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Iron Status Alterations in Osteoporotic Pre and Postmenopausal Women: Perubahan Status Zat Besi pada Wanita Pra dan Pasca Menopause dengan Osteoporosis

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Abstract

General Background: Osteoporosis is a major skeletal disorder associated with fractures, disability, and increased mortality among women. **Specific Background:** Alterations in bone metabolism may influence hematological parameters and iron status, particularly during the menopausal transition. **Knowledge Gap:** Limited data are available regarding the association between blood variables and iron status in pre- and post-menopausal women with osteoporosis in Basrah. **Aims:** This study aimed to evaluate blood parameters and iron status indicators among pre- and post-menopausal women suffering from osteoporosis. **Results:** Ninety-seven women aged 40–60 years were assessed using DEXA and laboratory analysis. Osteoporotic women showed significant decreases in hemoglobin, packed cell volume, and serum iron, accompanied by a significant increase in serum ferritin. Red and white blood cell counts and total iron-binding capacity showed no significant changes compared with healthy controls. These findings were consistent in both pre- and post-menopausal groups. **Novelty:** The study provides regional evidence linking iron status disturbances with osteoporosis among menopausal women in Basrah. **Implications:** Monitoring iron-related blood parameters may support clinical evaluation of osteoporosis in pre- and post-menopausal women.

Keywords: Osteoporosis, Iron Status, Hemoglobin, Ferriti, Menopausal Women

Key Findings Highlights:

1. Reduced hemoglobin and packed cell volume were observed in osteoporotic women.
2. Serum iron levels declined while ferritin levels increased in affected groups.
3. Cellular blood counts remained stable despite altered iron profiles.

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Introduction:

The human skeleton is composed of mineralized matrix with both organic and inorganic components, The living segment of the matrix is firstly type I collagen, which compose more than 25% of bone and collagen fiber provides bone with flexibility[1]. It explained theinorganic matrix as mainly mineral salts include calcium phosphate and fewer amounts of manganese, chlorine, potassium are also present in bone[2]. The bone formation in childhood is most rapid as a result of more bone growth and lengthening , 90% of bone growth takes place before the age of 20 years, between the ages of 20 and 30 bones grow their final 10% but become thicker rather than longer[3] **.** The “peak bone mass” means bones reach their largest and strongest levels at the age of 30 to 35. During The age 35 to 40 the process of bone loss starts as bone resorption overtake bone formation [4].

The World Health Organization (WHO) defines osteoporosis as having a bone mineral density (BMD) at least (-2.5) standard deviations below the average value of a healthy young adult population. This criterion provides clinicians with an objective basis for diagnosing the condition and planning appropriate management [5].

As well osteoporosis is known as “silent disease” due to advances silently without noticeable symptoms until a fracture occurs. Such osteoporotic fractures cause severe pain, decreased quality of life, loss of workdays, and disability. Moreover, about 20% of women who suffer a hip fracture die within a year as an indirect consequence of the injury[6].

The evidence of blood support to bones is reflected by alter of osteoblasts on osteoclast progress which was introduced by a study showed that the involvement of osteoblasts in long-term bone marrow cultures includes their role in generating hematopoietic regulatory molecules, producing factors that inhibit the cell cycle, and establishing interactions with early hematopoietic cells [7]. The relationship between iron deprivation and metabolic activity of bone explained by evaluating markers of bones renewal in osteoporosis women [8]. The iron deficiency can cause a reduction in bone mineral density (BMD) and mechanical strength among young women. Furthermore, iron consumption has been shown to be correlated with BMD in healthy postmenopausal women. [9]. The association between iron deficiency and bone loss has also been demonstrated, indicating that hematocrit levels are affected in individuals with osteoporosis women too low for about 53% of that of healthy women and the hemoglobin level in the iron-deficient group was significantly reduced, reaching approximately 28% of the level observed in the control group [10]**.**

Consequently, this study intends to distinguish between osteoporosis women in pre and post- menopausal and differences of blood variables associated with iron status level in different age groups.

Patients and Methods:-

The present study was carried out from September 2024 to April 2025 in Basrah province and enrolled 97 female patients aged 40–60 years, with a body weight of 55–75 kg and a height of 155–160 cm. All participants attended a private clinic at Ibn-Albitar Hospital, where bone mineral density (BMD) was assessed using dual-energy X-ray absorptiometry (DEXA) with a Lunar Prodigy device (version 16, USA) at the hip and lumbar spine. Based on the World Health Organization (WHO) criteria, the patients were classified into normal, osteopenia, and osteoporosis groups.

Human models:-

The Ninety seven women are allocated based on to pre and post- menopause into:-

a. Twenty one healthy women age between (40-50) years old

b. Thirty tree osteoporosis women age between (40-50) years old

c. Fifteen healthy women age between (51-60) years old

d. Twenty eight osteoporosis women age between (40-50) years old

The forma turned into organized to have a facts statistics to sufferers regarding middle in line with seek subject.

Dual Energy X-ray Absorptiometry

DEXA is the gold widespread technique for estimating fracture threat and diagnosing osteoporosis. It has low radiation exposure, and affords an correct and specific dimension of BMD on the lumbar sacral spine, wrist, neck of femur and overall body. DEXA machines characteristic unique software program that measurements and compute bone mineral density on a pc monitor [11].

The collection of s ample

After diagnosing of disease by DEXA, five (ml) of blood sample venous was drawing from each participants. The collected blood samples were separated into two portions, one portion was transferred into a sterile anticoagulant tube containing EDTA for the assessment of hematological parameters. The remaining blood was placed in a disposable tube, left at room temperature for at least 30 minutes to allow clotting, and then centrifuged at 3000 rpm for 10 minutes. The resulting serum

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was carefully transferred into a designated tube and stored at –20°C until further analysis or used immediately.

Blood parameters and iron status measurement

By using (Automated Hematology Analyzer) the blood parameters were measured, by calculate a time until a fixed quantity of cell is reached or by calculate a number of blood cells during a fixed time. While iron status was counts by two methods one by using VIDAS automated quantitative method was used to measure serum levels employing the Enzyme-Linked Fluorescent Assay (ELFA) technique.

Statistical analysis

By test analysis of variance (ANOVA) version (SPSS20) the differences among the groups were considered statistically significant at a level of ($p \leq 0.05$) according to Least Significant Differences test (R.L.S.D).

Results

The changes in blood parameters can be show in table (1) that include a significant variance ($p \leq 0.05$) in Hb , PCV and serum iron in pre – menopausal osteoporosis women group, also significant increase in serum ferritin at the same statistical level, while other investigation like RBC , WBC and total iron binding capacity have no changes compared with healthy group women.

Blood parameters	pre- menopausal osteoporosis women (n=33)	Healthy control women (n=21)	P value
RBC count (10^6) /cmm^3	3971 ± 5.25	4099 ± 5.21	p≤0.05
WBC count (10^3) / cmm^3	4862 ± 4.01	5298 ± 4.16	p≤0.05
Hb (g/dl)	*9.11 ± 2.33	12.35 ± 1.48	p≤0.05
PCV%	*21.87 ± 1.38	29.92 ± 1.17	p≤0.05
S. iron (micg /dl)	*38.86 ± 3.66	63.72 ± 6.13	p≤0.05
S. ferritin (ng /ml)	**199.42 ± 7.83	121.05 ± 6.66	p≤0.05
TIBC (micg /dl)	253.12 ± 4.88	259.02 ± 5.08	p≤0.05

Table 1. **Table 1 : Blood parameters and iron status in pre- menopausal osteoporosis women compared with healthy control women**

***Significant decrease at p≤0.05(mean ± SD).**

****Significant increase at p≤0.05(mean ± SD).**

The table (2) focus on blood investigation include the population of post- menopausal women have changes in blood parameters that include a significant decrease in Hb , PCV and iron, more than a notable increase in ferritin at ($p \leq 0.05$). No possess alteration in RBC , WBC and TIBC relative to healthy group women.

Blood parameters	post - menopausal osteoporosis women (n= 28)	Healthy control women (n= 15)	P value
RBC count (10^6) /cmm^3	3522 ± 4.16	3771 ± 4.31	p≤0.05
WBC count (10^3) / cmm^3	5225 ± 3.37	5489 ± 3.99	p≤0.05
Hb (g/dl)	*9.09 ± 2.63	12.01 ± 2.26	p≤0.05
PCV%	*19.95 ± 1.64	28.75 ± 1.55	p≤0.05
S. iron (micg /dl)	*35.43 ± 2.44	54.94 ± 5.01	p≤0.05
S. ferritin (ng /ml)	**166.87 ± 6.29	119.72 ± 4.18	p≤0.05
TIBC (micg /dl)	239.82 ± 6.83	244.77 ± 6.88	p≤0.05

Table 2. **Table 2 : Blood indices and iron profile in post - menopausal osteoporosis women compared with healthy control women**

***Significant decrease at p≤0.05(mean ± SD).**

****Significant increase at p≤0.05(mean ± SD).**

Discussion

The findings of the present study expound a decline in hemoglobin concentration and packed cell volume (PCV) among women diagnosed with osteoporosis, whereas red and white blood cell counts stayed comparable to those of healthy controls. Moreover, serum iron levels were significantly lower in osteoporotic women, while serum ferritin concentrations showed a notable elevation. In contrast, total iron-binding capacity (TIBC) showed no significant difference between the two groups of similar age.

These outcomes suggest that red and white blood cell production is likely unaffected, possibly because the reduced iron content within the bone marrow responsible for hemoglobin synthesis does not hinder the generation of normal blood cells

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[12]. This explains the similarity in cellular variables between osteoporotic and healthy women. Such hematological variations in osteoporotic patients may be attributed to the impact of osteoporosis on bone marrow stem cells (MSCs), which are fatal for bone fracture repair and play a key role in the regeneration of cartilage, ligaments, tendons, muscles, and adipose tissue [13].The observed decline in hemoglobin concentration and PCV values may be linked to the differentiation of hematopoietic stem cells, which occurs in close association with bone forming cells inside the bone marrow void[14]. Recent studies have suggested that human osteogenic cell can sustain the proliferation and maintenance of hematopoietic stem/progenitor cells both in vitro and potentially in vivo [15].

This hypothesis is supported by evidence highlighting several functions of osteoblasts: their regulatory effect on osteoclast development, their involvement in sustaining long-duration bone marrow cultures, their secretion of hematopoietic-promoting molecules and cell-cycle suppressors, and their direct cell-to-cell interplay with early hematopoietic progenitors [16,17].The maintenance of normal total iron-binding capacity (TIBC) values among osteoporotic women could be explained by the fact that TIBC alterations are more closely linked to other pathological conditions, such as celiac disease [18]. Several studies have indicated that abnormal TIBC may contribute to the pathogenesis of this disorder [19]. Moreover, insufficient iron profile can impair physical performance and enhance vulnerability to infections, the deficiency of iron is known to cause fatigue and reduce work efficiency, whereas maintaining adequate iron levels has been shown to improve multiple aspects of wellbeing, particularly in young women [20].

Iron deficiency can contribute to reduced vitamin D levels, which subsequently impairs calcium absorption in the intestine. This disruption negatively affects bone formation by enhancing bone resorption and decreasing bone mineral density, ultimately leading to osteoporosis [21]. Furthermore, ferritin levels are closely regulated by iron metabolism in the human body; its two subunits are synthesized under iron-dependent control mechanisms, indicating that ferritin plays an essential role in maintaining systemic iron homeostasis [22].

Elevated ferritin concentrations have also been linked to lower bone mineral density across multiple skeletal regions and a greater risk of osteoporosis and fractures, particularly in women aged 45 years and older [23]. The rise in ferritin levels among osteoporotic women may also result from estrogen deficiency, as reduced estrogen exerts harmful effects on bone health [24]. During this stage, serum ferritin levels can increase two- to threefold due to the absence of an efficient iron excretion mechanism, contributing to the decline in bone mineral density in pre-and post-menopausal women [25].

C o nclusion

Notable alterations in blood indices and iron profile were observed among women with osteoporosis in Basrah.

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Ethics Statement

Consent was obtained from the women participating in the study and their families through a form prepared by the institution’s Ethical and Professional Conduct Committee.

Funding

During the conduct of this research, the participants did not receive any financial fees from any scientific entity or institution.

Conflict of Interest

According to the authors, the study was conducted without any conflict of interest or commercial problems.

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