

# الآية القرآنية

قال الله تعالى:

لَقَدْ أَرْسَلْنَا رُسُلَنَا بِالْبَيِّنَاتِ وَأَنْزَلْنَا مَعَهُمُ الْكِتَابَ وَالْمِيزَانَ لِيَقُومَ النَّاسُ بِالْقِسْطِ وَأَنْزَلْنَا

الْحَدِيدَ فِيهِ بَأْسٌ شَدِيدٌ وَمَنْفَعٌ لِلنَّاسِ وَيَعْلَمَ اللَّهُ مَنْ يَنْصُرُهُ وَرُسُلَهُ بِالْغَيْبِ إِنَّ اللَّهَ قَوِيٌّ عَزِيزٌ

(سورة الحديد الآية 25)

# Dedication

*I dedicate this work to:*

*My darling parents who are always supporting me and encouraging me to success.*

*My sister and brothers who cooperated with me and gave me help and motivation.*

*My friends and colleagues who gave me the possibility of completing this thesis.*

*Everyone who has helped me to learn new things and to reach this level.*

# Acknowledgment

First of all my gratitude and thanks to our Almighty God, most gracious and most merciful, Who gave me the serenity, means of strength and patience to finish this work.

With grateful appreciation I acknowledge the effort of my supervisor **Dr. Munsoor Mohammed Munsoor** for his supervision, keen, unlimited patience, generous support and guidance.

I would like to express my gratitude and sincere thanks to all staff of Obstetrics and Gynaecology Laboratory in Khartoum Teaching Hospital for their help during samples collection. Special thanks are extended to all laboratory staff in Ribat University Hospital for their help and encouragement during samples analysis.

Also, I would like to thank all my subjects; the pregnant women who contributed to complete this research.

Finally, my deep gratitude goes to the members of Medical Laboratories College in Sudan University for their motivation during this study.

# Abstract

This a 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.

The study included 100 Sudanese females; 80 were pregnant women (aged 16 to 42 years) and 20 were healthy non pregnant women (as control). The 80 pregnant women, who were apparently in good health, are informed about the study and their consent for participation was obtained. Study population was divided in to 3 groups according to the trimesters (first, second and third trimester).

Venous blood sample of 5 ml was collected from each subject. Automated hematological analyzer (Sysmex KX21N) was used for CBC and automated biochemical analyzer (Selectra XL) was used for serum iron and serum ferritin assessment.

The results were analyzed by Statistical Package for Social Science (SPSS version 11.5) and the means of TWBCs count, RBCs count, Hb level, HCT%, Red cell indices (MCV, MCH, MCHC), PLT count, serum iron and serum ferritin level were  $7.8 \times 10^3/\mu\text{l}$ ,  $4.2 \times 10^6/\mu\text{l}$ , 11.5 g/dl, 35.1%, 81.6 fl, 27.3 pg, 33.1 g/dl,  $243 \times 10^3/\mu\text{l}$ , 94  $\mu\text{g}/\text{dl}$  and 35.6  $\mu\text{g}/\text{l}$  respectively.

The frequency of antenatal care follow up among study population was 77.5%. Seventy three percent of pregnant women among the study population were Multigravidae. Sixty nine percent of women reported that they were taking iron supplements regularly during pregnancy. The third trimester of study population was more frequent (58.8%), followed by second trimester (21.3%) and first trimester (20%).

The study revealed that there was statistically significant difference in the means of TWBCs count, RBCs count, Hb level, HCT%, MCV, MCH and serum ferritin level among study group when compared with control group ( $P<0.05$ ). In addition, there was statistically significant decrease in the mean of RBCs count and serum ferritin level in the second trimester ( $P<0.05$ ) and significant decrease in the mean of PLT count in the third trimester ( $P<0.05$ ).

There was statistically significant decrease in the mean of serum ferritin level among pregnant women who were not taking iron supplements ( $P=0.005$ ). Also, there was statistically significant decrease in the mean of Hb level and serum ferritin level among pregnant women who were not followed up ( $P<0.05$ ).

The prevalence of anemia (Hb  $<11.0$  g/dl) was 33.8% among the study group, the majority (85.2%) of these anemic patients were mildly anemic, whereas (11.1%) were moderately anemic. There was only one case of severe anemia (3.7%). Most of those anemic pregnant women (74%) were found to have IDA, while (25.9%) had other types of anaemia. IDA had been found in high percentage in the third trimester (50%). This high prevalence of IDA among pregnant women may be due to malnutrition and lack of iron medications during pregnancy.

# ملخص الدراسة

هذه الدراسة مقطعية وصفية وتحليلية هدفت إلى تحديد حالات فقر الدم بسبب عوز عنصر الحديد بين السيدات الحوامل السودانيات. وقد أجريت هذه الدراسة خلال الفترة من 29 مارس إلى 10 مايو 2012 بمستشفى الخرطوم التعليمي.

شملت الدراسة 100 امرأة سودانية، 80 منهن كن سيدات حوامل (أعمارهن بين 16- 42 سنة) و20 منهن كن نساء صحيحات غير حوامل (للمقارنة). وتم إخطار السيدات الحوامل بهذه الدراسة وأهميتها وأخذت موافقتهن على المشاركة. ثم قسمت النساء الحوامل إلى ثلاث مجموعات حسب مراحل الحمل (الثالث الأول والثاني والثالث).

وقد تم جمع 5 مل من الدم الوريدي من كل امرأة مشاركة في هذه الدراسة. تم استخدام جهاز التحليل الدموي الآلي (Sysmex KX21N) لإجراء فحوصات تعداد الدم الكامل ثم استخدم جهاز التحليل الكيميائي الآلي (Selectra XL) لإجراء فحوصات الدم المصلية لمعرفة مستوى الحديد والفريتين.

وقد تم تحليل النتائج إحصائياً باستخدام برنامج الحزم الإحصائية (الإصدار 11.5). وتم حساب المتوسط لعدد كريات الدم البيضاء ، وعدد كريات الدم الحمراء ، ومستوى خضاب الدم (الهيموغلوبين) ، ومكداس الدم الأحمر ، ومؤشرات الخلية الحمراء (متوسط حجم الخلية ، متوسط هيموغلوبين الخلية ، متوسط تركيز هيموغلوبين الخلية) ، وعدد الصفائح الدموية ، ومستوى الحديد والفريتين في مصل الدم وكانت  $7.8 \times 10^3$  مايكروليتر ،  $4.2 \times 10^6$  مايكروليتر ، 11.5 جم/دسل ، 35.1 % ، 81.6 فيمتوليتر ، 27.3 بيكوجرام ، 33.1 جم/دسل ،  $243 \times 10^3$  مايكروليتر، 94 مايكروجرام/دسل و 35.6 مايكروجرام/ليتر بالتتابع.

أوضحت الدراسة أن نسبة الحوامل اللاتي كن يراجعن في مراكز الرعاية خلال فترة الحمل كانت (77.5%) . ثلاثة وسبعون بالمئة من النساء الحوامل في هذه الدراسة أنجبن من قبل. تسعة وستون بالمئة من السيدات الحوامل كن يأخذن أدوية داعمة للحديد بشكل منتظم خلال فترة حملهن. كانت نسبة الحوامل اللاتي كن في الفترة الأولى من الحمل 20%، بينما اللواتي كن في الفترة الثانية 21.3% أما الحوامل اللاتي كن في الفترة الثالثة من حملهن كانت نسبتهن هي الأغلب 58.8%.

وكشفت الدراسة أن هناك اختلاف ذو دلالة إحصائية واحتمالية أقل من (0.05) في متوسطات عدد كريات الدم البيضاء ، عدد كرات الدم الحمراء ، ومستوى الهيموغلوبين ، ومكداس الدم الأحمر ، ومؤشرات الخلية الحمراء (متوسط حجم الخلية ، متوسط هيموغلوبين الخلية) ومستوى الفريتين في مصل الدم لدى النساء الحوامل بالمقارنة مع المجموعة الضابطة.

وهناك نقصان واضح وذو دلالة إحصائية واحتمالية أقل من (0.05) في متوسط مستوى الفريتين وعدد كريات الدم الحمراء لدى النساء الحوامل اللاتي كن في الجزء الثاني من الحمل، بينما كان هناك نقصان واضح في متوسط عدد الصفائح الدموية لدى النساء الحوامل اللاتي كن في الجزء الثالث من الحمل .

كما بينت الدراسة بأن متوسط مستوى خضاب الدم ومستوى الفيريتين لدى النساء الحوامل اللاتي كن لايراجعن في مراكز الرعاية خلال فترة الحمل كانت أقل بدلالة إحصائية واحتمالية أقل من (0.05). كما تبين أن متوسط مستوى الفيريتين لدى النساء الحوامل اللاتي كن لا يأخذن أدوية داعمة للحديد خلال فترة حملهن كانت أقل بدلالة إحصائية واحتمالية أقل من (0.05).

أظهرت النتائج أن 33.8% من الحالات التي شملتها الدراسة كانت تعاني من فقر الدم، معظمهم بين الحالات البسيطة والمتوسطة (بنسبة 85.2% و 11.1% بالتتابع) , بينما لم يكن هناك سوى حالة واحدة فقط تعاني من فقر الدم الشديد (بنسبة 3.7%). ومن بين تلك الحالات اللاتي كانت تعاني من فقر الدم (74% ) يعانون من فقر الدم بسبب عوز عنصر الحديد وقد تبين من خلال النتائج أن معظم الحالات وأشدّها تأثيراً هي فترة الحمل الأخيرة والتي كانت تمثل (50% ). إن هذا الانتشار المرتفع لفقر الدم بين النساء الحوامل ربما يكون بسبب سوء التغذية وعدم تناول أدوية الحديد أثناء فترة الحمل.

# List of contents

Subject	Page No
الآية القرآنية	I
Dedication	II
Acknowledgment	III
Abstract	IV
ملخص الدراسة	VI
List of contents	VIII
List of Tables	XI
List of Figures	XII
List of Abbreviations	XIII
<b>Chapter One</b>	
<b>Introduction and Literature review</b>	
1.1 Blood	1
1.2 Complete Blood Count (CBC)	2
1.3 Blood disorders	7
1.3.1 Anemia	7
1.3.1.1 Classification of Anaemia	7
1.4 Iron deficiency anemia	8
1.4.1 Causes of iron deficiency anemia	9
1.4.2 Clinical features of iron deficiency anemia	9
1.4.3 Laboratory investigations of iron deficiency anaemia	10
1.5 Iron metabolism	11
1.5.1 Distribution of body iron	11
1.5.2 Dietary Iron	12
1.5.3 Iron Absorption	12
1.5.4 Iron Transport	13
1.5.5 Iron Storage	13
1.5.6 The Iron Cycle	14
1.5.7 Iron Requirement	14
1.5.8 Diagnostic methods for investigating iron metabolism	14
1.5.8.1 Serum iron	14

1.5.8.2 Serum ferritin	15
1.5.8.3 Bone marrow aspiration	15
1.5.8.4 Total Iron-Binding Capacity	15
1.5.8.5 Serum transferrin receptors	16
1.5.8.6 Red cell protoporphyrin	16
1.5.8.7 Red cell ferritin	16
1.5.8.8 Percentage of hypochromic red cells	16
1.6 Pregnancy	17
1.6.1 Physiological changes during pregnancy	17
1.6.1.1 Physical changes	17
1.6.1.2 Hormonal changes	18
1.6.1.3 Musculoskeletal changes	18
1.6.1.4 Cardiovascular changes	19
1.6.1.5 Metabolic changes	19
1.6.1.6 Renal changes	20
1.6.1.7 Gastrointestinal changes	20
1.6.1.8 Hematological changes	20
1.7 Iron Deficiency Anaemia during pregnancy	22
1.8 Pregnancy and Iron Absorption	22
1.9 Iron Supplementations during Pregnancy	23
1.10 Assessment of Iron Deficiency during Pregnancy	24
1.11 Effect of maternal anemia and iron deficiency on mother and fetus	25
1.12 Incidence of IDA among pregnancy in Sudan and world wide	26
1.12.1 Incidence of IDA among pregnancy in Sudan	26
1.12.2 Incidence of IDA among pregnancy in the worldwide	27
1.13 Rationale	30
1.14 Objectives	31
1.14.1 General objective	31

1.14.2 Specific objectives	31
<b>Chapter Two Materials and Methods</b>	
2.1 Study design	32
2.2 Study population	32
2.3 Inclusion criteria	32
2.4 Exclusion criteria	32
2.5 Study area	32
2.6 Time limit	32
2.7 Sample size	33
2.8 Tool of data collection	33
2.9 Data analysis	33
2.10 Data presentation	33
2.11 Ethical consideration	33
2.12 Methods	34
2.12.1 sample collection	34
2.12.2 Preparation of thin blood film	34
2.12.3 Staining of thin blood film	34
2.12.4 Examination of blood film	35
2.12.5 Preparation of Serum	35
2.12.6 CBC Sysmex principle	36
2.12.7 Selectra–XL background and principle	36
2.13 Serum iron	37
2.14 Serum ferritin	37
<b>Chapter Three Results</b>	
3. Results	38
<b>Chapter Four Discussion, Conclusion and Recommendations</b>	
4.1 Discussion	49

4.2 Conclusion	53
4.3 Recommendations	54
<b>References</b>	
References	55
<b>Appendices</b>	
Appendix (1): Questionnaire	60
Appendix (2): Master sheet	61
Appendix (3): Consent form	65
Appendix (4): Laboratory requirements	66
Appendix (5): Color plates	67
Appendix (6): Figures	70

# List of Tables

No.	Title	Page
Table (1-1)	Normal values for the complete blood count (CBC)	6
Table (3-1)	Mean of age between study group and control group	38
Table (3-2)	Frequency and percent of age group among study and control group	38
Table (3-3)	Frequency and percent of demographic categorical characteristics of study participants	39
Table (3-4)	Comparison between study group and control group in hematological parameters and iron status	40
Table (3-5)	Descriptive statistic of hematological parameters and iron status among the three trimesters	41
Table (3-6)	Frequency and percent of anemia among study participants	42
Table (3-7)	Distribution of anaemia among studied anemic pregnant women according to their trimester	42
Table (3-8)	Distribution of the degree of anaemia among studied anemic pregnant women related to its severity	43
Table (3-9)	Frequency and percent of Iron Deficiency Anaemia among studied anemic pregnant women	43
Table (3-10)	Distribution of IDA among each trimester	44
Table (3-11)	Comparison between anemic and control groups in hematological parameters and iron status	45
Table (3-12)	Association between serum iron and serum ferritin level and iron supplements intake during pregnancy among study participants	46
Table (3-13)	Association between Hb level and gravidity among study participants	47
Table (3-14)	Association between Hb level, serum iron and serum ferritin level and antenatal care follow up during pregnancy among study participants	48

# List of Figures

No.	Title	Page
Figure (3-1)	The mean of age among study group and control group	70
Figure (3-3)	Distribution of studied pregnant women according to their follow up	70
Figure (3-3)	Distribution of studied pregnant women according to their gravidity	71
Figure (3-3)	Distribution of studied pregnant women according to their gestational age	71
Figure (3-3)	Distribution of studied pregnant women according to iron supplements intake	72
Figure (3-5)	The mean of serum ferritin level among each trimester	72
Figure (3-5)	The mean of PLT count among each trimester	73
Figure (3-5)	The mean of RBCs count among each trimester	73
Figure (3-6)	Frequency of anaemia among study participants	74
Figure (3-7)	Distribution of anaemia among study participants according to their trimester	74
Figure (3-8)	Distribution of the degree of anaemia among studied anemic pregnant ladies related to its severity	75
Figure (3-12)	Association between serum ferritin level and iron supplements intake among study participants	75
Figure (3-14)	Association between Hb level and antenatal care follow up among study participants	76
Figure (3-14)	Association between serum ferritin level and antenatal care follow up among study participants	76

# List of Abbreviations

Abbreviation	Term
BUN	Blood Urea Nitrogen
CBC	Complete Blood Count
CO <sub>2</sub>	Carbon dioxide
EDTA	Ethylene Diamine Tetraacidic Acid
Fl	Fimto liter
GFR	Glomerular Filtration Rate
GI	Gastro Intestinal
GIT	Gastro Intestinal Tract
Hb	Hemoglobin
HCG	Human Chorionic Gonadotropin
HCT	Hematocrite
hPL	Human Placental Lactogen
IDA	Iron Deficiency Anaemia
Kg	Kilogram
MCH	Mean Corpuscular Hemoglobin
MCHC	Mean Corpuscular Hemoglobin Concentration
MCV	Mean Corpuscular Volume
PC	Programmed Computer
PCV	Packed Cell Volume
Pg	Pico gram
PLT	Platelet
RBCs	Red Blood Cells
RCFer	Red Cell Ferritin
RDW	Red cell Distribution Width
RE	Reticulo Endothelial
R.T	Room Temperature
SD	Standard Deviations
SPSS	Statistical Package for Social Science
sTfR	Soluble Transferrin Receptor
TIBC	Total Iron Binding Capacity
TWBCs	Total White Blood Cells
WBC	White Blood Cell
Wk	Week