ORIGINAL ARTICLE

# Serum Lipid Profile, Serum Magnesium and Fasting Serum Glucose in Newly Diagnosed Type 2 Diabetic Subjects

R Karim[1], W Nargis[1], KA Begum[2], SS Subhan[3], *MN Uddin*[3]

*[1]Dept of Biochemistry, Uttara Adhunik Medical College, Uttara, Dhaka*
*[2]Dept of Biochemistry, Bangladesh Medical College, Dhanmondi, Dhaka*
*[3]Dept of Biochemistry, National Institute of Cardiovascular Diseases (NICVD), Dhaka*

ABSTRACT

Type 2 diabetes is considered as a major health burden due to its rising prevalence and disabling, life threatening complications. Dyslipidemia, often coexisting with T2DM as a feature of insulin resistance, is hypothesized to be linked with altered magnesium homeostasis. This study was designed to evaluate the serum magnesium levels and its influence on serum lipids in type 2 diabetics. Lipid profile, serum magnesium (Mg) and fasting serum glucose (FSG) were measured in 30 newly diagnosed normotensive type 2 diabetic patients chosen as cases (Group II) just before introducing any treatment, and was compared with that of 30 healthy controls (Group I). The serum magnesium was found to be significantly lower ($p < 0.001$) and LDL-c was found to be significantly higher ($p < 0.01$) in cases. The correlation analysis revealed a significant negative association of FSG to serum magnesium ($r = -0.720$), total cholesterol ($r = -0.483$) and a positive correlation to HDL-c ($r = -0.440$). However, serum magnesium showed a significant positive relation only with serum HDL-c ($r = 0.372$, $p < 0.05$). Serum magnesium and lipid fractions showed wide range of variation within the normal reference ranges in the newly diagnosed T2D subjects. Further large scale studies are needed to elucidate the association of serum magnesium with lipid profile changes. Estimation of serum magnesium level may prove useful in T2DM with normal or abnormal lipid levels or in those who are prone to develop dyslipidemia or certain complications associated with dyslipidemia.

**Key words:** Lipid Profile, Type 2 Diabetes, Serum Magnesium, Fasting Serum Glucose

## Introduction

Diabetes Mellitus (DM) is now recognized as a global health challenge of the 21st century. The highest percentages of increases in diabetic prevalence are reported to be in developing nations, like that of South-East Asia regions[1]. Several small-scale population based studies conducted in Bangladesh have revealed an increasing trend of diabetes prevalence both in rural and urban communities[2-7]. A recent rural population based study[5] showed higher prevalence of diabetes (7.2%) and of impaired glucose regulation [both impaired glucose tolerance (IGT) and/or impaired fasting glucose (IFG)] (6.5%) compared to that of previous studies[2-4]. However, this resembles the reports of prevalence (T2DM 8.1% - 11.2% and IFG 5.9%) in other urban population based studies conducted at different points of time[6,7].

The diabetes associated complications are major stimuli for the enhancement of efforts towards its control. Of all the types, Type 2 diabetes is the most prevalent (85-90%) one which usually remains asymptomatic for a long time and in practice, is often presented with a significant number of complications associated with it[8].

Dyslipidemia is frequently found in type T2DM as a feature of insulin resistance syndrome; one of the key elements of pathogenesis in T2DM. Moreover, this plays an important role in the development of atherosclerosis resulting in macrovascular complications (coronary heart disease) which is the leading cause of mortality and morbidity in diabetic subjects[8,9].

Different reports suggest that diabetes mellitus is also associated with disturbances in electrolyte metabolism. In patients with high fasting glucose, $Na^+$ and $Mg^{2+}$ tend to be lower while $K^+$ is higher. Among the three parameters, only serum $Mg^{2+}$ significantly correlate with the level of hemoglobin $A_{1C}$ and thus may be related to long-term control of diabetes. Hypomagnesemia may worsen insulin resistance. The kidneys possibly lose their ability to retain magnesium during periods of severe hyperglycemia. The increased loss of magnesium in urine may then result in lower blood levels of magnesium[10]. Thus, magnesium depletion and insulin resistance result in a vicious cycle of worsening insulin resistance and decrease in intracellular $Mg^{2+}$ which limits the role of magnesium in vital cellular processes[10,11].

Among the clinical variables, poor glycemic control, prolonged duration, and coexisting hypertension have been proven as the potential predictors of dyslipidemia in T2DM[12]. However, recent studies have shown association of low serum magnesium with dyslipidemia in T2DM[13-16]. A number of studies have also reported beneficial effects of magnesium supplementation on lowering plasma total cholesterol and LDLc and an increase of HDLc level[17,18]. However, the number of such studies correlating all these parameters in DM patients in our country is limited and often underreported. Considering the above facts and the increasing prevalence of DM in Bangladesh, the present study was conducted with an objective to evaluate the serum magnesium, fasting sugar and lipid profile in T2DM cases and to compare them with those of controls and to correlate them, with other parameters.

## Materials and Methods

In the present study, 30 newly detected normotensive T2DM subjects, never treated with any hypoglycemic, anti-hypertensive or lipid lowering drugs, aged between 20 to 30 years were selected as untreated new cases (Group II). Age-and gender-matched 30 healthy subjects (healthy relatives or unrelated attendants of patients with normal blood glucose) having no family history of diabetes up to second generations were chosen as control (Group I). All the subjects were selected purposively from the outpatient department of BIRDEM.

All the biochemical tests were done in the Department of Cell and Molecular Biology, BIRDEM following standard methods and procedures[5]. Blood glucose level was measured by Glucose Oxidase method and serum $Mg^{2+}$ by Ion Sensitive Electrode Method by using NOVA-8 analyzer. Plasma lipids were measured by enzymatic-colorimetric methods. The high density lipoprotein cholesterol (HDL-c) was measured by phosphotungstic-precipitation methods. The low density lipoprotein cholesterol (LDL-c) was calculated by the Friedewald's equation[14], given that none had TG level above 400 mg/dl. TG concentration of $>400$ mg/dl were excluded from the study. Besides, subjects taking medications known to affect lipid profile, or patients with known endocrinopathies, osmotic symptoms, history of ketosis, weight loss of $>3$ kg in preceding 3 months, microvascular complications, recent ($<1$ year) MI, acute coronary syndrome, stroke, severe co-morbid diseases (cancer and renal failure), alcohol consumption, or any other known major illness; liver disease, ALT $>3$ times normal were excluded. After obtaining informed consent, a detailed sociodemographic data, family history of diseases and medical history were recorded. Physical and clinical examinations were done on the very first day of visit and recorded in a predesigned questionnaire.

Data were expressed as Mean $\pm$ SD. Statistical

comparisons between different groups were made using t-test, and correlation co-efficient was calculated to determine the association between said variables. All the data were compiled and analyzed with SPSS 12.0. A p value $<0.05$ was considered as significant.

## Results

The new untreated T2DM cases had significantly higher ($p<0.001$) mean fasting serum glucose (14.86 $\pm$ 5.0 mmol/l) than that of the controls (4.23 $\pm$ 0.67 mmol/l). Statistical analysis showed significant difference of serum magnesium ($p<0.001$) and LDL-c ($p<0.01$) between the study groups (Table-I).

**Table-I:** Comparison of serum magnesium and lipid profile between the study groups.

| Groups(n) | $Mg^{2+}$ (mmol/l) | TG (mg/dl) | TC (mg/dl) | HDL-c (mg/dl) | LDL-c (mg/dl) |
|---|---|---|---|---|---|
| I (30) | 0.58 ±0.04 | 83± 22 | 141± 37 | 36± 4 | 87± 38 |
| II(30) | 0.44±0.08* | 74± 26 | 150± 40 | 34± 5 | 114± 37** |
| p values | 0.0001 | 0.153 | 0.369 | 0.092 | 0.007 |

*Difference between groups was calculated by students unpaired't' test. (* & **) superscript in each column indicate significance difference at level p value <0.001 & <0.01, respectively. Group I: controls; Group II: newly diagnosed untreated diabetic patients.*

Correlation analysis registered no significant association of FSG to serum magnesium or lipid profile in control, but for the diabetic cases FSG showed significant negative correlation with serum $Mg^{2+}$ and total cholesterol (-0.720, -0.483; p = 0.0001& 0.007, respectively) as well as a positive relation with HDL Cholesterol (r = 0.440,p = 0.015). Similarly serum $Mg^{2+}$ depicted significant association in diabetic group where serum $Mg^{2+}$ was positively related to serum HDL-c (r =0.372, p = 0.042) only (Figure-1).

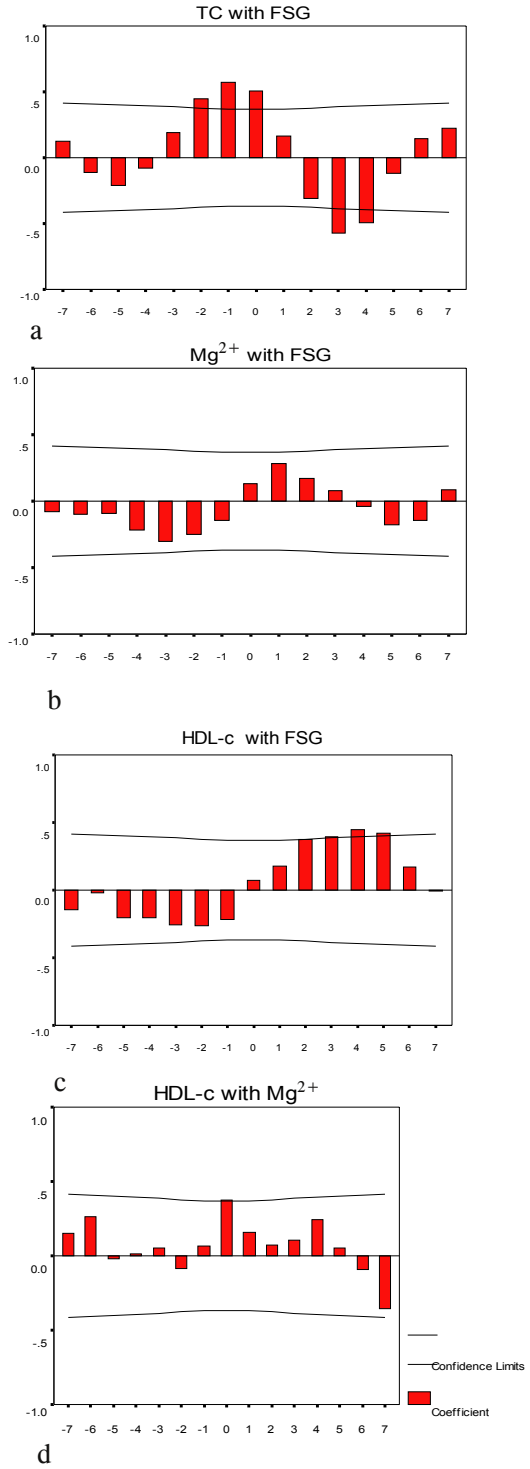


**Figure-1:** Cross correlations of fasting serum glucose, serum $Mg^{2+}$ and lipid levels (a, b, c, d) in newly diagnosed T2DM cases.

## Discussion

In this study different values have been noticed in lipid parameters between the two groups, but within the normal reference ranges. The major lipid profile fractions; total cholesterol, triglyceride and LDL-c are considered desirable or normal up to 200 mg/dl, 150 mg/dl and 100 mg/dl respectively and HDL-c > 40 mg/dl for male and > 50 mg/dl for female is considered low or abnormal[19,20]. The mean values of TG and total cholesterol in both study groups were close to these reference limits. However, the mean LDL-c was significantly higher in diabetic groups. The HDL-c was also found below the desired reference limit for both diabetic and healthy control groups with no statistically significant difference. These observations are consistent with a recent local study which revealed that most of the respondents had total cholesterol and triglyceride within normal limit but majority had abnormal LDL-c (about 60%) and HDL-c (82%) level[21]. There was a fall of serum magnesium below the lower reference limit (1.7 to 2.4 mmol/l) in both diabetics and controls[16]. However, there were no set of reference values for serum $Mg^{2+}$ or lipid fractions in Bangladeshi population for valid comparison. Serum $Mg^{2+}$ was also found to be significantly lower in diabetics than controls[13].

Fasting serum glucose (FSG) showed a significant inverse correlation to TC and a positive association with HDL-c in newly diagnosed cases of this study. But, a number of studies done to illustrate metabolic control of diabetes mellitus and serum lipid levels have shown just the opposite; positive relation with TC, LDL-c levels and negative relation with HDL-c[22,23]. Indeed, studies with controversial reports are available as well showing no such correlation with cholesterol[24,25].

One of the major findings of the present study was a significant inverse correlation of serum $Mg^{2+}$ with FSG and a direct association with HDL-c in diabetic subjects only, like most of the studies referred earlier[13-16]. Some of these have also showed the same in terms of FSG for controls as well[13]. Again, there is evidence of significant negative correlation with other lipid fractions in cases, but the observation differed from one another. Mishra et al[13] found a significant negative correlation of serum $Mg^{2+}$ with TG and VLDL-c and strong positive association ($p < 0.001$) with HDLc. There was also a negative relation to TC and LDL-c which was statistically insignificant. On the other hand, Nasri et al[14,15] showed significant inverse correlations of serum $Mg^{2+}$ with serum Total and LDL cholesterol, but non-significant correlations of serum $Mg^{2+}$ with serum Lp(a), HDL-c and TG. Another recent study simply compared serum $Mg^{2+}$ in T2DM with and without complications (mainly CAD) in contrast to a healthy control group revealing highly significant lower levels in complicated diabetic subjects[16]. Hence, despite of such controversies, it could be concluded that the lower levels of serum magnesium may have a bearing on the altered lipid levels even within the normal ranges.

This small scale study was undertaken to explore the level as well as interrelation of serum magnesium and the established common biochemical parameters namely lipid profile and fasting serum glucose in T2DM subjects. Depletion of serum $Mg^{2+}$ below the lower reference value was common for both healthy and the diabetic subjects with a highly significant statistical difference. Lower serum $Mg^{2+}$ level showed significant correlation with FSG and HDL-c in the newly diagnosed cases with no proven complications, which could be considered as a hidden link between the pathogenesis of diabetes and its progression towards certain complications. Large scale population based studies are necessary for further clarification of the facts. Meanwhile, estimation of serum $Mg^{2+}$ might be added to the routine biochemical monitoring along with lipid profile in T2DM subjects from the very first day of their diagnosis.

## References

1. Wild S, Roglic G, Green A, et al. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. **Diabetes Care** 2004; **27:** 1047-53.
2. Hussain A, Vaaler S, Sayeed MA, et al. Type 2 diabetes and impaired fasting blood glucose in rural Bangladesh: a population based study. **Eur J Public Health** 2007; **17:** 291-6.

3. Rahim MA, Hussain A, Khan AKA, et al. Rising prevalence of type 2 diabetes in rural Bangladesh: A population based study. **Diabetes Res Clin Pract** 2007; **77:** 300-5.

4. Hussain A, Rahim MA, Khan AKA. Type 2 diabetes in rural and urban population: diverse prevalence and associated risk factors in Bangladesh. **Diabet Med** 2005; **22:** 931-6.

5. Akhter A, Fatema K, Afroz A, Bhowmik B, Ali L, Hussain A. Prevalence of Diabetes Mellitus and its Associated Risk Indicators in a Rural Bangladeshi Population. **The Open Diabetes Journal** 2011; **4:** 6-13.

6. Sayeed MA, Mahtab H, Khanam PA, Latif ZA, Banu A, Khan AK. Prevalence of diabetes and impaired fasting glucose in urban population of Bangladesh. **Bangladesh Med Res Counc Bull** 2007; **33:** 1-12.

7. Rahim MA, Vaaler S, Keramat Ali SM, Khan AK, Hussain A, Nahar Q. Prevalence of type 2 diabetes in urban slums of Dhaka, Bangladesh. **Bangladesh Med Res Counc Bull** 2004; **30:** 60-70.

8. Alvin CP. Harrison's Principles of Internal Medicine.17th Edition. McGraw-Hill; 2008.

9. Chehade JM, Gladysz M, Mooradian AD. Dyslipidemia in type 2 diabetes: prevalence, pathophysiology, and management. **Drugs** 2013; **73:** 327-39.

10. Institute of Medicine. Food and Nutrition Board. Dietary Reference Intakes: Calcium, Phosphorus, Magnesium, Vitamin D and Fluoride. National Academy Press. Washington DC, 1999.

11. Hua, H: Gonzales, J: Rude, R K. Magnesium transport induced ex vivo by a pharmacological dose of insulin is impaired in non-insulin-dependent diabetes mellitus. **Magnes Res** 1995; **8:** 359-66.

12. Karim MN, Ahmed KR, Bukht MS, Akter J, Chowdhury HA, Hossain S, Anwar N, Selim S, Chowdhury SH, Hossain F, Ali L. Pattern and predictors of dyslipidemia in patients with type 2 diabetes mellitus. **Diabetes Metab Syndr** 2013; **7:** 95-100.

13. Mishra S, Padmanaban P, Deepti G N, Sarkar G, Sumathi S, Toora B D. Serum Magnesium and Dyslipidemia in Type-2 Diabetes Mellitus. **Biomed Res** 2012; **23:** 295-300.

14. Nasri H, Baradaran H R. Lipid in association with serum magnesium in diabetes mellitus patients. **Bratisl Lek Listy** 2008; **109:** 302-306.

15. Nasri H, Baradaran A. Correlation of serum magnesium with dyslipidemia in maintenance hemodialysis patients. **Acta medica** 2004; **47:** 263-265.

16. Baig M S A, Shamshuddin M, Mahadevappa K L, Attar A H, Shaikh A K. Serum Magnesium as a Marker of Diabetic Complications. **J Evol Med Dent Sci** 2012; **1:** 119-123

17. Yokota K, Kato M, Lister F, et al. Clinical efficacy of magnesium supplementation in patients with type 2 diabetes. **J Am Coll Nutr** 2004; **23:** 506S-9S.

18. Lal J, Vasudev K, Kela AK, Jain SK. Effect of oral magnesium supplementation on the lipid profile and blood glucose of patients with type 2 diabetes mellitus. **J Assoc Physicians India** 2003; **51:** 37-42.

19. B. Jan. Analyzing the National Cholesterol Education Program Adult Treatment Panel III Report: Its New Better? **J Clin Hypertens** 2001; **3:** 292-295.

20. Third report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation and treatment of High Blood Cholesterol in Adults (Final report). **National Institute of Health Publication** 2002. No. 02-5215.

21. Elham N and Flora M S. Pattern Of Lipid Profile Among Type 2 Diabetic Patients. **Ibrahim Med Coll J** 2012; **6:** 12-17.

22. Ahmed N, Khan J and Siddiqui TS. Frequency of dyslipidaemia in type 2 diabetes mellitus in patients of Hazara division. **J Ayub Med coll Abbottabad** 2008; **20:** 51-54.

23. Habit SS, Aslam M: Risk factor, knowledge and health status in diabetic patients. **Saudi Med J** 2003; **24:** 1219-1224.

24. Parmar D, Sakariya K, Vidja K, Mehta N, Kakaiya M. A Correlation between Dyslipidaemia and Glycaemic Control in Type 2 Diabetic Patients. **NJIRM** 2012; **3:** 46-48.

25. Sert M, Morgul G, Tetiker BT. Diabetic dyslipidemia is a well-known issue, but what about lipoprotein a levels in Type 2 diabetics? **Int J Diabetes Metab** 2010; **18:** 81-87.