بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate Studies

Assessment of Serum Levels of Magnesium and Zinc in Sudanese Patients with Type 2 Diabetes Mellitus – in Khartoum State

تقويم مستوى الماغنيسيوم والزنك في مصل الدم في السودانيين المصابين بداء السكرى من النوع الثانى- فى ولاية الخرطوم

A dissertation submitted for partial fulfillment for Master degree of Medical Laboratory Science (Clinical chemistry)

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بسم الله الرحمن الرحيم

اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ (1) خَلَقَ الْإِنْسَانَ مِنْ عَلَقٍ (2) اقْرَأْ وَرَبُّكَ الْأَكْرَمُ (3) الَّذِي عَلَّمَ بِالْقَلَمِ (4) عَلَّمَ الْإِنْسَانَ مَا لَمْ يَعْلَمْ (5)

صدق الله العظيم

سورة العلق الآيات {1-5}

Dedication

To My Father, Mather,

My brothers, and sisters,

My friends and everyone who encourage us

Ehsan AbdelazizYousif Mohamed

Acknowledgements

At first, all praise is to ALLAH who gave me the power to complete this work.

I would like to pay special thankfulness, warmth and appreciation to the person's bellow that made the research successful and assisted in every point to cherish our goal.

I express our deepest thanks to supervisor Dr. Mariam Abbas, for her vital support and assistance, her encouragement made it possible to achieve the goal.

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Finally, thanks for all participants who cooperate by answering the long questionnaire, without their contributions; this would never have been done.

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List of Abbreviations

BMI	Body Mass Index
DM	Diabetes Mellitus
FBS	Fasting Blood Sugar
GDM	Gestational Diabetes Mellitus
HIV	Human Immunodeficiency
IDDM	Insulin Dependent Diabetes Mellitus
IV	Intravenous
MODY	Maturity Onsent Diabetes of the Young
NIDDM	Non Insulin Dependent Diabetes Mellitus
OHA	Oral Hypoglycemic Agent
PTH	Parathyroid Hormone
T1DM	Type 1 Diabetes Mellitus
T2DM	Type 2 Diabetes Mellitus
WHO	World Health Organization

Abstract

Background: The metabolism of several trace elements has been reported to be altered in diabetes mellitus and these trace elements might have specific role in the pathogenesis and progress of this disease.

Objective: The aim of the study to investigate serum levels of magnesium and zinc in type 2 diabetes mellitus patients in Khartoum state.

Method: Cross sectional study was conducted in Khartoum state from March to November 2018 in 90 subjects (45 diabetic patients and 45 age and sex matching healthy controls), both groups age ranged from 33 to 75 years. Serum magnesium, zinc, fasting blood sugar (FBS) and BMI were measured in both groups. Statistical was done by using SPSS version 20.

Result: Serum levels of magnesium and zinc were significant decreased in patients (mean± SD: 1.95±0.09mg/dl and 0.236 ±0.093mg/l) when compared to controls (mean ± SD: 2.08±0.11mg/dl and 0.767±0.199mg/l) which P- value (P=0.000 and P=0.000, respectively). FBS and BMI were significantly increased in patients with type 2 diabetes mellitus (mean ± SD: 181.6±60.0mg/dl and 26.5±4.1) when compared to controls (mean ± SD: 85.3±8.0mg/dl and 24.4±3.2) which P-value (P=0.000, P=0.011, respectively). Serum zinc level was significant decreased in type 2 diabetes mellitus on insulin treatment (mean ±SD: 0.164±0.027mg/l) when compared to patients who were on oral hypoglycemic agent (OHA) (mean ± SD: 0.257±0.096mg/l) which P value =0.005. However there was insignificant difference serum magnesium level in type 2 diabetes mellitus on insulin treatment (mean ±SD: 1.96±0.06mg/dl) when compared to patients who were on OHA (mean ± SD: 1.95±0.10mg/dl) which P value = 0.740. There was negative correlation between serum magnesium level and duration of disease (r= -0.328, P=0.028) and no correlation with age, FBS and BMI (P=0.402, P=0.797, P=0.929, respectively). Negative correlation between serum zinc level and age (r= -0.354, P value =0.017) and duration of disease(r= -0.579, P value =0.000) and no correlation with FBS and BMI (r= 0.186, P=0.200, respectively).

Conclusion: Type 2 diabetic patients had decreased levels of both serum magnesium and zinc. Type 2 diabetic patients treated with insulin had lower level of zinc compared to patients treated with OHA, while magnesium concentration is not affected by type of treatment. Both concentration of magnesium and zinc are negatively correlated with duration of diseased.

المستخلص

الخلفية:

افادات تقارير عن عملية التمثيل الغذائى للعديد من العناصر النذرة [الدقيقة] في داء السكرى وهذه العناصر قد يكون لها ادوار محددة في التسبب و التقدم في هذا المرض.

الهدف:

تهدف هذه الدراسة لمعرفة مستويات المصل من الماغنيسيوم و اللزنك في مرضى السكرى من النرع الثانى في ولاية الخرطوم.

الطريقة:

اجريت دراسة مقطعية في ولاية الخرطوم في الفترة من مارس الى نوفمبر 2018 في 90 شخص 45مريضا مصابا بالسكرى و 45 يتطابقون بالعمر والجنس كلا المجموعتين تتراوح اعمارهم بين 33 الى 75 سنة تم قياس مستويات المصل من الماغنيسيوم و الزنك و مستوى السكر الصائم في كلا المجموعتين وتم الاجراء الاحصائى باستخدام SPSS الاصدار 20.

النتيجة:

انخفضت مستويات المصل من الماغنيسيوم و الزنك بشكل ملحوظ عند المرضى مقارنة مع مجموعة الضبط بفروقات معنوية (P=0.000, P=0.000). على التوالى, وكانت زيادة كبيرة فى مستوى السكر الصائم ومؤشر كتلة الجسم BMI في داء السكرى من النوع الثانى مقارنة مع مجموعة الضبط بفروقات معنوية (P=0.000, P=0.011) على التوالى.

انخفض مستويات المصل من الزنك بشكل ملحوظ في مرضى السكرى على علاج الانسولين مقارنة مع المرضى الذين كانو على OHA (P=0.005) ولم يكن هنالك فرق كبير في مستوى المصل من الماغنيسيوم في مرضى السكرى على علاج الانسولين مقارنة مع المرضى الذين كانوOHA (P=0.740)

كان هنال ارتباط سلبي بين مستوى الماغنيسيوم في الدم و مدة المرض(P=0.028) وعدم وجود علاقة مع تقدم العمر ومستوى السكر الصائم ومؤشر كتلة الجسم BMI (P=0.402, P=0.797, P=0.929) على التوالى.

وارتباط سلبي بين المصل من الزنك مع تقدم العمر و مدة المرض(P=0.017, P=0.000) على التوالى, وعدم وجود علاقة مع مستوى السكر الصائم ومؤشر كتلة الجسم BMI (p=0.186, P=0.200) على التوالى.

الخلاصة:

مرضى السكرى من النوع الثاني قد انخفضت لديهم مستويات الماغنيسيوم والزنك و كان لدى مرضى السكرى من النوع الثاني الذين عولجوا بالانسولين مستوى منخفض من الزنك مقارنة مع الذين عولجوا بال OHA بينما لا يتاثر الماغنيسيوم بنوع العلاج كما توجد علاقة سلبيا مع تركيز كل من الماغنيسيوم و الزنك مع مدة المرض.

Chapter One

1. Introduction, Rational and Objectives

1.1 Introduction

Diabetes mellitus (DM) represents today a disease with massive spreading with medico-social consequences. Recent research has shown a close relationship between some specific micronutrients and this disease, with implications for the pathogenesis of this disease and vascular complication. The relationship between nutrition and diabetes was suspected early and over the last 20 years, numerous studies have found alteration in micronutrients status of patients with diabetes mellitus. There are accumulating evidences that the metabolism of several trace metals are altered in diabetes mellitus and these micronutrients might have specific role in pathogenesis and progression of the disease. Diabetes mellitus has been shown to be associated with abnormalities in the metabolism of zinc, chromium, copper, magnesium and manganese (Oyedeji et al., 2014).

Various studies have measured the levels of minerals in diabetic patients; the pioneering studies showed that low serum zinc levels in diabetic patients may be associated with the pathogenesis of diabetes mellitus. In addition low levels of magnesium in diabetic patients have been reported (Roshanrauan et al., 2018).

A study was done by Tiwari et al (2017) showed the low level of serum zinc in type 2 diabetes mellitus patients compared to healthy control, whereas there was no significant difference in serum magnesium level, fasting blood sugar, post prandial blood sugar and glycated hemoglobin has significant positive correlation in type 2 diabetes mellitus (Tiwari et al.,2017).

Other study was done by Vidya et al (2016) Shown serum magnesium was significantly decreased in diabetics than control and negative linear relationship between magnesium and fasting blood sugar; and magnesium and post prandial blood sugar (Vidya et al., 2016).

Also in 2014 Santa et al showed serum levels of magnesium and zinc were lower in diabetic patients than healthy individuals and FBS has significant negative correlation with serum zinc and no significant correlation with serum magnesium (Santa et al., 2014).

1.2 Rationale

Diabetes mellitus is the commonest major metabolic disease and most prevalent disease worldwide related to morbidity due to micro and macro vascular complication (Devi et al., 2016).

Diabetes mellitus is now one of major health problem in Sudan resulting in 10% of all hospital administration (Ahmad et al., 2001). Dasarathan et al (2017) reported that lower serum zinc level was found to be responsible for the development of macro vascular complications in type 2 diabetes mellitus. Hence there is aneed for zinc supplementation in diabetic patients to prevent long term complications associated with diabetes mellitus. Corica et al (1996) in their study showed that hypomagnesaemia was highly prevalent in diabetic patients.

Seedahmed and Ahmad (2013) reported that lower serum magnesium level in Sudanese type 2 diabetes mellitus compared to control group, Hamd and abdalla (2017) reported that lower serum magnesium level in Sudanese type 1 and type 2 diabetes mellitus when compared with corresponding control group; there is no enough data concerning serum zinc in type 2 diabetic patients in Sudan, that why we attempt to do this study.

1.3 Objective:

1.3.1 General objective:

To assess the serum levels of magnesium and zinc in patients with type 2 diabetes mellitus.

1.3.2 Specific objectives:

To estimate and compare the serum levels of magnesium and zinc among study groups.

To correlate between ages, duration of disease, BMI, FBS, serum magnesium and serum zinc among type 2 diabetes mellitus.

To correlate between type of treatment and serum levels of magnesium and zinc in type 2 diabetic patients.

Chapter Two

2. Literature review

2.1 Diabetes mellitus

Diabetes mellitus (DM) is a group of metabolic disorders of carbohydrate metabolism in which glucose underutilized, producing hyperglycemia. Some individuals may experience acute life threatening hyperglycemia episodes such as ketoacidosis or hypersmolar coma. As the disease progresses individuals are at increased risk for development of specific complication, including retinopathy, renal failure, neuropathy and atherosclerosis. The last condition may result in stroke, gangrene or coronary artery disease (Sacks, 2008).

2.2 Prevalence of diabetes mellitus:

Diabetes mellitus is the most prevalent diseases worldwide and type 2diabetes is most common type that affects millions of individuals every year across the globe. According to the data published by International Diabetes Federation in their 5th edition of Diabetes Atlas is expected to rise from 366 million in 2011 to 552 million by 2030 (Dasarathan et al., 2017).

2.3 Classification of diabetes mellitus:

Insulin Dependent Diabetes Mellitus (IDDM) known as type 1 diabetes mellitus (T1DM) due to B-cells destruction usually lead to absolute insulin deficiency. Non Insulin Dependent Diabetes Mellitus (NIDDM) has known as type 2 diabetes mellitus (T2DM) due to progressive insulin secretary defect on the background of insulin resistance. Gestational diabetes mellitus (GDM), that is diabetes diagnosis in second and third trimester of pregnancy that not clearly overt diabetes it occurs in 4% of all pregnancy; patients with GDM have a 30% to 50% chance of developing DM, usually type 2 diabetes mellitus. Specific type of diabetes due to other cause e.g. monogenic diabetes syndrome such as neonatal diabetes and maturity onset diabetes of the young (MODY). Disease of exocrine pancreas such as cystic fibrosis. Any drug or chemical induce diabetes such as in the treatment of HIV or after organ transplantation (Mathew et al., 2015).

2.4 Type 2 diabetes mellitus:

Type 2 diabetes mellitus is characterized by hyperglycemia as result of an individual's resistance to insulin with and insulin secretary defect, this resistance result a relative not an absolute insulin deficiency. Type 2 diabetes constitutes the majority case, approximately 90% of all cases of diabetes. Most patients in this type are obese or have an increased percentage of body fatty distribution in the abdominal region. This type of diabetes often goes undiagnosed for many years and is associated with strong genetic predisposition with patients as increased risk with an increase in age, obesity and lack of physical exercise. Characteristics usually include adult onset of the disease and milder symptoms than in type 1, with ketoacidosis seldom occurring. However these patients are more likely to go into a hyperosmolar coma and are at increased risk of developing macrovasculas and microvascular complications (Freeman, 2013).

2.5 Pathogenesis of type 2 diabetes mellitus:

Insulin resistance and B-cells dysfunction are pathological defects in patients with type 2 diabetes mellitus. Insulin resistance is decreased ability of insulin to act on peripheral tissue and is thought to be the primary underlying pathological process, and B-cells dysfunction is inability of the pancreas to produce sufficient insulin to compensate for the insulin resistance. Clinically there is a relative deficiency of insulin early in the disease and absolute insulin deficiency late in the disease; it is uncertain whether type 2 diabetes mellitus is primary due to defect in B-cell secretion, peripheral resistance to insulin or both. Type 2 diabetes mellitus is an extremely heterogeneous disease and that no single cause is adequate to explain the progression from normal glucose tolerance to diabetes; the fundamental molecular defects in insulin resistance and insulin secretion result from a combination of genetics and environmental factors (Sacks, 2008).

2.5.1 Insulin resistance:

Insulin resistance is define as decreased biological response to normal concentration of circulation insulin; it is found in both obese nondiabetic individuals and in patients with type 2 diabetes mellitus; the underlying pathophysiology has not been identified but insulin resistance is usually attributed to defect in insulin action (Sacks, 2008).

2.5.2 Loss of B-cells function:

The increased B-cell demand induced by insulin resistance is associated with progressive loss of B-cells function that is necessary for the development of fasting hyperglycemia; the major defect is a loss of glucose induced insulin release that is termed selective glucose unresponsiveness hyperglycemia appears to render the B-cells increasingly unresponsive to glucose and the extend of dysfunction correlates with both the glucose concentration and the duration of hyperglycemia. Other insulin secretary abnormalities in individuals with type2 diabetes include disruption of the normal polsatile release of insulin and a increased ratio of plasma proinsulin to insulin (Sacks, 2008).

2.5.3 Diabetogenes:

Genetic factor contribute to the development of type 2 diabetes the concordance rate for type 2 diabetes in identical twins approaches 100%, in addition type 2 diabetes is 10 time more likely to occur in obese individuals with apparent who has diabetes than in an equally obese individuals without diabetic family history, the mode of inheritance however is unknown and type 2 diabetes has been described as geneticists nightmare, it is genetically more complex that mendelian disorders and not inherited according to mendelian rules (Sacks, 2008).

2.5.4 Environmental factors:

Environmental factors such as diet and exercise are important determinants in the pathogenesis of type 2 diabetes (Sacks, 2008).

2.6 Diagnosis of type 2 diabetes mellitus:

The diagnosis of diabetes mellitus depends solely on the demonstration of hyperglycemia, and diagnosis of type 2 diabetes may be difficult because the metabolic changes are often no sever enough for the patients to notice symptoms of diabetes (Sacks, 2008).

The diagnosis of diabetes mellitus depend on four criteria, there are glycated hemoglobin equal or more than 6.5% using National Glycohemoglobin Standardization Program (NGSP) – certified method, a fasting plasma glucose equal or more than 126 mg\dl, an OGTT with 2 hours post load (75 g glucose level) equal or more than 200 mg\dl or symptoms of diabetes plus a random plasma glucose level equal or more than 200 mg\dl (Freeman, 2013).

2.7 Serum magnesium:

Magnesium is the most fourth abundant cation in the body and second most abundant intracellular ion. The role of magnesium in the body is widespread; it is an essential cofactor of more than 300 enzymes; including those important in glycolysis, transcellular ion transport, neuromuscular transmission and synthesis of carbohydrates, proteins, lipids, and nucleic acids (Harwell, 2013).

Magnesium is an essential ion involved in glucose homeostasis at multiple levels; it is cofactor in the glucose transport system of hepatocyte plasma membranes and it regulates hepatocyte mitochondrial functions; it catalyzes the various enzymes involved in the phosphorylation of glucose in anaerobic metabolism, as well as in oxidative decarboxylation in the citric acid cycle and can modulate the mechanism of energy transfer from high energy phosphate bonds. Magnesium also plays a role in the release of insulin and maintenance of pancreatic beta cell cycle; it can presumably increase the affinity and number of insulin receptors (Farid, 2012).

2.7.1 Regulation of serum magnesium:

The small intestine may absorb 20% to 65% of the dietary magnesium depending on the need and intake. Regulation of body magnesium is controlled largely by the kidney which can reabsorb magnesium in deficiency states or readily excrete excess magnesium in overload states, because the renal threshold for magnesium is approximately 0.60 to 0.85 mmol\l , this is close to normal serum concentration, slight excesses of magnesium in serum are rapidly excreted by kidney. Also magnesium regulation appears to be related to that of calcium and sodium, parathyroid hormone (PTH) increases the renal reabsorption of magnesium and enhances the absorption of magnesium in the intestine, however changes in ionizing calcium have greater effect on PTH secretion; aldosterone and thyroxine apparently have the opposite effect of PTH in the kidney increasing the renal excretion of magnesium (Harwell, 2013).

2.7.2 Clinical application of serum magnesium:

Hypomagnesaemia is most frequently observed in hospitalized individuals in intensive care units or those receiving diuretic therapy or digitalis therapy there are many causes of hypomagnesaemia. Reduced intake of magnesium, magnesium deficient diet as a result of starvation, chronic alcoholism or magnesium deficient IV therapy can cause a loss of the ion.

Various gastrointestinal disorders may cause decreased by intestine as malabsorption syndromes, intestinal resection or hypass surgery, nasogastric, pancreatits and prolonged remitting diarrhea or laxative use. Also magnesium loss due to increased excretion by way of urine can occur as a result of various renal and endocrine disorders or the effects of certain drugs on the kidney.

Hypermagnesaemia is observed as frequently as hypomagnesaemia, the most common in renal failure. The most severe elevation are usually a result of the combined effects of decreased renal function and increased intake of commonly prescribed magnesium containing medications such as antiacids, enemas or cathartics (Harwell, 2013).

Hypermagnesaemia has been associated with several endocrine disorders; thyroxin and growth hormone cause decrease in tubular reabsorption of magnesium, and adrenal insufficiency may cause mild elevation as result of decreased renal excreation of magnesium. Dehydration can cause apseudohypermagnesaemia, can be corrected by rehydration. Also mild serum magnesium elevation can occur in individuals with multiple myeloma and bone metastases (Harwell, 2013).

2.8 Serum zinc:

Zinc is an essential micronutrient, which has an important role in the functioning of hundreds enzymes in insulin metabolism and act as an efficient antioxidant, concerning metabolic diseases like insulin resistant, metabolic syndrome and diabetes. Zinc is important because it plays in the stabilization of insulin hexamers, pancreatic storage of hormone and is an efficient antioxidant; while oxidation is consider being a main component in initiation and progression of insulin resistances and diabetes (Farid, 2012).

2.8.1 Clinical applications of serum zinc:

The most frequent causes of zinc deficiency are inadequate intake due to low zinc containing diet, loss of zinc during food processing or prolonged intravenous alimentation. Malabsorption due to ingested of absorption inhibitors or drugs; Excessive loss of zinc in digestive fluid, increased urinary elimination, burns and hemdialysis; increased demand during pregnancy and neonates (Yanagisawa, 2002).

Chapter Three

3. Material and Methods

3.1 Materials.

3.1.1 Study design

Across – sectional comparative study was been conducted.

3.1.2 Study area and period

This study was carried out in Khartoum state – Sudan from March to December 2018.

3.1.3 Study population

There were 90 subjects enrolled in this study (45 diabetic patients and 45 health controls) with age ranged from 33 to 75 (20 male and 25 female)

Inclusion criteria

All diagnosed patients with type 2 diabetes mellitus, and normal health age and sex matched individuals were included.

Exclusion criteria

Patients who are taking zinc and magnesium supplementation or drugs that interfere with zinc and magnesium absorption, patients with malabsorption, chronic diarrhea, and patients suffering from coronary heart disease, thyroid disorder, adrenal dysfunction, gastrointestinal disorder and renal disorder, also alcoholism, pregnancy and lactation mothers were excluded from the study.

3.1.4 Ethical consideration

The study proposal was approved by Scientific Committee of Clinical Chemistry Department, College of Medical Laboratory Science, Sudan University of Science and Technology. An informed consent was obtained from each participant (Appendix I). Clinical data was collected records and demographic data was collected by questionnaire (Appendix II).

3.1.5 Sampling

After informed consent, 5 ml venous blood fasting from 8 – 12 hours were collected from each participants under aseptic condition in two different containers; fluoride oxalate for glucose estimation and plain containers for magnesium and zinc estimation using disposable syringes

from vein after cleaning the skin with 70% alcohol. Serum was separated by centrifugation at 3000 rpm for three minutes.

3.2 Methods

3.2.1 Fasting blood glucose estimation:

Principle: glucose in sample oxidize in the present of glucose oxidase enzyme to give gluconate and hydoregen peroxide, in the present of peroxidase enzyme give oxygen and water, then oxygen in the present of oxygen accepter and phenol as indicator give color, the density of color proportional to glucose concentration. (Appendix III).

3.2.2 Serum magnesium estimation:

Principle: magnesium ions from a colored chelate complex when reacting with phosphonazo III, the intensity of the color is proportional to the magnesium concentration (Appendix IV).

3.2.3 Serum zinc estimation:

Concentration of serum zinc was estimated using atomic absorption spectrophotometer after serum diluted 1:5 with demonized water and the preparation aspirated directly into flame. The principle is based on dissociation of the element by flame from its chemical bonds. This is then placed in unexcited or ground state (neutral atom). The neutral atom at low energy level is capable of absorbing radiation at very narrow bandwidth corresponding to its own line spectrum (Butrimovitz and Purdy, 1994).

3.2.4 Calculation of body mass index (BMI):

This was done by measurement of height in meter (m) and weight in kilograms (kg). The BMI was calculated from average height and weight as follow:

$$BMI = \text{Weight (kg)} / (\text{Height (m)})^2$$

3.2.5 Data analysis:

The data obtained were processed statistically using SPSS program version 20. Differences were significant when the P- value was ≤ 0.05. The differences in the mean were compared using independent sample t- test and Person's correlation was used to determine the association between variables.

Chapter Four

4. Results

There were 90 subjects enrolled in this study (45 diabetic patients and 45 health controls) with age ranged from 33 to 75 years (20 male and 25 female)

The serum levels of magnesium, zinc and FBS were measured in samples obtained from participants and statistical analysis was done and results were as follow:

Table 1 shows a significant decreased of serum levels of magnesium and zinc in patients (mean+ SD: 1.95±0.09mg/dl and 0.236 ±0.093mg/l) when compared to healthy control (mean ±SD: 2.08±0.11mg/dl and 0.767±0.199mg/l) with P- value (P=0.000 and P=0.000, respectively). And a significantly increased in FBS and BMI in patients with type 2 diabetes mellitus (mean ± SD: 181.6±60.0mg/dl and 26.5±4.1) when compared to healthy controls (mean ± SD: 85.3±8.0mg/dl and 24.4±3.2) with P- value (P=0.000 and P=0.011, respectively).

Table 2 Shows a significant decreased of serum zinc level in type 2 diabetes mellitus on insulin treatment (mean ±SD: 0.164±0.027mg/l) when compared to patients who were on OHA (mean ± SD: 0.257±0.096mg/l) which P value =0.005. However there was no significant difference serum magnesium level in type 2 diabetes mellitus on insulin treatment (mean ± SD: 1.96±0.06mg/dl) when compared to patients who were on OHA (mean ± SD: 1.95±0.10mg/dl) which P value = 0.740.

Figure 1 A scatter plot shows no- correlation between serum magnesium and age in type 2 diabetic patients (r= -0.128 and p= 0.402).

Figure 2 A scatter plot shows no- correlation between serum magnesium and FBS in type 2 diabetic patients (r= 0.039 and P= 0.797).

Figure 3 A scatter plot shows negative correlation between serum magnesium and duration of disease in type 2 diabetic patients (r= -0.328 and P= 0.028).

Figure 4 A scatter plot shows no- correlation between serum magnesium and BMI in type 2 diabetic patients (r= 0.014 and P= 0.929).

Figure 5 A scatter plot shows negative correlation between serum zinc and age in type 2 diabetic patients (r= -0.354 and P= 0.017).

Figure 6 A scatter plot shows no- correlation between serum zinc and FBS in type 2 diabetic patients (r= -0.201 and P= 0.186).

Figure 7 A scatter plots shows negative correlation between serum zinc and duration of disease in type 2 diabetic patients (r= -0.579 and P= 0.000).

Figure 8 A scatter plot shows no- correlation between serum zinc and BMI in type 2 diabetic patients (r= 0.195 and P= 0.200).

Table 1 Comparisons between means serum levels of magnesium, zinc, FBS and BMI in type 2 diabetes mellitus and controls.

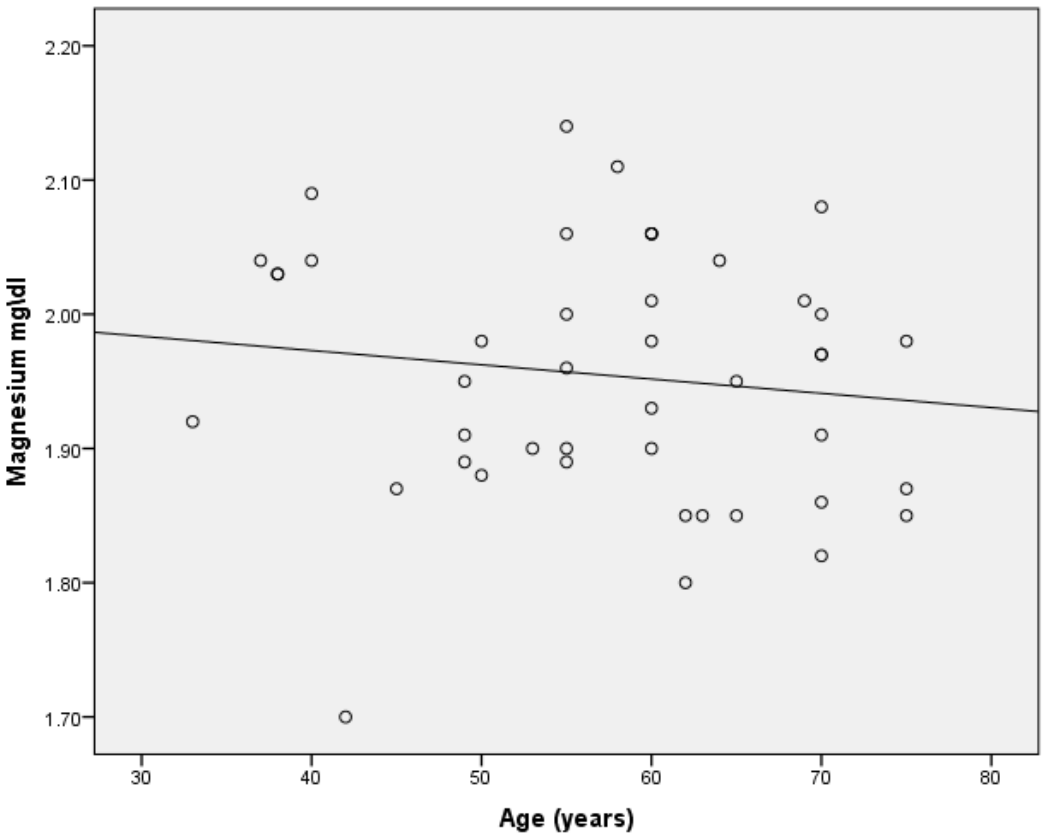
Variables	Study groups	Mean ± SD	P. value
FBS(mg\dl)	Case	181.6±60.0	0.000
	Control	85.3±8.0	
Serum magnesium (mg\dl)	Case	1.95±0.09	0.000
	Control	2.08±0.11	
Serum zinc(mg\l)	Case	0.236±0.093	0.000
	Control	0.767±0.199	
BMI	Case	26.5±4.1	0.011
	Control	24.4±3.2	

Independent sample t- test was used, P- value ≤ 0.05 considered as significant.

Table 2 Comparisons between means serum levels of magnesium and zinc in type 2 diabetes mellitus according to type of treatment.

Variables	Treatment types	Number	Mean± SD	P.value
Serum magnesium (mg\dl)	Insulin OHA	10 35	1.96±0.06 1.95±0.10	0.740
Serum zinc (mg\l)	Insulin OHA	10 35	0.164±0.027 0.257±0.096	0.005

Independent sample t- test was used, P- value ≤ 0.05 considered as significant.

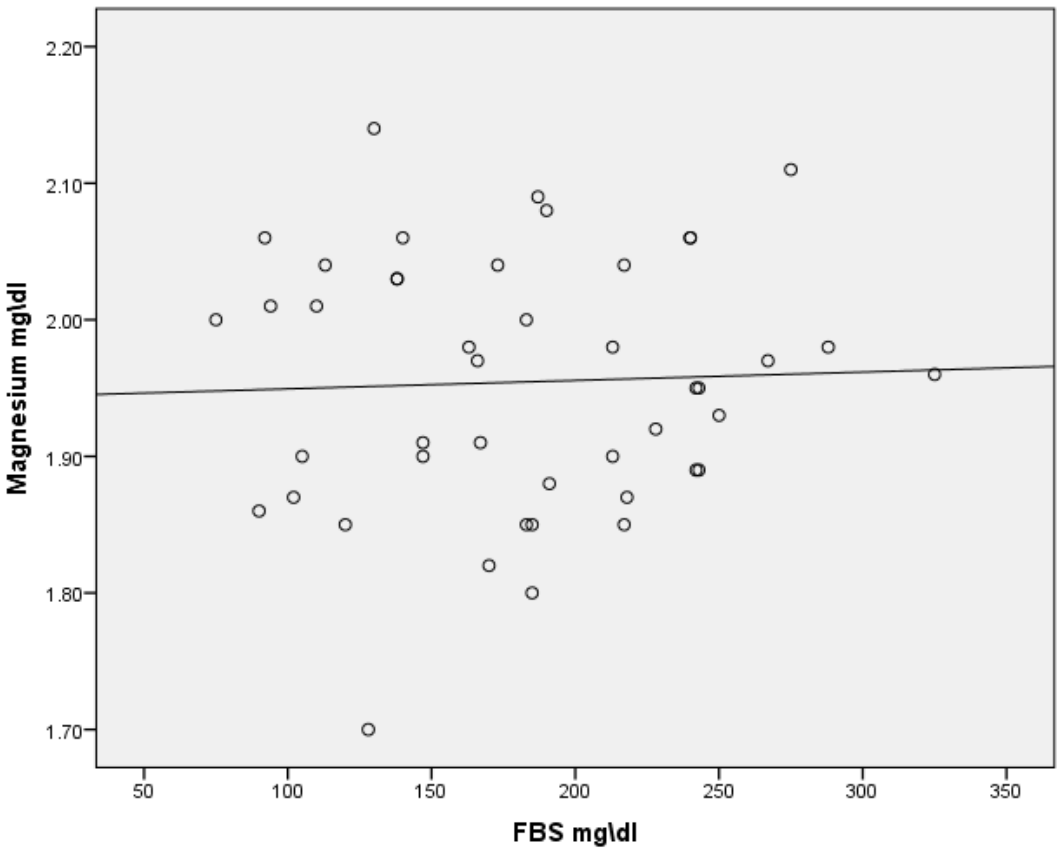


r = -0.128

P = 0.402

Figure 1: Correlation between serum magnesium and age in type 2 diabetic patients

r: is a regression co- efficient, P: is a strength significance of correlation



r = 0.039
P =0.797

Figure 2: Correlation between serum magnesium and FBS in type 2 diabetic patients

r: is a regression co- efficient, P: is a strength significance of correlation

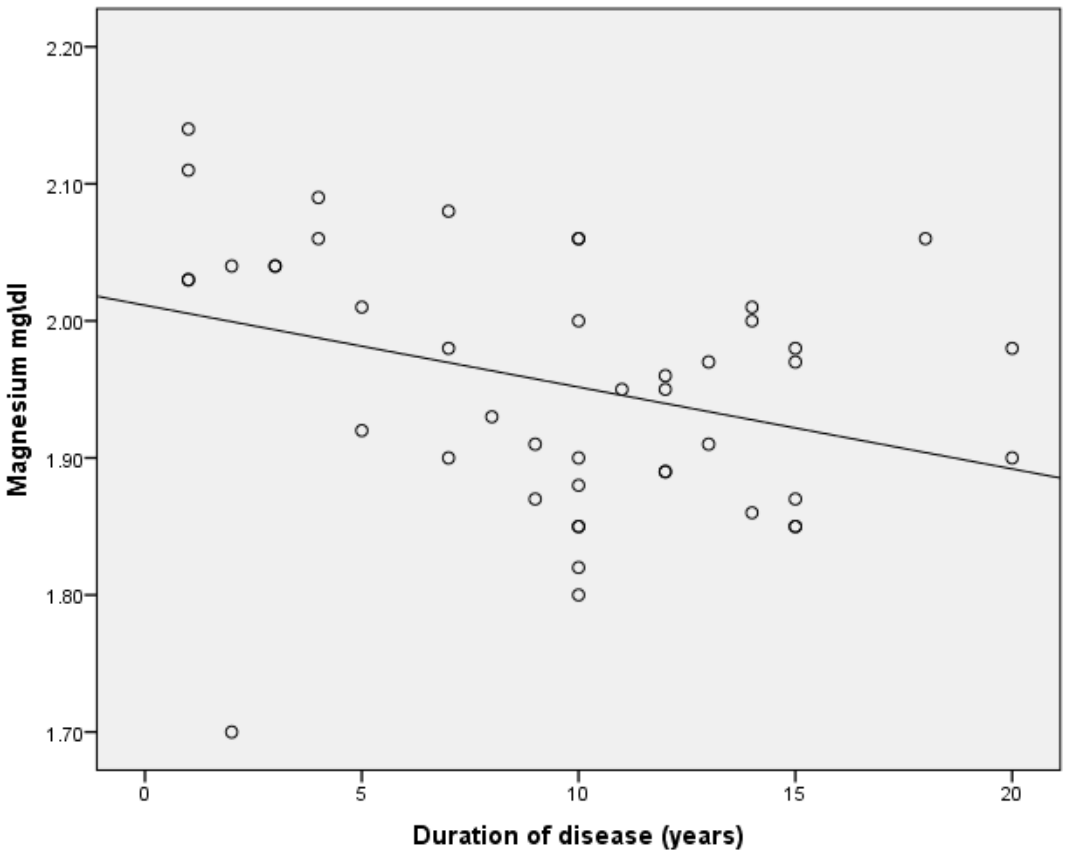


Figure 3: Correlation between serum magnesium and duration of disease in type 2 diabetic patients

r: is a regression co- efficient, P: is a strength significance of correlation

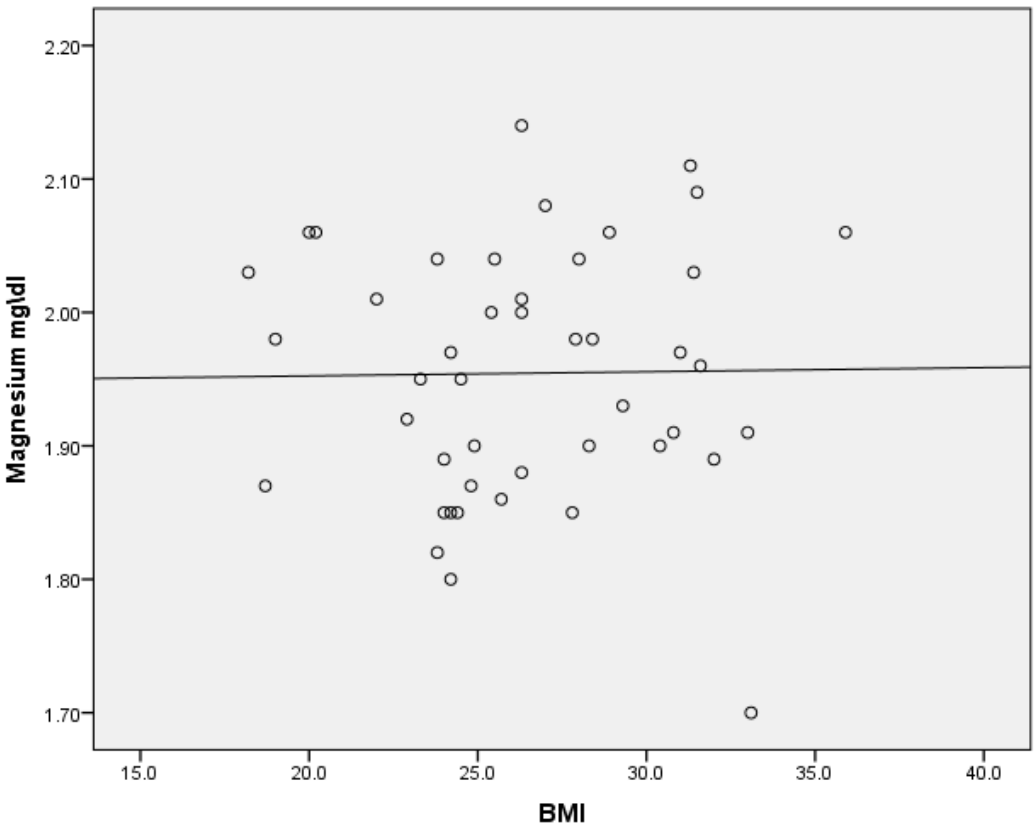


Figure 4: Correlation between serum magnesium and BMI in type 2 diabetic patients

r: is a regression co- efficient, P: is a strength significance of correlation

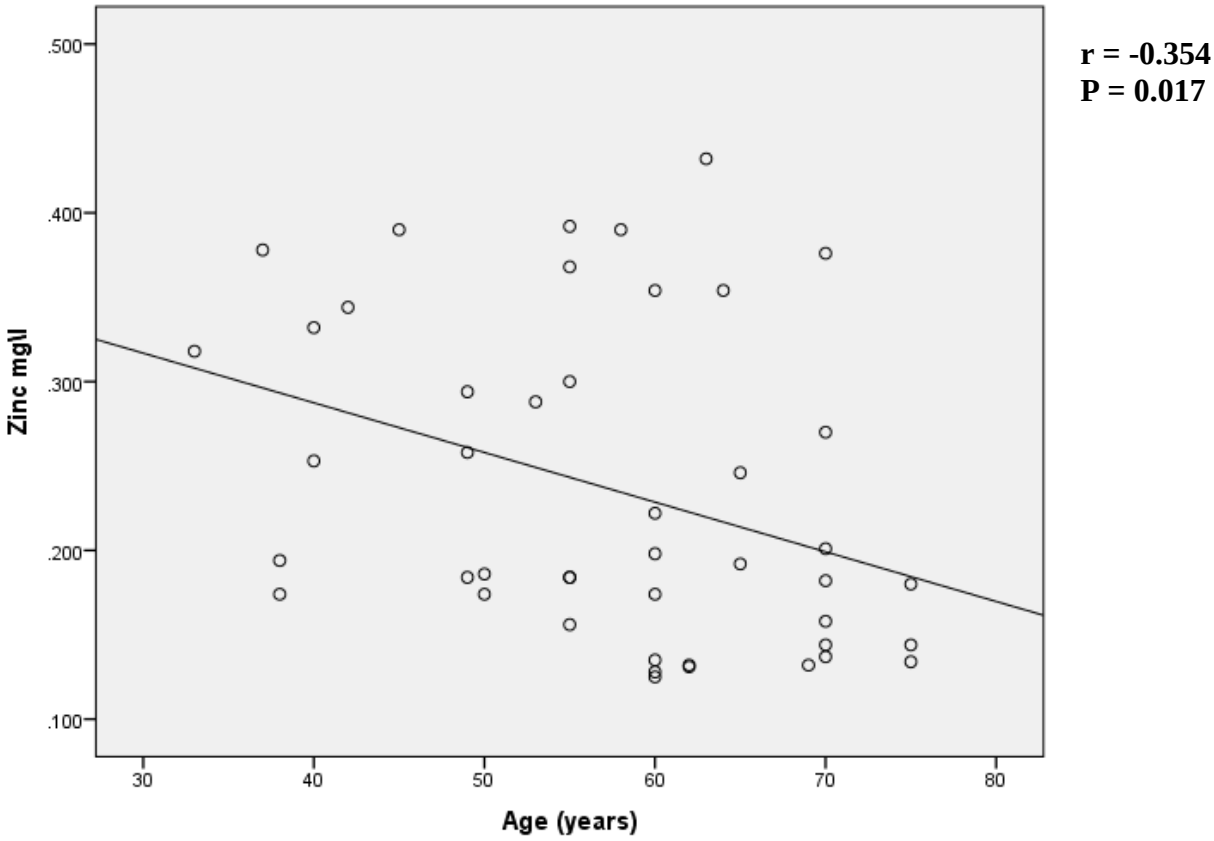
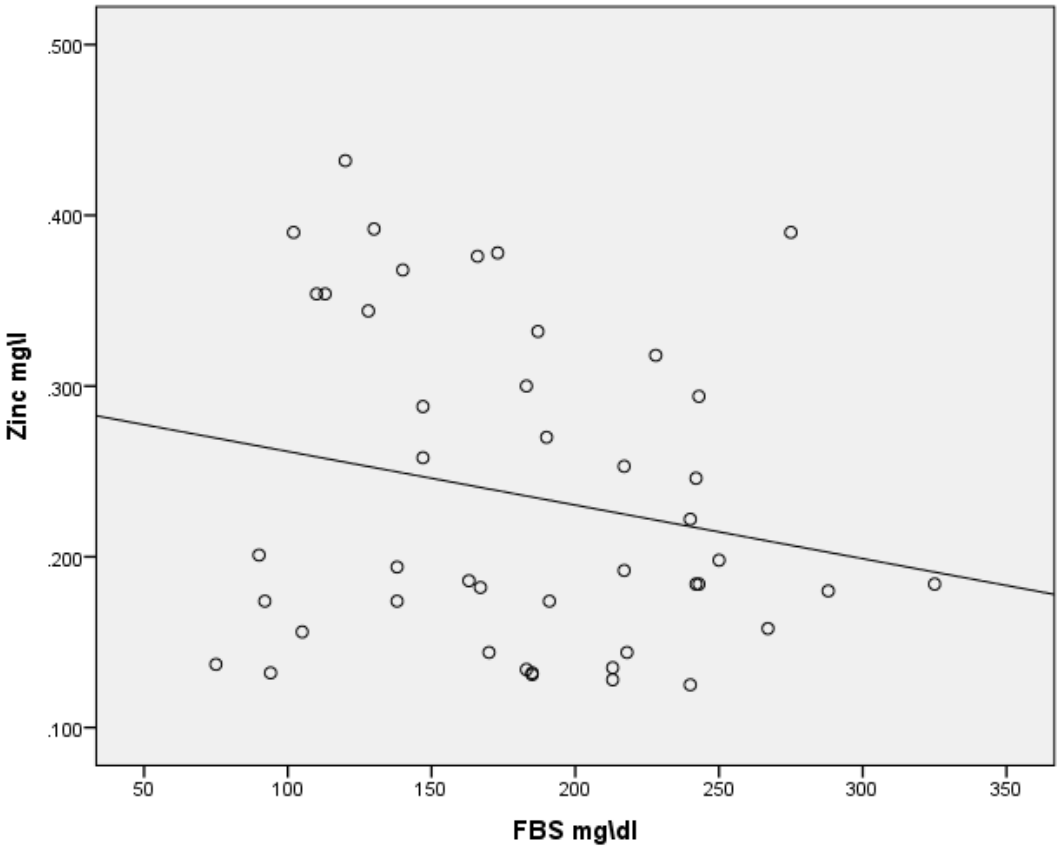


Figure 5: Correlation between serum zinc and age in type 2 diabetic patients

r: is a regression co- efficient, P: is a strength significance of correlation



r = -0.201
P = 0.186

Figure 6: Correlation between serum zinc and FBS in type 2 diabetic patients

r: is a regression co- efficient, P: is a strength significance of correlation

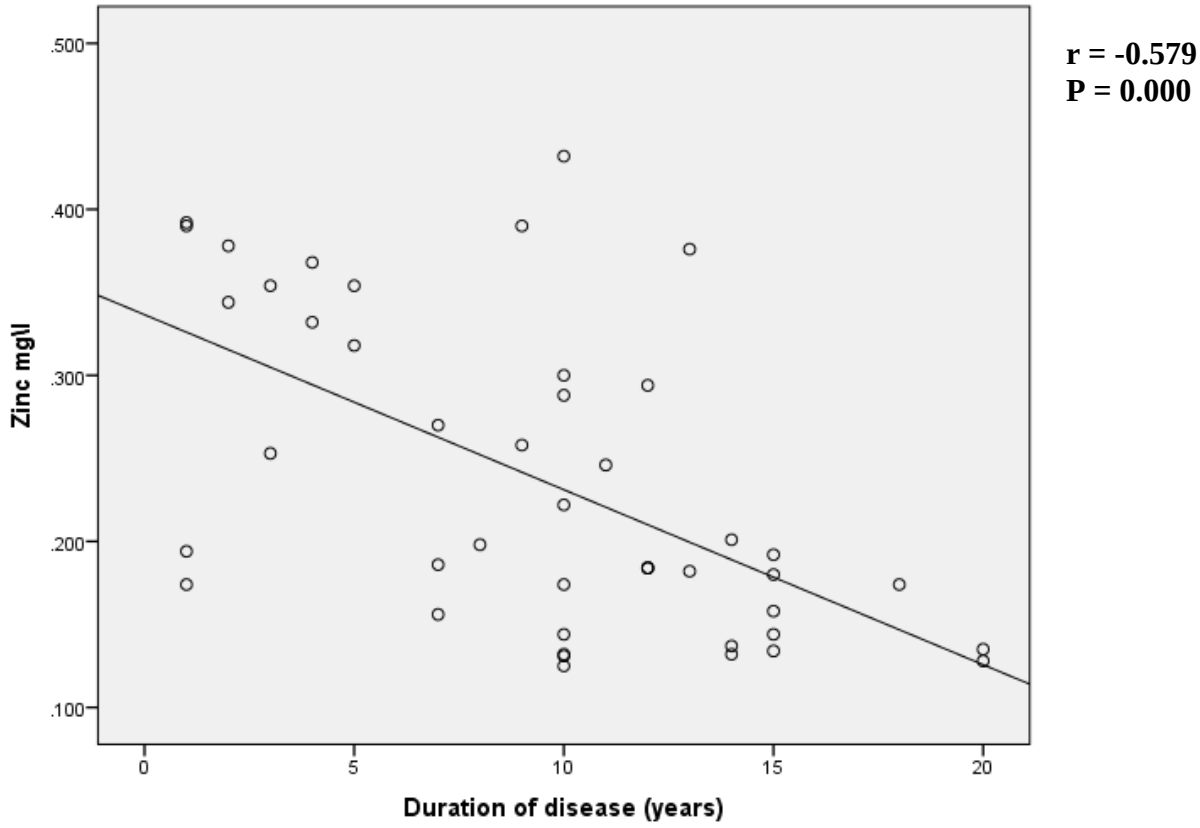
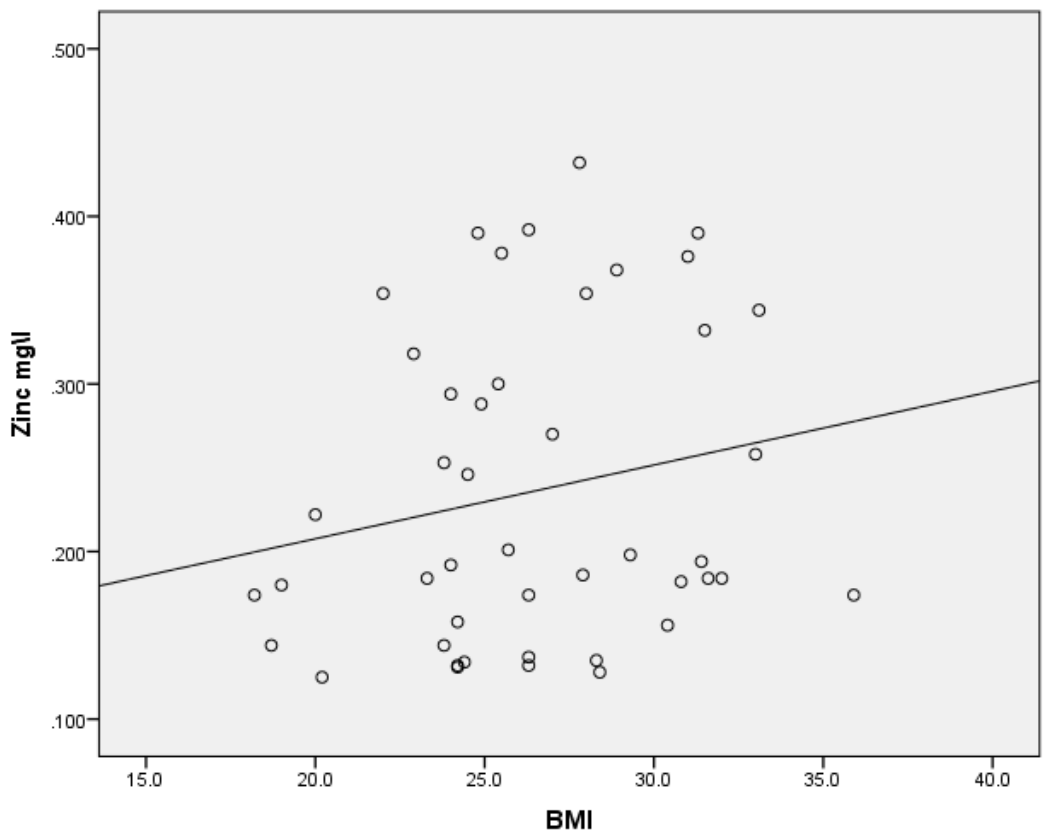


Figure 7: Correlation between serum zinc and duration of disease in type 2 diabetic patients

r: is a regression co- efficient, P: is a strength significance of correlation



r = 0.195
P = 0.200

Figure 8: Correlation between serum zinc and BMI in type 2 diabetic patients

r: is a regression co- efficient, P: is a strength significance of correlation

Chapter five

5. Discussions, Conclusions and Recommendation

5.1 Discussions

Direct association of trace element with health and disease is already established, diabetes mellitus one of the commonest disease of the mankind is linked with trace element metabolism.

In this study, it were observed that mean serum of magnesium and zinc levels were significantly low in diabetic patients as compared to healthy controls, similar observation were reported by Santa et al who observed significantly lower serum magnesium and zinc levels in diabetic patients than healthy individuals (Santa et al., 2014). Also similar observation were reported by Oyedeji et al who demonstrated significant reduction of the zinc and magnesium metals in type 2 diabetes mellitus(Oyedeji et al., 2014). Hypomagnesaemia and hypozincemia observed in diabetic patients due to increased urinary loss (polyuria or osmotic diuresis) or decreased gastrointestinal absorption. (Tiwari et al., 2017).

BMI was observed to be significantly higher in diabetic patients than healthy controls this agreed with study done by Dasarathan et al who showed BMI was significantly higher in diabetic group as compared to control (Dasarathan et al., 2017). The finding of an average BMI that is in the overweight suggests a possible interplay of genetic factor, sedentary lifestyle and lack of exercise (Agrawal et al., 2017).

FBS was significant higher in diabetic patients than healthy controls this agreed with study done by Farid that diabetic patients have significantly higher levels of FBS than control groups,the reason for this might be that most of the diabetic patients in our study group were probably with poor glycemic control (Farid, 2012).

Serum level of zinc was significant low in type 2 diabetes mellitus on insulin treatment compared to patients who were on OHA, similar observation was reported by Jansen et al who showed type 2 diabetes patients treated with insulin displayed lower serum zinc compared to those not injecting insulin, insulin leads to an increase in intracellular zinc and that insulin signaling was enhanced by elevated intracellular zinc concentrations (Janasen et al., 2012). However there was no significant difference serum magnesium level in type 2 diabetes mellitus on insulin treatment when compared to patients, who were on OHA, this disagreed with study done by Kauser et al who observed serum magnesium level were significant lower in type 2

diabetes mellitus on insulin treatment when compared to patients, who were on OHA (Kauser et al., 2014).

Serum magnesium has significant negative correlation with duration of disease this agrees with study done by Hamd and Abdalla we detected inverse correlation between serum magnesium and duration of diabetes (Hamd and Abdalla, 2017). Also Seedahmed and Ahmed showed negative correlation between plasma level of magnesium and duration of disease; long duration of diabetes is associated with higher incidence of complications due to longer duration of uncontrolled diabetic status lead to low magnesium levels (Seedahmed and Ahmed, 2013). And serum magnesium had no significant correlation with age, FBS and BMI this is agrees with study done by Mamza et al who observed on significant correlation between serum magnesium and FBS and BMI (Mamza et al., 2016). And disagree with study done by Farid showed magnesium has negative correlation with FBG (Farid, 2012).

Serum zinc has significant negative correlation with age and duration of disease this disagree with study done by Masoon et al who observed on significant associated of serum zinc with age and duration of diabetes (Masoon et al., 2009). And no significant correlation with FBS and BMI this agrees with study done by Mamza et al who observed on significant correlation between serum magnesium and FBS and BMI (Mamza et al., 2016). And disagree with study done by Dasarathan et al showed serum zinc has strong negative correlation FBG and BMI in type 2 diabetic patients (Dasarathan et al., 2017).

5.2 Conclusion

Type 2 diabetic patients had decreased levels of both serum magnesium and zinc. Type 2 diabetic patients treated with insulin had lower level of zinc compared to patients treated with OHA, while magnesium concentration is not affected by type of treatment. Both concentration of magnesium and zinc are negatively correlated with duration of diseased.

5.3 Recommendations:

- More different studies needed to approve correlation of serum magnesium and zinc levels with glycemic control in type 2 DM.
- There is a need to explore the serum magnesium and zinc levels in type 2 DM related to complications.
- Diabetic patients are screening for hypomagnesmia and hypozincemia and institution of supplementation if it is detected.

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