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Assessment of serum calcium, phosphorus, magnesium, iron, and zinc in osteoporosis postmenopausal women

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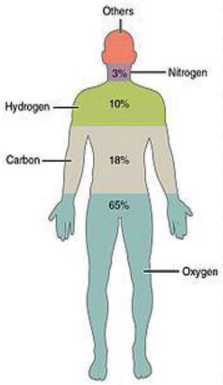
Objectives The present study aims to show the evaluation of serum (phosphorus, calcium, magnesium, zinc, and iron) in patients under study and compare with controls group and radiological finding and its significance in diagnosing of osteoporosis. Dual-energy X-ray absorptiometry (DEXA) is the essential indicative decision by which to screen women >50 years of age for osteoporosis; Evaluation variation of T-scores.
Methods Serum calcium and other measures were compared between the patients group (122) and controls (32). The patients were determined to have osteoporosis as DEXA check.
Results Comparison between patients and controls group: serum calcium significantly decreased in a postmenopausal women (osteoporosis) when compared to postmenopausal women (healthy); serum phosphorus, serum magnesium, serum iron, and serum zinc between the two groups significantly decreased in postmenopausal women (osteoporosis); T-scores were significantly decreased in postmenopausal osteoporosis group women, compared to control groups.
Conclusion Serum calcium, phosphorus, magnesium, iron, and zinc levels in postmenopausal women, these minerals were found to have a significant relationship with the controls group and were almost as low or normal. It was considered to be essential in diagnosis and detection. Diagnosis of osteoporosis disease in postmenopausal women by DEXA is the right choice for detection by using as T-scores.
Keywords osteoporosis, calcium, phosphorus, magnesium, iron, zinc, T-scores

Introduction

Osteoporosis is a bone disorder in which the bone density is decreased and the auxiliary respectability of trabecular bone is aggravated. Cortical bone turns out to be more permeable and more slender. This renders the bone extremely powerless and more prone to fracture. Osteoporosis is described by reducing BMD and enhanced the likelihood of bone fracture.[1] The fracture sequela incorporates torment mental trouble, stature changes, raise horridness and mortality, and expanded hospitalization.[2,3] The diagnosis of osteoporosis can be done by measuring BMD.[4] The most well-known technique for measuring BMD is dual-energy X-ray absorptiometry (DEXA). The conclusion of osteoporosis requires examinations concerning conceivably modifiable fundamental causes; this might be finished with blood tests. Depending on the probability of a hidden issue, examinations for the tumor with metastasis deep down, various myeloma, Cushing's infection and other previously mentioned causes might be performed. Estimation of BMD, radiography, and biochemical markers are critical in diagnosing osteoporosis.[5] Bone density testing is utilized to analyze quiet experience the ill effects of osteoporosis, and X-beam films are discounted other bone or ligament conditions. Thin bones might be analyzed on an X-ray film, yet bone thickness testing is more exact. It is conceivable to recognize osteoporosis noninvasively and early. Osteoporosis might be determined after cracks that happen to have an insignificant injury, by estimation of BMD with bone densitometry which is otherwise called DEXA check, or by a coincidental finding on an X-ray film.[6,7] DEXA filter is considered as a moment depiction of bone status. This sweep, likewise referred to aggregately as BMD test, is utilized to distinguish the measures of bone mass in the spine or the entire body and to evaluate its density. Some studies have shown that information regarding bone mineral density at any anatomic site is equally valuable for estimating the risk of crack all in all.[6–8] DXEA is viewed as the highest quality level for the conclusion of osteoporosis. Osteoporosis is analyzed when BMD is not exactly or equivalent to 2.5 standard deviations underneath that of a youthful 30–40-year-old,[9] healthy adult women reference population. This is translated as a T-score. But bone density decreases with age, more people become osteoporotic with increasing age,[9,10] the World Health Organization has established the following diagnostic guidelines.[9,11] The International Society for Clinical Densitometry takes the position that a diagnosis of osteoporosis in men under 50 years of age should not be made on the basis of densitometric criteria alone. It additionally states, for premenopausal, T-scores ought to be utilized, and the determination of osteoporosis in such ladies likewise ought not to be made on the premise of densitometric criteria alone.[12] A T-score of −2.5 or below indicates osteoporosis.[13] Minerals are essential for normal growth and development of skeleton in humans and animals. Although they are micro building components in bone, they play important functional roles in bone metabolism and bone turnover. The exact involvement of trace elements in osteoporosis has not been clarified.[14,15] The abundance and the percentages of the macronutrients in the body weight are as follows: (Fig. 1).



Element	Symbol	Percentage in Body
Oxygen	O	65.0
Carbon	C	18.5
Hydrogen	H	9.5
Nitrogen	N	3.2
Calcium	Ca	1.5
Phosphorus	P	1.0
Potassium	K	0.4
Sulfur	S	0.3
Sodium	Na	0.2
Chlorine	Cl	0.2
Magnesium	Mg	0.1
Trace elements include boron (B), chromium (Cr), cobalt (Co), copper (Cu), fluorine (F), iodine (I), iron (Fe), manganese (Mn), molybdenum (Mo), selenium (Se), silicon (Si), tin (Sn), vanadium (V), and zinc (Zn).		less than 1.0

Fig. 1 **The main elements that compose the human body.**

Calcium	1.5–2.1%	Sodium	0.2%
Phosphorus	1–1.2%	Magnesium	0.1%
Potassium	0.4%	Chloride	0.2%
Sulfur	0.3%		

Material and Methods

According to cross-sectional dual center study conducted at DEXA unit in the radiology department in Al-Sader Teaching Hospital in AL-Najaf Province/Iraq from August 2015 to April 2016, the prevalence of osteoporosis in Iraqi women a total of 154 females from age of 50–80 years were randomly selected from the patients attending the outpatients clinic. Osteoporosis was diagnosed according to WHO criteria. Women were excluded from the study if they had endocrine diseases, environmental factors, diseases with altered activity (like rheumatoid arthritis, cerebrovascular mischances, incessant obstructive aspiratory sicknesses) or got any hostile to osteoporosis treatment, as well as hormone substitution treatment at the season of BMD estimation. A sum of 154 ladies associated with this investigation with mean age 63.75 ± 10.24 years. Blood samples were taken from 122 osteoporosis women and 32 women apparently healthy as a controls group. Consent was obtained from the patient's first-degree relatives. These patients were also informed that the results of the study would be provided to them as free useful laboratory tests. The patients were diagnosed with osteoporosis as DEXA scan. The diagnosis was established by observing clinical symptoms and conducting hematological. None of these controls was anemic or manifested an evident systemic disease.

Methods

Assays

Estimation of calcium, phosphorus, magnesium, iron, and zinc quantitatively were performed using a calorimetric method by auto biochemistry analyzer (AU240, China), units provided by (JTC, Germany Pishtaz Teb-Iran). DEXA estimation and restorative history members with DEXA estimations were characterized into various classes of osteoporosis in view of their T-scores measured by DEXA and their response to the inquiry in regards to breaking. The most critical data to check is the right recognizable proof of the patient, his date of birth, and furthermore the sex and ethnicity. T-scores recorded at the lumbar spine (L1–L4) by using DEXA machine (Dexxum). Osteoporosis was diagnosed according to World Health Organization (WHO) guidelines criteria for a diagnosis of Osteoporosis.

Table 1. **Comparison of serum some minerals between osteoporosis and healthy group in postmenopausal women**

Minerals	Patients ($n = 122$) (Mean ± S.E.)	Control ($n = 32$) (Mean ± S.E.)	*P* value
Ca (mg/dl)	8.06 ± 0.10*	10.09 ± 0.15	<0.0001
Mg (mg/dl)	1.95 ± 0.06*	2.28 ± 0.09	0.0115
Pi (mg/dl)	1.65 ± 0.09*	3.94 ± 0.17	<0.0001
Fe (mg/dl)	90.05 ± 2.68*	142.10 ± 3.42	<0.0001
Zn (mg/dl)	89.92 ± 2.49*	107.02 ± 3.07	0.0013
T-scores	−3.82 ± 0.29*	1.90 ± 0.19	<0.0001

(*): Statistically significant differences ($P < 0.05$).

Statistical analysis

Statistical analysis was performed in the data of present study were articulated as (Mean ± standard errors), the statistical analysis (descriptive statistics, correlation coefficients, *P*-value) were calculated by using GraphPad Prism. The comparison between two groups was analyzed by *t*-test and the comparison between two groups were analyzed by SPSS 16.0. when *P*-value < 0.05 was statistically significant.

Results

Comparison between patients with osteoporosis and control group. The results of the (Table 1) revealed significant differences in some minerals between osteoporosis group and healthy group, significantly decreased ($P < 0.05$) in serum calcium, magnesium, phosphorus, iron, zinc, and T-scores compared with the healthy group showed that serum calcium was significantly decreased in postmenopausal women when compared to controls in (Fig. 2). Serum phosphorus was significantly decreased in osteoporosis postmenopausal women compared to controls in (Fig. 3). Serum magnesium significantly decreased in osteoporosis postmenopausal women compared to controls (Fig. 4). Serum iron was significantly decreased in postmenopausal women (osteoporosis) compared to controls (Fig. 5), and serum zinc was significantly decreased in osteoporosis postmenopausal women compared to controls (Fig. 6). T-scores were significantly decreased in osteoporosis postmenopausal women compared to control (Fig. 7). In our results, the mean of serum calcium for patients group was 8.06 ± 0.109 and for a healthy group was 10.09 ± 0.15 mg/dL, ($P < 0.0001$). The mean of serum phosphorus for patients group was 1.65 ± 0.09 and for a healthy group was 3.94 ± 0.17 mg/dL, ($P < 0.0001$). The mean of serum magnesium for patients group was 1.95 ± 0.06 and for controls group was 2.28 ± 0.09 mg/dL, ($P = 0.0115$). The mean of serum iron for patients group was 90.05 ± 2.68 and for controls group was 142.10 ± 3.42 mg/dL, ($P < 0.0001$). The mean of serum zinc for patients group was 89.92 ± 2.49 and for controls group was 107.02 ± 3.07 mg/dL, ($P = 0.0013$); and the mean of T-scores for patients group was −3.828 ± 0.298 and for controls group was 1.90 ± 0.19 ($P < 0.0001$).

Discussion

Minerals such as magnesium, zinc, calcium, phosphorus, and iron are all essential for health. They help to promote strong

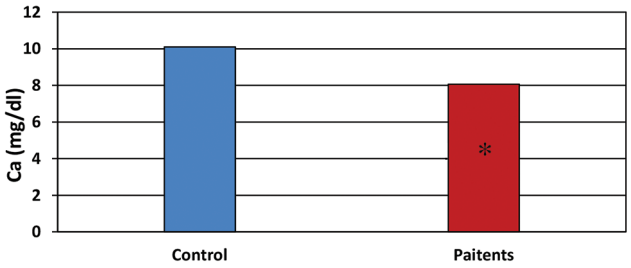


Fig. 2 **Comparison of serum calcium between OP and HT group in postmenopausal women.**

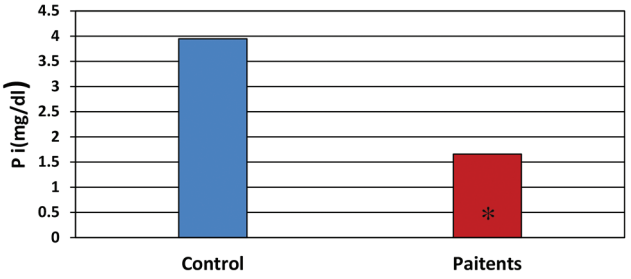


Fig. 3 **Comparison of serum phosphorus between OP and HT group in postmenopausal women.**

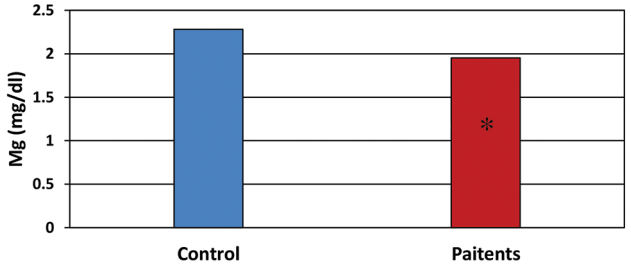


Fig. 4 **Comparison of serum magnesium between OP and HT group in postmenopausal women.**

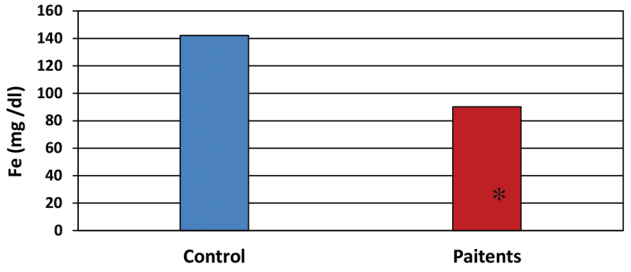


Fig. 5 **Comparison of serum iron between OP and HT group in postmenopausal women.**

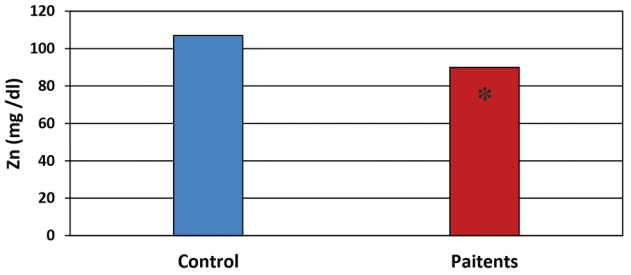


Fig. 6 **Comparison of serum zinc between OP and HT group in postmenopausal women.**

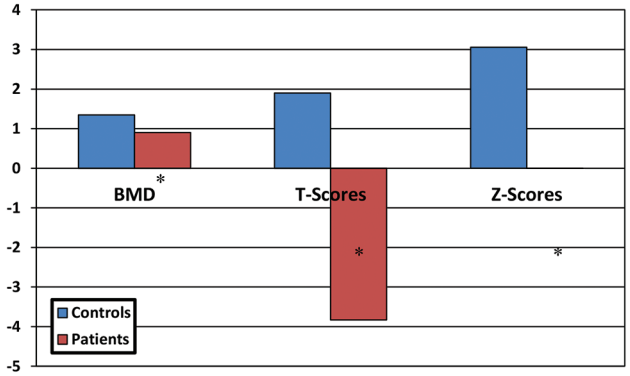


Fig. 7 **Bar chart distribution of studied sample according to BMD, T-scores, and Z-scores.**

bones and are important for bone metabolism. Studies have demonstrated that calcium, magnesium, and zinc are essential for organic bone matrix synthesis.[16]

As shown in Table 1 serum calcium, magnesium, phosphorus, iron, and zinc in postmenopausal with osteoporosis are significantly decreased ($P < 0.05$) compared with the healthy group.

Serum calcium

Serum calcium was normal in both postmenopausal women with osteoporosis and postmenopausal women without osteoporosis because osteoporosis causes decrease in the total mineralized bone without a decrease in the ratio of bone mineral to the organic matrix. Thus, there is a decrease in the overall amount of bone. The mean of serum calcium in the patients group was 8.06 ± 0.109 mg/dl, while the mean of serum calcium in the controls group was 10.09 ± 0.15 mg/dl, shown in Fig. 2, and the typical range for serum calcium is 8.1–10.6 mg/dl, so both groups were within the normal range. Like our findings, several studies showed that serum calcium determination was no significant values for diagnosis of osteoporosis as their outcomes were inside typical range.[17,18,20–23]

A lacking admission of either calcium, vitamin D, or both will impact calcium-managing hormones. A lack of either calcium or vitamin D will bring about decreased calcium ingestion and a lower convergence of flowing ionized calcium. At the point when this happens, parathyroid hormone (PTH) discharge is fortified and there is a subsequent increment in PTH levels. The total impact of higher PTH levels, optional to poor calcium, and vitamin D sustenance (optional hyperparathyroidism), is an expansion in bone redesigning prompting a huge loss of bone and an expanded break chance.

Serum magnesium

Serum magnesium was below the normal range in each osteoporosis and healthy in postmenopausal women. The mean of serum magnesium in the patients' group was 1.95 ± 0.0) mg/dl, while in the controls group it was 2.28 ± 0.09 mg/dl shown in Fig. 4 the normal range for serum magnesium is 1.8–2.3 mg/dl. The similar study reported that the mean of serum magnesium in the patients' group was 11% of patients group was less than 1.9 mg/dl, and this is the significant value. And this result helps in diagnosis of the osteoporosis.[24] Similar study reported that the mean of serum magnesium in the patients' group.

The mean level of serum magnesium is essentially little than 1.8 mg/dl for patients gathering (P = 0.0115). Around 78% of the patients have magnesium levels beneath 1.8 mg/dl. This marvel requires more examination, for example, relationship of magnesium to the level of parathyroid hormone and kidney work trial of the objective gathering. As magnesium is plentiful intracellularly, there might be an imperfection in the vehicle of magnesium in the favors of more intracellular levels.[24,25]

The study of Mishra et al. (2015) reported that serum magnesium level is significantly lower (P < 0.0001) in postmenopausal women when compared to healthy women.[26]

Magnesium is commonly stored in bone, which contains 60–65% of the body's magnesium. Most studies on magnesium and bone have considered only BMD, and it is still uncertain what influence magnesium could have on osteoporotic fractures.[24] Although magnesium deficiency is more common than excess,[23] research indicates that both too low and too high magnesium intake may be harmful to bone health.[26]

A tight control of magnesium homeostasis is by all accounts essential for bone well-being. On the premise of test and epidemiological investigations, both low and high magnesium effects affect the bones. Magnesium insufficiency adds to osteoporosis specifically by following up on a precious stone arrangement and on bone cells and in a roundabout way by affecting on the discharge and the action of parathyroid hormone and by advancing second rate irritation.[25] Less is thought about the components in charge of the mineralization surrenders watched when magnesium is raised. By and large, controlling and keeping up magnesium homeostasis speaks to a supportive intercession to keep up bone integrity.[26] Magnesium lack through a few instruments can impact on bone well-being. Low magnesium adjusts the structure of apatite precious stones. Surely, osteoporotic ladies with showed magnesium insufficiency have bigger sorted out precious stones in trabecular bone than sound ladies and bigger gems cause bones don't bear a typical load. Additionally, magnesium insufficiency related to the lessening of the levels of PTH and in this way the decline of vitamin D.[24,26]

Serum phosphorus

Serum phosphorus was normal in both osteoporosis postmenopausal with and healthy women since osteoporosis causes diminish in the aggregate mineralized bone without an abatement in the proportion of bone mineral to an organic matrix. Consequently, there is a lessening in the general measure of bone. The mean of serum phosphorus in the patients' gathering was 1.65 ± 0.09 mg/dl, while the mean of serum phosphorus in the control group was 3.94 ± 0.17 mg/dl, shown in Fig. 3, and the normal range for serum phosphorus is 2.2–5 mg/dl, so both groups were within the normal range. Like our findings, a few investigations demonstrated that serum phosphorus assurance was of not noteworthy esteem for analysis of osteoporosis as their outcomes were within an ordinary range.[17,18,27]

The investigation of Mishra et al. (2015) revealed that there was no critical distinction of phosphorus level in the post-menopausal group.[25] Intense phosphorus inadequacy is related to the arrival of calcium from the skeleton, bringing about low bone mineralization.

Takeda et al. (2012) have been accounted for decrease the generation of 1,25-hydroxyvitamin D, increment PTH in serum,[33] and lessen the retention of calcium from the intestine.[28–31]

Serum iron

The mean of serum iron in the patients' group was 90.05 ± 2.68 mg/dl, while the mean of the control group was 142.10 ± 3.42 mg/dl shown in Fig. 5. The current study is in accordance with studies.[31-34]

A press is fundamental in oxygen transport and takes an interest in numerous enzymatic systems in the body, with basic parts in collagen union and vitamin D absorption.
This is of extraordinary enthusiasm, as this supplement inadequacy is an overall general medical issue and in the meantime osteoporosis and bone adjustments are profoundly predominant. At last, it is speculated that unending iron lack instigates bone resorption and hazard of osteoporosis.[35] It acts as a cofactor for enzymes involved in collagen synthesis,[36] and is involved in the activation of vitamin D, along these lines influencing calcium absorption.[27] Low-iron accessibility has been accounted to be related to osteoporosis and low BMD in postmenopausal women.[37] Too high centralizations of iron may, nonetheless, go about as a poison to bone cells and add to osteoporosis or other bone maladies in individuals with impeded iron digestion and iron over-burden.[36,38,39] The creators infer that iron overabundance prompts expanded oxidative anxiety, which initiates provocative changes at that point intervene bone misfortune through changes in bone resorption. In an expansion, the press itself may affect osteoblastic movement, as exhibited *in vitro*,[38] and in hemochromatosis patients who indicated bring down markers of bone formation.[40] Finally, press chelators, for example, deferoxamine repress osteoblast and fibroblast multiplication, osteoblast forerunner separation, and collagen arrangement, and upgrade osteoblast apoptosis. Press is fundamental for cell development and working, in this manner, it is not amazing that iron deficiency influences bone digestion. Plack may have more critical well-being repercussions and a higher effect on open health,[41] played out a fascinating examination in human osteoblast cells to decide the impacts of both over the top iron and low iron on osteoblast action. They reasoned that overabundance press repressed osteoblast movement in a fixation subordinate way; mild iron lack advances osteoblast action yet serious low iron levels hindered osteogenesis. Reports from researchers have demonstrated the connection between dietary iron limitation and bone well-being and found that extreme healthful iron confinement significantly affects bone and influencing BMD. In a few investigations, diminishes in bone development or potentially increments in bone resorption markers were found.[34] These parameters were recouped in the wake of providing a typical or high-press diet.[39] In sound postmenopausal ladies, a positive relationship between dietary iron and BMD was found.[44] Other examinations report higher serum transferrin and lower yet not significant ferritin levels in women with osteoporosis diverged from controls.[32] Therefore, the hormonal circumstance assumes a part tweaking the impacts of iron on bone health.[35] A connection between press digestion and bone was first settled from clinical examinations that watched a higher frequency of osteoporosis and cracks in

patients with scatters of iron digestion, for example, inherited hemochromatosis, thalassemia, and sickle cell disease.[45]

Serum zinc

The results of serum zinc in osteoporosis group were 89.92 ± 2.49 mg/dl, while the mean of the controls group was 107.02 ± 3.07 mg/dl, shown in (Fig. 6), This is agreement with[24,45–47] studies.

Zinc, as a follow component, is fundamental for a capacity of a few basic catalysts in osteoblasts that are basic for collagen union and other products.[47] Other investigations have demonstrated that magnesium and zinc are basic for natural bone framework synthesis,[16] and magnesium inadequacy may influence the nature of bone by diminishing bone development, keeping the ideal gem arrangement and negatively affecting PTH.[45] Furthermore, zinc is required for the aggregate physiological movement of vitamin D on calcium digestion.[47]

Mutlu et al. (2007) in their investigation showed reduced levels of magnesium and zinc in serum tests of post-menopausal with osteoporosis than healthy.[16]

Sadeghi, et al. (2014) in Iran demonstrated that the mean of serum zinc in patients with bone breaks was huge lower than typical range and supplementation with zinc caused a noteworthy height of serum zinc and positively affected callus formation.[45] Although many examinations recommended that low serum zinc fixations can be the consequence of low zinc dietary intake.[47]

Conclusions

Serum phosphorus, calcium, iron, magnesium, and zinc levels in postmenopausal women, these metals were found to have a significant relationship with the controls group and were almost as low or normal. This was considered to be essential in diagnosis and detection. Diagnosis of this disease in women by DEXA is the right choice in detection by using as T-scores.

Recommendations

Recommended women should make DEXA scan to prevent fractures identifying postmenopausal with low bone mineral density; And use it during the treat osteoporosis for follow-up can reduce the risk factor, for example, the fractures in this population. Family history plays a great effect on having osteoporosis so any woman has maternal or paternal with osteoporosis should make screening test to prevent the osteoporosis. More research is needed to cover the various aspects of osteoporosis. It is recommended to establish a professional society in Najaf that deal with osteoporosis as a public health problem. Assess the level of zinc, calcium, magnesium, and Iron in foods that consumed by old people. Study the effect of other elements on osteoporosis. Determination of the level of organic sulfur in osteoporosis.

Conflict of Interest

None.

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