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Prediction of BMD based on Body Mass Index in Patients scanning by Dual-Energy X-Ray Absorptiometry -A Retrospective Analysis

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Abstract— Background: Bone Mineral Density (BMD), which uses a specialized scan to measure the density of minerals present in bones, can be measured using Body Mass Index (BMI), which is a good indicator. **The aim** of this study to predict the BMD based on body parameters such as BMI, height and age. **Method and Results**: a retrospective study was conducted at King Abdullah Bin Abdul-Aziz Hospital University between May 2022 and August 2022. Seventy patients were selected based on the selection criteria. DEXA scan done for hip joints and lumber spine .The data was coded and analyzed using SPSS version 26 , DEXA results are obtained in T & Z score , the study found 70 patients comprised 82.9% (n=58) female and 17.1% (n=12) male .The descriptive statistical evaluation results showed that the mean age of the patients was 61.31(±12.30) years and observed mean BMI was 29.98 (±6.92) kg/m2 ,this study found that had linear regression relation between T and Z score of hip joints and spine and patients BMI (P < 0.0001) also showed that had linear relation between Z & T of spine score and patients height and age respectively. **Conclusion**: This study concluded that can predict the Z & T score of hip joints and spine from patient's body parameters such as BMI ,age and height .

Keywords: Bone Mineral Density; Body parameters; Dual Energy X-Ray Absorptiometry

1-Introduction

Bone Mineral Density (BMD), which uses a specialized scan to measure the density of minerals present in bones, can be measured using Body Mass Index (BMI), which is a good indicator[1]. Osteoporosis is characterized by low BMD, impaired bone architecture and is represented by an increased fracture risk. Its major complications include osteoporotic fractures, which affect men and women and cause significant morbidity and mortality worldwide[2].Osteoporosis has become a major public health issue for senior citizens, based on population age analysis. It was estimated that by 2050, the global incidence of hip fractures will triple by 10% in men, and it may double in women compared with 1990 data[2] .Estimations and projections of probable hip fractures have been performed for various populations in different countries, especially in the older population.[3,4]

The potentially high cumulative rate of fractures, which frequently occur due to an increase in disability [5,6,7]has resulted in a significant social and economic burden related to bone health. BMD has been used to diagnose osteoporosis for several decades. The World Health Organization defines osteoporosis as a BMD score of ≥2.5 standard deviations (SD) below the average for young healthy women[8].The relationship between BMD and osteoporosis has also been documented in the scientific literature [9]. BMD is one of the most powerful predictors of initial osteoporotic fracture [10]. In premenopausal women, a specific BMD value (≥2.5 SD, T-score 2.5 SD) is considered an indicator of osteoporosis in women [9].

BMD is a heritable characteristic, and genetic differences in BMD have been well documented [11]. The relationships between BMD and different diseases, demographic variables, and biochemical and molecular parameters are complex. A comprehensive scientific understanding of such relationships leads to the consideration of BMD as a vital predictor of multiple conditions, including osteoporosis, osteopenia, fracture risk, and others.

The present study was conducted to understand how to obtain BMD results from different parameters such as age, height, weight, and body mass index (BMI). Furthermore, the statistical analysis and evaluation of the obtained results allowed us to understand the interrelation between the parameters and their statistical significance.

2-Methods

2-1 Study location and population

This retrospective study was conducted at King Abdullah Bin Abdul-Aziz hospital university between May 2022 and August 2022.Adult patients included in the study were admitted to the DEXA Department. Strict selection criteria were implemented, and patients with spinal abnormalities or artificial hip joints were excluded from the present study. This study was approved by Institutional Review Broad(IRB) Princess Nourahbint Abdulrahman University (IRB number: 22-0323).

2-2 DEXA protocol

DEXA was used to determine the bone mineral density of the selected patient population. DEXA machines use low-dose X-ray beams with two different energies. Such beams are used to depict the patients' bone and soft tissue absorption. Subsequently, the patients' BMDs are determined by subtracting the absorption of soft tissues from the overall absorption.

The results obtained from the DEXA scan are presented through the T- and Z-scores; the T-score indicates the difference between the patients' measured BMD and the ideal peak bone mass achieved by a young adult, and the Z-score indicates the difference between the patients' measured BMD and the ideal peak bone mass achieved by age-matched peers.

Data were collected and tabulated in a spreadsheet, and statistical analysis were performed using the statistical package SPSS® version 26. Descriptive and inferential statistical calculations were used to analyze the data. A paired t-test was used to compare the means where the level of significance was 0.05 ($P < 0.05$).

3-Results

The final dataset of 70 patients comprised 82.9% (n=58) female and 17.1% (n=12) male patients.(Table 1) .The descriptive statistical evaluation results for the important parameters considered in this study are presented in (Table 2). The mean age of the patients was 61.31(±12.30) years, with a minimum age of 25 years and a maximum age of 83 years. Their observed mean weight was 78.24 (±22.11) kg and the calculated mean BMI was 29.98 (±6.92) kg/m2 (Table 2).

The Z-score for the spine examination was -1.76 (±1.86), and for the hip, it was -0.79 (±1.39). Similarly, the T-score obtained from the spinal cord examination was -1.29 (±1.71), and from the examination of the hip, it was -1.13 (±2.08) (Table 2).

The regression model developed with the Z-score of the spine as a dependent variable and other parameters as predictors showed that BMI and height were significant contributors ($P<0.05$) (Table

3). In contrast, analysis with the T-score of the spine examination as a dependent variable suggested that BMI and age were the major and significant predictor variables (P<0.05) (Table 4). A similar regression analysis was conducted using the T-score of the hip as the dependent variable (Table 5). BMI was a significant (P<0.05) contributing predictor variable for T-score (hip).

Table 1. Shows distribution of gender

Gender	Frequency	Percent
Male	12	17.1%
Female	58	82.9%

Table 2. Statistical analysis outcomes of the descriptive analysis (mean, standard deviation, minimum and maximum) of the demographic variables

Statistics	Age	Weight	Height	BMI	Z-score Spine	T-score Spine	Z-score Hip	T-score Hip
Mean	61.31	78.24	158.16	29.98	-1.76	-1.29	-0.79	-1.13
Standard deviation	12.306	22.112	13.817	6.9275	1.86	1.71	1.39	2.08
Minimum	25	43	104	12.9	-5.70	-5.00	-3.50	-9.00
Maximum	83	169	182	49.5	3.30	5.80	2.50	3.80

BMI, body mass index

Table 3. Association between the Z-scores of spine analysis, BMI and height.

Coefficients [a]	Unstandardized Coefficients		
Model	B	t	Significance
(Constant)	-11.937	-4.057	0.000
BMI	0.115	3.670	0.000
Height	0.042	2.701	0.009

[a] Dependent variable: Z_ score spine
BMI, Body Mass Index

Table 4. Association between the T-scores of spine analysis, BMI and age.

	Coefficients [a]		
	Unstandardized Coefficients		
Model	B	t	Significance
(Constant)	-6.274	-4.610	0.000
BMI	0.103	3.729	0.000
Age	0.031	2.003	0.049

[a] Dependent variable: T_ score spine
BMI, Body Mass Index

4-Discussion

The DEXA method is a global standard procedure used to evaluate and estimate body composition[12], bone density, and bone mineral density[13,14] and helps in understanding medical conditions such as osteoporosis and osteopenia. Our study conducted to predict BMD from body parameters using DEXA scan.

In the present study, BMD was evaluated by scanning the hip and spine regions (L2–L4), and the obtained results were presented as T-scores and Z-scores. The standard categorization of BMI by the center for disease control and prevention CDC indicates that a BMI of <18.5 is underweight, between 18.5 and 24.9 is normal, between 25.0 and 29.9 is overweight, and ≥30.0 is obese. Therefore, the mean BMI of the study participants (29.981 ± 6.92) was borderline for obesity(Table 2).

This study showed linear relation between BMD, BMI and age as BMI and age increased, the BMD will be decrease which was approximately consistent with previous studies have shown that bone mineral density is directly related to age and BMI, especially in patients with rheumatoid arthritis; low BMD is associated with increased age and low BMI[15]and also other study using DEXA analysis of BMI and BMD in the Middle East Asian population of the United Arab Emirates, it was suggested that low BMD may occur due to growing age and reduced BMI [1]. In female patients with Crohn's disease, a lower BMD was associated with low BMI and higher platelet counts.[16] Furthermore, BMD is associated with certain risk factors, such as hip fracture, osteoporosis[17] ,osteopenia[18] and other conditions.

Several studies related to BMD have been conducted in the African population. In an older (>65 years) female African population, a lower mean BMD was observed in patients with hypertension taking diuretics [19]. The differential relationship between obesity and bone density has been evaluated in different global populations, suggesting an inverse correlation between BMI and BMD in the African-American female population[20]. Another study conducted on the Sudanese postmenopausal female population suggested no correlation between lipid profile and BMD [21].

5-Conclusions

We concluded that the DEXA results of the hip were significantly associated with BMI only; the obtained regression equations are as follows:

And the Z-score of the spine was significantly associated with the BMI and height, whereas the spine T-score was associated with BMI. The obtained regression equations were as follows:

$$Zspine_{score} = BMI \cdot 0.115 + height \cdot 0.042 - 11.937 \text{(Equation. 1)}$$

$$Tspine_{score} = BMI \cdot 0.103 + age \cdot 0.031 - 6.274 \text{ (Equation. 2)}$$

$$T^{hip}_{score} = BMI \cdot 0.092 - 3.905 \text{ (Equation. 3)}$$

$$Z^{hip}_{score} = BMI \cdot 0.066 - 2.778 \text{ (Equation. 4).}$$

6-Limitations and Recommendations

The present study was limited to a small number of participants, and the study sample was confined for one hospital. For generalized confirmation and establishing a relationship with other parameters, a larger multicenter study with a diverse study population should be conducted. Evaluation of DEXA with other imaging modalities, such as quantitative computed tomography and ultrasound, and additional relevant parameter considerations are required to confirm and generalize the outcomes of the present study.

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Appendix

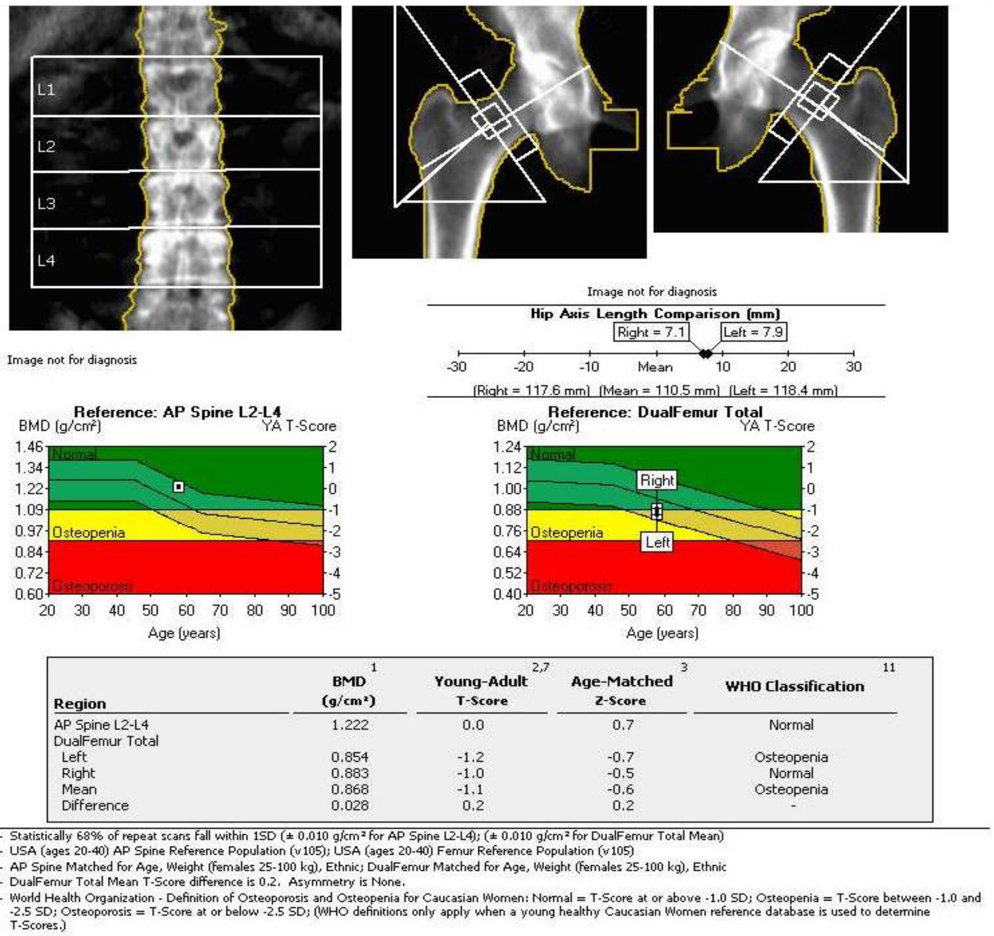

Figure 1. A sample dual energy X-ray absorptiometry report of a study participant. BMD, bone mineral density; AP, Anteroposterior; WHO, World Health Organization