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Hemoglobin and Red Blood Cells Count in Pregnant Sudanese Women

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Abstract

The study discussed the physiological changes of pregnancy in Sudanese pregnant women the study aimed to assess the effect of pregnancy in Red blood cell, Packed Cell Volume (PCV) and hemoglobin among Sudanese pregnant women, and to correlate the PCV as an indicator of hemodilution in different trimesters among Sudanese women using or not using iron and folic acid supplement. The researcher used cross sectional study which applied on 300 pregnant women presented to Port-Sudan obstetrical Hospital for antenatal care from 2019 to 2020. The samples were collected with Chemically clean and sterile disposable needles, syringes and swab were used for all blood samples, 4.5 mL of blood was collected from each participant into a tube containing the anticoagulant Ethylene Diamine Tetraacetic Acid (EDTA), gently mixed the tube five to six times A full blood count was performed using Hematological analyzer (Sysmex XP 300). The study found out that 90 women in each trimester of pregnancy (first, second and third) the mean value of Hemoglobin (Hb) in pregnant women was 11.3±1.4 g/dl, 11.4 ±1.4 g/dl and 10.3±1.2 g/dl in 1st, 2nd and 3rd trimester respectively. The study also found out that the mean value of PCV was 33.35%. Moreover, Hb was lower during 3rd trimester compared with 1st (hemodilution). The cut off level for anemia in Sudanese non pregnant females could be even lower than 11g/dl as the normal level was found to be lower than the international one. Due to hemodilution anemia in pregnancy is considered if Hb less than 9g/dl. The study recommends that diagnosis of anemia should be revised during pregnancy as this study has shown Hb level less than 9g/dl (66%) can be the cut off level.

Keywords: Hemodilution, Anemia, Pregnancy, Hemoglobin.

Abbreviations: PCV-Packed Cell Volume, EDTA- Ethylene Diamine Tetraacetic Acid, MCV-Mean Corpuscular Volume, MCHC-Mean Corpuscular Hemoglobin Concentration.

During pregnancy, the pregnant mother undergoes significant anatomical and physiological changes in order to nurture and accommodate the developing fetus. These changes begin after conception and affect every organ system in the body. There are many hematological changes during pregnancy including the blood volume, the red blood cells and the WBCs. Maternal blood volume increases during pregnancy, and this involves an increase in plasma volume as well as in red cell and white cell volumes. The plasma volume increases by 40% to 50%, whereas the red cell volume goes up by only 15% to 20%, which causes a situation that is described as "physiological anemia of pregnancy". Despite this hemodilution, there is usually no change in Mean Corpuscular Volume (MCV) or Mean Corpuscular Hemoglobin Concentration (MCHC). However, several hormones such as angiotensin, aldosterone, atrial natriuretic peptide, oestrogen and progesterone may be involved in this interesting phenomenon. The red cell mass increases by an increase in maternal erythropoietin production. [1-4].

The drop in hemoglobin is by 1-2 g/dl by the late second trimester and stabilizes thereafter in the third trimester, when there is a reduction in maternal plasma volume due to an increase in levels of atrial natriuretic peptide. Women who take iron supplements have less pronounced changes in hemoglobin, as they increase their red cell mass in a more proportionate manner than those not on iron supplements. The red blood cell indices change little in pregnancy. However, there is a small increase in Mean Corpuscular Volume (MCV), of an average of 4 fl in an iron-replete woman, which reaches a maximum at 30-35 weeks gestation and does not suggest any deficiency of vitamins B12 and folate. Increased production of RBCs to meet the demands of pregnancy, reasonably explains why there is an increased MCV (due to a higher proportion of young RBCs which are larger in size). Hemoglobin concentration <9.5 g/dl in association with a mean corpuscular volume <84 fl probably indicates co-existent iron deficiency or some other pathology [5]. The normal reference range for Hb during pregnancy has not been established and this limits the diagnosis of anemia in pregnancy. The World Health Organization has



suggested that anemia is present in pregnancy when Hb concentration is <11 g/dl. A pilot study in Sudan on hemoglobin level in relation to the PCV as an indicator of plasma volume hemodilution has suggested that lower Hb values should be considered for anemia diagnosis in Pregnancy. In this study the normal hemoglobin levels were studied in different trimesters [6].

Methods

A cross sectional study was performed on 300 pregnant women presented to Port-Sudan obstetrical Hospital for antenatal care from the period July 2019 to April 2020. This was a questionnaire used for collecting data of study. Blood (4.5 mL) was collected from each participant cubital vein using the stander vacutainer blood collection system. The pregnant women were requested to sit upright on the chair, a tourniquet was applied 5-8 Cm above the venipuncture, the site was swabbed with alcohol. A full blood count was performed using Hematological analyzer (Sysmex XP 300). 50µl was taken from each labeled tube to the Sysmex container and mixed manually or with a mixer to be ready for the machine to perform the counts. The instrument automatically count RBCs, Hb, and PCV. The reagents used on this device were Rinse and Diluent. The principle of the device depends on electricity e.g. Red cell distribution width RDW-SD and RDW-CV, depend on the average size of RBCs or MCV, also TWBCs count and deferential depend on volumetric study Each cell is measured by forward-scatter laser light. Electrical system they displace their volume in a conductive fluid, which causes a change in electrical resistance as each cell passes through the aperture. This change is proportional to the cell volume.

Results

Hemoglobin: The mean Hb value of pregnant women was 11.3±1.4 g/dl, with a range of 7.8-18.7 g/ dl. the Number of pregnant women of Hb less than 11 g/dl in this study was 103 (38%) who were considered anemic according to WHO criteria **Table 1** shows the mean Hb, RBCs and PCV in studied pregnant women. Hb was lower during the 3rd trimester (T3) (10.3±1.2g/dl) compared with the 1st (11.6±1.6g/dl) and 2nd trimesters (11.4±1.4g/dl), P = 0.008.

RBCs counts: The mean of RBCs count was 4.1x106 /mm3 with a range of 2.26-4.1x106/mm3. RBCs count were lower during 2nd P = < 0.001 and 3rd trimester (3.9±0.45 x106 /mm3 (P= 0.007) table 1.

PCV: The mean PCV was 33.35 % with a range of 22.8-54.4 %. The PCV was lower in the 2nd (33.7±3.4%) and 3rd trimesters (32.1±3.3%) compared with the 1st (34.17±4.3%) P =0.000 **table 1**. Hb, RBCS and PCV reference values for Sudanese female in Khartoum were showed in **table 2**. There are significant differences between Hb, PCV, and RBCs count of pregnant women and adult non pregnant Sudanese women (P= 0.000). (**Figure 1,2,3**).

Variable	Mean of all ± SD	T1	T2	T3	P value
Hb g/dl	11.3±1.4	11.6	11.4	10.3	T2 vs T3< 0.001
					T1 vs T3<0.008
					T1 vs T2<0.008
PCV%	33.35	34.1	33.7	32.1	T2 vs T3< 0.000
					T1 vs T3<0.003
					T1 vs T2<0.003
RBCs (x10 ⁶ /mm ³)	4.1	4.1	4.2	3.9	T2 vs T3< 0.007
					T1 vs T3<0.001
					T1 vs T2<0.001

Table1: The mean of Hb, PCV, RBCs count during pregnancy (T=trimester).

Variables	Female (n=348) mean ± sd (Sudan)	Female (n=155) port Sudan
Hb (g/dl)	12.2 ±1.5	12.5± 1.7
RBCs (10 ⁶ / mm3)	4.5±0.4	4.5± 0.44
PCV (%)	39.2± 5	39.5±22.5

Table 2: Hb, RBCS, and PCV values for Sudanese female.

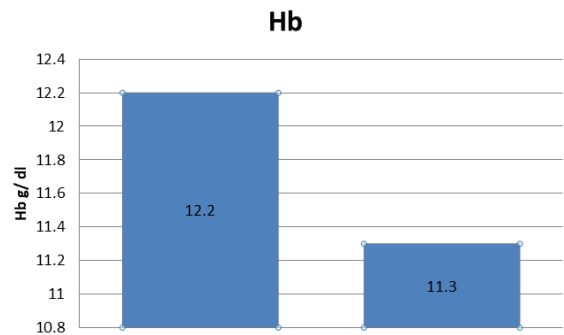


Figure 1: Comparison of Hb, of non-pregnant normal Sudanese females values with the pregnant women.

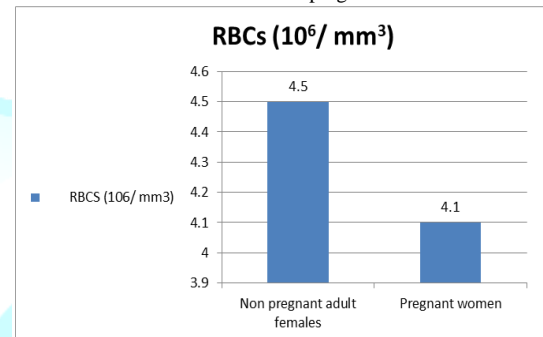


Figure 2: Comparison of RBCs of pregnant women with the normal Sudanese females.

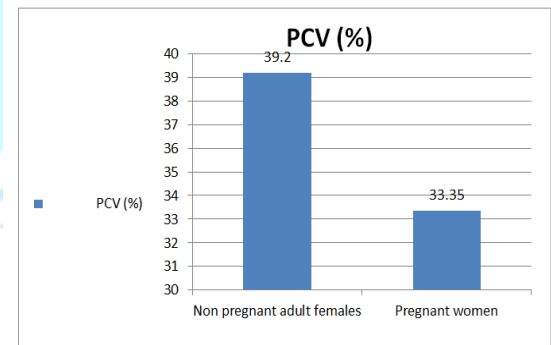


Figure 3: The difference in PCV between pregnant women and normal Sudanese females.

There are (143) women who used iron and folic acid supplement in this study and there were (126) women not used this supplement, There was no significant difference in Hb level between pregnant ladies not using supplement (11.2 g/dl) and those who used them during pregnancy (11.4 g/dl), (P=.32) (**figure 4**).

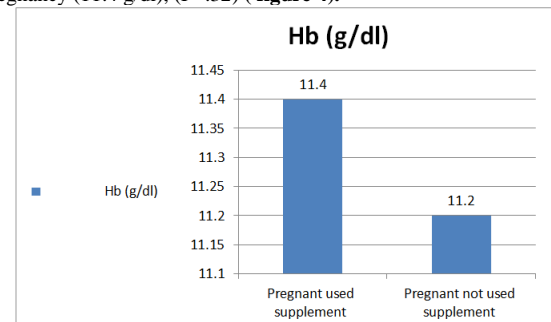


Figure 4: Relation of supplement uses with Hb level during pregnancy.



Hb level and tobacco use

Seven pregnant women used tobacco in this study four of them used shisha (average between one to two times/day for period of one to six years) (mean Hb were 11.7) and only one was smoker (one time/day) for six years (Hb was 12.4), while two females were snufflers (mean Hb were 10.1). Accordingly, there was no significant effect of tobacco use during pregnancy on Hb level $P=0.188$.

Discussion

Hemoglobin and anemia during pregnancy

The cut off level of hemoglobin for diagnosing anemia in pregnancy was taken in most studies as less than 11g/dl according to the WHO recommendation. This level is less than that diagnosing anemia in non-pregnant ladies (12g/dl) as with pregnancy there is hemodilution [2]. The cut off level for anemia in Sudanese non pregnant females could be even lower than 11g/dl as the normal Sudanese level was found to be lower than the international one [7]. This cut off level for anemia in pregnancy in Sudan was used in many studies [8-17]. Ishag Adam carried out several studies on anemia during pregnancy in Sudan. For example in Eastern Sudan He found that 26% of the group of his study were anemic (Hb <9.5 g/ dl) and 3.2% were severely anemic (Hb = 5.6 g/ dl) [8]. In this study 38% of the pregnant ladies were anemic according to the WHO criteria. Ishag Adam also has classified anemia during pregnancy in Sudan as mild to moderate (Hb 7-10.9 g/dl) and severe with Hb <7 g/dl [17].

Anemia, iron supplementation and susceptibility to falciparum malaria in Khartoum was investigated also by Ishag Adam and he found that sever malaria was a leading cause of anemia. 788 out of 885 pregnant women used iron supplement and folic acid in Khartoum state [2]. There was no association between iron deficiency anemia and helicobacter pylori among pregnant women in Khartoum [13]. Aisha defined mean HbA1c during pregnancy as 4.37 %, (4.7% in 1st, and 3.98 % during 3rd trimester). A pilot study on the relation of PCV as an indicator of hemodilution in pregnancy suggested that the cut off level of anemia in pregnancy should be lower than 11g/dl [18].

The normal Hb level in pregnancy in different trimesters is important for anemia diagnosis in pregnancy [19] In a study done by Duria in Khartoum state the hemoglobin levels in the different trimester were found to be: (10.8 g/d-10.6 g/dl-10.8 g/d) during 1st, 2nd and 3rd trimester respectively. Here in this study the mean of Hb during the 1st trimester was 11.6 g/dl, in 2nd trimester was 11.4 g/dl, while in 3rd trimester was 10.3 g/ dl. There is significant decrease of Hb level during the trimesters of pregnancy (**table 1**) which can be explained by the nutrition of the ladies, and there is significant relation between the decrease in Hb level and PCV. Also there was significant relation between Hb level and the Number of parity in this study.

As shown in figure (1) there is significant difference between Hb in this study from normal Adult Sudanese females [7]. The decrease in Hb level in pregnancy is mostly related to hemodilution, also there is significant difference between Hb in this study and normal adult females in Port Sudan whose mean Hb was 12.5 g/d, ($P=0$). According to the WHO definition of anemia in pregnancy all the pregnant females in the third trimester in this study are considered anemic and 38.1% of all the sample are considered anemic.

If the hemodilution has been considered as factor the diagnosis of anemia the PCV is an indicator of anemia: Dilution factor= $\frac{\text{Pregnant plasma\%}}{\text{Standard plasma\%}}$, then the PCV of the pregnant women in the third trimester was 32% (**table1**) which means that the plasma % was 68% and the normal plasma % is 61% (**table 2**), so the dilution factor will be: $\frac{68}{61}=1.1$ (69). If we multiply this dilution factor with the third trimester Hb: 1.1×10.2 it will equal 11.4g/dl, which is not the level of anemia. If we consider the total Hb in a normal women with

Hb level of 12g/dl (below which she will be considered anemic), with a 5L blood volume then her total blood Hb will be:

$$\text{Total blood Hb} = \text{Blood volume in ml}/100 \times \text{the Hb level} = 5000/100 \times 12 = 600\text{g}$$

If hemodilution considers 40-50% of plasma in pregnancy, will increase the blood volume to about 6.5L in pregnancy, then the normal total Hb of 600 g will give a level in pregnancy of: $\frac{600}{6500} \times 100=9.2\text{g/dl}$, below which she can be considered anemic. So, Anemia in pregnancy should be diagnosed if the Hb level is less than 9.2g/dl (Less than 66%).

Conclusions

Calculation the mean of Hb, PCV, and RBCs in pregnant ladies in Port Sudan .The normal hematological values in pregnancy are different from normal Sudanese values. There is decrease in Hb level due to delusional effect of pregnancy it is suggested that the diagnosis of anemia on pregnancy if Hb is less than 9/dl.

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