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Incidence of Neonatal Anemia in Saad Abul-illa Hospital in Khartoum During 2015-2017

A Thesis Submitted in Partial Fulfillment for The Requirement Of the Degree of M.Sc in Biochemistry

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DEDICATION

To my dear family and husband . To my lovely mother

sisters , brothers and friends

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My great thanks to allh for giving me help and enlightenment. I would like to express my immense thanks to Dr.Othman for his assistance in approving the study . He give me much time for suggestion and careful supervision during the period of this study .My special appreciation is extended to Prof.Khalid , Prof.M. EL-sheikh Barri and Dr.Fatima for their co-supervision and valuable advice .Special thanks are extended to the staff of pediatric center in Saad Abul-illa Hospital for their help and assistance . My thanks to the teaching staff of the international University of Africa and Batch one M.Sc. for their greate help and support .Thanks also are extended to my husband , Hisham – El-Sir for his care and support and for sharing my wish to reach the goal of completing this task .Finally , I would like to express my thanks to my lovely friend Amel ,who was a great inspiration to me .

Abbreviations

Term	Abbreviations
RBCs	**R**ed **B**lood **C**ells
Hb	**H**emoglobin
HbF	**F**etal **H**emoglobin
HbA	**A**dult **H**emoglobin
EPO	**E**rythropoietin
LBW	**L**ow **B**irth **W**eight
AOP	**A**nemia **O**f **P**ermature
NICU	**N**eonatal **I**ntensive **C**are **U**nit
G6 PDH	**G**lueose-6- **P**hosphate **D**ehyfrogenates
PK	**P**yruvate **K**inase
HK	**H**exo**K**inase
IDA	**I**ron **D**eficiency **A**nemia
HIV	**H**uman **I**mmune deficiency **V**irus
LMP	**L**ast Menstrual **P**eriod
WHO	**W**orld **H**ealth **O**rganization
RH	**R**hesus factor
EDTA	**E**thylene **D**iamine **T**etra acetic **A**cid
GA	**G**estational **A**ge
ISBT	**I**nternational **S**ociety of Blood **T**ransfusion
NVD	**N**ormal **V**aginal **D**elivery
S/C	**C**aesarean **S**ection

Abstract

Background : Anemia during neonatal period is a major public health problem that contributes to neonatal morbidity and mortality .

Objective : the study was conducted in Saad Abul-illa Hospital , in Khartoum state ,sudan , to investigate neonatal anemia in new born babies during the year 2015-2017.

Methods : retrospective study where 356 neonates (186 males , 170 females _) were included in the study .Data was collected from the records included : Hb measurement , Blood grouping weight and gender of neonates and their gestational age . Hb level was measured using spectrophotometer by Drabkin`s method . The data was statistically analyzed by Anova and T-test and the level of P value ≤ 0.05 was considered significant .

Results : prevalence of the Blood complications among neonates was 9% during the period of the study , (45.40%) were anemic (31.18%) have normal Hb and 28.37% have abnormally high Hb.

Low birth weight and preterm have a significantly (P≤0.05) lower Hb compared to that of normal weight and post-term neonates .

Conclusion: The incidence of Hb complications among neonates may be due the poor maternal care and poor antenatal Care , which are the most important factors for neonatal anemia .

المستخلص

الخلفية: يعد فقر الدم خلال فترة حديثي الولادة مشكلة صحية عامة رئيسية تسهم في مرض ووفيات المواليد.

الهدف: أجريت الدراسة في مستشفى سعد أبو العلا ، بولاية الخرطوم ، السودان ، للتحقيق في فقر الدم عند الأطفال حديثي الولادة خلال الفترة 2015-2017.

الطريقة: دراسة بأثر رجعي حيث تم تضمين 356 حديثي الولادة (186 من الذكور ، 170 إناث _) في الدراسة. تم جمع البيانات من السجلات بما في ذلك: قياس هيموقلوبين ، و نوع فصيلة الدم ونوع حديثي الولادة وعمر الحمل. تم قياس مستوى Hb باستخدام مقياس الطيف الضوئي بواسطة طريقة Drabkin.

تم تحليل البيانات احصائياً باستخدام Anova و T-test ($P \leq 0.05$)

النتائج: كان معدل انتشار مضاعفات الدم بين المواليد 9٪ خلال فترة الدراسة ، (45.40٪) مصاب بفقر الدم (31.18٪) معدل Hb طبيعي و 28.37% مصاب بارتفاع Hb غير طبيعي.

انخفاض وزن المواليد والخدج لديهم Hb أقل بشكل ملحوظ مقارنة بالوزن الطبيعي وحديثي الولادة.

الخلاصة: إن حدوث مضاعفات Hb بين المواليد قد يكون بسبب سوء رعاية الأمهات وضعف الرعاية السابقة للولادة ، والتي تعد أهم العوامل لفقر الدم عندهم .

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Chapter One

1.1 Introduction:

Anemia means that there is insufficiency in the total amount of the red blood cells(RBCs), .It is a condition in which the number and size of (RBCs), or the hemoglobin concentration, falls below an established cut- off value, consequently impairing the capacity of the blood to transport oxygen around the body [1]. Anemia is an indicator of both poor nutrition and poor health.

Neonatal anemia is the most hazardous problem which affect the infant development and hence the life of millions of children who are affected by the condition. However this may be attributed partly to the maternal health status and the gestational age especially preterm neonates [2].

Neonatal anemia may be due: to blood loss , increase in RBC destruction and decrease in RBC production. Anemia affects one third of the global population worldwide being highest in Africa(55%) Asia (41.6%) and lowest in Europe (1.7%) and north America (6.1%) [3] .the prevalence of anemia among reproductive women differs in various countries around the world: for example, Burundi (64.4% to 28% in 20 years); China (50.0% to 19.9% in 19 years); Nepal (65% to 34% in 8 years); Nicaragua (36.3% to 16.0% in 10 years); Sri Lanka (59.8% to 31.9% in 13 years); and Viet Nam (40.0% to 24.3% in 14 years)[4]

In Sudan a study carried out on anemia at Wad Madani Hospital, indicated that neonatal anemia is likely due to low birth weight (LBW) [5]. Likewise a study carried out at Kassala hospital revealed many maternal complications and preterm birth in woman who had no antenatal care [6] . It is evident that studies carried out about Sudanese neonatal anemia were insufficient and scarce . This

study is intended to investigate neonatal anemia in Saad-Abul-illa Hospital in Khartoum state during 2015-2017.

1.2 Objectives:

1.2.1 General Objective:

To investigate neonatal anemia in newborn babies at Saad-Abul-illa hospital in Khartoum state during 2015-2017.

1.2.2 Specific Objective:

1- To investigate the incidence of neonatal anemia at Saad-Abul-illa Hospital during 2015-2017.
2- To determine Hb levels of neonates .
3- To measure weights of neonates .
4- To investigate the effect of mode of delivery and gestational age on Hb level.

Chapter Two

Literature review

2.1 Background

Neonatal anemia is defined by ahemoglobin or hematocrit concentration of greater than 2 standard deviation below the mean for post natal age [7] . Hematopoiesis in the fetus and neonate is in aconstant state of flux and evolution as the newborn adapts to a new milieu . Fetal erythropoiesis occurs sequentially during embryonic development in three sites: yolk sac, liver and bone marrow [8] . At the birth , almost all RBCs are produced in the bonmarrow , although a low level of hepatic erthropoiesis persists through the first few days of life . The production of RBCs is controlled by erythropoietin (EPO) produced by kidneys.

All newborn infants have a physiological drop in Hb level 2-3 months after birth due to the breakdown of fetal (FHb) that is to be replaced by adult (AHb) and due to the low level of erythropoietin (EPO).IN addition preterm infants have lower Hb levels at birth compared with term infants [9] .As shown in various studies" Hb levels are gestational age dependent [10-11] .moreover "erythropoiesis in preterm infants may be impaired due to low iron stores.

Transplacental transport of iron from mother to fetus occurs mainly in the third trimester of pregnancy and is thus reduced in preterm infants.preterm infants are also at increased risk of blood loss due to frequent diagnostic blood tests. [13]

As shown in several studies" the amount of blood drawn in neonates admitted toaneonatal intensive care unit (NICU)department accounts for important blood loss [12] ,the amount of blood drawn equals the amount of

blood transfused in preterm infant born between 30-32 gestational age(GA) [13] .

2.2 Patho-physiology

In the 8-10 week period immediately following birth, all infants universally experience a decrease in hemoglobin (Hb) that results in varying degrees of anemia. The rapidity with which this anemia develops and its ultimate severity are determined by a combination of multiple physiologic and nonphysiologic processes . Preterm infants are especially vulnerable to these processes for two reasons. First, the severity of the developmental postnatal decrease in Hb is most pronounced in the least mature infants, placing them at high risk of developing clinically significant anemia. Second, as a group, preterm infants are particularly prone to developing severe cardiorespiratory and infectious illnesses, the diagnosis and management of which requires frequent laboratory assessment, resulting in heavy phlebotomy loss. It is the combination of developmentally regulated physiologic processes (commonly referred to as anemia of prematurity (AOP) along with concomitant pathologic and iatrogenic processes that contribute to the progressive anemia experienced by virtually all preterm infants [14] . Management will depend on cause and severity of anemia. For example for prenatal, diagnosis of significant fetal anemia is usual except in hymolytic disease of the newborn. Fetal transfusion may be needed for severe anemia. For postnatal (AOP) is common. The main methods of management are: limit blood drawing for laboratory test or treatment with recombinant human erythropoietin (EPO) . [14]

2.3 causes of neonatal anemia:

The causes of anemia may be classified as impaired red blood cell (RBC) production, increased RBC destruction (hemolytic anemias), blood loss and fluid overload (hypervolemia). Several of these may interplay to cause anemia eventually. Indeed, the most common cause of anemia is blood loss, but this usually does not cause any lasting symptoms unless a relatively impaired RBC production develops, in turn most commonly by iron deficiency [15] .

2.3.1 Impaired RBCS production:

RBCS production (erythropoiesis) take place in bone marrow under the control of the hormone EPO. Juxtaglomerular cells in the kidney produce EPO in response to decrease oxygen delivery[16] . The main impaired included:

2.3.1.1 Disturbance of differentiation of stem cells:

It can lead to many types of anemia like:

1. Aplastic anemia [16] affects all kinds of blood cells. It is a hereditary disorder.
2. Anemia of renal failure [17] by insufficient of erythropoietin production
3. Anemia of endocrine disorders

2.3.1.2 Disturbance maturation of erythroblasts:

Also it leads to many types of anemia like :-

1. Pernicious anemia [18] is a form of megaloblastic anemia due to vitamin B_{12} deficiency.
2. Anemia of folic acid deficiency.

3. Anemia of prematurity, by diminished erythropoietin response to declining hematocrit levels, combined with blood loss from laboratory testing, generally occurs in premature infants at two to six weeks of age.[19]
4. Iron deficiency anemia, resulting in deficient heme synthesis [19]
5. Thalassemias, causing deficient globin synthesis[20]
6. Congenital dyserythropoietic anemias, causing ineffective erythropoiesis.

2.3.2 Increased destruction of (RBCs):

Anemia of increased red blood cell destruction are generally classified as hemolytic anemia [21] . These are generally featuring jaundice and elevated lactate dehydrogenase levels. Hemolytic anemia can be intrinsic or extrinsic.

2.3.2.1 Intrinsic hemolytic anemia:

It develops when the RBCS produced by body don't function properly. This condition is often inherited, such as in people with sickle cell anemia and thalassemia [22]. Other times, a metabolic abnormality, such as in people with G6PD deficiency[23], or RBCs membrane instability can lead to this condition**.**

2.3.2.2 Extrinsic hemolytic anemia:

It develops by several methods, such as when the spleen taps and destroys healthy RBCs or an autoimmune reaction occurs[24]. It can also come from RBCs destruction due to:

- Infections, including malaria[25].
- Tumors.
- Autoimmune disorders.
- Leukemia.

- Lymphoma

2.3.3 Blood loss:

Anemia of prematurity from frequent blood sampling for laboratory testing, combined with insufficient RBC production Trauma[26] or surgery, causing acute blood loss. Although usually indicative of maternal hemorrhage, maternal vaginal bleeding may result from torn fetal placental or umbilical vessels and lead to sudden, massive fetal blood loss.

2.4 maternal status:

Women are more likely than men to have low iron stores because of blood loss at the time of menstruation. During pregnancy, the fetal demand for iron increase. Maternal daily iron requirements ranges from =1 to 2.5 mg/day during 1st trimester and 6.5 mg/day in the third trimester. The average daily diet in the developed world contains =10-14 mg nonheme iron[27], however not all of it can be absorbed[28]. Evidence from stable-isotope studies suggests that the percentage of nonheme iron absorbed from food during normal pregnancy increases from 7% at 12 week of gestation to 36% at 24 week and 66% at 36 week. These dramatic changes enable the healthy pregnant woman to cope with the extra demands of iron during pregnancy without becoming anemic [29] . It was reported that if the woman's diet is deficient in iron, as is the case in many developing countries, fetal requirements can be met only by additional contributions of iron from maternal stores [30] . This demand by the developing fetus may cause the mother to develop iron deficiency anemia if she had inadequate beginning of pregnancy.

2.5 Hemoglobin

Hemoglobin (American) or **Heamoglobin** (British) abbreviated **Hb** or **Hgb** [31] , is the iron-containing oxygen-transporter metalloprotein in the red blood cells of all vertebrates as well as the tissues of some invertebrates[32].

Hemoglobin is a protein made up of four poly-peptide. Each chain is attached to a heam group composed of prophyrin attached to an iron atom. These iron prophyrin complexes coordinate oxygen molecules reversibly, an ability directly related to the role of Hb in oxygen transport from the respiratory organs (lungs) to the other organs of the body [33]. Where it releases the oxygen to permit aerobic respiration to provide energy to power the function of the organism in a process called metabolism [34], and carries about 20-25% Carbon dioxide (CO_2) to exhaled by the lungs.

In adults, Hb is made up of four subunits two alpha and two beta (α_2, β_2)it is known as adult hemoglobin (HbA). In fetuses, Hb is known as fetal hemoglobin (HbF) consisting of two alpha and two gamma subunits (α_2, γ_2) [35]. It is the main oxygen transport protein in fetus during the last seven months of development in the uterus and persists in the new born until roughly 2-4 months old. Functionally, HbF differs from HbA in that it is able to bind oxygen with greater affinity than adult form , giving the developing fetus better access to oxygen from the mother's blood stream [36]. HbF is nearly completely replaced by HbA by approximately 6 months postnatally.

2.6 Prevalence of neonate's anemia:

Neonate anemia is a global public health problem affecting both developing and developed countries with major consequences for human health as well as social and economic development which results in a loss of billions of dollars annually [36] . According to the 2015 World Health Organization (WHO) report, anemia affected 1.62 billion (24.8%) people globally [36]. Geographically, those living in Asia and Africa are at the greatest risk.

Anemia is multi-factorial in etiology; the disease is thought to be mainly caused by iron deficiency in developing countries. In sub-Saharan Africa where iron deficiency is common, the prevalence of anemia has often been used as a proxy for iron deficiency anemia (IDA)[37]. Other micronutrient deficiency (vitamins A and B12, riboflavin, and folic acid) has also been a cause of anemia during pregnancy[37]. Infectious diseases such as malaria, helminthes infestations, and HIV are also implicated with high prevalence of anemia in sub-Saharan Africa[38]. There was also a considerable variation in the prevalence of pregnancy anemia because of the differences in socioeconomic conditions, lifestyles, and health seeking behaviors of different population across different countries and cultures and obstetrics and gynecological related condition of pregnant mothers[38].

The effect of anemia during pregnancy on maternal and neonatal life ranges from varying degrees of morbidity to mortality. As many studies elucidated, severe anemia (Hb < 7 g/dL) during pregnancy has been associated with major maternal and fetal complications. It increases the risk of preterm delivery [39], low birth weight, (LBW)intrauterine fetal death, neonatal death, maternal mortality, and infant mortality [39].

Anemia prevalence data remains an important indicator of public health since anemia is related to morbidity and mortality in the population groups usually considered to be the most vulnerable like pregnant women. At a global level, anemia prevalence is a useful indicator to assess the impact of widespread or highly effective interventions and to track the progress made towards the goal of reducing anemia during pregnancy [39]. Anemia prevalence study is also useful to monitor the progress of reproductive health [39]. Despite the efforts made to reduce the burden, its prevalence has not been studied yet comprehensively in developing countries.

In Sudan at Kassala Hospital, Eastern Sudan in the period of January–December 2009 were stated that Out of 4,689 delivered women, (14.7%) were teenagers, (67.1%) had no antenatal care and (12.6%) were grandmultiparous. Obstetric complications included: pre-term birth (2.6%); pre-eclampsia/eclampsia (4.2%); hemorrhage(2.9%); malpresentation (5.5%); obstructed labor (1.9%) and ruptured uterus (0.6%). Caesarean delivery rate was (31.1%.),While 89.4% of the newborn babies were taken home, 6% were admitted to the nursery, 4.4% were stillbirths, and (0.2%) immediate neonatal deaths. There were 26 maternal deaths (550 per 100,000 live births), mainly due to septicaemia (38.4%), hemorrhage (19.2%), embolism (15.3%) and malaria (11.5%). Later at wad Madani hospital [5] a study reflected that, there was (12.6%) out of 1224 singleton deliveries neonates were low birth weight (LBW) deliveries and the rest were small for gestational age. In comparison with controls, significantly more women in the case group did not attend antenatal care.

2.7 Blood groups:

Blood group (also called a blood type) is a classification of blood based on the presence and absence of antibodies and also based on the presence or

absence of inherited antigenic substances on the surface of red blood cells (RBCs). These antigens may be proteins, carbohydrates, glycolipids depending on the blood group system. Blood types are inherited and represent contributions from both parents [(34)]. There are many blood group systems in human, but the common systems are:

2.7.1 ABO blood group system:

The *ABO system* is the most important blood-group system in human-blood transfusion which was adopted by international society of blood transfusion (ISBT)[40]including:

1. Antigen A with antibody B
2. Antigen B with antibody A
3. Antigen AB has no antibodies
4. Antigen nil (group O) with antibody A and B

2.7.2 Rh blood group system:

The Rh system (Rh meaning *Rhesus*) is the second most significant blood-group system in human-blood transfusion with currently 50 antigens.

Rh disease can develop in these cases[41]. Rh negative blood types are much less common in Asian populations (0.3%) than they are in European populations (15%).(31) The presence or absence of the Rh(D) antigen is signified by the + or − sign, so that, for example, the A− group is ABO type A and does not have the Rh (D) antigen.

2.8 Pregnancy & Gestational Age :

2.8.1 pregnancy:

Pregnancy is known as gestation, is the time during which one or more offspring develops inside a woman.A multiple pregnancy involves more than one offspring, such as with twins. Pregnancy can occur by sexual intercourse or assisted reproductive technology. Childbirth typically occurs around 40 weeks from the last menstrual period (LMP). This is just over nine months, where each month averages 29½ days. When measured from conception it is about 38 weeks. An embryo is the developing offspring during the first eight weeks following conception, after which, the term *fetus* is used until birth. Symptoms of early pregnancy may include missed periods, tender breasts, nausea and vomiting, hunger, and frequent urination. [43] it is confirmed with a pregnancy test. [43]

Pregnancy is typically divided into three trimesters. The first trimester is from week one through 12 week and includes conception, the second trimester is from week 13through 28 and third trimester is from week 29 through 40. [44]

2.8.2Gestational Age (GA) :

Is the common term used during pregnancy to describe how far along the pregnancy is. It is measured in weeks, from the first day of the woman's LMP to the current data. A normal pregnancy can range from 38 to 42 weeks. Neonate delivered at this range called full term neonate, while the preterm delivered before complete 38 weeks and post date after 42 weeks (GA). [44]

Chapter three

Material and methods

3.material

3.1 Study area:

This study was carried out in Saad Abul-illa hospital in Khartoum from 2015-2017.

3.2 Study design:

Retrospective study was conducted on Sudanese neonates with Hb anemia during the period from 2015 -2017.

3.3 Study Subjects:

Data of this study were obtained from records of Saad Abul-illa hospital which include 356 neonates (186 males, 170 females).

3.4 Data Collection:

Data of this study included: Hb measurement, blood grouping, weights, gender and gestational age of neonates.

3.5 Sample Size:

Sample size of this study were 356 neonates (186 males, 170 females).

3.6 Exclusion Criteria:

Normal neonates were excluded.

3.7 Ethical Consideration:

The objectives of this study was explained to all mothers participating in this study and they agreed to participate the study.

3.8 Collection and preparation of blood samples :

1. The skin were cleaned with antiseptic then a band was wrapperd around the arm of neonate .

2. With disposable syringe from the vein 3ml of blood were withdrawn and transferred directly into tubes containing ethylene diamine tetra acetic acid (EDTA) as anticoagulant . the whole blood was directly used for measurement of Hb and blood groups.

3.9 Biochemical measurements :

Biochemical parameter measurement were Hb and Blood grouping.

3.9.1 Measurement of hemoglobin :

Hb was determined according to the Drabkin's method [45] .

Principle:

The principle of this method is that ' when blood with a solution containing potassium ferricyanide and potassium cyanide . The potassium ferricyanide oxidized iron to form methemoglobin . The potassium cyanide combines with methemoglobin to form cyanmethemoglobin, which give stable green color read photometrically at the wave length 540 nm.

REAGENTs:

Drabkin's solution contains: sodium bicarbonate 140 mg, potassium ferricyanide 200mg and potassium cyanide 50 mg dissolved in a liter of distilled water.

Procedure:

1. three test tubes were labeled: Blank tube , STD tube , Test Tube .In each tube 20 µl of blood were added .

2. 5 ml of Drabkin reagent were added into each tube except the Blank tube, then 5 ml of water were added.

3. the tubes were mixed well and allowed to stand for 15 minutes.

4. Absorbance measure in spectrophotometer at 540 nm , after that Hb level was measured by this Formula.

$$\text{Hb conc.(g/dL)} = \frac{0.DT\ sample}{0.D\ std} \times conc.STD$$

3.9.2 Blood grouping test:

20 µl of the blood sample were mixed with antibodies

(A,B or AB) in slide ,to attack type A and B blood groups .

1. If the blood cells clump together when mixed with antibodies against type A blood that mean the sample is type B blood .

2. If it is clump when mixed with antibodies type B ,that means the sample is type A blood.

3.If it is clump when antibodies type AB were added and mixed that means the slide is type O blood .

4.Type AB has no antigen .

3.9.3Determination of Rhesus (Rh) factor :

The known blood type specimen were mixed with an anti-Rh serum and see the response was reported. If the sample's cells were clump together , this means that the sample has Rh –positive blood (O+ve) .

3.10 Statistical Analysis:

Values were presented as a mean ± standard deviation (SD) of the mean of all measured variables. For comparison between the different groups, analysis of variance (ANOVA) test and sometimes **T** test were carried out using (SPSS version IBM statistic 22.0.0.0) program package at 95% confidence. Level of P. value of ≤0.05 was considered significant.

Chapter four

4. Results:

Results of this study were obtained from records of Saad Abul-illa Hospital and from record of samples analyzed for Hb and blood groups during 2015-2017

4.1 Neonates with complications:

Results presented in table(1) indicated that about 9% of the total delivered neonate (7042) during the period 2015-2017 at Saad-Abul-illa Hospital suffered various hemoglobin complications. During 2016 the percentage (7.9%) of affected neonates was slightly lower than those of the other years about (9%). Records of the hospital revealed that annually delivered neonates with Hb complication were more than two hundred cases.

Table (1) Total delivery and Percentage of affected neonates during the years 2015 , 2016 and 2017

Year	Total delivery	Neonates with complication	% of affected
2015	2261	224	9.90%
2016	1935	140	7.23%
2017	2846	272	9.55%
Mean ± SD	2364± 488.7	212±66.81	8.89±1.45

4.2 Distribution of neonates according to Hb level :-

Distribution of neonates with Hb complications were represented according to their Hb level table (2) revealed that about 44.45% of neonates anemic, 28.37% have abnormality high Hb level and those with normal Hb were 31.18% .

Table (2) distribution of neonates according to Hb level:

Hb level g/dl	THE YEAR OF STUDY			*Total	Percentage %
	2015	2016	2017		
UNDER NORMAL(<14) ± SD	48	28	68	144	40.45
NORMAL(14-20) ± SD	35	36	40	111	31.18
OVER NORMAL (>20) ± SD	16	42	43	101	28.37
total	99	106	151	356	100

*P ≤ 0.00

4.3 The effect of sex on Hb level:

Result given in table (3) showed that Hb in males (15.3% ±2.7 g / dL) was slightly higher than that of the females Hb (14.4% ± 2.9 g / dL).

Table (3) Level of Hemoglobin in male and female neonates

Gander	n	%	* Hb ± SD g/dl
Male± SD	186	52.2%	15.3 ± 2.7
Female ± SD	170	47.8%	14.4 ± 2.9
Total / mean ± SD	356	100%	15.1 ± 2.8

*P ≤ 0.34

4.4 The effect of mode of delivery on Hb level:

As shown in table (4) about 37% of the neonates were delivered normally and their Hb level was (15.4% ± 2.9) whereas 63% were caesarean delivery and their Hb level was (14.9% ± 2.7) . There is no significant deferent between them .

Table (4) Effect of Mode of delivery on Hemoglobin Level

MODE OF DELIVERY	n	%	* Hb± SD g/dl
Normal vaginal delivery (NVD ± SD)	132	37%	15.4 ± 2.9
Caesarean section C/S ± SD	224	63%	14.9 ± 2.7
Total / mean ± SD	356	100%	15.1 ± 2.8

*P ≤ 0.08

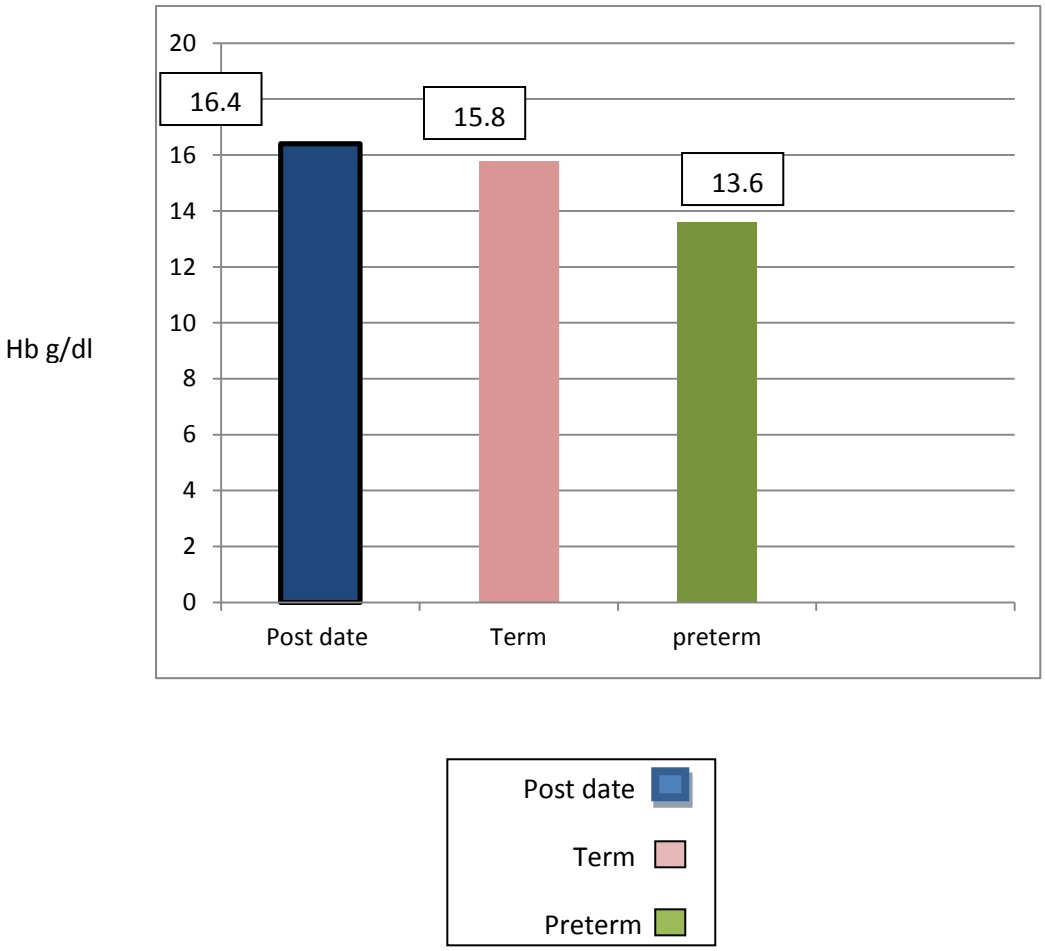
4.5 The effect of gestational age on Hb level:

Results shown in table (5) and fig (1) indicated that (34.5% ± 3.0) newborn were preterm babies, (58.1% ± 2.4) were full term, and (7.3% ± 2.3) were post term. The level of Hb increased significantly with increasing of age and highest Hb was observed for post term neonate whereas, the lowest Hb was reported for preterm ones which is significant.

Table [5] Hemoglobin level of neonates with different gestational age

GESTATIONAL AGE	n	%	* Hb ± SD g/dl
PRETERM ± SD	123	34.5%	13.6 ± 3.0
TERM ± SD	207	58.1%	15.8 ± 2.4
POST DATE ± SD	26	7.4%	16.4 ± 2.3
Total / mean ± SD	356	100%	15.1 ± 2.8

*P ≤ 0.00



Fig(1) hemoglobin level of different gestational age neonates

4.6Association of Hb level with neonates blood group:

Results presented in table (6) stated that the differences in Hb level among the various blood group were not significant. The highest number of neonates have O+ve (146) followed by the blood group A+ve (95) and the lowest number were A-ve (7).

Table (6) Association between baby blood groups and Hemoglobin Level

Baby blood groups	n	%	* Hb± SD g/dl
A+	95	26.7%	15.3 ± 3.0
B+	60	16.9%	14.9 ± 2.4
AB+	13	3.7%	15.0 ± 3.08
O+	146	41%	15.2 ± 2.8
A-	7	2%	14.8 ± 2.3
B-	10	2.8%	14.3 ± 2.0
AB-	7	2%	15.1 ± 3.0
O-	13	3.7%	15.4 2.9
Total / mean ± SD	356	100%	15.1 2.8

*P ≤ 0.87

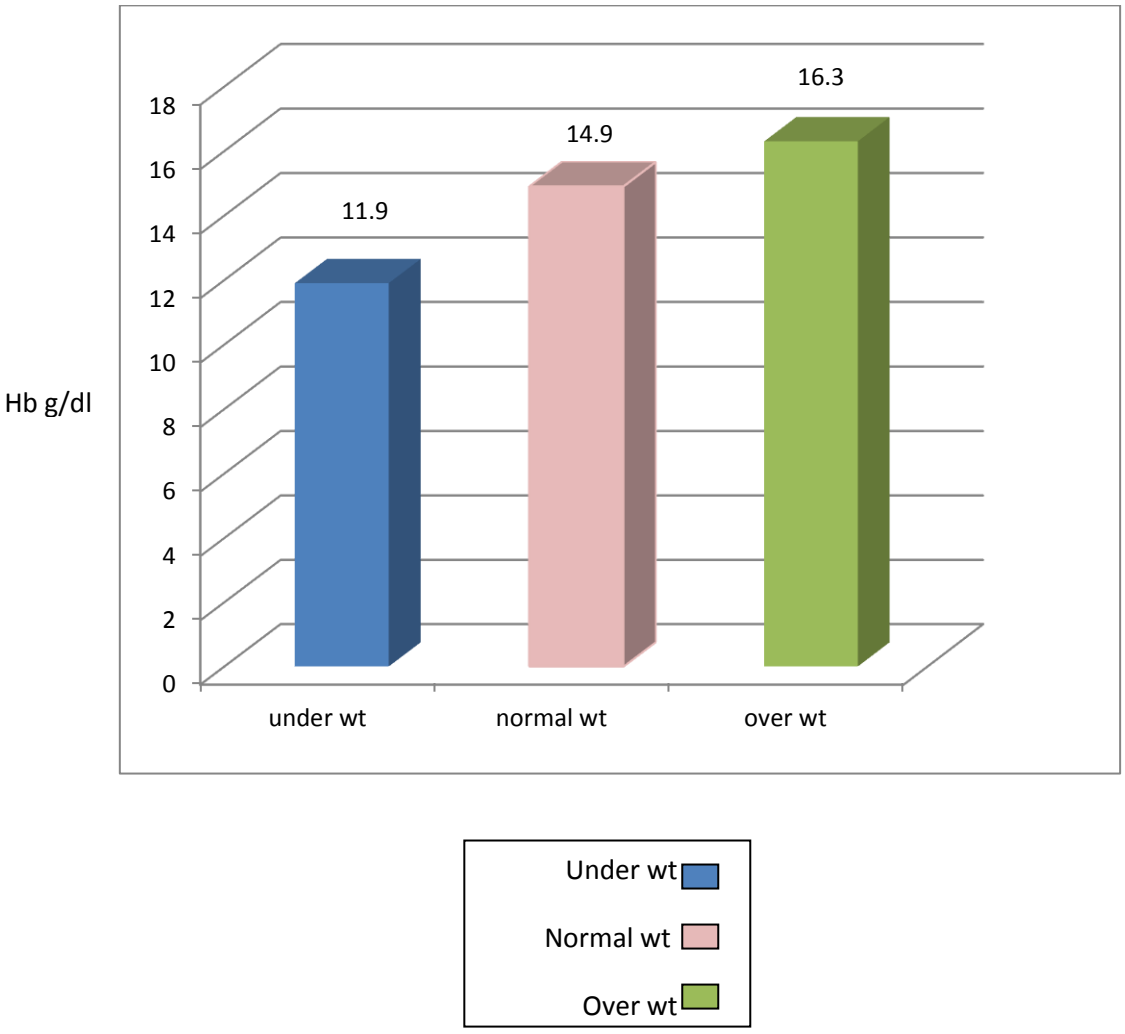
4.7 The effect of weight on Hb level:

Result shown in table (7) and fig (2)indicated that (31) neonates were born with low weight (≤ 1.5Kg) and their Hb level was (11.9 ± 2.6 g / dl) and 218 neonates were born with normal weight (1.5 – 3.00 Kg) and their Hb level was (14.9 ±2.9 g / dl), whereas 107 neonates born with over weight (≥3)Kg and their Hb level was (15.1 ± 2.8 g / dl).

Table (7) Neonates weights and their Hemoglobin Level

Baby weight kg	n	%	* Hb± SD g/dl
UNDER WEIGHT (<1.5) ± SD	31	8.7%	11.9± 2.6
NORMAL WEIGHT (1.5-3) ± SD	218	61.2%	14.9± 2.7
OVER WEIGHT (>3) ± SD	107	30.1%	16.3± 2.3
Total / mean ± SD	356	100%	15.1 ± 2.8

*P ≤ 0.00



- **Fig(2):mean of the hemoglobin (g/dl) according to the body weight**

Chapter Five

Discussion

Incidence of the Hemoglobin complication among neonates was about (9%) table (1)this may state that there is a challenging health problem which may be attributed to maternal health. These results agreed with the results obtained in Kassala and Wad-Madani hospitals [5-6] ,that Indicate the maternal status was poor and there was no antenatal care .These complications maybe attributed to the poor socio-economic status of Sudanese people especially those who have no access private hospital because of the higher cost .

Our study reported that there about (44.45%) of the neonates were with abnormally lower Hb , (28.37%) with abnormally higher Hb , whereas (31.18/%) only were with normal Hb level table(2). It is evident that the majority of neonates were anemic and special care is highly needed to improve their health status . This condition of abnormally Hb is called (Polythycemia) is due to a low oxygen level in the blood (hypoxia) or due to passive transfusion of RBCs into the neonatal circulation . [10]

The slightly higher Hb level of males (15.3±2.7 g/dl) compared to that of females (14.4 ±2.9 g/dl) table (3) which was not significant may exclude gender difference in Hb level between neonates . These observations are beyond the scope of this study, hence at this stage there is no physiological difference .

The current study showed that the level of Hb was not effected with the mode of delivery table (4). This result agreed with that obtained in Madani Hospital which indicated that neonatal anemia is likely due to low birth Wight (LBW) [5] . Our explanation to these cases that most of the caesarean may be a pretern to save the mother and the baby.

On the other hand the previous studies stated that; lack of antenatal care and maternal health were the main risk factors for caesarean section followed by decrease in Hb level. It is worth mentioning that both Hb and neonates weights increased significantly with gestational age . These results agreed with several studies which stated that the Hb levels are gestational age dependent [11-10]. In fact preterm delivery may terminate the natural neonate growth , thus leads to lower Wight and Hb

The current study reported that there was no association between the blood groups and the neonates Hb levels table (6). The differences in the Hb levels among the various blood groups were not significant. It is evident that blood groups and (Rhesus factor are necessary for conception and continuation of pregnancy , how ever they have effect on the level of Hb . [41]

Conclusions

- In this study it was found that gestational age and neonate Wight significantly the affect the level of Hb , whereas the effect of gender and the mode of delivery was not significant . Although the O+ and A+ blood groups were the dominant but no significant effect of Hb level was reported .

Recommendations

1- Further studies are needed to link between maternal health status and neonates health in all of Khartoum states hospitals.

2- Neonate's anemia may increase greatly in the near future because of the socio-economic factor. A prompt programs for neonatal care are highly needed to reduce neonatal anemia.

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