Correlation of Serum Magnesium Level with Bone Mineral Density in Osteoporotic Postmenopausal Women

Munmun Hossain[1*], Israt Jahan Chowdhury[2], Habiba Akter[3], Farzana Noor[4], Fahmida Sharmin Joty[5]

ARTICLE INFO

Received: 12 May 2026
Accepted: 26 May 2026
Published Online: 8 June 2026

DOI: 10.5281/zenodo.20586284

Volume: 9, Number: 4, Page: 66-70

e-ISSN: 2789-5912
ISSN: 2617-0817

*Corresponding author

ABSTRACT

Introduction: Osteoporosis is a frequently occurring metabolic bone disorder marked by reduced levels of bone minerals and higher susceptibility to bone fractures. Out of all the micronutrients that regulate bone metabolism, magnesium has a significant role in the production of bones. **Aim of the study: To** determine the relationship between blood magnesium concentration and bone mineral density in postmenopausal women with osteoporosis. **Methods & Materials:** This case-control study was carried out at the Department of Physiology, Sir Salimullah Medical College (SSMC), Dhaka, Bangladesh (July 2017 to June 2018). A total of 60 postmenopausal women aged 45-60 years were selected and divided into two groups: Group A included 30 osteoporotic postmenopausal women (cases), and Group B included 30 apparently healthy non-osteoporotic postmenopausal women (controls). For statistical analysis, SPSS (V. 26.02) was used. **Result:** The study showed that osteoporotic postmenopausal women had significantly lower serum magnesium levels compared to non-osteoporotic controls (1.24±0.66 vs 1.91±1.00 mEq/L; p=0.003). Bone mineral density was also markedly reduced in the osteoporotic group, with significantly lower spinal (−3.27±0.89 vs −0.26±0.58; p<0.001) and femoral T-scores (−2.72±0.90 vs −0.35±0.48; p<0.001). In addition, serum magnesium showed a significant positive correlation with both spinal (r=+0.413; p=0.023) and femoral BMD (r=+0.441; p=0.015). **Conclusion:** Serum magnesium levels were significantly lower in osteoporotic postmenopausal women compared with non-osteoporotic controls. The osteoporotic group also had much lower bone mineral density at spinal and femoral sites. In addition, serum magnesium was quite positively correlated with BMD. This means that the lower the magnesium, the less the bone mass in postmenopausal women.

Keywords: *Serum Magnesium, Bone Mineral Density, Osteoporotic Postmenopausal Women*

1. *Associate Professor (C.C.), Department of Physiology, Shahabuddin Medical College, Dhaka, Bangladesh (ORCID: 0009-0003-5155-5575)*
2. *Assistant Professor, Department of Physiology, Addin Women's Medical College, Dhaka, Bangladesh*
3. *Associate Professor, Department of Physiology, Khwaja Yunus Ali Medical College, Sirajganj, Bangladesh*
4. *Associate Professor (C.C.), Department of Physiology, Ashiyan Medical College Hospital, Dhaka, Bangladesh*
5. *Associate Professor, Department of Obstetrics & Gynaecology, Bangladesh Medical College, Dhaka, Bangladesh*

INTRODUCTION

Osteoporosis is a systemic skeletal disorder that leads to a decrease in bone mass and a weakening of bone microstructure, thereby making bones more fragile and vulnerable to fractures. It is a major public health problem, mostly among postmenopausal women, as bone loss is accelerated due to a lack of estrogen after menopause [1]. Worldwide, osteoporosis and osteopenia are significant causes of morbidity, disability, healthcare costs, and lowering of quality of life. The osteoporosis burden will add up with aging populations, mainly in developing countries where preventive measures and early screening are still lacking [2]. Osteoporosis in postmenopausal women stems from low estrogen levels [3]. This causes bones to break down faster than they rebuild. Osteoclasts outpace osteoblasts, leading to lower bone mineral density and higher fracture risk. Bone mineral density remains the best marker for diagnosing the condition. DEXA scans are routinely used to measure it, but a T-score at or below 2 and 5 confirms a diagnosis of osteoporosis [4]. Besides other skeletal sites, the spine and femur remain the most frequently assessed ones as they are highly vulnerable to osteoporotic changes and fractures. Calcium and vitamin D have long been considered indispensable components of bone health, but other micronutrients, e.g. magnesium, are garnering more and more attention in the maintenance of skeletal strength [5]. Magnesium, the fourth most abundant cation in the human body, is stored in bone tissue for approximately 50-60% of total body magnesium [6]. This trace mineral has a multifunctional role in bone remodelling by changing the action of osteoblasts and osteoclasts, keeping calcium balance, and modifying vitamin D metabolism. Lack of magnesium might be responsible for, among other things, the failure of bone development, a change in the pattern of crystal formation and a decrease in bone strength, whereas an increase in bone susceptibility to fractures [7]. Several consistencies strengthened the correlation between low serum magnesium levels and bone mineral density reduction in postmenopausal women. Studies also pointed out that a shortage of magnesium might disturb the process of bone build-up and promote bone degradation, which in turn results in osteoporosis [8]. Fang et al.'s meta-analysis showed that postmenopausal women diagnosed with osteoporosis had lower serum magnesium levels than healthy women [9]. Also, significant associations of serum magnesium levels with BMD at different skeletal sites were noted in postmenopausal women with osteoporosis, which implies that magnesium could affect bone health [10]. Because of this, this study was designed to assess the association of serum magnesium level with bone mineral density in osteoporotic postmenopausal women.

METHODS & MATERIALS

This case-control study was conducted in the Department of Physiology, Sir Salimullah Medical College (SSMC), Dhaka, Bangladesh, from July 2017 to June 2018 after approval from the Institutional Ethics Committee of Sir Salimullah Medical College. A total of 60 postmenopausal women aged 45–60 years were enrolled and divided into two groups: Group A comprising 30 osteoporotic postmenopausal women (cases) and Group B comprising 30 apparently healthy non-osteoporotic postmenopausal women (controls). Cases were recruited from the outpatient departments of Orthopedics at Sir Salimullah Medical College, Mitford Hospital and Dhaka Medical College Hospital, while controls were selected

through personal contact using consecutive purposive sampling. Written informed consent was obtained from all participants. All subjects were age- and BMI-matched, normotensive, non-diabetic, and had normal renal function. Blood pressure was measured to rule out hypertension. Fasting blood glucose (FBG) and serum creatinine levels were assayed to exclude diabetes mellitus and renal failure. Serum magnesium levels were determined in both groups by the Methyl Thymol Blue Complexometric Method at the Physiology Department, SSMC. Bone mineral density (BMD) was determined by Dual-Energy X-ray Absorptiometry (DEXA) at the Centre for Nuclear Medicine and Ultrasound, Dhaka Medical College Hospital, and T-scores at the spine and femur were used to report the results. Data were shown as mean standard deviation (SD). Differences between groups were determined by an unpaired t-test, and the relationship between serum magnesium level and bone mineral density was evaluated by Pearson's correlation coefficient test. A significance level of $p<0.05$ was used. Statistical analysis was done with the help of Statistical Package for Social Sciences (SPSS) for Windows version 22.

RESULTS

The mean age was slightly higher in Group A than in Group B (52.1±4.6 vs. 50.0±4.2 years; p=0.073). Mean body weight was 55.0±10.7 kg in Group A and 59.1±5.2 kg in Group B (p=0.067). Mean systolic blood pressure was comparable between the groups (117.1±6.3 vs. 117.8±5.8 mmHg; p=0.674), and identical mean diastolic blood pressure values were observed (75.6±5.83 vs. 75.6±6.26 mmHg; p=1.000). Mean serum creatinine levels were 0.9±0.25 mg/dL and 1.0±0.27 mg/dL in Groups A and B, respectively (p=0.320). Mean fasting blood glucose (FBG) levels were also similar between groups (4.7±0.78 vs. 4.9±0.85 mmol/L; p=0.455). No statistically significant differences were observed between the two groups for these parameters (*Table II*).

Table I

Distribution of Age, Weight, Blood Pressure, Serum Creatinine, and Fasting Blood Glucose Levels in Both Case and Control Groups (n = 60).

Parameters	Group A (n=30) Mean ± SD (Range)	Group B (n=30) Mean ± SD (Range)	p value
Age (years)	52.1 ± 4.6 (45–60)	50.0 ± 4.2 (45–60)	0.073
Weight (kg)	55.0 ± 10.7 (40–83)	59.1 ± 5.2 (52–74)	0.067
Systolic BP (mmHg)	117.1 ± 6.3 (110–125)	117.8 ± 5.8 (110–125)	0.674
Diastolic BP (mmHg)	75.6 ± 5.83 (70–85)	75.6 ± 6.26 (65–85)	1.000
Serum Creatinine (mg/dL)	0.9 ± 0.25 (0.5–1.6)	1.0 ± 0.27 (0.5–1.5)	0.320
FBG (mmol/L)	4.7 ± 0.78 (3.35–6.47)	4.9 ± 0.85 (3.61–6.87)	0.455

An unpaired t-test was done.

The mean systolic blood pressure was 117.83±5.83 mmHg in Group A and 117.17±6.39 mmHg in Group B (p=0.674). Mean diastolic blood pressure was identical in both groups (75.67±6.26 vs. 75.67±5.83 mmHg; p=1.000). The mean serum creatinine level was slightly higher in Group A than in Group B (1.04±0.27 vs. 0.97±0.25 mg/dL; p=0.320). Mean fasting blood glucose levels were 4.90±0.85 mmol/L in Group A and 4.78±0.78 mmol/L in Group B (p=0.455). No statistically significant differences were observed between the groups regarding blood pressure, serum creatinine, and fasting blood glucose levels (*Table II*).

Table II

Blood Pressure, Fasting Blood Glucose and Serum Creatinine Levels in Both Groups (n=60).

Parameters	Group A (n=30) Mean ± SD (Range)	Group B (n=30) Mean ± SD (Range)	p value
Systolic blood pressure (mmHg)	117.83 ± 5.83 (110–125)	117.17 ± 6.39 (110–125)	0.674 ns
Diastolic blood pressure (mmHg)	75.67 ± 6.26 (65–85)	75.67 ± 5.83 (70–85)	1.000 ns
Serum creatinine (mg/dL)	1.04 ± 0.27 (0.5–1.6)	0.97 ± 0.25 (0.5–1.5)	0.320 ns
Fasting blood glucose (mmol/L)	4.90 ± 0.85 (3.61–6.87)	4.78 ± 0.78 (3.35–6.47)	0.455 ns

An unpaired t-test was performed to compare the groups.

The mean serum magnesium level was significantly higher in Group A compared to Group B (1.91±1.00 vs. 1.24±0.66 mEq/L; p=0.003). This finding indicates a statistically significant reduction in serum magnesium levels among osteoporotic postmenopausal women compared to non-osteoporotic postmenopausal women (*Table III*).

Table III

Serum Magnesium Level in Both Groups (n=60).

Parameters	Group A (n=30) Mean ± SD (Range)	Group B (n=30) Mean ± SD (Range)	p value
Magnesium (mEq/L)	1.91 ± 1.00 (0.5–3.7)	1.24 ± 0.66 (0.2–2.6)	0.003**

An unpaired t-test was performed to compare the groups.

The mean spinal BMD T-score was significantly lower in Group B compared to Group A (−3.27±0.89 vs. −0.26±0.58; p<0.001). Similarly, the mean femoral BMD T-score was also significantly lower in Group B than in Group A (−2.72±0.90 vs. −0.35±0.48; p<0.001) *Table IV*.

Table IV
T-score of Bone Mineral Density in Both Groups (*n*=60).

Parameters	Group A (n=30) Mean ± SD (Range)	Group B (n=30) Mean ± SD (Range)	p value
Spinal BMD (T-score)	−0.26 ± 0.58 (−1 to 0.8)	−3.27 ± 0.89 (−6 to −1.5)	<0.001***
Femoral BMD (T-score)	−0.35 ± 0.48 (−1 to 1)	−2.72 ± 0.90 (−5.5 to −0.2)	<0.001***

An unpaired t-test was performed to compare the groups.

Serum magnesium level showed a significant positive correlation with both spinal BMD (r=+0.413, p=0.023) and femoral BMD (r=+0.441, p=0.015) among osteoporotic postmenopausal women (*Table V*).

Table V
Correlation of Serum Magnesium Level with Bone Mineral Density in Osteoporotic Postmenopausal Women (*n*=30).

Parameters	r value	p value
Spinal BMD	+0.413	0.023*
Femoral BMD	+0.441	0.015*

Pearson's correlation coefficient test was performed to determine the relationship between serum magnesium level and bone mineral density.

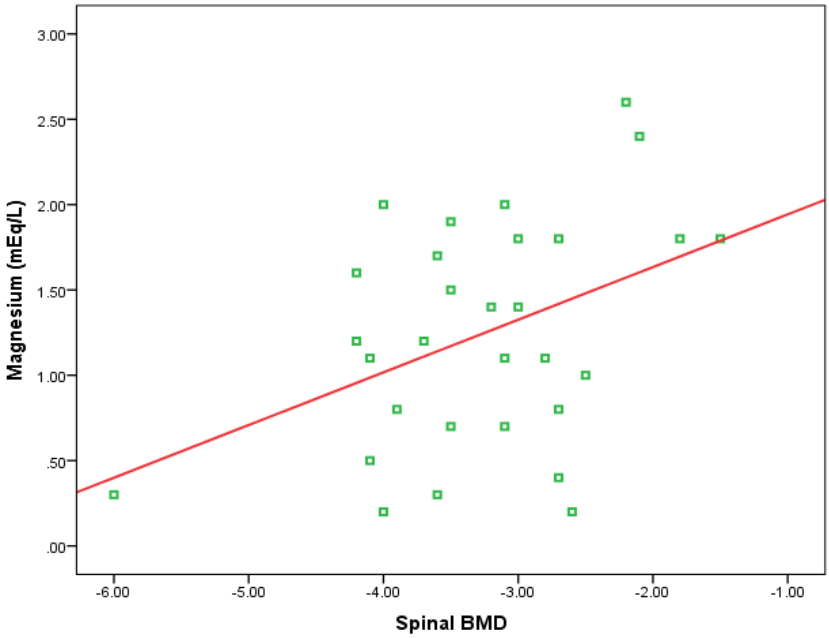

Figure 1: Correlation of serum magnesium level with Spinal BMD in osteoporotic postmenopausal women (*n*=30).

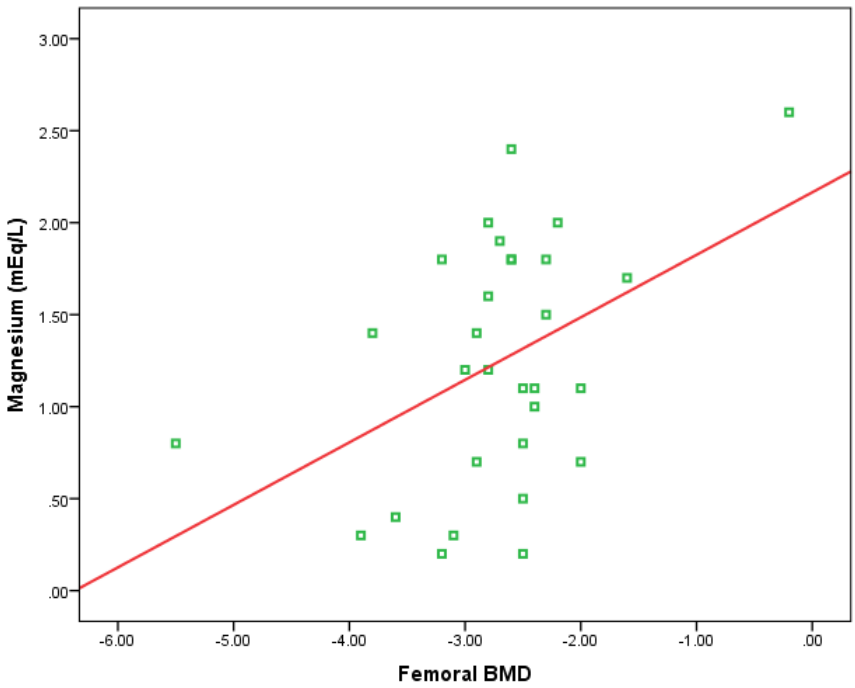

Figure 2: Correlation of serum magnesium level with Femoral BMD in osteoporotic postmenopausal women (*n*=30)

DISCUSSION

Here, the average serum magnesium concentration is a lot less ($p < 0.05$) in osteoporotic postmenopausal females compared to that of the non-osteoporotic that are postmenopausal ones. In fact, this result matches the results of the other researchers [10-12]. Though Odabasi et al. discovered a lower mean serum magnesium level in osteoporotic postmenopausal women than that of non-osteoporotic postmenopausal women, the difference was not statistically significant. Same thing, Roshan et al. reported that the average serum magnesium level was lower in osteoporotic postmenopausal women than in osteopenic postmenopausal women. Still, the difference was not statistically significant [13,14]. In contrast, Sharma et al. discovered a higher level of serum magnesium in osteoporotic postmenopausal women than in osteopenic postmenopausal women, and the difference was statistically significant [11]. This discrepancy may be caused by different locations and dietary habits in the context. In the present study, serum magnesium concentration was positively linked to spinal and femoral neck bone mineral density in osteoporotic postmenopausal women. The association was statistically significant ($p < 0.05$). The same result was reported by Mederle et al. and Okyay et al. [10,15]. Though Liu et al. did not observe any correlation between serum magnesium level and bone mineral density in postmenopausal women. Osteoporosis is the outcome of an imbalance between bone formation and bone resorption [16]. The formation and maintenance of bone depend on the coordinated actions of osteoblasts and osteoclasts. Throughout life, osteoclasts remove bone matrix, and osteoblasts replace it. Lu, Pringa and Chou found that magnesium supplementation causes proliferation and differentiation of osteoblasts. Leidi et al. observed that low magnesium impairs osteoblast-like SaOS-2 cell proliferation by upregulation of inducible nitric oxide synthase and consequent induction of nitric oxide release [17,18]. Belluci et al. found that a lack of magnesium leads to a rise in the number of osteoclasts [19]. Because of this, a magnesium deficiency not only reduces the production of osteoblasts but also enhances the formation of osteoclasts. Because of this, a magnesium deficiency contributes to the manifestation of osteoporosis. Some researchers believe that a deficiency in magnesium in postmenopausal women may cause endothelial dysfunction [11].

LIMITATIONS

- The study was conducted with a relatively small sample size, which may limit the generalizability of the findings.
- Being a case-control study, a causal relationship between serum magnesium level and bone mineral density could not be established.
- Participants were recruited from selected hospitals and by personal contact, which may introduce selection bias.
- Serum magnesium level was measured only once and may not accurately reflect long-term magnesium status.
- Potential confounding factors such as dietary magnesium intake, physical activity, vitamin D status, calcium intake, and socioeconomic factors were not evaluated.

CONCLUSION

This study demonstrated a significant reduction in serum magnesium levels among osteoporotic postmenopausal women compared to non-osteoporotic controls, along with markedly lower bone mineral density at both spinal and femoral sites. Furthermore, serum magnesium showed a significant positive correlation with BMD, indicating that lower magnesium levels are associated with decreased bone mass in postmenopausal women.

RECOMMENDATION

Based on the findings of this study, routine assessment of serum magnesium level may be considered in postmenopausal women, particularly those at risk of osteoporosis, along with bone mineral density screening for early detection. Dietary counselling and adequate magnesium intake through balanced nutrition or supplementation, when indicated, should be encouraged as a preventive strategy against osteoporosis. Further large-scale prospective studies are recommended to better establish the causal relationship between magnesium status and bone mineral density

FUNDING

No funding sources

CONFLICT OF INTEREST

None declared

REFERENCES

1. McClung MR, Miller PD, Papapoulos SE. Osteoporosis: An overview. Primer on the Metabolic Bone Diseases and Disorders of Mineral Metabolism. 2018 Oct 3:393-7.
2. Salari N, Ghasemi H, Mohammadi L, Behzadi MH, Rabieenia E, Shohaimi S, Mohammadi M. The global prevalence of osteoporosis in the world: a comprehensive systematic review and meta-analysis. Journal of orthopaedic surgery and research. 2021 Oct 17;16(1):609.
3. Ji MX, Yu Q. Primary osteoporosis in postmenopausal women. Chronic diseases and translational medicine. 2015 Mar 1;1(01):9-13.
4. Cosman F, de Beur SJ, LeBoff MS, Lewiecki EM, Tanner B, Randall S, Lindsay R. Clinician's guide to prevention and treatment of osteoporosis. Osteoporosis International. 2014 Oct;25(10):2359-81.
5. Alabadi B, Civera M, Moreno-Errasquin B, Cruz-Jentoft AJ. Nutrition-based support for osteoporosis in postmenopausal women: a review of recent evidence. International journal of women's health. 2024 Dec 31:693-705.
6. Uwitonze AM, Razzaque MS. Role of magnesium in vitamin D activation and function. Journal of Osteopathic Medicine. 2018 Mar 1;118(3):181-9.
7. Castiglioni S, Cazzaniga A, Albisetti W, Maier JA. Magnesium and osteoporosis: current state of knowledge and future research directions. Nutrients. 2013 Jul 31;5(8):3022-33.
8. Peacock M, Liu G, Carey M, McClintock R, Ambrosius W, Hui S, Johnston CC. Effect of calcium or 25OH vitamin D3 dietary supplementation on bone loss at the hip in men and women over the age of 60. The Journal of Clinical Endocrinology & Metabolism. 2000 Sep 1;85(9):3011-9.
9. Chang J, Yu D, Ji J, Wang N, Yu S, Yu B. The association between the concentration of serum magnesium and postmenopausal osteoporosis. Frontiers in medicine. 2020 Aug 4;7:381.
10. Mederle OA, Balas M, Ioanoviciu SD, Gurban CV, Tudor A, Borza C. Correlations between bone turnover markers, serum magnesium and bone mass density in postmenopausal osteoporosis. Clinical interventions in aging. 2018 Aug 3:1383-9.
11. Sharma RA, Sharma PR, Kumar PR, Gupta GA. Role of magnesium in post-menopausal women with osteoporosis and osteopenia. Asian J Pharm Clin Res. 2016;9(1):198-9.
12. Razmandeh R, Nasli-Esfahani E, Heydarpour R, Faridbod F, Ganjali MR, Norouzi P, Larijani B, Khoda-Amorzideh D. Association of Zinc, Copper and Magnesium with bone mineral density in Iranian postmenopausal women–a case control study. Journal of Diabetes & Metabolic Disorders. 2014 Mar 6;13(1):43.
13. Odabasi E, Turan M, Aydin A, Akay C, Kutlu M. Magnesium, zinc, copper, manganese, and selenium levels in postmenopausal women with osteoporosis. Can magnesium play a key role in osteoporosis? Ann. Acad. Med. Singap.(Online). 2008:564-7.
14. Mahdavi-Roshan M, Ebrahimi M, Ebrahimi A. Copper, magnesium, zinc and calcium status in osteopenic and osteoporotic post-menopausal women. Clinical Cases in Mineral and Bone Metabolism. 2015 Jun 1;12(1):18.
15. Okyay E, Ertugrul C, Acar B, Sisman AR, Onvural B, Ozaksoy D. Comparative evaluation of serum levels of main minerals and postmenopausal osteoporosis. Maturitas. 2013 Dec 1;76(4):320-5.
16. Liu SZ, Yan H, Xu P, Li JP, Zhuang GH, Zhu BF, Lu SM. Correlation analysis between bone mineral density and serum element contents of postmenopausal women in Xi'an urban area. Biological trace element research. 2009 Dec;131(3):205-14.
17. Lu WC, Pringa E, Chou L. Effect of magnesium on the osteogenesis of normal human osteoblasts. Magnesium Research. 2017 Jun 1;30(2).
18. Leidi M, Dellera F, Mariotti M, Banfi G, Crapanzano C, Albisetti W, Maier JA. Nitric oxide mediates low magnesium inhibition of osteoblast-like cell proliferation. The Journal of Nutritional Biochemistry. 2012 Oct 1;23(10):1224-9.
19. Belluci MM, Schoenmaker T, Rossa-Junior C, Orrico SR, de Vries TJ, Everts V. Magnesium deficiency results in an increased formation of osteoclasts. The Journal of Nutritional Biochemistry. 2013 Aug 1;24(8):1488-98.