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BONE MINERAL DENSITY IN MIDLIFE WOMEN: THE STUDY OF WOMEN'S HEALTH IN QATAR

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Abstract

Objectives—The aim of this study is to investigate bone mineral density (BMD) for a large cross-section of midlife Arab women living in Qatar and to evaluate the association of body mass index, menopause status, and nationality, on BMD of the spine and femur.

Study design—A cross-sectional study was conducted among women aged 40–60 recruited from nine primary care health centers in Qatar. BMD (g/m²) was assessed at the lumbar spine and the femur.

Results—The combined prevalence of osteopenia and osteoporosis was 4% at the femur and 16.2% at the spine. BMI and menstrual status were both independently associated with BMD at the spine and at the femur (all p values <0.001). As BMI increased, BMD increased at both the spine and femur. Women who menstruated in the past 12 months had 0.82 g/cm² and 0.61 g/cm² greater BMD at the spine and femur, respectively, compared with women who had not menstruated in 12 months. Nationality was not associated with mean BMD of the spine or the femur.

Conclusions—No significant differences were observed between Qatari and non-Qatari women in terms of mean BMD values at the spine and the femur except for femur in the age group 55–60, where values were lower among non-Qataris (p=0.04). Multivariate analysis showed that BMI and menstrual status were found to be strongly associated with BMD levels at the spine and femur. The high prevalence of obesity observed in this sample may explain the low levels of osteopenia and osteoporosis observed.

Keywords

Bone mineral density; menopause; body mass index; Qatar

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Conflict of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

INTRODUCTION

The widespread use of dual-energy x-ray absorptiometry (DXA) has enabled the assessment of bone mineral density (BMD) at various skeletal sites (1). Numerous studies have reported the great variation in BMD levels by age group, sex, and geographical area (2,3) and by ethnicity/race (4). BMD values also differ widely among local regions, such as the Gulf States (2,5,6). Reference ranges for BMD have been reported for Qatari (7), Emirati (8), Saudi (1), and Kuwaiti (9) female populations using DXA and have been found to be generally lower than Caucasian populations (10). In a previous study comparing BMD measurements of Qatari women to women from Kuwait, Saudi Arabia, and Lebanon, Qatari women were found to have lower BMD values of the spine when compared to Kuwaiti women but higher levels than Lebanese women and levels similar to Saudi women (7). BMD values of the total femur were higher in Qatari women aged 40–59 years compared with Kuwaiti, Saudi, and Lebanese women (7).

The effect of body mass on bone density has been well documented, indicating that obesity plays a protective role in rates of bone loss, especially in late perimenopause and after menopause (11,12). In the Study of Women's Health Across the Nation (SWAN), body size was reported to attenuate differences in changes in bone resorption observed between ethnic groups (11,13).

Cross-sectional studies (14) and prospective investigations (13,15) have reported the strong relationship between the endogenous hormone environment and BMD. Studies conducted in the Gulf region have rarely reported the independent effects of menopausal status and body size simultaneously (14). The aim of this study is to report BMD for a large cross-section of midlife Arab women living in Qatar and to evaluate the association of body mass index, menopause status, and additionally, nationality, on BMD of the spine and femur. BMD levels will be compared to earlier results from Qatar and to those of other neighboring Arab countries.

MATERIALS AND METHODS

Participants

The Study of Women's Health in Qatar: Examining the physical, biological, psychological and social changes in women in their middle years (SWIQ) is a two-phase, mixed methods study conducted in Doha, in the State of Qatar. A report on the qualitative phase of the study has been previously reported (16). The data for this study were derived from a cross-sectional study conducted from July 2011 through May 2012. Women were recruited from nine primary care health centers. The health centers were selected to represent geographically, East, West, North, South and Central locations of the population in Qatar.

Participants were eligible for inclusion if they were between 40 and 60 years of age, were either of Qatari nationality or other Arab nationals, and were Arabic or English speaking. Participants were excluded if they had a history of bilateral oophorectomy. The protocol and consent form were approved by the institutional review boards for research involving human participants at each institution.

The survey instrument was first developed in English and then translated into Arabic. The survey instrument was piloted during the qualitative phase of focus groups, to ensure clarity and appropriateness of language. Surveys were then back-translated into Arabic to confirm the quality of the translation. A total of 638 women met the eligibility criteria and completed the survey and had a valid DXA study.

Data from the current study were compared to data obtained in a previous study conducted in Qatar (7), using similar methods. In the study by Hammoudeh et al, BMD was measured at the lumbar spine anterior-posteriorly and right and left femur using DXA with Lunar Expert XL Scanner (7). Women with Qatari nationality only were included in the Hammoudeh et al study (7).

Measures

Bone mineral densitometry measurements—BMD (g/m^2) was assessed at the BMD unit using a Lunar Prodigy DXA system (Lunar Corp., Madison, WI). The antero-posterior lumbar spine (L2-L4) and the mean of the proximal right and left femur (including total femur, neck, Ward's triangle and the trochanter) were measured by two technologists and then reviewed by one rheumatologist using methods described (7,12). Quality control of the DXA scanner included daily calibration and duplicate measures of a sample of the participants. The precision of the system, reported in a previous study, was found to be 1.6% for the spine and 1.2% for the total femur (7,12). BMD was categorized according to the World Health Organization criteria based on the T-score. Values between -1.0 and -2.5 were classified as osteopenia, a T-score of -2.5 or below as osteoporosis, and a T-score of -1.0 and above as normal (17).

Anthropometric measurements—Height and weight were assessed twice by physical examination by a technician. The average of each pair of assessments was used. Body mass index (BMI) was calculated as weight (in kilograms) divided by the square of height (in meters).

Menstrual status

Questions about menopausal status included: asking about the last menstrual cycle, whether menstruation had occurred in the previous 12 months, any menstrual irregularity, and whether a cycle had changed in length. Menopausal status was categorized into premenopausal, perimenopausal, and postmenopausal. If a woman had not menstruated in the past 12 months, she was categorized as post-menopausal. If a woman had a regular menstrual period within the past 12 months with no change in cycle length and no missed cycle, she was categorized as premenopausal. Perimenopause was defined as having had a regular menstrual period within the past 12 months and either a change in cycle length or a missed cycle. Women having a hysterectomy but at least one ovary were categorized separately.

Statistical Analysis

Data were expressed as mean and standard deviation (SD) unless otherwise stated. Student's t-test was used to compare group means of continuous variables. Multivariable regression

analyses were used to evaluate the independent associations between nationality, BMI, menopause status, and BMD values. The odds ratios, 95% confidence intervals, and p values of the covariates were reported. All statistical tests were 2-sided, and $p < 0.05$ was considered statistically significant. Analyses were performed using SAS version 9.2 software (SAS Institute, Inc.).

RESULTS

Selected characteristics of the 636 female participants are presented in Table 1. Approximately half were between 40–49 years of age and half were 50–60 years. A good proportion were obese (73.3%) and overweight (22.5%). Nearly half of them were in perimenopausal status (42.3%) followed by postmenopausal women (32.1%).

Table 2 compares the mean BMD ($\pm$ SD) measurements at the spine by nationality and age group. Mean BMD of the spine was nearly stable for Qatari women in the age group 40–44 years (1.168 ± 0.122) and 45–49 years (1.171 ± 0.168) and then decreased after age 50. For non-Qatari women, mean BMD of the spine decreased as age increased (Figure 1). No statistical differences in means are found between women of Qatari vs non-Qatari nationality

Table 3 shows mean BMD at femoral sites by age and nationality. BMD values gradually decreased with age and become significantly lower at age 55–60 at the trochanter and total femur among non-Qataris compared to Qataris (Figure 2).

Table 4 presents the distribution of BMD T-score categories of the spine and total femur by age for the entire cohort. The prevalence of osteoporosis and osteopenia of the spine was 1.4% and 14.8%, respectively. For the total femur, the prevalence of both osteoporosis (0.2%) and osteopenia (3.8%) was low.

Mean BMD of the spine and femur according to menstrual status are presented in Table 5. Women who had not menstruated in the past 12 months had significantly lower mean BMD at both the spine (1.10 ± 0.16) and total femur (0.95 ± 0.14) compared to women who menstruated in the past 12 months: spine (1.2 ± 0.15) and femur (1.01 ± 0.13) (both p values < 0.0001).

Multiple regression analysis shows that BMI and menstrual status were both independently associated with BMD at the spine and at the femur (Table 6). As BMI increases, BMD increases at both the spine and hip. Women who menstruated in the past 12 months had 0.82 g/cm^2 and 0.61 g/cm^2 greater BMD at the spine and hip, respectively, compared with women who had not menstruated in the last 12 months. Nationality was not associated with mean BMD of the spine or femur.

Table 7 compares mean BMI and mean BMD observed in the current study with mean values in an earlier study conducted in Qatar (7). Mean BMD at the spine was higher among women 50–60 in the current Qatar study than found in the earlier Qatar study, while mean BMD at the femur among women 40–49 in the current study was lower than women aged 40–49 in the previous study conducted in Qatar. Most strikingly, however, is the highly

statistically significant increase in mean BMI observed in both age groups. In the current study, mean BMI was higher in Qatari women in the age group 40–49 years (33.9 kg/m² vs 30.7 kg/m²) and 50–60 years (35.0 kg/m² vs 32.9 kg/m²) compared to previous study in Qatar.

DISCUSSION

This study found that BMD loss among Arab women 40–60 years of age declined very gradually, with changes occurring somewhat earlier at the spine. The prevalence of osteopenia and osteoporosis of both femur and spine was 4% and 16.2%, respectively. Although no significant differences were observed between Qatari and non-Qatari women in terms of BMD at the spine, mean BMD measures were slightly higher among non-Qatari women in the age group 40–54 years, whereas BMD was nearly same for both nationalities in the age group 55–60 years.

In the present study, multivariate analysis showed that BMI and menstrual status were found to be strongly associated with BMD levels at the spine and femur. Previous studies have reported higher BMD in overweight and obese women compared with normal weight women (2,12,18,19). While many of these reports have examined the relationship between BMI and changes in BMD by BMI categories, it is noteworthy that this study observed a strong continuous relationship between BMI and BMD levels in a sample of women where 73.3% of women were obese and 22.5% were overweight. The high prevalence of obesity observed in the study sample could be the reason for low levels of osteopenia and osteoporosis.

The effect of menstrual status was found to be associated with BMD of the spine and femur, both in univariate analysis and after controlling for BMI. Cross-sectional associations between menstrual status and BMD, although highly significant at both the spine and femur, were greater at the spine, where BMD increased 0.82 g/cm² for women still menstruating compared to women who had not menstruated in the previous year.

These results are consistent with other cross-sectional studies (11) but cannot be compared with longitudinal studies that assess the rate of bone loss across the menopausal transition (11,20). Longitudinal research evaluating the risk factors for bone loss and rates of BMD change among women in the Middle East is needed.

To our knowledge, this is the first study conducted in Qatar to compare BMD levels of Qatari nationals to that of non-Qataris. No significant differences were observed between Qatari and non-Qatari women in terms of mean BMD values at the spine and the femur except for femur in the age group 55–60 years ($P=0.036$). In the study sample, it should be noted that non-Qatari women included 18 different nationalities, the most frequent being from Egypt, Jordan, Palestine, Sudan, Lebanon, and Syria. Thus, they represented women of many backgrounds that could have included varied behavioral factors which may impact BMD such as dietary intake and physical activity.

Previous studies have reported on the prevalence of low bone mass in the Middle East, however, some of these have excluded women having BMIs above 30 kg/m² (1,9). Not

surprisingly, given the positive association of BMD with BMI, prevalence rates of osteopenia and osteoporosis were reported to be higher than that observed in the current study. Studies from Kuwait and Qatar, which did not include BMI as an inclusion or exclusion criterion, also reported higher rates of osteopenia and osteoporosis than observed here (2,7). However, it should be noted that the studies from Kuwait and Qatar reported mean levels at least 2 BMI points below those presented in our sample.

Although greater BMI may be seen as “protective” of low bone mass, the growing problem of obesity in the Middle East presents rising concerns related to the increasing rates of hypertension and type 2 diabetes mellitus (21–24). In Qatar, in particular, the prevalence of overweight and obesity has been reported to be over 70% (22,25,26).

This study has some limitations. First, the cross-sectional design does not allow inferences regarding a cause and effect relationship of BMI, menopause status, and nationality with respect to BMD. Secondly, the participants were drawn from nine primary care health centers and may not be representative of the general Arab female population in Qatar. Although these centers were selected to represent the population in Qatar geographically, women going to these centers may have been motivated to monitor or maintain their health.

A strength of this study, however, was the standardized data collection protocols used for assessing BMD, BMI, and menopause status. Height and weight were determined twice by physical examination and the average of the two assessments was used; survey items were rigorously pilot tested to ensure clarity.

Finally, it should be emphasized that the present study was cross-sectional with no data specifically addressing fracture risk. Future work is needed to accurately assess the risk of osteopenia and osteoporosis and its attendant sequelae in this rapidly developing country.

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Figure 1. Bone mineral density (BMD, g/cm²) of Qatari females at spine compared with non-Qatari females

Figure 2.
Bone mineral density (BMD, g/cm²) of Qatari females at femur compared with non-Qatari females

Table 1

Selected Characteristics of the Study Participants

Characteristics	Total Sample (N=636)
Age	
40–49, no. (%)	319 (50.2)
50–60, no. (%)	317 (49.8)
Nationality	
Qatar, no. (%)	270 (42.4)
Non-Qatar, no. (%)	366 (57.5)
Egypt	116 (18.2)
Jordan	62 (9.7)
Palestine	51 (8.0)
Sudan	32 (5.0)
Lebanon	28 (4.4)
Syria	23 (3.6)
Others	54 (8.5)
Body Mass Index (kg/m²)	
24.9	27 (4.3)
25–29.9	143 (22.5)
30	466 (73.3)
Menopause Status	
Premenopausal	144 (22.6)
Perimenopausal	269 (42.3)
Postmenopausal	204 (32.1)
Hysterectomy	19 (3.0)
Menstruated in last 12 months	
Yes	416 (65.4)
No	220 (34.6)

Table 2
Comparison of the mean BMD ($\pm$ SD) measurements at spine by nationality and age

Age Group	BMD at spine (g/cm ²)				P-Value	
	Qatari		Non-Qatari			% Difference
	N	(Mean ± SD)	N	(Mean ± SD)		
TOTAL						
40-44	50	1.168±0.122	95	1.195±0.141	2.8	
45-49	67	1.171±0.168	107	1.181±0.135	1.0	
50-54	95	1.134±0.158	95	1.158±0.155	2.4	
55-60	57	1.11±0.147	69	1.063±0.146	-3.8	

Table 3
Comparison in BMD at the femur site between Qatari and non-Qatari women by age

Variables	Qatari		Non-Qatari		Diff	P-value
	n	n	Mean $\pm$ SD	Mean $\pm$ SD		
Neck						
40-44	50	95	0.982 $\pm$ 0.119	0.991 $\pm$ 0.120	0.009	0.670
45-49	67	107	0.978 $\pm$ 0.143	1.002 $\pm$ 0.122	0.023	0.251
50-54	93	95	0.963 $\pm$ 0.125	0.953 $\pm$ 0.143	-0.010	0.610
55-60	59	67	0.931 $\pm$ 0.125	0.923 $\pm$ 0.118	-0.008	0.728
Ward						
40-44	50	95	0.862 $\pm$ 0.140	0.857 $\pm$ 0.125	-0.005	0.812
45-49	67	107	0.832 $\pm$ 0.162	0.851 $\pm$ 0.137	0.019	0.403
50-54	93	95	0.801 $\pm$ 0.162	0.802 $\pm$ 0.172	0.001	0.974
55-60	59	66	0.740 $\pm$ 0.145	0.731 $\pm$ 0.138	-0.010	0.698
Troch						
40-44	50	95	0.850 $\pm$ 0.149	0.843 $\pm$ 0.121	-0.008	0.743
45-49	67	107	0.847 $\pm$ 0.137	0.859 $\pm$ 0.128	0.013	0.538
50-54	93	95	0.850 $\pm$ 0.126	0.829 $\pm$ 0.142	-0.021	0.282
55-60	59	66	0.825 $\pm$ 0.124	0.782 $\pm$ 0.106	-0.043	0.040
Shaft						
40-44	50	93	1.286 $\pm$ 0.163	1.258 $\pm$ 0.164	-0.027	0.341
45-49	67	106	1.285 $\pm$ 0.189	1.282 $\pm$ 0.163	-0.003	0.911
50-54	93	95	1.286 $\pm$ 0.165	1.245 $\pm$ 0.201	-0.041	0.130
55-60	59	66	1.251 $\pm$ 0.148	1.199 $\pm$ 0.161	-0.052	0.063
Total						
40-44	50	93	1.060 $\pm$ 0.127	1.056 $\pm$ 0.126	-0.005	0.837
45-49	67	107	1.062 $\pm$ 0.154	1.066 $\pm$ 0.131	0.004	0.852
50-54	93	95	1.057 $\pm$ 0.138	1.032 $\pm$ 0.161	-0.025	0.256
55-60	59	67	1.029 $\pm$ 0.127	0.981 $\pm$ 0.125	-0.048	0.036

Table 4

BMD T-Score at spine and total femur by age

Age Group	Spine(L2-L4)		Femur			
	-2.5 SD n(%)	-1 to -2.5 SD n(%)	-1 SD n(%)	-2.5 SD n(%)	-1 to -2.5 SD n(%)	-1 SD n(%)
40-44	0(0)	15(10.3)	130(89.7)	0(0)	4(2.8)	141(97.2)
45-49	1(0.6)	14(8.1)	159(91.4)	0(0)	2(1.2)	172(98.9)
50-54	2(1.1)	33(17.4)	155(81.6)	0(0)	11(5.9)	177(94.1)
55-60	6(4.8)	32(25.4)	88(69.8)	1(8)	7(5.6)	118(93.7)
All	9(1.4)	94(14.8)	532(83.8)	1(0.2)	24(3.8)	608(96.1)

Table 5

Mean BMD of the Spine (L2-L4) and Femur by Menstrual Status

Bone Mineral Density	Menstruated in the last 12 months?		P-value
	Yes	No	
Spine, N (%)	416 (65.6)	218 (34.4)	
Mean $\pm$ SD	1.20 $\pm$ 0.15	1.10 $\pm$ 0.16	<0.0001
Femur, N (%)	416 (65.8)	216(34.2)	
Mean $\pm$ SD	1.01 $\pm$ 0.13	0.95 $\pm$ 0.14	<0.0001

Table 6

Multivariable regression analysis with BMD T-score at spine (L2-L4) and BMD T-score at Femur as Dependent Variables

Variables	β	SE	P value	95% CI (β)	Lower bound	Upper bound
Dependent variables: BMD at Spine(N=634)						
Qatari Nationality (ref = Non-Qatari)	-0.14	0.10	0.16	-0.33		0.05
BMI	0.03	0.01	0.0004	0.01		0.04
Menstruated in past 12 months (ref = no)	0.82	0.10	<0.0001	0.62		1.02
Dependent variables: BMD at Femur (N=632)						
Qatari Nationality (ref = Non-Qatari)	0.08	0.08	0.35	-0.09		0.24
BMI	0.08	0.01	<.0001	0.07		0.09
Menstruation past 12 months (ref = no)	0.61	0.09	<.0001	0.43		0.77

Table 7

BMI and BMD at spine and femur among Qatari Nationals.

	Qatari Nationals Current Study		Qatari Nationals Previous Study ⁷		P value
	N	(Mean ± SD)	N	(Mean ± SD)	
BMI(kg/m²)					
40–49	117	33.9±6.1	154	30.7±5.4	<0.001
50–60	153	35.0±5.9	106	32.9±5.7	0.002
BMD at spine* (g/cm²)					
40–49	117	1.170±0.149	155	1.149±0.145	0.243
50–60	152	1.121±0.155	106	1.065±0.180	0.008
BMD at Femur (g/cm²)					
40–49	117	1.008±0.140	155	1.041±0.129	0.044
50–60	152	0.991±0.131	106	0.992±0.144	0.952

* BMD at spine is AP spine T-score for both Qatari studies.