بسم الله الرحمن الرحيم

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Normal Reference Values of Some Hematological Parameters among Adult Sudanese People in Elmatama Locality

A thesis Submitted for partial fulfillment of the Msc Degree in Medical Laboratory Sciences in (Haematology)

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الآيـــــة

بسم الله الرحمن الرحيم

قال تعالى:

﴿ وَلَا تَقُولَنَّ لِشَيْءٍ إِنِّي فَاعِلٌ ذَلِكَ غَداً * إِلَّا أَن يَشَاءَ اللَّهُ وَاذْكُر رَّبَّكَ إِذَا نَسِيتَ وَقُلْ عَسَى أَن يَهْدِيَنِ رَبِّي لِأَقْرَبَ مِنْ هَذَا رَشَداً ﴾

الكهف (23-24)

Dedication

To my angel in life … to the meaning of love and to the meaning of compassion and dedication …

(My Mother)

To those who curse God with prestige and dignity …

To those who taught me tender without waiting …

(My Father)

To those who helped me in the march of life ... To those who tighten my arms ...

(Dear husband).

"To my other mother ... to that which overwhelmed me from the tenderness of motherhood was my mother who did not give birth to

(My husband's mother)

To those who like fraternity and distinguished by loyalty and giving to those with whom I was happy,

(My brothers and sisters)

To whom I knew how to find them and taught me not to waste them … To those who pushed me forward

(My friends).

To they made my life happy ….

(My kids)

Acknowledgement

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(To all my professors).

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We also thank everyone who helped to complete this research.

List of abbreviations

NR	Normal reference values
RBCs	Red blood cells
Hb	Hemoglobin
HCT	Hematocrit
MCV	Mean cell volume
MCH	Mean cell hemoglobin
MCHC	Mean cell hemoglobin concentration
WBCs	White blood cells
PLTS	Platelets cell
PCV	Packed cell volume
CBC	Complete blood count
EDTA	Ethylene Diamine Tetra Acetic Acid
SPSS	Statistical Package for The Social Sciences

Abstract

Reference values are affected by some factors such as age, sex, diet, drug in take, it is thus important that standard reference values of local population should be established.

This study was conducted to determine the normal reference values of hemoglobin, Hematocrit, red blood cells, red blood cell indices, white cells and platelets counts in adult healthy individual in Elmatama locality. Total numbers of samples of 301 healthy individuals selected. 2.5ml of EDTA anti coagulated venous blood samples were collected from each subject. The complete blood count (CBC) was measured by using automated hematological analyzer (mindry BC 3000 puls). Analysis was done in Ibrahim Farah center.

The ages of the subjects ranged from 18 to 68 years. A questionnaire was filled for each subject. The results of male showed: Hb (13.9±1.2) g/dl, HCT (35.9±2.4)%. RBCs count (5.1±1.7) $\times 10^{12}$/L. MCV (72.6±4.1) fl. MCH (27.6±4) pg. MCHC (37.8±4.3) g/dl. WBCs count (5.9±2.0)$\times 10^{9}$/L. Platelet count (237±59.2) $\times 10^{9}$/L. recording the Female the result showed Hb (11±1.5) g/dl. HCT (30.2±4.4) %. RBCs count (4.4±.6) $\times$ 10^{12}/L. MCV (69.9±5.7) fl. MCH (25.4±2.9) pg. MCHC (36.4±2.9) g/dl. WBCs count (6.5±1.7) $\times$ 10^{9}/L. Platelets count (276.5±67.7) $\times 10^{9}$/L.

Similar studies were done in Khartoum area, the values are relatively close to results that obtained in our study.

المستخلص

القيم المرجعية تتأثر ببعض العوامل مثل العمر، العرق، والجنس لذلك من الأهمية تحديد قيم مرجعية محلية. هذه الدراسة أجريت لتحديد القيم المرجعية الهموقلبين الدم وحجم الخلايا المعبئة وخلايا الدم الحمراء ومعاملات خلايا الدم الحمراء والخلايا البيضاء والصفائح الدموية في الأشخاص الأصحاء البالغين في محلية المتمة، إجمالي عدد العينات (301) عينة، تم جمع (2.5) مم من الدم الوريدي في مادة (EDTA) المضادة للتخثر وتم قياس تعداد الدم الكامل (CBC) باستخدام محلل الدم الآلي (mindry BC 300 puls) وقد تم التحليل في مجمع إبراهيم فرح. وكانت تتراوح أعمار المشاركين من (18–68) عاماً وقد تم ملء استبيان من قبل كل مشارك وقد أظهرت النتائج عند الرجال الهموقلبين (13.6± 1.2 جم/ديسلتر) وحجم الخلايا المعبئة %(35.9 ±2.4) وعدد كريات الدم الحمراء (5.1 ±1.7) × 10^{12}/ لتر متوسط حجم الخلية (72.6± 4.1/ فيمتوليتر) متوسط سعة الخلية من هيموغلبين الدم (27.6± 4.3 بايقو جرام) متوسط تركيز هموقلبين الدم في الخلية (37.8 ± 4.3جرام/ ديسلتر) عدد كريات الدم البيضاء (5.9± 2.0 × 10^{9} / لتر) وعدد الصفيحات الدموية (237± 59 × 10^{9} / لتر)، وأظهرت نتائج النساء أن هموقلبين الدم(11 ±1.5 جرام/ ديسلتر) وحجم الخلايا المعبئة (30±4.4 %) عدد كريات الدم الحمراء (4.4± 0.6 × 10^{12} / لتر) متوسط حجم الخلية (69.9±5.7 فيمتولتر) ومتوسط سعة الخلية من هموقلبين الدم(25.4±2.9 بايقوجرام) ومتوسط تركيز هموقلبين الدم في الخلية (36.4±2.9 جرام/ديسلتر) وعدد كريات الدم البيضاء (6.5±1.7 × 10^{9} / لتر) وعدد الصفيحات الدموية (276.5±67.7 × 10^{9} / لتر).

أجريت دراسات مشابهة بالخرطوم وكانت القيم متقاربة نسبياً للنتائج في هذه الدراسة.

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1.1 Introduction

Establishing the reference range of any analytic is an extreme importance for making a medical decision. Most studies conducted around the world to establish reference hematological ranges showed significant differences among different races and populations. There are many factors may affect the reference range of the hematological parameters including age, sex and genetic background [1, 2, 3]. These factors must be considered while establishing hematological normal values for any population for the reason that a hematological value within the recognized normal range of certain population may be pathological in another population or situation. It is of great importance to have national hematological reference values for proper diagnosis, orientation and treatment decision. The first study on the hematology of the adult was published in 1924. [4]

The normal reference should be determined carefully by selecting a sample of normal healthy individuals who are representative for the population, analyze their specimens and averaging out their test results. [5.6]

Red blood cell, white blood cell and platelet are the formed element of blood. Their count altered in various diseases and estimation of them of count is basic hematologic investigation. [7]

The examination of complete blood cell count procedure white is routinely performed in the hematology laboratory. [8]

This study aims to establish reference ranges for adult individual in Elmatamma locality.

1.2 Rationale

Health and disease can only be distinguished by accurate and reliable reference values of a particular laboratory test. It is now a proven fact that there is considerable variation in hematology reference intervals depending on the demographic and pre analytical variables. [9] It is now widely accepted that there are no universal or international standard hematological parameters and all reference values are affected to some extent by factors such as age, race, diet, drug intake, method employed for determination etc. It is thus important that standard reference values of local population should be established. Few studies were done in this filed in specific population not representing all Sudanese population. So the importance of this study establishes reference range among adult individual in Elmatama locality.

1.3 Objectives

1.3.1 General objective:

To determine some hematological parameters in adult people between (18 – 68) years in Elmatamma locality.

1.3.2 Specific objectives:

1. To measure hemoglobin concentration in adult people in the study population.
2. To determine red blood cells, count in adult people in the study population.
3. To determine packet cell volume in adult people in the study population.
4. To measure red blood cell indices in adult people in the study population.
5. To determine white blood cell counts and plate late count in adult people in the study population.

Chapter Tow

Literature review

2. Literature review

2.1: The blood:

Blood is specialized body fluid in animals that delivers necessary substance such as nutrients and oxygen to the cells and transporter 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 (plasma 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 osmatic pressure of blood the blood cells are mainly red blood cells (also called RBCs or erythrocyte) and white blood cells and platelet.

The most venous blood carries carbon dioxide. Product of metabolic produced by cells from the tissue to the lungs to be exhaled. (4)

The formation of blood cells (hemopoietin) is determined by the interaction of multiple genes and involves cytokines and other protein factors. The relative ease with which hematopoietic cells can be studied and the development of new techniques in cell biology have enabled us to understand many of the factors determining cell renewal and differentiation based on this knowledge, major progress has been made in the last 15 years in the treatment and diagnosis of many hematological disorder. (10)

2.2: Function:

Blood performs many important functions within the body supply of oxygen to the tissue (bound to hemoglobin – which carried in red cells) including supply of nutrients such as glucose, amino acid and fatty acids dissolved in the blood or bound to plasma protein (e.g. blood lipid).

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

- Immunological function. Including circulation of white blood cells and detection of foreign material by antibodies.
- Coagulation which is one part of the body self repair mechanism blood clotting after wound in order to stop bleeding.
- Messenger function, including the transport of hormones and the signaling of the tissue damage.
- Regulation of core body temperature.
- Hydraulic function. [4]
- Regulation of body PH.

2.3: Constituents of human blood:

Blood accounts for 7% of human body weight with an average density of a proximately 1060kg/m very close to pure water density of 1000kg/m the average adult has blood volume of roughly 5 litters (1.3gal) which composed of plasma and several kinds of cells. These blood cells (which also called corpuscles or formed element) consist of erythrocytes (red blood cells RBCs), leukocytes (white blood cells), and thrombocyte (platelet), the blood cells constitute about 45 whole blood, the plasma about 45.3%.

The study of cellular components of blood are usually performed as hematological screening test, this screening test known as the complete blood count.

2.3.1: Red blood cell:

Erythropoiesis is the development process by which new erythrocytes are produced, it lasts about 7 days. Through this process erythrocytes are continuously produced in the red bone marrow of large bones, at a rate of about 2 million per second in a healthy adult. (In the embryo, the liver is the main site of red blood cell production.) The production can be stimulated by the hormone erythropoietin (EPO), synthesized by the kidney. Just before and after leaving the bone marrow,

the developing cells are known as reticulocytes, these comprise about 1% of circulating red blood cells.

Red blood cells (RBCs), also called erythrocytes, are the most common type of blood cell and the vertebrate organism's principal means of delivering oxygen (O_2) to the body tissues via blood flow through the circulatory system. RBCs take up oxygen in the lungs or gills and release it into tissues while squeezing through the body's capillaries. The cytoplasm of erythrocytes is rich in hemoglobin, an iron containing biomolecule that can bind oxygen and is responsible for the red color of the cells. The cell membrane is composed of proteins and lipids, and these structure provides properties essential for physiological cell function such as deformability and stability while traversing the circulatory system and specifically the capillary network. In humans, mature red blood cells are flexible and oval biconcave disks. They lack a cell nucleus and most organelles, in order to accommodate maximum space for hemoglobin. Approximately 2.4 million new erythrocytes are produced per second in human adults, quarter of the cells in the human body are red blood cells. Red blood cells are also known as, red cells. Red blood corpuscles (an archaic term), hamates, erythroid cells or erythrocytes (from Greek erythros for "red" and kytos for "hollow vessel", with -cyte translated as "cell" in modern usage).

The functional lifetime of an erythrocyte is about 100–120 days, during which time the erythrocytes are continually moved by the blood flow push (in arteries), pull (in veins) and a combination of the two as they squeeze through micro vessels such as capillaries. [11]

Increase in red blood cells known as polycythemia, result from:

- Dehydration.
- Lung (pulmonary) disease.
- Kidney or other tumor that produces excess erythropoietin.
- Smoking.

- Genetic causes (altered oxygen sensing, abnormality in hemoglobin oxygen release).
- Polycythemia Vera a rare disease.

Decrease in red blood cells known as anemia result from:

- Acute or chronic bleeding.
- RBC destruction (e.g., hemolytic anemia, etc.).
- Nutritional deficiency (e.g., iron deficiency, vitamin B12 or folate deficiency).
- Bone marrow disorders or damage.
- Chronic inflammatory disease.
- Kidney failure

2.3.1.1: Hemoglobin:

Also spelled haemoglobin and abbreviated Hb or Hgb, is the iron-containing oxygen-transport metallic protein in the red blood cells of all vertebrates. Hemoglobin in the blood carries oxygen from the respiratory organs (lungs or gills) to the rest of the body (i.e. the tissues). There it releases the oxygen to permit aerobic respiration to provide energy to power the functions of the organism in the process called metabolism. [12] Hemoglobin has an oxygen-binding capacity of 1.34 mL O_2 per gram. [13] This increases the total blood oxygen capacity seventy-fold compared to dissolved oxygen in blood. The mammalian hemoglobin molecule can bind (carry) up to four oxygen molecules. [14]

Hemoglobin is involved in the transport of other gases. It carries some of the body's respiratory carbon dioxide (about 10% of the total) ascarbaminohemoglobin, in which CO_2 is bound to the globin protein. The molecule also carries the important regulatory molecule nitric oxide bound to a globin protein thiol group, releasing it at the same time as oxygen. [15] Hemoglobin is also found outside red blood cells and their progenitor lines. Other cells that contain hemoglobin include the A9 dopaminergic neurons in the substantianigra,

macrophages, alveolar cells, and mesangial cells in the kidney. In these tissues, hemoglobin has a non-oxygen-carrying function as an antioxidant and a regulator of iron metabolism. Hemoglobin and hemoglobin-like molecules are also found in many invertebrates, fungi, and plants. In these organisms, hemoglobin's may carry oxygen, or they may act to transport and regulate other things such as carbon dioxide, nitric oxide, hydrogen sulfide and sulfide. A variant of the molecule, called leghemoglobin, is used to scavenge oxygen away from anaerobic systems, such as the nitrogen-fixing nodules of leguminous plants, before the oxygen can poison the system. (16)

2.3.2: White blood cells (WBCs):

Also called leukocytes or leucocytes, are the cells of the immune system that are involved in protecting the body against both infectious disease and foreign invaders. All leukocytes are produced and derived from a multipotent cell in the bone marrow known as a hematopoietic stem cell. Leukocytes are found through out the body, including the blood and lymphatic system. (12)

Five different and diverse types of leukocytes exist. These types are distinguished by their physical and functional characteristics. Monocytes and neutrophils are phagocytic. (17)

The number of leukocytes in the blood is often an indicator of disease, and thus the WBC count is an important subset of the complete blood count. The normal white cell count is usually between 4 and 11×10^9/L. In the US this is usually expressed as 4,000–11,000 white blood cells per microliter of blood. They make up approximately 1% of the total blood volume in a healthy adult. An increase in the number of leukocytes over the upper limits is called leukocytosis result from: -

- Infection, most commonly bacterial or viral.
- Inflammation.
- Leukemia, myeloproliferative disorders.
- Allergies, asthma.

- Tissue death (trauma, burns, heart attack)

And a decrease below the lower limit is called leucopenia, result from:-

- Bone marrow disorders or damage.
- Autoimmune conditions.
- Severe infections (sepsis).
- Lymphoma or other cancer that spread to the bone marrow.
- Diseases of immune.

The name "white blood cell" derives from the physical appearance of a blood sample after centrifugation. White cells are found in the buff, a thin, typically white layer of nucleated cells between the sediment red blood cells and the blood plasma. The scientific term leukocyte directly reflects its description. It is derived from the Greek word leak- meaning "white" andkytos meaning "hollow vessel", with -cyte translated as "cell" in modern use. The buffy coat may sometimes be green if there are large amounts of neutrophils in the sample, due to the hemcontainingenzyme myeloperoxidase that they produce. [18]

Types:

2.3.2.1: Neutrophil:

Neutrophils are the most abundant white blood cell, constituting 60-70% of the circulating leukocytes [18]. They defend against bacterial or fungal infection. They are usually first responders to microbial infection; their activity and death in large numbers forms pus. They are commonly referred to as polymorph nuclear (PMN) leukocytes, although, in the technical sense, PMN refers to all granulocytes. They have a multi-lobed nucleus, which consists of three to five lobes connected by slender strands. [19]

This gives the neutrophils the appearance of having multiple nuclei, hence the name polymorph nuclear leukocyte. The cytoplasm may look transparent because of fine granules that are pale lilac when stained. Neutrophils are active in phagocytizing bacteria and are present in large amount in the pus of wounds. These

cells are not able to renew their lysosomes (used in digesting microbes) and die after having phagocytized a few pathogens. [20] Neutrophils are the most common cell type seen in the early stages of acute inflammation. The life span of a circulating human neutrophil is about 5-4 days. [21]

2.3.2.2: Eosinophil:

Eosinophil's compose about 2-4% of the WBC total. This count fluctuates throughout the day, seasonally, and during menstruation. It rises in response to allergies, parasitic infections, collagen diseases, and disease of the spleen and central nervous system. They are rare in the blood, but numerous in the mucous membranes of the respiratory, digestive, and lower urinary tracts. They primarily deal with parasitic infections. Eosinophil's are also the predominant inflammatory cells in allergic reactions. The most important causes of eosinophilia include allergies such as asthma, hay fever, and hives; and also parasitic infections. They secrete chemicals that destroy these large parasites, such as hook worms and tape worms that are too big for any one WBC to phagocytize. In general, the nucleus is bi-lobed. The lobes are connected by a thin strand. The cytoplasm is full of granules that assume a characteristic pink-orange color with eosin staining. [21]

2.3.2.3: Basophil:

Basophiles are chiefly responsible for allergic and antigen response by releasing the chemical histamine causing the dilation of blood vessels. Because they are the rarest of the white blood cells (less than 0.5% of the total count) and share physicochemical properties with other blood cells, they are difficult to study. They can be recognized by several coarse, dark violet granules, giving them a blue hue. The nucleus is bi- or tri-lobed, but it is hard to see because of the number of coarse granules that hide it. They excrete two chemicals that aid in the body's defenses, histamine and heparin. Histamine is responsible for widening blood vessels and increasing the flow of blood to injured tissue. It also makes blood vessels more permeable so neutrophils and clotting proteins can get into connective

tissue more easily. Heparin is an anticoagulant that inhibits blood clotting and promotes the movement of white blood cells into an area. Basophils can also release chemical signals that attract eosinophil's and neutrophils to an infection site. [21]

2.3.2.4: Lymphocyte:

Lymphocytes are much more common in the lymphatic system than in blood. Lymphocytes are distinguished by having a deeply staining nucleus that may be eccentric in location, and a relatively small amount of cytoplasm. Lymphocytes include:

2.3.2.4.1: B Cells:

Make antibodies that can bind to pathogens, block pathogen invasion, activate the complement system, and enhance pathogen destruction.

2.3.2.4.2: Tcells:

CD4+ helper T cells: T cells displaying co-receptor CD4 are known as CD4+ T cells. These cells have T-cell receptors and CD4 molecules that, in combination, bind antigenic peptides presented on major histocompatibility complex (MHC) class II molecules on antigen-presenting cells. Helper T cells make cytokines and perform other functions that help coordinate the immune response. In HI infection, these T cells are the main index to identify the individual's immune system integrity.CD8+ cytotoxic T cells displaying co-receptor CD8 are known as CD8+ T cells. Nearly all nucleated cells display MHCI.γδ T cells possess an alternative T cell receptor (different from the αβ TCR found on conventional CD4+ and CD8+ T cells). Found in tissue more commonly than in blood, γδ T cells share characteristics of helper T cells, cytotoxic T cells, and natural killer cells. Natural killer cells are able to kill cells of the body that do not display MHC class I molecules, or display stress markers such as MHC class I polypeptide-related sequence A (MIC-A). Decreased expression of MHC class I and up-regulation of MIC-A can happen when cells are infected by a virus or become cancerous. [22]

2.3.2.5: Monocyte:

Monocytes, the largest type of WBCs, share the "vacuum cleaner" (phagocytosis) function of neutrophils, but are much longer lived as they have an extra role, they present pieces of pathogens to T cells so that the pathogens may be recognized again and killed. This causes an antibody response to be mounted. Monocytes eventually leave the blood stream and become tissue macrophages, which remove dead cell debris as well as attacking micro organisms. Neither dead cell debris nor attacking micro organisms can be dealt with effectively by the neutrophils. Unlike neutrophils, monocytes are able to replace their lysosomal contents and are thought to have a much longer active life. They have the kidney shaped nucleus and are typically a granulated. They also possess abundant cytoplasm. Once monocytes move from the blood stream out into the body tissues, they undergo changes (differentiate) allowing phagocytosis and are then known as macrophages. [21]

2.3.3: Blood Platelet:

Also called thrombocytes, are a component of blood whose function (along with the coagulation factors) is to stop bleeding by clumping and clogging blood vessel injury. Platelets have no cell nucleus, they are fragments of cytoplasm which are derived from the megakaryocytes of the bone marrow, and then enter the circulation. These inactivated platelets are biconvex discoid (lens-shaped) structures 2–3 μm in greatest diameter. Platelets are found only in mammals, whereas in other animals (e.g. birds, amphibians) thrombocytes circulate as intact mononuclear cells. On a stained blood smear, platelets appear as dark purple spots, about 20% the diameter of red blood cells. The main function of platelets is to contribute to hemostasis, disorder of platelet function is a thrombocytopathy. Low platelet concentration is thrombocytopenia and is due to either decreased production or increased destruction.

Examples for causes of thrombocytopenia:

- Viral infection (mononucleosis, measles, hepatitis).
- Rocky mountain spotted fever.
- Platelet autoantibody.
- Drugs (acetaminophen, quinidine, sulfa drugs).
- Cirrhosis.
- Autoimmune disorders.
- Sepsis.
- Leukemia, lymphoma.
- Myelodysplasia.
- Chemo or radiation therapy.

Elevated platelet concentration is thrombocytosis and is either congenital, reactive (to cytokines), or due to unregulated production one of the myeloprolerative neoplasm's or certain other myeloid neoplasm's.

Examples for causes of thrombocytosis:

- Cancer (lung, gastrointestinal, breast, ovarian, lymphoma).
- Rheumatoid arthritis, inflammatory bowel disease, lupus.
- Iron deficiency anemia.
- Hemolytic anemia.
- Myeloproliferative disorder as essential thrombocythemia[23].

2.4 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 perform 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 complete blood count (CBC) produced by automated hematology analyzer provides several result, some of which are more important than other. [8]

The cells that circulate in the blood stream are generally divided into three types: white blood cells (leukocytes), red blood cell (erythrocytes), and platelets (thrombocytes). Abnormally high or low count may indicate the presence of many forms. of disease, and hence blood counts are amongst the most commonly performed blood test in medicine, as they can provide an over view of patient's general health status. A complete blood count (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), sometime citrate to stop it from clotting, and transported to 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). [39]

2.5 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 computer for review, blood counting machines aspirate a very small amount of the specimen through narrow tubing within this tubing, there are sensor that count the number of cell 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. [8]

Other instrument measure different characteristics of the cells to categorize them. Because an automated cell counter sample 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 categories, in addition to counting, measuring and analyzing red blood cells, white blood cells and platelet, 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 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. [40]

A complete blood count with normally include:

- Red blood cells count – the number of red cells is give as an absolute number perlite.
- Hemoglobin – the amount of hemoglobin in the blood, expressed in grams per deciliter.
- Hematocrit or packet cell volume (PCV) – this is the fraction of whole blood volume that consists of red blood cells.

Red blood cell indices:

- Mean corpuscular volume (MCV)- the average volume of the red cells, measured in femtolitres. Anemia classified as microcytic or macrocytic based on this value is above or below the expected normal range.
- Mean corpuscular hemoglobin (MCH) – the average amount of hemoglobin per red blood cell, in pictograms.
- Mean corpuscular hemoglobin concentration (MCHC)– the average concentration of hemoglobin in the cells.
- White blood cells.
- Platelets. [40]

Chapter Three

Materials and Methods

3. Materials and Methods

3.1 Study design:

This is a cross-sectional descriptive study design to determine some hematological parameters in the healthy adult between (18-68) years in Elmatamma during the period between of April 2018 to July 2018.

3.2 Study area:

The study was conducted in Elmatamma which located in northern Sudan, located in the river Nile state.

3.3 Ethical consideration:

Procedure of venous blood sampling was explained to the adult. All participants were informed about the research objectives and procedure during the interview period.

3.4 Study Population:

A total of (301) samples were collected from venous blood from adult health people between (18-68) years.

3.5 Inclusion criteria:

Normal Healthy adult people in ages ranged (18 – 68) years.

3.6 Exclusion criteria:

- Anemic person and other diseases.
- Those individual under 18 years old and above 68 years old.
- Smokers peoples.

3.7 Data collection:

Data were collected using structural interviewing questionnaire, which was designed to collect and maintain all information needed.

3.8 Blood sample:

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 3-6 hours) for analysis.

3.9 Methods:

3.9.1 Requirement:

- EDTA container.
- Syringes and tourniquet.
- Cotton.
- Alcohol 70%.
- Gloves.

3.9.2 Reagent:

- Cell pack (diluents).
- Stromatolyser.
- Cell clean.

3.9.3 Principle of cell counter:

These cell analyzers use the electronic impedance principle in counting. When a cell drawn into a constant current, flowing from an electrode, the electrical conductivity changes. This generates an equivalent voltage pulse. The amplitude of the pulse is directly proportional to the volume of the represented cell (MCV). The number of pulses corresponds to the number of cells detected (WBC, RBC and PLT). The hemoglobin level is measured by the cyanmethemoglobin method. When the cyanmethemoglobin reagent (potassium ferricyanide, sodium bicarbonate and potassium cyanide) is added to the blood sample it will lyse the RBCs forming a colored compound that its intensity is proportional to the amount of hemoglobin present. [24] [25].

The RBC indices the HCT, MCH, and MHCH are calculated by the machine using the following formulas. [26]

HCT = (RBCs×10^{12}/L×MCV) /10(%)

MCH = (Hb/RBCs×10^{12} /L) ×10 (pg.)

MCHC =Hb/HCT × 100 (gm/dl).

3.9.4 Procedure:

The reagent for operation were checked ,then the power switch was turn on auto rinse and back ground check were automatically performed then three level of control (low count, normal count and high) were applied after selection whole blood mode of analysis sample number were introduced by pressing sample number key then enter key was pressed after that sample was mixed carefully thetab bring in close contact with sample probe and the start key was pressed, after therequired volume of blood were aspirated ,then tube was removed ,result was displayed the screen and printout.

3.10 Data analyses:

Data were analyzed by SPSS statistical package of social science. Version20.

Chapter Four

Results

4 Results

In this result show RBCs count in male (5.1 ± 1.7) in female (4.4 ± 0.6) and Hb in male (13.6 ± 1.2) in female (11.0 ± 1.5) and HCT in male (35.9 ± 2.4) in female (30.2 ± 4.4) and MCV in male (72.6 ± 4.1) in female (69.9 ± 5.7)and MCH in male (27.6 ± 4.3) in female (25.4 ± 2.9) and MCHC in male (37.8 ± 4.3) in female (36.4 ± 2.9), P Values< 0.001 statistically significant difference between males and females: table (4 – 1).

TWBCs count in male (5.9 ± 2.0) in female (6.5 ± 1.7) and PLTS in male (237.1±59.2) in female (272.5 ± 67.7), P value<0.01 statistically significant difference between males and females: table (4-2).

Table (4-1): Shows the mean±SD FOR RBCS parameter:

Parameter	RBCS	Hb	HCT	MCV	MCH	MCHC
Male N=(186)	5.1 ±1.7	13.6 ±1.2	35.9 ±2.4	72.6 ±4.1	27.6 ±4.3	37.8 ±4.3
Female N=(115)	4.4 ±0.6	11.0 ±1.5	30.2 ±4.4	69.9 ±5.7	25.4 ±2.9	36.4 ±2.9

Table (4-2): Shows mean ± SD for WBCS and PLTS.

Parameter	WBCS	PLTS
Male N=(186)	5.9± 2.0	237.1 ± 59.2
female N=(115)	6.5 ± 1.7	272.5 ± 67.7

Chapter Five

Discussion

Conclusion

Recommendations

5.1 Discussion

This study was conducted during the period from April to July in Elmatamma to establish normal range of hematological parameters among healthy adult people, study results show the hematological parameter was significantly different for men compared to women.

The normal hemoglobin concentration in male (13.6±1.2) g/dl is higher than normal hemoglobin concentration in female (11.0 ±1.5) g/dl. Hemoglobin in male (13.6 ±1.2) g/dl is less than hemoglobin in male of Sudanese population (14.6±1.5)[27] and less than British population (15.7± 2.25) g/dl [28] and less than normal hemoglobin in male of Saudian population (15.2±1.1) g/dl.[29] the hemoglobin concentration in female (11.0± 1.5) g/dl is less than normal hemoglobin concentration in female of Sudanese population (12.04±1.3) [30] and less of British population (13.75 ±2.75)g/dl.[28] and also less than normal hemoglobin concentration in the female of Saudi population (13.8± 1.1) g/dl. [29]

The normal RBCs Count in female (4.4 ± 0.6) 10^6/μL is lower than male (5.1 ± 1.7) ×10^6/μL. Normal RBCs Count in male of Elmatamma population (5.1± 1.7) ×10^6/μLhigher than in male of Sudanese population (5.1±.5) [31], (5.3±.6) [27] and higher than in male of British population (5.0±0.5) ×10^6 [28] and slightly high than American population Normal Values: males: 4.5 to 6.0 million/cu mm blood [32], and slightly high than germane population Men 4.7-6.1 million /mm3.[33] German population and American population are the similar to each other in red count for both sexes. Normal RBCs Count in female of Elmatamma population (4.4±.6) is similar RBSC count in female of Sudanese population (4.6±.4) [31], (4.6±.4) [30]close to of female of British Population Women (4.3± 0.5×10/μL) [28] and similar female of Chinese population (3.68 – 5.13) ×10^{12}/L. [34].

The HCT in male (35.9± 2.4) % is higher than HCT in female (30 ±4.4) %, MCV in male (72.6 ±4.2) fl higher than MCV in female (69.9± 5.7)fl, MCH in

male (28± 4.3)pg. increase than MCH in female (25± 2.9)pg., MCHC in male is (97.8± 4.3)g/dl increase than MCHC in female (36.4 ±2.9)g/dl.

The normal total WBCs count in male (5.9 ± 2.0) $\times 10^3/\mu L$ was slightly lower than female (6.5 ± 1.7) $\times 10^3/\mu L$, the total white blood cell count in male of Elmatamma population (5.9±2.0) when compared to another study in Sudan was close to (5.9±1.7). [35] and slightly less than (6.6±1.96) [27], and higher than black population of the Witwatersrand (south Africa) (5.60±1.51) $\times 10^9/\mu L$. [36] But less than British population (7.0±3.0) $\times 10^3/\mu L$.[28] and less than Chinese (3.97-9.15) $\times 10^9/L$. [34]

Total white blood cell count of female was (6.5± 1.7) close to total WBSC count in female of Sudanese population (6.5±2). [30] and high than south Africa (5.60 ±1.51) $\times 10^9/L$. [36], but less than British population:(7.0 ±3.0) $\times 10^3$ µL. [28] and less than Chinese population (3.69-9.16) $\times 10^9/L$ in female. [34]

The platelet counts in males (237±59) $\times 10^3/\mu L$ was lower than female (276.5±67.7) $\times 10^3/\mu L$. We observes that Platelet count high in female than male, that is conformed to the National Centre for Biotechnology Information, U.S. National Library of Medicine (The platelet count of healthy males was compared to that of healthy females. A higher platelet count in women was confirmed [37] that reverse to RBCs Count which it higher in males than females.

Platelet account Elmatamma population (237±59) close to platelet count in male of Sudanese population (246±72) $\times 10^3/\mu L$ [35] and less than black population of the Witwatersrand (south Africa) platelet account was (280 ±59.4) $\times 10^9/L$ for men and similar Togo $236 \times 10^9/L$ in male.

Platelet account in Elmatamma population in female (276.5±68) similar platelet count in Sudanese population (277.8±72.4) [31] and less than black population of the Witwatersrand (south Africa) platelet account was (317±64.0) $\times 10^9/L$ [36] and high than Togo (247×10^9). [38]

5.2 Conclusion

The hematological parameter in adult male higher than female except WBCS and plate late. The normal hemoglobin concentration in adult of Elmatamma population is lower than hemoglobin concentration of British and Saudian in adult population.

The normal red blood cell count in adult male higher than British and German male and red blood count in female is similar of British female and chaises population.

The normal total white blood cell account of Elmatamma population is higher than black population of the Witwatersrand (south Africa) but less than British and chains' population.

The platelet account in Elmatamma population less than black population of the Witwatersrand (south Africa) and slightly higher than Togo.

5.3 Recommendations

1. Further studies in this topic should be done to support this study.
2. Study hematological parameter for children to establish normal value in Elmatamma locality.
3. Periodic follow up and monitoring of hematological parameter for all adult males and female for anemia and other blood disorder.

Chapter Six

References

Appendix

6.1 References

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Appendix

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Questionnaire about Hematological Reference Values for Healthy Adults

1. Age:

a. 18 – 28years ( ) b. 29 – 38years ( ) c. 49 – 58 years ( )

d. 59 – 68 years ( )

2. Sex:

a. male ( ) b. female ( )

3. Tribe:

a. Galieen ( ) b. Nouba ( ) c. Hasania ( ) d. Others ( )

4. How many meals you eat per day?

1. …… 2- …… 3- ……. More ……

5. Do you eat red meat ?

a. Yes ( ) b. No ( )

6. Are you complaining of any disease ?

a. Yes ( ) b. No ( )

If yes identify please ……

7. Are you on any medication?

a. Yes ( ) b. No ( )

If Yes identify please ……

8. Do you or any of your family have anemia ?

a. Yes ( ) b. No ( )

If yes identify please ……..

9. How many days the menstrual period stays?

……

10. Did you undergo to operation during last 12 month ?

a. Yes ( ) b. No ( )

11. Did you donate or receive blood during the last 6 month ?

a. Yes ( ) b. No ( )

12. Are you smoker ?

a. Yes ( ) b. No ( )