بسم الله الرحمن الرحيم
Omdurman Islamic University Journal of Applied Sciences (OIUJ)-(ASC)
مجلة جامعة أم درمان الاسلامية للعلوم التطبيقية
https://journal.oiu.edu.sd/index.php/oiuj
https://doi.org/10.52981/oiuj v22i1.3482
2026 Jan; 22(1):27-36
ISSN: 5361-1858
رجب 1447هـ

Hypomagnesemia in Sudanese Patients with Hypertension: Case–Control Study

Rimaz Gurashi[1], Abuagla M. Dafalla[2], Suhair A. Ahmed[1], Shereen Faisal[1], AbdElkarim A. Abdrabo[1], Amira S. Khalafalla[2], Hala Abdalazeem Aljack[3], GadAllah Modawe[4*]

1. *Department of Clinical Chemistry , Faculty of Medical Laboratory Sciences, Al-Neelain University, Khartoum, Sudan.*
2. *Department of Clinical Chemistry, Faculty of Medical Laboratory Sciences, University of Gezira, Wad Medani, Sudan.*
3. *Department of Clinical Chemistry, Faculty of Medical Laboratory Sciences, Omdurman Islamic University, Omdurman, Sudan*
4. *Department of Biochemistry, Faculty of Medicine and Health Sciences, Omdurman Islamic University , Omdurman, Sudan*

Corresponding Email address: gadobio77@gmail.com - gadobio77@oiu.edu.sd

To cite this article:
Rimaz Gurashi[1], Abuagla M. Dafalla[2], Suhair A. Ahmed[1], Shereen Faisal[1], AbdElkarim A. Abdrabo[1], Amira S. Khalafalla[2], Hala Abdalazeem Aljack[3], GadAllah Modawe[4*] , Hypomagnesemia in Sudanese Patients with Hypertension: Case–Control Study , Omdurman Islamic University Journal, Sudan
ISSN: 5361-1858
https://doi.org/10.52981/oiuj v22i1.3482

Abstract

Background: Magnesium plays a crucial role in vascular tone regulation and blood pressure homeostasis. Hypomagnesemia has been implicated in the pathophysiology of hypertension; however, data among Sudanese populations remain limited

Objective: To assess serum magnesium levels in Sudanese patients with hypertension and compare them with apparently healthy controls.

Materials and Methods: This analytical case–control study was conducted in several clinics in Khartoum State between August and October 2021. The study included 50 hypertensive patients and 50 healthy controls. Patients with diabetes mellitus, heart disease, renal disease, recent illness, or those receiving steroids or diuretics were excluded. Serum magnesium levels were measured using a spectrophotometric method (BioSystem kits). Data analysis was performed using SPSS version 25, applying independent t-tests and correlation analysis. A p-value below 0.05 was considered statistically significant.

Results: The sex in study population, in case group, male 26(52%), female 24(48%) and the control group male 28(57%), female 21(43%). the age in study case was (54.7 ± 11.3years), while in control group (22.8 ± 0.96 years), The BMI in case group was (28.1 ± 5.58), while in control group was (23.1 ± 4.50). The serum mg was a significantly lower in patients than control group with p value =0.000. Their significant difference in serum mg according to according to diastolic blood pressure with p value = 0.05. Serum magnesium showed no significant association with age, body mass index, or duration of hypertension.

Conclusion: Hypertensive patients in this Sudanese population had lower serum magnesium levels than healthy individuals. These findings suggest that hypomagnesemia may be associated with hypertension and highlight the potential value of monitoring magnesium levels in hypertensive patients.

Keywords: Serum magnesium, hypertension, Sudanese, and BMI.

Introduction

Hypertension remains one of the leading modifiable risk factors for cardiovascular morbidity and mortality worldwide[1]. Despite advances in diagnosis and treatment, its underlying biological mechanisms are complex and not yet fully understood[2]. Electrolyte imbalance, particularly involving magnesium, has been increasingly recognized as a potential contributor to blood pressure dysregulation[3].

Magnesium is an essential intracellular cation involved in vascular smooth muscle relaxation[4], endothelial function, and modulation of inflammatory and oxidative stress pathways[5]. Experimental and clinical studies have suggested that reduced magnesium levels may increase vascular tone and promote hypertension[6]. Several epidemiological studies have reported lower dietary intake or serum magnesium concentrations among hypertensive patients[7]; however, findings across populations have been inconsistent, and causality remains uncertain[8].

Importantly, most existing evidence originates from Western and Asian populations, while data from African countries, including Sudan, are scarce[9]. Differences in dietary patterns, socioeconomic factors, and healthcare access may influence magnesium status and its relationship with hypertension[10], limiting the generalizability of findings from other regions. In Sudan, hypertension represents a growing public health burden[11], yet biochemical factors associated with its development and progression have not been adequately explored[12].

Therefore, this study aimed to assess serum magnesium levels in Sudanese patients with hypertension and compare them with apparently healthy individuals, in order to contribute local evidence regarding the potential association between magnesium status and hypertension.

Materials and Methods

Study population: Analytical case control hospital study conducted in different clinics at Khartoum city, Khartoum stat, from period during August to October 2021. A total of 100 subjects enrolled in this study, 50 hypertensive patients as case group and other 50 apparently healthy subjects as control group, the age of patients ranged between 31 to 90 years with their (54.7 ± 11.3years) and the gender male 26(52%), female

24(48%). The duration of disease ranged between 1 to 25 years with their mean (8.84 ± 5.964years). The systolic pressure was (128.16 ±.727) while the diastolic pressure of patients (75.02 ± 29.512). The BMI in case group was (28.1 ± 5.58). The age of control ranged between 21 to 24 years with their (22.8 ± 0.96 years) and the gender male 28(57%), female 21(43%). The BMI in control group was (23.1 ± 4.50).

Inclusion and exclusion criteria: Patient diagnosed was hypertensive (case) and apparently healthy subject considered as control. Hypertensive patients with any diseases like DM, CHD, CRF or history of recent illness and used of steroid drugs or diuretics were excluded.

Methodology: Venous blood samples (3–5 mL) were collected from all participants under aseptic conditions and allowed to clot at room temperature. Samples were then centrifuged at 3000 rpm for 10 minutes to obtain serum, which was analyzed immediately or stored at 2–8 °C for short-term analysis.

Serum magnesium concentrations were determined using a colorimetric spectrophotometric method based on the formation of a colored complex between magnesium ions and xylidyl blue, using commercially available BioSystems diagnostic kits (BioSystems S.A., Barcelona, Spain). Absorbance was measured using a calibrated laboratory spectrophotometer according to the manufacturer's instructions.

Instrument calibration was performed prior to analysis using the manufacturer-provided standard solutions. Internal quality control procedures were applied with normal and pathological control sera to ensure analytical accuracy and precision. All measurements were carried out under standardized laboratory conditions, and results were expressed in mg/dL.

Ethical approval: The study approval was obtained from ministry of health of Khartoum State and from Alneelain University, faculty of medical laboratory sciences.

Statistical analysis: The data was analyzed using SPSS version (25) and used T-test and correlation to analyzed data.

Results

The sex in study population, in case group, male 26(52%), female 24(48%) and the control group male 28(57%), female 21(43%) . the age in study case was (54.7 ± 11.3years), while in control group (22.8 ± 0.96 years), The BMI in case group was (28.1 ± 5.58), while in control group was (23.1 ± 4.50). Table (1).The serum mg in case group was (1.50 ±0.27) while in control group was (2.00 ± 0.26). There was a significantly difference between serum magnesium in case than control with p value (0.000) table (2). Their no significant difference in serum mg according to gender as showed in table (3). There is no any significant difference in serum mg according to systolic blood pressure**,** see table (4). Their significant difference in serum mg according to according to diastolic blood pressure with p value = 0.05 as in table (5). No association between serum mg and age duration of disease and BMI. Figures (1, 2 and 3).

Table (1): Demographic characteristics of study population

Characteristic	Patients	Control
	Frequency N=50	Frequency N=50
Gender	Male: 26 (52%)	Male: 28 (57%)
	Female: 24 (48%)	Female: 21 (43%)
Age (years)	54.7 ± 11.3years	22.8 ± 0.96 years
BMI (kg/m^2)	28.1 ± 5.58	23.1 ± 4.50

Table (2): Mean concentration of serum Mg $^{+2}$ in patients and control groups

		NO	(Mean ±S.D)	*p-value*
P. Mg $^{+2}$	Case	50	1.50 ±0.27	0.00**
	Control	50	2.00 ± 0.26	

The results expressed as (Mean±SD) and *P*-value less than 0.05 was statistically considered significant.

Table (3): Mean concentration of serum Mg $^{+2}$ in patients group according to gender

	Gender	NO	(Mean ±S.D)	*p-value*
P. Mg $^{+2}$	Male	26	1.52 ± 0.30	0.685
	Female	24	1.48 ± 0.24	

The results expressed as (Mean±SD) and *P*-value less than 0.05 was statistically considered significant.

Table (4): Mean concentration of serum Mg^{+2} in patients group according to systolic blood pressure

	Systolic blood pressure	NO	(Mean ±S.D)	*p-value*
P. Mg^{+2}	Patients with normal systolic blood pressure	2	1.40 ± 0.14	0.54
	Patients with high systolic blood pressure	42	1.52 ± 0.27	

The results expressed as (Mean±SD) and *P*-value less than 0.05 was statistically considered significant.

Table (5): Mean concentration of serum Mg^{+2} in patients group according to diastolic blood pressure

	Diastolic blood pressure	NO	(Mean ±S.D)	*p-value*
P. Mg^{+2}	Patients with normal diastolic blood pressure	11	1.65 ± 0.33	0.05*
	Patients with high diastolic blood pressure	44	1.46 ± 0.23	

The results expressed as (Mean±SD) and *P*-value less than 0.05 was statistically considered significant.

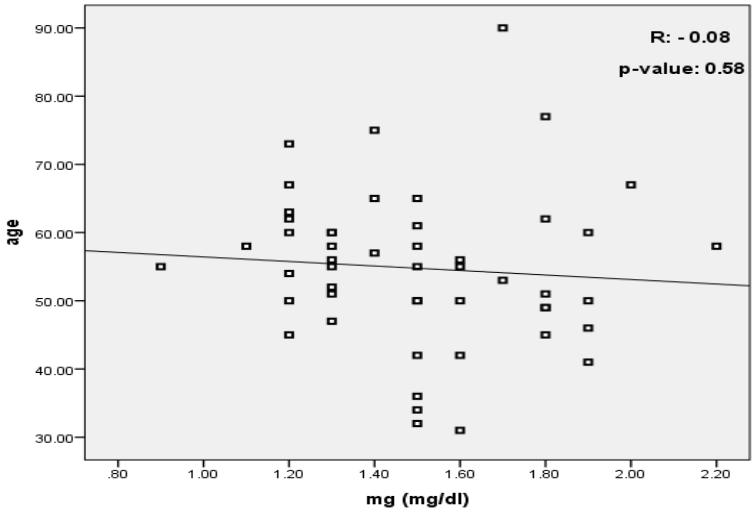
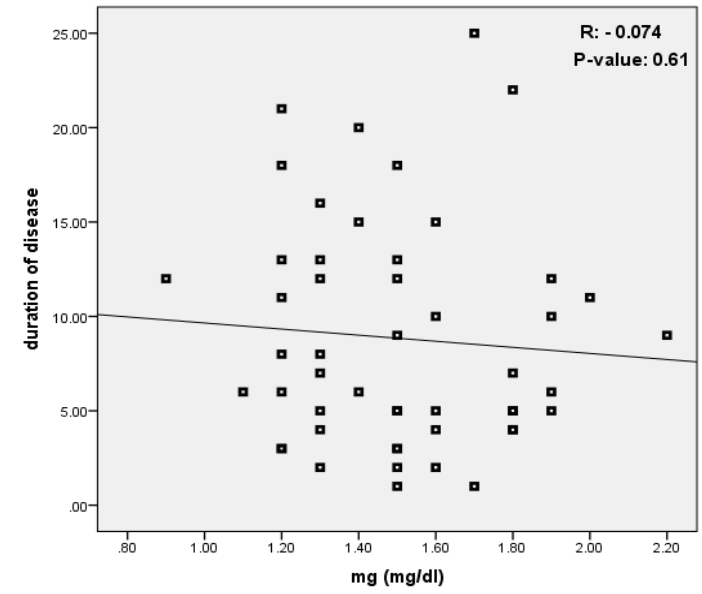


Figure (1): Correlation between serum Mg $^{+2}$ level and age of hypertensive patients



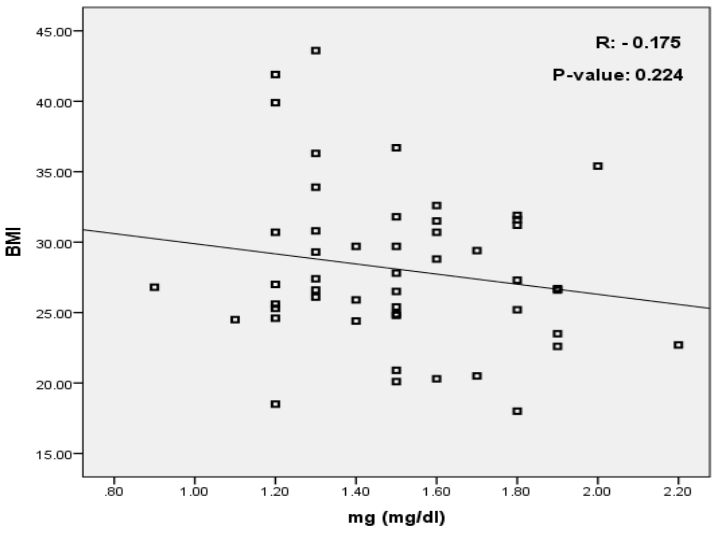


Figure (3): Correlation between serum Mg $^{+2}$ level and BMI in patient group

Discussion

The present case–control study demonstrated significantly lower serum magnesium levels in Sudanese patients with hypertension compared with apparently healthy controls. This finding supports the hypothesis that hypomagnesemia is associated with hypertension and reinforces the potential role of magnesium in blood pressure regulation.

Our results are consistent with several previous studies conducted in different populations. Athab et al. reported significantly reduced serum magnesium levels among Iraqi adults with essential hypertension compared with normotensive controls.[10] Similarly, Zangana and Khazaal observed lower magnesium concentrations in hypertensive patients in Erbil, Iraq, suggesting a regional pattern

in Middle Eastern populations.[4] These findings are further supported by Correa et al., who demonstrated an inverse association between serum magnesium levels and blood pressure in a large cohort study, particularly with diastolic blood pressure.[15]

In the present study, serum magnesium levels were significantly lower in patients with elevated diastolic blood pressure, while no significant association was observed with systolic blood pressure. This observation aligns with previous reports indicating that magnesium may exert a greater influence on peripheral vascular resistance rather than arterial stiffness.[3] [14] Magnesium is known to act as a natural calcium antagonist, promote nitric oxide synthesis, and reduce vascular smooth muscle contraction, thereby contributing to vasodilation and lower diastolic pressure.[2] [5]

No significant associations were observed between serum magnesium levels and gender, age, body mass index, or duration of hypertension. Similar findings have been reported by Correa et al., who found no correlation between magnesium levels and age,[15] and by Kass et al., who noted that magnesium deficiency may occur independently of demographic factors.[12] However, variability among studies may be attributed to differences in dietary magnesium intake, renal magnesium handling, medication use, and study design.

The absence of a significant relationship between serum magnesium and systolic blood pressure contrasts with some interventional studies and meta-analyses that reported modest reductions in systolic blood pressure following magnesium supplementation.[12] [14] This discrepancy may be explained by the observational nature of the present study, which limits causal inference, as well as the lack of dietary intake assessment and intracellular magnesium measurements. Serum magnesium represents only a small fraction of total body magnesium and may not accurately reflect intracellular magnesium status.[13]

From a public health perspective, dietary habits and socioeconomic conditions in Sudan may contribute to inadequate magnesium intake. Limited consumption of magnesium-rich foods such as whole grains, legumes, and green leafy vegetables may increase the risk of hypomagnesemia, particularly among patients with chronic conditions such as hypertension. This highlights the importance of nutritional assessment in routine clinical practice.

Despite its strengths, including standardized laboratory measurements and clearly defined inclusion and exclusion criteria, this study has limitations. The relatively small sample size and the absence of dietary magnesium assessment restrict the generalizability of the findings. Additionally, the cross-sectional design precludes determination of causality between magnesium deficiency and hypertension.

Conclusion: This study concluded that serum magnesium levels were significantly lower in patients with hypertension compared with healthy controls and were independently associated with elevated diastolic blood pressure. In contrast, no significant associations were observed between serum magnesium levels and systolic blood pressure, age, gender, body mass index, or duration of hypertension. These findings suggest that magnesium deficiency may be selectively linked to vascular mechanisms influencing diastolic blood pressure rather than general demographic or anthropometric factors. Incorporating magnesium assessment into the clinical evaluation of hypertensive patients may help identify an overlooked metabolic abnormality.

Strengths and Limitations

Strengths: This study used a clearly defined case–control design with appropriate inclusion and exclusion criteria. Serum magnesium was measured using standardized spectrophotometric methods with calibration and quality control. The inclusion of a healthy control group strengthened internal validity. Importantly, the study provides locally relevant data from Sudan, addressing a regional knowledge gap regarding biochemical factors associated with hypertension.

Limitations: The relatively small sample size and cross-sectional design limit generalizability and prevent causal inference. Dietary magnesium intake and detailed antihypertensive medication data were not assessed. Serum magnesium may not fully reflect total body magnesium status, and the age difference between cases and controls may have introduced residual confounding.

Declaration of interest

The authors declare that there is no conflict of interest

Funding

Nil

References

1. Athab AK, Al-Taee HA, Ali AS. Serum magnesium in a sample of Iraqi adults with essential hypertension. Iraqi Journal of Medical Sciences. 2020;18(2):117–122. doi:10.22578/IJMS.18.2.5 iraqijms.net
2. Zangana SN, Khazaal SA. Evaluation of serum magnesium level among patients with essential hypertension in Erbil-Iraq. Diyala Journal of Medicine. 2021;20(2):23–30. DOI:10.26505/DJM.20025781115 djm.uodiyala.edu.iq+1
3. Correa S, Guerra-Torres XE, Waikar SS, Mc Causland FR, et al. Serum magnesium, blood pressure, and risk of hypertension and chronic kidney disease progression in the CRIC study. Hypertension. 2021 Dec;78(6):1771-1780. doi:10.1161/HYPERTENSIONAHA.121.17694. PubMed
4. National Institutes of Health, Office of Dietary Supplements. Magnesium — Health Professional Fact Sheet. NIH ODS. 2022 [cited 2025 Dec]. Available from: https://ods.od.nih.gov/factsheets/Magnesium-HealthProfessional/ Iraqi Academic Scientific Journals
5. Jahnen-Dechent W, Ketteler M. Magnesium basics. Clin Kidney J. 2012;5(Suppl 1):i3–i14. doi:10.1093/ndtplus/sfr163 Iraqi Academic Scientific Journals
6. Seo JW, Park TJ. Magnesium metabolism. Electrolyte Blood Press. 2008;6(2):86-95. doi:10.5049/EBP.2008.6.2.86 Iraqi Academic Scientific Journals
7. Tamboli BL, Singh DP, Sharma MK. Role of waterborne magnesium in preventing chronic diseases. Int J Collab Res Int Med Public Health. 2011;3:78–87. Iraqi Academic Scientific Journals
8. Azoulay A, Garzon P, Eisenberg MJ. Comparison of the mineral content of tap water and bottled waters. J Gen Intern Med. 2001;16(3):168–175. doi:10.1111/j.1525-1497.2001.04189.x Iraqi Academic Scientific Journals
9. Bohnen N, Degenaar CP, Jolles J. Influence of age and sex on 19 blood variables in healthy subjects. Z Gerontol. 1992;25(5):339–345. Iraqi Academic Scientific Journals
10. Cunha AR, Umbelino B, Correia ML, et al. Magnesium and vascular changes in hypertension. Int J Hypertens. 2012;2012:754250. doi:10.1155/2012/754250 Iraqi Academic Scientific Journals
11. Sontia B, Touyz RM. Role of magnesium in hypertension. Arch Biochem Biophys. 2007;458(1):33-39. doi:10.1016/j.abb.2006.10.018 Iraqi Academic Scientific Journals
12. Belin RJ, He K. Magnesium physiology and pathogenic mechanisms that contribute to the development of the metabolic syndrome. Magnes Res. 2007;20(2):107–129. Iraqi Academic Scientific Journals
13. Barbagallo M, Veronese N, Domínguez LJ. Magnesium in Aging, Health and Diseases. *Nutrients.* 2021;13(2):463. doi:10.3390/nu13020463
14. Rosanoff A, Costello RB, Johnson GH. Effectively Prescribing Oral Magnesium Therapy for Hypertension: A Categorized Systematic Review of 49 Clinical Trials. *Nutrients.* 2021;13(1):195. doi:10.3390/nu13010195

15. Correa S, Guerra-Torres XE, Waikar SS, Mc Causland FR. Serum magnesium, blood pressure, and risk of hypertension and chronic kidney disease progression in the CRIC study. *Hypertension.* 2021 Dec;78(6):1771–1780. doi:10.1161/HYPERTENSIONAHA.121.17694
16. Naik SM, Sehra R, Bansal M. Association of serum calcium and serum magnesium in gestational hypertension and pre-eclampsia. *Int J Clin Obstet Gynaecol.* 2022;6(4):07–11. doi:10.33545/26174693.2022.v6.i4a.118
17. Kebir NE, Zahzeh T, Khaled MB, Diaf M. Magnesium, a key element for the management of hypertension, cardiovascular complications, retinopathy, and diabetic foot in diabetes. *Egypt Acad J Biol Sci C, Physiol Mol Biol.* 2021;13(2):177–188. doi:10.21608/eajbsc.2021.124919.1350
18. Chen G, Li Y, Deng G, Shrestha S, Chen F, Wei Y, Huang Z, Pan J, Zhang Z. Associations of plasma copper, magnesium, and calcium levels with blood pressure in children: a cross-sectional study. *Biol Trace Elem Res.* 2021 Mar;199(3):815–824. doi:10.1007/s12011-020-02398-1