Hematological Indices of Pregnant Sudanese Woman Attended Wad Medani Health Care Centers in Gezira State, Sudan

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Hematological Indices of Pregnant Sudanese Woman Attended Wad Medani Health Care Centers in Gezira State, Sudan

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ABSTRACT

Objectives: The study aimed to determine the overall mean value of selected hematological parameters at different trimesters of pregnancy.

Methods: Observational cross-sectional case control study involved 321 healthy pregnant women attending for ANC at secondary health care centers in Wad Medani, Gezira State, Sudan in the period between Feb. to Jul. 2016. They were divided into their first (n= 89), second (n= 173), and third (n= 59) trimester of pregnancy, and 29 healthy non-pregnant women as control. A full blood count was performed on each sample using automated hematology analyzer.

Results: The pregnant and non-pregnant women mean age was 26.34±6.51 years (range 14-53 years), their weight range between 40-93 kg. A significant decrease in RBC count (p = 0.002), Hb concentration (p = 0.01), PCV (p = 0.000), platelet counts (p = 0.000) and TIBC (p = 0.04), and a remarkable increase in WBC count (p = 0.03) and MCHC (p = 0.02) in pregnant compared with non-pregnant women. RBC (p = 0.02), PLT (p = 0.01), lymphocytes (p = 0.00) and Iron (p = 0.01) were significantly decreased along the different trimesters of pregnancy, respectively. On the other hand, WBC (p = 0.00), MCV (p = 0.01), MCH (p = 0.01), MCHC (p = 0.03) and Neutrophils (p = 0.00) were significantly increased. The different trimesters of pregnancy correlated positively with WBCs and Neutrophils (r = 0.26 and 0.32, respectively), and negatively with lymphocytes (r = -0.31).

Conclusions: The alteration of the hematological parameters at different trimesters of pregnancy necessitate the monitoring of these parameters during pregnancy. The significant decrease of Hb concentration and serum iron level suggest iron therapy for all women.

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This study aimed to evaluate trimester pattern of change by determining the mean value of fourteen hematological parameters (WBC, RBC, Hb, packed cell volume [PCV], Hb, mean cell volume [MCV], mean corpuscular hemoglobin [MCH], mean corpuscular hemoglobin concentration [MCHC], PLTs, neutrophils [NEUT], lymphocytes [LYMPH], MIXED, iron, ferritin and total ion binding capacity [TIBC]) at different trimesters of pregnancy in women referred to the secondary care centers in Gezira state, Sudan.

2. Methodology

2.1. Patients and methods

This was an observational cross-sectional case-control study encompassed 321 women, their mean age 25.49±5.61 years (range 15-50 years), who referred to three major and central localized secondary health care centers (Abusonon, Shuheed Alzubair, and Bannat) in Wad Medani City, Gezira state Sudan, and 29 non-pregnant age-matched women as controls. Gezira state is one of the most agricultural states in Sudan. It lies between the Blue Nile and the White Nile rivers. It locates in the rich savanna region between latitude 13°-15.2° N and longitude 32.5°-34° E. Wad Medani was considered the largest city and the capital of the state. This study was carried out during the period from Feb. to Jul. 2016. Ethical approval was obtained from the research and ethical committee of the Federal Ministry of Health, at Gezira state. Informed consent was obtained from all the participants. Relevant personal, social, demographic, and stage of pregnancy information were obtained through designed questionnaire to suit the study. Based on the history and clinical examination, pregnant women with hypertension, splenomegaly, HIV positive, HBV positive, bleeding disorders, anemia, and on treatment with non-steroidal anti-inflammatory drugs (NSAIDS) were excluded from the study.

2.2. Hematological measurements

Following an overnight fast, 3.0 mL of venous blood was collected from each of the 350 consented women and dispensed into an ethylene diamine tetra-acetic acid (EDTA) anticoagulant bottle, which was labeled and stored at room temperature (RT) until analyzed within 5 h of collection, using an automated hematology analyzer by Sysmex (Kobe, Japan). The Susmex autoanalyzer able to test 19 parameters per sample including Hemoglobin (Hb) concentration, white cell count (WBC, Platelets count), MCH, MCV, MCHC, absolute neutrophil count (ANC), absolute lymphocyte count (ALC), and mixed count were estimated. Standardization, calibration of the instrument, and processing of the samples were done according to the manufacturer’s instructions. The analyzer generated a print of the results within around 30 seconds. Total iron binding capacity (TIBC) was calculated as the arithmetic sum of serum iron concentration and unsaturated iron binding capacity (UIBC); percent transferrin saturation was calculated as the ratio of serum iron and TIBC expressed as a percentage.

2.3. Statistical analysis

Data were analyzed using SPSS (NY, USA) version 20. The descriptive data was presented herein as means ± standard deviation (SD) or percentage. Student t-test had been used to compare the different variables between the pregnant and non-pregnant groups. One-way analysis of variance (ANOVA) were used to determine the statistical differences in the values of each hematological parameter at the different trimesters of pregnancy. Correlation analysis had been done between the different parameters (the independent variables) and different trimesters (the dependent variable). The P value less than 0.05 was considered statistically significant.

3. Results

A total number of 350 women were studied, their mean age was 26.34±6.51 years (range 14-53 years), 321 (91.7%) pregnant and 29 (8.3%) non-pregnant women, their weight range between 40-93 kg. To compare between the pregnant and non-pregnant groups in terms of employment, 308 (96.0%) and 20 (69%) were housewives, and 12 (3.7%) and 9 (31.0%) were employed, and the majority 319 (99.4%) and 26 (89.7%) their age between 14-43 years old, respectively. Most of the pregnant women 173 (53.9%) were in their second trimester at the time of the study, followed by 89 (27.7 %) in their first trimester and 59 (18.4 %) in their third trimester, Table 1. There was a statistically significant decrease in RBC (p= 0.002), Hb concentration (p = 0.01), PCV (p= 0.00), platelet counts (p=0.00) and TIBC (p= 0.04) in pregnant women as compared with non-pregnant women. On the other hand, there was statistically significant increase in WBC count (p= 0.03) and MCHC (p= 0.02) in pregnant women compared with non-pregnant controls, Table 2.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Pregnant</th>
<th>Non-Pregnant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (range)</td>
<td>25.49±5.61</td>
<td>26.72±4.25</td>
</tr>
<tr>
<td>Age group (years)</td>
<td>14-23</td>
<td>132 (41.1)</td>
</tr>
<tr>
<td></td>
<td>24-33</td>
<td>158 (49.2)</td>
</tr>
<tr>
<td></td>
<td>34-43</td>
<td>29 (9.1)</td>
</tr>
<tr>
<td></td>
<td>44-53</td>
<td>2 (0.6)</td>
</tr>
<tr>
<td>Total</td>
<td>321 (100)</td>
<td>29 (100)</td>
</tr>
<tr>
<td>Weight group (kg)</td>
<td>40-49</td>
<td>33 (10.3)</td>
</tr>
<tr>
<td></td>
<td>50-59</td>
<td>86 (26.8)</td>
</tr>
<tr>
<td></td>
<td>60-69</td>
<td>122 (38.0)</td>
</tr>
<tr>
<td></td>
<td>70-79</td>
<td>69 (21.5)</td>
</tr>
<tr>
<td></td>
<td>80 and above</td>
<td>11 (3.4)</td>
</tr>
<tr>
<td>Total</td>
<td>321 (100)</td>
<td>29 (100)</td>
</tr>
<tr>
<td>Trimester</td>
<td>1st</td>
<td>89 (27.7)</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>173 (53.9)</td>
</tr>
<tr>
<td></td>
<td>3rd</td>
<td>59 (18.4)</td>
</tr>
<tr>
<td>Total</td>
<td>321 (100)</td>
<td></td>
</tr>
</tbody>
</table>

A significant increase in WBC (p= 0.00), MCV (p= 0.01), MCH (p= 0.01), MCHC (p= 0.03), and NEUT (p= 0.00). On the other hand, a significant decrease in RBC (p= 0.02), PLT (p= 0.01), LYMPH (p= 0.00), and Iron (p= 0.01) was found in the different trimesters of pregnancy, Table 3.

The different trimesters of pregnancy correlated positively with WBCs count and NEUT (r = 0.26 and 0.32, respectively), and negatively with LYMPH (r = -0.31). As shown in figure 1, the weight of the pregnant woman increases with the increase in the number of pregnancy, although, the correlation coefficient for the two parameters was not very high (r² = 0.1149).
**Table 2** Hematological parameters of pregnant and non-pregnant women

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Non-pregnant (control) (n= 29)</th>
<th>Pregnanat (n= 321)</th>
<th>Mean ± SD</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBC (x10^9/L)</td>
<td>6.30 ± 1.46</td>
<td>6.96 ± 1.77**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RBCs (x10^6/µL)</td>
<td>4.41 ± 0.55**</td>
<td>4.06 ± 0.48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hb (g/dL)</td>
<td>11.72 ± 0.85**</td>
<td>11.24 ± 1.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCV (%)</td>
<td>36.03 ± 2.90**</td>
<td>33.47 ± 3.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCV (fl)</td>
<td>83.32 ± 6.91</td>
<td>82.77 ± 6.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCH (pg)</td>
<td>28.50 ± 3.11</td>
<td>28.17 ± 3.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCHC (g/dL)</td>
<td>33.21 ± 1.51</td>
<td>33.93 ± 1.54*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLT (x10^9/L)</td>
<td>268.90 ± 73.21**</td>
<td>213.26 ± 67.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCV (fl)</td>
<td>57.97 ± 9.18</td>
<td>60.98 ± 5.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCV (%</td>
<td>42.10 ± 5.19</td>
<td>37.77 ± 8.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MIXED (%)</td>
<td>1.55 ± 0.83</td>
<td>1.36 ± 0.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRON</td>
<td>89.86 ± 32.89</td>
<td>95.44 ± 38.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FER</td>
<td>48.34 ± 52.42</td>
<td>57.54 ± 58.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIBC</td>
<td>464.03 ± 115.74*</td>
<td>416.15 ± 107.23</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*= P < 0.05; **= P < 0.01; WBC= white blood cells, RBC=red blood cells, Hb= hemoglobin, PCV= packed cell volume, MCV= mean cell volume, MCH= mean corpuscular hemoglobin, MCHC= mean corpuscular hemoglobin concentration, PLT= platelet, NEUT= neutrophils, LYMHPH= lymphocytes, FER= ferritin, TIBC= total iron binding capacity.

In Sudan, two studies in Khartoum state based on few numbers of cases or hematological parameters in normal pregnant women [3, 10], or in the trimester of pregnancy [11], however, comparable reports in Gezira state among normal pregnant Sudanese women are lacking. This study showed significant fall in RBC, Hb, PCV, PLT and TIBC in pregnancy women compared with the control. On the other hand, highly significance increase in WBC and MCHC of pregnant women compared with non-pregnant women. Similar results were demonstrated in Sudan by Elgari [3], who found that, RBC, Hb and PCV were significantly reduced among pregnant women, and some of our results were similar to a study undertaken by Lybiaby Azab et al. [4], who reported significance decrease in Hb, RBC and blood platelets.

Despite the significant decrease in Hb levels among pregnant women compared to the control group, the result of Hb levels showed no significant difference between the different trimester of pregnancy. The reason behind that discrepancy was that, the drop-in hemoglobin was typically by 1–2 g/dL in the late second trimester and stabilizes thereafter in the third trimester, and this change is less pronounced when iron supplementation was taken [12]. The result was consistent with previous study [2, 11], and contrary with other studies indicated significant decline in Hb during stages of pregnancy [4, 6, 13].

In this study, we found remarkable decrease in RBC, PLT counts, lymphocytes and serum iron from the first to third trimester. The progressive decline in RBC and serum iron was most likely due to lack of supplementation, since, earlier report stated the increase in RBC mass to approximately 30% between the second and third trimesters when iron and folate were supplemented [14].

A remarkable reduction in PLT counts as pregnancy advanced marker was consistent with previous studies [4, 5, 15]. It had been stated earlier that PLT counts may decrease to approximately 10% in normal pregnancies, that decrease may occurred during the third trimester of pregnancy [16], that decrease was thought to be due to dilution effects and accelerated destruction of PLT passing over the often scarred and damaged trophoblast surface of the placenta [17]. The significant decrease in lymphocytes % in this study, was indicated before [4, 18], and contrary with previous report indicates mild elevation in leucocyte during trimesters [5].

![Fig. 1](image)

Weight (kg)

No. of pregnancy

**Fig. 1** Correlation between weight and no. of pregnancy.

**4. Discussion**

During pregnancy, significant hematological and metabolic changes mostly related to hormonal utero placental changes.

**Table 3** Values of hematological parameters between trimester in pregnant women

<table>
<thead>
<tr>
<th>Parameters</th>
<th>1st trimester (n= 117)</th>
<th>U.L.</th>
<th>L.L.</th>
<th>2nd trimester (n= 152)</th>
<th>U.L.</th>
<th>L.L.</th>
<th>3rd trimester (n= 52)</th>
<th>U.L.</th>
<th>L.L.</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBC (x10^9/L)</td>
<td>6.46 ± 1.27</td>
<td>3.8</td>
<td>8.6</td>
<td>6.93 ± 1.83</td>
<td>4.3</td>
<td>9.5</td>
<td>7.85 ± 1.91</td>
<td>5.0</td>
<td>10.2</td>
<td>0.00</td>
</tr>
<tr>
<td>RBCs (x10^6/µL)</td>
<td>4.18 ± 0.56</td>
<td>3.1</td>
<td>5.25</td>
<td>4.02 ± 0.44</td>
<td>3.1</td>
<td>4.7</td>
<td>4.01 ± 0.47</td>
<td>3.1</td>
<td>4.9</td>
<td>0.02</td>
</tr>
<tr>
<td>Hb (g/dL)</td>
<td>11.24 ± 1.27</td>
<td>8.5</td>
<td>13.7</td>
<td>11.17 ± 1.27</td>
<td>8.7</td>
<td>13.9</td>
<td>11.44 ± 1.30</td>
<td>8.7</td>
<td>13.9</td>
<td>0.39</td>
</tr>
<tr>
<td>PCV (%)</td>
<td>33.79 ± 3.22</td>
<td>27</td>
<td>39.8</td>
<td>33.19 ± 3.37</td>
<td>26.5</td>
<td>40.3</td>
<td>33.84 ± 3.61</td>
<td>26.4</td>
<td>40.8</td>
<td>0.27</td>
</tr>
<tr>
<td>MCV (fl)</td>
<td>81.49 ± 7.47</td>
<td>66.1</td>
<td>95.3</td>
<td>82.84 ± 5.24</td>
<td>73.3</td>
<td>95.1</td>
<td>84.63 ± 6.46</td>
<td>72.3</td>
<td>94.1</td>
<td>0.01</td>
</tr>
<tr>
<td>MCH (pg)</td>
<td>27.52 ± 3.45</td>
<td>20.2</td>
<td>34.2</td>
<td>28.19 ± 2.80</td>
<td>23.6</td>
<td>34.3</td>
<td>28.07 ± 3.13</td>
<td>22.8</td>
<td>34.2</td>
<td>0.01</td>
</tr>
<tr>
<td>MCHC (g/dL)</td>
<td>33.61 ± 1.66</td>
<td>29.9</td>
<td>37.1</td>
<td>33.98 ± 1.49</td>
<td>31.8</td>
<td>36.6</td>
<td>34.26 ± 1.42</td>
<td>31.2</td>
<td>37.0</td>
<td>0.03</td>
</tr>
<tr>
<td>PLT (x10^9/L)</td>
<td>226.78 ± 84.69</td>
<td>66</td>
<td>388</td>
<td>213.52 ± 55.84</td>
<td>101.5</td>
<td>315.9</td>
<td>193.85 ± 61.25</td>
<td>65.4</td>
<td>325.8</td>
<td>0.01</td>
</tr>
<tr>
<td>NEUT (%)</td>
<td>56.75 ± 9.28</td>
<td>40.3</td>
<td>74.3</td>
<td>62.01 ± 7.97</td>
<td>46</td>
<td>79.6</td>
<td>64.39 ± 5.81</td>
<td>54.1</td>
<td>74.1</td>
<td>0.00</td>
</tr>
<tr>
<td>LYMPH (%)</td>
<td>41.93 ± 9.22</td>
<td>24.4</td>
<td>58.4</td>
<td>36.81 ± 8.25</td>
<td>18.6</td>
<td>53.4</td>
<td>34.29 ± 5.79</td>
<td>24.2</td>
<td>45</td>
<td>0.00</td>
</tr>
<tr>
<td>MIXED (%)</td>
<td>1.33 ± 0.96</td>
<td>-1.7</td>
<td>4.3</td>
<td>1.37 ± 0.87</td>
<td>10</td>
<td>16</td>
<td>1.37 ± 0.87</td>
<td>-1.4</td>
<td>4.2</td>
<td>0.92</td>
</tr>
<tr>
<td>IRON (µg/dL)</td>
<td>106.35 ± 40.55</td>
<td>23</td>
<td>179.4</td>
<td>90.22 ± 34.85</td>
<td>16.8</td>
<td>170.4</td>
<td>94.19 ± 42.34</td>
<td>13.2</td>
<td>160.8</td>
<td>0.01</td>
</tr>
<tr>
<td>FER (mg/dL)</td>
<td>61.62 ± 53.11</td>
<td>31.7</td>
<td>58.3</td>
<td>43.58 ± 60.59</td>
<td>37.6</td>
<td>46.8</td>
<td>48.81 ± 58.95</td>
<td>26.5</td>
<td>35.3</td>
<td>0.41</td>
</tr>
<tr>
<td>TIBC (µg/dL)</td>
<td>422.74 ± 92.86</td>
<td>231.3</td>
<td>616.5</td>
<td>405.49 ± 109.59</td>
<td>184.6</td>
<td>617.8</td>
<td>440.32 ± 114.89</td>
<td>202.3</td>
<td>686.7</td>
<td>0.09</td>
</tr>
</tbody>
</table>

U.L.= upper limit, L.L.= lower limit, WBC= white blood cells, RBC=red blood cells, Hb= hemoglobin, PCV= packed cell volume, MCV= mean cell volume, MCH= mean corpuscular hemoglobin, MCHC= mean corpuscular hemoglobin concentration, PLT= platelet, NEUT= neutrophils, LYMPH= lymphocytes, FER= ferritin, TIBC= total iron binding capacity.
Our study reported a statistically significant increase in the WBC, MCV, MCH, MCHC and NEUT from the first to third trimesters. The result of the remarkable high WBC count was in agreement with previous studies found a significant arising in the total leucocyte count during the states of pregnancy, which was primarily relevant to increased neutrophils in blood circulation as a response to physiological stress induced by the pregnant state [2, 3, 5, 8]. Our study agreed with Ifeanyi et al. [19], who reported significant high levels of MCV, MCH, MCHC in the different stages of pregnancy. Other studies showed a decrease in MCV, MCH and MCHC [4, 7], or no differences in trimesters [5, 6, 20].

The different trimesters of pregnancy correlated positively with WBCs count and NEUT, and negatively with LYMPH. This result consistent with the recent result reported by Li et al. [21]. Our results seem comparable with data in the literature; nevertheless, the discrepancy in the literature results indicates the interplay between the physiological, the environmental, and the socio-economic factors.

5. Conclusion

In summary, we emphasized the alteration of the hematological parameters at different trimesters of pregnancy, which necessitates the routine monitoring at least once every trimester. The significant decrease of Hb concentration and serum iron level suggest iron therapy for all women. The limitation in the sample size, the centers selected, the hematological parameters, and the restricted area of study require further studies to support our result outcome.

Informed consent and ethical approval. A written consent after describing the study objectives and its possible outcomes was attained. Ethical clearance from the ethical committee was granted.

Author contribution. AAA received and designed the study; AAA and HMH collected and analyzed the data with an input from KEK and AEH; AAA and HMH wrote the initial draft of the manuscript; KEK and AEH critically revised the draft.

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