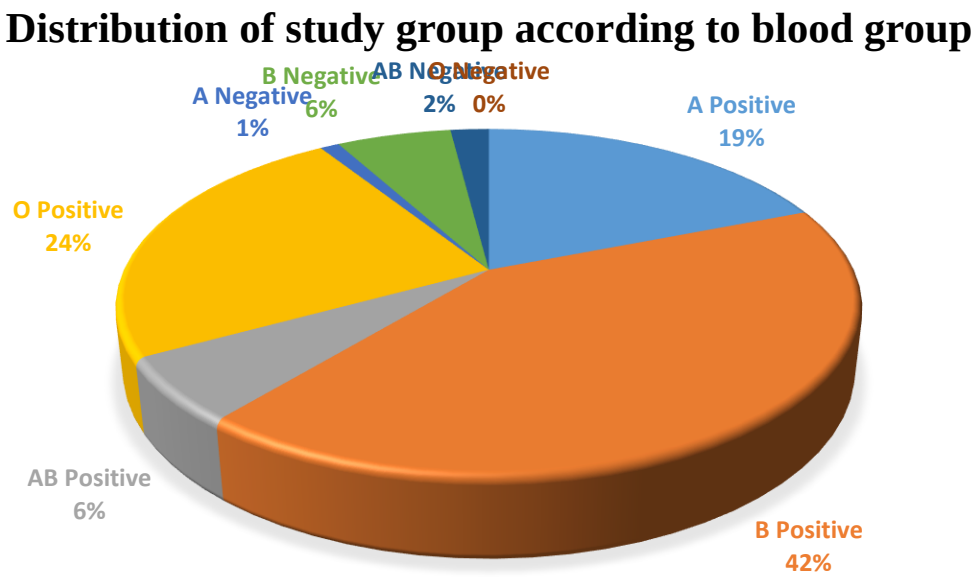


Figure No.2 Distribution of study group according to blood group

The mean age of all pregnant females was 30.83±8.2 with a minimum age was 16 year, whereas maximum was 48 years. Mean age of pregnant female was 30.83±8.2 years in current study, similar to Anjum et al. study (26.07±5.04 years) (22). Mean hemoglobin (g/dl) was 11.08±1.5 with minimum 6.7 and maximum was 14.7. Low hemoglobin were reported in present study, which could be due to increase concentration of plasma (23). The minimum and maximum values of hematocrit (%), red blood cell (million/cmm), mean cell volume (fl), mean cell hemoglobin (pg), mean cell hemoglobin concentration (%), leucocytes (/cmm), neutrophils (%), lymphocytes (%), monocytes (%), eosinophils (%) and platelets (/cmm) are shown in table no. 3

Table No.3 Minimum and maximum value of age and various hematological parameters

Descriptive Statistics					
Parameters	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Age	100	16	48	30.83	8.225
HGB(g/dl)	100	6.7	14.7	11.083	1.5965
HCT (%)	100	23	44	34.33	4.168
TRBC(10^6/µL)	100	3.50	6.50	4.5332	0.54462
MCV(fl)	100	58	89	75.26	6.973
MCH(pg)	100	16	30	24.32	3.324
MCHC(g/dl)	100	24	36	32.02	2.098
TLC(10^3/µL)	100	3.1	19.6	9.562	2.9805
Neutrophils (%)	100	23	95	67.06	11.337
Lymphocytes (%)	100	2	75	27.86	11.624
Monocytes (%)	100	1	6	3.24	0.830
Eosinophils (%)	100	1	4	2.42	0.654
Platelets(10^3/µL)	100	44.1	3200.0	347.781	305.5260
Valid N (list wise)	100				

In present study, anemia was found in 51.0% (n=51) pregnant female. Anemia reported from Bangladesh 49 %(25) and Nepal 58.6% prevalence (26). The prevalence of anemia in pregnant female was 67.5% in district Karak, Pakistan (24). Some studies reported high percentage of anemia (90.5%) from urban regions of Pakistan (27). Hematocrit was below normal in 24.0% female whereas the TRBC, MCV, MCH and MCHC were found low in 22.0%, 47.0%, 69.0% and 10.0% hemoglobin level were found in51.0% (n=51) in pregnant female respectively. The hematocrit level was found low in 24.0% pregnant female while normal in 73.0%. TRBC was reported normal in majority female whereas low in 22.0%. The MCV, MCH and MCHC were low in 47.0%, 69.0% and 10.0% respectively, in pregnant female while high in few. TLC was normal in 75.0% while high in 24.0% female with pregnancy. Neutrophils, lymphocytes, monocytes, eosinophils and platelets level were normal majority pregnant female with 80.0%, 77.0%, 99.0%, 98.0% and 78.0% respectively as shown in table no. 4.

Table No.4 Low, normal and high level of several hematological parameters

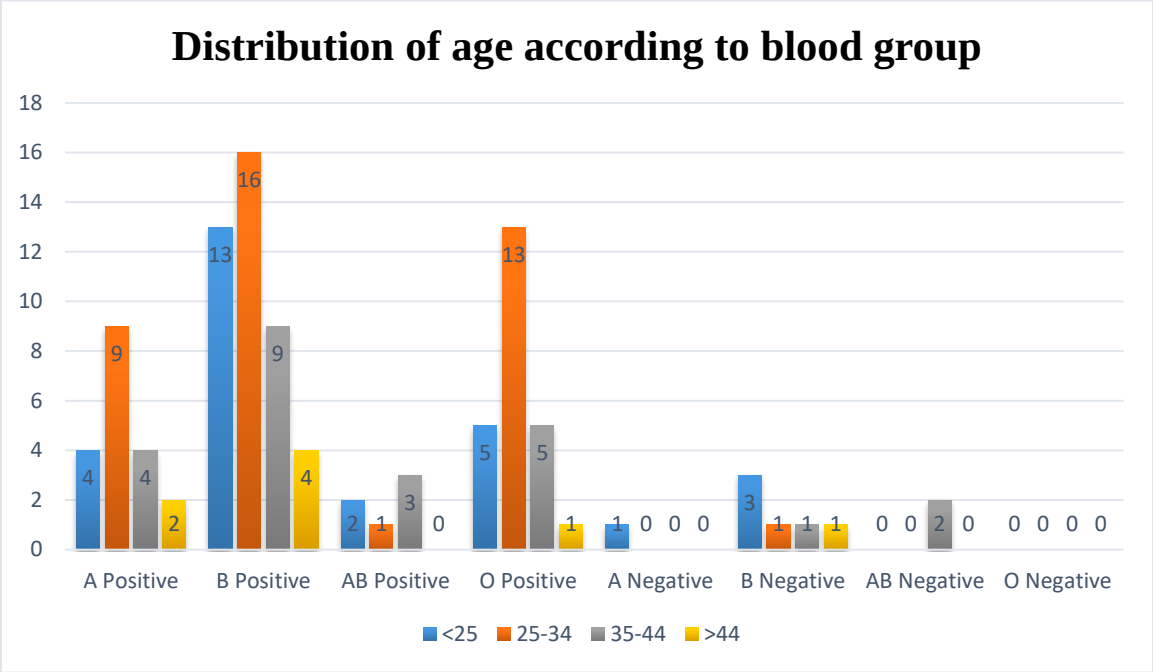
Parameters	Low % (n)	Normal % (n)	High % (n)
HGB(g/dl)	51	49	0
HCT (%)	24	73	3
TRBC(10^6/µL)	22	73	5
MCV(fl)	47	53	0
MCH(pg)	69	31	0
MCHC(g/dl)	10	86	4
TLC(10^3/µL)	1	75	24
Neutrophils (%)	2	80	18
Lymphocytes (%)	19	77	4
Monocytes (%)	1	99	0
Eosinophils (%)	1	98	1
Platelets(10^3/µL)	3	78	19

This table cross-tabulates age groups with blood groups, providing insights into the age distribution within each blood group category. For example, among A positive, the majority were in the 25-34 age group (9 out of 19), while among B positive, AB positive, O positive , A negative, B negative, AB negative and O negative the distribution was more evenly spread across age groups as shown in table no .5.

Table No.5 Distribution of age according to blood group (n = 100)

Blood Group	Age (years)				Total
	<25 years	25-34 years	35-44 years	>44 years	
A Positive	4	9	4	2	19
B Positive	13	16	9	4	42
AB Positive	2	1	3	0	6
O Positive	5	13	5	1	24
A Negative	1	0	0	0	1
B Negative	3	1	1	1	6
AB Negative	0	0	2	0	2
O Negative	0	0	0	0	0
Total	28	40	24	8	100

Figure No.3 Distribution of age according to blood group (n = 100)



Discussion

According to the WHO cutoff values [24], prevalence of anemia in this study indicated not much lower than sever public heath importance. This result was consistent with study done in Jimma University Specialized Hospital, South West Ethiopia, 2006 (38.2%) [25] and West Arsi Zone, Ethiopia, 2013 (36.6%) [26]. However, the result of the present study was much lower than WHO report, 2008 (62.7%) in Ethiopia [24]. This might have happened due to the model used to estimate prevalence of anemia and the time difference. The prevalence of anemia in this study is also low as compared to the prevalence of anemia reported from Morogoro municipality, Tanzania, 2010 [27], South Eastern Nigeria, 2007 [28], Sudan, 2009[29], Kenya, 2007 [30] , Uganda, 2013[31] , China, 2009 [32], Malaysia, 2012 [33] and Gilgel Gibe dam area, Southwest Ethiopia, 2012 [34] which reported 95%, 76.9%, 70%, 69.1%, 63.1%, 58.6%, 57.4% and 53.9% prevalence rates, respectively. This variation might be due to study population difference. For instance, in Tanzania where the highest prevalence was reported, most of the participants were in their last trimester whereas most of the participants in our study were in the 2nd and 1st trimester. The other possible reason might be due to low prevalence of malaria compared to other studies; for example, a study in Gilgel Gibe Dam area, Southwest Ethiopia, 2012 [34] reported 11.60% of malaria cases among pregnant women while the prevalence of malaria was 3.58% in our study.

On the other hand, prevalence of anemia in this study was higher than similar studies conducted in Nakhonsawan, Thailand 2010 [35], Azezo Health Center Gondar Town, North West Ethiopia 2013 [36], and Tikur Anbessa Specialized Hospital, Addis Ababa Ethiopia 2014 [37] which reported as 14.1%, 21.3% and 21.6%, respectively.

According to WHO classification for degree of anemia, among anemic pregnant women, [38] (3.89%) were severely anemic. The proportion of severe anemia in this study was higher compared to similar studies in Nigeria 2014 (0.3%)[39] , Sudan 2010 (2.1%) [29] and Tanzania 2011 (2.1%) [40]. Mainly, this might be due to the method used for measurement of Hb level of pregnant women. The study conducted in Nigeria used packed cell volume or hematocrit for identification of anemic cases [39], but in our case, Hb was measured using a HemoCue hemoglobinometer (HemoCue AB, Angelhom, Sweden) [29, 40](which is accurate and precise method for measurement of Hb. This method we used is a recommend method for field research work.

Anemia in pregnancy is related to different socio-demographic factors [35, 37, 41]. This study assessed socio-demographic variables associated with anemia. Age group of 15-24 years, family size greater than four, multigravida and monthly household income less than 968 Ethiopian Birr showed statistically significant association with anemia. This indicates a higher prevalence of anemia in young pregnant mothers, large family size and large number of children ever borne. In different studies, age, family size, parity and economical status were found to be significantly associated with anemia during pregnancy [35, 37, 41] which were consistent with our study. Reports on prevalence of anemia in women of reproductive age in Meghalaya, 2010 [42] and in India, 2008 [43](were consistent with the current finding.

In this study, anemia among pregnant women was significantly associated with presence of clinical illness. Pregnant women who had clinical illness and intestinal parasitic infection were more likely to be anemic than pregnant women who did not have clinical illness and intestinal parasitic infections. In the present study, anemia was more prevalent at the third trimester. This might be due the fact that increase in trimester may cause reduction in maternal iron reserves. There was also a statistically significant association between anemia and history of excess menstrual bleeding (usage of more than two sanitary pads within a day during menstruation). These might be due to the fact that increase in number of sanitary pad usage per day reflects increase in the amount of blood flow-one of the predisposing factors for the occurrence of anemia. Undernourished pregnant women who had low BMI<18.5 kg/m2 were more likely to have anemia. This might be due to the fact that anemia is one of the most common nutritional deficiency disorders. Because the study was cross-sectional in design, it did not show which preceded, anemia or risk factors. Additionally, Micronutrient (serum iron, folate and vit-B12) levels, which might be root causes of anemia, were not assessed.

In conclusion, the overall prevalence of anemia in this study indicated that it is a moderate public health problem. Intervention strategies should focus on associated factors of anemia among pregnant women. Increase awareness for family planning methods might have a contribution for reducing risk of anemia. Economic and nutritional empowerment should be considered. Large scale longitudinal studies should be done to identify specific etiologies and root causes of anemia among pregnant women by assessing micronutrients (serum iron, folate and vit-B12 levels).

Conclusion

The study sheds light on the hematological characteristics of pregnant women, emphasizing age distribution, blood group prevalence, and the prevalence of abnormal hematological parameters. Most participants fell within the age range of 25 to 34 years, with smaller proportions in younger and older age groups. B Positive was the most prevalent blood group, followed by O Positive and A Positive, showcasing the diverse blood group composition. Anemia was notable, with over half of the participants exhibiting low hemoglobin levels. Additionally, varying levels of abnormality were observed in parameters like Hematocrit, Total Red Blood Cell Count, and Mean Cell Volume. However, parameters such as Total Leukocyte Count and Platelets generally showed normal levels. Analysis of age distribution within each blood group revealed diverse patterns, suggesting potential age-related variations in hematological parameters. These findings underscore the importance of monitoring hematological parameters during pregnancy for maternal health and well-being.

References

1. Nawaz, S., et al., *Blood transfusion reactions during pregnancy*. Journal of Rawalpindi Medical College, 2013. **17**(2).
2. Alkhatib, A., *The role of laboratory medicine for health during pregnancy.* EJIFCC, 2018. **29**(4): p. 280-284.
3. Mohamed, A.O., K.M. Hamza, and A. Babker, *Physiological changes in some hematological and coagulation profile among Sudanese healthy pregnant women.* Int J Med Sci Public Health, 2016. **5**(3): p. 525-8.
4. Purohit, G., T. Shah, and J. Harsoda, *Hematological profile of normal pregnant women in Western India*. 2015.
5. Mba, C.O., T.C. Adias, and E.M. Eze, *Acute Phase Reactant Correlates Among Pregnant Women in Port Harcourt, Nigeria.* European Journal of Biomedical and Pharmaceutical Sciences, 2018. **5**(8): p. 87-94.
6. James, T.R., H.L. Reid, and A.M. Mullings, *Are published standards for haematological indices in pregnancy applicable across populations: an*

evaluation in healthy pregnant Jamaican women. BMC pregnancy and childbirth, 2008. **8**: p. 1-4.
7. Abell, S.K., et al., *Inflammatory and other biomarkers: role in pathophysiology and prediction of gestational diabetes mellitus.* International journal of molecular sciences, 2015. **16**(6): p. 13442-13473.
8. Das, S., et al., *Study of hematological parameters in pregnancy.* IOSR Journal of dental and medical sciences, 2013. **12**(1): p. 42-4.
9. Imam, T. and A. Yahaya, *Packed cell volume of pregnant women attending Dawakin Kudu General Hospital, Kano state, Nigeria.* Int Jor P App Scs, 2008. **2**(2): p. 46-50.
10. Banhidy, F., et al., *Iron deficiency anemia: pregnancy outcomes with or without iron supplementation.* Nutrition, 2011. **27**(1): p. 65-72.
11. Shaw, J., et al., *Current knowledge of the aetiology of human tubal ectopic pregnancy.* Human reproduction update, 2010. **16**(4): p. 432-444.
12. Ifeanyi, O.E., *A review on pregnancy and haematology.* Int. J. Curr. Res. Biol. Med, 2018. **3**(5): p. 26-8.
13. Akinbami, A.A., et al., *Hematological profile of normal pregnant women in Lagos, Nigeria.* International journal of women's health, 2013: p. 227-232.
14. El-Hioui, M., et al., *Iron deficiency and anaemia in rural school children in a coastal area of Morocco.* Pakistan J Nutr, 2008. **7**: p. 400-3.
15. Organization, W.H., *Reducing risks, promoting healthy life.* World health report 2002, 2002.
16. Balarajan, Y., et al., *Anaemia in low-income and middle-income countries.* The lancet, 2011. **378**(9809): p. 2123-2135.
17. Salhan, S., et al., *Evaluation of hematological parameters in partial exchange and packed cell transfusion in treatment of severe anemia in pregnancy.* Anemia, 2012. **2012**.
18. Who, C., *Worldwide prevalence of anaemia 1993–2005*. WHO global database on anaemia, 2008.
19. Barooti, E., et al., *Prevalence of iron deficiency anemia among Iranian pregnant women; a systematic review and meta-analysis.* Journal of reproduction & infertility, 2010. **11**(1): p. 17.
20. Verster, A., *Guidelines for the control of iron deficiency in countries of the Eastern Mediterranean, Middle East and North Africa.* 1996.
21. Black, R.E., et al., *Maternal and child undernutrition: global and regional exposures and health consequences.* The lancet, 2008. **371**(9608): p. 243-260.
22. WHO, O., *Prevalence of Anaemia in Women: A Tabulation of Available Information.* 1992.
23. Baig-Ansari, N., et al., *Anemia prevalence and risk factors in pregnant women in an urban area of Pakistan.* Food and nutrition bulletin, 2008. **29**(2): p. 132-139.
24. McLean, E., et al., *Worldwide prevalence of anaemia, WHO vitamin and mineral nutrition information system, 1993–2005.* Public health nutrition, 2009. **12**(4): p. 444-454.
25. Belachew, T. and Y. Legesse, *Risk factors for anemia among pregnant women attending antenatal clinic at Jimma University Hospital, southwest Ethiopia.* Ethiopian Medical Journal, 2006. **44**(3): p. 211-220.
26. Obse, N., A. Mossie, and T. Gobena, *Magnitude of anemia and associated risk factors among pregnant women attending antenatal care in Shalla Woreda, West Arsi Zone, Oromia Region, Ethiopia.* Ethiopian journal of health sciences, 2013. **23**(2): p. 165-173.
27. Msolla, M. and J. Kinabo, *Prevalence of anaemia in pregnant women during the last trimester.* International journal of food sciences and nutrition, 1997. **48**(4): p. 265-270.
28. Uneke, C., D. Duhlinska, and E. Igbinedion, *Prevalence and public-health significance of HIV infection and anaemia among pregnant women attending antenatal clinics in south-eastern Nigeria.* Journal of health, population, and nutrition, 2007. **25**(3): p. 328.
29. Haggaz, A.D., E.A. Radi, and I. Adam, *Anaemia and low birthweight in western Sudan.* Transactions of the Royal Society of Tropical Medicine and Hygiene, 2010. **104**(3): p. 234-236.
30. Ouma, P., et al., *Malaria and anaemia among pregnant women at first antenatal clinic visit in Kisumu, western Kenya.* Tropical Medicine & International Health, 2007. **12**(12): p. 1515-1523.
31. Mbule, M.A., et al., *Determinants of anaemia among pregnant women in rural Uganda.* Rural and remote health, 2013. **13**(2): p. 1-15.
32. Ma, A., et al., *Anemia prevalence among pregnant women and birth weight in five areas in China.* Medical Principles and Practice, 2009. **18**(5): p. 368-372.
33. Nik Rosmawati, N., S. Mohd Nazri, and I. Mohd Ismail, *The rate and risk factors for anemia among pregnant mothers in Jerteh Terengganu, Malaysia.* J Community Med Health Educ, 2012. **2**(150): p. 2161-0711.1000150.
34. Getachew, M., et al., *Anaemia and associated risk factors among pregnant women in Gilgel Gibe dam area, Southwest Ethiopia*. Parasites & vectors, 2012. **5**: p. 1-8.
35. Sukrat, B., et al., *The prevalence of iron deficiency anemia in pregnant women in Nakhonsawan,*

Thailand. Medical journal of the Medical Association of Thailand, 2010. **93**(7): p. 765.
36. Alem, M., et al., *Prevalence of anemia and associated risk factors among pregnant women attending antenatal care in Azezo Health Center Gondar town, Northwest Ethiopia.* J Interdiscipl Histopathol, 2013. **1**(3): p. 137-144.
37. Jufar, A.H. and T. Zewde, *Prevalence of anemia among pregnant women attending antenatal care at tikur anbessa specialized hospital, Addis Ababa Ethiopia.* J Hematol Thromb Dis, 2014. **2**(125): p. 2.
38. Hussein, K., et al., *The risks for pre-term delivery and low birth weight are independently increased by the severity of maternal anaemia.* South African Medical Journal, 2009. **99**(2): p. 98-102.
39. Olatunbosun, O.A., et al., *Prevalence of anaemia among pregnant women at booking in the University of Uyo Teaching Hospital, Uyo, Nigeria.* BioMed research international, 2014. **2014**.
40. Msuya, S.E., et al., *Anaemia among pregnant women in northern Tanzania: prevalence, risk factors and effect on perinatal outcomes.* Tanzania journal of health research, 2011. **13**(1): p. 33-39.
41. Karaoglu, L., et al., *The prevalence of nutritional anemia in pregnancy in an east Anatolian province, Turkey.* BMC public health, 2010. **10**: p. 1-12.
42. Dey, S., S. Goswami, and M. Goswami, *Prevalence of anaemia in women of reproductive age in Meghalaya: a logistic regression analysis.* Turkish Journal of Medical Sciences, 2010. **40**(5): p. 783-789.
43. Bharati, P., et al., *Prevalence of anemia and its determinants among nonpregnant and pregnant women in India.* Asia Pacific Journal of public health, 2008. **20**(4): p. 347-359.