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Original Research Article

A Comparative Study of the Association Between Magnesium Levels, Diabetes and Body Mass Index

G C Verma[1], Amit Jakhar[2], Devendra Ajmera[3], Ajit Kumar Roat[4*]

[1] Senior Professor, Department of General Medicine, Government Medical College, Kota
[2] Junior Specialist, General Medicine, District Hospital, Laxmangarh, Sikar
[3] Assistant Professor, Department of General Medicine, Government Medical College, Kota
[4]Senior resident, Department of General Medicine, Government Medical College, Dungarpur

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Corresponding author: Dr. Ajit Kumar Roat
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Abstract:
Using findings from earlier studies on cardiovascular health, endothelial dysfunction, and diabetes management as a foundation, this research explores the complex interactions between magnesium levels, body composition, and diabetes. Our work indicates a statistically significant relationship between diabetes status and BMI by thoroughly analyzing Body Mass Index (BMI) and Waist Hip Ratio (WHR) in a Case group, which included people with hypomagnesemia and normomagnesemia. Magnesium levels in the Case group, however, had little to no effect on WHR or BMI. These results highlight the complicated interplay between magnesium and diabetes and body composition, calling for more research and comprehension of these intricate relationships.
Keywords: Magnesium, Diabetes, Body Mass Index.

Introduction

Due to its serious effects on public health, diabetes mellitus, a complicated metabolic condition, has been the focus of substantial research. Numerous researches have looked at the complex connections between low levels of magnesium and numerous physiological functions of the cardiovascular system. The pro-fibrogenic consequences of magnesium shortage were noted by Shivakumar (2002) [1], with possible implications for cardiovascular health. Low magnesium levels have been associated with endothelial cell dysfunction, a significant contributor to atherosclerosis and thrombosis (Maier et al., 2004) [2].

In human artery endothelial cells, the impact of magnesium concentrations on antioxidant systems was investigated (Zhou et al., 1999) [3,4]. Along with its significance in cardiovascular health, magnesium also plays a crucial part in the control of diabetes. The importance of exercise in the therapy of illness was emphasised by Ripoll and Leutholtz (2011) [5]. Works like "Principles of Diabetes Mellitus" (Poretsky, 2009) [6] have increased our understanding of diabetes in its entirety.

The development of knowledge regarding diabetes is highlighted by the historical viewpoint of the disease, which dates back to early findings by Dobson (1776) [7] and key contributions by researchers like Young (1957) [8] and Von Mehring and Minkowski (1890) [9]. It is crucial to take into account the current state of research when we examine the relationship between magnesium level, body composition, and diabetes risk. This work attempts to expand on the knowledge gained from earlier research, filling in any gaps and advancing our understanding of the complex interrelationships at play.

We aim to provide fresh and significant insights into possible links between magnesium shortage, body composition characteristics, and diabetes risk by integrating information from both magnesium-related cardiovascular studies and diabetes research.

Aims and Objectives:

1. Investigate the potential correlation between magnesium levels and body composition parameters, including BMI and Waist Hip Ratio, among individuals with diabetes and in a control group.
2. Determine if there is a significant association between magnesium status and the prevalence of diabetes, considering the impact of gender and treatment modalities on these relationships.

Materials and Methods

Type of study: Hospital-based, comparative, descriptive study.

Study area: New Medical College & Hospital, Kota.

Study period: 2020-2021 (one year).

Sample size: 100 patients (50 Type 2 DM and 50 Controls) from Medicine OPD, Diabetes clinic, or various wards of Medical College and Associated Group of Hospitals, Kota.

Diagnostic criteria for Type 2 Diabetes Mellitus: ADA criteria (Fasting plasma glucose ≥ 126 mg/dl, Two-hour plasma glucose ≥ 200 mg/dl after a glucose challenge, HbA1C ≥ 6.5%, or symptoms of diabetes plus random blood glucose concentration ≥ 200 mg/dl).

Inclusion criteria: Established cases of Type 2 diabetes mellitus within the last 1 to 6 months, age between 30 to 60 years, and normal healthy subjects for comparative study.

Exclusion criteria: Patients with renal failure, acute myocardial infarction in the last six months, on diuretics or magnesium supplements, malabsorption, chronic diarrhea, history of alcohol abuse, and patients refusing to give informed consent.

Institutional Ethics Committee approval was obtained, and patients provided informed written consent. The study involved a detailed history, clinical examination, and complete laboratory work-up, including fasting and post-prandial plasma glucose, HbA1C, renal and liver function tests, lipid profile, CBC, and serum magnesium level estimation using the Calmagite dye method. Anthropometric measurements, ECG, and X-ray chest were also performed. The HbA1C level was determined through HPLC analysis.

Data Analysis:

1. Data was entered in Microsoft excel and data analysis was done on SPSS version 16. The plan was submitted to the Ethical Committee of the Institute and study was initiated only after ethical approval.
2. Data was expressed in percentages.
3. Appropriate test of significance was applied.
4. P<0.05 was considered significant.

Ethical issues:

1. A written and informed consent was taken from all concerned competent authority/study subjects.
2. No pressure or coercion was exerted on subjects for participation in the study.
3. Confidentiality and privacy was ensured at all stages.
4. Data was used for research purpose only.

Results:

Table 1: Gender-wise distribution

Gender	Diabetic group		Control group	
	Number	Percentage	Number	Percentage
Males	29	58%	36	72%
Females	21	42%	14	28%
Total	50	100%	50	100%

The gender distribution of study participants is shown in the table, which compares a diabetic group to a control group. For men, the diabetes group included 29 people (58%) whereas the control group had 36 people (72%). 14 (28%) of the female participants were in the control group, while 21 (42%) of them had diabetes. Each group included 50 individuals in total, including 50 people of each gender. With a larger percentage of men in the control group and a higher percentage of females in the diabetic group.

Table 2: Mode of treatment in Case group subjects

Treatment	Hypomagnesemia	Normomagnesemia	Total
OHA	12 (38.70%)	19 (61.29%)	31
Insulin	2 (40%)	3(60%)	5
Insulin + OHA	5 (35.71%)	9(64.28%)	14
Total	19	31	50

χ^2=0.006 DF=1 P=0.9492 Not Significant. Based on the magnesium levels of the participants in the Case group, the table demonstrates the way of therapy. A total of 12 (38.70%) patients with hypomagnesemia (low magnesium levels) got therapy with oral hypoglycemic agents (OHA), 2 (40%) received treatment with insulin, and 5 (35.71%) received treatment with both insulin and OHA. Among individuals with normomagnesemia (normal magnesium levels), 19 (61.29%) got OHA treatment, 3 (60%) insulin treatment, and 9 (64.28%) both insulin and OHA treatment. There were 50 subjects in all. A p-value of 0.9492 was obtained using the Chi-square test (2) with a degree of freedom (DF) of 1, showing that there was no significant correlation between the Case group's magnesium levels and the treatment method.

Table 3: Distribution of BMI in Diabetics and Control Group

BMI (Kg/m2)	Group I (Diabetic)			Group II (Control)		
	Hypomagnesemia	Normomagnesemia	Total	Hypomagnesemia	Normomagnesemia	Total
Normal	3	5	8(16%)	0	26	
(18.5-24.9)	(15.78%)	(16.12%)			(55.32%)	26(52%)
Over weight	6 (31.57%)	7 (22.58%)	13(26%)	2 (66.66%)	11 (23.40%)	13(26%)
(25.0-29.9)						
Obese	10	19		1	10	
(≥ 30)	(52.63%)	(61.29%)	29(58%)	(33.33%)	(21.27%)	11(22%)
Total	19 (100%)	31(100%)	50	3 (100%)	47 (100%)	50(100%)

χ^2=26.099 d.f.=2 P <.001 Significant. Based on their magnesium levels, Group I (Diabetic) and Group II (Control) are divided into two categories for Body Mass Index (BMI) in the table. Eight (16%) of the hypomagnesemic people in Group I had a normal BMI (18.5-24.9), thirteen (26%) were overweight (25.0-29.9), and thirty (58%) were obese (30). The BMIs of 26 (52%) in Group II (Control) with normomagnesemia were normal, whereas those of 13 (26%) and 11 (22%) in Group II (Control) were overweight and obese, respectively. The results of the Chi-square test (2) revealed a considerable correlation between magnesium levels, BMI distribution, and diabetes status, with a significant p-value (0.001). The findings indicate that, when compared to the control group, the diabetic group had a greater prevalence of overweight and obesity, which may be related to hypomagnesemia.

Table 3A: BMI in Diabetics and Control Group

Parameter	Mean ± SD		t value	P value	Significance
	Group I (Diabetic)	Group II (Control)			
BMI (Kg/m2)	31.07 ± 5.21	26.91 ± 4.64	4.7674	<0.05	Significant

The mean Body Mass Index (BMI) for Group I (Diabetic) and Group II (Control) is compared in the table. In comparison to Group II, which has a mean BMI of 26.91± 4.64, Group I has a higher mean BMI of 31.07± 5.21. The results of the t-test showed a strong correlation between diabetes status and BMI, with a significant t value of 4.7674 and a p-value of 0.05 showing a statistically significant difference in BMI between the diabetic and control groups.

Table 3B: BMI in Case group subjects

Parameter	Mean ± SD		t value	P value	Significance
	Hypomagnesemia	Normomagnesemia			
BMI (Kg/m2)	31.36 ± 4.67	30.92 ± 5.50	0.3861	0.6824	Not Significant

Based on magnesium levels, the table compares the mean Body Mass Index (BMI) for the Case group. The mean BMI is 31.36 ± 4.67 in those with hypomagnesemia and 30.92 ± 5.50 in those with normomagnesemia.

A non-significant t value of 0.386 and a matching p-value of 0.682 (>0.05) from the t-test show that there is no statistically significant difference in BMI between those in the Case group who have hypomagnesemia and those who do not.

This shows that changes in BMI among this group may not be highly correlated with magnesium levels.

Table 4: Distribution of WHR in Diabetics & Control

Waist Hip Ratio	Group I (Diabetic)			Group II (Control)		
	Hypomagnesemia	Normomagnesemia	Total	Hypomagnesemia	Normomagnesemia	Total
Normal Male <0.9 Female <0.8	2 (10.52%)	4 (12.90%)	6(12%)	0	22 (46.80%)	22 (44%)
Overweight Male 0.9- 0.99 Female 0.8-0.84	4 (21.05%)	6 (19.35%)	10 (20%)	2(66.66%)	11 (23.40%)	13(26%)
Obese Male ≥ 1.00 Female ≥ 0.85	13 (68.42%)	21 (67.74%)	34 (68%)	1 (33.33%)	14 (29.78%)	15 (30%)
Total	19 (100%)	31 (100%)	50 (100%)	3 (100%)	47 (100%)	50 (100%)

Based on magnesium levels, the table shows how the Waist Hip Ratio (WHR) categories within Diabetic Group I and Control Group II are distributed. Among those with hypomagnesemia in the diabetic group, 6 (12%) of those had a normal WHR for males and females (0.9 and 0.8, respectively), whereas 10 (20%) were overweight and 34 (68%) were obese. In the Control group with normomagnesemia, 15 (30%) of the participants were obese, 13 (26%) of them were overweight, and 22 (44%) had normal WHRs. According to the results, more people with hypomagnesemia in the diabetic group than in the control group had an obese WHR.

Table 5: Mean Waist Hip ratio in Case group subjects

Parameter	Mean ± SD		t value	P value	Significance
	Hypomagnesemia	Normomagnesemia			
Waist Hip Ratio	0.993 ± 0.0758	0.966 ± 0.105	1.3291	0.1926	Not Significant

Based on magnesium levels, the chart compares the mean Waist Hip Ratio (WHR) for the Case group. The mean WHR is 0.993 ±0.0758 in those with hypomagnesemia and 0.966 ±0.105 in those with normomagnesemia. A non-significant t value of 1.3291 and a matching p-value of 0.1926 (>0.05) from the t-test show that there is no statistically significant difference in WHR between those in the Case group who have hypomagnesemia and those who do not.

This shows that changes in Waist Hip Ratio within this group may not be significantly impacted by magnesium levels.

Conclusion

1. While there was no significant difference in Body Mass Index (BMI) and Waist Hip Ratio (WHR) between individuals with hypomagnesemia and normomagnesemia within the Case group, our findings suggest that magnesium levels may not play a substantial role in shaping these parameters in this context.
2. The research reveals a notable association between diabetes status and Body Mass Index (BMI), indicating that individuals with diabetes tend to have a higher mean BMI compared to the control group. However, magnesium levels did not exhibit a significant influence on this relationship.
3. Despite the lack of significant associations between magnesium levels and body composition parameters within the Case group, the study highlights the importance of further investigations to comprehend the complex interplay between magnesium metabolism and diabetes-related factors.

Limitations

1. Limited Sample Size: The study's relatively small sample size may restrict the generalizability of findings, potentially overlooking subtle relationships between magnesium levels and body composition parameters that could be significant in a larger population.

2. Cross-Sectional Design: The study's cross-sectional design only allows for the observation of associations at a single point in time, preventing the establishment of causal relationships or the exploration of temporal changes in magnesium levels and their impact on body composition and diabetes risk over time.

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