

# The Role of Magnesium in the Management of Type 2 Diabetes Mellitus

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**Abstract:** Background: The sugar is broken down and enters the digestive system and forms glucose. It enters the blood stream and causes increasing in blood glucose levels. Insulin is the hormone produced by the pancreas that regulates the blood glucose levels. When glucose molecules are high, these molecules leave the blood and enter the beta cell in the pancreas. Blood glucose levels are decreased and taken up by the liver cells and other body cells as a result less and less insulin is released by the pancreas and blood glucose levels become normal. Material and methods: The present study was carried out in the south Indian population at Father Muller Medical College, among 150 recently diagnosed type 2 diabetes mellitus patients aged between 20 years and forty years. Permission was obtained from the Institutional ethics committee. The patients were included who attended the department of internal medicine, history of the patients was obtained before including into the study. Blood samples for glucose, insulin, HDL and haemoglobin A1c estimation were collected after 10–12 h fast before and after the study. A random sample was also collected for glucose estimation. Blood glucose and HDL were analyzed by semi autoanalyser. Serum fasting insulin level was assayed by ELISA method (GenxBio). HbA1c was done by HPLC method. Results: There was increased blood glucose observed in the diabetic patients before supplementation of magnesium. After supplementation of magnesium to diabetic patients for 14 weeks, there was a drastic reduction in the blood glucose levels compared to the patients before magnesium supplementation which was statistically significant ( $p < 0.001$ ). Similarly, in the case of HDL, there was an increase in the diabetic patients before supplementation of magnesium. After supplementation of magnesium to diabetic patients for 14 weeks, there was an improvement in good cholesterol levels compared to the patients before magnesium supplementation which was statistically significant ( $p < 0.003$ ). There was decreased insulin in the diabetic patients before supplementation of magnesium. After supplementation of magnesium to diabetic patients for 14 weeks, there was an increase in insulin levels compared to the patients before magnesium supplementation which was statistically significant ( $p < 0.004$ ). Similarly, in the case of HbA1c, there was an increase in the diabetic patients before supplementation of magnesium. After supplementation of magnesium to diabetic patients for 14 weeks, there was a reduction in HbA1c levels compared to the patients before magnesium supplementation which was statistically significant ( $p < 0.005$ ). Conclusion: Type 2 diabetes, which involves loss of insulin and leptin sensitivity, is easily preventable and nearly 100 percent reversible without drugs. However, preventing this disease requires a multi-faceted approach. Getting adequate magnesium is just one part of the formula. Other critical lifestyle factors include exercise and optimizing gut flora.

**Keywords:** Diabetes; Magnesium; Insulin; glucose; antidiabetic drugs

## 1. Introduction

The sugar is broken down and enters the digestive system and forms glucose. It enters the blood stream and causes increasing in blood glucose levels (1). The various mechanisms that have brought down the blood glucose level to normal set point are examples of homeostasis. The body's tendency to maintain relatively constant internal conditions. Insulin is the hormone produced by the pancreas that regulates the blood glucose levels. When glucose molecules are high, these molecules leave the blood and enter the beta cell in the pancreas. The beta cell responds by releasing the hormone insulin. Insulin enters the blood stream and is transported to all over the body. In the case of liver, insulin binds to liver cells, causing them to take up more glucose. Inside the liver cells, glucose is converted to glycogen, a storage molecule. Blood glucose levels are decreased and taken up by the liver cells and other body cells as a result less and less insulin is released by the pancreas and blood glucose levels become normal. In the case of fasting condition, blood glucose levels are low. The alpha cells present in the pancreas release the hormone glucagon and it enters the blood stream and acts on the target cells in the liver. Glucagon binds to receptors on the liver cells which in turn break down glycogen to glucose. It increases the blood glucose levels as a result less glucagon is released by the pancreas. In this way, two hormones posing opposite effects allow the body to maintain homeostasis of glucose levels. In diabetes

the body is unable to maintain homeostasis of blood glucose levels. There are two types of diabetes. In type-1 diabetes, beta cells of the pancreas are destroyed by the immune system which results in less insulin production. In type-2, the pancreas produces glucose and target cells do not take up glucose. In both types of diabetes, when blood glucose levels are high, cells do not take up additional glucose and blood glucose remains high. According to the American Diabetes Association, there were 415 million cases of diabetes in the year 2015 and it is expected to rise to 645 million cases worldwide by 2040 (2). In the current scenario, one in eleven adults has diabetes and it may increase to 1 in 10 adults by 2040. Diabetes increases the risk of many serious health problems. Treating it at the right time can correct/stabilize the disease. Non-pharmacological approaches include recommended lifestyle changes; patients can also be able to prevent or delay the onset of complications. Complications include foot, neuropathy, stroke, high blood pressure and kidney disease. Recent studies have shown that magnesium has a role in glucose management. Magnesium increases insulin secretion thereby lowering glucose levels (3). There were also beneficial effects including increasing good cholesterol levels and decreasing inflammation. Previous studies showed that supplementation resulted in a modest reduction in fasting sugar levels and an increase in good cholesterol levels. Beneficial effects were shown in 15% of previously diagnosed diabetes patients (4). Magnesium is a mineral required for many enzymes in

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the body which helps to hydrolyse protein to carbohydrate in the body, important to keep blood sugar balance, acts as natural statin in the body and its necessary in the nerve cell to nerve cell to create movement. Magnesium is antagonise the calcium, whenever there is less magnesium in the body calcium takes upper hand. Magnesium relaxes muscle and calcium tighten the muscle. Deficiency of magnesium it can lead heart attack. Thus, the present study was investigated the role of magnesium in maintaining sugar balance.

## 2. Material and Methods

The present study was carried out in south Indian population at Father Muller Medical College, among 150 recently diagnosed type 2 diabetes mellitus patients aged between 20 years and forty age. American Diabetes Association criteria were followed throughout study period. This study was conducted after obtaining approval from Institutional Ethics Committee at Father MullersMedical College. The patients were included who attended to department of the internal medicine, history of the patients were obtained before including into study. Inclusion criteria included diabetes treatment with either diet alone or any combination of oral antidiabetic agents. Exclusion criteria includes- patients with hypothyroidism, patients suffering from chronic inflammatory diseases and infections, liver disease, nephritis, CVS problem, abdominal hernias, tumour and pregnant ladies. Informed concerned was obtained from all

the patients before including into study. Supplementation of magnesium (100mg/day) for 14 weeks.

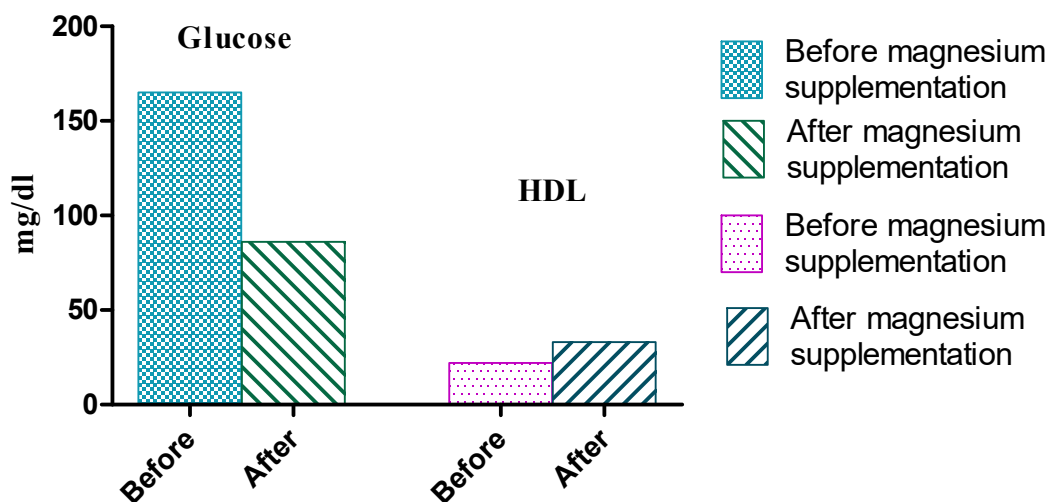
Blood samples for glucose, insulin, HDL and haemoglobin A1cestimation were collected after 10–12 h fast before and after the study. A random sample was also collected for glucose estimation. Blood glucose and HDL were analysiswas performed by semi autoanalyser. Serum fasting insulin level was assayed by ELISA method (GenxBio).HbA1c done by HPLC method.

The date represents mean±SD. Analysis of variance (ANOVA) was used to perform the results. Statistical analysis was done using Statistical Package for Social Sciences (SPSS).

## 3. Results

**Table 1:** Table showing fasting blood glucose and HDL levels in type 2 diabetic patients

Parameters	Before magnesium supplementation	After magnesium supplementation	P value
Blood glucose (mg/dl)	165±4	86±3	0.001
High density lipoprotein (mg/dl)	38±2	60±3	0.003



**Figure 2:** Graphical representation of glucose and HDL levels in type 2 diabetic patients compared to the patients before magnesium supplementation which was showed statistically significant ( $p < 0.003$ ).

There was increased blood glucose was observed in the diabetic patients before supplementation of magnesium. After supplementation of magnesium to diabetic patients for 14 week, there was drastic reduction on the blood glucose levels compared to the patients before magnesium supplementation which was showed statistically significant ( $p < 0.001$ ).

Similarly in the case of HDL was showed less in the diabetic patients before supplementation of magnesium. After supplementation of magnesium to diabetic patients for 14 week, there was improvement in good cholesterol levels

**Table 2:** Table showing insulin and HbA1c levels in type 2 diabetic patients

Parameters	Before magnesium supplementation	After magnesium supplementation	P value
Blood insulin (mIU/l)	22±2	33±2	0.004
Haemoglobin A1c (millimoles/M)	50±3	40±1	0.005

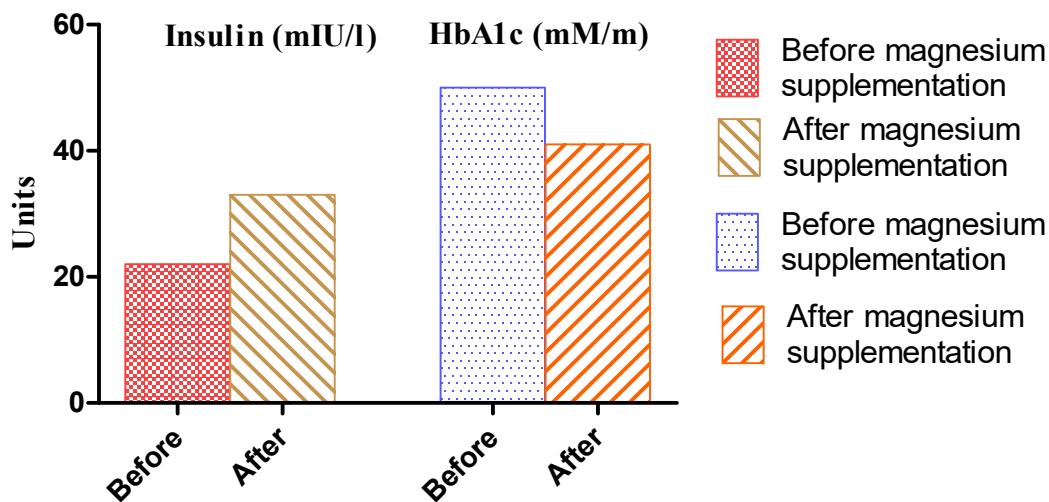


Figure 2: Graphical representation of Insulin and HbA1c levels in diabetic patients

There was decreased insulin was observed in the diabetic patients before supplementation of magnesium. After supplementation of magnesium to diabetic patients for 14 week, there was increased insulin levels compared to the patients before magnesium supplementation which was showed statistically significant ( $p < 0.004$ ).

Similarly in the case of HbA1c was showed more in the diabetic patients before supplementation of magnesium. After supplementation of magnesium to diabetic patients for 14 week, there was reduction in HbA1c levels compared to the patients before magnesium supplementation which was showed statistically significant ( $p < 0.005$ ).

#### 4. Discussion

Magnesium is the fourth most abundant mineral in the body. Insufficientmagnesium level of leads to cellular damage and deterioration of proper metabolic function that typically snowballs into more significant health problems. Previous study reported to have now detected 3,751 magnesium-binding sites on human proteins, reflecting how important this mineral is to a great many biological processes (5). Magnesium plays a role in detoxification processes and therefore is important for minimizing damage from environmental chemicals, heavy metals, and other toxins.

It also plays roles in preventing migraine headaches, cardiovascular disease include heart attack, blood pressure, stroke and sudden cardiac arrest reduces all these causes.

One of the study in the year 2013 involving pre-diabetics found that most had inadequate magnesium intake. Those with the highest magnesium intake reduced their risk for blood sugar and metabolic problems by 71 percent (6). In the present also showed similar type of results in consistent with previous report. Earlier work by grel et al found that higher magnesium intake reduces risk of impaired glucose and insulin metabolism and slows progression from pre-diabetes to diabetes in middle-aged Americans (7). Researchers stated, "Magnesium intake may be particularly beneficial in offsetting risk of developing diabetes.

In a large Japanese study published in *Diabetic Medicine* December 2013, researchers found magnesium intake was a significant protective factor against type 2 diabetes in the general Japanese population, especially among those "with insulin resistance, low-grade inflammation and a drinking habit (8). In the present data also showed improvement in the glucose levels. This could be the mechanism by which magnesium controls glucose and insulin homeostasis appears to involve two genes responsible for magnesium homeostasis. It is well known that people with insulin resistance also experience increased excretion of magnesium in their urine, which further contributes to diminished magnesium levels. This magnesium loss appears to be secondary to increased urinary glucose, which increases urinary output.

Therefore, inadequate magnesium intake seems to prompt a vicious cycle of low magnesium levels, elevated insulin and glucose levels, and excess magnesium excretion.

#### 5. Conclusion

Type 2 diabetes, which involves loss of insulin and leptin sensitivity, is easily preventable, and nearly 100 percent reversible without drugs. However, preventing this disease requires a multi-faceted approach. Getting adequate magnesium is just one part of the formula. Other critical lifestyle factors include exercise and optimizing gut flora.

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