Occurrence of Iron Deficiency Anemia among Pregnant Women in Bashair Hospital, Khartoum State

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A Dissertation
Submitted to University of Gezira in Fulfillment of The partial Requirements for the Award of the Degree of Master of Science in Hematology

Department of Hematology

Faculty of Medical Laboratory Sciences

University of Gezira

2015
Occurrence of Iron Deficiency Aneamia among pregnant
Women in Bashair Teaching Hospital, Khartoum State.

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Date of Examination 30 / 4 / 2015
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Date of Examination 30 / 4 / 2015
(لَقَدْ أَرْسَلْنَا رُسُلَنَا بِالْبِيْنَاتِ وَأَنزِلْنَا مَعْهُمُ الْكِتَابَ وَالْمِيزَانَ لِيَقُومَ النَّاسُ بِالْقِسْطِ وَأَنزِلْنَا الْحَدِيدَ)
فيهِ بَأْسٌ شَدِيدٌ وَمَنَافِعُ لِلنَّاسِ وَلِيَعْلَمَ اْللهُ مِن يُنصُرُهُ وَلِيَعْلَمَ اْللهُ بَأْسَ الْعَذَابِ أَنَّ اْللهَ قُوٍّ عَزِيزٌ
(ال الحديد: آية 25)
Dedication

To
My Parents.
To
My husband
To
My brothers.
To
My sisters.
And
to Sudanese pregnant women
Acknowledgements

First, all thanks of ALLAH for giving me the power and – willing to complete this study.

I would like to our supervisor of this project professor Babiker Ahmed Mohammed for the valuable guidance and advice. He inspired us greatly to work in this project. Also my thanks to hematology lab at Bashair Hospital for their great help. I am deeply indebted and grateful to all who contributed to this work.
Iron Deficiency Anemia
(2014-2015)
M.Sc. in Hematology
Ibtihal Hamad Mohammed Hamad

Abstract

Anemia is often due to iron deficiency which is caused by insufficient dietary intake or poor absorption of iron to replace losses. Iron deficiency anemia has a negative impact on physical work capacity, cognitive performance and resistance to infection. The research studied the Iron Deficiency Anemia among Sudanese women which is considered as a severe health problem according to World Health Organization (WHO). IDA is defined as a decrease amount of Hemoglobin to less than 11 gm/dl in 1st or 3rd trimester, or less than 10.5 gm/dl in the 2nd trimester, so the laboratory test is based on CBC (Cell Blood Counting). So a group of 48 pregnant women were studied for iron deficiency anemia at Bushier Teaching Hospital, Khartoum State. Their age range was between 20 and 40 years old. Tests performed were CBC and iron profile. It was found that 33 (68.75%) have iron deficiency anemia and increased TIBC while 15 (31.25%) are not affected.
حدوث فقر الدم الناتج عن نقص الحديد وسط الحوامل

ماجستير أمراض الدم

٢٠١٤

إبتهال حمد محمد حمد

ملخص

إنما نقص الحديد يحدث نتيجة لعدم أخذ الجسم كفايته من الحديد نتيجة لعدة أسباب منها عدم توفير الأغذية التي تحتوي عنصر الحديد. إنما نقص الحديد ذات أثر سلبي على الأفراد من ناحية الصحة والنتاج. يتناول هذا البحث دراسة حالات فقر الدم الناجم عن نقص الحديد لدى النساء الحوامل بالسودان، والذي صنفته منظمة الصحة العالمية (WHO) من المشاكل الصحية بالغة الأهمية بالسودان. يعتبر الحديد من العناصر الهامة التي لا غنى لجسم الإنسان عنها، ويكسب عنصر الحديد هذه الأهمية نسبة لدوره الفعال في العديد من الوظائف الحيوية، لاسيما دخوله في تكوين مادة الهيموغلوبين. والهيموغلوبين هو عبارة عن مادة موجودة في كريات الدم الحمراء، والتي تعطى الدم لونه الأحمر أو ما يسمى (هيم)، ونسبة لذلك يعتبر الحفاظ على المستوي السليم لعنصر الحديد كمكمزARDS للهيموغلوبين داخل الجسم أمر ضروري للغاية. يدعم صحة الإنسان في تجاوز وظائف الأعضاء، ويساعد في الحفاظ على قوة مناعة الجسم الطبيعية. يعرف فقر الدم "الأنيميا" أثناء الحمل على أنه هبوط في تركيز الهيموغلوبين لأقل من 11 غ/ديسيلتير في الثلاثين أو الثلاث من الحمل، أو أن يكون تركيز الهيموغلوبين أقل من 5.5 غ/ديسيلتير في الثالثين من الحمل، ويتم التشخيص بإجراء تحليل الدم المعروف بـCBC. وقد قمت بدراسة مجموعية تتألف من ٤٦ امرأة حامل بمستشفى بシアر التعليمي بولاية الخرطوم، وكانت أعمارهن بين ٢٠ و ٤٠ عامًا. وخلصت نتائج الدراسة إلى أن ٣٣ من كامل العينة (7١.٣٪) لديهم أمميا نقص الحديد مع المؤشرات المنخفضة مصحوبة بزيادة معدلات Total Iron Binding (TIBC) في حين أن ١٣ من اجمالي العينة (٢٨.٦٪) أظهرت خلاًً من أعراض نقص الحديد مما يبين عدم تضررهم من فقر الدم. (الرجاء الرجوع إلى محتويات البحث للتفاصيل).
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<th>Description</th>
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<tr>
<td>B12</td>
<td>Vitamin B12</td>
</tr>
<tr>
<td>CBC</td>
<td>Complete blood count</td>
</tr>
<tr>
<td>DMT1</td>
<td>Divalent metal transporter 1</td>
</tr>
<tr>
<td>Dcytb</td>
<td>Duodenal cytochrome b</td>
</tr>
<tr>
<td>EDTA</td>
<td>Ethylenediaminetetraacetic acid</td>
</tr>
<tr>
<td>Hb</td>
<td>Hemoglobin</td>
</tr>
<tr>
<td>Hct</td>
<td>Hematocrit</td>
</tr>
<tr>
<td>FSC</td>
<td>Forward side scatter</td>
</tr>
<tr>
<td>IDA</td>
<td>Iron-deficiency</td>
</tr>
<tr>
<td>LCD</td>
<td>Liquid-crystal display</td>
</tr>
<tr>
<td>MCH</td>
<td>Mean cell hemoglobin</td>
</tr>
<tr>
<td>MCHC</td>
<td>Mean cell hemoglobin concentration</td>
</tr>
<tr>
<td>MCV</td>
<td>Mean cell volume</td>
</tr>
<tr>
<td>NSAIDs</td>
<td>Non steroidal anti-inflammatory drugs</td>
</tr>
<tr>
<td>PCV</td>
<td>Packed cell volume</td>
</tr>
<tr>
<td>Plt</td>
<td>Platelets</td>
</tr>
<tr>
<td>RBCs</td>
<td>Red blood cells</td>
</tr>
<tr>
<td>RDW</td>
<td>Red cell distribution width</td>
</tr>
<tr>
<td>SD</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>TIBC</td>
<td>Total iron-binding capacity</td>
</tr>
<tr>
<td>WBC</td>
<td>White blood cells</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
</tbody>
</table>
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**Table (4.1)**  Age Groups among affected women

**Table (4.2)**  Parameters of pregnant women

**Table (4.3)**  Iron profile among pregnant women

**Table (4.5)**  Relations between, MCV, WBC, Plt, serum iron, TIBC and serum ferritin among study group
Chapter One
**Introduction**

1.1 Aneamia

*Aneamia* is usually defined as a decrease in amount of red blood cells (RBCs) or the amount of hemoglobin in the blood. It can also be defined as a lowered ability of the blood to carry oxygen. When anemia comes on slowly the symptoms are often vague and may include: feeling tired, weakness, shortness of breath or a poor ability to exercise. Anemia that comes on quickly often has greater symptoms which may include: confusion, feeling like one is going to pass out, and an increased desire to drink fluids. There needs to be significant anemia before a person becomes noticeably pale. There may be additional symptoms depending on the underlying cause.

There are three main types of anemia, that due to blood loss, that due to decreased red blood cell production, and that due to increased red blood cell breakdown. Causes of blood loss include trauma and gastrointestinal bleeding among others. Causes of decreased production include iron deficiency, a lack of vitamin B12, thalassemia and a number of neoplasms of the bone marrow among others. Causes of increased breakdown include a number of genetic conditions such as sickle cell anemia, infections like malaria and some autoimmune diseases among others. It can also be classified based on the size of red blood cells and amount of hemoglobin in each cell. If the cells are small it is microcytic anemia, if they are large it is macrocytic anemia and if they are normal sized it is normocytic anemia. Diagnosis in men is based on a hemoglobin of less than 130 to 140 g/L (13 to 14 g/dL) while in women it must be less 120 to 130 g/L (12 to 13 g/dL).1,2 Further testing is then required to determine the cause.

Certain groups of individuals, such as pregnant women, benefit from the use of iron tablets for prevention. Dietary supplementation, without determining the specific cause, is not recommended. The use of blood transfusions is typically based on a person’s signs and Symptoms. In those without symptoms they are not recommended unless hemoglobin levels are less than 60 to 80 g/L (6 to 8 g/dL). These recommendations may also apply to some people with acute bleeding.1
Erythropoiesis-stimulating medications are only recommended in those with severe anemia.

Anemia is the most common disorder of the blood with it affecting about a quarter of people globally. Iron-deficiency anemia affects nearly 1 billion. It is more common in females than males among children, during pregnancy and in the elderly. Anemia increases costs of medical care and lowers a person's productivity through a decreased ability to work.²

1.2 Epidemiology of Aneamia

According to last World Health Organization (WHO) regional statistics in Sudan dated 2006, 47.78% of Sudanese pregnant women are affected by Iron Deficiency Anemia, and due to this rate WHO describe this health problem as severe case. WHO studied and collect data for sample size 150 pregnant women in each of the six states listed in (Table 1.1) below:

**Table (1.1) Prevalence of Anemia and haemoglobin concentration by State**

<table>
<thead>
<tr>
<th>Year</th>
<th>State</th>
<th>Sample size</th>
<th>Proportion (%) of population with haemoglobin below:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>1994 - 1995</td>
<td>S. Darfur</td>
<td>150</td>
<td>39.2</td>
</tr>
<tr>
<td></td>
<td>Gezira</td>
<td>150</td>
<td>55.6</td>
</tr>
<tr>
<td></td>
<td>Kassala</td>
<td>150</td>
<td>37.4</td>
</tr>
<tr>
<td></td>
<td>N. Kordofan</td>
<td>150</td>
<td>44.9</td>
</tr>
<tr>
<td></td>
<td>Red Sea</td>
<td>150</td>
<td>56.4</td>
</tr>
<tr>
<td></td>
<td>Nahr El Neil</td>
<td>150</td>
<td>53.1</td>
</tr>
</tbody>
</table>

Globally, Anaemia affects 1.62 billion people (95% CI: 1.50–1.74 billion), which corresponds to 24.8% of the population (95% CI: 22.9–26.7%). The highest prevalence is in preschool-age children (47.4%, 95% CI: 45.7–49.1), and the lowest prevalence is in men (12.7%, 95% CI: 8.6–16.9%). However, the population group
with the greatest number of individuals affected is non-pregnant women (468.4 million, 95% CI: 446.2–490.6). (Table 1.2)³

Table (1.2) Global anaemia prevalence and number of individuals affected

<table>
<thead>
<tr>
<th>Group</th>
<th>Prevalence of anaemia</th>
<th>Population affected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent</td>
<td>95% CI</td>
</tr>
<tr>
<td>Preschool-age children</td>
<td>47.4</td>
<td>45.7-49.1</td>
</tr>
<tr>
<td>School-age children</td>
<td>25.4</td>
<td>19.9-30.9</td>
</tr>
<tr>
<td>Pregnant women</td>
<td>41.8</td>
<td>39.9-43.8</td>
</tr>
<tr>
<td>Non-pregnant women</td>
<td>30.2</td>
<td>28.7-31.6</td>
</tr>
<tr>
<td>Men</td>
<td>12.7</td>
<td>8.6-16.9</td>
</tr>
<tr>
<td>Elderly</td>
<td>23.9</td>
<td>18.3-29.4</td>
</tr>
<tr>
<td>Total population</td>
<td>24.8</td>
<td>22.9-26.7</td>
</tr>
</tbody>
</table>

Despite of international efforts from governmental and non-governmental agencies, the prevalence of anemia is still the same in developing world. The main reason of this static figure is the difficulties associated with prophylactic therapy.

Even today, around six hundred thousand women die each year in pregnancy and child-birth, basically in developing countries. Out of which, around eight to 16 percent deaths occur mainly due to ADI anemia. The disease contributes significantly to total maternal mortality from hemorrhage, Infection, abortion, obstructed labor and eclampsia⁴.

In most of the developing countries repeated pregnancies in very short internals and poor diet plans are major causative agents of anemia and maternal death during pregnancy.
Health experts suggest that blood iron level of women of child-bearing age should be regularly monitored and special precaution measures should be taken once she is found to be pregnant. Proper nutritional care is necessary to overcome this problem and save the life of thousands of women who die due to anemia while giving birth to her child.

11 Rationale

About 44 percent of pregnant women are anemic. The most common cause of anemia is iron deficiency, which is associated with 115,000 maternal deaths.\(^5\)

Very few countries have so far taken nation-scale action to eliminate iron deficiency anemia. Much effort is required to overcome such a problem. There are many thousands scientific researches, papers, thesis, and dissertations that studied Iron Deficiency Anemia. Farah, Asma Mohammed Zeyada – two M.Sc. students from University of Sudan for Science and Technology – issued cross-sectional descriptive and analytical study, aimed to investigate status of Iron deficiency anemia among Sudanese pregnant women. The study was carried out during the period (29 March 2012-10 May 2012) at Khartoum Teaching Hospital.\(^1\)

1.3 Objectives

General objective:

To determine Occurrence of iron deficiency anemia among pregnant women attending at Bashayer Hospital, Khartoum state during the period from June to September 2014.

Specific objectives:

- To determine Hb, PCV, red cell counts,
- To determine the iron profile in the study group.
- To determine the thin blood film in the study group.

\(^1\) M.Sc. thesis published on January 1st 2012, University of Sudan for Science and Technology
Chapter Two
2.1 Iron-deficiency anemia

Iron-deficiency anemia (IDA) is a common anemia caused by insufficient dietary intake and absorption of iron, and/or iron loss from bleeding which can originate from a range of sources such as the intestinal, uterine or urinary tract.

Iron deficiency causes approximately half of all anemia cases worldwide, and affects women more often than men. World estimates of iron deficiency occurrence are somewhat vague, but the true number probably exceeds one billion people. This can result if:

- The body does not make enough red blood cells
- Bleeding causes loss of red blood cells more quickly than they can be replaced

The most significant cause of iron-deficiency anemia in developing world children is parasitic worms: hookworms, whipworms, and roundworms. Worms cause intestinal bleeding, which is not always noticeable in faces, and is especially damaging to growing children. Malaria, hookworms and vitamin A deficiency contribute to anemia during pregnancy in most underdeveloped countries. In women over 50 years old, the most common cause of iron-deficiency anemia is chronic gastrointestinal bleeding from nonparasitic causes, such as gastric ulcers, duodenal ulcers or gastrointestinal cancer.

Anemia is one result of advanced-stage iron deficiency. When the body has sufficient iron to meet its needs (functional iron), the remainder is stored for later use in all cells, but mostly in the bone marrow, liver, and spleen. These stores are called ferritin complexes and are part of the human iron metabolism systems. Ferritin complexes in humans carry about 4500 iron atoms and form into 24 protein subunits of two different types.

2.1.1 Signs and symptoms

Iron-deficiency anemia is characterized by the sign of pallor (reduced ox hemoglobin in skin or mucous membranes), and the symptoms of fatigue, lightheadedness, and weakness. None of the symptoms (or any of the others below) are sensitive or
specific. Pallor of mucous membranes (primarily the conjunctiva) in children indicates anemia with best correlation to the actual disease, but in a large study was found to be only 28% sensitive and 87% specific (With high predictive value) in distinguishing children with anemia [hemoglobin (Hb) <11.0 g/dl] and 49% sensitive and 79% specific in distinguishing severe anemia (Hb< 7.0 g/dl). Thus, this sign is reasonably predictive when present, but not helpful when absent, as only one-third to one-half of children who are anemic (depending on severity) will show pallor. Iron-deficiency must be diagnosed by laboratory testing.

Because iron deficiency tends to develop slowly, adaptation occurs and the disease often goes unrecognized for some time, even years; patients often adapt to the systemic effects that anemia causes. In severe cases, dyspnea (trouble breathing) can occur. Unusual obsessive food cravings, known as pica, may develop. Pagophagia or pica for ice has been suggested to be specific, but is actually neither a specific or sensitive symptom, and is not helpful in diagnosis. When present, it may (or may not) disappear with correction of iron-deficiency anemia.

Other symptoms and signs of iron-deficiency anemia include: breathlessness, glossitis, angular cheilitis, and koilonychias.

### 2.1.2 Cause

A diagnosis of iron-deficiency anemia then requires further investigation as to its cause. It can be caused by increased iron demand / loss or decreased iron intake, and can occur in both children and adults.

The cause of chronic blood loss should all be considered, according to the patient's sex, age, and history, and anemia without an attributable underlying cause is sufficient for an urgent referral to exclude underlying malignancy. In babies and adolescents, rapid growth may outpace dietary intake of iron, and result in deficiency without disease or grossly abnormal diet. In women of childbearing age, heavy or long menstrual periods can also cause mild iron-deficiency anemia.
2.1.3 Parasitosis

The leading cause of iron deficiency worldwide is infestation with parasitic worms (helminthes such as tapeworms, flukes, and roundworms). The World Health Organization estimates that "approximately two billion people are infected with soil-transmitted helminthes worldwide". Parasitic worms cause both inflammation and chronic blood loss.

2.1.4 Blood loss

Blood contains iron within red blood cells, so blood loss leads to a loss of iron. There are several common causes of blood loss: Women with menorrhagia (heavy periods) are at risk of iron-deficiency anemia because they are at higher-than-normal risk of losing a larger amount blood during menstruation than is replaced in their diet. Slow, chronic blood loss within the body such as from a peptic ulcer, angiodysplasia, a colon polyp or gastrointestinal cancer can cause Iron-deficiency anemia. Gastrointestinal bleeding can result from regular use of some groups of medication, such as (NSAIDs) e.g. aspirin, anticoagulants such as clopidogrel and warfarin, although these are required in some patients, especially those with states causing thrombophilia.

2.1.5 A lack of iron in the diet

The body normally gets the iron it requires from foods. If a person consumes too little iron, or iron that is poorly absorbed (non-heme iron), they can become iron deficient over time. Examples of iron-rich foods include meat, eggs, leafy green vegetables and iron-fortified foods. For proper growth and development, infants and children need iron from their diet, too.

2.1.6 Iron malabsorption

Iron from food is absorbed into the bloodstream in the small intestine, especially the duodenum and proximal ileum. Many intestinal disorders can reduce the body's ability to absorb iron. There are different mechanisms that may be present.
In cases where there has been a reduction in surface area of the bowel, such as in celiac disease, inflammatory bowel disease or post-surgical resection the body can absorb iron, but there is simply insufficient surface area.

If there is insufficient production of hydrochloric acid in the stomach, hypochlorhydria / achlorhydria (often due to chronic Helicobacter pylori infections or long-term proton pump inhibitor Ferrous and Ferric iron salts will precipitate out of solution in the bowel which are poorly absorbed.

In cases where systemic inflammation is present, iron will be absorbed into enterocytes, but due to the reduction in basolateral Ferro protein molecules which allow iron to pass into the systemic circulation, iron is trapped in the enterocytes and is lost from the body when the enterocytes are sloughed off.

Depending on the disease state, one or both mechanism may occur.

2.1.7 Pregnancy

Without iron supplementation, iron deficiency anemia occurs in many pregnant women because their iron stores need to serve their own increased blood volume as well as be a source of hemoglobin for the growing fetus, and for placental development. Other less common causes are intravascular hemolysis and hemoglobinuria.

2.1.8 Infant development

Iron-deficiency anemia for infants in their earlier stages of development may have greater consequences than it does for adults. An infant made severely iron-deficient during its earlier life cannot recover to normal iron levels even with iron therapy. In contrast, iron deficiency during later stages of development can be compensated with sufficient iron supplements. Iron-deficiency anemia affects neurological development by decreasing learning ability, altering motor functions, and permanently reducing the number of dopamine receptors and serotonin levels. Iron deficiency during development can lead to reduced myelination of the spinal cord, as well as a change in myelin composition. Additionally, iron-deficiency anemia has a
negative effect on physical growth. Growth hormone secretion is related to serum transferrin levels, suggesting a positive correlation between iron-transferrin levels and an increase in height and weight. This is also linked to pica, as it can be a cause.

2.1.9 Diagnosis

Anemia may be diagnosed from symptoms and signs, but when it is mild, it may not be diagnosed from mild nonspecific symptoms. Pica, an abnormal craving for dirt, ice, or other "odd" foods occurs variably in iron and zinc deficiency, but is neither sensitive nor specific to the problem, so is of little diagnostic help.

Anemia is often first shown by routine blood tests, which generally include a complete blood count (CBC) which is performed by an instrument which gives an output as a series of index.

Numbers. A sufficiently low hemoglobin (Hb) by definition makes the diagnosis of anemia, and a low hematocrit value is also characteristic of anemia. Further studies will be undertaken to determine the anemia's cause. If the anemia is due to iron deficiency, one of the first abnormal values to be noted on a CBC, as the body's iron stores begin to be depleted, will be a high red blood cell distribution width (RDW), reflecting an increased variability in the size of red blood cells (RBCs). In the course of slowly depleted iron status, an increasing RDW normally appears even before anemia appears.

A low mean corpuscular volume (MCV) often appears next during the course of body iron depletion. It corresponds to a high number of abnormally small red blood cells. A low MCV, a low mean corpuscular hemoglobin and/or mean corpuscular hemoglobin concentration, and the appearance of the RBCs on visual examination of a peripheral blood smear narrows the problem to a microcytic anemia. The numerical values for these measures are all calculated by modern laboratory equipment.

The blood smear of a patient with iron deficiency shows many hypochromic and rather small RBCs, and may also show poikilocytosis and anisocytosis. With more
severe iron-deficiency anemia, the peripheral blood smear may show target cells, hypochromic pencil-shaped cells, and occasionally small numbers of nucleated red blood cells. Very commonly, the platelet count is slightly above the high limit of normal in iron deficiency anemia (this is mild thrombocytosis). This effect was classically postulated to be due to high erythropoietin levels in the body as a result of anemia, cross-reacting to activate thrombopoietin receptors in the precursor cells that make platelets; however, this process has not been corroborated. Such slightly increased platelet counts present no danger, but remain valuable as an indicator even if their origin is not yet known.

The diagnosis of iron-deficiency anemia will be suggested by appropriate history (e.g., anemia in a menstruating woman or an athlete engaged in long-distance running), the presence of occult blood in the stool, and often by other history. For example, known celiac disease can cause malabsorption of iron. A travel history to areas in which hookworms and whipworms are endemic may be helpful in guiding certain stool tests for parasites or their eggs.

Body-store iron deficiency is diagnosed by diagnostic tests, such as a low serum ferritin, a low serum iron level, an elevated serum transferrin and a high total iron binding capacity. A low serum ferritin is the most sensitive lab test for iron deficiency anemia. However, serum ferritin can be elevated by any type of chronic inflammation and so is not always a reliable test of iron status if it is within normal limits (i.e., this test is meaningful if abnormally low, but less meaningful if normal).

Serum iron levels (i.e. iron not part of the hemoglobin in red cells) may be measured directly in the blood, but these levels increase immediately with iron supplementation (the patient must stop supplements for 24 hours), and pure blood-serum iron concentration in any case is not as sensitive as a combination of total serum iron, along with a measure of the serum iron-binding protein levels (TIBC). The ratio of serum iron to TIBC is the most specific indicator of iron Deficiency, when it is sufficiently low. The iron saturation (or transferrin saturation) of < 5% almost always indicates iron deficiency, while levels from 5% to 10% make the diagnosis of iron deficiency possible but not definitive. Saturations over 12% (taken alone) make the diagnosis unlikely. Normal saturations are usually slightly lower for
women (>12%) than for men (>15%), but this may indicate simply an overall slightly poorer iron status for women in the "normal" population.
2.3. Maternal Physiology

Maternal physiological changes in pregnancy are the normal adaptations that a woman undergoes during pregnancy to better accommodate the embryo or fetus. They are physiological changes, that is, they are entirely normal, and include cardiovascular, hematologic, metabolic, renal and respiratory changes that become very important in the event of complications. The body must change its physiological and homeostatic mechanisms in pregnancy to ensure the fetus is provided for. Increases in blood sugar, breathing and cardiac output are all required. Levels of progesterone and estrogens rise continually throughout pregnancy, suppressing the hypothalamic axis and subsequently the menstrual cycle. The woman and the placenta also produce many hormones.

The body must change its physiological and homeostatic mechanisms in pregnancy to ensure the fetus grows properly and receives adequate nutrition. Increases in blood sugar, breathing and cardiac output are all required.

2.3.1 Blood volume

- Increases progressively from six to eight weeks’ gestation
- Maximum volume at 32 weeks - 45% increase
- Possibly due to estrogen stimulation of renin-angiotensin-aldosterone system

2.3.2 RBC mass

- Red blood cell mass increases by 250-450 cc by term
- Increased production
- Possibly hormonally mediated

2.3.3 Iron

- Maternal requirement is 1000 mg
- Normal pregnant woman needs to absorb about 3.5 mg/day of iron
  - The goal of iron supplementation is to prevent maternal iron deficiency
  - Iron is actively transported to the fetus
2.3.4 Implications

- The increase in plasma volume and RBC mass translates into a 45% increase in circulating blood volume
- may protect from hemodynamic instability
- may serve to dissipate fetal heat production and provide increase renal filtration
- physiologic anemia of pregnancy may:
  - Function to decrease blood viscosity
  - Improve intervillous perfusion?

2.3.5 Leukocytes

- Peripheral wbc rises progressively during pregnancy
  - 1st $\Delta$ – mean 9500/mm³ (3000-15,000)
  - 2nd and 3rd $\Delta$ – mean 10,500 (6000-16,000)
  - Labor – may rise to 20-30,000
- Rise is due to increase in pmns (demargination)

2.3.6 Platelets

- Platelets experience a progressive decline but should remain within normal range
- Likely due to increased destruction

2.3.7 Coagulation Factors

- Increased levels
  - Fibrinogen (Factor I)
  - Factors VII through X
- No change in prothrombin (Factor II), Factors V and XII
- Decline in platelet count, Factors XI and XIII
  - Bleeding time and clotting time are unchanged in normal pregnancy
Iron Deficiency Anemia among pregnant women

Table 2.1 Change in lab values in iron deficiency anemia

<table>
<thead>
<tr>
<th>Change</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease</td>
<td>ferritin, hemoglobin, MCV</td>
</tr>
<tr>
<td>Increase</td>
<td>TIBC, transferrin, RDW</td>
</tr>
</tbody>
</table>

Iron-deficiency anemia and thalassemia minor present with many of the same lab results. It is very important not to treat a patient with thalassemia with an iron supplement, as this can lead to hemochromatosis. A hemoglobin electrophoresis provides useful evidence for distinguishing these two conditions, along with iron studies.

Conventionally, a definitive diagnosis requires a demonstration of depleted body iron stores obtained by bone marrow aspiration, with the marrow stained for iron, because this is invasive and painful, while a clinical trial of iron supplementation is inexpensive and not traumatic, patients are often treated based on clinical history and serum ferritin levels without a bone marrow biopsy. Furthermore, a study published April 2009 questions the value of stainable bone marrow iron following parenteral iron therapy.
2.4 Anemia in Pregnancy

Normally during pregnancy, erythroid hyperplasia of the marrow occurs, and RBC mass increases. However, a disproportionate increase in plasma volume results in hemodilution (hydremia of pregnancy): Hct decreases from between 38 and 45% in healthy women who are not pregnant to about 34% during late single pregnancy and to 30% during late multifetal pregnancy. Thus during pregnancy, anemia is defined as Hb < 10 g/dL (Hct < 30%). If Hb is < 11.5 g/dL at the onset of pregnancy, women may be treated prophylactically because subsequent hemodilution usually reduces Hb to < 10 g/dL. Despite hemodilution, O2-carrying capacity remains normal throughout pregnancy. Hct normally increases immediately after birth.

Anemia occurs in up to one third of women during the 3rd trimester. The most common causes are iron deficiency and folate deficiency. Obstetricians, in consultation with a perinatologist, should evaluate anemia in pregnant Jehovah's Witness patients (who are likely to refuse blood transfusions) as soon as possible.

2.4.1 Symptoms and Signs

Early symptoms are usually nonexistent or nonspecific (eg, fatigue, weakness, light-headedness, mild dyspnea during exertion). Other symptoms and signs may include pallor and, if anemia is severe, tachycardia or hypotension. Anemia increases risk of preterm delivery and subsequent low birth weight.10

2.4.2 Diagnosis

Typically, Hct is ≤ 30%, and MCV is < 79 fL. Decreased serum iron and ferritin and increased serum transferrin levels confirm the diagnosis.

2.4.3 Treatment

- Ferrous sulfate 325 mg po once/day

One 325-mg ferrous sulfate tablet taken midmorning is usually effective. Higher or more frequent doses increase GI adverse effects, especially constipation, and one
dose blocks absorption of the next dose, thereby reducing percentage intake. About 20% of pregnant women do not absorb enough supplemental oral iron; a few of them require parenteral therapy, usually iron dextran 100 mg IM every other day for a total of ≥ 1000 mg over 3 wk. Hct or Hb is measured weekly to determine response. If iron supplements are ineffective, concomitant folate deficiency should be suspected.

Neonates of mothers with iron deficiency anemia usually have a normal Hct but decreased total iron stores and a need for early dietary iron supplements.

2.4.4 Prevention

Although the practice is controversial, iron supplements (usually ferrous sulfate 325 mg po once/day) are usually given routinely to pregnant women to prevent depletion of body iron stores and prevent the anemia that may result from abnormal bleeding or a subsequent pregnancy.

2.4.5 Folate Deficiency Anemia in Pregnancy

Folate deficiency (see Folate Deficiency and discussed in Megaloblastic Macrocytic Anemias) increases risk of neural tube defects and possibly fetal alcohol syndrome. Deficiency occurs in 0.5 to 1.5% of pregnant women; macrocytic megaloblastic anemia is present if deficiency is moderate or severe. Rarely, severe anemia and glossitis occur.

2.4.6 Diagnosis

Folate deficiency is suspected if CBC shows anemia with macrocytic indices or high RBC distribution width (RDW). Low serum folate levels confirm the diagnosis.

2.4.7 Treatment

Treatment is folate 1 mg po bid. Severe megaloblastic anemia may warrant bone marrow examination and further treatment in a hospital.
2.4.8 Prevention

For prevention, all pregnant women are given folate 0.4 mg po once/day. Women who have had a fetus with spina bifida should take 4 mg once/day, starting before conception.\textsuperscript{11}

2.4.9 Human iron metabolism

Human iron metabolism is the set of chemical reactions maintaining human homeostasis of iron. The control of this necessary but potentially toxic substance is an important part of many aspects of human health and disease. Hematologists have been especially interested in the system of iron metabolism because iron is essential for red blood cells, where most of the human body's iron is contained. Understanding this system is also important for understanding diseases of iron overload, like hemochromatosis, and iron deficiency, like iron deficiency anemia.

The absorption of dietary iron is a variable and dynamic process.

The amount of iron absorbed compared to the amount ingested is typically low, but may range from 5\% to as much as 35\% depending on circumstances and type of iron. The efficiency with which iron is absorbed varies depending on the source. Generally the best-absorbed forms of iron come from animal products. Absorption of dietary iron in iron salt form (as in most supplements) varies somewhat according to the body's need for iron, and is usually between 10\% and 20\% of iron intake. Absorption of iron from animal products, and some plant products, is in the form of heme iron, and is more efficient, allowing absorption of from 15\% to 35\% of intake. Heme iron in animals is from blood and heme containing proteins in meat and mitochondria, whereas in plants, heme iron is present in mitochondria in all cells that use oxygen for respiration.\textsuperscript{12}

Like most mineral nutrients, the majority of the iron absorbed from digested food or supplements is absorbed in the duodenum by enterocytes of the duodenal lining. These cells have special molecules that allow them to move iron into the body. To be absorbed, dietary iron can be absorbed as part of a protein such as heme protein or iron must be in its ferrous Fe\textsuperscript{2+} form. A ferric reductase enzyme on the enterocytes' brush border, duodenal cytochrome B, reduces ferric Fe\textsuperscript{3+} to Fe\textsuperscript{2+} A protein called
divalent metal transporter one, which transports all kinds of divalent metals into the body, then transports the iron across the enterocyte's cell membrane into the cell.

These intestinal lining cells can then either store the iron as ferritin, which is accomplished by Fe$^{3+}$ binding to Apo ferritin (in which case the iron will leave the body when the cell dies and is sloughed off into feces) or the cell can move it into the body, using a protein called ferroportin. The body regulates iron levels by regulating each of these steps. For instance, cells produce more Dcytb, DMT1 and Ferro protein in response to iron deficiency anemia.\textsuperscript{13}

The human body's rate of iron absorption appears to respond to a variety of interdependent factors, including total iron stores, the extent to which the bone marrow is producing new red blood cells, the concentration of hemoglobin in the blood, and the oxygen content of the blood. The body also absorbs less iron during times of inflammation. Recent discoveries demonstrate that hepcidin regulation of ferroportin (see below) is responsible for the syndrome of anemia of chronic disease.

While Dcytb is unique to iron transport across the duodenum, ferroportin is distributed throughout the body on all cells which store iron. Thus, regulation of ferroportin is the body's main way of regulating the amount of iron in circulation.

Hephaestin, a ferroxidase that can oxidize Fe$^{2+}$ to Fe$^{3+}$ and is found mainly in the small intestine, helps ferroportin transfer iron across the basolateral end of the intestine cells.\textsuperscript{13}

Iron absorption from diet is enhanced in the presence of vitamin C and diminished by excess calcium, zinc, or magnesium.

2.4.10 Reasons for iron deficiency

Iron is an important topic in prenatal care because women can sometimes become iron-deficient from the increased iron demands of pregnancy.\textsuperscript{14}

Functional or actual iron deficiency can result from a variety of causes, explained in more detail in the article dedicated to this topic. These causes can be grouped into several categories:

- Increased demand for iron, which the diet cannot accommodate.
- Increased loss of iron (usually through loss of blood).
Iron Deficiency Anemia among pregnant women

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- Nutritional deficiency. This can result due to a lack of dietary iron or consumption of foods that inhibit iron absorption, including calcium, phytates and tannins. Black tea steeped for long has high tannins.
- Inability to absorb iron because of damage to the intestinal lining. Examples of causes of this kind of damage include surgery involving the duodenum, or diseases like Crohn's or celiac sprue which severely reduce the surface area available for absorption.
- Inflammation leading to hepcidin-induced restriction on iron release from enterocytes (see below).

Reducing anemia will decrease maternal mortality, and increase physical capacity and work productivity in adults.
Chapter Three
Materials and methods

3.1 Study Design:

This is a cross-sectional descriptive and analytical study conducted in Bashayer, a Khartoum state hospital to determine and investigate iron deficiency anemia among 46 pregnant women.

3.1.1 Study Population:

Forty eight samples were collected from pregnant women.

3.1.2 Ethical consideration:

Permission for conducting this research was taken from the Pregnant Women and medical director of Bashair hospital.

3.2 Method of data collection:

Data were collected using a structured questionnaire interview, which include all needed information concerning each case investigated.

3.2.1 Collection of blood specimens:

Blood was collected by a clean venipuncture in plastic containers (EDTA containers) From each pregnant woman 5ml of Venus blood were withdrawn using Sterile syringes for the complete blood count (CBC), plain containers for the serum iron profile).

3.2.2 Analysis required:

In each specimen, the following tests were done Hb, PCV, red cell counts, MCV, MCH, MCHC, WBC, platelet counts, reticulocyte counts and serum iron concentration.
3.3 Methodology of the CBC:

3.3.1 Instrument:

The MYTHIC 18 is an automated hematology analyzer for invitro diagnostic use in clinical laboratory, performing hematology analysis on whole blood collected on EDTA tubes.

In this instrument only human blood or artificial control blood should be run. 15

3.3.2 General overview:

The sample volume is 9.8 micro liters; the throughput of MYTHIC 18 is 60 samples per hour, and performing 18 analysis parameters 17

3.3.3 Reagent specification:

All reagents must be stored at room temperature (15 to 25); the shelf life once opened 60 days. 15

3.3.4 Diluents' reagent:

Clear and odorless aqueous solution, was used to carry out the necessary dilutions for the measurements.

The active components of the Diluents were 0.45% Sodium chloride, 1.00% sodium Sulfate and buffer and preservative 15

3.3.5 Lyses reagent:

It is clear aqueous solution with a light almond odder, was used to lyses the red blood cells, the white blood cells differentiation and Cyanomethemoglobin complex formation was used during the measurement. The active components of lyses reagent were 3.50% Surfactant, 0.03 Potassium Cyanide and Quaternary Ammonium Salt. 15

3.3.6 Cleaning reagent:

Clear aqueous solution, blue in color, was used to carry out the cleaning the measurement system and hydraulic circuit.
Components of cleaning solution are enzymes, potassium and Sodium salts, surfactant and preservatives and coloring agents.\(^{15}\)

### 3.4 Principles of automated analyzer system:

The counting of cellular elements in blood sample was done with the impedancemetry technique. This technique was based on the modification of the impedance of the calibrated aperture soaking in an electrolyte and going through a constant course delivered by two electrodes located on both sides of the aperture. A vacuum applied on side of the aperture allow the cells passage. They oppose their physical volume to the course passage. A voltage impulse was registered at the electrodes terminal. The height of this impulse was proportional to the cell volume. The innovative optical detection system was covered by two patents pending. This technology called: OCHF (for optical cytometer hydro focus free)

Was based on a unique innovative concept of an active sample flow and passive sample flow was introduced in the flow cell under pressure and the sheath was only dedicated to maintain it. This principle was unable to introduce a large quantity of sample and to use a great dilution rate (which allows doing hemoglobin measurement with the same dilution). For each cell throwing the optical detection area, to pulses were generated. When for the axis loss light (ALL) measurement and for the forward side scatter (FSC) measurement. The result of those two axes of measurement was high dilution matrix that unable to identify the white cells population, the five parts different was obtained by the optical matrix analysis after action of the lytic reagent (banding pattern).

The reagent destroyed the red blood cells and their stroma’s, composed the oxy hemoglobin chromogen and produced the white blood cell membrane to keep it in closed native state. The hemoglobin measurement was directly done in the white blood cells chamber spectrophotometer at 555 nm. Hemoglobin was detected by formation a chromogenoxy hemoglobin type (cyanide free technique). Measurement blank hemoglobin was done for each analytic cycle and during the startup raising step. Leucocytes analysis was done by impedancemetry in the white blood cells counting chamber, the other ten parameters were obtained by flowcytomery measurement. The erythrocyte analysis was done by impedancemetry in red blood
cells counting chamber and by analysis of the hemoglobin inside the white blood cells chamber as previously described. Seven parameters were obtained, RBCs, HGB, MCV, MCH, MCHC, RDW, the red cells indices were calculated. Platelets analysis was made by impedanemetry in the red cell counting chamber at the same time with red blood cell, four parameters were obtained. 

3.5 Procedure:

- The reagent needed was checked.
- The power switch was turned. Self-auto rinse, and background check was automatically performed and the vend (vend for analysis) will appear. Whole blood mode was selected.
- Sample number and patient name were entered.
- Sample was mixed sufficiently.
- The tube was set to the sample probe, and in that condition the start switch was pressed.
- When the sucking of sample was done the tube was removed.
- After that automatic analysis was done and the result was displayed in the screen.

3.5.1 Sysmex

The System is an automatic multi-parameter blood cell counter for in vitro diagnostic use in clinical laboratories. The processes approximately 60 samples an hour and displays on the LCD screen the particle distribution curves of WBC, RBC, and platelets, along with data of 18 parameters, as the analysis results. 

3.5.2 overview of instrument

The System performs speedy and accurate analysis of 18 parameters in blood and detects the abnormal samples. To assure easy sorting of abnormal samples in the laboratory, the instrument displays abnormal.

Analysis data with abnormal marks attached on the LCD screen. Thus, displayed analysis data allows detecting those samples, which are outside the tolerance and need further analysis and reconsideration.
The System employs three detector blocks and two kinds of reagents for blood analysis. The WBC count is measured by the WBC detector block using the DC detection method. The RBC count and platelets are taken by the RBC detector block, also using the DC detection method. The HGB detector block measures the hemoglobin concentration using the non-cyanide hemoglobin method.\textsuperscript{16}

3.6 Blood film:

\begin{itemize}
  \item A small drop of blood was placed in the center line of a slide about 1cm from one end.
  \item Then, without delay, the spreader was placed in front of the drop at an angle of about 30 to the slide and was moved back to make contact with the drop.
  \item The drop was spread quickly along the line of contact. With a steady movement of the hand, the drop of blood was spread along the slide.
  \item The spreader did not lift off until the last trace of blood was spread out, with a correctly sized drop; the film was about 3cm in length. The film was dried by air then stained.\textsuperscript{17}
\end{itemize}

3.6.1 Staining of blood film:

\begin{itemize}
  \item A Romano sky (Leishman's) stain was used.
  \item The film was flooded by the stain for two minutes then the buffer was applied (tap water) for additional five minutes.\textsuperscript{17}
  \item After that the slide was washed well by the buffer and let to dry by air. The film was examined under the microscope (100 lenses). \textsuperscript{16}
\end{itemize}

3.7 Methodology of the iron profile:

The instrument:

The A25 analyzer was an automatic analyzer for random access in vitro diagnosis specially designed for performing biochemical and turbid metric clinical analyses. The analyzer was performed patient-by-patient analyses and was enabled the continual introduction of samples. The results were shown immediately after each measurement. The analyzer could carry out one preparation every 15 seconds. The A25 analyzer was made up of three basic elements: the operating arm, the dispensing system and the reading and reactions rotor\textsuperscript{17}
3.8 Serum iron:

3.8.1 Principle of the method:

Transferrin-bound ferric irons in the sample were released by guanidinium and reduced to ferrous by means of hydroxylamine.

Ferrous ions were reacting with ferrozine forming a colored complex

3.8.2 Reagents:

Reagent1 Guanidinium chloride 1.0 mol/L, hydroxylamine 0.3 mol/L, acetate buffer 0.4 mol/L. Reagent2 Ferrozine 8mmol/L. The storage of the reagent at 2-8 C. Reagents was stable until the expiry date shown in the label when stored tightly closed and if contaminations were prevented during their use. Absorbance of the blank over 0.050 at 560 nm.  

3.8.3 Samples:

Serum or heparinized plasma was collected by standard procedures. (Bruits CA, et al, 2005).

3.8.4 Reference values:

Women: 50-170 µg/dl = 9.0 -30mol/L. Men: 65- 175 µg/dl =11.6-31.3 mol/L. 

17

18
Chapter Four
Results

About (71.74%) of Study group were found to have IDA, while the rates of deficient women in thesis noted on chapter two was (74%) and (25.9%) had other types of anemia. These semi identical outcomes indicate that there is a noticeable increase in prevalence of anemia in Sudan since last statistical data of WHO in 2006.

The six tables listed below showing the findings of age distribution, CBC and iron profile for test ”33” and control “13” women as follows:

Table (4.1): Age Groups among affected women

<table>
<thead>
<tr>
<th>Age group</th>
<th>No. of affected pregnant women</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20</td>
<td>10</td>
</tr>
<tr>
<td>20 - 30</td>
<td>6</td>
</tr>
<tr>
<td>31 - 35</td>
<td>3</td>
</tr>
<tr>
<td>35 – 40</td>
<td>13</td>
</tr>
<tr>
<td>&gt;40</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
</tr>
</tbody>
</table>
Table (4.2): Parameters of pregnant women

<table>
<thead>
<tr>
<th>Age group</th>
<th>Mean Hb + SD</th>
<th>Mean WBC + SD</th>
<th>Mean Plts. + SD</th>
<th>Mean MCV + SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20</td>
<td>5.99 ± 0.92</td>
<td>8430 ± 2514.43</td>
<td>311.1 ± 438.25</td>
<td>56.5 ± 5.56</td>
</tr>
<tr>
<td>20 - 30</td>
<td>29300 ± 34228.45</td>
<td>29300 ± 34228</td>
<td>1.83.25 ± 43.68</td>
<td>55.25 ± 5.91</td>
</tr>
<tr>
<td>31 - 35</td>
<td>5.56 ± 1.15</td>
<td>9725 ± 2593.81</td>
<td>209.625 ± 50.00</td>
<td>56.125 ± 9.63</td>
</tr>
<tr>
<td>35 - 40</td>
<td>6.10769 ± .88</td>
<td>14500.8 ± 20169.30</td>
<td>208.154 ± 53.13</td>
<td>61.4615 ± 8.39</td>
</tr>
<tr>
<td>&gt;40</td>
<td>5.8 ± 0.26</td>
<td>7500 ± 3041.38</td>
<td>223.333 ± 75.06</td>
<td>58 ± 2.65</td>
</tr>
</tbody>
</table>
Table (4.3): Iron profile among pregnant women

<table>
<thead>
<tr>
<th>Age group</th>
<th>Mean Free Iron+ SD</th>
<th>Mean TIBC+ SD</th>
<th>Mean Ferritin + SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50 to 170 μg/dL</td>
<td>250–370 μg/dL</td>
<td>18-160 ng/m</td>
</tr>
<tr>
<td></td>
<td>(45-66 μmol/L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 20</td>
<td>12.99±5.00</td>
<td>573.3±109.54</td>
<td>1.43±0.60</td>
</tr>
<tr>
<td>20 - 30</td>
<td>15.45±4.75</td>
<td>638.25±64.23</td>
<td>0.85±0.31</td>
</tr>
<tr>
<td>31 - 35</td>
<td>14.17±3.01</td>
<td>576.00±114.05</td>
<td>0.73±0.25</td>
</tr>
<tr>
<td>35 -40</td>
<td>14.68±5.57</td>
<td>610.23±88.26</td>
<td>1.09±0.46</td>
</tr>
<tr>
<td>&gt;40</td>
<td>12.53±4.23</td>
<td>653.63±118.04</td>
<td>0.8±0.40</td>
</tr>
</tbody>
</table>
Table (4.4) Relations between, MCV, WBC, Plt, serum iron, TIBC and serum ferritin among study group and controls

<table>
<thead>
<tr>
<th>Test and test control</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>HB Test</td>
<td>5.94</td>
<td>0.93</td>
</tr>
<tr>
<td>HB Control</td>
<td>12.78</td>
<td>1.56</td>
</tr>
<tr>
<td>MCV Test</td>
<td>58.11</td>
<td>7.58</td>
</tr>
<tr>
<td>MCV Control</td>
<td>83.60</td>
<td>5.11</td>
</tr>
<tr>
<td>WBCs Test</td>
<td>14020</td>
<td>16436.57</td>
</tr>
<tr>
<td>WBCs Control</td>
<td>4033.67</td>
<td>1249.66</td>
</tr>
<tr>
<td>PLTs Test</td>
<td>190.40</td>
<td>225.31</td>
</tr>
<tr>
<td>PLTs Control</td>
<td>234.13</td>
<td>442.30</td>
</tr>
<tr>
<td>Serum Iron Test</td>
<td>14.02</td>
<td>4.84</td>
</tr>
<tr>
<td>Serum Iron Control</td>
<td>38.44</td>
<td>7.64</td>
</tr>
<tr>
<td>TIBC Test</td>
<td>603.27</td>
<td>95.54</td>
</tr>
<tr>
<td>TIBC Test Control</td>
<td>327.19</td>
<td>48.77</td>
</tr>
<tr>
<td>Serum Ferritin Test</td>
<td>1.11</td>
<td>0.52</td>
</tr>
<tr>
<td>Serum Ferritin Control</td>
<td>13.49</td>
<td>1.25</td>
</tr>
</tbody>
</table>
Chapter Five
Discussion, Conclusion and Recommendations

Discussion
Out of 46 pregnant women 33 were found to be iron deficient. Pregnancy itself and the possible low income of the families are main causes. Unfortunately, most women start pregnancy without sufficient stores of iron to meet their body's increased demands, particularly in the second and third trimesters. If you get to the point where you no longer have enough iron to make the hemoglobin you need, you become anemic.

Iron deficiency is considered the world's most common single-nutrient disorder. The study group of patients show consistent lowest results regarding CBC and iron parameters. These ladies of course, are of low income plus illiterates. Many of these women have multiple pregnancies. The most significant weight gain and storage of iron by the fetus occurs during the last trimester of pregnancy. Poverty is the main factor that causes iron deficiency anemia. Most women with poor and live in poor areas. The treatment for anemia depends on the cause. Iron supplements are not always the answer.

5.1 Conclusion
The incidence of iron deficiency anemia in pregnant women.

About 33 (68.75%) have iron deficiency anemia and increased TIBC while 15 (31.25%) are not affected.

5.2 Recommendations

- Monitoring of HB Level in pregnant women monthly.
- Distribution of iron and folate to pregnant women
- Iron Supplementations
- Documents stating the national policy on iron deficiency
References:

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