

# **1. Introduction and literature review**

## **1.1. Introduction**

Smoking is a practice in which a substance is burned and the resulting smoke breathed and absorbed into the bloodstream. Most commonly the substance is the dried leaves of the tobacco plant which have been rolled into a small square of rice paper to create a small, round cylinder called a cigarette (Centre of control and prevention2010).

Smokers are at greater risk for cardiovascular diseases, respiratory disorders, cancer, peptic ulcer bone matrix loss and hepato toxicity (Witschim2001).

Electrolytes are ions capable to carrying an electric charge, classified as anions and cations based on the type of charge they carry. Electrolytes are essential compound in different process contractility (potassium, magnesium, calcium) co factor in enzyme activation regulation including volume and somatic regulation (sodium, potassium, chloride) myocardial rhythm and regulation of adenosine triphosphate (Atpase),acid base balance (bicarbonate, potassium, chloride) blood coagulation(calcium),the body have many system for monitoring and maintain electrolyte concentration (Bishop,2010). Electrolytes disturbances may lead to sever and even life-threatening metabolic abnormalities such as coronary heart disease, liver disease, lung infection, kidney failure, disorders of endocrine system (jay,2000). Kidneys help in regulation and distribution of electrolytes, one of the ways smoking damages kidney functions by affecting the blood flow within the body, smoking harden the arteries and narrow to the kidney and cause them less efficient.

## **1.2. Literature review**

### **1.2.1. Smoking**

Smoking is the inhalation of the smoke of burning tobacco encased in cigarettes, pipes, and cigars. Casual smoking is the act of smoking only occasionally, usually in a social situation or to relieve Stress smoking habit is a physical addiction to tobacco products. Many health experts now regard habitual smoking as a psychological addiction, too, and one with serious health consequences.

Cigarettes look deceptively simple, consisting of paper tubes containing chopped up tobacco leaf, usually with a filter at the mouth end. In fact, they are highly engineered products, designed to deliver a steady dose of nicotine (Milne, 1998).

Cigarette tobacco is blended from two main leaf varieties: yellowish 'bright', also known as Virginia where it was originally grown, contains 2.5-3% nicotine; and 'burley' tobacco which has higher nicotine content (3.5-4%). US blends also contain up to 10% of imported 'oriental' tobacco which is aromatic but relatively low (less than 2%) in nicotine. In addition to the leaf blend, cigarettes contain 'fillers' which are made from the stems and other bits of tobacco which would otherwise be waste products. These are mixed with water and various flavorings and additives. The ratio of filler varies among brands. For example, a high filler content makes a less dense cigarette with a slightly lower tar delivery. Additives are used to make tobacco products more acceptable to the consumer. Around 600 additives are currently permitted for use in tobacco products in the United Kingdom. They

include humectants (moist) to prolong shelf life; sugars to make the smoke seem milder and easier to inhale; and flavourings such as chocolate, vanilla and menthol. While some of these additives may appear to be quite harmless in their natural form they may be toxic in combination with other substances. Also when additives are burned, new products of combustion are formed and these may be toxic (Ash, 1999).

Tobacco smoke is made up of “side stream smoke” from the burning tip of the cigarette and “mainstream smoke” that is delivered to the smoker via the filter or mouth end. Tobacco smoke contains thousands of different chemicals which are released into the air as particles and gases. Many toxins are present in higher concentrations in side stream smoke than in mainstream smoke and, typically, nearly 85% of the smoke in a room results from side stream smoke.( US Surgeon General,1984).

The particulate phase includes nicotine, “tar” (itself composed of many chemicals), benzene and benzo (a) pyrene. The gas phase includes carbon monoxide, ammonia, dimethyl nitrosamine, formaldehyde, hydrogen cyanide and acrolein. Some of these have marked irritant properties and more than 60, including benzo (a) pyrene and dimethyl nitrosamine, have been shown to cause cancer.<sup>6</sup> In 2003, the Tobacco Manufacturers’ Association published an analysis of the tobacco smoke content of 25 of the UK’s leading cigarette brands(Arista Laboratories,2003).

#### **1.2.1.1. Effect of smoking in the body**

Central nerves system: One of the ingredients in tobacco is a mood-altering drug called nicotine. Nicotine reaches brain in mere seconds. It’s a central nervous system stimulant, can feel more energized for a little while. As that effect subsides, you feel tired and crave more. Nicotine is habit forming.

Smoking increases risk of macular degeneration, cataracts, and poor eyesight. It can also weaken your sense of taste and sense of smell, so food may become less enjoyable, body has a stress hormone called corticosterone, which lowers the effects of nicotine. If Physical withdrawal from smoking can impair cognitive functioning and make felling anxious, irritated, and depressed. Withdrawal can also cause headaches and sleep problems (Pictrangelo, 2014).

Respiratory system: Smoking damages entire cardiovascular system. When nicotine hits body, it gives blood sugar a boost. Nicotine causes blood vessels to tighten, which restricts the flow of blood (peripheral artery disease). Smoking lowers good cholesterol levels and raises blood pressure, which can result in stretching of the arteries and a buildup of bad cholesterol (atherosclerosis). Smoking raises the risk of forming blood clots. Blood clots and weakened blood vessels in the brain increase a smoker's risk of stroke. Smokers who have heart bypass surgery are at increased risk of recurrent coronary heart disease. In the long term, smokers are at greater risk of blood cancer (leukemia). There's a risk to nonsmokers, too. Breathing secondhand smoke has an immediate effect on the cardiovascular system. Exposure to secondhand smoke increases risk of stroke, heart attack, and coronary heart disease (Pictrangelo, 2014).

Skin, hair and nail: Some of the more obvious signs of smoking involve the skin. The substances in tobacco smoke actually change the structure of your skin. Smoking causes skin discoloration, wrinkles, and premature aging. Your fingernails and the skin on your fingers may have yellow staining from holding cigarettes. Smokers usually develop yellow or brown stains on their

teeth. Hair holds on to the smell of tobacco long after you put your cigarette out. It even clings to nonsmokers. (Pictrangelo, 2014).

Cardio vascular system: Smoking damages entire cardiovascular system. When nicotine hits body, it gives blood sugar a boost. After a short time, you're left feeling tired and craving more. Nicotine causes blood vessels to tighten, which restricts the flow of blood (peripheral artery disease). Smoking lowers good cholesterol levels and raises blood pressure, which can result in stretching of the arteries and a buildup of bad cholesterol (atherosclerosis). Smoking raises the risk of forming blood clots.

Blood clots and weakened blood vessels in the brain increase a smoker's risk of stroke. Smokers who have heart bypass surgery are at increased risk of recurrent coronary heart disease. In the long term, smokers are at greater risk of blood cancer (leukemia).

There's a risk to nonsmokers, too. Breathing secondhand smoke has an immediate effect on the cardiovascular system. Exposure to secondhand smoke increases your risk of stroke, heart attack, and coronary heart disease (Pictrangelo, 2014).

Digestive system: smokers are at great risk of developing oral problems. Tobacco use can cause gum inflammation (gingivitis) or infection (periodontitis). These problems can lead to tooth decay, tooth loss, and bad breath.

Smoking also increases risk of cancer of the mouth, throat, larynx, and esophagus. Smokers have higher rates of kidney cancer and pancreatic

cancer. Even cigar smokers who don't inhale are at increased risk of mouth cancer.

Smoking also has an effect on insulin, making it more likely that you'll develop insulin resistance. That puts you at increased risk of type 2 diabetes. When it comes to diabetes, smokers tend to develop complications at a faster rate than nonsmokers.

Smoking also depresses appetite, so you may not be getting all the nutrients your body needs. Withdrawal from tobacco products can cause nausea (Pictrangelo, 2014).

Sexual and reproductive system: Restricted blood flow can affect a man's ability to get an erection. Both men and women who smoke may have difficulty achieving orgasm and are at higher risk of infertility. Women who smoke may experience menopause at an earlier age than nonsmoking women. Smoking increases a woman's risk of cervical cancer.

Smokers experience more complications of pregnancy, including miscarriage, problems with the placenta, and premature delivery.

Pregnant mothers who are exposed to secondhand smoke are also more likely to have a baby with low birth weight. Babies born to mothers who smoke while pregnant are at greater risk of low birth weight, birth defects, and sudden infant death syndrome (SIDS). Newborns who breathe secondhand smoke suffer more ear infections and asthma attacks. (Pictrangelo, 2014).

### **1.2.2. Electrolytes**

Electrolytes are ions capable of carrying an electric charge they are classified as anions or cations based on the charge they carry. Anions have negative charge and move toward the anode whereas cations migrate in the direction of the cathode because of their positive charge. (Bishop, 2010)

**Electrolytes play role in** Volume and osmotic regulation (sodium, chloride, potassium), myocardial rhythm and contractility (potassium, magnesium), cofactor in enzyme activation (magnesium, calcium, zinc), regulation of adenosine triphosphatase (ATPase) ion pump (magnesium) acid base balance, (bicarbonate potassium), blood coagulation (calcium, magnesium), and the production and use of ATP from glucose (magnesium, phosphate) (Bishop, 2010).

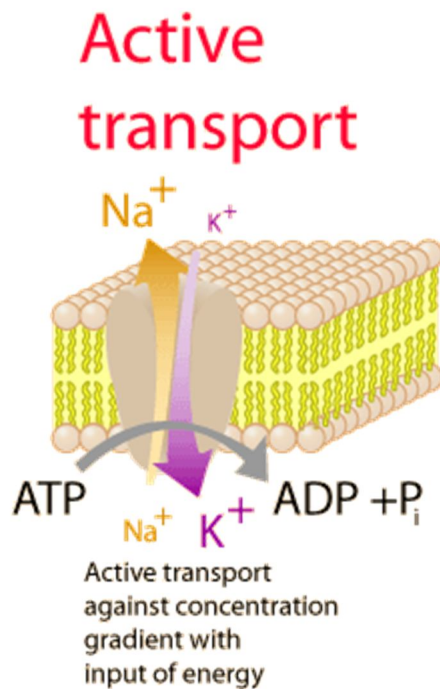
#### **1.2.2.1. Distribution of electrolytes**

Sodium is predominant cations the intracellular concentration being less than tenth of that within the extra cellular fluid the intracellular potassium concentration is about 30 times that of extracellular fluid, about 95% of the somatically active sodium is outside cell and same proportional of potassium intracellular these differential concentration are maintained by cell surface energy depend sodium potassium pump (Philip, 1997).

#### **1.2.2.2. Sodium potassium pump**

The process of moving sodium and potassium ions across the cell membrane is an active transport process involving the hydrolysis of ATP to provide the necessary energy. It involves an enzyme referred to as  $\text{Na}^+/\text{K}^+$ -ATPase. This process is responsible for maintaining the large excess of  $\text{Na}^+$  outside the

cell and the large excess of  $K^+$  ions on the inside. A cycle of the transport process is sketched below. It accomplishes the transport of three  $Na^+$  to outside the cell and the transport of two  $K^+$  ions to inside. This unbalanced charge transfer contributes to the separation of charge across the membrane. The sodium-potassium pump is an important contribute to action potential produced by nerve cells. This pump is called a P-type ion pump because the ATP interactions phosphorylates the transport protein and causes a change in its conformation ( Enger, etal ,2007).



#### 1.2.2.3. Sodium

Is a chemical element with symbol Na (from latin: *natrium*) and atomic number 11. It is a soft, silver-white, highly reactive metal and is a member of the alkali metals (Wells, John C. 2008). Sodium functions largely in controlling and regulating water balance. When sodium is reabsorbed from the kidney tubules, chloride and water are reabsorbed with it, thus



maintaining ECF volume. Sodium is found in many foods, such as bacon, ham, processed cheese (Astle,2005).

**Sodium regulation:** Regulation of sodium via the hormones renin, angiotensin, and aldosterone. In states of sodium depletion, aldosterone levels increase, and in states of sodium excess, aldosterone levels decrease ( Boundless,2015).

A low renal perfusion pressure stimulates the release of renin, which forms angiotensin I which is converted to angiotensin II. Angiotensin II will correct the low perfusion pressure by causing constriction of blood vessels and by increasing sodium retention by a direct effect on the proximal renal tubule and by an effect operated through aldosterone. The perfusion pressure to the adrenal gland has little direct effect on aldosterone secretion and the low blood pressure operates to control aldosterone via the renin angiotensin system. Aldosterone also acts on the sweat ducts and colonic epithelium to conserve sodium. When aldosterone has been activated to retain sodium the plasma sodium tends to rise. This immediately causes release of ADH which causes water to be retained, thus retaining Na<sup>+</sup> and H<sub>2</sub>O in the right proportion to restore plasma volume ( Boundless, 2015).

In addition to aldosterone and angiotensin II other factors influence sodium excretion. Atrial peptide also causes loss of sodium by the kidneys: it is secreted from the heart in high sodium states due either to excess intake or cardiac disease. Elevated blood pressure will also tend to cause Na<sup>+</sup> loss and a low blood pressure usually leads to sodium retention ( Boundless, 2015).

Hyponatremia defined as serum or plasma level less than 135mmol/l(OHMS,2002).decreased levels may be increased sodium loss ,can occur with decreased aldosterone production, prolonged vomiting or diarrhea or severe burns can result in sodium loss. Increased water retention caused dilution of serum as with chronic renal failure, nephritic syndrome, and hepatic cirrhosis. Water imbalance can occur as a result of excess water intake, as with polydipsia, syndrome of inappropriate AVP secretion caused increased in water retention because of increased ADH (kumar,1998).

Increased serum sodium concentration results from excess loss of water as in diabetes insipidus, fever, burns or exposure to heat. Also excess intake of salt, gastrointestinal tract loss of hypotonic fluid may occur either by kidney or through profuse sweating, diarrhea (kumar, 1998).

#### **1.2.2.4. Potassium**

Is a chemical element with symbol K (derived from neo-latin *kalium*), is the major intracellular cation in tissues cell high intracellular concentration are maintained by Na<sup>+</sup>, K<sup>+</sup> ATPase pump (titz,2008).

Hypokalemia is plasma potassium concentration below the lower limit of reference range, can occur with gastrointestinal (vomiting, diarrhea, intestinal tumor malabsorption) or urinary loss renal loss of potassium result from kidney disorders such as renal tubular acidosis, and may occur due to increased cellular uptake (Gennari,1998).

Hyperkalemia is plasma potassium concentration above the limit of reference range. the most common causes is decreased renal excretion (acute or chronic renal failure, hypoaldosteronism, Addison disease) or cellular shift (acidosis, muscle injury, chemotherapy, leukemia) or increased

intake of potassium in oral or IV potassium replacement therapy. And artificial due to sample hemolysis or prolonged tourniquet use or thrombocytosis (Bishop, 2010).

**Potassium regulation:** Normal potassium homeostasis is achieved by a balance between potassium intake, intra-and extracellular distribution and urinary excretion by the cortical collecting ducts, under normal circumstances, an increase in potassium intake will lead to an increase in the serum potassium concentration and intracellular redistribution, facilitated by insulin and b-adrenogenic receptors, followed by a stimulus for collecting duct to increase excretion in the urine (Kavitha,2012).

#### **1.2.2.5. Calcium**

In plasma calcium present in three form bound to albumin, complexed with citrate and phosphate, and free ions (Marshall,2007).

Calcium has many function in the body in addition to structural role in bones and teeth, it is essential for muscle contraction, affected the excitability of nerves, is a second messenger, involved in action of several hormones and required for blood coagulation (Marshall,2007).

**Calcium regulation:** When blood calcium becomes too low, calcium sensing receptors in the parathyroid gland become activated. This results in the release of PTH which acts to increase blood calcium, e.g. by releasing it from bones (increasing the activity of bone-degrading cells called osteoclasts). This hormone also causes calcium to be reabsorbed from urine and the GI tract. Calcitonin, released from the C cells in the thyroid gland, works the opposite way, decreasing calcium levels in the blood by causing more calcium to be fixed in bone ( Brini ,etal,2013).

Calcium plays a key role in a wide range of biologic functions, either in the form of its free ion or bound complexes. One of the most important functions as bound calcium is in skeletal mineralization. The vast majority of total body calcium (>99%) is present in the skeleton as calcium-phosphate complexes, primarily as hydroxyl apatite, which is responsible for much of the material properties of bone. In bone, calcium serves two main purposes: it provides skeletal strength and, concurrently, provides a dynamic store to maintain the intra- and extracellular calcium pools (Wang, 2006).

The remaining 1% is mostly in blood and other extracellular fluid (Bishop, 2010).

Hypocalcemia occurs in primary hypoparathyroidism, glandular aplasia, destruction or removal, acute pancreatitis, vitamin D deficiency and renal disease. Severe depletion of calcium can cause tetany with muscle spasms and paresthesias (Bishop, 2010).

Hypercalcemia occurs in primary hyperthyroidism, adenoma or glandular hyperplasia, hyperthyroidism, malignancy, multiple myeloma, prolonged immobilization and increased vitamin D (Bishop, 2010).

#### **1.2.2.6 .Phosphate**

Found everywhere in living cells and participate in many of the most important biochemical processes the genetic material deoxyribonucleic acid (DNA) and (RNA), (Bishop, 2010).

**Phosphate regulation:** Phosphate in blood may be absorbed in the intestine from dietary sources. Released from cell into blood, and lost from bone. These processes are relatively constant and easily regulated by renal excretion or reabsorption of phosphate (Bishop, 2010).

Concentration of all phosphate compounds in blood about 12mg/dl, most of that is organic phosphate. It is predominant intracellular anion about 80% of the total body pool of phosphate is contained in bone, 20% in soft tissue, and less than 1% is active in serum /plasma (Bishop, 2010).

Hypophosphatemia occurs in about 1% to 5% of hospitalized patients (Shiber, 2002). Incidence increased with patient of diabetic ketoacidosis, chronic obstructive pulmonary disease, asthma, malignancy, ICU patient with sepsis (Bishop, 2010).

Hyperphosphatemia occurs in acute or chronic renal failure, and increased intake of phosphate or release of cellular phosphate, increased break down of cell (Bishop, 2010).

#### **1.2.2.7. Acid base homeostasis**

Acid–base homeostasis is the part of human homeostasis concerning the proper balance between acids and bases, also called body PH. The body is very sensitive to its pH level, so strong mechanisms exist to maintain it. Outside the acceptable range of pH, proteins are denatured and digested, Enzymes lose their ability to function, and death may occur (Carolin, 2013).

**Acid base imbalance:** Acid base imbalance occurs when a significant insult causes the blood pH to shift out of the normal range (7.35 to 7.45). An excess of acid in the blood is called acidemia and an excess of base is called alkalemia. The process that causes the imbalance is classified based on the etiology of the disturbance (respiratory or metabolic) and the direction of change in pH (acidosis or alkalosis). There are four basic processes: metabolic acidosis, respiratory acidosis, metabolic alkalosis and respiratory alkalosis (Yeomans, 1985).

**Acidosis:** Acidosis is an increased acidity in the blood and other body tissue occur when arterial pH falls below 7.35(Needham, A. 2004).

**Respiratory acidosis** respiratory acidosis results from a build-up of carbon dioxide in the blood (hypercapnia) due to hypoventilation. It is most often caused by pulmonary problems, although head injuries, drugs (especially anesthetics and sedatives), and brain tumors can cause this acidemia. Pneumothorax, emphysema, chronic bronchitis, asthma severe pneumonia, and aspiration are among the most frequent causes. It can also occur as a compensatory response to chronic alkalosis (jackie, 2008).

**Metabolic acidosis** results from increased production of metabolic acids or disturbances in the ability to excrete acid via the kidneys. Renal acidosis is associated with an accumulation of urea and creatinine as well as metabolic acid residues of protein catabolism (Yee,2010).

**Alkalosis:** Refers to a process reducing hydrogen ion concentration of arterial blood plasma (alkalemia). In contrast to acidemia (serum pH 7.35 or lower), alkalemia occurs when the serum pH is higher than normal (7.45 or higher). Alkalosis is usually divided into the categories of Respiratory alkalosis and metabolic alkalosis or a combined alkalosis (Yee, 2010).

**Respiratory alkalosis** respiratory alkalosis is caused by hyperventilation, resulting in a loss of carbon dioxide. Compensatory mechanisms for this would include increased dissociation of the carbonic acid buffering intermediate into hydrogen ions, and the related excretion of bicarbonate<sup>1</sup> both of which lower blood pH Hyperventilation-induced alkalosis can be seen in several deadly central nervous system diseases such as stroke, certain cancer (Yee,2010).

**Metabolic alkalosis** caused by repeated vomiting, resulting in a loss of hydrochloric acid with the stomach content. Severe dehydration and the consumption of alkali are other causes. It can also be caused by administration of diuretics and endocrine disorders such as Cushing syndrome. Compensatory mechanism for metabolic alkalosis involves slowed breathing by the lungs to increase serum carbon dioxide, a condition leaning toward respiratory acidosis. As respiratory acidosis often accompanies the compensation for metabolic alkalosis, and vice versa, a delicate balance is created between these two conditions (Yee,2010).

### **1.3. Rationale**

Cigarette smoke contains over 7,000 chemicals, 69 of which are known to cause cancer. Smoking is directly responsible for approximately 90 percent of lung cancer deaths and approximately 80-90 percent of COPD (emphysema and chronic bronchitis) deaths ( U.S Department of Health and Human Services,2010).

Nicotine is the ingredient in cigarettes that causes addiction. Smokers not only become physically addicted to nicotine; they also link smoking with many social activities, making smoking an extremely difficult addiction to break (National Institute of Drug Abuse, 2001)

Electrolytes are very important in the body some researchers found the smokers have biochemical change and imbalance occurs in electrolytes. On the base that nicotine make acidosis in the body, leading to electrolyte imbalance (Pannuru, 2009) the present study aimed to evaluate the electrolytes levels in Sudanese smokers.



## **1.4. Objectives**

### **1.4.1 General objective**

-To study the effect of smoking on the level of serum sodium, serum potassium, serum calcium and serum phosphate in Sudanese male smokers.

### **1.4.2 Specific objectives**

-To estimate the level of serum sodium, serum potassium, serum calcium and serum phosphate in smokers comparison of non smokers.

-To correlate between the number of cigarettes and level of serum sodium, serum potassium, serum calcium and serum phosphate.

-To correlate between of duration of smoking and level of serum sodium, serum potassium, serum calcium and serum phosphate

## **2. Materials and Methods**

### **2.1. Material**

**2.1.1. Study design:** This is a descriptive analytical comparative study.

**2.1.2. Study area:** The study was conducted in Khartoum state

**2.1.3. Study population:** This study included 70 smokers as case and 50 non smokers as control group in Khartoum state during period from February to March 2015.

**Inclusion Criteria:** The criteria of inclusion of the test group based male cigarettes smokers, and non smokers males as control group.

**Exclusion criteria:** Non smokers or smokers with renal disease, hypertention and bone diseases were excluded.

**2.1.4. Samples:** About 5ml of venous blood were collected from each smokers and controls. The samples collected under aseptic conditions and placed in sterile plane containers, and after clotting centrifuged for 3 minutes at 3000 RPM to obtain serum, the obtained serum were kept at -20c till the time of analysis.

**2.1.5. Ethical consideration:** Smokers who voluntarily accepted to participate in the study were included.

#### **2.1.6. Equipments:**

- Automation mindray BS200
- Centrifuge
- Sterile plane containers
- Disposable syringes
- 70% alcohol
- Tourniquets
- Cotton
- Micropipettes (automatic pipettes)
- Graduated pipettes

Iron selective electrode

#### **2.1.7. Reagents:**

**a)** Reagents of calcium enzymatic, liquid, (arsenazoIII) method for estimation of calcium concentrations.

They are supplied by Shenzhen mindray company, and reagent, composed of:

Phosphate buffer 0.3mmol/l

8-hydroxyquinoline-5-sulfonic acid 0.5mmol/l

arsenazoIII < 2% (m/v)

Reagents of phosphate enzymatic(phosphomolybdate)method for estimation of phosphate concentrations.

They are supplied by Shenzhen mindray company, and reagent, composed of:

Ammonium molybdate 0.3mmol/l

Sulphuric acid 0.5mmol/l

Surfactant <2%(m/v)

#### **2.1.8. Data analysis:**

Data was analyzed by using the SPSS computer program, the mean and standard deviation of serum electrolytes were obtained and the independent t.test used for comparison ( $p\text{-value} \leq 0.05$ ) was considered significant.

## **2.2. Methodology**

### **2.2.1. Estimation of calcium concentration using the enzymatic (arsenazoIII) method: (appendix II)**

#### **Principle of method:**

By using 8-hydroxy-5-sulfonic acid to eliminate the interference of magnesium, calcium ions combine with arsenazoIII to produce blue colored complex at neutral solution. the absorbency increase is directly proportional to the concentration of calcium.

**Calculation:**

The analyzer calculates the ca concentration for each sample automatically after calibration.

Conversion factor:  $\text{mg/dl} \times 0.25 \text{ mmol/l}$

**Reference values:**

Serum 2.20-2.65 mmol/l (depend on the calcium reagent).

**2.2.2. Estimation of phosphate concentration using the enzymatic (phosphomolybdate) method :(appendix III)****Principle of method:**

Ammonium molybdate combines with phosphate in present of sulphuric acid to produce phosphomolybdate complex. The absorbency increase is directly proportional to te concentration of phosphate.

**Calculation:**

The analyzer calculates the ca concentration for each sample automatically after calibration.

Conversion factor:  $\text{mg/dl} \times 0.323 \text{ mmol/l}$

**Reference values:**

Serum 2.5-4.5 mg/dl (depend on the phosphate reagent).

### **2.2.3. Estimation of sodium and potassium concentration using the iron selective electrode (appendix IV)**

#### **Principle of method:**

Iron selective electrode is a transducer (or sensor) that converts the activity of a specific ion dissolved in a solution into an electrical potential, which can be measured by a voltmeter or pH meter. The voltage is theoretically dependent on the logarithm of the ionic activity, according to the Nernst equation. The sensing part of the electrode is usually made as an ion-specific membrane, along with a reference electrode.

### **2.3. Quality control**

Two level of control materials should be analyzed with each batch of samples and run with each new calibration with each new reagent, and after specific maintenance or troubleshooting procedures as detail in system manual .

### 3. Results

In this study seventy smokers and fifty non smokers Sudanese male participant were enrolled (70 smokers serve as case group and 50 were non smokers serve as control group) to study the effect of smoking on serum sodium, potassium, calcium and phosphate.

The serum sodium, potassium, calcium and phosphate level were estimated and data analyzed statistically using computer Spss program, and the result were as follow:

**Table 3.1** shows a comparison between means of sodium, potassium, calcium and phosphate in Sudanese smokers and non smokers

**Figure 3.1** shows a significant positive correlation between number of cigarette and amount of change in sodium (p.value 0.000,  $r=0.506$ )

**Figure 3.2** shows a significant positive correlation between number of cigarette and amount of change in potassium (p.value 0.000,  $r=0.385$ )

**Figure 3.3** Shows a significant positive correlation between number of cigarette and amount of change in calcium (p.value 0.007,  $r=0.318$ )

**Figure 3.4** shows a significant positive correlation between number of cigarette and amount of change in phosphate (p.value 0.002,  $r=0.36$ )

**Figure 3.5** shows a significant positive correlation between duration of cigarette and amount of change in sodium (p.value 0.000,  $r=0.552$ )

**Figure 3.6** shows a significant positive correlation between duration of cigarette and amount of change in potassium (p.value 0.000,  $r=0.459$ )

**Figure 3.7** shows a significant positive correlation between duration of cigarette and amount of change in calcium (p.value 0.000,r=0.406)

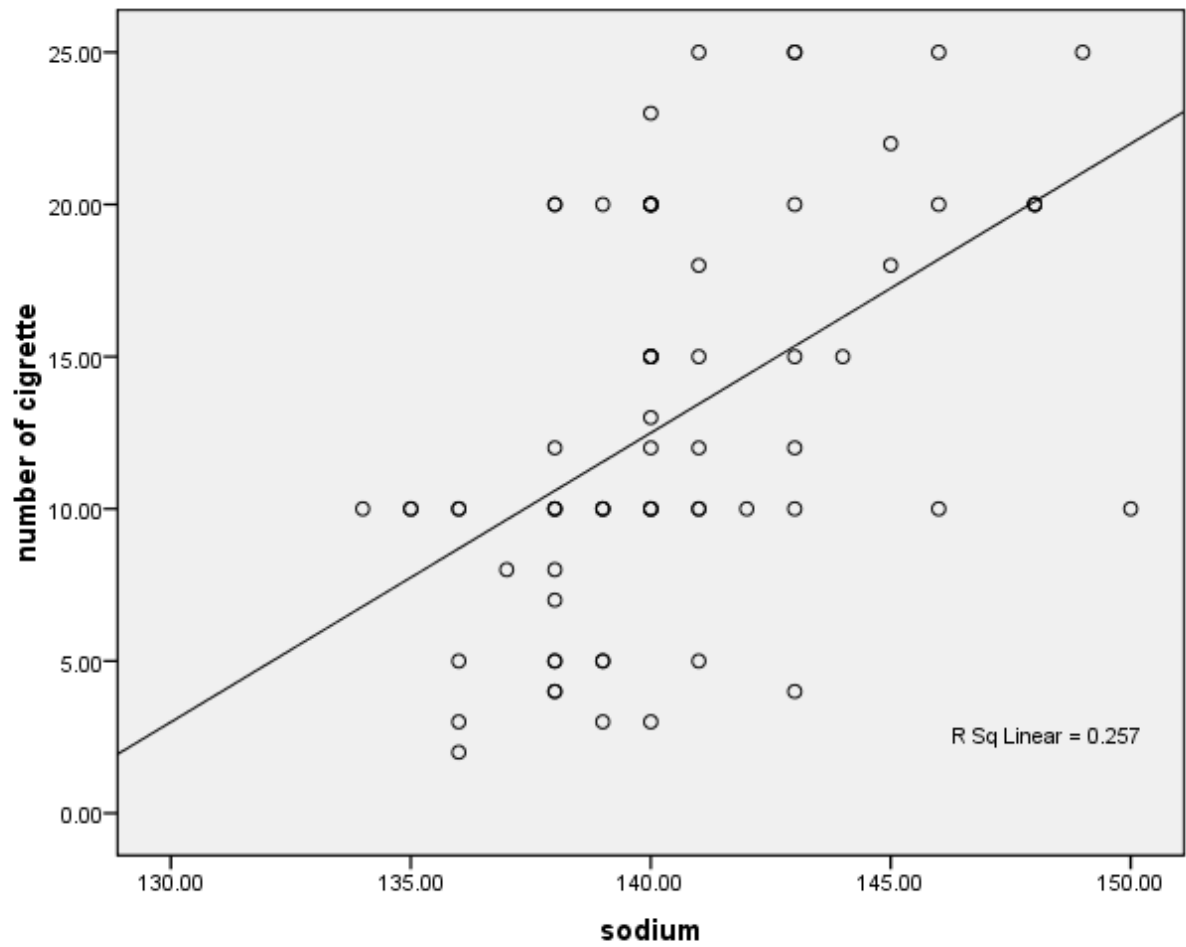
**Figure 3.8** shows a significant positive correlation between duration of cigarette and amount of change in phosphate (p.value 0.000,r=0.532).



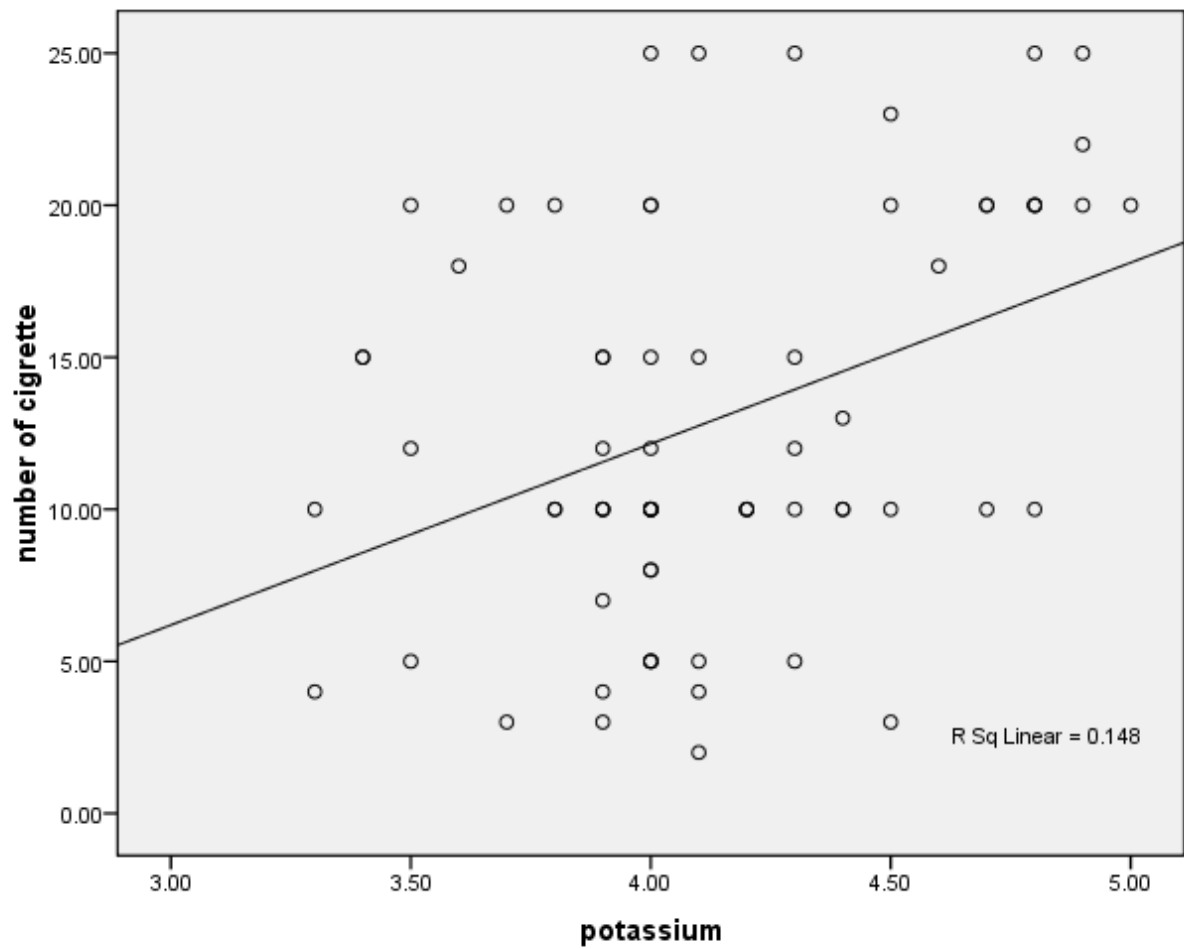
**Table 3.1:** Comparison between means of sodium, potassium, calcium and phosphate in Sudanese smokers and non smokers.

Variable	Smokers	Non smokers	p.value
Sodium mmol/l	140±3.7	137±2.4	0.000
potassium mmol/l	4.1±0.42	3.7±0.23	0.000
calcium mg/dl	9.9±0.75	9.5±0.65	0.003
phosphate mg/dl	3.9±0.62	3.2±0.46	0.000

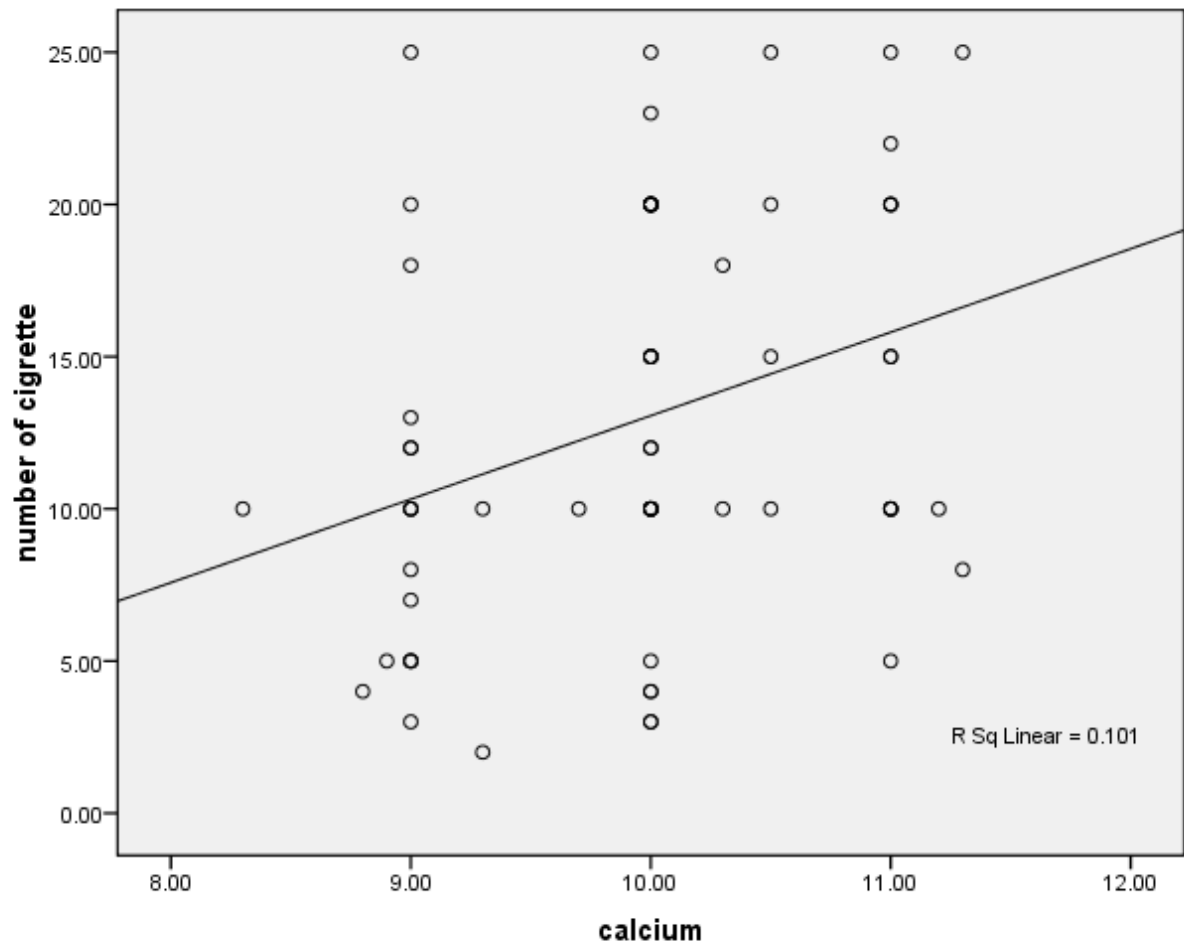
Indepent test was used for comparison value considered significant at level <0.05



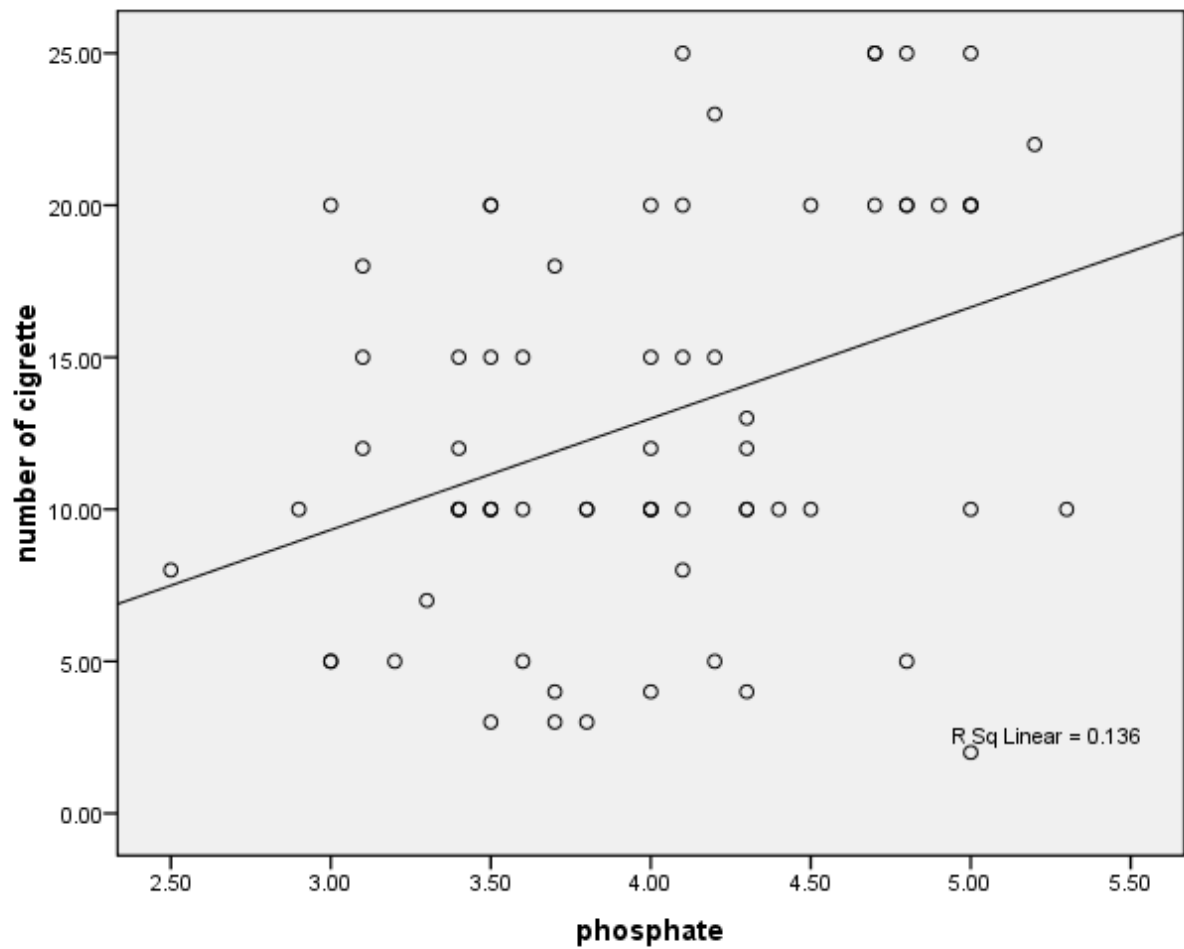
**Figure 3.1:** Correlation between number of cigarette and amount of change in sodium .



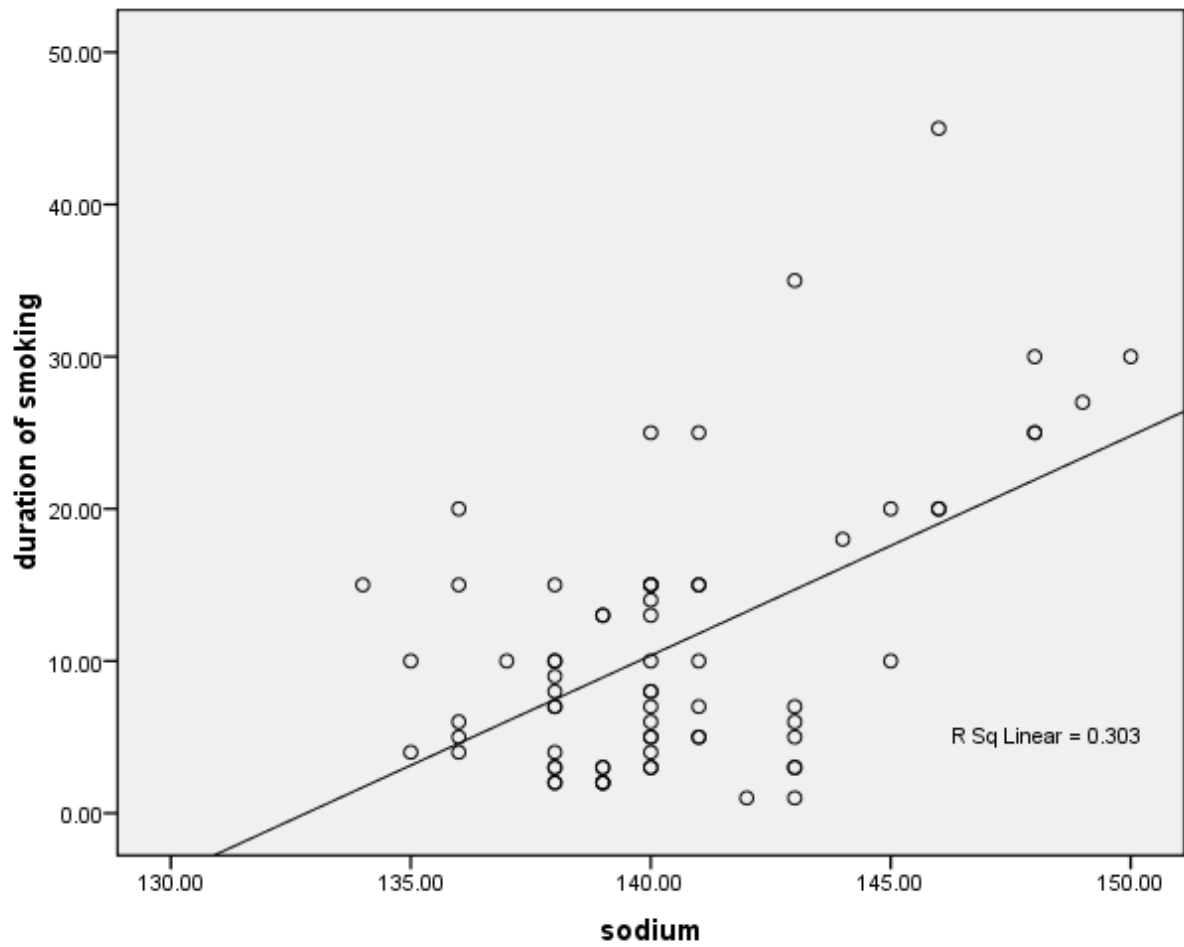
**Figure 3.2:** Correlation between number of cigarette and amount of change in potassium .



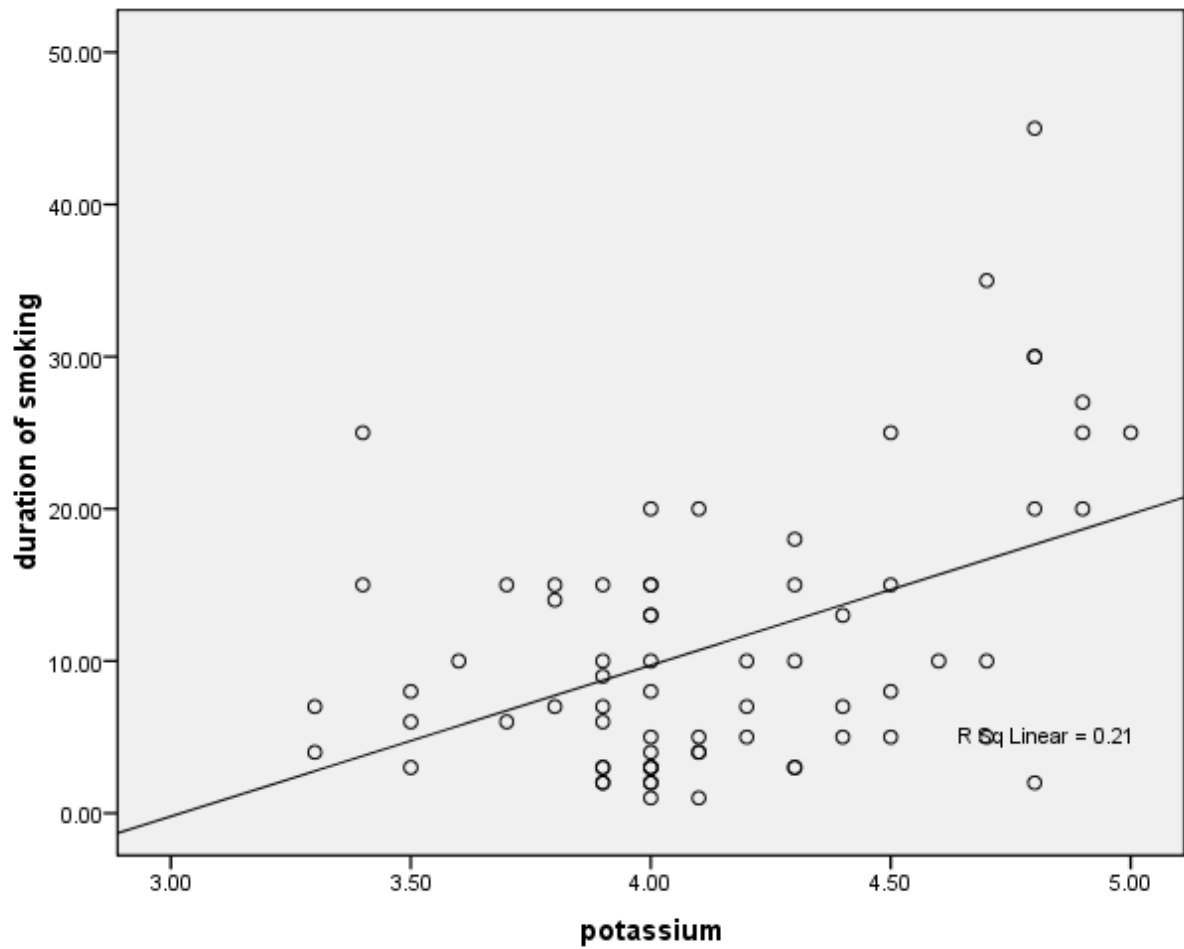
**Figure 3.3:** Correlation between number of cigarette and amount of change in calcium .



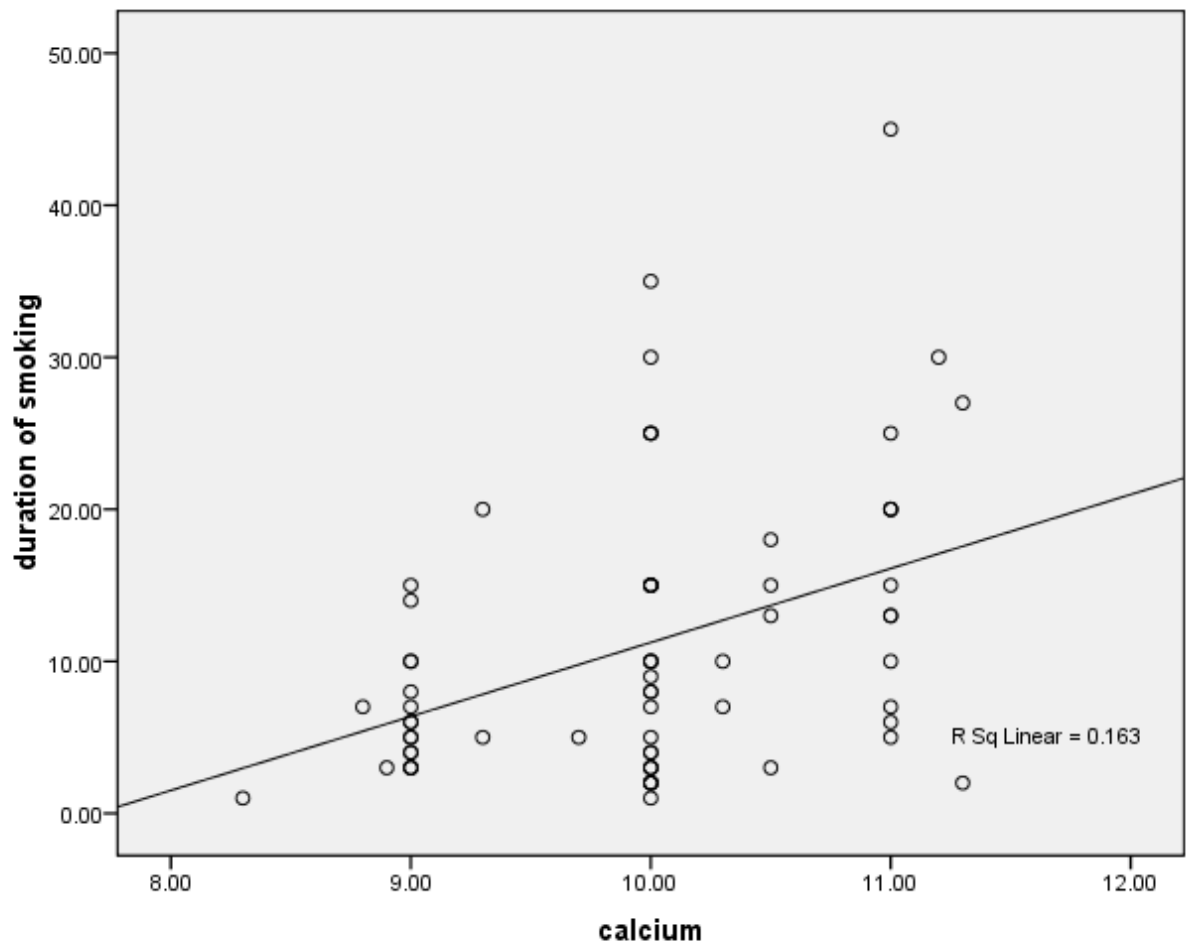
**Figure 3.4:** Correlation between number of cigarette and amount of change in phosphate .



**Figure 3.5:** Correlation between duration of cigarette and amount of change in sodium .

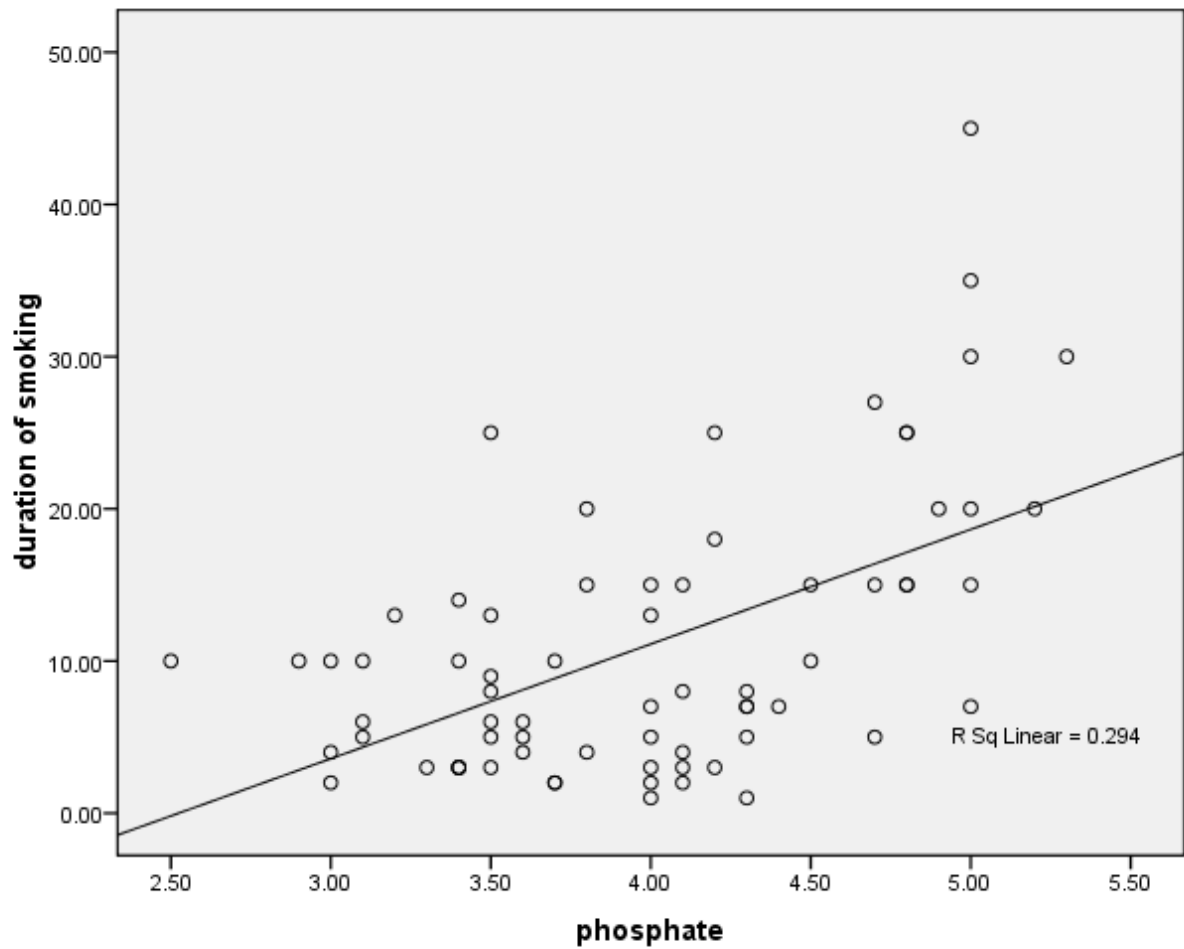


**Figure 3.6:** Correlation between duration of cigarette and amount of change in potassium .



**Figure 3.7:** Correlation between duration of cigarette and amount of change in calcium .





**Figure 3.8:** Correlation between duration of cigarette and amount of change in phosphate .

## **4. Discussion, Conclusion and Recommendations**

### **4.1. Discussion**

Cigarette smoking is the largest preventable cause of death and disabling in developed contraries. Cigarette smoking contain over 7000 chemical 69of winch are known to cause cancer (surgeon general, 2010).

Hypoxia represent stress that induced cell growth arrest and injury that lead to acidosis and electrolyte imbalance (Bokhoven, 1961). Cigarette smoke consist of many chemical including nicotine and gaseous compound carbon mono oxide was accumulate in human body with repeated smoking (wankuen, 2003) chronic exposure to low level of carbon mono oxide result hypoxia (sagone, 1973)

Many studies have assessed the effect of smoking on electrolytes imbalance. In the present study 70 smokers were included to the analysis the electrolyte found a significant increase in sodium, potassium, calcium and phosphate with p.value0.000,0.000,0.003 and 0.000 respectively as shown in table 3.1

This study were agreed with the study done by (Pannuru, 2009) found a significant increase was observed in electrolytes with p. value ( $<0.05$ ). Statistical analysis showed a significant correlation between increase in sodium potassium, calcium and phosphate and number of cigarettes per day as shown in fig3.1,3.2,3.3 and 3.4 respectively.

Also statistical analysis showed a significant correlation between increase in sodium potassium, calcium and phosphate and duration of smoking cigarette as shown in fig 3.5, 3.6, 3.7, and 3.8.

## **4.2. Conclusion**

This study concluded that:

1. The level of serum sodium, serum potassium, and serum calcium and serum phosphate are significantly increased in cigarette smokers compared to non smokers.
2. The level of serum sodium, serum potassium, serum calcium and serum phosphate are positively correlated with duration and number of cigarette per day.

### **4.3. Recommendation**

From the results of this study it is recommended that:

1. Healthy education program about effects of cigarette smoking on body health must be done.
2. For reliable result more researches to study the effect of smoking in other electrolytes must be done.

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Appendix I

**Sudan University of science and technology**

**College of Graduate studies**

**Questionnaire**

**General information:**

Name.....

Age.....

No of cigarettes per day.....

Duration of smoking per  
year.....

**Other Disease:**

Yes (     )

No (     )

.....

**Clinical Investigation:**

Serum sodium .....mmol/ L

Serum potassium .....mmol/ L

Serum calcium .....mg/ dL

Serum phosphate .....mg/ dL

Date.....

Sign.....