Journal of Clinical Densitometry: Assessment of Skeletal Health, vol. 14, no. 4, 384−394, 2011

1094-6950/14:384−394/$36.00
DOI: 10.1016/j.jocd.2011.03.009

Review Article

Osteoporotic Fractures, DXA, and Fracture Risk Assessment: Meeting Future Challenges in the Eastern Mediterranean Region

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Abstract

The purpose was to report on the burden of osteoporotic fractures in the Eastern Mediterranean Region (EMR) and the use of bone mineral density (BMD) dual-energy X-ray absorptiometry (DXA) databases for osteoporosis diagnosis. PubMed electronic database was reviewed using the following MeSH terms: ''Hip fractures,'' ''Fractures, Compression,'' ''Radius Fractures,'' ''Osteoporosis,'' ''Bone density,'' and ''Middle East'' up to July 2009. Incidence of hip fractures varied across the EMR between 100 and 295 per 100,000 person-years in women and 71 and 200 per 100,000 person-years in men. No data were found on other nonvertebral osteoporotic fractures. Prevalence of radiographic vertebral fractures older than 65 yr ranged between 15% and 25% in women and 7.3% and 18% in men. By 2020, the number of hip fractures older than 50 yr would increase by 20%. DXA manufacturer's reference curves for the spine were higher than population-specific ones. At the hip, National Health and Nutrition Examination Survey (NHANES) and population-based curves were comparable. Estimates of the relative risk of vertebral fracture per SD decrease in BMD using NHANES and local data set were similar, that is, 1.61 (1.17−2.23) and 1.49 (1.14−1.95), respectively. The EMR is similar to southern Europe regarding incidence rates of hip fracture, suggesting the health burden to be significant. Using DXA at the hip, population-specific reference databases did not perform better than NHANES on which the FRAX model has been developed highlighting the need for reviewing fracture risk assessment strategies in the EMR.

Key Words: Bone density; DXA; Eastern Mediterranean Region; hip fracture; incidence; osteoporosis.

Introduction

The health burden of osteoporosis in developed countries has been acknowledged by health authorities leading to a series of recommendations and guidelines on prevention, screening, and management *(1−8)*.

Demographic prospects in developing countries with increased life expectancy, high prevalence of sedentary lifestyle, and smoking all lead to projections that the burden of osteoporosis will increase significantly in the near future *(9)*.

The large variability in the incidence of nonvertebral fractures, and particularly hip fractures, is well recognized and may reflect the contribution of additional risk factors beyond bone mineral density (BMD), that is, proximal femur anatomy, body mass index, daily living conditions, and the numerous risk factors of falling *(10−14)*. Information regarding the epidemiology of nonvertebral osteoporotic fractures in the Eastern Mediterranean region (EMR) remains quite limited.

The World Health Organization operational definition of osteoporosis that is based on a T-score ≤ -2.5 using central dual-energy X-ray absorptiometry (DXA) *(1)* has raised a debate in the literature regarding the appropriate reference database one should use, that is be it ''population specific,'' or ''universal,'' a question that has direct bearing with regard to case-finding strategies and fracture risk assessment *(15−20)*. Although both the International Osteoporosis Foundation (IOF) and International Society for Densitometry (ISCD) recommend the use of a standard universal database, namely the National Health and Nutrition Examination

Received 01/07/11; Revised 03/24/11; Accepted 03/28/11.
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Survey (NHANES) database at the hip, the extent to which this recommendation has been implemented in the EMR seems limited.

Objectives

The aim of this article was to report on the epidemiologic evidence relevant to the health burden of osteoporosis and the different reference data sets used for T-score determination using DXA in the EMR.

Methods

A literature review was done through the PubMed electronic database from 1966 until September 2009. Keywords were selected from the MeSH thesaurus. The first query used the following MeSH terms **"Hip fractures"[MeSH] AND "Middle East"[MeSH]** and identified 73 papers. The second query **"Fractures, Compression"[MeSH] AND "Middle East"[MeSH]** provided no results. The third query **"Radius Fractures"[MeSH] AND "Middle East"[MeSH]** identified 4 papers not relevant to our study purposes. The fourth query **"osteoporosis"[Mesh] AND "Middle East"[MeSH]** identified 186 papers. The fifth query "**bone density"[Mesh] AND "Middle East"[MeSH]** identified 137 papers.

All papers with a title and abstract relevant to the study were reviewed. Related references, with titles relevant to the study objectives, were also reviewed.

Demographic data prospects were obtained from the following Web site: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTHEALTHNUTRITIONANDPOPULATION/ *(9)*.

Results

Incidence of Osteoporotic Fractures and Basic Characteristics

Six studies reported *on hip fracture incidence* and provided characteristics of subjects with such fractures. In 5 studies, hip fracture cases were identified from hospital admissions, and incidence figures estimated with reference to the population in the catchment's area as the denominator, with extrapolation and adjustment for the general population at national level. One study was based on a hip fracture registry within ministry of public health (Table 1).

In Saudi Arabia, a retrospective review of case records of Saudi residents of Riyadh city, who were 40 yr or older and who were admitted to any of the local acute-care hospitals over a period of 12 mo was used to identify hip fracture cases *(21)*.

In Kuwait, a prospective study was conducted at a specialized orthopedic hospital, which provides services to residents in the 3 governorates representing about 70% of the total population of Kuwait. All new hip fracture patients who were operated on or treated conservatively during a 4-yr period (1992−1995) were included *(22)*.

In Lebanon, a prospective survey that included all hospitals with orthopedic surgery departments in the capital Beirut collected information on new hip fracture cases over a 3-mo period. An extrapolation was made for the estimation of the annual incidence for the population of Beirut and the Lebanese population at large *(23)*. More recently a population-based study making use of the ministry of public health hip-fracture registry evaluated the incidence of hip fractures in individuals aged 50 yr and older in Lebanon for the years 2006, 2007, and 2008. Crude incidence rates varied across the years between 164 and 188 per 100,000 for females and between 88 and 106 per 100,000 for males, with a female/male ratio of 1.6−2.1 *(27)*.

In Iran, a multicenter population-based prospective study on accidental Injuries was conducted in 9 provinces across the country, covering about 9.5 million individuals over a 4.5-mo period. All patients aged $\geq$50 yr with radiographically confirmed proximal femur fractures were included *(24)*.

In Oman, hip fracture cases were prospectively identified in the single referral Sur hospital and the age-adjusted incidence rate in subjects older than 40 yr was then estimated at 140 per 100,000 person-years *(25)*.

In Morocco, register and medical records data were collected from the 5 public hospitals in the province of Rabat. Hip fracture was restricted to cervical or trochanteric types *(26)*.

No studies on nonvertebral osteoporotic fractures, other than hip fractures, could be identified within the EMR.

Demographic and Clinical Characteristics of Patients With Osteoporotic Hip Fractures

Few case-series and case-control studies have provided information on demographic characteristics of subjects with hip fractures in the EMR.

The mean age at hip fracture was quite similar across different cases-series and case-control studies in the EMR, with values between 70 and 79 yr. In Saudi Arabia, a retrospective study of 43 subjects who sustained a proximal femoral fracture and were admitted to the orthopedic department of the King Fahd University Hospital in al-Khobar city between January 2001 and December 2006, reported a mean age of 72.1 yr *(28)*. A similar retrospective study from Al-Riyadh city, reported a mean age of 73 yr *(21)*. In Turkey, a retrospective study of 107 female patients who experienced hip fractures after the age of 60 yr revealed a mean age of 74 yr, with a range from 63 to 100 yr *(29)*. In the case-control study of 274 patients with hip fractures from Lebanon, the mean age for hip fracture subjects was 72.1 (8.5) yr *(30)*.

Gender ratio consistently showed predominance of females, as expected, across the various studies from Iran, Jordan, Kuwait, Lebanon, Oman, and Saudi Arabia. The female-to-male ratio among hip-fracture cases older than 50 yr was reported as 1.1 in Iran, 1.2 in Morocco, 1.3 in Oman, 1.4 in Saudi Arabia and Jordan, and 1.5 in Kuwait and Lebanon *(22−30)*.

Table 1
Hip Fracture Incidence Rates Among Eastern Mediterranean Region Countries

Study	Case finding	Reference population	Incidence rate in females (person-years)	Incidence rate in males (person-years)
(21)	Retrospective review of case records	Riyadh city Saudi population >50 yr of age	100/100,000	71/100,000
(22)	Prospective study conducted at an orthopedic hospital	Three governorates (about 70% of the total population) standardized for 1985 US population	295/100,000 (95% confidence interval [CI]: 238.8−350.8)	200/100,000 (95% CI: 163.3−236.5)
(23)	Prospective survey. All hospitals with orthopedic surgery in the capital Beirut	Beirut city Lebanese population >30 yr of age	153/100,000	100/100,000
(27)	Hip fracture registry at the ministry of public health	Lebanese population 2006, 2007, and 2008 standardized for 1985 US population	164−188/100,000 (Lebanese population) 329−370/100,000 (2000 US population)	88−106/100,000 (Lebanese population) 329−370/100,000 (2000 US population)
(24)	Multicenter population-based prospective study	Nine provinces across the country, about 9.5 million individuals Iranian population >50 yr of age	115.6 (95% CI: 107.4−124.3)	115.2 (95% CI: 107.2−123.7)
(25)	Prospective singe center	Omani population	140/100,000	
(26)	Register of 5 public hospitals in the province of Rabat restricted to cervical or trochanteric types	Rabat population	52.1/100,000 (95% CI: 40.9−63.3)	43.7/100,000 (95% CI: 33.3−52.2)

The *anatomic distribution* of hip fractures was reported in 3 studies. In the study from Kuwait, the proportions were as follows: intertrochanteric fractures 59%, femoral neck fractures 34%, and subtrochanteric fractures 7%, with no gender difference (22). In the Rabat study, hip fracture data was restricted to cervical and trochanteric fractures. No significant difference was found between genders in terms of cervical to trochanteric ratio in both women (0.97) and men (1.03). In the ministry of health registry study from the proportions for femoral neck fractures was 73.9%, 71.5%, and 78.8% for the years 2006, 2007, and 2008, respectively, and for pertrochanteric (both intertrochanteric and trochanteric) it was 24.6%, 25.3%, and 18.9%, respectively; whereas for subtrochanteric it was 1.4%, 3.2%, and 2.2%, respectively (27).

Comorbidity in hip fractures was addressed in 2 studies, whereby up to 70% had 2 or more comorbid medical conditions (30,31).

Burden of Osteoporotic Fractures in the EMR

Mortality related to osteoporotic hip fractures was documented in 3 case series. A case series from Turkey included 92 hip fracture patients (56 females, 36 males) who were operated and had follow-up data up to 36 mo postfracture, and reported a 3-yr mortality rate of 61% in females and 50% in males (32). Another retrospective study from Saudi Arabia reported an average 2-yr mortality rate of 27% (33). In a case-control retrospective study from Lebanon, the average mortality rate was 47%; most deaths occurred within the first year postoperatively with significantly higher mortality among men compared with women (30).

The *global burden* of osteoporotic fractures in terms of disability-adjusted life-years (DALYs) following fracture has been addressed in a single large population-based study in Iran, the Multicenter Study on Accidental Injuries (24). Accordingly, hip fractures generated 16,708 DALYs, composing of 8812 (52.7%) years of life lost and 7896 (47.3%) years of life with disability. Accordingly, Iran accounted for 0.85% of the global burden of hip fracture and 12.4% of that burden in the Middle East (34).

Prevalence of Osteoporosis Using DXA With Regard to Reference Data Sets

Eight cross-sectional studies reporting osteoporosis prevalence by DXA, among postmenopausal women and the

elderly population, were identified. Osteoporosis prevalence was often estimated using the manufacturer's reference curve, occasionally a population-specific reference data set, and in a single study the NHANES reference data set (Table 2).

In Iran, 1 cross-sectional survey collected data from 4188 individuals referred to a community-based outpatient osteoporosis center in Tehran (3848 females, 92%) with a mean (SD) age of 53.4 (11.8) yr. Osteoporosis prevalence, using GELunar DPX-L (GELunar, Madison, WI, USA) database was 24.7% at spine, 12.4% at the hip, and 27.8% at any of the 2 sites *(35)*. Another cross-sectional community-based survey included 2085 healthy Iranian subjects (75% women), aged 20−88 yr, also using a GELunar DPX database, reported osteoporosis prevalence at any site among subjects aged 50 yr and older to be 36.1% in women and 24.5% in men *(36)*.

In Turkey, a multicenter study of postmenopausal women, residing in 5 big cities, in 4 different regions of Turkey, mean age (SD) 57.6 (9.6) yr, reported 30% to be osteoporotic at any site using a MetriScan Densitometer database (Alara Inc., CA, USA) *(37)*. Another community-based study, among the elderly, including 783 females and 464 males aged 65 yr and older and using Hologic QDR 4500A densitometer, reported 63.5% of women and 45.9% of men as having osteoporosis at any site *(38)*.

In Saudi Arabia, a single-center cross-sectional survey of 830 postmenopausal women, 50−80 yr of age, at King Khalid University Hospital, Riyadh, reported 39.5% to be osteoporotic at any site using GELunar *(39)*. Another study using simulation approach estimated osteoporosis prevalence in women aged 50−70 yr at around 23% *(40)*.

In Jordan, a study of 400 women who visited outpatient clinics at 2 community hospitals in Amman City, with a mean (SD) age of 53 (12) yr, reported 29.6% as osteoporotic at any site using GELunar *(41)*.

In Lebanon, a population-based survey on a random sample of elderly subjects aged 65−84 yr, using the NHANES database, reported osteoporosis prevalence at total hip to be 33.0% (27.5−38.8) in women and 22.7% (16.2−30.2) in men *(42)*.

Population-Specific Data Sets

Eleven studies *(43−53)* on premenopausal women and young adult populations reported BMD and T-score distribution by site, age, and gender providing estimates of mean peak bone mass mainly at the spine and the hip (Fig. 1 Table 3). Four of these studies *(43,48,49,53)* reported population-based reference data sets with a properly selected random sample quite representative of the general population, including young adults. The remaining 7 studies *(44−47,50−52)* reported no explicit sampling frame or no proper random selection.

Most studies compared the manufacturer's database to a population-specific one in terms of the calculated prevalence of osteoporosis defined by BMD obtained with each data set. One study *(42)* compared the performance of using a population-specific database and of an NHANES database to identify subjects with prevalent radiographic vertebral fractures.

In Iran, the *Iranian multicenter osteoporosis study* included 5201 subjects aged from 20 to more than 70 yr (2340 males, mean age 42.7 ± 13.8) by random cluster sampling from civil status registries of 5 major cities. DXA was performed using a GELunar and the NHANES reference curve for proximal femur with phantom cross calibration between centers. Standardized peak bone mass values were comparable to reference values from Western countries and to reported references from other Eastern Mediterranean countries *(43)*. Another Iranian population-based cross-sectional survey was conducted in Teheran and included 553 subjects (34% men, 66% women) randomly selected from 50 blocks in the city. DXA was also performed and usinga GELunar with the manufacturer's database as a reference and reported Q4 similar findings (*44*).

In *Kuwait*, 623 healthy Kuwaiti women, aged 20−79 yr, with no explicit sampling frame, were evaluated using a GELunar DPX machine. Average peak bone mass at the spine was 1.238 ± 0.14 g/cm^2 and the hip was 1.022 ± 0.11 g/cm^2, slightly higher values than NHANES reference values, but the difference was not statistically significant *(45)*, Fig. 2 and Table 3.

In *Saudi Arabia*, 1 study included 1980 randomly selected subjects from 18 primary health care centers in Jeddah area (age range 20−79 yr, 915 males and 1065 females) using GELunar. Average peak bone mass at total hip was estimated at 0.992 ± 0.17 g/cm^2 in females and 1.098 ± 0.19 g/cm^2 in males, values quite comparable to the NHANES values. However, using manufacturer's reference data set, confidence interval (CI) for osteoporosis prevalence was 6.3−7.8% at the total hip compared with 1.2−4.7% when using the Saudi reference database *(46)*. Another study compared T-score distribution across 4 reference curves, 2 from Saudi Arabia, 1 from Lebanon, and 1 from Kuwait among 1653 women referred for DXA using a GELunar at the Security Forces Hospital, Riyadh, Saudi Arabia. Saudi reference curves were comparable, while on average Lebanese reference values were lower and Kuwaiti reference values were higher than both Saudi reference curves; however, no testing for statistical significance of the difference was reported *(47)*.

In *Morocco*, a population-based survey was carried out on 569 Moroccan women and 592 Moroccan men, aged between 20 and 79 yr, randomly selected in the area of Rabat, using a cluster sampling frame *(48,49)*. DXA was performed with-GELunar. Peak BMD at the total hip was 1.029 ± 0.11 g/cm^2 in women and 1.161 ± 0.16 g/cm^2 in men *(49)*. The use of the GELunar reference data set classified 18.1% of men as osteoporotic at the spine compared with 7.4%, using the Moroccan curve, and 7.8% using a Lebanese reference curve. The proportion of men identified with osteoporosis at the hip were more comparable across curves, it was 6% with the Moroccan curve, 3.9% with the US, and 5.3% with the European GELunar reference data sets.

In *Turkey*, 1 study among 323 healthy young adults (171 women, 152 men), aged 19−25 yr, using Hologic QDR 4500A reported T-scores distribution but no BMD values. Using the manufacturer's reference data set, average T-scores

Table 2
Mean Peak BMD (±SD) at the Lumbar Spine, Total Hip, and FN in Both Genders in Various Eastern Mediterranean Region Populations

			Women's peak BMD			Men's peak BMD		
Country (reference)	DXA reference data set	Age group (yr)	Spine	Hip[a]	FN	Spine	Hip	FN
Iran *(43)*	Lunar 7164, GE Madison, WI, USA	20–36	1.182 ± 0.127	**1.006 ± 0.126**		1.181 ± 0.153	**1.096 ± 0.159**	
Iran *(44)*	Lunar DPX-MD machine	20–29	1.198 ± 0.132	**0.962 ± 0.132**		1.209 ± 0.132	**1.098 ± 0.15**	
Kuwait *(45)*	Lunar DPX-IQ (Lunar, Madison)	30–39	1.238 ± 0.14	**1.022 ± 0.11**		NA	**NA**	
Saudi Arabia *(46)*	Lunar DPX-IQ (Lunar, Madison)	30–39	1.128 ± 0.11	**0.992 ± 0.17**	0.963 ± 0.16	1.137 ± 0.09	**1.098 ± 0.19**	1.045 ± 0.20
Morocco *(8,49)*	Lunar Prodigy Vision, GE	20–29	1.156 ± 0.12	**1.029 ± 0.11**		1.205 ± 0.15	**1.161 ± 0.16**	
Lebanon *(52)*	Lunar DPX-L	20–29	1.100 ± 0.13		0.912 ± 0.10	1.139 ± 0.13		1.033 ± 0.14
Lebanon *(53)*	Lunar DPX-L	20–29	1.180 ± 0.12	**0.97 ± 0.11**		1.18 ± 0.14	**1.07 ± 0.15**	

Abbr: BMD, bone mineral density; SD, standard deviation; FN, femoral neck; DXA, dual-energy X-ray absorptiometry; NA, not available.
[a]The National Health and Nutrition Examination Survey total hip BMD mean value (SD) among non-Hispanic whites is 1.101 g/cm^2 (0.144) in males and 1.008 g/cm^2 (0.126) in females within the age group 20–29 yr; and 1.082 g/cm^2 (0.144) and 0.990 g/cm^2 (0.126), respectively, within the age group 30–39 yr.

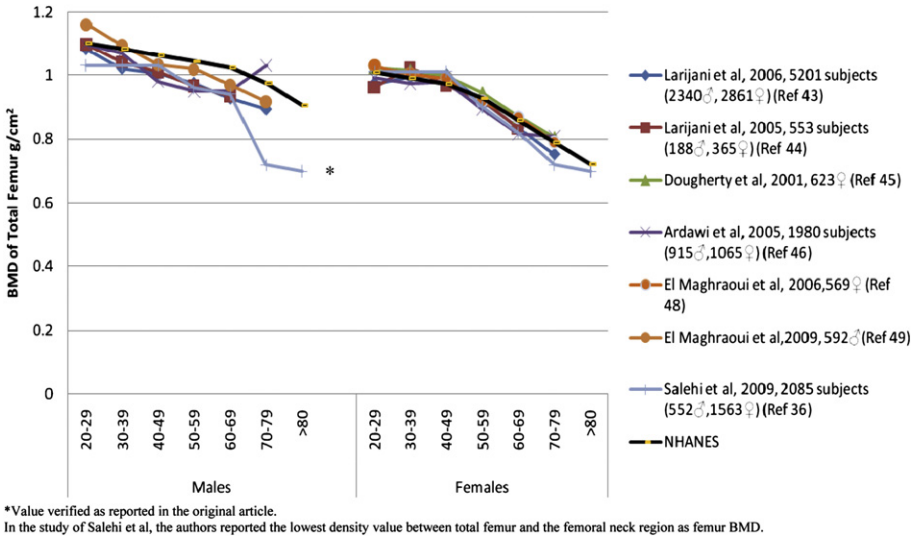

Fig. 1. Mean total femur bone mineral density (BMD, g/cm^2) by 10-yr age groups in both genders across various Eastern Mediterranean Region (EMR) countries. (Data are from studies using DPX-Lunar densitometers). The National Health and Nutrition Examination Survey database values are as provided from Lunar manufacturer.

at the spine and proximal femur were significantly lower than zero in both genders. Using the local population reference data set for T-score calculation, the prevalence of low BMD defined as a T-score <-1 was 14.0% at the lumbar spine and 14.6% at the femoral neck in women, and 15.8% at the lumbar spine and 17.1% at the femoral neck in men, proportions that were significantly lower with corresponding numbers of 50.3% and 60.8% in women and 42.8% and 30.9% in men, when using manufacturer's database *(50)*. Another study included 951 subjects (639 women and 312 men) aged from 15 to 79 yr. BMD was measured however at the calcaneus using a dual X-ray and laser Calscan (Demetech AB, Stockholm, Sweden) bone densitometer. Mean BMD value for healthy young adults (20−39 yr old) was 0.411 ± 0.058 g/cm^2 in women and 0.504 ± 0.068 g/cm^2 in men. Values were on the average about 1 standard deviation lower in both genders and across all ages groups as compared with the Swedish database *(51)*.

In *Lebanon*, 3 studies were identified. The first study included 858 women and 165 men aged 20−79 yr with no explicit sample selection frame and it used GELunar. Lebanese BMD values were generally slightly lower than the US and European reference values in younger age groups, with smaller differences in the older age groups *(52)*. Authors reported similar age-related changes in BMD in the Lebanese when compared with both US and European reference databases. The second study reported BMD distribution in a randomly selected young adult population using a cluster-sampling frame from Beirut and its suburbs. DXA was performed in 3 centers, 1 with a Hologic 4500W, 1 with Hologic 4500A, and the third one with GELunar. Cross calibration across centers was performed by having 45 women simultaneously tested at the 3 centers and a linear regression was applied to allow conversion of densitometry measurements from 1 machine to the other. BMD values were 1.01 ± 0.11 g/cm^2 in women and 1.01 ± 0.13 g/cm^2 in men at the lumbar spine, and 0.84 ± 0.10 g/cm^2 in women and 0.94 ± 0.15 g/cm^2 in men at the total hip, on the Hologic densitometer The corresponding GELunar values were 1.18 ± 0.12 g/cm^2 in women and 1.18 ± 0.14 g/cm^2 in men at the lumbar spine, and 0.97 ± 0.11 g/cm^2 in women and 1.07 ± 0.15 g/cm^2 in men at the total hip *(53)*. Whether measured on GELunar or Hologic, the T-scores derived with reference to the NHANES database were significantly less than zero in women both in the spine and the hip. The NHANES-derived total hip mean T-score (SD) for women was −0.8 (0.9), and for men −0.7 (1.0), both being significantly less than zero *(53)*.

The third study included a randomly selected sample of elderly subjects from Beirut and its suburbs using the same sampling frame of the peak BMD study. DXA was performed in 2 centers, 1 with Hologic 4500W machine, and the 1 with Hologic 4500A, with cross calibration between both centers. In addition, standard X-rays of the spine were performed, and vertebral fractures were assessed using the Genant semiquantitative technique providing the only published paper on the prevalence of radiographic vertebral fractures in the EMR, thus allowing for an estimation of the relative risk of vertebral fracture in association with BMD loss. With reference to NHANES, osteoporosis prevalence at total hip was 33.0% (27.5−38.8) in women and 22.7% (16.2−30.2) in men. Excluding grade I fractures, the prevalence of vertebral fractures, was estimated at 19.9% (15.4−25.0) in women and 12.0% (7.3−18.3) in men. Compared with the NHANES, the population-specific database was less sensitive to identify subjects with prevalent radiographic vertebral fractures. However, as expected, the relative risk of vertebral fracture per SD decrease (RR/SD) in BMD was similar across the 2 databases. In women, RR/SD was 1.61 (1.17−2.23) using the

Table 3
Osteoporosis Prevalence in Various Eastern Mediterranean Region Populations

Reference	Country	Database	Study population	N (% women) Mean age (SD), age range	% With OP by DXA any site	% With OP by DXA any site
					Women	Men
(35)	Iran	NHANES[a]	Community-based osteoporosis center	N = 4188 (91.9%) Mean age: 53.4 (11.8)	27.8[b] (26.4−29.2)	
(36)	Iran	NHANES	Cross sectional	N = 2085 (75%) 50 yr and above	36.1 (33.7−38.6)	24.5 (20.9−28.5)
(37)	Turkey	NHANES[a]	Multicenter study, 5 big cities	N = 724 PM women Mean age: 57.6 (9.6)	30.2 (26.7−33.5)	NA
(38)	Turkey	NHANES[a]	Retrospective study	N = 1247 (62.8%) 65 yr and above	65.0 (61.6−68.3)	45.9 (41.3−50.6)
(39)	Saudi Arabia	NHANES	King Khalid Hospital	N = 830, PM women 50−80 yr	39.5 (36.2−42.9)	NA
(40)	Saudi Arabia	NHANES[a]	Simulation approach	PM women 50−70 yr	23.0	NA
(41)	Jordan	Spanish Reference	Community-based outpatient clinics	N = 400, PM women Mean age: 53 (12)	29.6 (25.1−34.2)	NA
(42)	Lebanon	NHANES	Population-based random sample	N = 460 (65%) 65 yr and above	33.0 (27.5−38.8)	22.7 (16.2−30.2)

Note: Osteoporosis is defined as a T-score ≤ -2.5 at any site (spine, hip, or forearm).
Abbr: PM, postmenopausal; NHANES, National Health and Nutrition Examination Survey.
[a]Presumed to be NHANES or manufacturer's database in view of the high prevalence of osteoporosis.
[b]This value is the frequency of osteoporosis diagnosis according to the site of assessment as an aggregate for both genders.

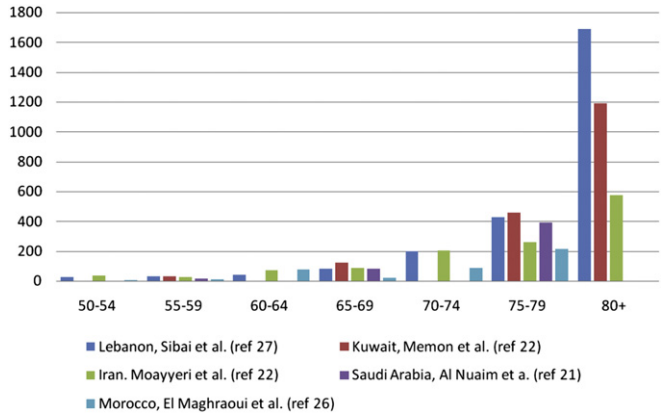

Fig. 2. Exponential increase of hip fracture incidence by age in women older than 50 yr in various countries in the Eastern Mediterranean Region (EMR).

NHANES database and 1.49 (1.14−1.95) using the local database. In men, the figures were 1.59 (0.94−2.72) using NHANES and 1.43 (0.95−2.16) using the local data set *(42)*.

Discussion

Similarly to other large geographic areas worldwide, the incidence rate of hip fractures varies across population studies in the EMR, albeit within a narrower range, estimates ranging from 100 to 295/100,000 person-years in women and 71 to 200/100,000 person-years in men.

Limitations regarding hip fracture estimates in the EMR include the small number of studies available, the frequent lack of clear inclusion criteria, the relative short-time frame and retrospective nature of the studies, and the lack of large epidemiologic population-based cohorts across the region. Despite these limitations, the currently available hip fracture incidence rates in the EMR were similar to those reported in other Southern Europe and Mediterranean countries, as reported in the Mediterranean Countries Osteoporosis Study (MEDOS) study and lower than reported rates in Northern Europe, North America, and Australia *(10,11,56−65)*. Indeed, in the MEDOS study, hip fracture incidence rates in France varied between 100 and 250 per 100,000 person-years and were below 100 per 100,000 person-years in southern European countries *(56)*. In the European Prospective Osteoporosis Study, hip fracture incidence rates were 130 (95% CI: 80−170) per 100,000 person-years in women and 80 (95% CI: 40−100) per 100,000 person-years in men *(64)*. The US Women's Health Initiative study reported an annualized incidence rate of hip fractures 160 per 100, 000 person-years *(65)* and the Dubbo cohort, which included subjects aged 60 yr and older, incidence rates of hip fracture were 759 (95% CI: 647−871) per 100,000 person-years in women and 329 (95% CI: 241−417) per 1100,000 person-years in men *(11)*.

Female-to-male gender ratio among subjects with hip fracture ranged between 1.1 and 1.5, a ratio that is somewhat lower than what has been reported in US and European population, possibly reflecting both regional epidemiological characteristics and different gender-based life expectancies *(9)* (Table 4).

Mean age at hip fracture was similar across all surveys in the area, ranging between 72 and 74 yr, and was significantly lower than the mean reported age reported in developed countries, again reflecting the shorter life expectancy in the EMR, in both genders. All reported age distributions of hip fracture incidence rates across the EMR show consistently the exponential increase beyond age 70 yr (Fig. 2). The prevalence of radiographic vertebral compression fractures older than 65 yr was estimated at around 20% in women and 12% in men by our group *(42)*. These figures are similar to those reported in European countries *(13)*, providing some evidence on the burden of osteoporosis in EMR countries. No epidemiological data on nonhip, nonvertebral, osteoporotic fractures in the EMR could be identified.

Prevalence of osteoporosis based on BMD among postmenopausal women and men older than 50 yr is quite comparable across EMR countries, estimated at around 30% in women and 20% in men, based on manufacturer's database for the spine *(36−42)* (Table 1). However, manufacturer's reference values at the spine were overall significantly higher than spine BMD values in population-based data sets across the various studies in the EMR, and therefore osteoporosis prevalence could be overestimated or underestimated depending on the reference data set used.

Interestingly, population-based reference values at the hip were often closer to the NHANES reference values. Moreover, all data sets showed similar decline of BMD with age (Fig. 1). Furthermore, data relating BMD to radiographic vertebral fractures in a cohort of elderly subjects in Lebanon revealed similar estimates for the relative risk of vertebral fracture per SD decrease in BMD whether a population specific or the NHANES data set were used.

No evidence was found to support using local or regional databases instead of the NHANES as a universal database. Based on the current evidence, we believe that along with the IOF and ISCD recommendations *(17−19)*, the NHANES database would be the most appropriate database to be used in the EMR. This would help comparisons across populations in the EMR and between the EMR and other parts of the world. In addition, the use of the NHANES would ensure consistency in values obtained with those derived using the online fracture risk assessment calculator (FRAX) *(54)* that is now available for Lebanon, Jordan and Tunisia *(55)*.

Table 4
Life Expectancy (yr) at Birth in the Arab World, Middle East and North Africa (MENA), European Countries (OCDE), and the United States

Gender	Arab World	MENA	OCDE	USA
Females	69.9	72.4	81.1	80.4
Males	66.3	68.8	75.4	75.2
Total	68.1	70.6	78.2	77.7

From a public health perspective, mortality figures for hip fracture in the EMR although limited are quite alarming. Mortality rates exceeded 25% at 2 yr and reached 60% at 3 yr, despite a relatively younger mean age of individuals with hip fractures in the EMR compared with developed countries *(30–33)*. Demographic prospects for the next decade suggest a significant increase in the proportion of subjects older than 65 yr in the Middle East and North Africa (MENA) region. The proportion of women older than 65 yr would rise by about 30%, from 4.8% in 2010 to 6.0% in 2020. Similarly, for men the increase would be about 25% from 4.0% to 4.9%. Such demographic changes would translate in 17% increase in the number of hip fractures over the next decade in both genders. Accordingly, the expected number of hip fractures among subjects older than 65 yr in the MENA region in 2020 would be around 300,000 in women and 250,000 in men *(9)*.

In conclusion, the health burden of osteoporosis in the EMR is quite significant. Hip fracture incidence ranged between 100 and 295 per 100,000 person-years across the EMR in postmenopausal women. Female-to-male ratio among hip fracture subjects ranged between 1.1 and 2.4 and the mean age at the time of hip fracture ranged between 71 and 79 yr. Mortality rates exceed 25% by 2 yr following fracture. Osteoporosis prevalence using DXA was quite similar across study populations in the EMR, around 30% at the lumbar spine when BMD is measured using the manufacturer's reference database. T-score distribution in population-specific databases was often lower than both GELunar and Hologic databases, and the age-related decrease in BMD was similar across all databases, in both genders and in all studies. Estimates of the relative risk of vertebral fracture per SD decrease in BMD in an elderly Lebanese cohort were comparable, whether the NHANES or a population-specific database was used.

Overall, population-specific data sets seemed no better than the NHANES data set for fracture risk assessment using DXA, thus justifying the use of the universal NHANES database for osteoporosis assessment in the EMR, as is recommended in other regions worldwide. Furthermore, the FRAX calculator is based on the NHANES database, and is now available for Lebanon and Jordan, thus allowing absolute fracture risk assessment and health policy decision making regarding osteoporosis in several countries in the EMR.

Demographic prospects in the MENA region suggest that the burden of osteoporosis will rise significantly by 2020, calling for cost-effective health policies to reduce the incidence of hip fractures and fracture-related mortality and morbidity.

Acknowledgments

The authors would like to thank Ms. Rola El Rassi for her assistance in article preparation and submission.

The authors report no conflict of interest.

No disclosures.

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