



ORIGINAL ARTICLE

## To study the haemoglobin levels in patients with hypomagnesemia suffering from type 2 diabetes mellitus.

Syed Farhan Uddin<sup>1</sup>, Habib-ur-Rehman Chohan<sup>2</sup>, Naila Noor<sup>3</sup>, Kiran Waheed<sup>4</sup>, Jamshed Warsi<sup>5</sup>, Zulfiqar Laghari<sup>6</sup>

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**ABSTRACT... Objective:** To study the association of anemia with serum magnesium levels in diabetic type 2 patients. **Study Design:** Cross Sectional Retrospective study. **Setting:** Department of Physiology of Sindh University Jamshoro in collaboration with the Diabetic OPD of Liaquat University Hospital Hyderabad. **Period:** January 2022 to June 2022. **Methods:** The data size comprised 300 patients suffering from diabetes mellitus type 2. They were divided into two groups. The control group comprised of 160 type 2 DM patients with normal serum magnesium levels and the test group comprised of 140 patients with decreased serum magnesium levels. The serum magnesium level was determined by Roche C311 auto analyzer while the hemoglobin level was measured by Sahli's hemoglobinometer. **Results:** Type 2 Diabetic patients with normal serum magnesium level shows 18.75% decrease haemoglobin level while Type 2 Diabetic patients with hypomagnesemia showed 32.15% decrease in haemoglobin level. The P value was 0.01. The odds ratio was 2.05. **Conclusion:** Diabetes mellitus leads to hypomagnesemia and Hypomagnesemia produces anemia due to hemolysis.

**Key words:** Anemia, Diabetes Mellitus, Hypomagnesemia, Roche C3 Auto Analyzer.

### INTRODUCTION

As the level of stress, pollution, and food impurities increases, different diseases are rising. Diabetes mellitus is one of them. It is a multisystem disorder that causes damage to different organs of the body.<sup>1</sup> Based on its etiology, diabetes mellitus (DM) can be classified into three major categories, i.e., Type 1 DM, produced due to damage to beta cells of Langerhans, Type 2 DM, which originates because of the inability of peripheral receptors to respond to insulin, Gestational DM, which arises in pregnancy due to insulin resistance, and DM of other causes, usually endocrine in nature.<sup>2</sup> Recent researches have claimed that DM Type 2 may be produced by a deficiency of different minerals, and magnesium is among them. Excessive sugar consumption and decreased daily intake of different fruits lead to hypomagnesaemia, which may lead to DM Type 2.<sup>3</sup>

As DM is a multisystem and multifactorial

disorder, it may lead to cardiovascular accidents, myocardial infarction, neuropathies, and different kidney diseases.<sup>4</sup> The prevalence of DM is increasing globally. It is estimated that 463 million people were fighting against this global monster in 2019, and it would rise to 700 million people in 2045. It is a more common disorder that involves urban and more prosperous people than rural and lower-income people.<sup>5</sup>

Magnesium is abundant within the cell and is ranked second as the intracellular cation. It acts as a cofactor in 300 enzymatic reactions catalyzed by different kinases. It stabilizes the cell's integrity.<sup>6</sup> Magnesium has a unique role in glucose transport and metabolism.<sup>7</sup> Its deficiency leads to disturbance of the ATP enzyme system of the cell membrane, which is important for the transport of carbohydrate moiety inside the cell, leading to the production of Type 2 DM.<sup>8</sup> Magnesium deficiency affects the energy metabolism in the

1. MBBS, M.Phil, Associate Professor Physiology, Muhammad Medical College, Mirpurkhas.  
2. MBBS, M.Phil, Assistant Professor, Physiology, Muhammad Medical College Mirpurkhas.  
3. MBBS, M.Phil, Assistant Professor, Department of Physiology, Muhammad Medical College Mirpurkhas.  
4. MBBS, M.Phil, Assistant Professor, Department of Biochemistry, Indus Medical College, Tando Muhammad Khan.  
5. Ph.D, Professor Physiology, University of Sindh, Jamshoro.  
6. Ph.D, Professor Physiology, University of Sindh, Jamshoro.

**Correspondence Address:**  
Dr. Syed Farhan Uddin  
Department of Physiology  
Muhammad Medical College, Mirpurkhas.  
syedf4252@gmail.com

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cell membrane of red blood cells, leading to easy fragility and breakdown. This leads to a decrease in hemoglobin level and RBC count.<sup>9</sup> The normal serum concentration of magnesium ranges from 1.46 to 2.68 mg/dl. When the serum magnesium concentration falls below 1.46 mg/dl, it is called as Hypomagnesemia.<sup>10</sup>

Anemia is a disorder in which the hemoglobin concentration in the RBCs decreases, failing to meet the physiological demands of the human body.<sup>11</sup> Different studies have been conducted to find out the link between hypomagnesaemia and anemia. It is believed that there are multiple causes that lead to anemia, including hemolysis of RBCs, dysfunction of the endothelium, and intravascular inflammation.<sup>12</sup> World Health Organization (WHO) closely monitors the prevalence of anemia throughout the world. According to WHO, a serum hemoglobin level below 11 mg/dl is considered mild, and less than 7 mg/dl is considered the gross level of anemia.<sup>13</sup> Anemia has great implications for all the systems of the human body, including the cardiovascular, respiratory, musculoskeletal, and central nervous systems. A decreased hemoglobin level leads to easy fatigue ability.<sup>14</sup>

### **Rationale of the Study**

The rationale was to use the research from this study to revolutionize the treatment of diabetes mellitus type 2.

### **Aims and Objectives**

The current study set out to assess the relationship between anemia and type 2 diabetes caused by a change in serum magnesium levels.

### **METHODS**

This cross-sectional and retrospective study was conducted in the Department of Physiology of Sindh University Jamshoro in collaboration with the Diabetic OPD of Liaquat University Hospital Hyderabad from January 2022 to June 2022. A prerequisite ethical permission was granted by Sindh University Jamshoro via the letter No. Physiol/27 dated 10.03.2020. The sample size was comprised of 300 patients. Only those patients were selected who were suffering from type 2

diabetes mellitus and had an age limit between 45 and 65 years. Only male patients were selected. Patients with no present or past history related to any signs or symptoms of diabetic neuropathy were included. All participants were of similar socioeconomic status. HbA1c% levels were between 8.0% and 10.0%.

The exclusion criteria were: patients with type-1 diabetes mellitus, age below 45 years or above 65 years, any present or past history related to any signs and symptoms of diabetic neuropathy, retinopathy, or nephropathy, differences between the socioeconomic statuses of patients, like some belong to the very poor class, some belong to the middle class, or some belong to the upper socioeconomic class, and HbA1c% levels below 8.0% or above 10.0% of patients suffering from any other disease other than DM Type 2.

Before initiating blood sample collection, a routine clinical checkup was done, including blood pressure and temperature measurement. Their random sugar level was calculated through the Care Sense N glucometer. 4 ml of venous blood was collected aseptically from a prominent vein; 2 ml was transfused into a CP bottle containing anti-coagulant for haemoglobin estimation; and 2 ml was transfused into a plain bottle for serum magnesium estimation. The Roche C311 auto analyser was used to analyse serum magnesium levels, and Sahli's haemoglobinometer was used for haemoglobin estimation.

Serum magnesium concentration below 1.46 mg/dl was considered hypomagnesaemia<sup>10</sup> and a haemoglobin level below 12 g/dl was considered anaemia.<sup>13</sup>

### **Data Collection Procedure**

All the data collected during the study was incorporated in questionnaire Performa which was especially designed for this purpose

### **Data Analysis Procedure**

GraphPad Prism 9 was utilized for data analysis. Odd ratio and relative risk (RR) was performed. The P value was determined using Fischer's

exact test. P values less than .05 were regarded as significant.

### Ethical Consideration

- A prior permission was taken from the administration of OPD.
- Consent was taken from each participants prior to sample collection and their privacy was properly disguised.
- There was no conflict of interest.

### RESULTS

Type of Patients	Frequency	Percentage
Diabetes /Normal serum Magnesium	160(53.34%)	53.4%
Diabetes with Hypomagnesemia	140(46.66%)	46.6%
Total	300	100%

**Table-I. Sample size of the participants**

Table-I examines the frequency distribution of the patients. 160 (53.34%) patients had diabetes type 2 but their serum magnesium levels were normal; 140(46.66%) patients were diabetic type 2 and having low serum level of magnesium.

Table-II examines the association of hemoglobin level in diabetes with a normal serum magnesium levels versus diabetes with hypomagnesaemia. A significant association was found between hypomagnesaemia and decrease hemoglobin level (P value = 0.01, Odd ratio = 2.05, relative risk ratio = 1.19, like hood ratio = 1.44, sensitivity/specificity ratio = 0.57/0.60). Patients with hypo magnesia have 2.05% higher chances of developing anemia.

### DISCUSSION

Diabetes mellitus is a multi-system disorder that produces various complications in human body. There are many causes of this disease

including Insulin deficiency or resistance to its pharmacological action on peripheral receptors. Serum magnesium is closely associated with insulin action. Insulin deficiency causes hypomagnesemia and hypomagnesemia leads to insulin resistance at the peripheral receptors. so both are controlling each other on a vicious way.<sup>15</sup>

The current study results show that from the sample size of 300 participants, there were about 160 patients who were diabetic and also had hypomagnesemia. It also shows that patients with hypomagnesemia had decreased hemoglobin levels, which concludes that 32.15% of participants were suffering from a decrease in hemoglobin levels with statistical values that support these results. P value = 0.01, Odd ratio = 2.05, relative risk ratio = 1.19, like hood ratio = 1.44, sensitivity/specificity ratio = 0.57/0.60. These study results concur with the results of the study conducted by Smith et al. who also revealed the same results, but it was not clearly understood why diabetes type 2 causes Hypomagnesia. It was suggested that a decrease in magnesium levels would disturb the phosphorylation at the receptor site, which is most necessary for insulin function.<sup>16</sup> A similar study conducted by Anna H. et al. in 2023 revealed that patients suffering from hypomagnesemia also suffer from anemia.<sup>17</sup> The study conducted by Wu. et al also supports the hypothesis that hypomagnesemia leads to the development of diabetes mellitus in patients compared to the normal population.<sup>18</sup> Furthermore, another study conducted by Chen et al. also showed that the relationship between hypomagnesemia and low levels of hemoglobin in patients affected by diabetes mellitus is statistically significant with a p value of 0.001-0,002.<sup>19</sup>

Type of Patients	Normal Hb level	Decreased Hb level	Total	P Value	RR	Odd Ratio	Sensi/Speci	Like Hood Ratio
Diabetes /Normal serum Magnesium	130(81.25)	30(18.75%)	160(54%)	0.01	1.19	2.05	0.57/0.60	1.44
Diabetes with Hypomagnesemia	95(67.85%)	45(32.15%)	140(46%)					
Total	225(75%)	75(25%)	300(100%)					

**Table-II. Association of hemoglobin level in diabetes with normal serum magnesium level versus diabetes with hypomagnesaemia**

This close association between hypomagnesemia and anemia was also detected by Steef K in 2019, who found that a decrease in magnesium levels leads to a decrease in the production of RBCs from the bone marrow.<sup>20</sup> But there are also some studies that were conducted but shows no significant relationship between these parameters. A cohort study conducted by Patel et al. shows that there is no significant relationship between hypomagnesemia and low levels of haemoglobin in patients with diabetes mellitus, with a p value of 0.6.<sup>21</sup>

## CONCLUSION

It was concluded that diabetes mellitus produces hypomagnesaemia which in turn induces anemia.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.






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### AUTHORSHIP AND CONTRIBUTION DECLARATION

No.	Author(s) Full Name	Contribution to the paper	Author(s) Signature
1	Syed Farhan Uddin	Writing the paper.	
2	Habib-ur-Rehman Chohan	Data collection.	
3	Naila Noor	Statistical analysis.	
4	Kiran Waheed	Statistical analysis and experimentation.	
5	Jamshed Warsi	Data collection.	
6	Zulfiqar Laghari	Data analysis.	