



## BIOMEDICAL STATUS OF MACRO MINERALS, BLOOD GLUCOSE AND LIPIDS IN PATIENTS WITH TYPE 2 DIABETES

**D. Vijayakumar , J. Shilpa and C. Sathishkumar**

*1. Associate Professor, Department of Biomedical Engineering, Mahendra Institute of Technology, Mahendhirapuri, Mallasamudram, Namakkal-637 503 Tamilnadu*

*2. Assistant Professor, Department of Biomedical Engineering, Dhanalakshmi Srinivasan College of Engineering & Technology, Mamallapuram, Chennai – 603104 Tamilnadu*

*3. Assistant Professor, Department of Biomedical Engineering, Adhiyamaan College of Engineering, Hosur -635109 Tamilnadu*

### ABSTRACT

Diabetes is a chronic disease that occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces. In type 2 diabetes (formerly called non-insulin-dependent diabetes or adult-onset diabetes), the pancreas often continues to produce insulin, sometimes even at higher-than-normal levels, especially early in the disease. However, the body develops resistance to the effects of insulin, so there is not enough insulin to meet the body's needs. Type 2 diabetes mellitus is an expanding global health problem, closely linked to the epidemic of obesity. Individuals with diabetes are at high risk for both microvascular complications (including retinopathy, nephropathy and neuropathy) and macrovascular complications (such as cardiovascular comorbidities), owing to hyperglycaemia and individual components of the insulin resistance (metabolic) syndrome.

### INTRODUCTION

More than 95% of people with diabetes have type 2 diabetes. This type of diabetes is largely the result of excess body weight and physical inactivity. Type 2 diabetes was once rare in children and adolescents but has become more common. However, it usually begins in people older than 30 and becomes progressively more common with age. About 26% of people older than 65 have type 2 diabetes. People of certain racial and ethnic backgrounds are at increased risk of developing type 2 diabetes: blacks, Asian Americans, American Indians, and people of Spanish or Latin American ancestry who live in the United States have a twofold to threefold increased risk as compared with whites. Type 2 diabetes also tends to run in families.

People with type 2 diabetes may not have any symptoms for years or decades before they are diagnosed. Symptoms may be subtle. Increased urination and thirst are mild at first and gradually worsen over weeks or months. Eventually, people feel extremely fatigued, are likely to develop blurred vision, and may become dehydrated.

Sometimes during the early stages of diabetes, the blood glucose level is abnormally low at times, a condition called hypoglycemia. Because people with type 2 diabetes produce some insulin, ketoacidosis does not usually develop even when type 2 diabetes is untreated for a long time. Rarely, the blood glucose levels become extremely high (even exceeding 1,000 mg/dL [55.5 mmol/L]). Such high levels often happen as the result of some superimposed stress, such as an infection or drug use. When the blood glucose levels get very high, people may develop severe dehydration, which may lead to mental confusion, drowsiness, and seizures. Many people with type 2 diabetes are diagnosed by routine blood glucose testing before they develop such severely high blood glucose levels.

This present study were selected 20 patients with diabetes mellitus. This results obtained were compared with age, weight and sex matched disease free healthy controls.

### MATERIALS AND METHOD

Twenty clinically diagnosed diabetic patients from Rajah Muthiah Medical College and Research Institute, Chidambaram, Tamilnadu, India, who had not undergone any previous treatment

for their diabetes, were chosen for the study. An equal number of age and sex matched normal subjects were also investigated. They were sex and age between 40–60 years. From them 10-15 ml of blood sample were collected into two sets of sterile tubes, one set of tubes contain anticoagulant- EDTA and the another set of tubes without anticoagulant.

The anticoagulant containing tubes of whole blood was used for estimation of glucose. Another set without anticoagulant, were allowed to clot at room temperature for 15 minutes, the serum was separated and poured into small sterile eppendorff tubes. The whole blood and serum were stored in the refrigerator at 4°C till use.

Total cholesterol was estimated by the method of Zak's. Blood glucose was estimated by the method of Hyvarinen and Nikkila et al.

## RESULT

**TABLE 1**

Levels of serum cholesterol and triglycerides in normal subject and diabetic patients.

Parameters	Normal Subjects	Type2 Diabetes
Cholesterol(mg/dl)	174.1 ± 2.57(a)	259.6 ± 27.6*(b)
Triglycerides(mg/dl)	125.57 ± 2.74(a)	186.85 ± 11.47*(b)

The values are expressed as Mean ± SD

\*P<0.05, n=20

(a) and (b) = Comparison between normal subject and diabetic patients.

**TABLE 2**

Levels of serum sodium, potassium, calcium, chloride & phosphorous in normal subjects and diabetic patients.

Parameters	Normal Subjects	Type2 Diabetes
Sodium(mg/dl)	139.80 ± 3.89	129.75 ± 1.21**
Potassium(mg/dl)	4.54 ± 0.51	4.92 ± 0.10*
Calcium(mg/dl)	9.70 ± 0.31	7.01 ± 1.21**
Chloride(mg/dl)	99.37 ± 5.28	90.47 ± 0.48**
Phosphorous(mg/dl)	3.98 ± 0.75	5.77 ± 0.58**

The values are expressed as Mean ± SD, n=20

\*P<0.05 statistically significant level.

\*\*P<0.001 statistically significant level.

**TABLE 3**

Basic parameter of glucose was carried out in controls and type 2 diabetic patients. The results of the parameters were summarized in the tables

Parameters	Normal Subjects	Type2 Diabetes
Glucose(mg/dl)	99.00 ± 12.32	265.00 ± 35.25**

The values are expressed as Mean ± SD., n=20

\*\*P<0.001 statistically significant level.

## DISCUSSIONS

**Table 1** shows that cholesterol and TG levels were significantly increased (P<0.05) in type 2 diabetes mellitus when compared with controls.

In this present study, Serum cholesterol was increased in type 2 diabetes patients. The type 2 diabetes may leads to various secondary complication especially cardio vascular disease in which cholesterol deposits in blood vessels. Suryawanshi et al., (2006) have reported that high concentration of serum cholesterol in diabetes may be attributed to decreased muscular exercise or inhibition of cholesterol catabolism.

Kwak et al have reported that the mobilization of fatty acid from adipose tissue causes increased conversion of those fatty acids to triglycerides which cause triglyceridemia.

**Table 2** shows that decreased level of sodium, calcium and chloride and increased levels of serum potassium and phosphorous in patients with type 2 diabetes as compared to controls. Sodium level found to be decreased in Type 2 diabetic patients compared to control significantly (P<0.001). Decreased sodium level was reported in type 2 diabetes by Masahito Imamish, 2000, American association, 2000 and Angelina Trujillo, 1989.

In type 2 diabetic condition, the sodium level was decreased because of sodium excreted in the urine and the plasma rennin activity increased the renal sodium excretion in combination with elevated blood pressure.

Serum sodium concentration is decreased because of the osmotic flux of water from the cell to intracellular space in the presence of hyperglycemias. Thus, sodium level was found to be decreased in diabetic patients.

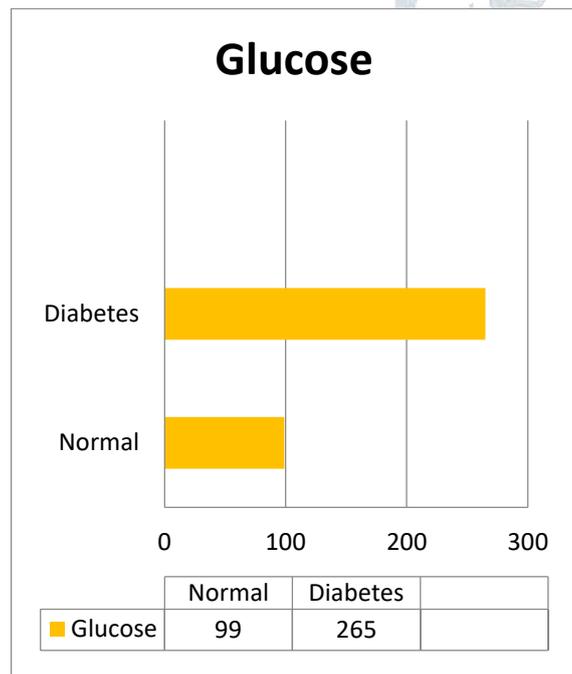
Potassium level was found to be increased in type 2 diabetic patients compared to control significantly (P<0.05). In the type 2 diabetic condition, the potassium concentration was elevated because of extracellular shifts of potassium caused by insulin deficiency action. The insulin is the major mediator of cellular uptake of potassium infused intravenously. In this type 2 diabetic condition the more insulin secreted but its biological response is less so the potassium concentration in the serum was increased.

Calcium level in controls and diabetic patients were shown in the following graph using mean and standard error values. In the type 2 diabetic conditions the calcium level was decreased. The PTH has three major independent sites of action like bone, kidney and intestine. It restored normal extracellular fluid calcium concentration by acting indirectly on the intestinal mucosa. All the three action of PTH, decrease serum calcium

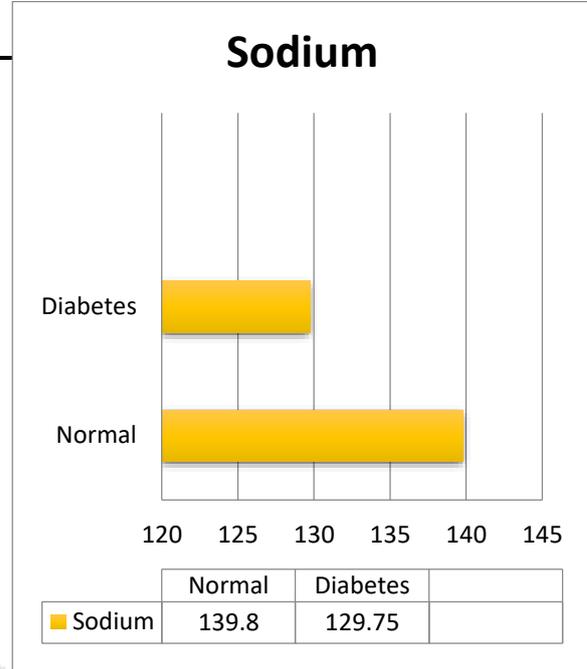
Chloride levels found to be decreased in type 2 diabetic patients compared too significantly(P<0.001). Decreased calcium level was reported in type 2 diabetes by onyesom I, 2006. Chloride level in control and diabetic patients were depicted in the following graph using mean and standard error values. In type 2 diabetes condition, the serum chloride concentration was decreased because increased excretion of urine (polyuria) along with sodium. In the hyponatremia condition the sodium and chloride concentration in the serum is low.

Phosphate levels was found to be elevated in type 2 diabetic patient compared to control significantly (P<0.001). Increased phosphate level in type 2 diabetes was reported by Ralph A Defronzo, 1975. In the 2 diabetic condition, the serum phosphorus concentration was increased. Generally, phosphate utilized for bone and teeth formation but metabolically, it is used for enzyme activity regulation and glucose utilization as glucose phosphate.

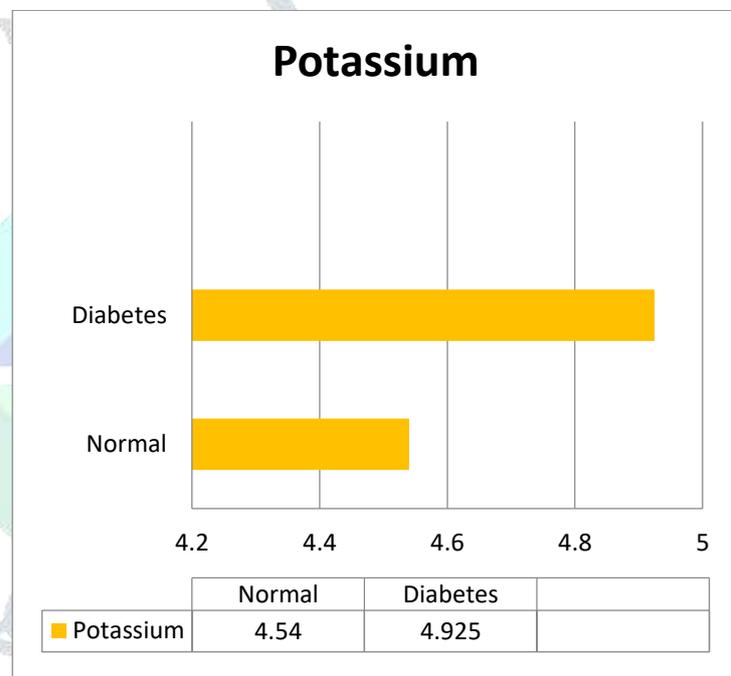
**Table 3** shows that glucose level was significantly increased (P<0.05) in type 2 diabetes mellitus when compared with controls. In type 2 diabetic condition, plasma insulin levels were increased but there biological action of insulin was decreased. This condition known as insulin resistance. The Beta cell responds to the insulin resistance by secreting increased quantities of insulin and in order to reduce blood glucose levels but it is unable to reduce glucose. Thus it is responsible for the elevation of glucose type 2 dibetes.



**Figure:1.** Glucose concentration in diabetes and normal



**Figure:2.** Sodium levels in diabetes and normal



**Figure:3.** Potassium levels in diabetes and normal

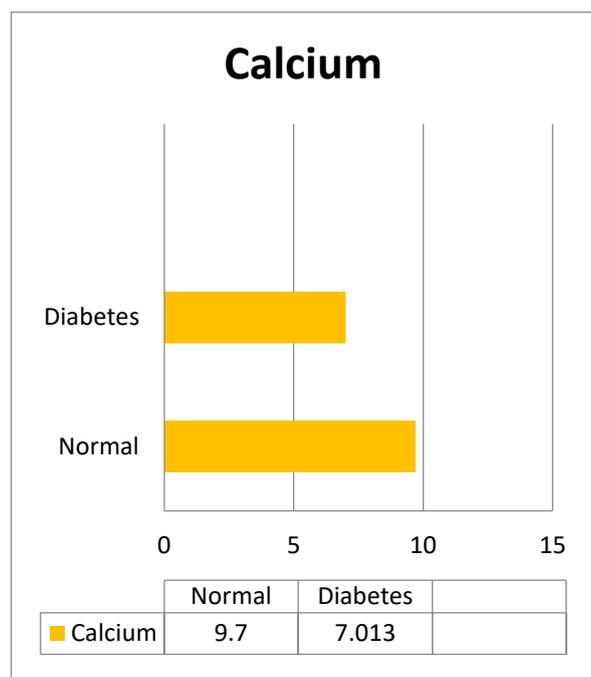


Figure:4. Levels of calcium in diabetes and normal

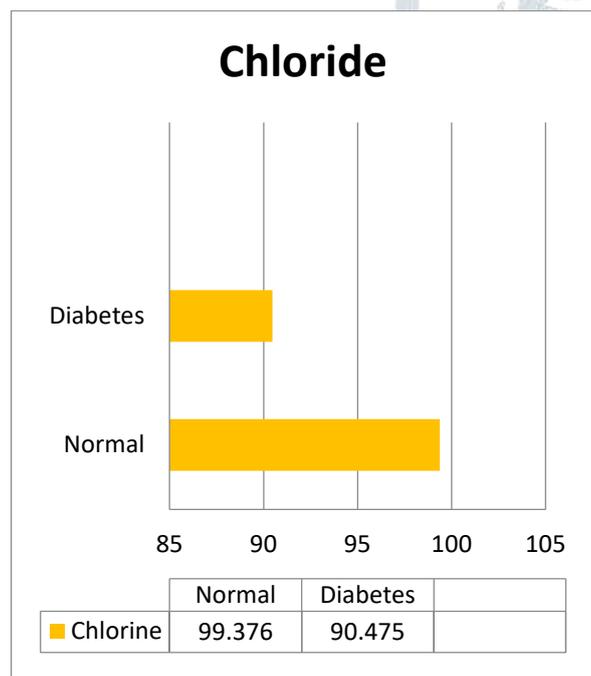


Figure:5. Chloride level in diabetes and normal

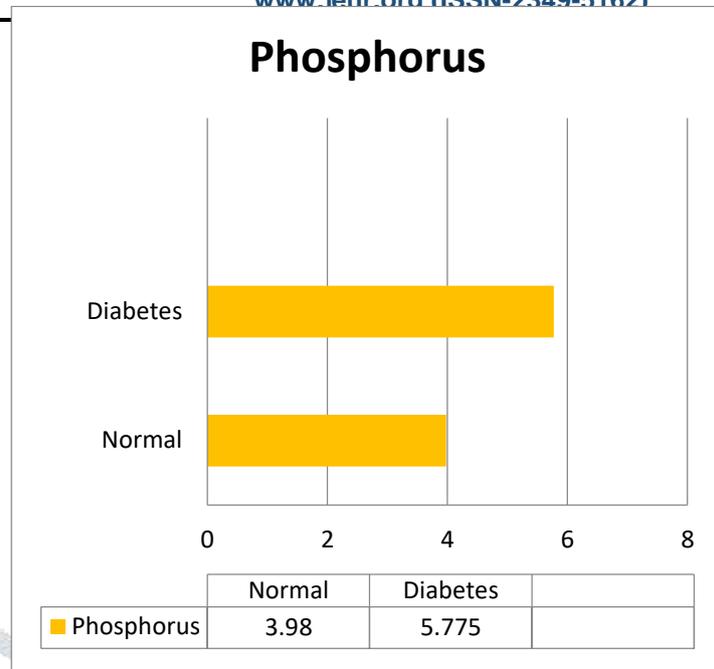


Figure:6. Level of Phosphorus in diabetes and normal

**CONCLUSION**

In our present study, cholesterol reported that high concentration of serum cholesterol in diabetes may be attributed to decreased muscular exercise or inhibition of cholesterol catabolism. The type 2 diabetic mellitus may leads to various secondary complication especially cardio vascular disease in which cholesterol deposits in blood vessels Similarly, triglycerides suggested that the mobilization of fatty acid from adipose tissue causes increased conversion of those fatty acids to triglycerides which cause triglyceridemia.

In this study, sodium level was decreased because of sodium excreted in the urine and the plasma rennin activity increased the renal sodium excretion in combination with elevated blood pressure. It restored normal extracellular fluid calcium concentration by acting indirectly on the intestinal mucosa. Hence, calcium level is diminished due the maturity problem, the lack of action of PTH secretion.

In the type 2 diabetic patients, the potassium concentration was elevated because of extracellular shifts of potassium caused by insulin deficiency action. Likewise, the serum phosphorus concentration were also increased. Generally, phosphate utilized for bone and teeth formation but metabolically, it is used for enzyme activity regulation and glucose utilization as glucose phosphate.

The basic metabolic parameter of glucose were carried out in this study. Glucose level was elevated in type 2 diabetes because of insulin resistance, obesity and few gene regulation.

Thus, in the present study we have demonstrated a significantly altered concentration of lipids and macro minerals in serum diabetic patients as compared to normal subjects. Therefore it is concluded that the levels of lipids and macro minerals have to be greatly government in type 2 diabetes mellitus which may avoid secondary complications.

## REFERENCES

1. Abdul-Ghani, M. A., Tripathy, D. & DeFronzo, R. A. Contributions of  $\beta$ -cell dysfunction and insulin resistance to the pathogenesis of impaired glucose tolerance and impaired fasting glucose. *Diabetes Care* **29**, 1130–1139 (2006).
2. Gardner, D. S. & Tai, E. S. Clinical features and treatment of maturity onset diabetes of the young (MODY). *Diabetes. Metab. Syndr. Obes.* **5**, 101–108 (2012).
3. Ruchi Mathur and William C Shiel, 2007. Diabetes Mellitus. *Medicine Net.com*. [http://www.medicinenet.com/diabetes\\_mellitus/article.htm](http://www.medicinenet.com/diabetes_mellitus/article.htm). (World Wide Web Resource)
4. Cholesterol and Diabetes” Supplement, Diabetes Forecast May 2006, American Diabetes Association. 1-800--DIABETES
5. Richard Donnelly and Karl R Davis, 2000. Type 2 diabetes and atherosclerosis. *Diabetes, Obesity and Metabolism*. 2 (suppl.1):S21-S30.
6. Chetan P Hans, R Saily and Devi D Bansal, 2002. Magnesium deficiency and diabetes mellitus. *Current science*. 83(12): 1456-1462.
7. P Dhindsa, A R Scott and R Donnelly, 2003. Metabolic and Cardiovascular effects of very-low-calorie diet therapy in obese patients with Type 2 diabetes in Secondary failure: Outcomes after 1 year. *Diabetic Medicine*. 20:319-324.
8. Z Hekimsoy and I K Oktem, 2003. Duration of obesity is not a risk factor for type 2 diabetes mellitus, arterial hypertension and hyperlipidemia. *Diabetes, Obesity and Metabolism*. 2:432-437.
9. J W Chu, F Abbasi, T L MC Laughlin, P Schaaf, T H Carlson, and G M Reaven, 2003. Lipoprotein risk factors for cardiovascular disease in patients with type 2 Diabetes mellitus treated with oral anti hyperglycaemic agents. *Diabetes, Obesity and Metabolism*. 5:333-337
10. H Ishil, F Umeda, T Hashimoto and H Nawata, 2004. Increased intracellular calcium mobilization in platelets from patients with type 2 diabetes mellitus. *Dibetologia*. 34(5): 332-336.
11. C J Bailey, 2005. Treating insulin resistance in type 2 diabetes with metformin and thiazolidine diones. *Diabetes, obesity and Metabolism*. 7:675-691.
12. Gerstein, H. C. *et al.* Annual incidence and relative risk of diabetes in people with various categories of dysglycemia: a systematic overview and meta-analysis of prospective studies. *Diabetes Res. Clin. Pract.* **78**, 305–312 (2007).