ISSN 2063-5346

Correlation of Iron Deficiency Anaemia and Other Associated Hematological Markers among Pregnant Women

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Article History: Received: 01.02.2023 Revised: 07.03.2023 Accepted:15.04.2023

Abstract

Anemia is the most common blood disorder encountered in pregnancy and affects approximately 38% of pregnant women globally. Iron deficiency anemia (IDA) continues to be the commonest etiology of anemia in pregnancy. The prevalence of iron deficiency (ID) in pregnant Indian women is amongst the highest in the world. The development of iron deficiency anemia is associated with increased risk of preterm births and low birth weight infants. IDA is characterized by microcytosis, (low MCV<80fl) and hypochromia(MCH<27pg) and blood film may confirm characteristic microcytic cells or pencil cells. While IDA is the commonest cause for decreased MCV, low MCV is insensitive and upto 40% of pregnant women with true IDA have normocytic indices. Stimulation of erythropoiesis in pregnancy masks the microcytosis of iron deficiency. A prospective observational study was performed on 100 pregnant women at Baraut, Medicity Hospital, Baghpat UP,India where 50 women were anemic and the results recorded the significant level of abnormal in all hematological parameters compared with 50 non anemic pregnant women and the significance was given as student's test (p<0.001)

***Keywords**:* IDA, pregnancy outcomes, MCH, MCHC, LBW etc

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INTRODUCTION

Anaemia is the blood disorder characterized by the reduction in Red Blood Cells count, Hemoglobin content and packed cell volume(Haematocrit). It is the common blood disorder in the general population.[1] Anaemia can affect people of all ages, races and ethnicities. If not treated or diagnosed properly that will lead to several complications or even life threatening. Anemia is adversely affecting women of reproductive age and child health which in turn results in increased morbidity and maternal death, and also hamper social-economic growth[2]

There might be certain precipitating factors including genetic causes such as hemoglobinopathies and also infections like malaria may contribute anemia. The nutritional consideration includes iron deficiency on one hand and deficiencies of vitamins like A and B_{12} and minerals such as copper on the other hand. Iron deficiency is the common cause of anemia in general population mostly.

According to the report of World Health Organization (WHO) over half a billion women or 29.9% of reproductive women aged 15–49 years were suffering from anemia in 2019 and most of them suffered due to iron deficiency(Cogswell,2009). Reproductive and adolescent women are more prone to anemia due to insufficient dietary intake and iron loss during menstruation and pregnancy[3].

Generally pregnancy is associated with increased demand for iron and therefore the risk of iron deficiency anemia is also increased gradually. Up to 52% of pregnant women in the developing countries are affected lowered iron stores in their newborn baby will increase the risk of subsequent iron deficiency anemia[4]. Iron deficiency causes adverse consequences on maternal and child health outcomes such as low birth weight, neonatal and maternal mortality and also other complications like restricted diets, growth spurt, and heavy blood loss[5]. Hence the present study is aimed for screening the clinical markers and the associated risk factors among pregnancy woman in the study area.

MATERIALS AND METHODS

Participants and study design

The current study was a descriptive and case control study in its design examined 100 samples of pregnant women for a period of 3 months duration (from October 2022 to December 2022) which includes anemic pregnant women (n=50) and non anemic pregnant women (n=50) participates from Baraut, Medicity Hospital Baghpat, UP India. The family and nutritional history was collected from all the participates by oral or questionnaire method. Venous blood (5mL) was collected by venipuncture method for the estimation of Hematological and other clinical parameters.

Statistical analysis

Data was recorded on a predesigned proforma and managed on an Excel spreadsheet. Frequency and percentage of each parameter was calculated and analyzed. The risk estimates were analyzed between the cases and controls expressed in the form of Mean $\pm$ SD with p values. The student t test was used to assess the statistical differences between cases and control and p value of <0.001was considered significant

Ethical Approval

Ethical approval was obtained from the Ethics Committee of Medicity Hospital Baghpat, UP India. Written informed consent was obtained from the pregnant women before sample collection.

3. RESULT AND DISCUSSION

Iron deficiency represents a large contribution to anemia as such needs immediate attention are required and action to be taken to increase the intake of iron through supplementation, food fortification and diversification of the diet. Estimation of haemoglobin concentration often used as proxy indicator for assessing iron status of population or control iron deficiency assuming that anemia is always associated with iron deficiency though many other possible reasons and factors are present. These kinds of surveys measure iron deficiency rarely and most of the time the contributing factors remain unidentified or unknown.

The present investigation study was designed to evaluate the impact of iron deficiency anemia in pregnant women and the study was conducted with a sample size of 100 including case(n=50) and control(n=50) were screened for a period of 3months.

Data on demographic profile of the study population were presented in (Table 1 & Figure 1)

TABLE.1. COMPARISON OF CLINICAL MARKERS FOR CASES AND CONTROLS

Markers	Anemic pregnant(*n*=50)	Non-anemic pregnant(*n*=50)	P values
Age(years)	26.8±1.9	26.8±1.6	0.001*
Hb (g/dL)	8.5±0.5	12.7±0.8	0.001*
Systolic	102.6±10.48	107.3 ± 14.3	0.15
Diastolic	73.33±7.11	72.7 ± 7.8	0.75
RBC (millions/cu.mm)	4.02±0.47	4.33±0.49	0.002*
ESR (mm/hr)	30.2±14.6	23.6±14.6	0.02*
PCV %	30.45±0.87	37.43±0.68	0.001*
MCV(fL)	82.64±8.88	73.9±6.1	0.001*
MCH(pg)	26.7 ± 1.1	28.1±1.1	0.001*
MCHC(g/dL)	30.7±0.9	33.1±0.7	0.001*
Ferritin (ng/mL)	20.45±18.42	39.67±54.70	0.001*
Infants weight(kg)	2.61±0.41	3.10±0.3	0.0001*

P- Value : Level of significance

P > 0.05 : Non- significant (NS) ***P***< 0.05: Significant (S)

P <0.01 : Highly Significant (HS)

Normal haemoglobin distributions vary with age and physiological status, for example, pregnant (varies by trimester) and non-pregnant women. The overall distribution of women in different categories by anemia levels showed that pregnant women had a higher prevalence of severe anemia than the non pregnant women because the Hb and RBC levels for all the pregnant women ($p<0.001$) were decreased significantly (8.5±0.5; 4.02 ±0.47)) and it was almost normal in non pregnant women (12.7± 0.8; 4.33±0.49).

During pregnancy, anemia is harmful both to the woman and child and is associated with a higher risk of maternal and fetal morbidity and mortality. Women need to have adequate storage of iron to meet the high requirements of this mineral during pregnancy. The total iron required during pregnancy is about 1000mg, but the majority of women do not meet this demand[6,7]

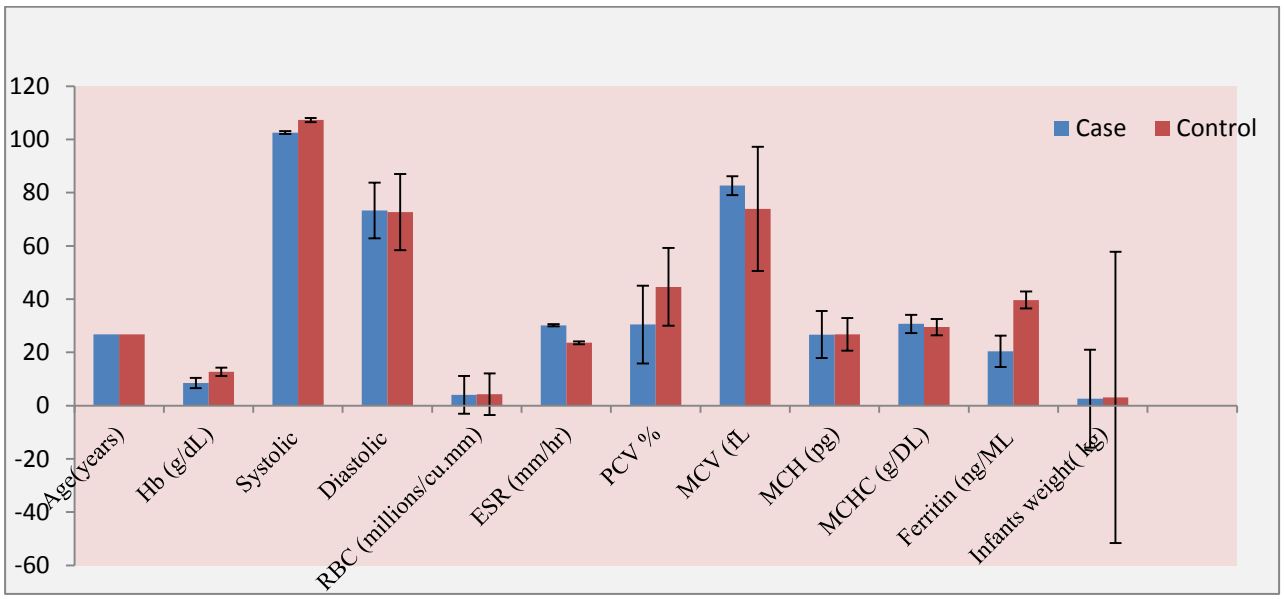

Fig.1 Clinical markers for Anemic and Non anemic pregnant woman

The erythrocyte sedimentation rate(ESR) is a test to evaluate the red blood sedimentation in autologus plasma. It is a non-specific test used in the assessment of the acute phase response to inflammatory disorders. In this study, median ESR values were much higher in pregnant women (29.5±14.6) compared to non pregnant controls (22.3±12.2), and there was a progressive increase with gestational age. The ESR was significantly higher (P>0.004)) in anaemic pregnant women compared to non-anaemic pregnant women[7,8]. The ESR is remarkably increased in the presence of anaemia and the acute phase proteins especially fibrinogen, serum amyloid A protein and C-reactive protein. Anaemia promotes rouleaux formation while the acute phase proteins coat the red cell membrane causing a reduction in the repulsive negative charge (zeta potential) thus enhancing aggregation and sedimentation[9]

Due to the influence of female sex hormones the ESR always higher in females when compared to males and it also increases with age, probably due to higher prevalence of diseases with increasing age[10].

During pregnancy the C-reactive protein and fibrinogen levels gets elevated and at the same time the albumin level gets down. Along with these factors the haemodilution at some point results in anaemia. The overall effect of these physiologic changes leads to increase of ESR with increasing gestational age[11]. The ESR is useful in monitoring of inflammatory disorders like lymphomas, polymyalgia rheumatica, rheumatoid arthritis, and temporal arteritis. In recent times, better alternatives have been found in plasma viscosity and C-reactive protein assay[12],

In pregnancy, the ESR is particularly inappropriate as a marker of inflammation because of its reported increase with gestational age[11]. Thus Creactive protein (CRP)assay is preferred in the assessment of inflammatory changes in pregnancy[13].

In the present investigation the results expressed statistically decrease in PCV among pregnant women (30.45±0.87)and there was no significant change in non pregnant women(37.43±0.68) which conveyed that the non pregnant women were all healthy. During pregnancy, the total blood volume increases by about 1.5L. The plasma volume is increase by 25%-80%, reaching its maximum by mid pregnancy. Red cell mass also increases by 10%-20% but the net result is that hemoglobin (Hb) concentration falls. As a consequence physiological increase in plasma level that is higher than the pregnancy associated increase in red cell mass. The stored irons are also dropped off by the end

of the pregnancy in majority of women unless iron is supplemented.

Iron deficiency accounts (IDA) for over 90% of anemia during pregnancy, therefore iron should be the main-stay of therapy. Anaemia directly affect the quality of life and virtually all organs of the body Maternal anemia influences mortality, fetal growth, premature death in utero, and fetal programming. Packed cell volume is one of the contributing factor that cause sedimentation of RBCs. The increase in haematocrit value simply means increase the number of red blood cells per unit volume of the suspension, so increasing haematocrit will increase erythrocyte aggregation. In contrast, increasing haematocrit will decrease sedimentation velocity of blood due to the increase in the viscosity of blood[14,15].

Similarly, MCV level were elevated in cases (82.64±8.88) and no significant changes in controls (73.9±6.1). MCV does not change significantly during pregnancy however, there was a small increase when compared to control group, which reached a maximum at 30-35 weeks gestation and does not suggest any deficiency of vitamins B12 and foliate. But at the same time to fulfill the demands of pregnancy RBC productions will be increased and that is the reason for increased MCV (due to a higher proportion of young RBCs which are larger in size). It was reported earlier that hemoglobin concentration <9.5 g/dL in association with a mean corpuscular volume <84 fl probably indicates coexistent iron deficiency or some other pathology[16]. High MCV was correlated with high mortality in patients with acute myocardial infarction (AMI)[10].

The concentrations of MCH(26.7±1.1)and MCHC(30.7±0.9) were considerably lower ($P < 0.05$) in the anemic pregnant mother than the healthy pregnant mother were detected during the study. A study conducted among Indian women suggested optimal cut-offs for Hb; 9.7 g/dL, MCV; 76.1 fl, MCH; 25.05 pg and MCHC; 31.35 g/dL in predicting iron deficiency anaemia during second and third trimesters[17]. The optimum cut-off derived for MCV, MCH and MCHC in the present study were parallel to the cut-off 82.64 fl, 26.7pg and 30.7g/dL widely used to identify microcytic anaemia which is caused by iron deficiency. The reason behind this is due to increase in MCV at the time of pregnancy.

This study also displayed the level of serum ferritin decreased significantly in pregnant women (20.45±18.42) compared to the non-pregnant women.(39.67±54.70)(($P < 0.05$).The reason for decline during pregnancy is increase in demand of iron which triggers ferritin mobilization from its stores. This is in line with the work done by Kurhade *et al*.,1994[18]. who showed that levels of serum ferritin were decreased in pregnancy compared to that in non-pregnancy and also demonstrated that non-pregnant women had more iron stores, therefore had less need for iron than their pregnant counterparts. The need of iron level raised in pregnancy induces its mobilization from its stores. During pregnancy, there is an immense stress on iron metabolism and it frequently induces iron deficiency which is characterized, by a reduced ferritin level.

Furthermore, some of the pregnant women started pregnancy with low iron stores, hence the reason for low ferritin in pregnancy compared to the controls.[19,20]. Ferritin is an acute phase reactant protein and is sometimes found elevated independent of the iron status during illness and inflammation. According to Bain *et al*., 2008[21] serum ferritin decreases in early pregnancy and usually remains low throughout pregnancy, even when supplementary iron is given.

Pregnancy is commonly associated with urinary tract infections and some occult infections. In such individuals, high serum ferritin levels are likely to be seen despite iron deficiency[22]. Ferritin progressively decreased from the first to the third trimester. This could be due to increased demand for fetal growth and development as pregnancy progressed. Our results corroborate with the

earlier reports of Oluchi Aloy-Amadi *et al*.,2020[23] where serum ferritin declined progressively from first to the third trimester. The massive stress on metabolism of iron at the time of pregnancy frequently stimulates iron deficiency resulting in ferritin level reduction. This also implies a progressive mineral transfer from the mother to the fetus. Serum ferritin also showed significantly lowest values in the third trimesters.

Low birth weight in infants is a leading public health problem that is mainly associated with an increased risk of newborn morbidity and mortality. Among the various causes of low birth weight in infants, aneamia during pregnancy is one among the factor which is occurred in each trimester of pregnancy globally. In this present investigational study the weight of infant from anemic mothers(2.61±0.41) were not as much of weight of infant from healthy group. The findings of the present results were comparable to the study done by Engidaw *et al.*,2022[24] in Ethiopia and Dubey and Kumar,2016[25] in India. Low birth weight (LBW) is a major public health problem in many developing countries, especially in India. Low birth weight is a multidimensional problem and it requires an integrated approach comprising medical, social, economical and educational measures to address the issue[26].

Examination of socio demographic and maternal characters associated with LBW is necessary to explore this issue. The burden of low birth weight deliveries are associated with inadequate ANC service utilization and unwanted pregnancy[27]. The most common causes of morbidity and mortality were found in low birth weight babies. Low birth weight proportion was higher in teenage pregnancies & primiparous women . provision of healthy diet before conception and throughout pregnancy had no overall effect on birth weight.[28,29] Frequency of LBW can be either controlled or prevented by increasing the gestational age, routine antenatal checkup, provision of balanced diet and adequate rest during antenatal period. Evidences suggest that those who did not visit antenatal checkup frequently were more prone to have LBW than those utilizes antenatal services adequately. So health policies should aim at early detection and effective management of under nutrition to reduce the burden of Low birth weight[30].

CONCLUSION

Occurrence of anaemia among pregnant women was a public health issue widely across the world. Widespread implementation of preventive and therapeutic strategies is still lacking in our country. Despite of several factors the most common cause of anemia in pregnancy is iron deficiency. IDA during pregnancy can be managed readily but still the demand for health remain unsolved because the management strategy completely depend upon the gestation period and severity of anemia. Anemia during pregnancy will forecast of LBW and the degree of LBW among newborns was moderately high. Though both haemoglobin and ferritin concentrations were considered as markers of iron deficiency, heamoglobin may not reflect the iron status of tissues and hence it is a late marker. However, serum ferritin (SR) is generally considered the best measure of iron deficiency in pregnancy. According to this study, the gold standard for the diagnosis of iron deficiency anemia is a low ferritin level. The primary treatment for iron deficiency anemia is intake of iron orally. Evidence suggests that iron can also be taken as dose dependent manner either daily or twice per day will be very effective with fewer side effects. Intravenous injection of iron can also be recommended for third trimester as well as second trimester for those who cannot tolerate or do not respond to oral iron. Also, regular nutrition education and counseling are essential based on the maternal educational status. Involvement of policymakers and other stake holders is required in treatment of anemia as well as to decrease the rate of LBW and its late consequences. It is believed that using a pragmatic approach combined with recent scientific knowledge along with service oriented medical fraternity may handle this problem all over the country so that the country can reach the goal of reduction in prevalence of anemia in reproductive age group at least by fifty

percent recommended by WHO 2025.

Conflict of Interest

The author(s) declare that there have no conflict of interest

Funding Sources

There are no funding sourcess

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