1-1. Introduction

Human body score temperature varies from day to day and from time to time, but theses fluctuations are small, usually no more than 1.0^0C .Humans are homeothermic and body temperature is regulated at about 37 ^{0}C +⁄- 1^0C.

The thermoregulatory center in the hypothalamus plays a very active role in keeping body temperature in the normal range. External(climatic) and internal(metabolic) heat sources influence body temperature .Heavy exersice, illness, and not only hot humid but also cold and windy environments alter body temperature outside the normal range .Ambient temperature, humidity ,air environment and radiant heat from the sun as well as warm and cold surface contribute to climatic heat stress.Metabolic heat is produced by exercise.When you are too hot, the blood vessels in your skin expand (dilate) to carry the excess heat to your skin's surface. You may begin to sweat, and as the sweat evaporates, it helps cool your body.

When you are too cold, your blood vessels narrow (contract) so that blood flow to your skin is reduced to conserve body heat. You may start shivering, which is an involuntary, rapid contraction of the muscles. This extra muscle activity helps generate more heat. Under normal conditions, this keeps your body temperaturewithin a narrow, safe range.Thermal homeostasis is maintained by the balancebetween heat gaining and heat dissipating mechanism, controlled by temperaturesensitive centres in the hypothalamus (Drobtaz;2004).

1-2.Literature review

Heat gain occur through oxidative metabolism of food ,exercise and increase muscle or metabolic activity, and elevated environmental temperature. Heat dissipating mechanisms includebehavioral changes (seeking in cooler location),peripheral vasodilation and change in circulation,evaporativecooling primarily in the form of respiratory heat exchange and radiation .(Mazzaferro;2004) .

1-2-1. Blood:

Blood is a vital fluid of the body and such the life line of human body .It is a red colored viscous fluid slightlysalt in taste.Blood is alkaline in reaction pH=7.4 and specific gravity range from 1.052 to 1.060 .In adult human blood volume range between 4.5 to 6.0 litters and approximately about one thirteen of adult human body weight. Temperature of circulating blood is 37.7C .Blood has two main component cells and plasma.Cells consist of 40% to 45% of total amount of blood, and plasma consist of 55% to 60% of total amount of blood,.(Talib;1995)

1-2-2.Blood function:

Blood is main transportation vehicle of the body.It is carries oxygen and nutrients to tissues and waste products of metabolism e.g carbon dioxide and urea to lung and kidneys. Most of the hormones are also carried from the endocrine gland to target organs. Blood also have impotanthemostatic functions exemplified in following. Blood circulation helps to distribute heat around the body from metabolically active and warmer organs,e.g liver and gut to peripheral organs .Buffer in the blood like hemoglobin,plasma,protin,bicarbonate and other help to keep hydrogen concentration of extracellular fluid constant at a ph 7.4 .Blood play

a vital protective function agnist infection by virtue of it is leukocyte and antibody (immunoglobulin) in the plasma.Furthermore injury to blood vessels is followedby blood clotting ,which stops further loss of blood (Sukkar*etal;*2000)

1-2-3. Blood component:

Blood consist of:

1-Formed element(blood cells)of three types:

a-Red blood cell(erythrocyte).

b- white blood cell(leukocyte).

C -platelet(thrompocyte).

2-Plasma:

Plasma consist of organic and inorganic substances dissolved in water .Plasma protein constitutemost of plasma solutes ,by weight, there are three types:
albumin, globulin and fibrinogen .Cells normally do not take up plasma protein,useplasma amino acid to make their own proteins.Thusplasmaprotin must be viewed Differently formed most the other organic constituents of plasma, use as the medium for transport to form cells.In contrast most plasma proteins perform their function in the plasma it self or in the interstitial fluid.(Widmaier*etal;*2006)

1-2-4. Hemopoiesis(blood cell formation):

Is the process by which immature precursor cell (pluripotential stem cell) develop into mature blood cell.

1-2-4-1. Site of hemopoiesis:

Formation of blood cell occur in different anatomical sites during the course of development from embryonic to adult life (Metcalf and Moore 1971). Production of blood cells commences in the yolk sac of the embryo, but then shift to the liver, and to lesser extent to the spleen, so that these organs become the dominant sites of production between the second and seventh month of gestation. The liver and spleen are superseded by the bone marrow , which serves as theonly important sites of blood cell production after birth. An exception is lymphocyte production, which occurs substantially in other organs, in addition to the bone marrow,in adult life.Haemopoietic tissue fills all of the cavity with in the bones of the newborn, but with increasingage become localized in the cavites of the upper shafts of the femur and humerus, the skull, pelvis ,spine and bone of the thorax. The total volume of haemopoietic tissue in adult is 1-2litres. This tissue is referred to as red marrow because of its macroscopic apperance; the remaining bone marrow in the more peripheral regions of the skeleton contain predominantly fatand termed yellow marrow. Yellow marrow also occupies a volume of 1-2 litres and serves as areserve space into which haemopoietic tissue can expand in response to an increased demand forblood cell production. Only in pathological situation does significant haemopoietic activity occur in the liver, spleen and other sites during adult life when it is referred to as extra medullary haemopoiesis (Frank *etal;*2011)

1-2-4-2.Erythropoiesis

Process by which red blood cells are formed; it is stimulated by decreased O_2 in circulation, which is detected by the kidneys, which then secrete the hormone called erythropoietin. Thishormone stimulates proliferation and increased

differentiation of red cell precursor which activate erythropoiesis in the haemopoietic tissue, ultimately producing red blood cells (Sukkar*etal*;1998).

Red cells are produced by proliferation and differentiation of precursors whose dominantrepresentatives in the bone marrow are the erythroblast. Erythroblast arerefferred to asnormoblast when their morphological feature are with in normal limits. During the course ofdifferentiation the size of erythroblast progressively decrease, and the character of the nucleusand cytoplasm changes as the cells proceed toward the point where proliferative capacity is lost and hemoglobin become the predominant protein in the cytoplasm.(Frank *etal;*2011)

1-2-4-2-1.Theerythroid series:

1-The pro-erythroblast:

It is the least mature of the morphologically identifiable members of the erythroid series. It hasdiameter of (14-20)µm and a basically round outline with several round nucleoli in the nucleus which occupies most of the cell. The chromatin in the nucleus consist of a network of fine red -purple strands.Acharacteristic feature is that the peripheral cytoplasm is more basophilic than in the myeloblast ,which is the corresponding member in the maturation sequence of the granulocytic series. Pro-erythroblast undergo rapid division and give rise to basophil erythroblasts.(Frank *etal*; 2011)

2-The basophilic erythroblast:

It is round cell with a diameter of (12-16) µm , and more basophil cytoplasm than the proerythroblast . It is also undergoes rapid proliferation.The nucleus occupies a relatively largeproportion of the cell, but differs from the nucleus of the pro-erythroblast by having coarserand more basophilic chromatin strands.

(Frank *etal*; 2011)

3-The polychromatic erythroblast

It is a round cell between (12-14)µm in diameter . The characteristic polychromatic appearance of the cytoplasm is derived from the mixture of thebasophilic ribonucleic acid (RNA) and acidophilichemoglobin . Nuclear chromatin is in coarse deeply basophilic clumps ,and proliferative activity ceases after in this stages. (Frank *etal*; 2011)

4-Orthochromatic erythroblast:

constitute the next and final stage of maturation of the nucleated red cell series. They aresmall and have a diameter between (8-12)µm. The nucleus is relatively small with a homogenous blue –black apperance . Active haemoglobin synthesis occurs in cytoplasmwhich contain mitochondria and ribosomes. The ribosomal RNA imparts a basophilic tint tothe cytoplasm is predominantly acidophilic due to the presence of large amount of haemoglobin. The nucleus is extruded from the orthochromatic erythroblast to form the reticulocyte.(Frank *etal*; 2011)

5-Reticulocytes:

They have the same biconcave discoid shape as mature red cells , although they have a slightlygreater volume and diameter than the latter. Reticulocyte cytoplasm is similar in staining characteristics to that of orthochromaticerythroblast ,which are distinguished from mature red cells by a diffuse basophilic hue. Whenstained with vital stains such as new methylene blue reveals deeply stained granules or chain of granules .Reticulocyte lose their mitochondria and ribosome over the course of a few days ,and in doing so lose the basophilic tint and evolve into the mature erythroyte.Red cell normally enter the blood at the stage of reticulocyte or of themature erythrocyte.(Frank *etal*; 2011)

6- Mature red blood cell:

Mature erythrocytes are unique among the cells of human tissues in that they normally lack nuclei and cytoplasmic structures such aslysosomes, and mitochondria. It is biconcave shape which allow maximum flexibility to transverse the smallest capillaries which have a diameter of only 5µm .The red cell membrane is composed of specialized protin (cytoskeleton) which responsible for red cell shape, and outer lipid bilayer which responsible for provide hydrophobic skin . Defect in both red cell membrane and lipid bilayer lead to change in shape and red cell destriction .lifespan of the red cell(120 days) .(Martin and Peter ;2008)

1-2-4-3.Hemoglobin:

Hemoglobin which is contained in red blood cell, the main function of red cell is to carry O2 to Tissuesand return carbon dioxide (CO_2) from tissue to lung in order to achieve this gaseous exchange they contain specialized protein called hemoglobin .(Hoffbrand*etal;* 2004)

1-2-4-3-1.Hemoglobin structure:

Each RBC contain approximately 640 million hemoglobin molecule ,each molecule of normal adult hemoglobin (Hb A) which is the dominant hemoglobin in the blood after age of3-6 month consist of four polypeptide chain 2α and 2β each with it is own heam group .The molecular weight of HbA is 68000. Normal adult blood also contain small quantity of two other hemoglobin ,HbF and HbA2 .These also contain α chain but with γ and δ respectively instead of β. The major switch from fetal hemoglobin to adult hemoglobin occur 3-6 month after birth.(Hoffbrand*etal;* 2004).

1-2-4-3-2.Hemoglobin synthesis:

Occur largely in mitochondria by series of biochemical reaction commencing with the condensation of glycine and succinyl Co enzyme. Under the reaction of the key rate limiting enzyme δ amino levulinic acid (ALA) synthetase. Pyridoxal phosphate (Vit B_6) is Co enzyme for this reaction which is stimulated by erythropoietin .Ultimately ,protoporphyrin combine with iron in ferrous state (Fe^{2+}) to form heam,each molecule of which combines with globulin chain made on polyribosome .Atetramer of four globin chains each with it is own heam group a pocket is then formed to make up hemoglobin molecule.(Hoffbrand*etal;* 2004)

1-2-4-4.Leucopoiesis:

It is the process of formation of white blood cells. The leukocyte may be divided into two broad groups: the phagocytes and immunocytes. Granulocytes which include three types of cell:neutrophils(polymorphs), eosinophils, and basophiles-together with monocytes comprise the phagocytes. Only mature phagocyte and lymphocyte are found in normal peripheral blood. The lymphocyte, their precursor cells and plasma cells make up the immunocytepopulation.The function of phagocytes and immunocytes in protecting the body against infection is closely connected with two soluble protein systems of the body: immunoglobulin and complement (Hoffbrand*etal;*2006).

1-2-4-4-1. Granulopoiesis:

Is the process of granulocyte formation.Thepredominant white blood cell, or leukocyte in the circulation is mature granulocyte.(Frank*etal;* 2011)

1-2-4-4-1-1.Granulopoiesis series:

1-Myeloblast:

Is relatively large cell(15-20)µm in diameter,with round to oval nucleus which Occupies a largeProportion of the cell. There are no typical granules in the moderately basophilic cytoplasm. Nuclear chromatin is arranged in a fine network of red-purple strands with occasional small aggregates. Nucleoli are typically prominent while two or three is the usual number, there maybe up to six nucleoli.(Frank*etal;* 2011)

2- Promyelocyte:

It is larger thanmyeloblast , loose chromatin with nucleoli and dark blue cytoplasm with large granules distributed through out the cytoplasm.
(Marcella*;*1997)

3-The myelocyte:

It has prominent cytoplasmic granules, and the area of cytoplasmic relative to the nucleus is greater than in the promyelocyte .The cytoplasm is also less basophilic, nucleoli are no longer present, and the chromatin appears more aggregated than in

thepromyelocyte.(Frank*etal;*2011)

4-Metamyelocyte:

The nucleus becomes indented and assumes a kidney –shaped appearance. Granules are prominent in the cytoplasm.(Frank*etal;* 2011).

5-Band or stab form:

The degree of indentation of nucleus is greater than 50% of nuclear diameter. Cytoplasmicgranules are identical to those in the mature segmented form.
(Frank*etal;* 2011)

6-Neutrophil (polymorph):

This cell has a characteristic dense nucleus consisting of between two and five lobes, and a pale cytoplasm with an irregular outline containing fine pink-blue granules or grey- blue granules. The granules are divided into:

a- Primary, which appear at the promylocyte stage.
b- Secondary (specific) which appear at the myelocyte stage and predominant in thematureneutrophil.

Both types of granules are lysosomal in origin. The life span of neutrophils in the blood is only 6-10 hours (Hoffbrand*etal;* 2006).
Neutrophils are the most common circulating form of granulocyte and play essential role in phagocytosing and killing invading microorganism .
(Frank *etal* ;2011).

Polymorphnucleareosinophils:

are slightly larger than segmented neutrophils and have a similar to that of the segmented neutrophil, and contain many granules which are larger than those in the segmented neutrophil. These granules stain bright orange with Romanovsky stain. They also stain with eosin which is employed to identify eosinophils in the more accurate direct eosinophil count. Granules ineosinophil series stain more

intensely with histochemical stain for peroxidase than granules in the neutrophil series(Frank *etal;*2011).

They enter inflammatory exudates and have special role in allergic response, defenceagnistparasites and removal of fibrin formed during inflammation (Hoffbrand*etal;*2006)

Polymorphonuclear Basophil:

They have many dark cytoplasmic granules which overlie the nucleus and contain heparin and histamine. In the tissue they become mast cell. They have immunoglobulin (IgE) attachment sites and their degranulation is associated with histamine release (Hoffbrand*etal;*2006).

Stab and segmented granulocyte are motile and thus posses the capacity to migrate into the blood passing through bone marrow sinusoids(Frank*etal;*2011).

1-2-4-4-2. Monopoiesis:

Is a process by which monocyte formed.

Monopoiesis series:

1-Monoblast:

Are the least mature morphologically recognizable members of monocyte-macrophageseries,and are very similar in appearance to myeloblast. They are located predominantly in the bone marrow,which is the major site of monocyte production..(Frank*etal;*2011).

2-The promonocyte:

It is similar in size to the promyelocyte ,but has more irregularly shaped, and often deeply cleft ,nucleus containing nucleoli. The cytoplasm contains granules often arranged in a localizedregion ,and the granules are larger and more basophilic than the mature monocyte.(Frank*etal;*2011).

3-The mature monocyte:

Is slightly larger than the segmented granulocyte. It has an irregularly shaped nucleus with fine chromatin .The shape of the nucleus ranges from almost round to sufficiently indented to produce a lobulated appearance .Cytoplasm is abundant and of a pale grey-blue tint. It contain some small neutrophilic or basophilic granules, which are less common than in granulocytes.Monocyte are motile cells and are thus capable of migrating into the blood passing through bone marrow sinusoids.(Frank*etal;*2011).

1-2-4-4-3.Lymphopoiesis:

Is process by which lymphocyte formed.Lymphocytes pass through a series of developmental changes in the course of evolving into various lymphocyte subpopulation . The developmental process in certain instances involves migration of immature precursors to other organs such as the thymus, where inductive effects on differentiation are mediated via locally produced factors.Mature lymphocytes are engaged in extensive recirculation through the exravascular and vascular compartments .This is important in facilitating the recognition of foreign antigens by lymphocytes, and it naturally assist the recognition by lymphocytes of foreign antigens to which the individual has been previously exposed. Cell –mediated and

antibody-mediated immune response involve a complex sequence of events in which lymphocyte subsets interact with other subsets of lymphocytes.
(Frank *etal;*2011).

1-2-4-4-3-1.lymphopoiesis series:

1-Lymphoblasts:

Are slightly smaller than the myeloblasts which they resemble ,except that the ratio of the diameter of the nucleus to that of the cell is greater and the number of the nucleoli per nucleus is fewer than in the myeloblast .Lymphoblast are actively dividing cells.(Frank *etal;*2011).

2- prolymphocyte:

Differ fromblast by subtle changes such as slightly more clumped chromatin ,a lessening of nuclear prominence and changes in sickness of nuclear chromatin (Bernadette ;1995)

3-The large lymphocyte:

Is between (12-16) µm in diameter, round in outline, nucleus is round or slightly indented, chromatin is more clumped and the cytoplasm is more abundant than in the lymphoblast which is usually pale blue. Some granules may be present in the cytoplasm, but are fewer than in the granulocyte.(Frank*etal;*2011).

4-Small lymphocytes:

Are between (9-12) µm in diameter, smaller than segmented granulocytes, cytoplasm usually forms only a thin medium to deeply basophilic rim encircling a

round or marginally indented nucleus which contains deeply staining heavily clumped chromatin.(Frank*etal*;2011).

1-2-4-5.Thrombopoiesis:

Platelet are formed in the bone marrow by megakaryocytes, and are subsequently released into the vascular compartment where they play an essential role in haemostasis.

The megakaryocytic series:

1-Megakaryoblast:

The most immature stage of platelet development, which resembles the myeloblast in it is basic feature. These cell amount to less than 8% of the total megakaryocytic population. (Frank *etal;*2011).

2-The promegakaryocyte:

Is the next stage in the sequence of maturation, and is larger than it is precursors because it has undergoneendoreduplication. Endoreduplication is nuclear replication without division of the series .Promegakaryocytes make up about 25% of megakaryocytes , and have deeply basophilic cytoplasm containing some basophilic granules. The nucleus may be lobulated and the chromatin is more deeply.(Frank *etal;*2011).

3-Mature megakaryocytes:

It is extremely large cell with accentric placed single lobulated nucleus and low nuclear to cytoplasmic ratiowith coarsely clumped chromatin, the cytoplasm stains light blue and contains many small red-purple granules .
(Hoffbrand*etal;*2006).

4-Platelet:

Are small, anucleate, terminal stage of development of the megakaryocytic series. They are discoid and have a diameter of 1-4µm. The cytoplasm stains light blue and contains small red-purple granules which are centrally located in platelet in blood films.Itis released into the circulation to prevent leakage of blood . The life span is about 1 week.(Emmanuel ;1993)

1-2-5.Complete blood cell count (CBC):

Complete blood cell count is a very common test that use to evaluate the three major type of cell in blood,red blood cell,white blood cell and platelet.
(Lewis*etal* ;2006)

1-2-5-1.Haemoglobin estimation:

The haemoglobin concentration of a solution may be estimated by several methods: by measurement of its color, by its power of combining with oxygen or carbon monoxide or by its iron content. The methods to be described are all colour or light-intensity matching techniques, which also measure to a varing extent, any methaemoglobin(Hi) or sulphaemoglobin (SHB) ,that may be present. Also Hbcan be determined accurately by spectrophotometry. The blood is diluted in a solution contain potassium cyanide and potassium ferricyanide and the absorbance of the solution is then measured in a spectrometer at wavelength of 540nm and thenHb is calculated with special formula(Lewis*etal;*2006).

1-2-5-2.Red blood cell estimation:

Red cell and other blood cells can be counted in systems based on either a perture impedance or Light –scattering technology. Because large number of cell canbecounted rapidly, there is a high level of precision. Consequently electronic

counts have rendered the RBC and red cellindices derived from it (the MCV and MCH) of much greater clinical relevance than was possible when only a slow and imprecise manual RBC was available(Lewis*etal*; 2006)

1-2-5-3. Haematocrit:

The haematocrit or packed red cell count (PCV) refer to the proportion of the volume of redcells relatives to the total volume of the blood. High -speed centrifugation in the microhaematocrit procedure used to sediment the red cells yields highly reproducible result .The values do not correspond strictly to those obtained by electronic automated devices which derive a result from a formula which involves multiplying the red cell count by the mean red cell volume ,themicrohaematocrit procedure is of value in providing a reliable and simple means for rapid determination by clinician of the red cell content of the blood.
(Frank *etal;*2011)

1-2-5-4.Red cell indices:

Red blood cell indices use to help diagnose the cause of anemia or a condition in which there are too few red blood cell. (Hutchison*etal;*2011) .

Mean corpuscular volume (MCV):

The mean volume of red cells was formerly determined by dividing the total volume of red cells(derived from the PCV) by the number of red cells in that particular sample of blood. Automated electronic-particle counting devices have revolutionized the estimation of the MCV. Most devices measure the electrical impedance caused by red cell as it passes through the counting mechanism and the extent of the impedance provide an accurate indication of the volume of each cell. The MCV derived by this means therefore provides a reliable index of the average

size of red cells,which is a guide of considerable importance to the nature of the disorder underlying an abnormality in the hemoglobin level. A subnormal MCV is indicative ofmicrocytosis, and an elevated MCV indicative of macrocytosis.
(Frank *etal;*2011).

Mean corpuscular hemoglobin(MCH):

The mean amount of haemoglobin per red cell (MCH) is also rapidly and reliably estimated by automated electronic counting devices by dividing the total amount of haemoglobin by the number of red cells in a sample of blood. A subnormal MCH occurs in microcytosis, but is even lower when microcytosis occurs in conjuction with a subnormal concentration of haemoglobin in the red cell, as in thalassaemia minor or iron deficiency(Frank *etal*;2011).

MCHC(Mean Cell Haemoglobin Concentration):

This test is measure the average concenteration ofhaemoglobin with in the red cell and it is used to evaluate and manage blood disorder.
(Fischbach and Dunning ;2004).
It is derived by dividing the concenteration of haemoglobinin g/dl by the volume of red cell in ml/dl. Both measurement are readily and reliably obtained by manual methods , and the result is expressed in g haemoglobin/dl packed red cells.
A subnormal MCH is usually indicative of an abnormality where interference with the synthesis of haemoglobin is greater than that of other constituents of red cells, as in thalassaemia or iron deficiency. Elevated value reflect dehyderation of the erythrocytes, and one of the relatively few important clinical causes of this phenomenon is spherocytosis (Frank *etal;*2011).

RDW_CV and RDW_SD

Red cell distribution width is derived from pulse analysis and can be expressed as standard deviation(SD) in (fl) or as coefficient variation(CV) (%) of measurement of red cell volumeRDW is usually increased in iron deficiency anaemiaandnormal in thalassemia trait.(Lewis*etal;*2006)

1-2-5-5.White blood cell count(WBCs):

Is determined in whole blood by usig lytic reagent which lsyis RBCs while WBC is intact. Fully automated instrument performWBCs by using impedance or light scattering technology.(Lewis*etal;* 2006)

1-2-5-6.pLatelet count:

Platelet can be counted in whole blood using the same techniques of electrical or electro-optical detection as are used for counting red cell .Also platelet can be counted by flowcytometer by labeling plt fluorescently with specific monoclonal antibody or combinationof antibodies.(lewis*etal;*2006)

Mean Platelet Volume(MPV):

The same technique that are used to size red cells can be applied to platelets. The calculated MPV is very dependent on the technique of measurement .When MPV is measured by impedance technology it has been found to vary inversely with plt count in normal subjects. MPV is higher in myeloproliferative disorders and lower in thrombocytopenia caused by megaloblasticanaemia or bone marrow failure.
(Lewis*etal;*2006).

Platelet Distribution Width (PDW):

Is a measure of platelet anisocytosis and pltcrit which is the the product of the MPV and pltcount. (Lewisetal; 2006).

1-2-6. Factors affect on CBC:

- Over and under filled tubes: all tubes with anticoagulant must be filled to the correct blood ratio in order to obtain accurate result.
- Hemolysis :which caused by use of very small bore needle ,forcing blood syring to an evacuated tube, and improper shaking of tubes.
- Tourniquet: improper use and left for longer time.
- Instrument: Calibration and monitoring of the analyzer .
  Gulati and Hyun ;1986)

1-2-7.Climatic adaptation:

Is two types:-

- Cold adaptation:

Is of three types: adaptation to extreme cold, moderate cold, and night cold.

- Heat adaptation:

Is of two types: adaptation to humid heat and to dry heat (desert conditions).

1-2-8.Adapting to Climate Extremes:

Humans and many other mammals have unusually efficient internal temperature regulating systems that automatically maintain stable core body temperatures in cold winters and warm summers. In addition, people have developed cultural patterns and technologies that help them adjust to extremes of temperature and humidity.In very cold climates, there is a constant danger of developing hypothermia, which is a life threatening drop in core body temperature to subnormal levels.The normal temperature for humans is about 98.6° F. (37.0°C.). However, individual differences in metabolism, hormone levels, physical activity, and even the time of day can cause it to be as much as 1° F.

(.6°C.) higher or lower in healthy individuals. It is also normal for core body temperature to be lower in elderly people. Hypothermia begins to occur when the core body temperature drops to 94° F. (34.4° C.). Below 85° F. (29.4°C.), the body cools more rapidly because its natural temperature regulating system (in the hypothalamus) usually fails.The now rapid decline in core body temperature is likely to result in death. However, there have been rare cases in which people have been revived after their temperatures had dropped to 57-60° F.(13.9-15.6°C.).(Dennis ;2012).Previous studies have shown that decreasing in the core body temperature to less than 38.9 ^{0}C with in 30 minutes of presentation improve survival.(Hubbard *etal*;1995).

When core body temperature in axcess of 40 ^{0}C lead to heat stroke with central nervous system (CNS) dysfunction.(Knochel*etal;* 1994)and (Khogali and Weiner 1980).

The life threatening illness result from failure od thermoregulatory mechanism coupled with an exaggerated acute phase response , causing an elevation in core body temperature and producing multi organ dysfunction .(Shapiro and Seidman 1990) The thermoregulatory control of human skin blood flow is vital to the maintenance of normal body temperatures during challenges to thermal homeostasis. Sympathetic neural control of skin blood flow includes the noradrenergic vasoconstrictor system and a sympathetic active vasodilator system, the latter of which is responsible for 80% to 90% of the substantial cutaneous vasodilation that occurs with whole body heat stress. With body heating, the magnitude of skin vasodilation is striking: skin blood flow can reach 6 to 8 L/min during hyperthermia.(Charkoudian,2003).

1-2-9.Factors affecting thermal acclimation:-

- Age:

Both infants and elderly have lessened ability to acclimatize to heat or cold

- Body size and shape:

The surface area to weight ratio.

- Body composition:

Subcutaneous adipose deposits insulate the core and make it more difficult to dissipate heat in hot or easier to retain heat in the cold.(Bindon,2002)

1-2-10.Previous study

Mohamed *etal; (*2005) investigated 16 healthy Malaysian males volunteers whom under went heat acclimaition (H.A) by exercising on a bicycle ergometer at 60% of VO_2 max for 60 min each day in a hot environment (31.1 ± 0.1^0C) for 16 days .Blood parameter and other test investigated recorded on day 1 and day 16. On these two days subject rested for 10 min,then cycled at 60% of VO_2 max for 60 min and rested again for 20 min.The result of testing level show that ,when compared to day 1 significant decrease in (Hb, HCT , RBCs and WBCs) and significant increase in (MCV,MCH,MCHC,RDW and PLt)) at rest when noted at day16.

Bodil*etal;(* 1992) reported thatheat acclimation was induced in 8 subjects by asking them to exercise until exhaustion at 60% of maximum O_2 consumption rate for 9-12 consecutive days at temperature 40^0C with 10% relative humidity . Five control subjects exercised similarly in a cool environment (20^0C) for 90 min for 9-12 days .Blood sample were collected and examined during rest. Two rest in first and last test experiment.The results showed thata significant decrease in (HCT and Hb) in boththe treatment and last test experiment were found.

Narges*etal*;(2012)found that the result of CBC can be affected by different factors such as temperature and incubation period .The difference in the time or period of incubation and temperature lead to a number of RBCs indices changes. The Hbconc,WBCs count and Plt count were not significantly decreased at roomtemperature (25^0C), but after incubating the sample at room temperature for 24 hours ,RBCsdecreased,HCT,MCV and MCHC increased significantly.MCH was also significantly increased after 24 hours incubation. The increase in MCV is known to reflect red cell swelling at room temperature (25^0C).

Mahmoodi*etal;(*2006) reported that blood samples stored at (25^0C,30^0C,37^0C) storage temperature for 48 hours incubationperiod.The result showed increase in WBCsbut not significant. The number of RBCs count at 37^0C decreased significantly after 48 hours incubation.MCHC after 8 hours decreased significantly .The change in Hct was not significant up to 24 hrs incubation ,but after 48 hrsincreased with increasing temperature. MCV increase significantly with increasing temperature. The Plt count after 48 hrs incubation increased with raising temperature significantly .Hbconcentration increased significantly with raising temperature after 48 hrs.

1-3.Rationale:-

Sudan is one of the equatorial countries, temperature in summer reaches about (45-50)^{0}C.It was found that some people who are exposed to high temperature such as hawker and police,are subject to many changesin the body during this exposure.Complete blood count(CBC) is one of the most common and conventional blood test that physician usually request.However the result of these testsmaybe affected by different factors such as exposure to low and high temperature.So the aim of this study is to investigate the effect of exposure to two different range of temperature on complete blood count.

1-4. Objectives

General objective:

To determine the effect of exposure of two different rangs of temperature(30-32C^0) vs(45-47C^0) on some blood parameters on Sudanese workers at Leader Ship Tower and New recruit of air force in Khartoum state.

Specific objectives:

1-To measureRBC,HGB,HCT,MCV,MCH,MCHC,RDW-CV and RDW-SD

2-To measureabsolute count ofGran, Lymph and Mid ,also percentage of Gran%,

Lymph% and Mid%.

3-To measurePLT,MPV and PDW at temperature range (30-32C^0) and temperature range (45-47C^0) using an autohaematologyanalyzer

(mindrayBC3000Plus).

Materials and Methods

2-1. Study design

This study is observational cross- sectional study.

2-2. Study area

The study was conducted at Leader ship Tower workersand New recruitcentre of Air Force in Khartoum state during March 2015

2-3. Study population

Eighty Sudanese adult male volunteers from air force were enrolled in this study with age range between (15-55) years old exposed for 6 hours under two different temperature $(30\text{-}32)^0$C vs $(45\text{-}47)^0$C .

2-4. Inclusion criteria

Healthy Sudanese males.

2-5. Exclusion criteria

The following were excluded from the study:-

1-Smokers.

2-Those who are sensitive to sun heatlight.

3-Subject who had blood transfusionduring the last three month.

4- Any individual who has a disease which may affectthe result of this study.

2-6. Data collection:

Data was collected by a designed questionnaire.

2-7. Blood collection:

The participant were divided into two group:

1-Group 1 were exposed to low temperature range (30-32)^{0}C stood for 6 hours and blood collected at the end of this period.

2- Group 2 were exposed to high temperature range (45-47)^{0}C and stood for 6 hours and blood was collected at the end of this period.

Blood collection was performed as described by Lewis*etal;*(2006).

Three milliliters (ml) of blood were collected from anticubital vein from each participant, under aseptic conditions, after cleaning the area around the vein with 70% alcohol, then were poured into EDTA blood container and mixed well before processing.

2-8. Materials required:

A. EDTA vacutainer tube (3ml)
B. 70% alcohol (etanol)
C. Sterile syrings
D. Cotton
E. Gloves
F. Rack
G. Ice
H. Auto hematological analyzer (mindrayBC-3000Plus).

2-9. Reagents

Commercial reagents were provided by Mindray(BC-3000Plus)manufacturer; consist of:

A. Diluent
B. Cleanser
C. Rinse
D. Lyses

2-10 Blood analyzer:

BC-3000 Plus autohematology analyzer is a quantitative automated hematology analyzer and leukocyte differential count for invitro diagnostic use in clinical laboratories.

2-10-1. Principle of blood analyzer (Mindray BC-3000PLUS)

There are two methods are used in the analyzer :Coulter method and colorometricmethod:

1-Blood cells(, RBCs, WBCs and PLts are counted and sized by the Coulter method.This method is based on the measurement of changes in electrical resistance produced by a particle, which in this case is bloodcel,suspended in a conductive diluents as it passes through an aperture of known dimensions .An electrode is submerged in the liquid on both sides of the aperture to create an electrical pathway.As each particles passes through the aperture a transitory change in the resistancebetween the electrodes is produced. This change produces a measurable electrical pulse.The number of pulses generated signals the number of particles that passed though the aperture. The amplitude of each pulse is

proportional to the volume of each particle .Each pulses is amplified and compared to the internal referance voltage channelswhich only accepts the pulses of a certain amplitude.

2-Hemoglobin is determined by colorimetric method .The WBC／HGB dilution is delivered to the WBC bath where it is bubble mixed with a certain amount of lyse ,which converts hemoglobin to HB complex that is measurable at 525 nm .An LED is mounted on one side of the bath and emits a beam of light,which passes through the sample and a 525nm filter, and then measured by photo-sensor that is mounted on opposite side.The signal is then amplified and the voltage is measured and compared to the blank reference reading amplified and the voltage is measured and compared to the blank reference reading.

2-10-2. Procedure:

1-The instrument was checked up for the sufficient of reagents, also electric power supply wasconnected.

2-The power was switched at the back of the analyzer at the (ON) position to turn on the analyzer. The power indicator lightilluminated and the screen displayed (Initializing). The analyzer sequentially initializing the file, hardware and fluidic system and whole initialized process last about 3-4 minutes .When the initialization is finished the analyzer is automatically enter count screen.

3-Sample were mixed well and entered to the probe sample then aspirate pressed, when LCD screen was displayed analyzing the sample was removed and the result were printed out.

2-10-3 Quality control:

Quality control is very important for obtaining highly reliable data over long period of time Itconsist of strategies and procedures that measure the precision and stability of the analyzer. It involve measuring materials with known, stable characteristic at frequent intervals .Analysis of the result with statistical methods allow the inference that sample results are reliable .Mindrayrecommends to run Q,C program daily with low, normal and high level control .Anew lot of control should be analyzed in parallel with the current lot prior to their expiration date. This may be accomplished by running the new lot of controls twice a day for five days using any empty Q.C files which calculate the mean,standard deviation and coefficient of variation for each selectedparameter.The instrument calculatemeans of these ten runs should be within the expected ranges published by the manufacture.

2-11. Ethical consideration :

This study was approved by the College of the Medical Laboratory Science, the Leader ship Tower and New recruit Centre of Air Force, also an informed consent was obtained from each participant before sample collection.The participants were issued that the results will be kept highly confidently and will be used for research purpose only.

2-12. Data analysis:

Datawere analyzed by using StasticalPackage for Social Science(SPSS) program version 16 by student t.test to separate mean$\pm$SD to know signs between two group.

Table (3-1) show significant decrease in RBCs count, Hb and HCT value of group2 which exposed to temperature (45-47) C°.While MCV, MCH, MCHC, RDW-CV and RDW-SD did not vary between the two group.

Table (3-1) :Effect of exposure to two range oftemperature onerythrocytic series

Groups / Parameters	Group1 (mean±SD)	Group2 (mean±SD)	P.Value
RBCs (1012/L)	6.04+1.54	4.71+0.47	0.00
HGB (g/dL)	16.76+4.25	13.18+1.11	0.00
HCT (%)	53.48+13.81	41.49+3.46	0.00
MCV (fL)	89.94+4.18	89.51+3.74	0.77
MCH (pg)	28.49+1.64	28.29+1.67	0.88
MCHC(g/dL)	31.85+0.62	31.77+1.13	0.13
RDW-CV (%)	13.93+0.73	14.41+1.18	0.05
RDW-SD (fL)	47.61+3.04	48.38+3.23	0.74

Significance level at $p \leq 0.05$

Table (3-2) show significant increase in WBCs count in group2 whichexposed to temperature (45-47) C°.WhileGran, Lymphocyte, mid did not vary between two group.

Table(3-2):**Effect of exposure to two range of temperature on leukocytic series**

Groups / Parameters	Group1 (mean ±SD)	Group2 (mean±SD)	P.Value
WBC (10^9⁄L)	5.86 ± 1.87	6.58±1.34	0.03
Gran (10^9⁄L)	3.18±1.35	4.04±1.21	0.29
Lymphocyte(10^9⁄L)	2.07±0.62	2.02±0.44	0.12
Mid (10^9⁄L)	0.59±0.31	0.64±0.19	0.31
Gran (%)	52.35±9.31	59.66±6.22	0.06
Lymphocyte (%)	37.24±9.61	32.11±10.78	0.61
Mid (%)	10.48±2.75	9.74±2.04	0.18

Significance level at $p \leq 0.05$

Mid: eosinophil, basophil and monocyte

Gran: neutrophil

Table (3-3) shows no difference in PLT, MPV and PDW between two group under study.

Table (3-3): Effect of exposure to two range of temperature on megakaryocytic series and indices

Groups / Parameters	Group1 (mean±SD)	Group2 (mean±SD)	P.Value
PLT (10^9/L)	202.58±108.79	230.28±30.04	0.13
MPV(fL)	9.55±0.74	9.43±0.85	0.65
PDW	15.68±0.25	15.54±0.47	0.41

Significance level at $p \leq 0.05$

MPV: Mean Platelet Volume.

PDW:Platelet Distribution Width

4-1. Discussion:-

The aim of this study was to know the effect of two different temperature onsome blood parameters.

The group which was exposed to high temperature showed significant decrease inRBCs,Hb and HCT values this result is on line with the finding of Mohamed*etal;*(2005).

The finding of this work with regard to HGB and HCT arecontradicting with the parameters of (Bodil*etal* ;1992) and (Mahmoodi*etal* ;2006)who reported significant increase .

RBCs count in this work is on line with Mahmoodi*etal;*(2006) and Narges*etal;(*2012),Hb value ison line with Narges*etal;(*2012) ,but HCTvalue disagree with Narges*etal;(*2012) who reported a significant increase.

There is no significant variation in this study betweenthe two group with regard toMCV, MCH, MCHC, RDW -CV and RDW-SD.

Mohamed *etal;*(2005) ,Mahmoodi*etal;*(2006) and Narges*etal;(*2012) found significant increase in MCV. Mohamed *etal;*(2005) and Narges*etal;(*2012) reported asignificant increase in MCHC but Mahmoodi*etal;*(2006) recordeda significant decrease in MCHC.

Mohamed *etal;*(2005) reporteda significant increase in MCH and RDW.In the current study no significant differenceswere found between the two groups on leukocytic series , platelet count and indices, except in WBCS which showed a significant increase in group2 (6.58$\pm$1.34) vs group1 (5.86$\pm$1.87)$\times 10^{9}$/L this study disagree with Mohamed *etal;*(2005) ,Mahmoodi*etal;*(2006) and Narges*etal;(*2012).

Platelet show no difference between two group under study this is on line with Narges*etal;(*2012) and disagree with Mohamed *etal;*(2005) and Mahmoodi*etal;*(2006).

Mohamed *etal;*(2005) foundthat there are differences in values of all hematologic parameters between pre and post exposure to heat ,these results indicate the cellular compartment of the blood shrank relative to the plasma component during the period of heat acclimation.

Other studies have shown that blood flow is reduced because of increased splanchnic vascular resistance.Rowell*etal;*(1971).

The variation of the results of this work from the other recorders could be explained by difference in the range and period of heat to which the participants were exposed ,age of the participant and life style or inter laboratory differences.

4-2. Conclusion:-

This study concluded the following:

- Group1 which were exposed to low temperature (30-32)^{0}C and group 2 which exposed to high temperature (45-47)^{0}C for six hours show some variation in CBC test of blood sample which effected by low and high temperature.
- Group 2 which exposed to high temperature (45-47)^{0}C for 6 hours showed a significant decrease in RBCs count, Hb and HCT values. Also MCV, MCH, MCHC, RDW-CV and RDW-SD showed no difference between two group under this study.
- WBCs count was asignificantly increased in group 2 . Absolute Gran, absolute Lymph , absoluteMid count, Gran% Lymph% and Mid%did not vary between two group under study .
- PLT, MPV and PDW didnot vary between two group under study .

4-3. Recommendation:

1. Blood samples for complete blood count (CBC)test must be measured immediately as soon as possible after collection.
2. CBC must be carried out at other environmental temperature and different exposure period.
3. To show seasonal variation using larger sample size and female included.
4. Further studies should be done in large groups with case control.

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Appendix

Sudan University of Science and Technology

College of Graduate Studies

Master program

Questionnaire

Effect of different temperature on complete blood count test of Sudanese worker in Leader ship

Tower of air force and scrounged center of air force

•Name:…….....

•Age:.....

•Gender: Male ( ) Female ( )

•Period of appointment and work:…….

•Do you suffer any disease: Yes ( ) No ( )

•If the answer is yes , mention disease:……,…….

.•Do you take any treatrment:…….……

•Do you smoke: Yes ( ) No ( )