Regional fat, weight and osteoporosis in elderly women in Egypt

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الدهن الناحي، الوزن، وتخلخل العظام في النساء المسنات في مصر

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الخلاصة: في سبيل اختبار فرضية كون دهن الناحية – وليس وزن الجسم الإجمالي – ذا تأثير وقائي على كثافة تَمَعْدُن العظام في النساء بعد سن الإياس، أجريَت دراسة مستعرضة في المدة من آذار/ مارس 2008 حتى حزيران/ يونيو 2009 شملت 303 نساء في سن الإياس متمتعات بالصحة، أثناء مراجعتهن لوحدة تخلخل العظام بُغْيَةَ التحري عنه. وقد قيسَت كثافة تَمَعْدُن العظام في الفقرات القطنية من الثانية حتى الرابعة في العمود الفقري، وعنق عظم الفخذ الأيسر عن طريق قياس امتصاص الأشعة السينية المزدوج الطاقة. وقيسَت نسبة دهن الناحية باستخدام الـمِفراس نفسه. وفي حين كان فرط الوزن كان عاملاً مستقلاً واقياً من كل من تخلخل عظام العمود الفقري (OR = 0.397، 95CI٪ = 0.214–0.739)؛ ومن تخلخل عظام الفخذ (OR = 0.289، 95CI٪ = 0.151–0.533)، فإن نسبة الدهن النَّاحيِّ لم تكن ذات تأثير وقائي.

ABSTRACT To test the hypothesis that regional fat and not total body weight has a protective effect on bone mineral density (BMD) in postmenopausal women, a cross-sectional study was conducted during the period from March 2008 to June 2009 on 303 healthy postmenopausal women presenting to the osteoporosis unit for screening purposes. BMD of the lumbar spine, L2–L4, and the neck of the left femur were measured by dual energy X-ray absorptiometry. Regional fat percentage was measured using the same scanner. While overweight was an independent protective factor for both spinal and femoral osteoporosis (OR = 0.397, 95% CI: 0.214–0.739; OR = 0.289, 95% CI: 0.151–0.553 respectively), regional fat percentage was not.

Graisses localisées, poids et ostéoporose chez les femmes âgées en Égypte

RÉSUMÉ Pour vérifier l'hypothèse selon laquelle les graisses localisées et non le poids corporel total ont un effet protecteur sur la densité minérale osseuse des femmes ménopausées, une étude transversale a été menée entre mars 2008 et juin 2009 sur 303 femmes ménopausées en bonne santé consultant le service de soins de l'ostéoporose à des fins de dépistage. La densité minérale osseuse du rachis lombaire, des disques L2–L4 et du col du fémur gauche a été mesurée par absorptiométrie biénergétique aux rayons X. Le pourcentage de graisses localisées a été mesuré avec la même méthode. Si le surpoids est un facteur protecteur indépendant à la fois de l'ostéoporose du rachis et du fémur (O.R. = 0,397 ; IC à 95 % : 0,214–0,739 ; O.R. = 0,289 ; IC à 95 % : 0,151–0,553 respectivement), ce n'est pas le cas pour le pourcentage de graisses localisées.

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Introduction

With increasing life expectancy, osteoporosis is becoming a major worldwide health problem affecting the elderly, especially women. The magnitude of the disease may become larger in developing countries, more particularly in the Middle East region where the prevalence of low bone mass is higher [1].

Recent studies have shown that obesity and osteoporosis share several common genetic and environmental factors [2]. Body fat mass, a component of body weight, is an important measure of obesity, and a considerable evidence indicates that fat mass may have beneficial effects on bone [2]. Women with more body fat have lower rates of bone resorption (an independent predictor of fracture) during menopause than women with less body fat [3]. In women, bone mineral status is much more closely associated with total body fat [4] and in a multivariate model total fat mass alone was correlated with whole body BMD [5].

To corroborate the reported data that regional fat topography may influence the bone mass independently of total adiposity [6], this study aimed to test the hypothesis that regional fat and not total body weight has a protective effect on BMD in postmenopausal women.

Methods

The study population consisted of all 303 apparently healthy postmenopausal women (women who had not had a menstrual period for ≥ 1 year [7]) presenting to the Osteoporosis Unit, Geriatrics and Gerontology Department, Ain Shams University Hospitals, Cairo for screening for BMD over a period of 16 months, March 2008–June 2009. There were no refusals to participate and all women gave verbal informed consent.

None of these women had a history of diagnosed low BMD and no history of any proven risk factor for osteoporosis apart from all being postmenopausal. None of the women had ever received any anti-resorptive treatment or any other drugs with known effect on bone mass.

BMD was measured by dual-energy X-ray absorptiometry (DEXA). Measurements were done at 2 sites: the lumbar spine (L2–L4) in the anteroposterior position, and the proximal femur (neck) on the left side using a densitometer (LUNAR DPX-MD+). Percentage regional fat in the paraspinal area and around the neck of the left femur was measured using the same scanner. All scans were performed by trained physicians and analysed by the researcher. Quality control procedures were followed in accordance with the manufacturer's recommendations. Daily routine calibration was done using the standard phantom supplied by the manufacturer. According to the manufacturer's recommendations, scan velocity was selected according to trunk height: fast mode for scanning subjects who are < 15 cm thick in the trunk region, medium mode for those who are 15–25 cm thick and slow mode for those who are > 25 cm thick. Abdominal sagittal height was used as an index of trunk height.

Weight and height were measured using a weighing machine with a height measuring scale (Wunder, Italy). Each woman was measured without shoes, standing with her feet together, and with her heels against the wall, standing totally erect and looking straight ahead without tipping the head up or down. The top of the ear and the outer corner of the eye were in a line parallel to the floor. Body mass index (BMI) was calculated as weight (kg)/height $(m)^2$. Women were classed as overweight if their BMI was > 27.3 kg/m^2 and obese if BMI was > 30 kg/m^2 [8].

The collected data were coded, tabulated, revised and statistically analysed using *SPSS*, version 17. Descriptive statistics were done for numerical data using mean and standard deviation and for category data by number and percentage. Correlations were done using the Pearson correlation. A logistic regression model was done for detection of the independent risk factors for osteoporosis of the lumbar spinal and the neck of the left femur. The significance of individual coefficients in the model was assessed by the Hosmer–Lemeshow test for goodness of fit and Wald χ^2 statistics. Level of significance was taken as *P*-value < 0.05.

Results

The age range of the 303 participants involved in this study, all apparently healthy postmenopausal women, was 56.6–90.0 years; 135 (44.6%) women were aged < 65 years, 132 (43.6%) were 65–< 75 years and only 36 (11.9%) were ≥ 75 years (Table 1). Age at menopause ranged from 29 to 61 years.

A total of 44.9% of the women reported a history of hypertension, but

Table 1 Characteristics of the participants, 303 postmenopausal women in Cairo

Characteristic	Mean	SD	Range
Age (years)	66.5	6.31	55.6–90.0
Age at onset of menopause (years)	49.5	4.9	29.0–61.0
Years since onset of menopause	16.9	7.7	2.0–40.0
No. of pregnancies	5.6	3.0	0–16
Weight (kg)	78.3	18.2	32.0–128.0
BMI (kg/m^2)	33.0	7.1	16.0–54.1

SD = standard deviation; BMI = body mass index.

Table 2 Correlation of bone mineral density (BMD) and regional fat percentage in postmenopausal women in Cairo (*n* = 303)

Risk factor	BMD (g/cm³)				Regional fat (%)			
	Paraspinal		Around neck of left femur		Paraspinal		Around neck of left femur	
	r	*P*	*r*	*P*	*r*	*P*	*r*	*P*
Age	–0.202	< 0.001	–0.365	< 0.001	–0.209	< 0.001	–0.464	< 0.001
No. of pregnancies	–0.052	0.363	–0.037	0.526	0.11	0.055	–0.062	0.285
Age at menopause	0.167	0.004	0.060	0.295	0.046	0.429	0.118	0.041
Years since menopause	–0.283	< 0.001	–0.339	< 0.001	–0.189	0.001	–0.456	< 0.001
Weight	0.315	< 0.001	0.335	< 0.001	0.599	< 0.001	0.457	< 0.001
Body mass index	0.276	< 0.001	0.284	< 0.001	0.625	< 0.001	0.623	< 0.001
Paraspine fat %	0.205	< 0.001	0.249	< 0.001	–	–	–	–
Parafemur fat %	0.034	0.558	0.100	0.081	–	–	–	–
Total cholesterol[a]	0.196	0.046	0.198	0.043	0.296	0.002	0.246	0.011
Triglycerides[a]	–0.001	0.995	–0.051	0.606	0.110	0.265	0.097	0.324

[a] *n = 105.*
r = Pearson correlation coefficient.

Table 3 Correlation between bone mineral density (BMD) and regional fat percentage within weight strata in postmenopausal women in Cairo (*n* = 303)

Weight quartile/% fat	BMD (g/cm³)			
	Lumbar spine		Neck of left femur	
	r	*P*	*r*	*P*
Q1				
Paraspinal	0.059	0.61	–	–
Parafemur	–	–	–0.017	0.88
Q2				
Paraspinal	0.035	0.76	–	–
Parafemur	–	–	0.102	0.383
Q3				
Paraspinal	0.102	0.38	–	–
Parafemur	–	–	–0.216	0.06
Q4				
Paraspinal	–0.041	0.73	–	–
Parafemur	–	–	–0.21	0.07

Q1 = weight ≤ 65 kg (n = 77; Q2 = weight 66–78 kg n = 75); Q3 = weight 79–90 kg (n = 77); Q4 = weight > 90 kg (n = 74).
r = Pearson correlation coefficient.

none were on diuretic therapy; 21.8% had type 2 diabetes, 14.9% had coronary artery disease, 7.6% had had a transient ischaemic attack or cerebrovascular stroke without residual weakness, 1.3% had peripheral artery disease and 68 (22.4%) had non-traumatic fragility fracture. The results of this study indicated that none of these medical conditions had a statistically significant relation with BMD in elderly women.

The women ranged in weight from 32 to 128 kg (Table 1). Body mass index (BMI) ranged from 16.0 to 54.1 (mean 32.98, SD 7.1 kg/m^2); 77.9% of the women were overweight (BMI > 27.3 kg/m^2) and 68.3% were obese (> 30 kg/m^2).

Osteoporosis of the lumbar spine was found in 52.0% of the participants (T-score ≤ –2.5) and 25.7% had osteoporosis of the neck of the left femur.

Only 105 of the 303 participants had a recent lipid profile (total cholesterol and triglyceride levels) in their medical records: 53.3% of them had hypercholesterolaemia (> 200 mg/dL) and 22.9% had hypertriglyceridaemia (> 160 mg/dL).

BMD of the lumbar spine and the neck of the left femur was significantly positively correlated with weight and paraspinal fat percentage ($P < 0.05$) (Table 2).

For further analysis, the sample population was stratified according to body weight into quartiles. Correlations between BMD and regional fat percentage within weight strata showed that there was no statistically significant correlation between BMD and regional fat percentage at both sites (Table 3).

Table 4 Logistic regression model for detection of independent risk factors for spinal osteoporosis in postmenopausal women in Cairo (final model)

Risk factor	B	SE	*P*	OR	95% CI
Duration of menopause	0.068	0.017	< 0.001	1.070	1.035–1.107
Overweight	–0.923	0.317	0.004	0.397	0.214–0.739
Constant	–0.307	0.424	0.469	0.736	–

Hosmer and Lemeshow test: $\chi^2 = 7.645$, P = 0.469.
B = regression coefficient; SE = standard error; OR = odds ratio; CI = confidence interval.

Table 5 Logistic regression model for detection of independent risk factors for femoral osteoporosis in postmenopausal women in Cairo (final model)

Risk factor	B	SE	*P*	OR	95% CI
Age at menopause	0.096	0.037	0.010	1.100	1.024–1.183
Duration of menopause	0.126	.025	< 0.001	1.134	1.080–1.190
Height	–0.059	.026	0.020	0.943	0.897–0.991
Overweight	–1.243	0.332	< 0.001	0.289	0.151–0.553
Constant	1.891	4.362	0.665	6.629	

Hosmer and Lemeshow test: $\chi^2 = 8.323$, P = 0.403.
B = regression coefficient; SE = standard error; OR = odds ratio; CI = confidence interval.

A logistic regression model for detection of independent risk factors for spinal and femoral osteoporosis was carried out. By successive removal of the least significant risk factors, the final model indicated that, while regional fat percentage failed to be significantly associated with osteoporosis (OR = 0.972, 95% CI: 0.945–1.0, *P* = 0.05 for paraspinal fat percentage), overweight had an independent effect on BMD of both the lumbar spine and the neck of the left femur (Tables 4 and 5).

In overweight women (BMI > 27.3 kg/m^2), the risk of having spinal osteoporosis was 0.92 times lower and the risk of having femoral osteoporosis was 1.24 times lower than normal weight women (Tables 4 and 5), and for every kilogram increase in weight, OR for BMD would decrease by 0.397 for spinal osteoporosis and 0.29 for femoral osteoporosis.

Discussion

The hypothesis that there is a protective effect of regional fat and not the body weight on BMD in postmenopausal women was tested in this study.

BMD of both lumbar spine and neck of left femur were associated with the traditional risk factors; BMD decreased with ageing, lower menopause age and more years since menopause (more time with lower estrogenic state). In addition, BMD had a statistically significant positive correlation with body weight and BMI. Furthermore, the results of the current study revealed that BMD was significantly positively correlated with regional fat percentage (higher values of fat mass may have a protective effect on bone density [5]). However, when logistic regression analysis was done, regional fat failed to show an independent effect on low BMD, while total body weight was protective against low BMD. There was also no statistically significant correlation between BMD and regional fat percentage in both sites within the weight strata.

A number of mechanisms for the fat–bone relationship exist and include the effect of regional soft tissue mass on skeletal loading and the association of fat mass with the secretion of bone active hormones (e.g. estrogens and leptin) from the adipocyte, as well as the secretion of bone active hormones from pancreatic beta cells (including insulin, amylin and preptin) [9].

The conflicting results suggest that there is a complex relationship between fat mass and bone mass, which is likely to be related to the patient's age, sex and ethnicity [10].

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