Hematological parameters of healthy pregnant women in three trimesters compared with parameters of non-pregnant women

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Anemia is a public health problem, especially in developing countries. All over the world iron deficiency is the main cause of anemia, especially during pregnancy. Pregnant women belong to the most vulnerable population group in Iraq.

The objective: to determine the impact of pregnancy on hematological parameters and to compare the hematological indicators in different periods of gestation with the indicators of non-pregnant women.

Materials and methods. The study was conducted over a three-month period at Baghdad hospitals and medical centers, including Baghdad Teaching Hospital, Al-Karam Hospital, and a health center in Al-Dorrah and Al-Shaab, Baghdad province, from September 1 to December 1, 2022. 60 pregnant women, 20 persons in each trimester, and 25 non-pregnant women (control) aged 18–35 years were included in the study. All participants were examined for hematological parameters: hemoglobin, erythrocytes, packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), measured of the concentration of hemoglobin in red blood cells (MCHC) and determined the level of iron in the blood (serum iron – SI, total iron binding capacity – TIBC, transferrin saturation – TS and serum ferritin – SF).

Results. A significant decrease in the hematological indicators of pregnant women in the first trimester of pregnancy compared to non-pregnant women was established – hemoglobin, erythrocytes, PCV, MCH, MCHC. The dynamics of the decrease in the level of these parameters increases in the second trimester, and also progressively decreases in the third trimester, which leads to anemia.

Starting from the first trimester and during the second and third trimesters, a decrease in the level of serum iron, transferrin saturation and serum ferritin was found in pregnant women compared to non-pregnant women, but the level of TIBC increased. During the second trimester, the need for iron begins to increase and continues to growth until the end of pregnancy. In addition, these research results indicate the importance of iron deficiency in the development of iron deficiency anemia.

Conclusions. During pregnancy, anemia and a decrease in the level of some hematological parameters were determined, which progresses with increasing gestational age and is less compared to that in non-pregnant women. A decrease in the level of iron in the blood serum was established from the first to the third trimester of pregnancy. The severity of anemia is related to many factors, especially age, education level, low income, type of diet and parity.

Keywords: three trimesters, pregnancy, anemia, hematology.
This work was completed in the Baghdad province for three months, including many Baghdad hospitals and health centers, including Baghdad teaching hospital, Al-Karama hospital and a health center in Al-Dorra and Al-Shaab during 1st September until 1 December 2022 in this research 60 pregnant women (20 in each trimester) between the ages of (18–35) years was selected from antenatal clinic. 25 non-pregnant age matched women used as control.

Included questionnaire for each pregnant: age, the date of the last menstrual period. It has been excluded from this study who had vaginal bleeding in the current pregnancy, diabetes mellitus, hemolytic disease, chronic hematological diseases and infected with the pressure, cardiac or liver diseases.

5 ml of venous blood was collected from each pregnant (in the first trimester blood was collected in the sixth week, the second trimester in the nineteenth week and third trimester the thirty-fifth week) and nonpregnant women (control), under aseptic condition and were divided blood into two parts contain per part 2.5 ml.

The first part of the blood is placed in a tube containing an anticoagulant substance (EDTA), and the second part is taken for blood tests. The second part of the blood is placed in a tube that does not contain an anticoagulant, then placed in a centrifuge at a speed of 3000 rpm to obtain serum, serum is stored at -20c, and biochemical tests are performed.

Measurement of the biochemical tests such as: the level of serum iron (SI) estimated by method of E. Burtis and E. Ashwood,1994 [8]. The reference value of SI in female 9–30.4 M mol/Ls measurement of Transferrin saturation (Ts) and total iron binding capacity (TIBC) by method of A. Gowenlock et al., 1988 [9]. Normal value of TIBC (44.5–73.5 M mol) and Ts (15–25%). The level of serum ferritin by P. Aisen,1990 [10] Normal value in women (20–200 ng/ml).

Statistical Analysis System SAS (2012), according to [11], used analysis of variance one way (ANOVA) to measure the effect of groups in study parameters, and the least significant difference (LSD) test was used to compare means in this study.

RESULTS AND DISCUSSION

Table 1 shows the hematological parameters according to the three trimesters of pregnancy and control (non-pregnant). Hemoglobin value in first trimester was (10.87±0.78) g/dl. Second trimester (9.90±0.66) g/dl and third trimester was (9.64±0.33) g/dl that decreased significantly (P<0.01) in comparison with the control (12.79±1.68) g/dl. On the other hand, Hematocrit (PCV%) was highly significant decreased (P<0.01) in 1st trimester (33.71±3.63)%, 2nd trimester (31.69±2.21) and third trimester (31.52±3.56)% compared with control (39.12±5.61)%.

The current study’s findings agreed with those recorded by C. Breymann et al., 2017 who discovered the decrease in the Hb, hematocrit and RBC count, presumably because of hem dilution of plasma effect [12]. The increased volume of plasma is primarily due to a hormonal effect, as both aldosterone and estrogen, which have been
greatly increased during pregnancy, cause enhanced fluid retention by the kidney. Furthermore, the bone marrow becomes more active and produces more red blood cells to compensate for the increased fluid volume.

As a result, at the time of the body’s birth, the mother’s circulatory system contains 1 to 2 liters of extra blood [13]. Many hormonal changes occur during pregnancy to ensure adequate blood flow from the maternal to the fetal unit [14]. Because of plasma volume expansion, hemoglobin concentrations may fall by 5 g/L during pregnancy [15].

The World Health Organization presently suggests Hb cutoffs, which vary depending on the trimester of pregnancy and should be defined as follows: <110 g/L in the first trimester, <105 g/L in the second trimester, and <110 g/L in the third trimester [16]. Hemoglobin and body mass index (BMI) are positively correlated; ethnicity influences hemoglobinopathy traits; and socioeconomic hardship is more likely to be associated with inadequate nutrition and/or co-occurring chronic illness, both of which are anemia risk factors [17].

The most important cause of hemoglobin lowering in pregnant females is relative hemodilution due to plasma expansion by 30–50% [18]. Iron deficiency, in addition to plasma expansion, can play a significant role in lowering hemoglobin concentrations, making them more likely to develop anemia [3].

Table 1 shows RBC has a highly significant different (P<0.01) were found decrease in the mean value of RBC in first, second and third trimesters (3.43±0.36, 3.14±0.52 and 3.12±0.35) 10⁶/mm³ respectively compared with value of control (3.90±0.65) 10⁶/mm³. These findings corroborate previous research., which found that a physiological decrease in Hb concentration occurs due to hemodilution and an assumed decrease in erythrocyte life span and result from increased plasma volume combined with inadequate iron intake [19] [2]. But, WBC count increased this could be due to the fetus’s body developing immunity [2].

Table 2 Shows a highly significant, increase (P<0.01) in SI, TS and SF of three trimesters compared with control (non-pregnant).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>1st Trimester</th>
<th>2nd Trimester</th>
<th>3rd Trimester</th>
<th>Control</th>
<th>LSD value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hb (g/dl)</td>
<td>10.87±0.78b</td>
<td>9.90±0.66b</td>
<td>9.64±0.33b</td>
<td>12.79±1.68a</td>
<td>1.51**</td>
</tr>
<tr>
<td>RBC (10⁹/MM³)</td>
<td>3.43±0.36b</td>
<td>3.14±0.52b</td>
<td>3.12±0.35b</td>
<td>5.90±0.65a</td>
<td>0.50**</td>
</tr>
<tr>
<td>PCV %</td>
<td>33.71±3.63b</td>
<td>31.69±2.21b</td>
<td>31.52±3.56b</td>
<td>39.12±5.61a</td>
<td>3.52**</td>
</tr>
<tr>
<td>MCV (fl)</td>
<td>84.95±4.82b</td>
<td>83.75±4.33c</td>
<td>83.17±5.11c</td>
<td>87.25±4.73a</td>
<td>1.15*</td>
</tr>
<tr>
<td>MCH (Pg)</td>
<td>31.69±4.55b</td>
<td>31.53±3.87c</td>
<td>30.90±3.21c</td>
<td>32.80±4.45a</td>
<td>1.10*</td>
</tr>
<tr>
<td>MCHC (g/dl)</td>
<td>32.25±4.11b</td>
<td>31.24±4.34c</td>
<td>30.58±2.41d</td>
<td>32.77±4.45a</td>
<td>0.50*</td>
</tr>
<tr>
<td>Parameters</td>
<td>1st Trimester</td>
<td>2nd Trimester</td>
<td>3rd Trimester</td>
<td>Control</td>
<td>LSD value</td>
</tr>
<tr>
<td>Serum iron(Si) µmol/L</td>
<td>8.18±0.88b</td>
<td>8.68±1.54a</td>
<td>7.87±0.32c</td>
<td>13.25±1.14a</td>
<td>0.52**</td>
</tr>
<tr>
<td>TIBC (µmol/L)</td>
<td>86.15±6.12c</td>
<td>82.34±7.81c</td>
<td>94.42±4.56e</td>
<td>76.34±6.67a</td>
<td>3.71**</td>
</tr>
<tr>
<td>Transferrin saturation(TS%)</td>
<td>10.15±0.88b</td>
<td>10.69±1.34a</td>
<td>8.96±1.32c</td>
<td>17.89±1.55a</td>
<td>1.12**</td>
</tr>
<tr>
<td>Serum ferritin (Sf) ng/ml</td>
<td>18.33±1.18b</td>
<td>13.18±1.37c</td>
<td>12.68±1.35c</td>
<td>34.38±2.88a</td>
<td>5.11**</td>
</tr>
</tbody>
</table>

Notes: all results are presented as mean± SE value; * – significant at (P<0.05); ** – significant at (P<0.01); mean having different small letter in horizontal raw are significant.
Iron deficiency anemia during pregnancy is a very common and preventable problem due to the expansion of plasma volume without the normal expansion of maternal hemoglobin mass [22]. Ferritin is the most often used index since it is essential to ascertain the body's iron status throughout pregnancy and the most useful and accurate screening test for iron buildup during pregnancy is serum ferritin (SF), which has been advised as the screening test [23].

Because of the increased iron consumption in the maternal red blood cell mass, SF concentration began to decrease between 12 and 24 weeks of pregnancy [24]. This is consistent with the findings of our research. The obvious drop in the TS with iron, as well as the small size of the RBC, all indicate a lack of iron [23].

These results are in line with those of [26]. In Nigeria, who demonstrated that the SI was lower in the first trimester than the second. Moreover, Additionally, demonstrated a decrease in the SI, SF, and SF highly significant (P < 0.01) in the third trimester compared to the control group, which is similar with the findings of our study. However, according to [27], the average iron intake was less than 60%, suggesting that rather than food hardship or disease, the significant prevalence of anemia was most likely caused by inadequate iron intake and poor dietary practices.

The causes of maternal anemia during pregnancy should therefore be further investigated. Additionally, Al-Mehaisen noted a prevalence of anemia of 49.4% in the third trimester in Jordan, which may have been brought on by the period’s increased need for micronutrients in the setting of unhealthful eating practices. It is generally known that throughout the second and third trimesters of pregnancy, maternal iron reserves decrease[28]. The majority of iron transfer from mother to fetus happens at this time, which coincides to the maximal efficiency of maternal iron absorption [18].

**CONCLUSIONS**

The results of the study showed a strong effect of pregnancy on the pregnant woman, as anemia increased throughout the rest of the blood analyzes, compared to non-pregnant women, and this was accompanied by a decrease in the status of iron in the serum from the first trimester until the third trimester. Severity of anemia is related to many factors especially age, educational level, low income, nutrients, and parity.

**Recommendation**

All pregnant women should receive an intervention to increase their intake of iron-rich foods and iron supplements. More research is needed because anemia during pregnancy is a serious condition that increases morbidity and motility.

**REFERENCES**

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