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The Comparison of Bone Mineral Density and Bone Mineral Content between Both Urban and Rural Women Groups in Mosul Governorate

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Abstract

In this study, the bone state of women in an urban group was measured and compared to a rural group. The assessments revealed the measurements of bone mineral content (BMC) and bone mineral density (BMD). A cross-sectional study was done at the DXA laboratory, Physiology Department, College of Medicine, University of Ninevah, Mosul, Iraq. 139 healthy females were enrolled through a college medical academic center assessment. They were split into two groups: rural (53 participants) and urban (86 participants). Study participants provided detailed anthropometric data. A DXA bone densitometer scanner type (STRATOS) from the (DMS) group in France was used to measure the T- and Z-scores. All sample groups were classified according to age from 30-79 years and divided into subgroups for every 10 years. The results show that BMC and BMD values were higher in the rural group in comparison with the urban group for all age categories with a highly significant p = 0.0001.

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Introduction

Osteoporosis is a disease that causes bone density and quality to deteriorate. It is a silent thief, manifesting itself only following the occurrence of a fragility fracture. Osteoporosis can have a negative impact on an individual's quality of life by impairing all of the individual's daily activities due to pain. Additionally, osteoporosis is a severe metabolic bone disease with a negative economic impact due to lost labor, job loss, long-term medication use, and prolonged hospitalization [1]. The term "osteoporosis" refers to the fact that bone mineral density plays a critical role in predicting fracture risk. Osteoporosis has reached epidemic proportions in Europe and America, with 75 million people affected and 9 million fractures occurring each year as a result of the disease [2]. Osteoporosis affects approximately 30% of postmenopausal women in the United States and Europe, according to studies. Over 200 million women worldwide are affected by osteoporosis, and women are eight times more likely to develop the disease than men [3]. Uncontrollable factors include gender, family history, ethnicity, race, advancing age, postmenopausal status, and body frame size. External risk factors such as insufficient exercise, prolonged periods of inactivity, smoking, and an inadequate diet, which includes eating disorders, low calcium intake, and low vitamin D consumption, are all manageable [4].

BMD is greatest in both sexes during childhood and adolescence, and maximum bone mass (BM) is typically reached by the age of 30. When the majority of women reach menopause, their BMD begins to decline due to decreased estrogen levels and aging [5]. A well-balanced diet high in calcium-rich foods, regular exercise, and other healthy lifestyle choices can help young adults increase their peak BMD, promote long-term bone health, and lower their risk of illness later in life [6]. BMD and BMC examinations are used to diagnose and predict fracture risk in patients with osteoporosis. DXA is considered the

"golden standard" for determining bone mineral density and content. This method can be used to measure BMD and BMC in regional locations such as the hip, spine, distal forearm, and the entire body. BMD values are typically distributed over the course of a person's life and remain essentially constant in both sexes until they reach the age of 50. Following that, bone loss occurs, most notably in women due to aging and decreased ovarian function [7],[8].

Bone density (BD) in women was discussed by using a DXA scan to determine the BMD (L1-L4) and osteoporosis prevalence in healthy women living in rural and urban areas of the Nineveh Governorate. Additionally, BMC (L1-L2), T-score, Z-score, abdominal fat percentage, and fracture risk factor for all participants were calculated.

1. MATERIALS AND METHODS

The study surveyed 139 individuals, 86 of whom were urban and 53 of whom were rural, aged 30 to 79, in Mosul and its environs in Iraq in 2022. The scientific section of the College of Medicine at Nineveh University has granted ethical clearance. The research is being carried out at the Medical Physics Unit of the Physiology Department at Nineveh University. Corticosteroid medication, rheumatic bone disease, and renal or liver disease were all ruled out of the study. We are using a STRATOS densitometer from the DMS group in France in conjunction with a 40 and 70 keV x-ray source. The lumbar spine scan takes approximately 1–2 minutes to complete. Participants must remove all metal accessories prior to the scan [9]. Anthropometric data on all participants was calculated, including their height, weight, and body mass index (BMI).

A stadiometer was used to determine the body weight (kg) and height (m). The following equation (1) was used to compute the BMI: [10]

$$BMI = \frac{Weight}{(Height)^2} \qquad (kg/m^2) \qquad (1)$$

The BMC and BMD of the lumbar spine are measured using a DXA machine. The scanner gathers data about the lumbar vertebrae, abdominal fat percentage, fracture risk factor, T-score, and Z-score, which are then classified as: normal at T-score at -1 and above, Osteopenia at T-score between -1 and -2.5, and Osteoporosis at T-score at or below -2.5 [11].
Where T and Z scores are determined using the following equations (2) (3)

$$\text{T score} = \frac{\text{aBMD}_{\text{patient}} - \text{aBMD}_{\text{young adult mean}}}{\text{SD}_{\text{young adult mean}}} \qquad (2)$$

$$\text{Z score} = \frac{\text{aBMD}_{\text{patient}} - \text{aBMD}_{\text{age-ethnicity-matched adult mean}}}{\text{SD}_{\text{age-ethnicity-matched adult mean}}} \qquad (3)$$

SPSS (Statistical Package for the Social Sciences) version 21 was used to evaluate the data generated by the DXA equipment. Descriptive statistics such as frequencies, proportions, and means with standard deviations were computed for all significant variables. The differences were declared significant at the $P < 0.05$ level.

2. Results

The current study enrolled a total of 139 females, with 86 from urban areas and 53 from rural areas. Table 1 summarizes the subjects' anthropometric measurements. The average age of participants was 57.37± 12.23 years in urban areas and 50.18± 13.94 years in rural areas. The mean height in urban areas was 1.57± 0.06 m, while in rural areas it was 1.60± 0.05 m, and the mean weight in urban areas was 79.31± 13.49 kg, while in rural areas it was 82.60 18.34 kg. Finally, the BMI for urban areas was 32.21± 5.69 Kg/m2, while rural areas had a BMI of 32.17 ± 6.86 Kg/m2,in Table (2)

Table 1: Descriptive characteristics of the participants for measurements.

Variables	Min. value	Max. value	Mean	SD
Age (year)	22	81	54	13.33
Height (m.)	1.40	1.76	1.58	0.06
Weight (kg)	42	135	80.56	15.54
BMI (kg/m^2)	16.20	55.50	32.20	6.14

Table 2: Descriptive variables for both rural and urban females

Variables	Urban	Rural	P-value
Age (year)	57.37± 12.23	50.18 ± 13.94	0.0001
Weight (kg)	79.31 ±13.49	82.60 ±18.34	0.1
Height (m)	1.57 ± 0.06	1.60±0.05	0.001
BMI (kg/m^2)	32.21 ± 5.69	32.17 ± 6.86	0.1
BMD L1-L4(g/cm^2)	0.95 ± 0.15	1.23± 0.14	0.0001
BMC L1-L4 (g)	52.01±9.36	68.55 ± 9.08	0.0001
T-Score	-1.34 ± 0.99	1.11± 1.01	0.0001
Z-Score	-0.30 ± 0.93	1.33 ± 0.91	0.0001

Table 3: BMI distribution

BMI groups	Urban		Rural	
	Number of participants (86)	Percentage (%)	Number of participants (53)	Percentage (%)
Normal	8	(9.3%)	9	(17.0%)
Overweight	24	(27.9%)	15	(28.3%)
Obese	54	(62.8%)	29	(54.7%)

Table (3) shows the BMI distribution for all studied participant groups and its percentages for every subgroup.

The BMC of the lumbar spine (L1–L4) is depicted in Figure (1) for all age groups. The results indicate that the BMC values for urban groups were 56.76, 56.05, 50.79, 51.08, and 49 g. Among rural groups, it was 64.72, 68.42, 71.35, 69.94, and 66.0 g. According to the figure below, rural groups have higher BMC values across all age categories, with the highest value being 71.35g in the 50–59 age group, compared to 56.76g in the 30–39 age group.

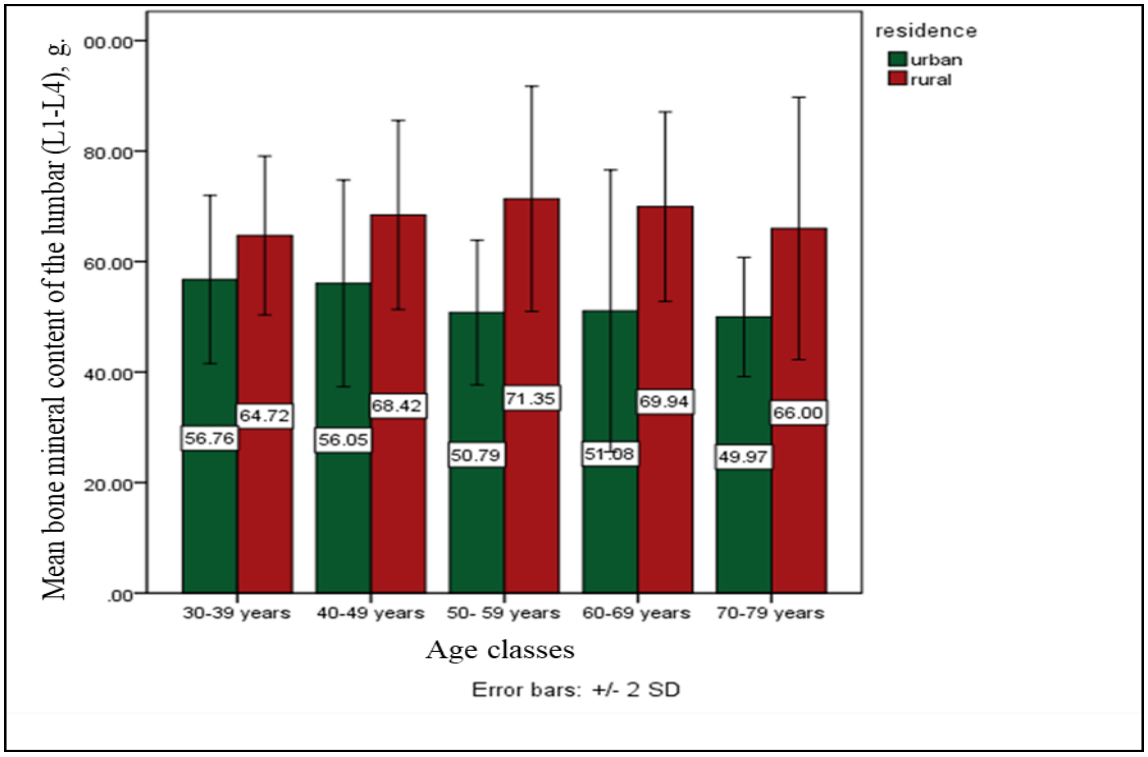

Figure 1. Graphical plot for BMC of the lumbar spine

The distribution of the mean (BMD) for both groups according to the age groups 30-79 year for each 10 years category is shown in Figure (2) and Table (4):

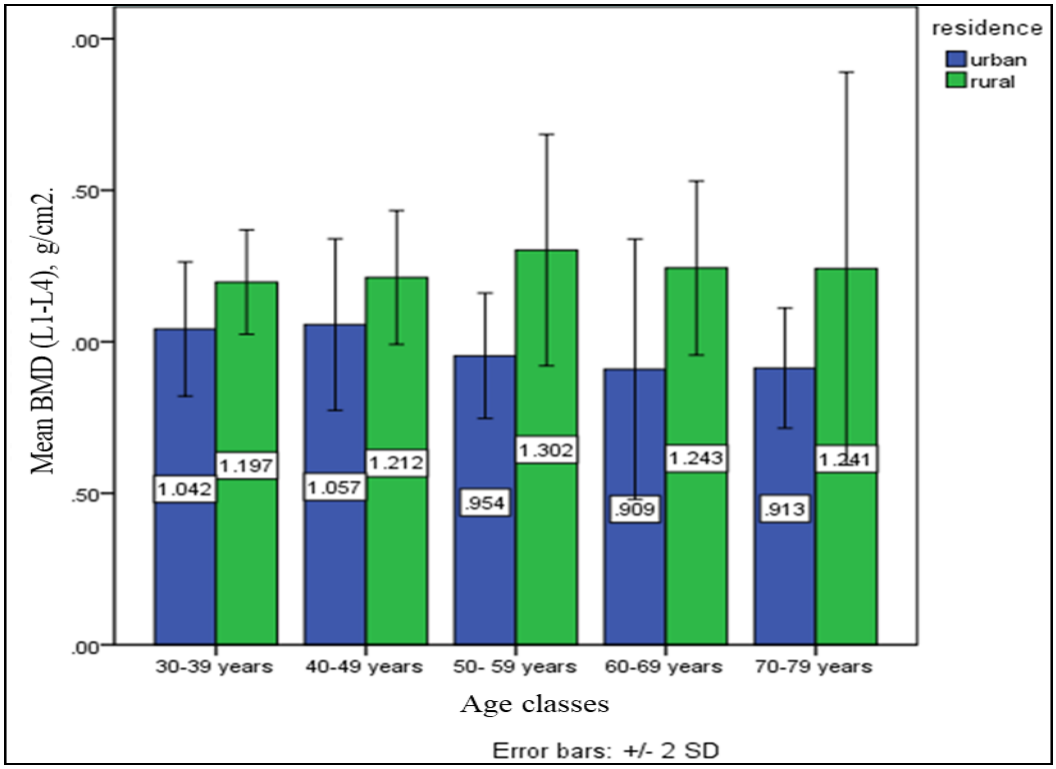

Figure 2. Graphical plot for the mean BMD

Figure 2 depicts the mean BMD L1-L4 for all age groups studied 30-79 year. The values of the mean BMD for both groups are explained by the results in Table 4.

Table 4: The measurements of BMD calcified in age classes for both groups.

Age classes	Bone Mineral Density (L1-L4), g/cm^2			P-value
	Total	Rural	Urban	
30-39 years	1.13±0.12	1.19±0.08	1.04±0.11	0.5
40-49 years	1.14± 0.14	1.21±0.11	1.05±0.14	0.9
50-59 years	1.04±0.20	1.30±0.19	0.95±0.10	0.06
60-69 years	1.02±0.19	1.24±0.14	0.93±0.12	0.6
70-79 years	1.01±0.22	1.28±0.27	0.91±0.09	0.09

We can arrange the BMD L1-L4 results for both groups according to age category and then compare them as shown in Tables 4 and 5. It is worth noting that the rural group's mean BMD value is higher than the urban group's mean value across all age groups.

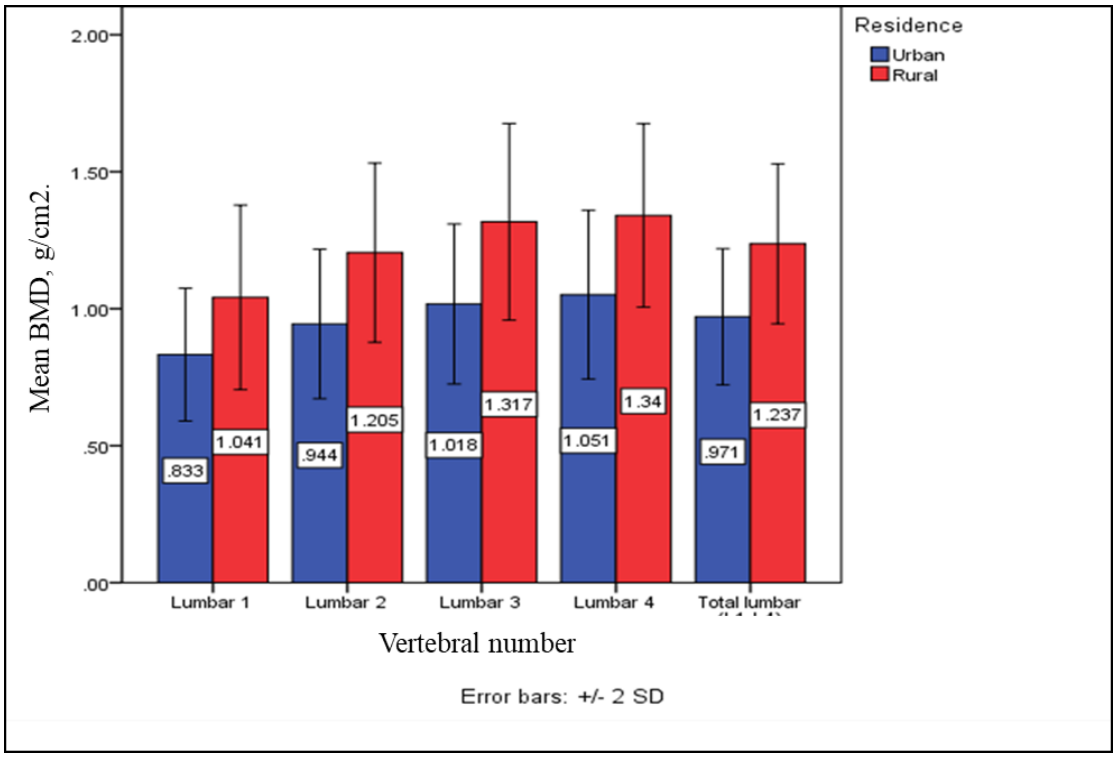

Figure 3: Graphical plot for the mean BMD

The values are 1.04±0.17 g/cm^2 vs. 0.83±0.12 g/cm^2, 1.20±0.16 g/cm^2 vs. 0.94±0.13 g/cm^2, 1.31±0.17 vs. 1.0±0.14 g/cm^2, 1.34±0.16 vs. 1.05±0.15 g/cm^2 and 1.23±0.14 vs. 0.97±0.12 g/cm^2 for each lumbar spine L1, L2, L3, L4, and total L1-L4 in Figure (3).

As shown in Figure 2, the mean BMD of the lumbar spine was higher in the rural than in the urban area for all age groups. The rural group had a higher BMD of 1.30 g/cm2 for categories 50 – 59 years and a lower BMD of 1.19 g/cm^2 for categories 30 – 39 years. While in the urban group, the higher BMD of 1.057 g/cm2 for is categories 40 – 49 years and the lower one is 0.90 g/cm2 for categories 60 – 69 years.

The T-score distribution among the participants according to age group and BMI of the three cases, healthy, overweight, and obesity, is depicted in Figure 4.

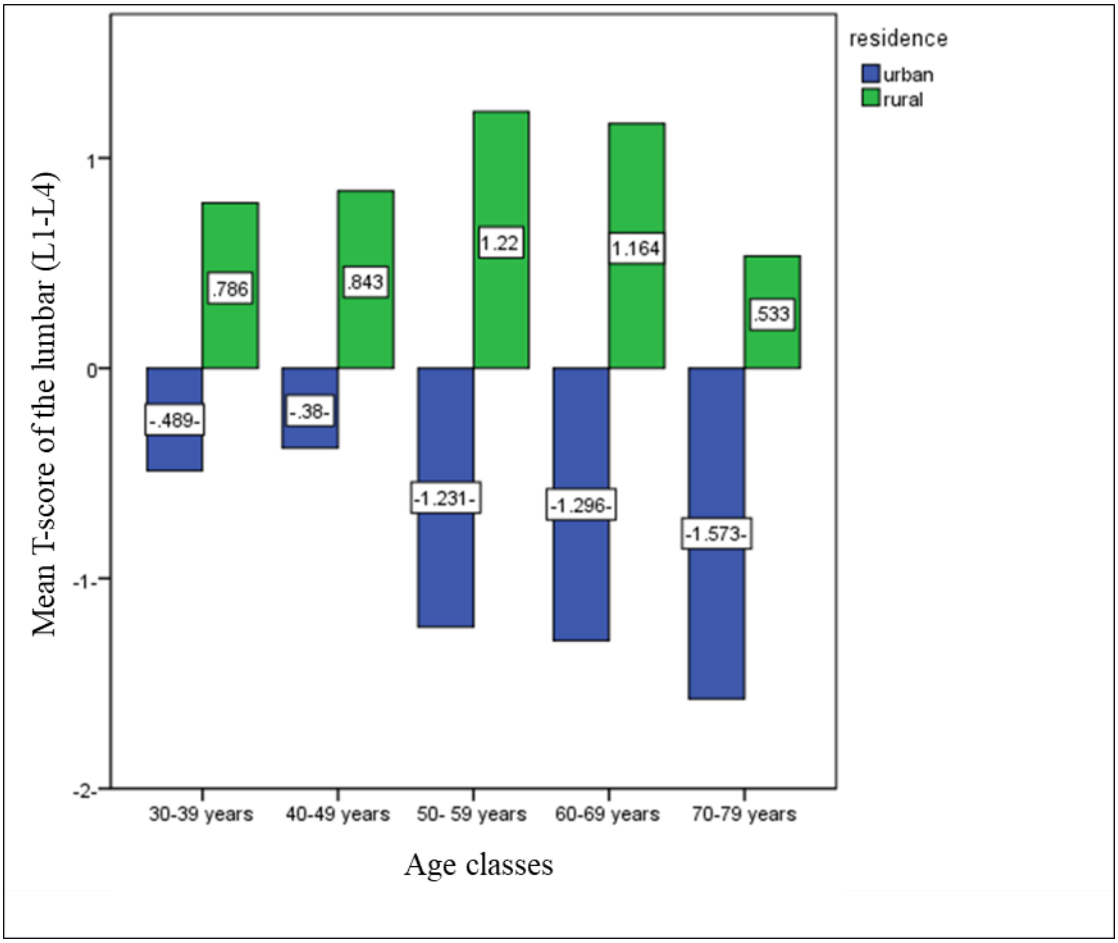

Figure 4: Graphical plot for the total T-score distribution according to age category

The results of the T-score for the L1-L4 is from the class of healthy for the rural group. Its measurements are 0.78, 0.84, 1.22, 1.16 and 0.53 for the categories of 30-39, 40-49, 50-59, 60-69 and 70-79 years, respectively. A higher T-score was in the categories of 50-59 years, while the lower one was in the categories of 70-79 years. Meanwhile, the results of the T-score are from a healthy class for urban group and equal to – 0.48 and – 0.38 for the categories of 30-39 and 40-49 years, respectively. The categories of 50-49, 60-69, and 70-79 years are from the osteopenia class with a degree of – 1.23, - 1.29, and – 1.57 respectively.

Meany measurements are gained from DXA during the assessments. Table 5 describes the parameters like abdomen fat percentage, tissue thickness around the spine segment in (cm), and radiation dose in (µGy) used during the measurements.

Table 5: The parameters that gained using DXA technique.

Parameters	Min.	Max.	Mean	Std. Deviation
Abdomen fat (%)	11.70	47.60	33.62	7.33
Tissue thickness in the spine (cm)	1.4.60	35.16	25.0	3.87
Radiation dose (µGy)	22.91	37.07	28.20	6.87

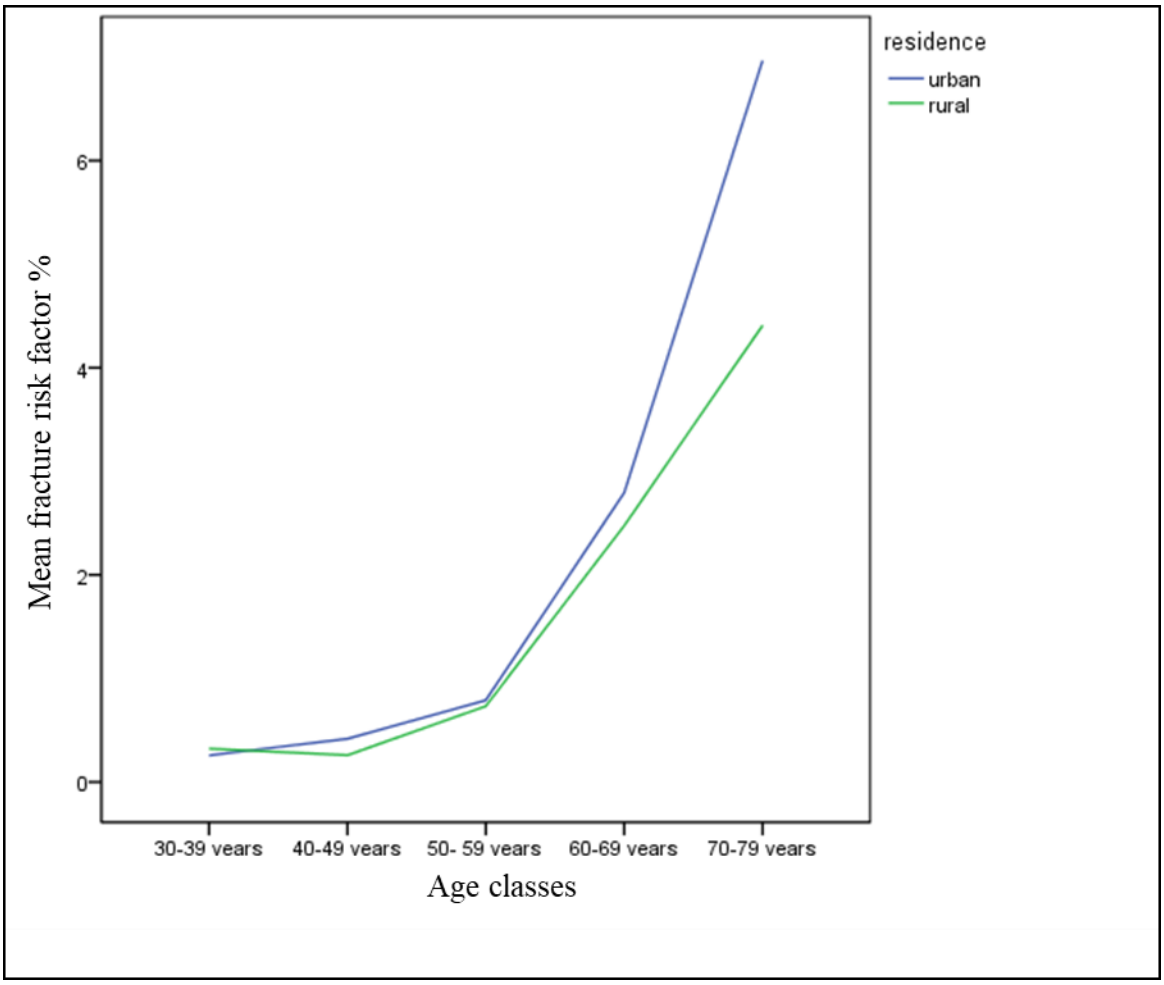

Figure 5: The mean fracture risk factor % changes with age classes.

From Figure 5, the lowest percentage of the mean fracture risk factor (FRF) was in the age 30-39 years and increased gradually as the age interval increased. The highest percentage of FRF was found at the age of 70–79 years, and this figure is because of the loss of BMD associated with menopause.

A correlation between the tissue thickness of the lumbar spine and the abdomen fat percentage for the subjects with highly significant ($p < 0.0001$) as shown in Figure 6.

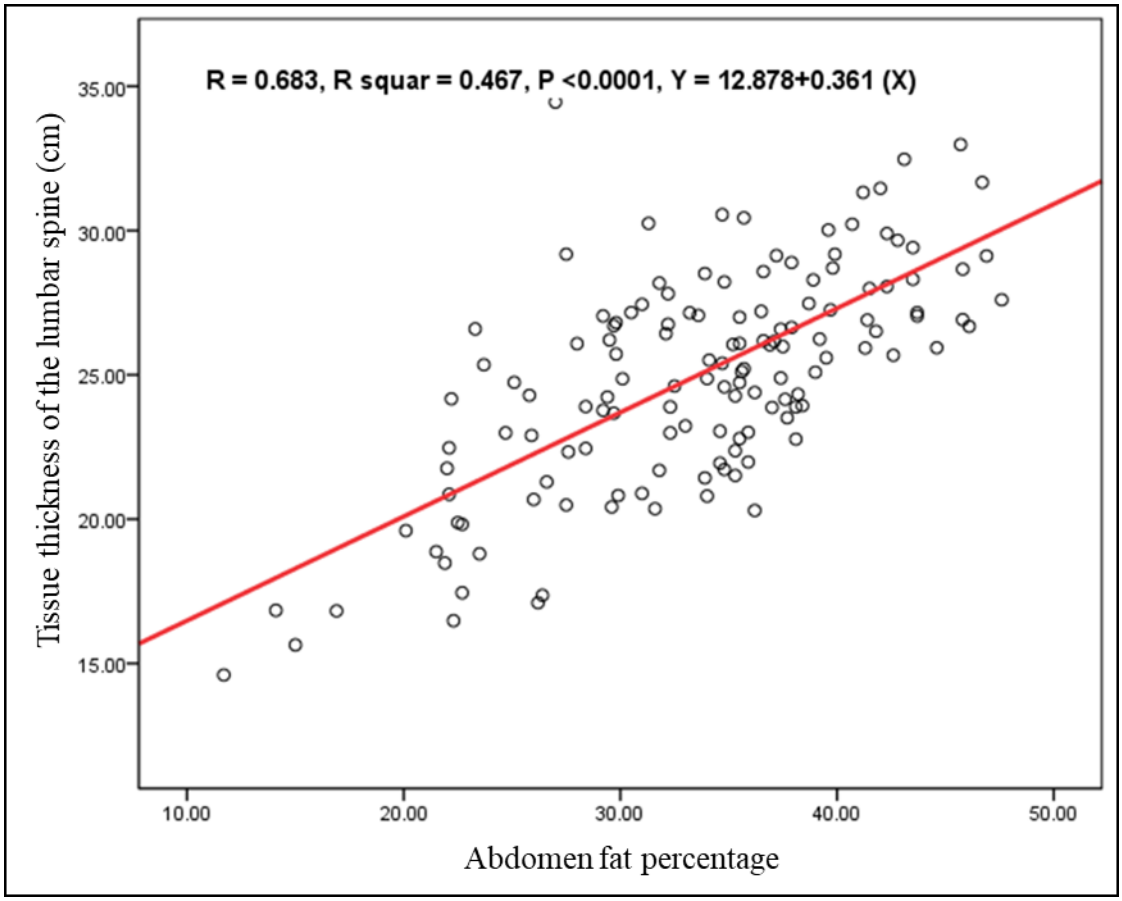

Figure 6: Correlation between the tissue thickness of the lumbar spine and the abdomen fat %.

The lumbar spine tissue thickness was measured using extensive correlation and regression analysis estimated with abdomen fat percentage of the body. The prediction equations have been constructed using the independent variables: (abdomen fat %) to yield a correspondence of the dependent variables that equal the abdomen fat %. The model of the tissue thickness of the lumbar spine estimation became:

Tissue thickness of the lumbar spine = 12.878+ 0.361× (Abdomen fat %) …… (3)

Figure 6 shows that the estimated correlation coefficients (r) are equivalent to 0.68, and the values of the determination coefficient R^2 for all prediction equations demonstrate that the independent variables accounted at least 46% of the variability predicted: $p<0.0001$.

3. Discussion

The study sheds new light on the BMC, BMD, T-score, and Z-score of females living in rural and urban areas of Iraq. Previously conducted studies incorporated quantitative ultrasonography and quantitative computed tomography (QCT) scans [12],[13]. In this study, we used the DXA technique to compute BMD (L1-L4) and also to show the differences in the bone status according to the residence of the participants. But it is helpful to use a DXA method that uses a small amount of X-rays and gives very accurate measurements of bone strength in just two minutes [14] [15].

The samples of the study were selected to make the differences less, especially in the age and BMI, for both samples, in order to match the results between the two groups and yield the bone density for both samples.

The mean BMC in both groups agreed that it was statistically significant in the ages between all subgroups from (30–79) years since; $p < 0.001$. The results show that the amount of BMC is higher in the rural subgroup by 12 (or 18, 29, 27, and 24) % for the age subgroups of (30-39), (40-49), (50-59), (60-69), and (70-79) years, respectively. This Figure 2, was in line with [16].

A study which found a higher BMC among individuals who farmed or ranched more than 75% of their lifetime (rural) versus those who had never lived in rural areas.

The average BMD of the lumbar spine for both groups indicate a highly significant level of p = 0.0001 throughout the ages (30-39), (40-49), (50-59), (60-69), and (70-79), with increases of 12, 13, 26, 25, and 28% over the urban subgroup. These findings corroborate previous research [17] [18] [19].

As illustrated in Figure 2, rural areas have a higher BMD (L1-L4) than urban areas, with a higher BMD of 1.302 g/cm^2 for categories 50–59 years and a lower BMD of 1.197 g/cm^2 for categories 30-39 years. Between 40 and 49 years of age, the BMD L1-L4 is 1.057 g/cm^2, while the lower one is 0.909 g/cm^2.

The advanced measurements for the lumbar vertebrae examinations (partial and complete) revealed that the urban group was 20-23% smaller than the rural group, p 0.0001. Our study is also consistent with that of Demonitrio et al. [19]. According to the study, living a lifetime was associated with a lower rate of BMC loss across all skeletal locations in participants aged 50 and older [20].

Any decline in BMD occurs after the age of 50 and is more closely associated with the onset of menopause in females due to decreased estrogen hormone secretion. So, the current trend toward hormone replacement therapy has good effects on stopping bone loss [21] [22].

As a result of the statistically significant relationship between the mean T-score and the rural subgroups of (30–39), (40–49), (50–59), (60–69), and (70–79) years, the mean T-score is greater in the rural subgroups of (30–39), (40–49), (50–59), (60–69), and (70–79) years, respectively.

According to Figure 4, the T-score, which is a measure of osteoporosis, demonstrates that increasing age is associated with bone loss, particularly after the age of 50. This is why Figure (4) indicates that the group sample falls into the osteopenia category for the urban age subgroups of 50–59, 60–69, and 70–79 years. So, postmenopausal women had lower bone state indices, which was in line with what had been found in previous studies [23], [24], [25],[26].

This research focused on bone health. The measurements revealed that bone loss occurred in the group of people who live in cities versus those who live in villages and rural areas, as well as in all small age groups. This is because the food consumed by rural dwellers is natural, as a result of their vegetable and fruit cultivation. Additionally, their daily manual labor strengthens their bones and muscles. It was also noted that rural groups have a high vitamin D level, as they are exposed to the sun's rays on a daily basis while working in their agricultural fields, which has a beneficial effect on bone density [27] [28] [29] [30].

4. Conclusion:

The mean BMD and BMC of the lumbar spine was higher in the rural than in the urban group for all age groups. The lumbar vertebrae examinations revealed that the urban group was 20 to 23% smaller than the rural group, p =0.0001. The reduction in BMD occurs after the age of 52, and is more closely associated with the onset of menopause in females due to decreased estrogen hormone secretion. The measurements revealed that bone loss occurred in the group of people living in cities versus those living in villages and rural areas.

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مقارنة الكثافة المعدنيه للعظام وكثافة محتوى المعادن العظمي للنساء الساكنات في داخل المدن وخارجها ضمن محافظة نينوى

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الملخص:

تم اجراء قياسات صحة العظام للنساء في المجموعة الحضرية ومقارنتها بالمجموعة الريفية. وقد اظهرت التقييمات التي تمت على اجراء قياسات المحتوى المعدني للعظام (**BMC**) وكثافة المعادن في العظام (**BMD**). أجريت هذه الدراسة المقطعية في مختبر **DXA** ضمن فرع الفسلجه / كلية الطب / جامعة نينوى / الموصل العراق. تمت الفحوصات على 139 من الإناث الأصحاء من خلال مراجعتهم المركز الطبي بالكلية. حيث تم تقسيم العينه إلى مجموعتين: ريفية وتشمل(53 مشاركًا) وحضرية وتشمل(86 مشاركًا). حيث تم اجراء القياسات الجسمية للمشاركات في الدراسة مثل قياسات **T**- و **Z**- باستخدام جهاز الدكسا من نوع (**STRATOS**) التابع لشركه (**DMS**) الفرنسيه. تم تقسيم عينة البحث الى مجموعات صغيرة, و حسب الفئات لفترة الاعمار من 30 – 79 سنة و تم تقسيمها لمجاميع صغيرة اي كل عشرة سنوات عمرية. و اظهرت النتائج ان كلا من المحتوى المعدني للعظام و كثافة العظام المعدنية كانت ذو قيمة عالية لمجموعة النساء الساكنة في البيئة الريفية مقارنة مع مجموعة النساء ذوات البيئة الحضرية و ذات دلاله احصائية معنوية.