

DOI: <http://dx.doi.org/10.18203/2320-1770.ijrcog20180150>

Original Research Article

## Effect of pregnancy on packed cell volume and total white blood cells count among Sudanese pregnant women attending antenatal care at Ribat University Hospital (Khartoum state)

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**Received:** 05 December 2017

**Accepted:** 08 January 2018

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### ABSTRACT

**Background:** During pregnancy the women undergo several structural and physiological changes almost in all body systems including the hematological profile. The main reported hematological change is the plasma expansion and haemodilution which affect the red blood cells (RBCs) and white blood cells (WBCs) count in addition to other hematological indices including packed cell volume (PCV). The objective of this study was to assess the effect of pregnancy on packed cell volume and white blood cells among Sudanese pregnant women and derive a formula for the normal values in pregnant women in relation to the packed cell volume.

**Methods:** An analytical case control study was conducted in Khartoum state, Sudan 2017. The study included 20 Sudanese pregnant women in the second and third trimesters attending the antenatal care at The National Ribat university hospital and 20 Sudanese non-pregnant women in the same age group as control. A questionnaire was used to collect socio-demographic and clinical data. 5ml of venous blood was collected in a container containing EDTA. Complete blood count (CBC) was measured by using automated cell counter Sysmex.

**Results:** There was statistically significant decrease in PCV value during 2nd and 3rd trimesters of pregnancy compared to the non-pregnant control group with p values (0.00 and 0.04 respectively), and statistically significant increase in WBCs count during 2<sup>nd</sup> and 3<sup>rd</sup> trimesters of pregnancy compared to the non-pregnant control group with p values (0.04 and 0.00 respectively). Also, a progressive increase in WBCs count with gestational age was demonstrated (second trimester  $6.65 \times 10^3/\mu\text{L}$ , third trimester  $7.43 \times 10^3/\mu\text{L}$ ). The results showed mean WBCs of  $7.79 \times 10^3/\mu\text{L}$ , when compared to the estimated values the results showed no significant difference with the mean WBCs in 2<sup>nd</sup> and 3<sup>rd</sup> trimesters (p value 0.06 and 0.39 respectively).

**Conclusions:** During pregnancy there was statistically significant decrease in PCV values, statistically significant increase in WBCs count and by considering the haemodilution factor there was a higher increase in WBCs count.

**Keywords:** Haemodilution, PCV, Sudanese pregnant women, WBCs

### INTRODUCTION

Pregnancy is characterized by many hematological changes, which may appear to be pathological in the non-pregnant state.<sup>1,2</sup> Many studies have identified the

hematological profile of the pregnant woman as one of the factors affecting pregnancy and its outcome.<sup>2,3</sup> During pregnancy, plasma expansion and haemodilution contribute to the majority of these changes, there is increase in plasma volume as well as in red cells and

white blood cells volume.<sup>4-7</sup> The total blood volume increases in order to supply the demands of the new vascular bed and also to compensate for blood loss occurring at delivery.<sup>1,6,8</sup> Modifications in the production of red cells and changes in plasma volume has some effects on some of the hematological indices such as red blood cells count, packed cell volume, hemoglobin concentration, platelet count, and white blood cell count.<sup>4,6,9</sup> Some of these are decreased like RBC and PLT counts partly as a result of the physiological haemodilution that occurs in pregnancy, while others are increased, such as the WBC count.<sup>4,5</sup>

Plasma volume in pregnancy was found to increase by about 10-15% at 6-12 weeks of gestation then expands rapidly until 30-34 weeks. The total gain of plasma volume at term is about 1.5L and results in a plasma volume of 4700-5200 mL, 30-50% above the non-pregnant women plasma.<sup>10-13</sup> During pregnancy the total volume of circulating blood increases.<sup>7</sup> Red blood cell mass was reported to increase by about 20-30% above non-pregnant levels by the end of pregnancy which is mainly driven by the increase in erythropoietin production.<sup>10,12,14</sup> Therefore, the increase in plasma volume is more than the increase in the red blood cells. Consequently, the packed cell volume decreases due to the haemodilution.<sup>2,15-17</sup> Regarding the white blood cells, many studies reported that pregnancy is usually associated with leukocytosis.<sup>3,12,18</sup> It is mainly from neutrophilia, which is attributed to physiologic stress and it is known to increase with gestational age.<sup>2,10,19,20</sup> So during pregnancy the mean white blood cells counts of 10,000–16,000 cells/uL with an upper level as high as 29,000 cells/uL at labor were observed.<sup>2</sup> The count falls to reach the normal non-pregnant range by the sixth day postpartum.<sup>10,11</sup> Some researchers reported that in a

woman with normal pregnancy, there is no change in the absolute lymphocyte count.<sup>10,20</sup> The monocytes count tended to increase, while the basophiles and eosinophils count may slightly decrease.<sup>20</sup> Also women with normal pregnancies can have a small number of immature cells in the peripheral circulation.<sup>2,10,12</sup>

**METHODS**

This was an analytical case control study conducted at The National Ribat University hospital, Khartoum, Sudan 2017 to assess the effect of pregnancy on PCV and WBCs count among Sudanese women. The study population included 20 Sudanese Pregnant women at second and third trimester aged between 18to 40 years and 20 Control of Sudanese non-pregnant women at the same age group, those with acute infection or anemia were excluded. A questionnaire was used to collect the socio-demographic and clinical data including age, parity, trimester of pregnancy, history of infection, abortion or sever bleeding and use of medicines during current pregnancy. Consent was obtained from each individual participating in the study.5ml of venous blood collected from each participant by a disposable needle in a container containing EDTA, complete blood count (CBC) was measured using automated cell counter Sysmex. Data was analyzed using the Statistical Package for Social Sciences (SPSS) computer program version 20(P value ≤0.05 considered significant).

**RESULTS**

The study population comprised 20 pregnant women, 7 in 2<sup>nd</sup> trimester and 13 in 3<sup>rd</sup> trimester and 20 non-pregnant women as control; all of them were within the child bearing age.

**Table 1: PCV and WBCs in 2<sup>nd</sup>, 3<sup>rd</sup> trimesters.**

Parameters		Mean±Std. Deviation	Minimum	Maximum
Packed cell volume (PCV)	Second trimester	29.2500±2.83843	27.00	33.40
	Third trimester	33.8313±3.79679	26.50	40.90
	Control	37.3500±3.08041	30.90	43.60
White blood cell count (WBCs) (×10 <sup>3</sup> /uL) parameters	Second trimester	6.6500±0.81035	5.80	
	Third trimester	7.4375±1.58151	4.70	
	Control	4.6700±0.76372	3.40	

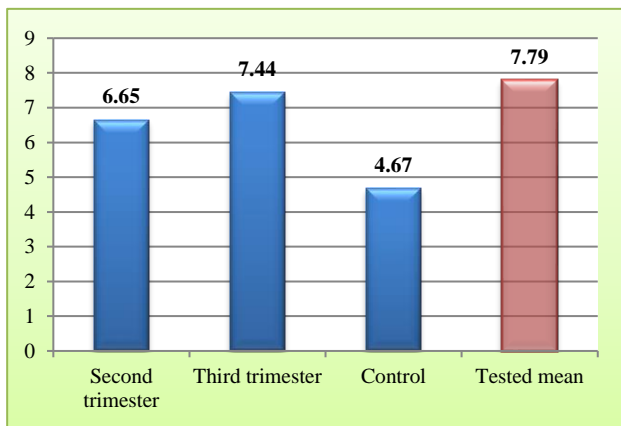
From the analysis the mean values for the pregnant women in 2<sup>nd</sup> trimester was as follows: PCV 29.25±2.83, WBCs 6.65×10<sup>3</sup>/uL±0.8 and the mean values for pregnant women in 3<sup>rd</sup> trimester was as follows PCV 33.83±3.79, WBCs 7.43×10<sup>3</sup>/uL±1.58 compared to PCV 37.35±3.08 and WBCs 4.67×10<sup>3</sup>/uL in control (Table 1).

The results showed a statistically significant decrease in PCV in 2<sup>nd</sup> and 3<sup>rd</sup> trimesters with p values (0.00 and

0.04, respectively) when compared to non-pregnant (Table 1). There is also a statistically significant increase in WBCs in 2<sup>nd</sup> and 3<sup>rd</sup> trimesters with P values (0.04 and 0.00, respectively) when compared to non-pregnant. Also, WBCs showed progressive increase with gestational age (Table 1). When the haemodilution effect on WBCs count was considered by applying the equation:

$$[\text{Plasma (pregnant)} / \text{plasma (control)}] \times \text{WBCs (pregnant)}$$

where the ratio of the plasma in pregnant ladies to that of the non-pregnant was taken as the dilution factor, the results showed mean WBCs of  $7.79 \times 10^3/\mu\text{L}$ , when compared with the estimated values the results showed significant difference with the mean WBCs in control group (p value 0.00), no significant difference with the mean WBCs in 2<sup>nd</sup> and 3<sup>rd</sup> trimesters (p value 0.006 and 0.39, respectively). So, the mean WBCs value for pregnant women in the 3<sup>rd</sup> trimester was more relevant to the value that was calculated by the equation (Figure 1).



**Figure 1: 2<sup>nd</sup> and 3<sup>rd</sup> trimester means WBCs and the estimated WBCs value of  $7.79 \times 10^3/\mu\text{L}$ .**

## DISCUSSION

Pregnancy is a physiological state that is characterized by different hematological changes. In this study we assessed the changes of PCV and WBCs count among Sudanese pregnant women in comparison to Sudanese non-pregnant values. It showed a statistically significant decrease in the mean PCV values for pregnant women in 2<sup>nd</sup> and 3<sup>rd</sup> trimesters, (Table 1). This is mainly due to the increase of plasma volume during pregnancy that lead to haemodilution. These results are consistent with Purohit G in India, and Anberbir S in Ethiopia, Abbas RE study conducted in Sudan.<sup>2,4,15</sup>

This study showed a statistically significant increase in the mean WBCs in 2<sup>nd</sup> and 3<sup>rd</sup> trimesters of pregnancy in comparison to non-pregnant values (Table 1), WBCs showed progressive increase with gestational age. These results are consistent with Anberbir S in Ethiopia, Mohamed AO in Sudan, but contradictory with Abbas RE study in Sudan which showed that WBCs count were within normal values for both case and control.<sup>4,14,15</sup> Leukocytosis during pregnancy may be due to physiological stress and hyper dynamic circulation.

During pregnancy Plasma volume was found to be increased by about 10-15% at 6-12 weeks of gestation then expands rapidly to reach about 30-50% at 30-34 weeks which might have an effect on some of hematological indices including the WBCs count, so if we considered the difference in plasma percentage among

pregnant and non-pregnant women and the effect of haemodilution to determine the actual values of WBCs during pregnancy the results showed a mean WBCs of  $7.79 \times 10^3/\mu\text{L}$  which is almost double the WBCs of the control, these results denote a direct relation between the PCV as a part of the haemodilution and the WBCs count during pregnancy. When the total WBCs were calculated in an extra 1.5 L of plasma it has reached:  $7790 \times 1500000 \mu\text{L} = 11685 \times 10^6$  extra cells in pregnant ladies!! With consideration of the effect of the stress and hyper dynamic circulation, this still needs a big scale study to confirm and explain the factors leading to this huge increase in WBCs during pregnancy.

## CONCLUSION

This study concluded that during pregnancy there was significant decrease in PCV values and a significant increase in WBCs in comparison to non-pregnant and by considering the haemodilution factor. It is highly recommended to include the PCV in the routine hematological blood test during pregnancy to consider the haemodilution factor that affects all hematological values. Further studies in Sudan with larger sample size and different pregnancy trimesters might show an accurate effect of haemodilution on blood cells and particularly WBCs count.

## ACKNOWLEDGMENTS

The authors would like to thank all the volunteers that participated in this study, staff of the National Ribat university hospital, department of obstetrics and gynecology and the medical laboratory.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

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**Cite this article as:** Ahmed WMM, Khalid A, Musa OA. Effect of pregnancy on packed cell volume and total white blood cells count among Sudanese pregnant women attending antenatal care at Ribat University Hospital (Khartoum state). *Int J Reprod Contracept Obstet Gynecol* 2018;7:371-4.