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Prevalence and Risk Factors of Osteoporosis Among Jordanian Postmenopausal Women Attending the National Center for Diabetes, Endocrinology and Genetics in Jordan

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Abstract

To assess the prevalence of osteoporosis and osteopenia among Jordanian postmenopausal women attending the National Center for Diabetes, Endocrinology, and Genetics (NCDEG), and to determine the potential associated risk factors. A cross-sectional study was conducted at (NCDEG) in Amman, Jordan. A total of 1079 Jordanian postmenopausal women aged between 45 and 84 years were included in this study that was conducted during the period between April 2013 and December 2014. All patients underwent bone mineral density measurement through dual-energy X-ray absorptiometry (DEXA) scan. DEXA scan was interpreted in terms of T score as per World Health Organization guidelines. The overall prevalence of osteoporosis and osteopenia was 37.5% and 44.6%, respectively. The maximum prevalence of osteoporosis was observed at the lumbar spine (32.4%) followed by the left femoral neck (14.4%), while the maximum prevalence of osteopenia was observed at the left femoral neck (56.1%) followed by the lumbar spine (41.3%). Patients with longer menopausal duration, normal or overweight body mass index, high parity, physical inactivity, positive family history of osteoporosis, inadequate sun exposure, high daily caffeine intake, low daily calcium intake, and delay in the age of menarche were all positively associated with osteoporosis. On the other hand, women with type 2 diabetes mellitus had lower risk of osteoporosis. There is a high prevalence of osteoporosis and osteopenia among Jordanian postmenopausal women. Necessary steps are needed for more public education and a wider dissemination of information about osteoporosis and its prevention.

Keywords: Jordan; osteoporosis; prevalence; risk factors; type 2 diabetes mellitus

Introduction

Osteoporosis causes more than 8.9 million fractures annually worldwide, resulting in an osteoporotic fracture every 3 seconds.[1]

Women are at a significantly higher risk for osteoporosis, which is estimated to affect around 200 million women worldwide.[2] In Jordan, Shilbayeh[3] found that the overall rate of osteoporosis was 30% among Jordanian women irrespective of menopausal status and 43.3% among postmenopausal women. In addition, El-Heis et al. reported that the prevalence of osteoporosis among a sample of Jordanian women referred for investigation of osteoporosis was 13.5% with current age; age at menarche, diabetes mellitus, hypertension, and renal problems were all significantly associated with an increased risk of osteoporosis.[4] One half of all postmenopausal women will experience an osteoporosis-related fracture during their lifetime, 25% of these women will develop a vertebral deformity, and 15% will experience a hip fracture.[5] Nearly 75% of all hip fractures occur in

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women and are invariably associated with chronic pain, disability, reduced mobility, increasing dependence, and future fractures risk.[6] Moreover, osteoporosis-related hip fracture is associated with increased mortality. During the first year following a hip fracture, the mortality rate reaches 20%.[7]

Risk factors associated with osteoporosis include age, female sex, ethnicity, family history of osteoporosis, smoking, vitamin D deficiency, low calcium and high caffeine intake, immobilization, increased age at menarche, early menopause, and underweight.[8]

The association between diabetes and osteoporosis is complex. Type 1 diabetes mellitus (T1DM) is characterized by low bone mineral density (BMD) due to low circulating levels of IGF-1 and insulin, and this usually occurs in young children before peak bone mass attainment. While type 2 diabetes mellitus (T2DM) is common in adults who have already attained peak bone mass, the effect of T2DM on BMD is controversial; it might have increased, decreased, or stayed normal.[9,10]

Aim of the Study

To assess the prevalence of osteoporosis and osteopenia among Jordanian postmenopausal women attending the National Center for Diabetes, Endocrinology, and Genetics (NCDEG), and to determine the potential associated risk factors.

Materials and Methods

Sampling and data collection

A cross-sectional study was carried out between April 2013 and December 2014 at the NCDEG in Amman, Jordan. All Jordanian women aged ≥45 years, of menopausal duration of more than 1 year, and who had received BMD by dual-energy X-ray absorptiometry (DEXA) at our center during the study period were eligible to be included in the study.

Patients with T1DM, malignancy, hyperthyroidism, uncontrolled hypothyroidism, primary or secondary hyperparathyroidism, Cushing syndrome, cirrhosis, systemic lupus erythematosus, rheumatoid arthritis, renal impairment, epilepsy, and premature menopause (<45 years old), or patients on one or more of the following medications: thiazolidinedione, heparin, warfarin, vitamin K, thiazide diuretics, anticonvulsants, cancer chemotherapy, GnRH (gonadotropin releasing hormone agonists), estrogen, barbiturates, methotrexate or glucocorticoids, were excluded from the study.

The data sources used were the patient's medical record and a structured interview questionnaire that was carried over the phone. The medical file was used to gather information on current age at BMD measurement, marital status, educational level, duration of menopause, age at menopause and menarche onset, parity, number of pregnancies and abortions, years of menstruation, breast feeding, diabetes status and its duration, hypertension status and use of statin or vitamin D3 supplementation, weight, and height.

The phone interview was used to gather information on lifestyle factors such as daily calcium intake, physical activity, lifetime daily caffeine consumption, sun exposure, smoking habit, immobilization status, family history of osteoporosis or fragility fracture, and history of pervious personal fragility fracture. Any other missing data from the medical file were completed through the phone interview.

Ethical considerations

The study protocol was approved by the ethics committee at the NCDEG. Through the phone calls, verbal consents were taken from the patients, and they were assured of confidentiality of data and to be used only for scientific research.

Definitions of the study variables

Measurements and laboratory analysis. Body mass index (BMI) was expressed as the quotient between weight (kg) and height squared (m^2). Patients were classified according to BMI following the recommendation of the World Health Organization (WHO) as adopted by the American Diabetes Association (ADA).[11] Smoking was classified into three categories according to WHO guidelines 1998; current smoker: a person who smokes cigarettes daily or occasionally; past-smoker: a person who formerly was a daily or occasional smoker, but currently does not smoke at all; and nonsmoker: a person who has never smoked before or has smoked very little in the past.[12]

Physical activity was measured as "the leisure time of any kind of moderate-intensity aerobic physical activity for a minimum of 30 minutes on five days each week."[13]

Immobilization was defined as "being confined to bed for a continuous period >2 months."[14]

Pre-diabetes and diabetes was diagnosed according to the ADA 2014. Moreover, diabetes was considered to be controlled if the patient had HbA1c <7.0%, fairly controlled if the patient had HbA1c between 7% and 7.9%, and uncontrolled if HbA1c ≥8%.

Sun exposure was defined in adults as "exposure of the hands, face, and arms to the sun daily for 10–15 minutes per day (uncovered and without sun screen)."[15]

Lifetime daily caffeine intake was estimated as the average daily intake of coffee, tea, caffeinated soft drinks, chocolate, and ice coffee. Coffee includes several types of instant, brewed, and Turkish coffee. The caffeine content was based on figures from the International Food Information Council Foundation Review[16] and was estimated in milligrams per day, each cup (8 oz. of brewed coffee contains 85 mg caffeine), (8 oz. of instant coffee contains 75 mg caffeine), (8 oz. of brewed tea contains 40 mg caffeine), (12 oz. of cola contains 40 mg caffeine). The mean caffeine concentration per cup of Turkish coffee (40 mL) is 165 mg.[17] Lifetime daily caffeine intake was coded into two different groups: 0, low caffeine intake (≤300 mg/day), and 1, high caffeine intake (>300 mg/day), at data analysis.[18]

Duration of menopause was calculated by subtracting age at menopause from current age at BMD measurement. Years of menstruation was calculated as the difference in years between age at menopause and age at menarche.

BMD was measured at the lumbar spine L1–L4 (anterior–posterior projection) and left femoral neck using DEXA (Hologic Discovery A Scanner), and expressed as g/cm^2. T-score value was only considered for analysis as recommended by the WHO diagnostic classification,[19] which classified the patients into three categories: normal BMD defined as (T-score at −1.0 and above), osteopenia (low bone mass) defined as (T-score between −1.0 and −2.5), while osteoporosis was defined as (T-score at or below −2.5).

Serum vitamin D3 concentrations were determined using radioimmunoassay (BIOSOURCE Europe S.A., Nivelles, Belgium) and was classified as follows: vitamin D deficiency (>20 ng/mL), vitamin D insufficiency (20–29 ng/mL), and vitamin D sufficient (≥30 ng/mL).[20]

Statistical analysis

Data were analyzed using the Statistical Program for Social Sciences (SPSS) version 20.0. Data were examined for data entry errors and outlying values; any error was corrected as appropriate. The overall prevalence of osteoporosis was calculated. The bivariate association between osteoporosis and a number of variables was assessed for statistical significance using the Chi-square test and *t*-test. Multivariate logistic regression was used to assess the independent variables of the disease status after adjusting for potential confounders, using adjusted odds ratios (OR) and 95% confidence intervals. p Value of <0.05 was considered statistically significant.

Results

Participant characteristics

This study included 1079 Jordanian postmenopausal women, aged 45–84 years with a mean age (standard deviation) of 61.1 (7.2) years.

The sociodemographic, reproductive, and clinical characteristics, family history of osteoporosis and fragility fractures, pervious personal fragility fractures, lifestyle, and laboratory characteristics of the study population are represented in Table 1. More than one-half (55%) of the sample was 60 years of age or more, 62% had their menopause at the age of 50 years or less, 49% had a menopausal duration of 11 years or more, and 26% had a menopausal duration of 5 years or less.

Ninety percent of the participants were married, 8% were single, and 15% were current smokers. More than half of the participants had an educational attainment of more than high school, 28% of them had less than high school education, 61% were obese, and 30% were overweight. About one-half of the participants were diabetic, 37% were pre-diabetic, and 13% had no diabetes. Of those who had diabetes, 40% of them had duration of diabetes of 10 years or more and 35% had diabetes duration of less than 5 years. Forty-nine percent of the diabetic participants had HbA1c of less than 7%, while 51% had HbA1c more than or equal to 7%. Sixty-four percent of the patients were hypertensive, 68% were on statin treatment for dyslipidemia, and 89% were taking vitamin D3 supplementation. Thirty-eight percent of the population had a parity of six children or more and 20% had two children or less. Thirty-nine percent of the women reported a history of one to two abortions and 50% had no history of abortion. Sixty percent of our population was physically inactive, 53% had inadequate sun exposure, 52% of them had high daily caffeine intake more than 300 mg/day, and 31% had low daily calcium intake of less than 600 mg/day. Thirty-two percent of the study population had reported a positive family history of osteoporosis, 3% had a history of immobilization, 24% had a positive family history of fragility fracture, and 19% had a personal history of previous fragility fracture. More than one-third (38%) of our sample had either vitamin D3 deficiency or insufficiency and 34% of our population had high parathyroid hormone of more than 55 pg/mL.

Prevalence of osteoporosis

The overall prevalence of osteoporosis in the study population (1079) was 37.5% ($n=405$), and 44.6% ($n=481$) were diagnosed with osteopenia. The maximum prevalence of osteoporosis at the lumbar spine was observed

Table 1. Frequency Distribution of the Study Sample by Certain Sociodemographic, Reproductive, Clinical, Lifestyle, and Laboratory Characteristics, and Health (Family History of Osteoporosis, Family History of Fragility Fracture, and Personal of Previous Fragility Fracture) Variables ($n = 1079$)

Variable	*n*	%
Current age at BMD (years)		
<60	488	45.2
≥60	591	54.8
Marital status		
Single	86	8.0
Married	974	90.3
Divorced or widowed	19	1.8
Education		
<High school	297	27.5
High school	221	20.5
>High school	561	52.0
BMI (kg/m^2)		
Normal	94	8.7
Overweight	321	29.7
Obese	658	61.0
Smoking		
Never smoke	922	85.4
Current	157	14.6
Physical activity		
No	646	59.9
Yes	433	40.1
Sun exposure		
No	567	52.5
Yes	512	47.5
Lifetime daily caffeine (mg/day)		
≤300	515	47.7
>300	564	52.3
Calcium intake (mg/day)		
<600	333	30.9
600–1000	476	4.1
>1000	270	25
Diabetic status		
No	145	13.4
Pre-DM	404	37.4
DM	530	49.1
Duration of diabetes (years)		
<5	174	34.7
5–9	129	25.7
≥10	199	39.6
Hypertension		
No	386	35.8
Yes	692	64.1
Use of statin		
No	346	32.1
Yes	733	67.9
Use of vitamin D3		
No	115	10.7
Yes	964	89.3
Immobilization		
No	1051	97.4
Yes	28	2.6
HbA1c for diabetic		
Controlled (<7%)	260	49.3
Fairly controlled (7–7.9%)	140	26.6
Un controlled (≥8%)	127	24.1
Parathyroid hormone (pg/mL)		
≤55	512	66.3
>55	260	33.7
Vitamin D3 level (ng/mL)		
Normal (≥30)	624	61.8
Insufficiency (20–29)	183	18.1
Deficiency (<20)	203	20.1
Age at menopause (years)		
≤50	667	61.8
>50	412	38.2
Menopausal duration at time of performing DEXA (years)		
≤5	283	26.2
6–10	268	24.8
≥11	528	48.9
Age at menarche (years)	mean ± SD = 13.71 ± 1.58	
Menstruation years (years)	mean ± SD = 36.12 ± 3.58	
Parity		
≤2	210	19.5
3–5	464	43
≥6	405	37.5
Abortion		
None	538	49.9
1–2	418	38.7
≥3	123	11.4
Ever breast feed		
No	225	20.9
Yes	854	79.1
Family history of osteoporosis		
No	739	68.5
Yes	340	31.5
Family history of fragility fracture		
No	817	75.7
Yes	262	24.3
Personal of previous fragility fracture		
No	874	81.0
Yes	205	19.0

BMD, bone mineral density; BMI, body mass index; DEXA, dual-energy X-ray absorptiometry; DM, diabetes mellitus; SD, standard deviation.

in 32.4% of the participants, followed by the left femoral neck (14.4%), while the prevalence of osteopenia was observed more at the left femoral neck (56.1%) followed by the lumbar spine (41.3%; Table 2).

Chi-square distribution was used to examine the independent distribution of osteoporosis by certain study variables. As indicated in Table 3, older age group, physically inactive, less sun exposed, participants with high parathyroid level, more caffeine drinkers, those with family history of osteoporosis/fragility fracture, and those with previous personal fragility fracture were more likely to have osteoporosis than their counterparts (p-value 0.000, 0.000, 0.000, 0.038, 0.015, 0.000, 0.001), respectively. Table 3 also indicated that marital status, BMI, calcium intake, diabetes status, duration of diabetes, menopausal duration, and parity were significantly positively associated with osteoporosis (p values

Table 2. Prevalence of Osteoporosis and Osteopenia Among Jordanian Postmenopausal Women (No. 1079)

	Normal (%)	Osteopenia (%)	Osteoporosis (%)
Total	17.89	44.58	37.53
Lumbar spine	26.2	41.3	32.4
Left femoral neck	29.6	56.1	14.4

Table 3. Chi-Square Distribution and Level of Significance of Osteoporosis by Certain Sociodemographic and Health Variables ($n = 1079$)

Variable	Normal no. (%)	Osteoporosis no. (%)	*p*
Current age at DMD (years)			0.000
<60	341 (69.9)	147 (30.1)	
≥60	333 (56.3)	258 (43.7)	
Marital status			0.002
Single	41 (47.7)	45 (52.3)	
Married	625 (64.2)	349 (35.8)	
Divorced or widowed	8 (42.1)	11 (57.9)	
Education			0.089
<High school	170 (57.2)	127 (42.8)	
High school	141 (63.8)	80 (36.2)	
>High school	363 (64.7)	198 (35.3)	
BMI (kg/m^2)			0.000
Normal	42 (44.7)	52 (55.3)	
Overweight	166 (51.7)	155 (48.3)	
Obese	461 (70.1)	197 (29.9)	
Smoking			0.261
Never smoke	580 (62.9)	342 (37.1)	
Current	94 (59.9)	63 (40.1)	
Physical activity			0.000
No	367 (56.8)	279 (43.2)	
Yes	307 (70.9)	126 (29.1)	
Sun exposure			0.000
No	321 (56.6)	246 (43.4)	
Yes	353 (68.9)	159 (31.1)	
Lifetime daily caffeine (mg/day)			0.015
≤300	341 (66.2)	174 (33.8)	
>300	333 (59)	231 (41.0)	
Calcium intake (mg/day)			0.013
<600	187 (56.2)	146 (43.8)	
600–1000	306 (64.3)	170 (35.7)	
>1000	181 (67)	89 (33)	
Diabetic status			0.003
No	75 (51.7)	70 (48.3)	
Pre-DM	246 (60.9)	158 (39.1)	
DM	353 (66.6)	177 (33.4)	
Duration of diabetes (years)			0.045
<5	129 (74.1)	45 (25.9)	
5–9	84 (65.1)	45 (34.9)	
≥10	124 (62.3)	75 (37.7)	
Hypertension			
No	233 (60.4)	153 (39.6)	0.295
Yes	465 (63.4)	252 (36.4)	
Use of statin			0.337
No	209 (60.4)	137 (39.6)	
Yes	465 (63.4)	268 (36.6)	
Use of vitamin D3			0.325
No	67 (58.3)	48 (41.7)	
Yes	607 (63)	357 (37)	
Immobilization			0.556
No	658 (62.6)	39.3 (37.4)	
Yes	16 (57.1)	12 (42.9)	
HbA1c for diabetic			0.403
Controlled (<7%)	173 (66.5)	87 (33.5)	
Fairly controlled (7–7.9%)	98 (70)	42 (30)	
Uncontrolled (≥8%)	79 (62.2)	48 (37.8)	
Parathyroid hormone (pg/mL)			0.038
≤55	325 (63.5)	187 (36.5)	
>55	145 (55.8)	115 (44.2)	
Vitamin D3 level (ng/mL)			0.279
Normal (≥30)	377 (60.4)	247 (39.6)	
Insufficiency (20–29)	116 (63.4)	67 (36.6)	
Deficiency (<20)	135 (66.5)	68 (33.5)	
Age at menopause (years)			0.390
≤50	410 (61.5)	257 (38.5)	
>50	264 (64.1)	148 (35.9)	
Menopausal duration at time of performing DEXA (years)			0.000
≤5	211 (74.6)	72 (25.4)	
6–10	166 (61.9)	102 (38.1)	
≥11	279 (56.2)	231 (43.8)	
Parity			0.052
≤2	125 (59.5)	85 (40.5)	
3–5	309 (66.6)	155 (33.4)	
≥ 6	240 (59.3)	165 (40.7)	
Abortion			0.752
None	342 (63.6)	196 (36.4)	
1–2	256 (61.2)	162 (38.8)	
≥3	76 (61.8)	47 (38.2)	
Ever breast feed			0.186
No	132 (58.7)	93 (41.3)	
Yes	542 (63.5)	312 (36.5)	
Family history of osteoporosis			0.000
No	492 (66.6)	247 (33.4)	
Yes	182 (53.5)	158 (46.5)	
Family history of fragility fracture			0.000
No	538 (65.9)	279 (34.1)	
Yes	136 (51.9)	126 (48.1)	
Previous personal fragility fracture			0.001
No	567 (64.9)	307 (35.1)	
Yes	107 (52.2)	98 (47.8)	

0.002, 0.000, 0.013, 0.003, 0.045, 0.000, 0.052), respectively. No significant association was found between osteoporosis and each of educational level, age of menopause, number of abortions, breast feeding, hypertension, use of statin or vitamin D3 supplementation, immobilization, smoking status, HbA1c level for diabetic participants, vitamin D3 level, calcium, phosphorus, albumin, alkaline phosphatase, and creatinine levels.

T-test indicated that the mean age at menarche among osteoporotic patients was significantly higher than the nonosteoporotic group (*p*-value 0.004). However, no

Table 4. *T*-test Between Osteoporosis and Normal Groups Among the Study Participants ($n = 1079$)

Variable	Group	Mean	Standard deviation	*p*
Age at menarche (years)	Normal	13.60	1.55	0.004
	Osteoporosis	13.89	1.62	
Years of menstruation	Normal	36.22	3.62	0.232
	Osteoporosis	35.95	3.51	

significant difference was found between the two groups in the mean years of menstruation, Table 4.

Multivariate analysis

Multiple logistic regression analysis was performed to examine the net effect of certain variables on osteoporosis after controlling for the effect of other variables in the model.

As shown in Table 5, the variables of menopausal duration, BMI, parity, diabetes status, family history of osteoporosis, physical activity, sun exposure, lifetime daily caffeine intake, daily calcium intake, and age at menarche were significant to the model. Current age at time of performing (DEXA), smoking, and vitamin D3 level were not significant to the model.

Patients with menopausal duration between 6–10 years and more than 11 years were 1.9 and 2.3 times (p values 0.003, 0.002), respectively, more likely to have osteoporosis compared to postmenopausal women who had menopausal duration ≤5 years.

The likelihood to develop osteoporosis among postmenopausal women with normal BMI and overweight were 3.1 and 2.6 times (p values 0.000, 0.000), respectively, compared to obese postmenopausal women. Parity of ≥6 children increased the risk of having osteoporosis by 1.6 times in comparison with a parity of ≤2 children (p-value 0.027).

Being nondiabetic or pre-diabetic increased the risk of having osteoporosis by 2.1 and 1.7 times (p values 0.001, 0.001), respectively, in comparison with diabetic patients. Having a positive family history of osteoporosis, physical inactivity, and inadequate sun exposure was associated with an increased risk of osteoporosis; OR were 1.8, 1.5, and 1.4 and p values were 0.000, 0.008, and 0.023, respectively. Participants with daily caffeine intake of more than 300 mg/day and calcium intake of less than 600 mg/day were more likely to develop osteoporosis than their counterparts; OR were 1.5 and 1.6 and p values were 0.005 and 0.018, respectively. The risk of osteoporosis increased by 10% for each 1 year delay in the age of menarche, OR 1.1 and p-value 0.013.

Table 5. Adjusted Odds Ratios and Their Levels of Significance of Osteoporosis by Certain Variables ($n = 1079$)

Variable	OR	*p*
Menopausal duration (years)		
≤5	1	
6–10	1.9	0.003
≥11	2.3	0.002
BMI (kg/m^2)		
Normal	3.1	0.000
Overweight	2.6	0.000
Obese	1	
Parity		
≤2	1	
3–5	0.864	0.460
≥6	1.6	0.027
Diabetic status		
No	2.1	0.001
Pre-diabetic	1.7	0.001
DM	1	
Family history of osteoporosis		
No	1	
Yes	1.8	0.000
Physical activity		
No	1.4	0.014
Yes	1	
Sun exposure		
No	1.4	0.023
Yes	1	
Lifetime daily caffeine intake (mg/day)		
≤300	1	
>300	1.6	0.005
Age at menarche	1.1	0.013
Calcium intake (mg/day)		
<600	1.6	0.018
600–1000	1.3	0.494
>1000	1	
Smoking		
No	1	
Yes	1.2	0.647 (NS)
Current age (years) at BMD		
<60	1	
≥60	1.4	0.114 (NS)
Duration of DM (years)		
<5	0.74	0.23 (NS)
5–10	0.99	0.96 (NS)
>10	1	
Vitamin D3 levels		
Normal (≥30)	1	
Insufficiency (20–29)	1.23	0.282 (NS)
Deficiency (<20)	1.19	0.453 (NS)

Using multiple logistic regression analysis.
NS, not significant; OR, odds ratio.

However, there was no association between osteoporosis and each of smoking, current age at time of performing DEXA, and vitamin D3 level.

Discussion

In this study, the prevalence of osteoporosis among Jordanian postmenopausal women attending the NCDEG

was 37.5%. This finding was higher than the 16.2% prevalence rate reported in Turkey,[21] comparable to the 37.8% in India,[22] but lower than the 44.1% prevalence rate reported in Saudi Arabia.[23] This inconsistency in the findings is perhaps related to differences in study design, diagnostic technique used, bone scan site chosen, lifestyle practice, and selection of patients.

Our data showed that nondiabetics or pre-diabetics were at a higher risk of developing osteoporosis than type 2 diabetic patients. This finding was consistent with the findings reported in several studies,[24–26] but not in other studies.[27,28]

This study confirmed that the years that had elapsed since menopause was an important factor for predicting osteoporosis even after adjusting for other variables. This finding was in agreement with that reported in research literature.[21,29,30]

Our study showed an association between the increase in age at menarche and risk of developing osteoporosis. Early menarche may have a protective effect on the development of osteoporosis since it is associated with higher circulating estrogen during and after menarche. Ito et al. and Parker et al. also found that there was a positive correlation of early menarche with high BMD.[31,32] However, our result was inconsistent with other studies,[33–35] which found no association between age at menarche and BMD, or fracture risk.

Consistent with the findings from other studies,[36,37] our data indicated that high parity was a risk factor for osteoporosis. On the other hand, Sadat-Ali et al. concluded that increased parity protects postmenopausal women from osteoporosis.[23]

Our data showed that obesity had a protective effect against osteoporosis and the effect of higher BMI may compensate for the negative influence of hypoestrogenic state on BMD during menopause. Several studies also supported this finding and suggested that higher body weight may underline both high bone density and lower incidence of fracture.[38,39] Many explanations had been suggested to explain such correlation, one of them is that larger body mass forces a greater mechanical loading on bone, thus the bone mass increases to accommodate this load. In addition, adipocytes are important sources of estrogen production in postmenopausal women and estrogen is known to inhibit bone resorption by osteoclasts. Inconsistent with our finding, Zhao et al. found that an increasing fat mass might not have a beneficial effect on bone mass.[40]

In our study, postmenopausal women with a daily caffeine intake of >300 mg/day were at greater risk of developing osteoporosis. Consistent with our finding, Rapuri et al. had also found that the intake of caffeine in amounts >300 mg/day accelerates bone loss at the spine in elderly postmenopausal women.[18] On the other hand, Ng et al. showed a clinically protective effect of coffee consumption on periodontal bone loss.[41] Several studies had demonstrated that caffeine acts directly on osteoblasts and osteocytes, disturbing the process of differentiation, multiplication, mineralization, and bone matrix production, leading to apoptosis of these cells.[42–45] In addition, caffeine may increase the differentiation of osteoclasts, resulting in greater loss of calcium in urine.[46] All these mechanisms may contribute to the decrease in bone density caused by high caffeine consumption.

It is well known that adequate calcium intake is an important factor for the maintenance of bone health during growing phase,[47,48] as well as the preservation of BMD in elderly individuals.[49,50] When calcium levels decrease, there is a fast compensatory increase in parathyroid hormone that stimulates osteoclast-mediated bone resorption.[51,52] One of the important findings in our study was the association between low calcium intake (<600 mg/day) and osteoporosis. In agreement with our finding, Ensrud et al. had reported that in elderly women, low fractional calcium absorption in the setting of low calcium intake increases the risk for hip fracture.[53]

Postmenopausal patients who lack adequate sun exposure were at a higher risk for developing osteoporosis in our study. However, our study failed to demonstrate the effect of vitamin D deficiency on osteoporosis since the vast majority of our patients were on vitamin D supplementation. In contrast with our findings, Gaugris et al. and Mezquita-Raya et al. found that an inadequate vitamin D level in postmenopausal women was a common risk factor for osteoporosis.[54,55]

Our study showed that an inadequate physical activity was associated with an increased risk of osteoporosis, indicating the importance of physical activity on risk reduction of falls through specific muscle strengthening and balance-training activities, which in turn would preserve muscle strength, delay sarcopenia (age-related muscle loss), and maintain neuromuscular function necessary to keep balance and good reaction to fall. In terms of effects on bone mass, physical activity may stimulate bone formation and thus improve BMD through exposing the skeleton to mechanical strain. In addition, Omland et al., found that physical activity was positively correlated to BMD, and also reported that exercise had a protective role in BMD.[56]

This study failed to find any significant association between smoking and osteoporosis. Consistent with our

finding, Young et al. also failed to find a significant correlation between smoking and osteoporosis.[57] On the contrary, Benson and Shulman and Krall and Dawson-Hughes found a significant association between tobacco exposure and the risk of osteoporosis.[58,59]

A strong association existed between family history of osteoporosis and the risk of developing osteoporosis in our study. Similar to our finding, other studies[60–62] showed that family history of osteoporosis was a significant and independent risk factor for osteoporosis.

Conclusion

There is a high prevalence of osteoporosis and osteopenia among Jordanian postmenopausal women. Necessary steps are needed for more public education and wider dissemination of information about osteoporosis and its prevention.

Limitations

First, our study sample was withdrawn from a pool of Jordanian postmenopausal women referred for DEXA screening during the study period, an approach that carries the risk of selection bias and subsequently, the conclusions may be influenced. However, our exclusion criteria, which eliminated many patients with chronic diseases and others on medications, which may interfere with bone density, minimized this effect to a great extent. Second, although the majority of data were collected from the medical radiological laboratory records performed in the center, an additional confirmatory phone interview was used to gather information on certain variables related to lifestyle behaviors, coffee drinking, exercise, and calcium supplementation, as well as family history of osteoporosis during the first 5 months of 2015, which were beyond the study period, and participants were asked to estimate the average daily consumption of coffee, calcium, and minutes of exercise "during the last year."

Recommendations

There is a need for further research to intensify public health education to improve women's knowledge and practices regarding osteoporosis and its prevention with special advice on adequate calcium, caffeine, and vitamin D intakes along with encouragement to do more regular physical activity.

Author Disclosure Statement

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Abbreviations Used

ADA = American Diabetes Association
BMD = bone mineral density
BMI = body mass index
DEXA = dual-energy X-ray absorptiometry
NCDEG = National Center for Diabetes, Endocrinology, and Genetics
TIDM = type 1 diabetes mellitus