بسم الله الرحمن الرحيم

Republic of Sudan

Ministry of Higher Education and scientific Research

University of Shendi

Faculty of Graduate Studies and Scientific Research

Establishment of Hematological Parameters Normal Values in Adult at Shendi Locality

A thesis Submitted for partial fulfillment of the Msc. Degree in Hematology

By

Hind Hassan Ahmed Mohammed

BSc. (Shendi University)(2003)

Supervisor

Dr. Hamza Ahmed Hassan Mohammed Eltoum
Assistant Profession in hematology medical laboratories science- Shendi University

July – 2018

الآية

قال الله تعالى :

بسم الله الرحمن الرحيم

﴿ اللهُ لا إلَهَ إلَا هُوَ الْحَيّ القَيّومُ لَا تَأْخُذُهُ سِنَةٌ وَلَا نَوْمٌ لَهُ مَا فِي السَمَاوَاتِ وَمَا فِي الأَرْضِ مَن ذَا الَذِي يَشْفَعُ عِندَهُ إلَا بِإذْنِهِ يَعْلَمُ مَا بَيْنَ أَيْدِيهِمْ ومَا خَلْفَهُمْ ولَا يُحِيطُونَ بشي مِنْ عِلْمِهِ إلَا بِمَا شاء

وَسِعَ كُرْسِيُهُ السَمَاوَاتِ والْأَرْضَ وَلَا يَؤُدُهُ حِفْظُهُمَا وَهُوَ الْعَلِيُ الْعَظِيمُ ﴾

صدق الله العظيم

سورة البقرة –الآية 255

الإهـــداء

إلهي لا يطيب الليل إلا بشكرك ولا يطيب النهار إلى بطاعتك .. ولا تطيب اللحظات إلا بذكرك .. ولا تطيب الآخرة إلا بعفوك .. ولا تطيب الجنة إلا برؤيتك

الله جل جلاله

إلى من بلغ الرسالة وأدى الأمانة .. ونصح الأمة .. إلى نبي الرحمة ونور العالمين..

سيدنا محمد صل الله عليه وسلم

إلى من كلله الله بالهيبة والوقار .. إلى من علمني العطاء بدون انتظار .. إلى من أحمل أسمه بكل افتخار .. أرجو من الله أن يمد في عمرك لترى ثماراً قد حان قطافها بعد طول انتظار

وستبقى كلماتك نجوم أهتدي بها اليوم وفي الغد وإلى الأبد

أبي الغالي: حسن احمد محمد

إلى من كان قلبها مدرسة لي .. إلى من تسربت دواخلها دون استئذان

إلى من استقبلتني بابتسامة حين أتيتها باكياً.. إلى من أثرت على نفسها من أجلنا

إلى من علمتنا العطف والحنان . الصبر – التسامح بل كل الأشياء الجميلة

إلى من لا أستطيع وصفها من تمنيت تقبيل تراب قدميها عند نجاحي

فأنا أعترف أنني مدينة بكل ما وصلت إليه وما أرجو أن أصل إليه من الرفعة إلى أمي الملاك عفواً أمي لا أستطيع مكافئتك أسأل الله أن يكافئك بالجنة مع محمد صل الله عليه وسلم فأنتِ لا أقول أعظم امرأة بل أقول أعظم شيء في تاريخ حياتي

إلى أمي الغالية منيرة محمد الحسن الزبير

إلى من قاسموني رحم أمي وشاركوني حنان أبي

إلى من صنعوا وكللوا لي نجاحي

أخواتي وأخواني الأعزاء

أهديكم بحثي عبقا تفوح منه رائحة اجتهادكم معي يطيبه وجودكم بين جنبي وتجمله فرحتكم وسعادتكم التي هي مبتغاى وسر سعادتي.

سأشكركم قدر استطاعتي ولكن سامحوني لأنني لأستطيع أن أوفيكم وأجزيكم بقدركم السامي فبارك الله فيكم ولا حرمني دعواتكم

إلى أخواني الذين لم تلدهم أمي.....إلى من تحلو بالإخاء وتميزوا بالوفاء .... إلى ينابيع الصدق الصافي ، إلى من سعدت وبرفقتهم في دروب الحياة الحلوة والحزينة سرت...إلى من كانوا معي على طريق النجاح والخير ....إلى من عرفت كيف أجدهم وعلموني أن لا أضيعهم....

الشكر والعرفان

سيبقي في حنايا النفس لأهل الفضل عرفاناً جميلا

فاكتب أحرفاً بمداد النور وابقي انشد الشكر الجزيل...

الشكر إلي الله أولاً ...

هناك أناس يقف اللسان عاجزاً عن شكرهم فلا عجب من ذلك

فهم أهل الشكر والثناء ...

هكذا كنت شموعا أوقدت المعرفة والعلم في دربنا

أساتذتي الأجلاء ...

ومشرف البحث الذي لم يبخل بجهده ووقته حتى خرج بحثي

بهذا الشكل...

الدكتور :حمزة احمد حسن

List of abbreviations

EDTA	Ethyl di amin tetra acidic acid
Hb	Haemoglobin
MCH	Mean corpuscular haemoglobin
MCHC	Mean corpuscular haemoglobin concentration
MCV	Mean corpuscular volume
PCV	Packed cell volume
PLT	Platelet
RBC	Red blood cell
TWBS	Total white blood cells

المستخلص

اختبار الدم الكامل يستخدم لتحديد تركيز الهيموقلوبين، كريات الدم الحمراء، الصفائح الدموية، حجم الخلايا المكدسة، معاملات كريات الدم الحمراء، كريات الدم البيضاء لتحديد العلاج المناسب.

جهاز مندري 0 300 Bc يستخدم بصوره واسعة في تحليل الدم الكامل ..

أجريت هذه الدراسة بمدينه شندي في الفترة من مارس حتى يوليو 2018م، اشتملت الدراسة علي 100 عينه جمعت على مضاد التجلط EDTA من وريد البالغين لتحديد المكونات الدموية. حللت النتائج بواسطة الحزمة الإحصائية للعلوم الاجتماعية وأظهرت الدراسة أن متوسط الهيموقلوبين في الذكور 13.9 g/dl والإناث 12.7 g/dl، كريات الدم الحمراء في الذكور $4.95 *10^{12}$ c/mm^3 والإناث $4.6*10^{12}$ c/mm^3، حجم الكريه الحشوي في الذكور 43.3% والإناث 39.7% ،حجم الكريه الوسطي في الذكور 90.6FL والإناث 87.9FL ، هيموقلوبين الكريه الوسطي في الذكور 30.2Pg والإناث 29.4Pg ، تركيز هيموقلوبين الكريه الوسطي في الذكور 33.9g/dl والإناث 32.5 g/dl، كريات الدم البيضاء في الذكور $5.7*10^9$/L والإناث $6.02*10^9$/L، والصفائح الدموية في الذكور $236*10^9$/L والإناث $276*10^9$/L.

ومن هنا يتضح أن:

- المكونات الدموية في الذكور أعلي من الإناث ما عدا الصفيحات الدموية وكريات الدم البيضاء.
- المكونات الدموية في الذكور والإناث البالغين تكون في المعدل الطبيعي ما لم توجد مسببات مرضية تؤدي إلي زيادة أو نقصان المعدل الطبيعي للمكونات الدموية.

Abstract

Complete blood count is used to measure hemoglobin concentration, white blood cells count, red blood cells count, platelet, packed cells volume and red blood cells indices, therapy allowing for appropriate therapy Mindray hematological analyzer (mindray B3000), that is commonly used for hematological analysis. This study was conducted to compare complete blood count between adult male and female. This study was conducted in Shendi teaching hospital which located in Shendi town in Sudan during the period between March to July 2018.

The study included 100 samples in EDTA anticoagulant containers were collected from venous of adult people to measure hematological parameters.

The results are analyzed by using statistical analysis performed with statistical package for social sciences (SPSS). The study showed The mean of hemoglobin was13.9g/dl in male and12.7g/dl in female, RBCs was 4.9 $x10^{12}$ c/mm^3 in male and 4.6 × 10^{12} c/mm^3 in female, Hct was 43.3 % in male and 39.7 % in female, MCV was90.6 FL in male and 87.9 FL in female, MCH was30.2 pg in male and 29.4in female, MCHC was33.9g/dlin male and 32.5g/dlin female, TWBCs was 5.7$x10^9$/L in male and6.02 × 10^9 / L in female and platelet was 236 $x10^9$/L in male and 276×10^9 / L in female.

The hematological parameter in adult male higher than in female but platelet and TWBCs was higher in female.

The all hematological parameters in adult male and female with in the normal range that means are healthy.

List of contents

List of tables

List of Figures

Chapter one

Introduction

Rationale

Objectives

1.1. Introduction

The development of human starts in the uterus after fertilization and during pregnancy which named prenatal development. After delivery many stages model of development have been proposed such as new-born, infancy, childhood, adolescence and adulthood that characterize by biological and physical changes.

Health of an individual is known to vary in different countries, in the same country at different times, and in same individuals at different ages. It is thus a relative and not an absolute stage. This means that the condition of individuals must be related to or compared with reference data. On comparing the individuals' data collects through the medical interview, clinical examination and supplementary investigations with the reference data, the condition of individuals can be interpreted. Reference value is defined as the value obtained by observation or measurement of a particular type of quality on an individual belonging to the reference group. Investigation of an individual should entirely depend on the normal ranges, which have been established to an individual’s locality. adult haematological parameters differ from neonate and infant . A study was done which revealed that various blood indices vary in the adult as compared to older children or infant. It depends on the age, day of life, environmental factors, and mode of nutritional and site of blood collection. The first study on the haematology of study in the hematology of the adult was published in 1924.

1.2 Rationale

The hematological parameters are very important in medicine because they help in diagnosis of diseases and monitor response to treatment. Interpretation of values obtained in an individual adult depends on the knowledge of the normal values for the locality. And also to establish normal range in male and female, in this study we attempt to start base line information to establish the hematological reference range in the adult blood and to compare it with the international reference value because there is no well reference range in Sudan.

1.3. Objectives

1.3.1. General objective:

To measure complete blood count in adult age between 18-36years.

1.3.2. Specific objectives:

1. To measure hemoglobin concentration, white blood cells count, red blood cells count, platelet count and packed cell volume.
2. To measure red blood cells indices.
3. To compare complete blood count between adult male and female.

Chapter Two

Literature Review

2. Literature review

2.1. The blood

Blood is specialized bodily fluid in animals that delivers necessary substance such as nutrients and oxygen to the cells and transport metabolic product away from waste those same cells in vertebrate it is composed of blood cells in liquid called blood plasma (plasma which constitutes 55% of blood in fluid is mostly water (92%by volume) and contains displaced proteins, glucose, mineral ion, hormones carbon dioxide (p lasma being the main medium for excretory product transportation)and blood cells themselves. Albumin it is the main protein in plasma and it is function to regulate the colloidal osmotic pressure of blood The blood cells are mainly red blood cells (also called RBCs or erythrocyte)and white blood cells including leukocytes and platelet .the most venous blood carries carbon dioxide. product of metabolic produced by cells from the tissue to the lungs to be exhaled.

Function

Blood performs many important functions with in the body:

1-Supply of oxygen to the tissue (bound to hemoglobin. Which carried in red cells) including:

2-Supply of nutrients such as glucose, amino acid and faty acids (dissolved in the blood or bound to plasma protein (eg blood lipid)

3-Removal of waste such as carbon dioxide, urea and lactic acid.

4-Immunological functions. Including circulation of white blood cells and detection of foreign material by antibodies.

5- Coagulation which is one part of the body self repair mechanism (blood clotting after wound in order to stop bleeding)

6-Messenger functions .including the transport of hormones and the signaling of the tissue damage.

7-Regulation of body pH.

8-Regulation of core body temperature.

9-Hydraulic function.

Constituents of human blood

Blood accounts for 7% of human body weight with an average density of approximately 1060kg\m very close to pure water density of 1000kg \m the average adult has ablood volume of roughly 5liters(1,3 gal) which composed of plasma and several kinds of cells. Theses blood cells (which also called corpuscles or (formed element) consist of erythrocytes (red blood cells RBCs) ,leukocytes(white blood cells) and thrombcytes(platelets) by volume, the blood cells constitute about 45% of whole blood ,the plasma about 54.3% and white cells about 7%whole blood (plasma and cells) .[1]

2.2 Hemopoiesis

Haematopoiesis (from Acient Greek "BLOOD" to make) (or hematopoiesis in amrecan English sometimes also haematopoiesis or hemopoiesis) is the formation of blood components. All cellular blood components are derived hematopoietic stem cells in healthy adult person.

New blood cells are produced daily in order to maintain steady state levels in the peripheral circulation.

Hematopoietic stem cells (HSCS) hematopoietic stem cells (HSCS)reside in the medulla of the bone (bone marrow)and have the unique to rise to all of the different mature blood cells type and tissue HSCs are self-renewing .when they proliferate ,at least some of their daughter cells remain as HSCs, so the pool of stem cells does not depleted. The other daughters of HSCS (myeloid and

lymphoiprogenitor cells), however can each commit to any of the alternative differentiation pathways that lead to production of one or more of specific.

All blood cells are derived into three lineages

Erythroid cells are the oxygen carrying red blood cells Both reticulocyte reticulocyte count estimates the rate of. Erythropoiesis and erythrocyte are functional and are released into blood. In fact Lymphocyte is the cornerstone of the adaptive immune system they are derived from common lymphoid progenitors. The lymphoid lineages is abundant cells in vertebrate blood are red blood cells .these contain hemoglobin an ion containing protein which facilitates transportation of oxygen by reversibly binding to this respiratory gas and greatly increasing it is solubility in blood in contrast. Carbon dioxide is almost entirely transport extra cellularly dissolved in plasma bicarbonate ion vertebrate blood it is bright red when it is hemoglobin is oxygenated .some animals such as crustaceeins and mollusks use hemocyanin to carry oxyge. Instead of hemoglobin.

Location

In developing embryos, blood formation occurs in aggregates of blood cells in yolk sac called blood islands. As development progresses, blood formation occurs in the spleen, liver and lymph nodes . when bone marrow develops, it eventually assumes the task of forming of the blood cells for entire organism . however maturation, activation and some proliferation of lymphoid cells occurs in secondary lymphoid organs (spleen , thymus , and lymph nodes) in children haematpoiesis occurs in the marrow of the long bones such as the femur and tibia in adults, it occurs mainly in the pelvis, cranium, vertebrate and sternum.

Exteramedulary

In some cases, the liver, thymus and spleen may resume their hematopoietic function, if necessary, this is called extra medullary haemopoiesis it may cause

these organs to increase in size substantially during fetal development ,since bone and thus bone marrow develop later the liver function as the main haemopoietic organ . there for, the liver is enlarged during development . and other vertebrate.[2]

2.3. Erythropoiesis

During erythropoiesis, the new cells formed following each cell division condenses, and hemoglobin (manufactured by ribosomes) begins to accumulate in the cytoplasm. Withhaemoglobinization the cytoplasm stains less blue and more pink-mauve. When the cells become about one third haemoglobinized, the nucleus is extruded and the cells collapsethe cells have no nucleus and stain pale mauve. They contain inwardly, forming biconcave discs. At the reticulocyte stage, range amounts of hemoglobin and only remnants of ribosomal RNA and endoplasmic reticulum. Reticulocytes enter the blood circulation and within 48 h, develop into fully haemoglobinized pink-red staining erythrocyte.

2.3.1. Red blood cell (erythrocyte)

The primary function of erythrocytes is gas exchange. They carry oxygen from the lungs to the tissues and return carbon dioxide (CO2) from the tissues to the lungs to be exhaled. Erythrocytes are a nucleate cells containing.

Few organelles; a large proportion of their cytoplasm consists of the iron containing oxygen transport molecule hemoglobin. Erythrocytes are shaped like biconcave disks approximately 7 to 8μm in diameter. The biconcave disk shape gives red blood cells (RBCs) the flexibility to squeeze their way through capillaries and other small blood vessels. Viewed under the microscope, RBCs look like a circle with a central hole, or central pallor, which is approximately one-third the diameter of the cell.

Erythrocytes are the most common cells in blood. The normal RBC count is approximately 4.5 to 6 million cells per microliter. The parameters by which

erythrocytes are usually measured are the blood hemoglobin (Hgb) in grams per deciliter (g/dL), the hematocrit (Hct) or packed cell.

Volume (volume of RBCs as a percent of total blood volume), and the RBC count (millions of cells per _L) (Table 1–1). The size of red cells is measured as the mean corpuscular volume (MCV), reported in femtoliters (fL1 fL = 10–15 L). The normal MCV is ~80 to 100 fL. Red blood cells that are smaller than 80 fL are called microcytic; those that are larger than 100 fL are called macrocytic. Red cells have a life span of approximately 120 days; therefore, approximately1% of red cells are replaced each day. Young red cells can be identified because they contain ribonucleic acid (RNA).With special stains such as new methylene blue, the RNA aggregates as visible particles called reticulin. Young RBCs containing RNA are designated as reticulocytes, and the number of reticulocytes in the peripheral blood (reticulocyte count) is the erythrocytes. the size of the erythrocytes is about the same as the nucleus of the small resting lymphocyte.[(3)]

2.3.2. Haemoglobin

Hemoglobin synthesis

The main function of red cells is to carry 02 to the tissues and to return carbon dioxide (C02) from the c- estimates of erythropoietin (EPO) in plasma and hemoglobin concentration. Anemia's exclude condition shown to be associated with impaired production of EPO tissues e lungs. In order to achieve this gaseous exchange they contain the specialized protein hemoglobin. Each red cell contains approximately640 million haemoglobiri. molecules. Each molecule of normal adult hemoglobin (Hb).A (the dominant hemoglobin in blood after the age of 3-6 months) consists of four polypeptide chains, 2' each with its own harem group. The molecular weight of Hb A is 68 000. Normal adult blood also contains small quantities of two other hemoglobin's: Hb F and Hb A2. These also contain *a*

chains, but with y and chains, respectively, instead of . The synthesis of the various globin chains in the fetus and adult is discussed in more detail in Chap. The blood granulocytes and monocytes are formed[4]

2.4.Granulopoiesis

In the bone marrow from a common precursor cell the blood granulocytes and monocytes are formed. In the granulopoietic series progenitor cells, myeloblasts, promyelocytes and myelocytes form a proliferative or mitotic pool of cells while the metamyelocytes, band and segmented granulocytes make up a post-mitotic maturation compartment Large numbers of band and segmented neutrophils are held in the marrow as a 'reserve pool' or storage comparhnent. The bone marrow normally contains more myeloid cells than erytlu'oid cells in the ratio of 2:1 to 12:1, the largest proportion being neuh'ophils and metamyelocytes. In the stable or normal state, the bone marrow.

2.4.1 LeukocyteSs(White Blood Cells)

Several types of leukocytes, or white blood cells (WBCs), are found in the blood. The normal WBC count is ~4,000 to 10,000/_L (4.0–10.0 _103/_L)

Leukocytes are usually divided into granulocytes, which Have specific granules, and granulocytes, which lack specific granules. Granulocytes are divided into neutrophils (with faintly staining granules), Eosinophil’s (with large reddish or eosinophilia granules), and basophils (With large dark blue or basophilic granules). Granulocytes are divided into lymphocytes and monocytes. Although they are called white *blood* cells, leukocytes predominantly function in tissues. They are only in the blood transiently, while they travel to their site of action.

2.4.2 Neutrophils

Neutrophils are the most common type of WBCs in adults. Two types are described: segmented neutrophils and band neutrophils:

• Segmented neutrophils (“sags,” also called polymorph nuclear neutrophil Leukocytes [PMNs or “polys”]) have a nucleus divided into Multipldistinct lobes connected by thin strands of chromatin the Cytoplasm has fine granules that stain lightly with the usual blood stains. Polynormally comprise 50 to 70% of total WBCs.

• **Band neutrophils** (“bands,” sometimes called “stabs”) have a horseshoe Shaped nucleus, without the distinct lobes of polys. They are an earlier stage than segmented neutrophils but are fully functional. Bands normally represent 2 to 6% of all WBCs; the number of bandsincreases with acute stress or infection. the primary function of neutrophils is phagocytosis, predominantly of bacteria; neutrophils are the primary defense against bacterial infection. bacteria are killed by antimicrobial agents contained or generated within neutrophil granules.neutrophils circulate in the blood for 10 hours and may live 1 to 4Days in the extravascular space. The trip is one way; once neutrophils leave The blood to enter tissues, they cannot return. A significant number of neutrophils Are rolling along the endothelial surface of blood vessels.

2-4-3 Eosinophil’s (“Eos”)

Eosinophil’s contain large granules that stain reddish-orange (eosinophilic) with usual blood smear stains. The nucleus is segmented (often bilobed). Functions of eosinophils include phagocytosis of antigen-antibody complexes and defense against parasitic infection. The normal eosinophil count<5%.

2.4.4 Basophils (Bassos)

Basophils contain large dark blue or purple (basophilic) granules, which often obscure the nucleus. The nucleus is segmented. Basophils are the least .Common type of leukocytes, normally ≤1% of total WBCs. The basophil ,Granules contain heparin (an anticoagulant), histamine (a fast vasodilator), the slow-reacting

substance of anaphylaxis (a slow vasodilator), and other. Compounds. Basophils appear to be involved in immediatehypersensitivity

Reactions related to immunoglobulin class E (IgE).

2.4.5. Lymphocytes (lymph)

Lymphocytes are the second most common type of leukocytes in adults (20–40% of WBC). The lymphocyte number is higher in children and also increases with viral infection.

Resting lymphocytes**:** Resting lymphocytes are usually small (7–10μm), are usually small (7–10μm), With a dark round to oval nucleus and scant amounts of pale blue cytoplasm the nucleus of a small, resting lymphocyte is about the same diameter as a normal erythrocyte Cells and Composition of the Peripheral blood.

Reactive ("*atypical*") lymphocytes A minority of lymphocytes are Larger, with more abundant pale blue cytoplasm and larger nuclei with Less condensed chromatin, and perhaps a nucleolus. These are Designated reactive or atypical lymphocytes. The number of large lymphocytes may be increased in viral infections such as infectious Mononucleosis.

2.4.6.Monocytes ("Monos")

In the blood, they enter tissue to become **tissue macrophages** (also called **histiocytes**). Monocytes are large cells, with abundant light gray to light blue finely granular cytoplasm. The nucleus has very finely granular chromatin and is often folded, bean shaped, or irregular Monocytes have two functions.

• **Phagocytosis** of microorganisms (particularly fungi and mycobacteria) And debris.

• **Antigen processing and presentation**. In this role, they are critical in Initiation of immune reactions.

Monocytes normally comprise ~3 to 8% of leukocytes. After 8 to 14 hours

Monocytes ("Monos")

Monocytes normally comprise ~3 to 8% of leukocytes. After 8 to 14 hours in the blood, they enter tissue to become tissue macrophages (also called.

Histiocytes). Monocytes are large cells, with abundant light gray to light blue finely granular cytoplasm. The nucleus has very finely granular chromatin and is often folded, bean shaped, or irregular Monocytes have two functions:

• **Phagocytosis** of microorganisms (particularly fungi and mycobacteria) and debris

• **Antigen processing and presentation**. In this role, they are critical in initiation of immune reactions.

2.5.Thrompopoiesis

Platelet production

Platelets are produced in the bone marrow by fragmentation of the cytoplasm of megakaryocytes, one of the largest cells in the body. The precursor of the megakaryocyte-the megakaryoblast-arises by process of differentiation from the haemopoietic stem cell . The megakaryocyte matures by endomitotic synchronous replication (i.e. DNAreplication in the absence of nuclear or cytoplasmic division) enlarging the cytoplasmic volume as the number of nuclear lobes increase in multiples of two. Apichlre of mature polyploid megakaryocytes is shown in. Very early oninvaginations of plasma membrane are seen, called the demarcation.

Membrane, which evolves through the development of the megakaryocyte into a highly branched network At a variable stage in development, most commonly at the eight nucleus stage, the cytoplasm becomes granular. Mahlre megakaryocytes are eXh'emely large, with an eccentric placed 2single lobu lated nucleus and a low nuclear to cytoplasmic ratio. Platelets form by fragmentation of megakaryocyte

cytoplasm, approximately each megakaryocyte giving rise to 1000-5000 platelets. The time interval from differentiation of the human stem cell to the production. thrombopoietin is the major regulator of platelet production and is constitutively produced by the liver and kidneys. Tlu'ombopoietin increases the via c- Mpl receptor. Platelet levels start to rise 6 days start of therapy and remain high for 7-10 days. Unfortlmately, tlu'ombopoietin is not available for routine clinical practice. Platelets also have c-Mpl receptors for thrombopoietin and remove it from the circulation. Therefore, levels are high in thrombocytopenia as a result of marrow aplasia and vice versa. The normal platelet count is approximately 250 x 10^9/L (range 150-400 x 10^9/L) and the normal platelet lifespan is 7-10 days. Up to one-third of the marrow output of platelets may be trapped at any one time in the normal spleen but this rises to 90% in cases of massive splenomegaly.

2.5.1. Platelet structure

Platelets are extremely small and discoid, 3.0 x0.5 11m in diameter, with a mean volume 7-11 fL. The ultrash'uchlre of platelets is represented in platelet production giving rise to 1000-5000 platelets. The time interval from differentiation of the human stem cell to the production of platelets averages approximately 10 days. Thrombopoietin is the major regulator of platelet production and is constitutively produced by the liver and kidneys. Thrombopoietin increases the number and rate of maturation of megakaryocytes via c-Mpl receptor. Platelet levels start to rise 6 days after the start of therapy and remain high for 7-10 days. Unfortlnately, thrombopoietin is not available for routine clinical practice. Platelets also have c-MP receptors for thrombopoietin and remove it from the circulation. Therefore, levels are high in thrombocytopenia as a result of marrow aplasia and The normal platelet count is approximately events leading to platelet plug formation during haemostasis. Adhesion to coHagen is facilitated by glycoprotein la (Grla).

Glycoproteins Ib (defective. in Bernard-Soulier syndrome) and IIb/IIIa (defective in tlu'ombasthenia) are important in the attachment of platelets to von Willebrand factor (VWF) and hence to vascular subendothelium .

plasma membrane invaginates into the platelet interior to form an open membrane (canalicular) system which provides a large reactive surface to which the plasma coagulation proteins may be selectively absorbed. The membrane phospholipids(previously known as platelet factor 3) are of particular importance in the conversion of coagulation factor X to Xa and prothrombin (factor II) to thrombin (factor IIa).

2.5.2Platelet antigens

Several platelet surface proteins have been fould to be important antigens in platelet-specific autoimmunity and they have been termed human platelet antigens (HPA). In most cases, two different alleles exist, termed a or b alleles (e.g. HPA-la). Platelets also express ABO and human leucocyte antigen(HLA) class I [(4)]

2.6. Complete blood count

A complete blood count (CBC), also known as full blood count (FBC) or full blood exam (FBE) or blood panel, is a test panel requested by a doctor or other medical professional that gives information about the cells in a patient's blood. A scientist or lab technician performs the requested testing and provides the requesting medical professional with the results of the CBC.

Alexander Vastem is widely regarded as being the first person to use the complete blood count for clinical purposes. Reference ranges used today stem from his clinical trials in the early 1960s.

The cells that circulate in the bloodstream are generally divided into three types: white blood cells (leukocytes), red blood cells (erythrocytes), and platelets (thrombocytes). Abnormally high or low counts may indicate the presence of many

forms of disease, and hence blood counts are amongst the most commonly performed blood tests in medicine, as they can provide an overview of a patient's general health status. A CBC is routinely performed during annual physical examinations in some jurisdiction. A phlebotomist collects the specimen, in this case blood is drawn in a test tube containing an anticoagulant (EDTA, sometimes citrate) to stop it from clotting, and transported to a laboratory.

In the past, counting the cells in a patient's blood was performed manually, by viewing a slide prepared with a sample of the patient's blood under a microscope (a blood film, or peripheral smear). Nowadays, this process is generally automated by use of an automated analyzer, with only approximately 30% samples now being examined manually.[6]

2.7. Automated blood count

The blood is well mixed (though not shaken) and placed on a rack in the analyzer. This instrument has many different components to analyze different elements in the blood. The cell counting component counts the numbers and types of different cells within the blood. The results are printed out or sent to a computer for review,Blood counting machines aspirate a very small amount of the specimen through narrow tubing. Within this tubing, there are sensors that count the number of cells going through it, and can identify the type of cell; this is flow cytometry. The two main sensors used are light detectors, and electrical impedance. One way the instrument can tell what type of blood cell is present is by size. Other instruments measure different characteristics of the cells to categorize them.Because an automated cell counter samples and counts so many cells, the results are very precise. However, certain abnormal cells in the blood may be identified incorrectly, and require manual review of the instrument's results and identifying any abnormal cells the instrument could not categorize .In addition to

counting, measuring and analyzing red blood cells, white blood cells and platelets, automated hematology analyzers also measure the amount of hemoglobin in the blood and within each red blood cell. This information can be very helpful to a physician who for example is trying to identify the cause of a patient's anemia. If the red cells are smaller or larger than normal, or if there's a lot of variation in the size of the red cells, this data can help guide the direction of further testing and expedite the diagnostic process so patients can get the treatment they need quickly.[6]

2-8 Manual blood count

Counting chambers that hold a specified volume of diluted blood (as there are far too many cells if it is not diluted) are used to calculate the number of red and white cells per litre of blood. To identify the numbers of different white cells, a blood film is made, and a large number of white cells (at least 100) are counted. This gives the percentage of cells that are of each type. By multiplying the percentage with the total number of white blood cells, the absolute number of each type of white cell can be obtained. The advantage of manual counting is that automated analysers are not reliable at counting abnormal cells. That is, cells that are not present in normal patients and are only seen in the peripheral blood with certain hematological conditions. Manual counting is subject to sampling error because so few cells are counted compared with automated analysis .Medical technicians examine blood film via a microscope for 30% of CBCs, not only to find abnormal white cells, but also because variation in the shape of red cells is an important diagnostic tool. Although automated analysers give fast, reliable results regarding how many red cells, the average size of the red cell, and the variation in size of the red cells, they don't detect cells' shapes. Also, some normal patients' platelets will clump in EDTA anticoagulated blood, which causes automatic analyzers to give a

falsely low platelet count. The technician viewing the slide in these cases will see clumps of platelets and can estimate if there are low, normal, orhigh numbers of platelets.[6]

A complete blood count will normally include

2.8.1 Red cells

1. Total red blood cells — The number of red cells is given as an absolute number per litre.
2. Haemoglobin - The amount of hemoglobin in the blood, expressed in grams per decilitre. (Low hemoglobin is called anaemia.)
3. Hematocrit or packed cell volume (PCV) - This is the fraction of whole blood volume that consists of red blood cells.
4. Red blood cell indices
    a. Mean corpuscular volume (MCV) - the average volume of the red cells, measured in femtolitres. Anaemia is classified as microcytic or macrocytic based on whether this value is above or below the expected normal range. Other conditions that can affect MCV include thalassemia, reticulocytosis and alcoholism.
    b. Mean corpuscular haemoglobin (MCH) - the average amount of haemoglobin per red blood cell, in picograms.
    c. Mean corpuscular haemoglobin concentration (MCHC) - the average concentration of haemoglobin in the cells.
5. Red blood cell distribution width (RDW) - a measure of the variation of the RBC population

2.8.2 White cell

- Total white blood cells - All the white cell types are given as a percentage and as an absolute number per litre.

2.8.3 Differential leucocytes counts will also include

- Neutrophil granulocytes — May indicate bacterial infection. May also be raised in acute viral infections. Because of the segmented appearance of the nucleus, neutrophils are sometimes referred to as "segs." The nucleus of less mature neutrophils is not segmented, but has a band or rod-like shape. Less mature neutrophils — those that have recently been released from the bone marrow into the bloodstream — are known as "bands" or "stabs". Stab is a German term for rod.
- Lymphocytes — Higher counts with some viral infections such as infectious mononuclesis and. Also raised in chronic lymphocytic leukaemia (CLL). Can be decreased by HIV infection. In adults, lymphocytes are the second most common WBC type after neutrophils. In young children under age 8, lymphocytes are more common than neutrophils¨
- Monocytes — May be raised in bacterial infection, tuberculosis, malaria, Rocky Mountain spotted fever, monocytic leukaemia, chronic ulcerative colitis and regional enteritis ˙
- Eosinophil granulocytes — increased in parasitic infections, asthma, or allergic reaction.
- Basophil granulocytes- May be increased in bone marrow related conditions such as leukaemia or lymphoma.

A manual count will also give information about other cells that are not normally present in peripheral blood, but may be released in certain disease processes .

2.8.4 Platelets

- Platelet numbers are given, as well as information about their size and the range of sizes in the blood.
- Mean platelet volume (MPV) - a measurement of the average size of platelets.

Many disease states are heralded by changes in the blood count

- leukocytosis can be a sign of infection.
- thrombocytopenia can result from drug toxicity.
- pancytopenia is generally as the result of decreased production from the bone marrow, and is a common complication of cancer chemotherapy.

2.9 Stage of human growth and development

2.9.1 Normal fetal development and growth

Determinant of birth weight are multi-factorial, and reflect the influence of the natural growth potential of the fetus and the intrauterine environment .the later is controlled by both maternal and placenta factors fetal growth is dependent on adequate transfer of nutrients and oxygen. This in itself is on appropriate maternal nutrition and placental perfusion. Other factor are important in determining fetal growth ,for example fetal hormones, they affect the metabolic rate ,growth of tissue and maturation of individual organs

2.9.2 Fetal blood formation

The first fetal blood cells are formed on the surface of the yolk sac from 14-19 days after conception. Haemopoiesis continues from this site until third post-conceptual month .during the fifth week of embryonic life, exteramedullary haemopoiesis begins in the liver and to lesser extent in the spleen .the bone marrow starts to produce red cells at 7 – 8 weeks and is the predominant source of red cells from 26 weeks gestation.

Most hemoglobin in the fetus is fetal hemoglobin (HbF) which has two gammas –chains (alpha -2, gamma-2). this differs from the adult haemoglobins HbA and HbA2 ,which have two beta- chains(alpha -2, beta-2)and two delta –chains (alpha-2,delta-2) respectively .Ninety percent of fetal hemoglobin is HbF between 10and 28 weeks gestation . From 28 to 34 weeks, aswitch to HbA occurs, and at term the ratio of HbF to HbA is 80:20 ;by 6 month of age ,only 1percent of haemoglobin is HbF . Akey feature of HbF is higher affinity for oxygen than HbA this in association with ahigher Hb concentration

2.9.3 Postnatal development

During infancy and childhood, there is active hematopoiesis in the medullary cavity of virtually every bone. With age, the hematopoietic ally Active marrow (**red marrow**) is gradually replaced by inactive marrow (**yellow marrow**), which consists predominantly of adipose tissue. In adults, hematopoiesis is restricted to the proximal long bones and the axial skeleton(skull, vertebral bodies, ribs, sternum, and pelvis). The yellow marrow can resume active hematopoiesis under conditions of chronic hematologic stress (chronic bleeding or hemolytic anemia).

2.9.4. Hemopoiesis during adult life

By about 25 years of age, the main site of hematopoiesis are the vertebrate ,ribs, sternum skull bones ,pelvis and sacrum, and the proximal ends of the femur and humerus.at these sites about half the marrow is red active cell producing marrow and the remainder ,non cell producing yellow fatty marrow .other bone marrow cavities in the body contain non haematopoietic fatty marrow .in certain blood disorders eg. Chronic dyserythropoietic, blood cell production can resume in the liver and speen (exteramedullary hematopoiesis) and the fatty marrow in some bones can become replaced by hematopoietic marrow [(3)]

2.10. Previous Studies

2.10.1. Reference Range Values Of Hematological Parameters In Healthy Pakistani Adults

Results

In Males, the mean Haemoglobin concentration (Hb) of 13.04g/dl and Haematocrit (HCT) ratio of 0.39l/l were significantly higher than females value of 11.63g/dl and 0.35l/l respectively. The mean Red Blood Cell (RBC) count of 5.3x 10^{12}/l in males was also significantly higher than the corresponding value of 4x 10^{12}/l in females ($p<0.05$). The value of Mean Corpuscular Volume (MCV) in males (76.30fl) was significantly higher than in females (73.84fl), ($p<0.05$). Similarly the Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) were significantly higher in males than corresponding values in females ($p<0.05$). On the other hand, the mean White Blood Cell count (WBC) of 8.25x10^9/l in males was lower than mean value of 8.42x10^9/l in females ($p<0.05$). Similarly the values for Platelet count of 255x10^9/l in males were also significantly lower than corresponding values of 255x 10^9/l in females ($p<0.05$) [20]

2.10.2. Provisional Study of Kuwait Adult Hematology Reference Range

Results

The obtained hematology reference range in this study considered the adult provisional Kuwaiti hematology reference range (APK-HRR). The APK-HRR categorized patients with slight microcytic hypochromic anemia and a slightly increased RBC, WBC and platelet count within the normal Kuwaiti population [25].

2.10.3. Provisional Study of Malian Adult Hematology Reference Range

Results

In our study population, the heamatological parameters ranges were mostly different to the universal established range. We found in our population a median white blood cell (WBC)count of 5200 cell/ul {3237.5-11900},Red Blood Cell (RBC) count of 4.94*10^6{3.56-6.17}, Hemoglobin (Hb)of 14.2g/dl {12.2-17.38}, Platelet count (PLT) OF 275*10^3/ul {145.4-614.4},lymphocytes 2050/ul {1200-3800} , neutrophils 2200/ul {1040-6220} monocytes 200/ul {100-660} ,esionphils 131/ul{0-1026} .We found significanl gender differenceses in RBC ,Hb level and MPV .However, RBC and Hb higher in males compared to females ($p<0.001$) ,whereas the Mean plalelet volume Lower volues (MPV) in males than females ($p<0.047$). The hemoglobin level for some West African conutries ranged from 13.5 to 15.1g/ dl for males and 12 to 13g/dl for females .However in East and Southern Africa, The values were any where from 14.1 to 16.1 for males and 11.2 to 14.4 for females [(12).]

2.10.4. Provisional Study of Asmara Adult Hematology Reference Range

Results

There was a significanl differences between males and females in the reference intervals for erythrocyte count, hemoglobin , hematocrit,mean cell volume , mean cell hemoglobin , mean cell hemoglobin concentration and differential white blood cell count . all the evaluated heamatological analytes were found to be higher in males than in females except for platelet count . the out of range percentage for the parameters extends from 3.5 to 46.7% with red blood cell count having the lowest while mean cell volume having the highest out of range percentage .The results indicated that the currently used reference imterval doesnot represent the population in Asmara and are different from those obtained elsewhere in Africa [(14).]

Chapter Three

Material & Methods

3. Material and methods

3.1. Study design

This is a cross sectional study design based on venous blood samples of adults in Shendi to determine the Haematological parameters in the normal adult.

3.2. Study area

The study was conducted at Shendi Teaching Hospital which is located in Shendi town in Sudan, during the period between March to July 2018. Shendi is a town in northern Sudan, situated on the east bank of the Nile 150 km northeast of Khartoum. Shendi is also about 45 km southwest of the ancient city of Meroe. Located in the River Nile state, Shendi is the center of the Ja'aliin tribe and an important historic trading center. Its principal suburb on the west bank is Al-Matamma. A major traditional trade route across the Bayuda desert connects Al-Matamma to Marawi and Napata, 250 km to the northwest.

3.3. Ethical considerations

Procedure of venous blood sampling was explained to the adult. All participants were informed about the research objectives and procedures during the interview period. A written valid consent was obtained from all participants.

3.4. Blood Sampling

2.5 ml of venous blood was taken from adult and transferred into an EDTA container. The sample was then sent as early as possible (maximum 3 to 6 hours) for analysis

3.5. Study population

A total of 100 samples were collected from venous blood from adult people.

3.6. Inclusion Criteria

A normal healthy adult in age between 18-36years.

3.7. Exclusion criteria for the adult

Exclusion of anaemic person and other blood disease

3.8. Data collection tools

The primary data will be collected by using questionnaire

3.9. Method

3.9.1. Materials

sterile syringe.

Dettol.

Cotton.

blood container with EDTA anticoagulant.

Complete blood count (CBC), were carried out followed a simple procedures, the patient was brought in to a collection room. Then he was informed about the study and 3ml of venous blood in ethylene-diamine-tetra-acetic acid (EDTA) was Collected.

3.9.2Mindary Haematology Analyzer (Mindray bc-3000)

1. Principle blood cells can be broadly divided into three categories red blood cells, White blood cells and platelets. The analyzer measures the number of cells and distinguishing between their types according to size using sheath flow *DC* detection. Electrical current is passed through a solution; this method measures the changes in electrical resistance that occurs when blood cells pass through detection aperture. This instrument performs hematology analyses according to the RF/DC detection method, Hydro Dynamic Focusing (DC Detection) and SLS-hemoglobin method.

The RF/DC detection method detects the volume of blood cells by changes in direct- current resistance.

3.9 Data analysis

The data were compared by using statistical analysis performed with Statistical Package for Social sciences (SPSS). To compare means and standard deviation of haematological values.

Chapter Four

Results

4. Results

Table (4-1) Show the frequency of age:

Age	Frequency	Percent
18-24	33	33%
25-30	43	%43
31-36	24	%24

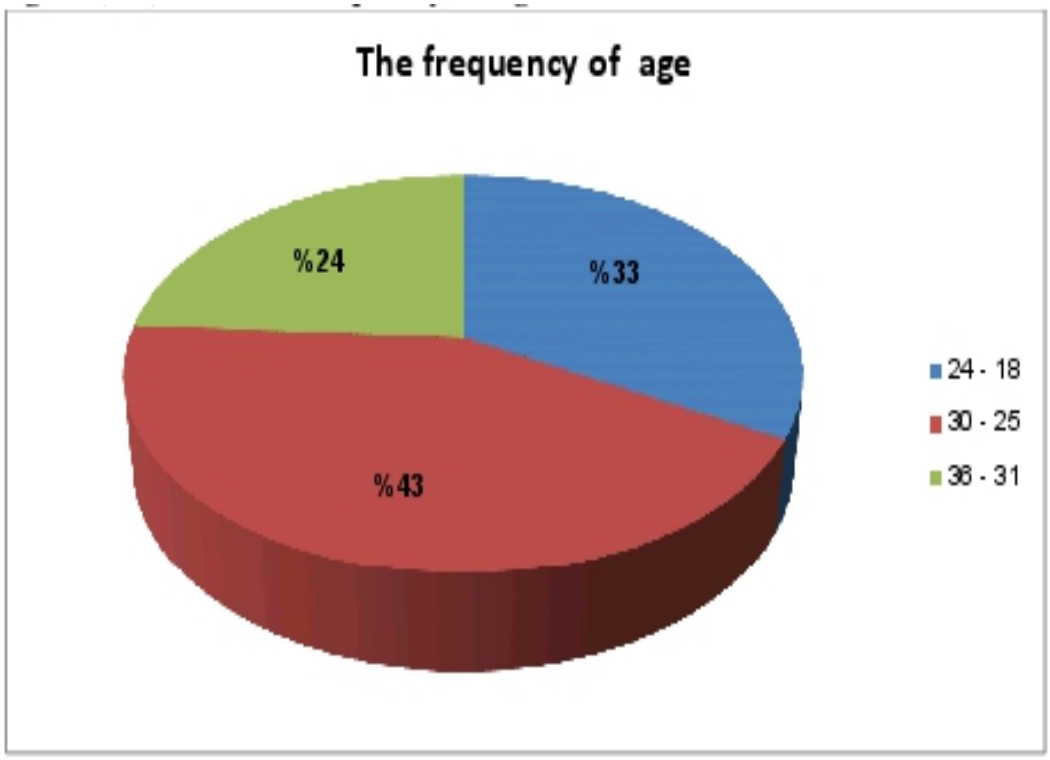

Figure (4-1): Show the frequency of age:

Table (4-2) Show the frequency of sex:

Sex	Frequency	Percent
Male	50	50%
Female	50	50%

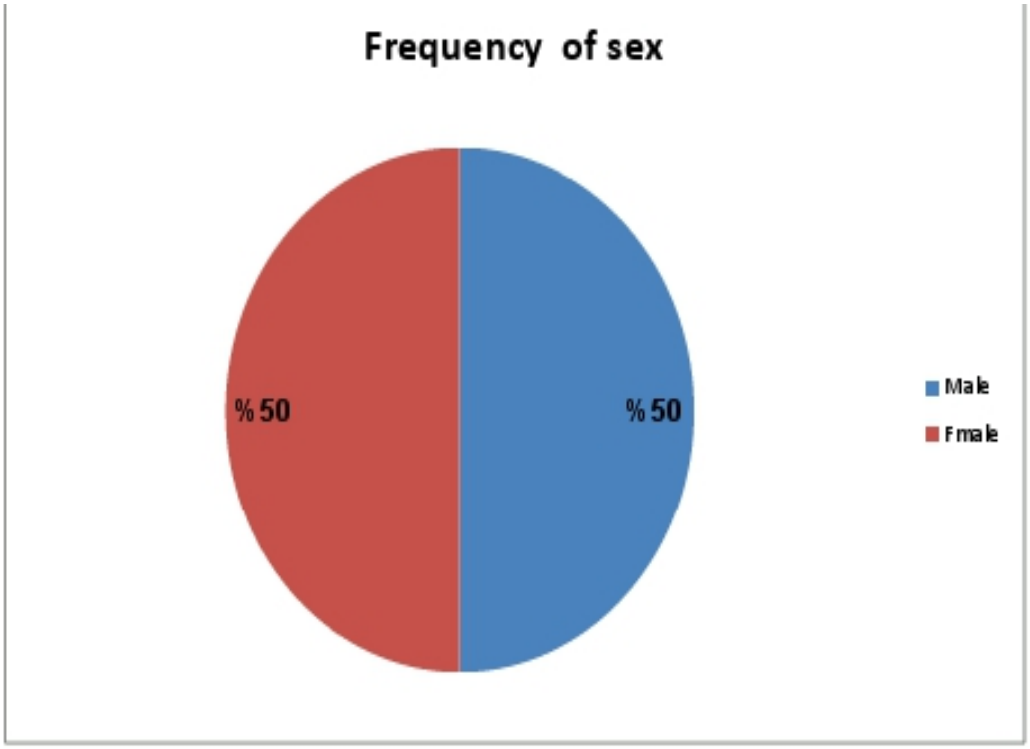

Figure (4-2): Show the frequency of sex.

Table (4-3): Show the mean and SD of MCH in study group.

Sex	Frequency	Mean (pg)	Std. Deviation	Mean+_2SD
Male	50	30.268	1.935	26.5 - 34.1 pg
Female	50	29.438	1.441	26.6 - 32.2pg

P.value (0.0342)

Table(4-4) Show the mean and SD of MCV in study group.

Sex	Frequency	Mean(fl)	Std. Deviation	Mean+_2SD
Male	50	90.605	4.302	82-99.2 fl
Female	50	87.905	3.705	80.5 - 95.3 fl

P.value (0.0035)

Table (4-5): Show the mean and SD of MCHC in study group:

Sex	Frequency	Mean(g/dl)	Std. Deviation	Mean+_2SD
Male	50	33.913	2.934	31- 36 g/dl
Female	50	32.580	1.561	29.3-35.7 g/dl

P.value (0.0132)

Table (4-6): Show the mean and SD of RBCs in study group.

Sex	Frequency	Mean($x10^{12}$/l)	Std. Deviation	Mean+_2SD
Male	50	4.9586	.34765	4.2-5.8× 10^{12} c/mm^3
Female	50	4.6118	.36624	3.8-5.4 × 10^{12} c/mm^3

P.value (0 .000)

Table (4-7): Show the mean and SD of Hct in study group.

Sex	Frequency	Mean(%)	Std. Deviation	Mean+_2SD
Male	50	43.380	3.4397	36.5-50.2**%**
Female	50	39.790	3.1227	33.8-46.2**%**

P.value (0 .000)

Table (4-8): show the mean and SD of Hb in study group:

Sex	Frequency	Mean(g/dl)	Std. Deviation	Mean+_2SD
Male	50	13.982	1.0101	12-16 **g/dl**
Female	50	12.722	1.1758	10.3-15.1 **g/dl**

P.value (0 .000)

Table (4-9): Show the mean and SD of platelet in study group:

Sex	Frequency	Mean($x10^9$/l)	Std. Deviation	Mean+_2SD
Male	50	236.18	53.428	129.3-343 × 10^9 /l
Female	50	276.94	69.930	137-417 × 10^9 /l

P.value (0 .001)

Table (4-10): Show the mean and SD of TWBCs in study group:

Sex	Frequency	Mean($x10^9$/l)	Std. Deviation	Mean+_2SD
Male	50	5.782	1.3938	3-8.6× 10^9/l
Female	50	6.020	1.4404	3.2-8.2× 10^9/l

P.value (0 . 043)

Chapter Five

Discussion

Conclusion

Recommendations

5.1. Discussion

This study was conducted to determine the hematological parameters of term healthy adult. It was observed that the mean of MCH in a normal healthy adult in male was 30.2 Pg, while the mean of MCH in female it was 29.4 Pg. when compare statistically showed significant difference.

the mean of MCV in a normal adult in male was 90.6 fl while in female was 87.9 FL. When compare statistically showed significant difference.

the mean of MCHC in a normal adult the mean of MCHC in male was33.9 g/dl while MCHC in female was 32.5 g/dl. When compare statistically showed significant difference.

the mean of RBCs in male it was 4.95×10^{12} cell/mm^3. and the mean of RBCs in female was 4.61×10^{12} cell/mm^3. when compare statistically showed significant difference.

the mean of HCT in male was 43.3%. while the mean of HCT in female was 39.7%. when compare statistically showed significant difference.

the mean of HGB in male was 13.9 g/dl. While the mean of HGB in female it was 12.7 g/dl. when compare statistically showed significant difference.

the mean of platelet highly increased in female, it was 276.9×10^9 cell/L than male, it was 236.1×10^9 cell/L. when compare statistically showed significant difference.

The mean of TWBCs in female increased, it was 6.02×10^9 cell/mm^3 than male it was 5.78×10^9 cell/mm^3. when compare statistically showed significant difference.

this results were similar with previous studies of pakestan and asmara.

5.2. Conclusion

On the basis of our results we concluded that:

 The mean of hemoglobin was13.9g/dl in male and12.7g/dl in female, RBCs was4.9 x10^{12} c/mm^3 in male and 4.6×10^{12} c/mm^3 in female, Hct was 43.3% in male and 39.7 % in female, MCV was90.6 FL in male and 87.9 FL in female, MCH was30.2 pg in male and 29.4 in female, MCHC was 33.9g/dl in male and 32.5 in female, TWBCs was 5.7x10^9/L in male and 6.02×10^9/L in female and platelet was 236.1x10^9/L in male and 276×10^9/ L in female.

 The Hb, PCV, RBCs in adult male higher than in female but platelet and TWBCs was higher in female.

5.3 Recommendations

1. Further study in this topic should be done with increase sample size and study area to obtain accurate result with quality control in hematology lab.
2. Periodic follow up and monitoring of hematological parameters for all adult males and females for anemia and other blood disorders.
3. Similar type of studies should be conducted in other town.

Chapter Six

References

Appendix

References

1. Hoff A.V. brand, Moss P.A.H., and Pettit I.E, Essential hematology, 2006, Fifth edition , page 22 , 24 , 25.
2. Sir joun pancie and Mitchell jewis , Pancie and Lewis. Practical Hematology , eleven edition , London , 1950 , 83.
3. Ramnarayan K., Essentials in hematology clinical pathology, Fourth edition, Jayper, London, 2012, page 359.
4. Mary Louise Turgeon, Clinical Hematology, Fifth Edition, London, 2012, page 612.
5. Ret chard M., Hiller E, Glass J, Biology and Clinical Management in: Modern Haematology, 2007, Second Edition page 16.
6. Atul ,Mehta B, A.victor and Hoffbrand, Haematology at Glance, , plakwell, 2005, second edition, page 9.
7. Hoffbrand A.V, catovsky D, Tudenham E.G. postgraduate Heamatology, (2005) , Fifth Edition, page 15.
8. Cheesbrough M, District Laboratory Practice in Tropical Countries, Cambridge, 2006, second edition, page 9, 11.
9. Osei-Bimpong, McLean R, Bhonda E, Lewis SM. The use of the white cell count and haemoglobin in combination as an effective screen to predict the normality of the full blood count. Int J Lab Hematol (2012) 34: 91-97.
10. Troussard X, Vol S, Cornet E, Bardet V, Couaillac JP, et al. Full blood count normal reference values for adults in France. J Clin Pathol. (2014) 67: 341-344.
11. Roshan TM, Rosline H, Ahmed SA, Rapiaah M, Wan Zaidah A, et al. Hematological reference values of healthy Malaysian population. Int J Lab Hematol. (2008) 31: 505-512.

12. Adetifa IM, Hill PC, Jeffries DJ, Jackson-Sillah D, Ibanga HB, et al. Haematological values from a Gambian cohort-possible reference range for a West African population. Int J Lab Hematol, (2009) 31: 615-622.
13. Lugada ES, Mermin J, Kaharuza F, Ulvestad E, Were W, et al. Population-based hematologic and immunologic reference values for a healthy Ugandan population. Clin Diagn Lab Immunol, (2004) 11: 29-34.
14. Jandl JH Blood: Textbook of Hematology (2nd ed), 2 Sub edition. Boston: Little Brown. Turgeon ML Clinical Hematology: Theory and Procedures. Lippincott Williams & Wilkins.2005.
15. Sissoko MS, Dabo A, Traoré H, Diallo M, Traoré B, et al. Efficacy of artesunate + sulfamethoxypyrazine/pyrimethamine versus praziquantel in the treatment of Schistosoma haematobium in children. PloS ONE, (2009) 4: e6732.
16. Diallo DA, Diawara F, Guindo A, Touré M, Traoré M, et al. Valeurs de référence érythrocytaires et leucocytaires chez le nouveau-né à Bamako, Mali. Mali Méd. (2012) 28: 36-43.
17. Harmening DM Clinical Hematology and Fundamentals of Hemostasis (5th ed) FA Davis Company, 100AD (2009).
18. Böhler T, Kynast-Wolf G, Coulibalyc B, Sièc A, Kapaunb A Gender-Specific Distribution of Hematological Parameters in Adults Living in Nouna, Burkina Faso. Open Hematol J (2008) 2: 1-4.
19. Kueviakoe IM, Segbena AY, Jouault H, Vovor A, Imbert M, et al. Hematological Reference Values for Healthy Adults in Togo. Int Sch Res Not 2011: (2010) e736062.
20. Miri-Dashe T, Osawe S, Tokdung M, Daniel N, Choji RP, et al. Comprehensive reference ranges for hematology and clinical chemistry

laboratory parameters derived from normal Nigerian adults. PloS ONE (2014) 9: e93919.

21. Al-Sweedan SA, Alhaj M The effect of low altitude on blood count parameters. Hematol Oncol Stem Cell Ther (2012) 5: 158-161.
22. Tsegaye A, Messele T, Tilahun T, Hailu E, Sahlu T, et al. Immunohematological reference ranges for adult Ethiopians. Clin Diagn Lab Immunol, (1999) 6: 410-414.
23. Saathoff E, Schneider P, Kleinfeldt V, Geis S, Haule D, et al. Laboratory reference values for healthy adults from southern Tanzania. Trop Med Int Health TM IH, (2008) 13: 612-625.
24. Katayev C, Balciza, Seccombe DW Establishing Reference Intervals for Clinical Laboratory Test Results: Is There a Better Way? Am J Clin Pathol, (2010) 133: 180-186.
25. Wangkheimayum S Determination of reference values of some routine clinical biochemistry parameters of apparently healthy North Indian subjects. J Biochem Res (2013) 1: 1-6.
26. Totali M, Gligor FG, Bojita M, Grigore C, Grigore C Determining hemoglobin reference values in children and teenagers from Sibiu area. Rev Romana Med Lab (2013) 21: 39-45.
27. Briggs C, Culp N, Davis B, d'onofrio G, Zini G, et al. ICSH guidelines for the evaluation of blood cell analysers including those used for differential leucocyte and reticulocyte counting. Int J Lab Hematol (2014) 36: 613-627.
28. Dosoo DK, Kayan K, Adu-Gyasi D, Kwara E, Ocran J, et al. Haematological and biochemical reference values for healthy adults in the middle belt of Ghana. PLoS One (2012) 7: e36308.

29. Solberg HE, Stamm D IFCC recommendation: The theory of reference values. Paer 4. Control of analytical variation in the production, transfer and application of reference values. J Automat Chem (1991) 13: 231-234.
30. Haileamlak A, Muluneh AT, Alemseged F, Tessema F, Woldemichael K, et al. Hematoimmunological profile at gilgel gibe field research center, southwest Ethiopia. Ethiop J Health Sci 22(S), (2012): 39-50.
31. Akinbo BD, Atere AD, Fatunade HB, Iyabor NO Haematological indices and absolute CD4 counts of apparently healthy population in Ondo State, Nigeria. Br J Med Med Res, (2015) 8: 717-723.
32. Palacpac NM, Ntege E, Balikagala B, Yeka A, Shirai H, et al. Hematological and biochemical data obtained in rural northern Uganda. Int J Environ Res Public Health, (2014) 11: 4870-4885.
33. Institute of Medicine (US) Committee on Assessing Interactions among Social, Behavioral, and Genetic Factors in Health; Hernandez LM, Blazer DG Genes, behavior, and the social environment: moving beyond the nature/nurture debate. National Academies Press, Washington (DC) (2006).
34. Kironde F, Sekikubo M, Naiwumbwe H, Namusoke F, Buwembo W, et al. Hematology and blood serum chemistry reference intervals for children in Iganga district of Uganda. Health, (2013) 5: 1261-1267.
35. Garcia-Basteiro AL, Bassat Q, Alonso PL Approaching the target: the path towards an effective malaria vaccine. Mediterr J Hematol Infect Dis, (2012) 4: e2012015.
36. Ramezani A, Shams M, Zarinfar N, Banifazl M, Aghakhani A, et al. Hematological reference values for healthy males in the central part of Iran. Iran J Pathol, (2014) 9: 50-55.

37. Rustad P Reference intervals for 25 of the most frequently used properties in clinical chemistry. Proposal by Nordic Reference Interval Project (NORIP), (2003).
38. Segolodi TM, Henderson FL, Rose CE, Turner KT, Zeh C, et al. Normal laboratory reference intervals among healthy adults screened for a HIV pre-exposure prophylaxis clinical trial in Botswana. PLoS One 9: (2014) e93034.
39. Ambayya A, Su AT, Osman NH, Nik-Samsudin NR, Khalid K, et al. Haematological reference intervals in a multiethnic population. PLoS One 9: (2014) e91968.

Appendix I

Questionnaire

Establishment of Hematological Parameters Normal Values in Adult at Shendi Locality

1.Name :

2.Age

A-18-24 ( ) b-25-30 ( ) c-31-36( )

3.Sex

A-male ( ) b-female ( )

4.do you Smoking?

A – Yes ( ) b-No ( )

Results:

Hb:
PCV:
RBCs:
MCV:
MCH:
MCHC:
WBCs:
PLT:

Appendix II

إقــرار بالموافقــة

الاسم:----------

العمر :---------- العنوان:----------

أوافق بمحض إرادتي بالمشاركة في البحث العلمي المتعلق بدراسة المعدل الطبيعي للمكونات الدموية للبالغين بمدينة شندي.

الباحثة: هند حسن احمد

بعد أن شرح لي بأنه لا يترتب عليه أي أذى جسدي أو نفسي وأعلم أن المشاركة في هذا البحث لن تؤثر بأي حال من الأحوال الصحية.

البحث بإشراف:

د. حمزة أحمد حسن

التوقيع : ---------- التاريخ :----------