Khalij-Libya Journal
of Dental and Medical Research
http://journals.khalijedental.com.ly/index.php/ojs/index eISSN:2708-888X

Original Article

Hypomagnesemia in Type II Diabetes

Rehab El-Megrabi*, Maryouma Aghil, Mariam Elahjal, Muna Elkouha, Ghada Amir, Hala Altuwati

Department of Medical Laboratory Sciences, Faculty of Medical Technology, The University of Tripoli, Libya
***Corresponding Email**: rehabalmegrbi@gmail.com*

ABSTRACT

***Background and aims**. Magnesium (Mg) is an important cofactor in a number of important enzymatic reaction and appears to play an important role in glucose metabolism and insulin homeostasis. There is a link between mg deficiency and type 2 diabetes. The present study was conducted to estimate serum mg levels in Type 2 Diabetes Mellitus (DM2) patients and to correlate these levels with pathogenesis. **Methods.** A total of 70 samples were collected from males and females aged from 20 to 80 years to compare the level of mg in each of them, and the samples were divided into two groups, group1 (n=40) for patients with type II diabetes and group2 (n=30) for healthy people. People with other chronic diseases such as hypertension, heart disease and thyroid disease were excluded. The percentage of mg was determined in the (Dimension RXL Max). **Results**. About 49 females out of 70 that represent 70% of our community whereas 21 males that represent 30 %. 30 of participants (42.9%) were non-diabetic (Health) while the other 40 participants (57.1%) were diabetic (patients). Although there was a negative correlation between the two variables, this difference was not significant (p =.238). **Conclusion**. Our research demonstrated an inverse relationship between magnesium levels and HbA1c in individuals with DM2. Our study adds to the existing evidence for this negative correlation, elucidating the intricate connections that give rise to this relationship. To obtain more precise results, future investigations conducted on a broader scale are imperative.*

Keywords. Type 2 Diabetes Mellitus, Magnesium, Glucose Metabolism, HbA1c

Citation: El-Megrabi R, Aghil M, Elahjal M, Elkouha M, Amir G, Altuwati H. Hypomagnesemia in Type II Diabetes. Khalij-Libya J Dent Med Res. *2023*;7(2):178–183. https://doi.org/10.47705/kjdmr.237216
Received: 23/11/23; **accepted:** 22/12/23; **published:** 27/12/23

INTRODUCTION

Magnesium (Mg) is an important cofactor in a number of important enzymatic reaction and appears to play an important role in glucose metabolism and insulin homeostasis. recently, various pieces of evidence point to a link between mg deficiency and type 2 diabetes [1]. Diabetes mellitus is classified based on the pathogenic process that leads to hyperglycaemia, there are two broad categories of diabetes mellitus, referred to as type 1 and type2. depending on the etiology of diabetes, factors contributing to hyperglycemia include decreased insulin secretion, increased glucose production, and decreased glucose utilization, the metabolic disorders associated with diabetes lead to pathophysiological changes in several organ systems. The association of hypomagnesemia with poor glycemic control and also with various long-term complications of diabetes mellitus has been reported, this study was conducted to evaluate the association of hypomagnesemia with glycaemic control [1,2]. The prevalence of hypomagnesemia in diabetes mellitus is 65% , persistent hypomagnesemia leads to elevated serum glucose levels and insulin resistance ,and the degree of magnesium deficiency is positively

correlated with serum glucose concentration and the degree of glycosuria second , hypomagnesemia can increase the risk of cardiovascular abnormalities , intracellular mg plays a key role in regulating insulin action [3], low mg levels result in defective tyrosine kinase activity at the insulin receptor level which lead to impairment in insulin action and worsening IR in type 2 diabetes [4,5]. The mechanisms by which hypomagnesemia can trigger or exacerbate existing diabetes are not fully understood. nevertheless, it seems that both insulin secretion and insulin action can be influenced, since insulin is involved in enhancing renal mg reabsorption, insulin deficiency or insulin resistance could promote urinary mg excretion. Therefore, hypomagnesemia appears to be a contributing factor to T2DM development, however, type 2 diabetes may also be implicated in low mg levels in the diabetic population [6].

A high percentage of patient with normal blood mg levels may suffer from cytokinesis. Mg deficiency, as the highest levels of mg are found in the skeletal system, muscles, bones and other organs. Thus, intracellular mg levels compared to serum mg levels are more representative for the study of mg not only in patients with diabetes or metabolic syndrome, but also in patients with cancer and cardiovascular disease or other diseases in which the balance of mg and glucose may be weak [7]. In one study, there was a graded inverse association between serum mg levels and type2 diabetes, this association remained significant even after accounting for potential confounders, including use of diuretics. The context points to a clear need to consider mg as a potential adjunct to type 2 diabetes therapy. In addition, there is ample evidence of the prevalence and adverse clinical consequences of mg deficiency in diabetics [8].

It has been reported that hypomagnesemia is becoming more common in patients with type 2 diabetes and undertreated. It is an important enzyme activator involved in many vital functions in the human body such as neuromuscular excitation, cell permeability, cell proliferation, apoptosis, etc. there are many other key roles of mg in various cellular processes that are still unclear and require extensive research [9].

Many studies conducted on different population groups have generally confirmed the protective role of mg in various human health problem. therefore, it is not surprising that there are recommendations to increase mg consumption to improve health, the scientific evidence supporting this recommendation is based on various randomized clinical trials that have shown that mg supplements improve several of the parameters analyzed. The mechanisms by which hypomagnesemia can trigger or exacerbate existing diabetes are not fully understood. nevertheless, it appears that both insulin secretion and insulin action can be impaired. Alternatively, some studies conducted in not morbid obese subjects showed that insulin resistance and chronic hyperglycemia could contribute to the development of hypomagnesemia [6]. In patients with T2D, hypomagnesemia can contribute to worsening insulin resistance, which can then lead to further reductions in serum mg concentrations. Hypomagnesemia in patients with T2D is associated with poor glycemic control; patients have higher fasting and postprandial plasma glucose levels and higher levels glycated hemoglobin (HbA1C) compared to patients with normal serum mg concentrations [10]. Hypomagnesemia can exacerbate insulin resistance, a condition than often precedes diabetes, or be a consequence of insulin resistance. Individuals with insulin resistance cannot use insulin efficiently and require larger amounts of insulin to maintain normal blood sugar levels. During periods of severe hyperglycemia, the kidneys may lose their ability to store mg. The increased urinary mg loss can then lead to lower blood mg levels in older adults, and correcting mg deficiency can improve insulin response and action [11].

Studies have indicated that taking mg by mouth for 28 days leads to reduced levels of FBS [12]. Mg intake and homeostasis the recommended daily dietary intake for mg is 6 mg /kg /day. this means 400 to 420 mg/day for adult males and 310-320 mg/day for adult females (with higher requirements for pregnant or lactating women) [11]. T2D is often associated with a change in mg status, an increased prevalence of mg deficiencies has been found in DM2 patients, particularly in patients with poorly controlled glycemic profiles,

longer disease duration and the presence of chronic micro-and macrovascular complications [12,13]. Taking medications such as metformin, also affects mg levels. however, the impact of metformin on mg homeostasis is complex and there is evidence of an increase in intracellular mg, that may offset the possible adverse effects of hypomagnesemia [14]. Various clinical studies have found that mg levels are lower in diabetics compared to non-diabetics, the association between hypomagnesemia and the pathogenesis of diabetes, poor glycemic control and various long-term complications of diabetes mellitus has also been reported. The present study was conducted to estimate serum mg levels in DM patients and to correlate these levels with pathogenesis.

METHODS

Study Subjects

A cross-sectional study was conducted from June to July 2023 at Tripoli university hospital and mukhtar laboratory. About 70 samples were collected from males and females aged from 20 to 80 years to compare the level of mg in each of them, and the samples were divided into two groups, group 1 (n=40) for patients with type II diabetes and group 2 (n=30) for healthy people. People with other chronic diseases such as hypertension, heart disease and thyroid disease were excluded.

Sample Collection

Blood was drawn intravenously by taking (5ml) of blood under sterile conditions and placed in a white tube (clot activator tube) and then placed in a centrifuge at 3000 cycles for 5minutes to separate the serum. The percentage of mg was determined in the (Dimension RXL Max).

Statistical Analysis

The statistical analysis of the result was preformed using SPSS (version 24). Independent T-test to compare the mean, standard deviation of test results in both groups diabetic and non-diabetic participants to check the difference between HbA1c ratio and Magnesium levels. Pareason correlation was carried out onto all subjects to determine correlation direction, and its strength. P value <.05 was considered as statistically significant.

RESULTS

A total of 70 participants were included in this study, there were 49 females that represent 70% of our community whereas 21 males were represent 30 %.

Table 1. Gender-wise distribution

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Male	21	30.0	30.0	30.0
Female	49	70.0	70.0	100.0
Total	70	100.0	100.0	

According to our obtained results, further sub division was done to determine the diabetic condition of participants. Results showed that 30 of participants (42.9%) were non-diabetic (Health) while the other 40 participants (57.1%) were diabetic (patients).

Table 2. Health Condition of the included subjects

Health Condition	Frequency	Percent	Valid Percent	Cumulative Percent
Non-Diabetic	30	42.9	42.9	42.9
Diabetic	40	57.1	57.1	100.0
Total	70	100.0	100.0	

The mean age of participants was 47.76 (STD= ±14.417). A Pearson correlation coefficient was computed to assess the linear relationship between Magnesium levels in mg/dl and level of HbA1c (%).

Table 3. Age Groups of the included subjects

Age Group	Frequency	Percent	Valid Percent	Cumulative Percent
20-35	15	21.4	21.4	21.4
36-50	22	31.4	31.4	52.9
51-65	26	37.1	37.1	90.0
66-80	7	10.0	10.0	100.0
Total	70	100.0	100.0	

Although there was a negative correlation between the two variables, r (68) = [r =.14], this difference was not significant p =.238.

Table 4. correlation between diabetes and Mg levels

Correlations		HbA1c	Mg level
HbA1c	Pearson Correlation	1	-.143
	Sig. (2-tailed)		.238
	N	70	70
Mg level	Pearson Correlation	-.143	1
	Sig. (2-tailed)	.238	
	N	70	70

DISCUSSION

Hypomagnesemia, a condition characterized by abnormally low levels of magnesium in the blood, is a noteworthy concern in individuals with Type II diabetes. While much attention is often directed towards glycaemic control and its associated complications in diabetes management, the role of magnesium deficiency in exacerbating diabetes-related complications has gained increasing recognition. Since magnesium plays a crucial role in various physiological processes, including glucose metabolism, insulin sensitivity, and cardiovascular health, the interplay between hypomagnesemia and Type II diabetes underscores the significance of addressing magnesium levels as a complementary aspect of diabetes care [4,10]. Therefore, the current investigation was carried out to assess the levels of magnesium in the serum of individuals with diabetes mellitus and to establish a connection between these levels and the underlying mechanisms of the disease.

According to the findings of our study, the levels of serum magnesium were notably reduced in individuals with T2DM in comparison to the control group (p=0.025). Earlier research studies have also documented similar outcomes by Latiwesh, Omar & Sheriff, Dhastagir, in 2016.and Husain, W.M., & Ahmed, R.E.in 2022 [16-21]. Furthermore, it was observed that there was a negative correlation between HbA1c and magnesium levels (r= -0.143), however this association was not statistically significant (p=0.238). The absence of a statistically significant correlation between magnesium levels and HbA1c in this study could be attributed to several factors including sample size, diet, medication, physical activity, genetics, and other micronutrient levels. This finding is comparable with the findings of a previous study conducted in Libya by Latiwesh, Omar & Sheriff, Dhastagir in 2016. They reached the conclusion that magnesium and HbA1c in the diabetic group showed a negative correlation (r=-0.198) based on Pearson's analysis. Despite their correlation analysis achieving statistical significance (p=0.049), this differs from our findings [16]. Research carried out by Kallianpur, Ruchika et al. in 2022, as well as by Palathingal, John Thomas & Thomas, Lekha in 2020, also exhibited a significant negative relationship between HbA1c and magnesium levels [18,19].

However, a study conducted by Saeed, H., Haj, S, & Qasim, B in 2018 in Iraq reported different findings. In their study, there was a positive correlation between magnesium and HbA1c in T2DM patients (r= 0.075) [20]. The presence of divergent correlations between magnesium levels and HbA1c in different studies could be attributed to a range of factors that influence the complex relationship between these variables, such as study population, methodology, and sub-group analysis. One of the reasons behind the negative correlation between magnesium levels and HbA1c in T2DM is insulin sensitivity.

Low magnesium levels are associated with reduced insulin sensitivity, leading to impaired glucose utilization by cells. This insulin resistance contributes to higher HbA1c levels, reflecting poorer glycaemic control [21,22]. Another contributing factor is oxidative stress, a condition where the balance between reactive oxygen species (ROS) and antioxidant defenses is disrupted. Magnesium deficiency can contribute to this condition. Oxidative stress can impair insulin sensitivity and contribute to higher HbA1c levels [23].

It's important to note that while these factors contribute to the negative correlation between magnesium levels and HbA1c in T2DM, individual responses can vary due to genetic predispositions, lifestyle factors, and the presence of other medical conditions. Addressing magnesium deficiency through dietary adjustments or supplementation, as part of a comprehensive diabetes management plan, may help improve insulin sensitivity and glycaemic

control, leading to a potential reduction in HbA1c levels [24, 25].

Limitations of this study

The cross-sectional design limits our ability to establish causality between hypomagnesemia and T2DM. Longitudinal studies are warranted to elucidate the temporal relationship and assess whether correcting magnesium deficiency can positively impact glycaemic control and diabetes outcomes. Additionally, confounding variables, such as medication use, dietary habits, and comorbidities, could influence the observed correlations and should be addressed in future research.

CONCLUSION

In summary, our research demonstrated an inverse relationship between magnesium levels and HbA1c in individuals with Type 2 Diabetes Mellitus. Our study adds to the existing evidence for this negative correlation, elucidating the intricate connections that give rise to this relationship. To obtain more precise results, future investigations conducted on a broader scale are imperative.

REFERENCES

1. Nasri H. Consequences of hypomagnesemia in type 2 diabetes mellitus patients. J Renal Inj Prev. 2014 Dec 1;3(4):99-100. doi: 10.12861/jrip.2014.28.
2. Olokoba AB, Obateru OA, Olokoba LB. Type 2 diabetes mellitus: a review of current trends. Oman Med J. 2012 Jul;27(4):269-73. doi: 10.5001/omj.2012.68.
3. Shaikh M, Devraiani B, Soomro A, Shah A. hypomagnesemia in type 2 diabetes mellitus. World Applied Sciences journal 2011;12(10):1803-6.
4. El-said N, Sadik N, Mohammed N. Magnesium in type 2 diabetes mellitus and its correlation with glycemic control. Int J Res Med Sci. 2015;3(8):1958-63.
5. Karthikeyan R, Yadalam PK, Anand AJ, Padmanabhan K, Sivaram G. Morphological and Chemical Alterations of Root Surface after Er:YAG laser, Nd:YAG Laser Irradiation: A Scanning Electron Microscopic and Infrared Spectroscopy Study. J Int Soc Prev Community Dent. 2020 Apr 17;10(2):205-212.
6. Ciudin A, Baena-Fustegueras JA, Fort JM, Encabo G, Mesa J, Lecube A. Successful treatment for the Dunnigan-type familial partial lipodystrophy with Roux-en-Y gastric bypass. Clin Endocrinol (Oxf). 2011 Sep;75(3):403-4.
7. Aschner P, Gagliardino JJ, Ilkova H, Lavalle F, Ramachandran A, Mbanya JC, Shestakova M, Chantelot JM, Chan JCN. Persistent poor glycaemic control in individuals with type 2 diabetes in developing countries: 12 years of real-world evidence of the International Diabetes Management Practices Study (IDMPS). Diabetologia. 2020 Apr;63(4):711-721.
8. Zghoul N, Alam-Eldin N, Mak I, Silver B, Weglicki W. Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy. 2018;389-400.
9. Pham PC, Pham PM, Pham SV, Miller JM, Pham PT. Hypomagnesemia in patients with type 2 diabetes. Clin J Am Soc Nephrol. 2007 Mar;2(2):366-73.
10. Patoa S, Das D. Serum Magnesium Levels and its Association with Glycated Hemoglobin in Type 2 Diabetes Mellitus Patients. J Assoc Physicians India. 2022 Apr;70(4):11-12.
11. Barbagallo M, Dominguez LJ. Magnesium and type 2 diabetes. World J Diabetes. 2015 Aug 25;6(10):1152-7. doi: 10.4239/wjd.v6.i10.1152.
12. Abdul-Ghani MA, Jayyousi A, DeFronzo RA, Asaad N, Al-Suwaidi J. Insulin Resistance the Link between T2DM and CVD: Basic Mechanisms and Clinical Implications. Curr Vasc Pharmacol. 2019;17(2):153-163.
13. Galicia-Garcia U, Benito-Vicente A, Jebari S, Larrea-Sebal A, Siddiqi H, Uribe KB, Ostolaza H, Martín C. Pathophysiology of Type 2 Diabetes Mellitus. Int J Mol Sci. 2020 Aug 30;21(17):6275. doi: 10.3390/ijms21176275.
14. Kirsten E Peters, SA Paul Chubb, Wendy A Davis, Timothy ME Davis. The Relationship between Hypomagnesemia, Metformin Therapy and Cardiovascular Disease Complicating Type 2 Diabetes: The Fremantle Diabetes Study. PloSon 2013;8 (9), e74355.
15. Rocio Barragan, Juan Llopis, Olga Portoles, Jose V Oscar Coltell. Lorenzo Rivas. (2020). Nutrients 12 (4), 1018.
16. Patoa S, Das D. Serum Magnesium Levels and its Association with Glycated Hemoglobin in Type 2 Diabetes Mellitus Patients. J Assoc Physicians India. 2022 Apr;70(4):11-12.

17. Kallianpur, Ruchika & Pereira, Treville & Anjali, A K & Shetty, Subraj & Gotmare, Swati & Pereira, Christina. (2022). Correlation of Serum Magnesium Levels in Type 2 Diabetes Mellitus: An Institutional Study.
18. John thomas P, Lekha T. Correlation Between Serum Magnesium Level and Hba1c in Glycemic Control of Type 2 Diabetes Mellitus. Journal of Diabetes & Metabolism. 2020;11. 1-3.
19. Saeed H, Haj S, Qasim B. Estimation of magnesium level in type 2 diabetes mellitus and its correlation with HbA1c level. Endocrinology, diabetes & metabolism. 2018;2(1):e00048.
20. Husain W, Ahmed R. The Correlation between Magnesium and HbA1C in type Two Diabetes. International Journal of Science and Management Studies. 2022;79–82.
21. Gommers, L. M. M., Hoenderop, J. G. J., Bindels, R. J. M., & De Baaij, J. H. F. (2015). Hypomagnesemia in Type 2 diabetes: a vicious circle? Diabetes, 65(1), 3–13.
22. Liu M, Dudley S. Magnesium, Oxidative Stress, Inflammation, and cardiovascular disease. Antioxidants (Basel, Switzerland). 2020;9(10):907.
23. Hruby A, McKeown N, Song Y, Djoussé L. Dietary magnesium and genetic interactions in diabetes and related risk factors: a brief overview of current knowledge. Nutrients. 2013;5(12):4990–5011.
24. Kalinga B, Bhojashettar S, Beig S, Niranjan M. Study of Serum Magnesium and Its Correlation with HbA1c in Patients with Type 2 Diabetes Mellitus. Journal of Evidence Based Medicine and Healthcare. 2020;7(17):853–857.