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ORIGINAL ARTICLE

Hip fracture incidence in Lebanon: a national registry-based study with reference to standardized rates worldwide

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Abstract
Summary Crude incidence rates for hip fractures in individuals aged 50 and above in Lebanon were determined using data from the national hip fracture registry. For the years 2006–2008, crude rates varied between 164 and 188/100,000 for females and between 88 and 106 per 100,000 for males. Using the US 2000 white population as a reference, the calculated age-standardized rates were closest to rates derived for southern Europe.
Introduction Owing to the demographic explosion, it is projected that the rates of hip fractures would increase the most in the Middle East and Asia. Few are the population-based studies investigating the incidence of hip fractures in the region.
Methods Using the Ministry of Health registry data, this population-based study evaluated the incidence of hip fractures in individuals aged 50 and above in Lebanon for the years 2006, 2007, and 2008.
Results Hip fracture 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. The overall mean age (SD) for hip fractures was 75.9 (9.2), 76.8 (9.0), and 77.0 (9.9) years in females in 2006, 2007, and 2008, respectively, and 74.4 (11.6), 76.3 (10.3), and 74.0 (12.1) years in males, respectively. Using the US 2000 white population as a reference, the age-standardized rates were 370.4, 335.1, and 329.0 for females and 109.7, 134.1, and 128.7 for males, for the years 2006, 2007, and 2008, respectively.
Conclusions The hip fracture age-standardized incidence rates in the Lebanese subjects receiving Ministry of Health coverage were lower than those found in northern Europe and the US and closest to rates derived for southern Europe.

Keywords Hip fracture · Incidence · Lebanon · National registry · Population-based study

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Introduction

With aging societies and changing disease patterns worldwide, the human, social, and economic costs of osteoporosis will continue to rise [1]. Of particular concern is the associated increased incidence of hip fracture and its accompanying high toll in terms of morbidity, mortality, and economic burden in this era of limited health care resources [2, 3]. There are great variations in hip fracture rates worldwide [4, 5]. Within southern Europe, for example, rates are lowest in Turkey (2.3 to 6.2 per 10,000) and highest in Seville, Crete, and Porto (9.8 to 37.0 per 10,000) [4].

There is a growing direction for basing treatment decision paradigms on absolute fracture probabilities. The

risk of fragility fractures correlates consistently with the risk of hip fracture, and thus, intervention thresholds can be determined based on the probability of hip fracture [5]. This is the basis for the Fracture Risk Assessment calculation Tool, FRAX, a web-based tool developed by the WHO that became available in February 2008 [http://www.shef.ac.uk/FRAX]. FRAX allows estimates to be derived for countries for which data on fracture incidence and mortality are available. It provides estimates for a 10-year probability of fracture, at the hip or at any of four sites (clinical spine, hip, forearm, and shoulder fractures), based on an individual's clinical risk profile and bone mineral density at the femoral neck [6]. Currently, this web-based model has allowed fracture rate estimates to be calculated for several countries in Europe, the United States, Argentina, China, Japan, and Hong Kong, but none in the Middle East. This study was conducted to determine the incidence of hip fracture in the Lebanese population, using the national registry data provided by the Ministry of Health (MOH), and to derive age-standardized rates for the Lebanese and compare them to similarly derived rates for several other countries worldwide.

Methods

The study population consisted of Lebanese patients who sustained a hip fracture between Jan 1, 2006 and Dec 31, 2008 and received their care exclusively through the Lebanese MOH. Only hip fractures in individuals aged 50 and above were considered in this analysis, as such fractures are usually considered osteoporotic fractures. Based on the Living Conditions Surveys conducted by the Central Administration for Statistics in Lebanon, the Lebanese population aged 50 years and over was estimated at 738,690 for the year 2006; 750,250 for 2007, and 762,660 for 2008 [7]. The proportion of the Lebanese citizens in this age group for whom healthcare is covered by the MOH, as the insurer of last resort, was overall 53.3% for 2006, yielding a total of 394,100 at-risk baseline population, and 51.7% for years 2007 and 2008, yielding 388,250 and 394,670 at-risk baseline population, respectively.

Age was divided into 5-year age bands (50–54, 55–59, 60–64, 65–69, 70–74, 75–79, and 80 and over). Age- and sex-specific crude incidence rates per 100,000 and their 95% confidence intervals were derived by dividing the number of cases over the total population receiving medical care by the MOH in each gender and age group. Using the US Census 2000 white population as the reference population [8], age-standardized rates (ASRs) were calculated according to the direct method described by Armitage and Berry [9]. For comparison of our results to those published from other countries/continents, electronic databases (Medline, PubMed, Scopus, and Google Scholar) were searched for the years between 1980 and 2009, entering in the key words: hip fracture and incidence rates. We selected studies that provided sufficient data in the published papers (number of incident cases and at-risk baseline population in each age group, stratified by gender) that allowed us to re-calculate country-specific ASRs using the same reference population, the US Census 2000, as employed for the data from Lebanon. This allowed for a comparison of standardized rates for Lebanon with similarly derived rates for other countries worldwide. We also relied on major reviews and original publications referred by co-authors for consideration [10–35].

Results

Age- and sex-specific incidence rates

The total number of hip fractures recorded in female subjects was 394 in 2006, 361 in 2007, and 345 in 2008, while the corresponding number for male subjects was 162, 193, and 194. Fractures were classified using the International Classification of Disease (ICD 10) codes as: S72.0 for femoral neck (73.9%, 71.5%, and 78.8% for the years 2006, 2007 and 2008, respectively), S72.1 for pertrochanteric (both intertrochanteric and trochanteric; 24.6%, 25.3%, and 18.9%, respectively), and S72.2 for subtrochanteric (1.4%, 3.2%, and 2.2%, respectively). The overall mean age (SD) for hip fractures was 75.9 (9.2), 76.8 (9.0), and 77.0 (9.9) years in females in 2006, 2007, and 2008, respectively, and 74.4 (11.6), 76.3 (10.3), and 74.0 (12.1) years in males, respectively. Crude incidence rates varied across the years between 163.9 and 187.5/100,000 per year for female subjects and between 88.1 and 106.5/100,000 per year for male subjects (Tables 1 and 2). There was a clear trend for a gradual increase in hip fracture cases with age, and a very sharp rise after age 65 years in females and 70 years in males (Fig. 1). The overall estimated female/male ratios varied across the years between 1.6 and 2.1 (Table 3).

Age-adjusted standardized incidence rates in Lebanon compared to other countries worldwide

The calculated ASRs per 100,000 in the Lebanese ranged across the years between 329.0 and 370.4 in women and between 109.7 and 134.1 for men. The corresponding figures for the neighboring countries in the region were 329.6 and 224 for women and men from Kuwait, and varied between 170.9 and 251.2 for women from Iran, and between 130.8 and 190.9 for Iranian men, depending on study site and year. Countries from other continents with

Table 1 Crude incidence rates of hip fracture per 100,000 population per year among females by age, Lebanon (2006–2008)

Age groups	2006				2007				2008			
	n	Population	Incidence rate	95% CI lower–upper	*n*	Population	Incidence rate	95% CI lower–upper	*n*	Population	Incidence rate	95% CI lower–upper
50–54	9	48,040	18.7	8.6–35.6	3	47,327	6.3	1.3–18.5	11	48,110	22.9	11.4–40.9
55–59	7	43,403	16.1	6.5–33.2	12	42,760	28.1	14.5–49.0	12	43,467	27.6	14.3–48.2
60–64	23	40,227	57.2	36.3–85.8	16	39,629	40.4	23.1–65.6	16	40,285	39.7	22.7–64.5
65–69	34	32,101	105.9	73.4–148.0	36	31,625	113.8	79.7–157.6	25	32,148	77.8	50.3–114.8
70–74	61	21,072	289.5	221.5–371.7	59	20,759	284.2	216.4–366.5	45	21,102	213.2	155.6–285.2
75–79	69	13,960	494.3	384.8–625.1	73	13,753	530.8	416.3–666.9	62	13,981	443.5	340.2–568.1
80+	191	11,367	1680.3	1452.1–1933.8	162	11,198	1446.7	1233.8–1685.4	174	11,383	1528.5	1311.3–1771.2
Overall	394	210,170	187.5	169.4–206.9	361	207,052	174.4	156.8–193.3	345	210,476	163.9	147.1–182.1

Table 2 Crude incidence rates of hip fracture per 100,000 population per year among males by age, Lebanon (2006–2008)

Age groups	2006				2007				2008			
	n	Population	Incidence rate	95% CI Lower–upper	*n*	Population	Incidence rate	95% CI Lower–upper	*n*	Population	Incidence rate	95% CI Lower–upper
50–54	6	42,275	14.2	5.2–30.9	7	41,647	16.8	6.8–34.6	13	42,336	30.7	16.4–52.5
55–59	10	32,290	31.0	14.9–57.0	5	31,811	15.7	5.1–36.7	11	32,337	34.0	17.0–60.9
60–64	13	31,496	41.3	22.0–70.6	12	31,029	38.7	20.0–67.6	15	31,542	47.6	26.6–78.4
65–69	19	29,659	64.1	38.6–100.0	23	29,219	78.7	49.9–118.1	16	29,702	53.9	30.8–87.5
70–74	17	23,475	72.4	42.2–115.9	24	23,126	103.8	66.5–154.4	31	23,509	131.9	89.6–187.1
75–79	27	14,198	190.2	125.4–276.6	35	13,987	250.2	174.4–347.8	34	14,218	239.1	165.7–334.0
80+	70	10,537	664.3	518.2–838.6	87	10,381	838.1	671.8–1032.7	74	10,552	701.3	551.1–879.6
Overall	162	183,929	88.1	75.0–102.7	193	181,199	106.5	92.0–122.6	194	184,197	105.3	91.0–121.2

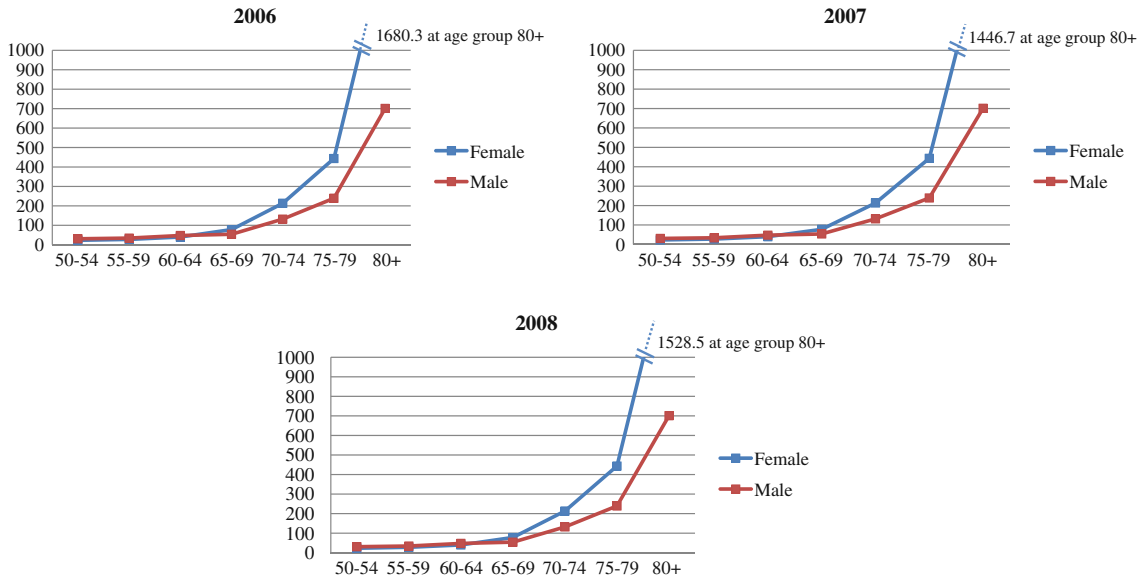


Fig. 1 Point crude estimates of hip fracture incidence per 100,000 by gender and age in Lebanon (2006–2008)

calculated rates within the range of the Lebanese data included the Canary Islands, Spain, and France for women (Fig. 2a) and Portugal, France, Canary Islands, Mexico, and Thailand for men (Fig. 2b). Worldwide, the female/male ratio ranged between 0.8 and 3.8, but exceeded 2 in most studies (data not shown). The highest ASRs were noted for Norway (964.0 for women and 411.7 for men), followed by the USA white population, Argentina, Australia, and Taiwan. The lowest calculated rates were for Korea, 44.0 for women and 52.4 for men, followed by Ecuador and China.

Discussion

This study is the first to provide crude incidence rates for hip fractures in Lebanon, by age and gender, in a large sample that represents around 50% of the older adult population receiving their care through the MOH. It also estimates age-standardized rates to the US 2000 white population, and compares them to similarly calculated figures for other countries from the five continents. The age- and gender-standardized incidence rates in this study were found to be comparable to those reported in the MEDOS study from Southern Europe, ranging from 100 to 300/100,000 person-years [4]. Although higher than those reported in Turkey, rates in Lebanon approached those from Seville, Paris, and Toulouse, and were closest to those reported from Crete, for both genders [4]. Concurrent with other studies from western countries [36], our figures showed a clear increasing trend with age and a sharp rise in incidence rates among women after age 65 years and a slight lag, that is after age 70 years, in men.

Table 3 Age-specific female/male risk ratios and their 95% confidence intervals (CI)

	2006		2007		2008	
	F/M ratio	95% CI	F/M ratio	95% CI	F/M ratio	95% CI
Age groups		Lower–upper		Lower–upper		Lower–upper
50–54	1.3	0.5–3.7	0.4	0.1–1.5	0.7	0.3–1.7
55–59	0.5	0.2–1.4	1.8	0.6–5.1	0.8	0.4–1.8
60–64	1.4	0.7–2.7	1.0	0.5–2.2	0.8	0.4–1.7
65–69	1.7	0.9–2.9	1.4	0.9–2.4	1.4	0.8–2.7
70–74	4.0	2.3–6.8	2.7	1.7–4.4	1.6	1.0–2.6
75–79	2.6	1.7–4.1	2.1	1.4–3.2	1.9	1.2–2.8
80+	2.5	1.9–3.3	1.7	1.3–2.2	2.2	1.7–2.9
Overall	2.1	1.7–2.6	1.6	1.4–2.0	1.6	1.3–1.9

Worldwide, the total number of hip fractures was estimated at 1.7 million in 1990 and is projected to increase to 6.3 million fractures in 2050, with the largest proportional increase anticipated to occur in Asia due to the demographic explosion in this region [36]. In the Middle East and North African region, in particular, rapid population growth rates have caused its population to quadruple since 1950, and is set to propel its total population to over 700 million by 2050, exceeding the population of Europe in that year [37]. It is anticipated that the largest proportional increase in older adult population will occur in Lebanon [38], and thus, increments in hip fractures would be anticipated. Assuming that current age-specific estimates of hip fractures prevail for the coming decades, the demographic transition, alone, will drive the overall crude rates among women to 179 and 193/100,000 in the years 2030 and 2050, respectively, and the overall crude rates among men to 124 and 143/100,000, respectively (data not shown). Hip fractures are associated with a substantial decrease in overall survival and incur major disability in

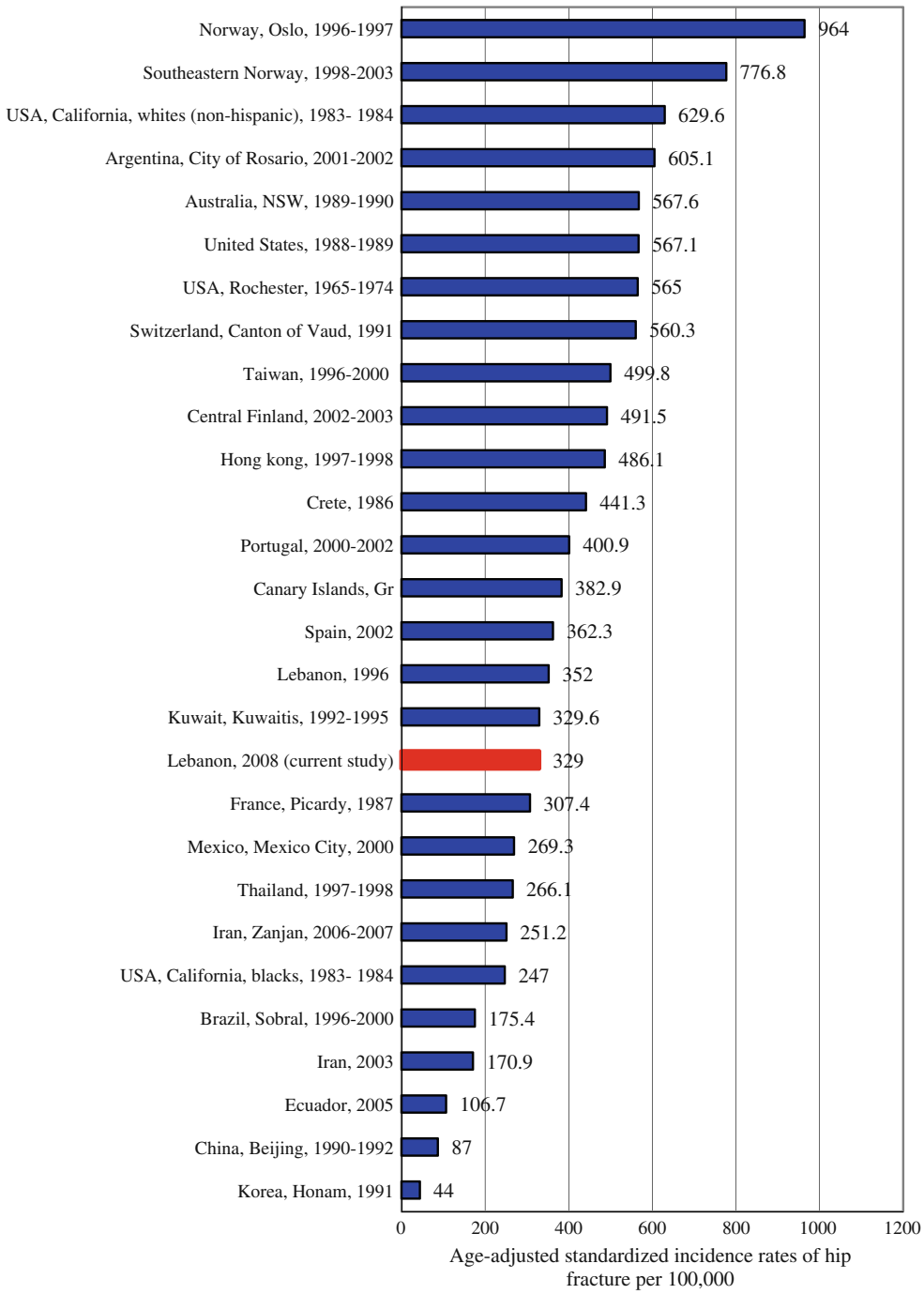
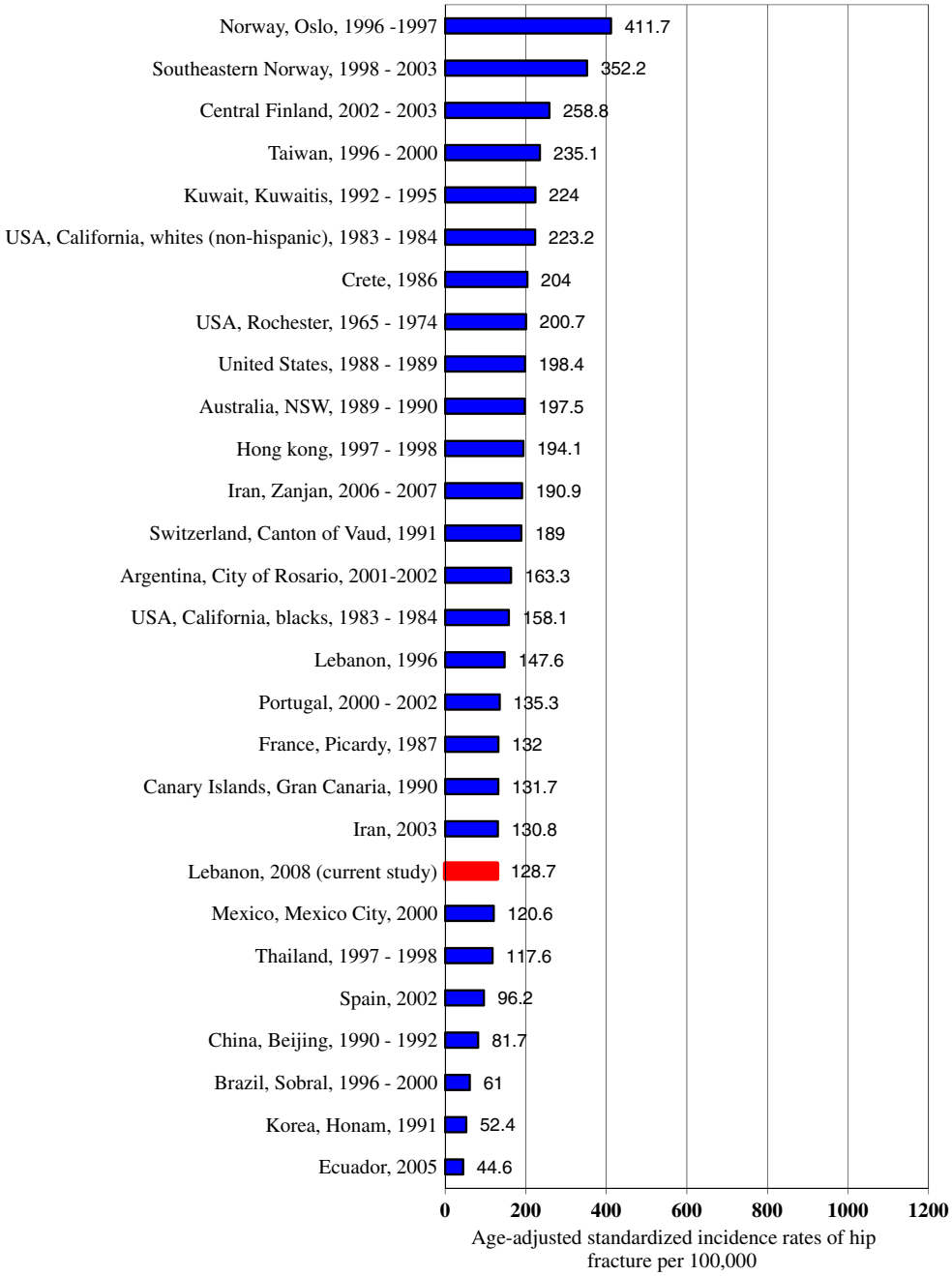


Fig. 2 **a** Age-adjusted standardized incidence rates of hip fracture among females per 100,000 in the Lebanese population compared to other countries worldwide. **b** Age-adjusted standardized incidence rates of hip fracture among males per 100,000 in the Lebanese population compared to other countries worldwide

Fig. 2 (continued)



terms of pain and loss of functional independence; and thus, constitute a substantial drain on social and economic health care resources [39–41].

Data on hip fracture incidence rates from the Middle East are scarce and are largely limited by means of selecting the study population. Study subjects are often derived from hospital-based case series or limited to urban populations selected exclusively from large cities, particularly the capital cities (Kuwait, Morocco, Oman, Saudi Arabia, and Iran) [11, 42–45]. Findings from these studies show that crude incidence rates among those aged 50 years and over are lowest in Morocco (52.1 and 43.7 per 100,000 in females and males, respectively) [42] and highest in Kuwait (295/100,000 in females and 200/100,000 in males) [11]. In Saudi Arabia, the incidence rates for individuals older than 40 years of age were 100/100,000 in females and 71/100,000 in males [44], and in Oman 150/100,000 and 130/100,000, respectively [43]. In Iran, annual incidence rate of hip fracture was estimated at 94/100,000 person-years in a large sample of individuals above age 50 [45]. Despite variations in the definitions of fractures, baseline populations, and years of study, crude incidence rates from our study compared well with some neighboring countries with similar demographic and epidemiological transition. In

comparison to other countries worldwide, findings from our study indicate that age-standardized incidence rates for the Lebanese were close to those of Spain and France in females and to those of Portugal, France, Canary Islands, Mexico, and Thailand in males.

To our knowledge, this study is the first nationwide population-based study of hip fracture incidence in the region using data from three consecutive years. The study utilized a uniform method for case identification and data capture through the Lebanese MOH hip fracture registry using ICD 10 codes and provided a unique comparative perspective on standardized rates for Lebanon with similarly derived rates for other regions worldwide. Study findings offer leads to researchers and policy makers for assessment of disease burden and for evidence-based health planning. The hip fracture estimates also provided essential data that allowed the development of a Fracture Risk Assessment (FRAX) calculation tool in Lebanon, which became available online in September 2009, as the first country with a FRAX calculator in the Middle East [http://www.sheffield.ac.uk/FRAX/tool.jsp?country=21]. The Lebanese national data presented herein, and its comparison to available evidence for fracture incidence rates in neighboring countries, provide a basis for consideration of a regional FRAX calculator, provided longevity in neighboring countries is comparable to the data in Lebanon.

The study, however, has potential limitations. Firstly, the study population was restricted to those covered by the MOH. Compared with the general population, these included a slightly higher proportion of females than males and of the oldest old than the younger age groups. While our population was comparable overall demographically to the total population, there may be some concerns that the MOH population may include a higher proportion of the lower socioeconomic strata, raising questions regarding applicability of the study findings to the country at large. This bias, if any, may result in an overestimate of the true incidence rates in the overall Lebanese population. Secondly, and owing to inherent administrative limitations in the MOH dataset, data on vertebral and forearm fractures, and on the impact of hip fractures on mortality and disability were lacking. Furthermore, while the F/M ratios were consistently higher in the older age groups across the three study years, the overall F/M ratios were lower in the years 2007 and 2008 compared to 2006. Analysis of the provisional 2009 dataset provided by the MOH post hoc, however, revealed a trend similar to the more recent years (i.e., 2007–2008). Finally, the comparison of the derived age-standardized rates between countries needs to be considered with caution. Studies have varied in their methodology employed to determine hip fractures. While most have included, in the identifications of hip fractures, fractures of the femoral neck, trochanter, intertrochanter, and subtrochanteric area, similar to the definition used in the Lebanese study, few have excluded subtrochanteric fractures, and two studies left that determination unclear [10, 15, 17, 18, 20, 24, 34]. Subtrochanteric fractures, nevertheless, constitute a minority of the total number of hip fractures [19, 27]. Moreover, the wide range of years of study may have substantial impact on variations in incidence rates across the years.

In conclusion, findings from this study indicate that hip fractures rates in Lebanon are similar to those derived from southern Europe. While hip fractures are recognized to be a major public health problem characteristic of many Western nations, current estimates in Lebanon and the demographic prospects in the near future point to the magnitude of the problem, the significance of implementing public preventive measures, and the need for a national policy on osteoporosis that is based on a case-finding strategy.

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Conflicts of interest None.

References

1. Sambrook P, Cooper C (2006) Osteoporosis. Lancet 367 (9527):2010–2018
2. Center JR, Nguyen TV, Schneider D, Sambrook PN, Eisman JA (1999) Mortality after all major types of osteoporotic fracture in men and women: an observational study. Lancet 353(9156):878–882
3. Burge R, Dawson-Hughes B, Solomon DH, Wong JB, King A, Tosteson A (2007) Incidence and economic burden of osteoporosis related fractures in the United States 2005–2025. J Bone Miner Res 22(3):465–475
4. Elffors L, Allander E, Kanis JA, Gullerg B, Johnell O, Dequeker J (1994) The variable incidence of hip fracture in southern Europe: the MEDOS Study. Osteoporos Int 4(5):253–263
5. Kanis JA, Johnell O, De Laet C, Jonsson B, Oden A, Ogelsby AK (2002) International variations in hip fracture probabilities: implications of risk assessment. J Bone Miner Res 17(7):1237–1244
6. Watts NB, Ettinger B, LeBoff MS (2009) FRAX facts. J Bone Miner Res 24(6):975–979
7. Central Administration of Statistics. Household Living Conditions Survey, 2004 and 2007. Lebanon, Presidency of Council of Ministers. http://www.cas.gov.lb/index.php?option=com_content&view=article&id=52&Itemid=27
8. U.S. Census Bureau (2000) Population by age, sex, race, and Hispanic or Latino origin for the United States: 2000. Tables 2, 3. Available at: http://www.census.gov/population/www/cen2000/briefs/phc-t9/index.html; Accessed March 10, 2010
9. Armitage P, Berry G (1994) Statistical methods in medical research, 3rd edn. Blackwell, Oxford
10. Baddoura R (2001) Incidence of hip fractures in the Lebanese population. East Mediterr Health J 7(4–5):368–375

11. Memon A, Pospula WM, Tantawy AY, Abdul-Ghafar S, Suresh A, Al-Rowaih A (1998) Incidence of hip fracture in Kuwait. Int J Epidemiol 27(5):860–865
12. Xu L, Lu A, Zhao X, Chen X, Cummings SR (1996) Very low rates of hip fractures in Beijing, People's Republic of China: the Beijing osteoporosis project. Am J Epidemiol 144(9):901–907
13. Moayyeri A, Soltani A, Larijani B, Naghavi M, Alaeddini F, Abolhassani F (2006) Epidemiology of hip fracture in Iran: results from the Iranian multicenter study on accidental injuries. Osteoporos Int 17(8):1252–1257
14. Soveid M, Serati AR, Masoompoor M (2005) Incidence of hip fracture in Shiraz, Iran. Osteoporos Int 16(11):1412–1416
15. Valizadeh M, Mazloomzadeh S, Azizi R (2008) Epidemiology of hip fractures in Zanjan, Iran. Arch Osteoporos 3(1–2):1–5
16. Lau EM, Lee JK, Suriwongpaisal P, Saw SM et al (2001) The incidence of hip fracture in four Asian countries: the Asian Osteoporosis Study (AOS). Osteoporos Int 12(3):239–243
17. Rowe SM, Yoon TR, Ryang DH (1993) An epidemiological study of hip fracture in Honam, Korea. Int Orthop 17(3):139–143
18. Chie WC, Yang RS, Liu JP, Tsai KS (2004) High incidence rate of hip fracture in Taiwan: estimated from a nationwide health insurance database. Osteoporos Int 15(12):998–1002
19. Sosa M, Segarra MC, Hernández D, Gonázlez A, Liminana JM, Betancor P (1993) Epidemiology of proximal femoral fracture in Gran Canaria (Canary Islands). Age Ageing 22(5):285–288
20. Dretakis EK, Giaourakis G, Steriopoulos K (1992) Increasing incidence of hip fracture in Crete. Acta Orthop 63(2):150–151
21. Lofthus CM, Osnes EK, Falch JA, Kaastad TS, Kristiansen IS, Nordsletten L, Stensvold I, Meyer HE (2001) Epidemiology of hip fractures in Oslo, Norway. Bone 29(5):413–418
22. Bjørgul K, Reikerås O (2007) Incidence of hip fracture in southeastern Norway. Int Orthop 31(5):665–669
23. Lönnroos E, Kautiainen H, Karppi P, Huusko T, Hartikainen S, Kiviranta I, Sulkava R (2006) Increased incidence of hip fractures. A population based-study in Finland. Bone 39(3):623–627
24. Jéquier V, Burnand B, Vader J-P, Paccaud F (1995) Hip fracture incidence in the Canton of Vaud, Switzerland, 1986–1991. Osteoporos Int 5(3):191–195
25. De Pina MF, Alves SM, Barbosa M, Barros H (2008) Hip fractures cluster in space: an epidemiological analysis in Portugal. Osteoporos Int 19(12):1797–1804
26. Baudoin C, Fardellone P, Potard V, Sebert JL (1993) Fractures of the proximal femur in Picardy, France, in 1987. Osteoporos Int 3 (1):43–49
27. Hernández JL, Olmos JM, Alonso MA, González-Fernández CR, Martínez J, Pajarón M, Llorca J, González-Macías J (2006) Trend in hip fracture epidemiology over a 14-year period in a Spanish population. Osteoporos Int 17(3):464–470
28. Silverman SL, Madison RL (1988) Decreased incidence of hip fracture in Hispanics, Asians, and blacks: California Hospital Discharge Data. Am J Public Health 78(11):1482–1483
29. Gallagher JC, Melton LJ, Riggs BL, Bergstrath E (1980) Epidemiology of fractures of the proximal femur in Rochester, Minnesota. Clin Orthop 150:163–171
30. Ho SC, Bacon WE, Harris T, Looker A, Maggi S (1993) Hip fracture rates in Hong Kong and the United States, 1988 through 1989. Am J Public Health 83(5):694–697
31. Clark P, Lavielle P, Franco-Marina F, Ramírez E, Salmerón J, Kanis JA, Cummings SR (2005) Incidence rates and life-time risk of hip fractures in Mexicans over 50 years of age: a population-based study. Osteoporos Int 16(12):2025–2030
32. Orces CH (2009) Epidemiology of hip fractures in Ecuador. Rev Panam Salud Pública 25(5):438–442
33. Castro da Rocha FA, Ribeiro AR (2003) Low incidence of hip fractures in an equatorial area. Osteoporos Int 14(6):496–499
34. Morosano M, Masoni A, Sánchez A (2005) Incidence of hip fractures in the city of Rosario, Argentina. Osteoporos Int 16(11):1339–1344
35. Lau EM (1993) Admission rates for hip fracture in Australia in the last decade. Med J Aust 158(9):604–606
36. Cooper C, Campion G, Melton LJ (1992) Hip fracture in the elderly: a world-wide projection. Osteoporos Int 2(6):285–289
37. Farzaneh R, Kent MM (2007) Challenges and opportunities: the population of the Middle East and North Africa. Popul Bull 62(2)
38. Sibai AM, Tohme R, Yount K, Yamout R, and Kronfol N. (Forthcoming). The older Arab—from veneration to vulnerability? In: R. Giacaman, S. Jabbour, M. Khawaja and I. Nuwayhid (eds) Public Health in the Arab World. Cambridge University Press, UK.
39. Giversen IM (2007) Time trends of mortality after first hip fractures. Osteoporos Int 18(6):721–732
40. Johnell O, Kanis JA (2004) An estimate of the worldwide prevalence, mortality and disability associated with hip fracture. Osteoporos Int 15(11):897–902
41. Hreybeh H, Salamoun M, Badra M et al (2004) Hip fractures in Lebanese patients: determinants and prognosis. J Clin Densitom 7 (4):368–375
42. El Maghraoui A, Koumba BA, Jroundi I, Achemlal L, Bezza A, Tazi MA (2005) Epidemiology of hip fractures in 2002 in Rabat, Morocco. Osteoporos Int 16(6):597–602
43. Shukla JJ, Khandekar RB (2008) Magnitude and determinants of osteoporosis in adult population of South Sharqiya region of Oman. Saudi Med J 29(7):984–988
44. Al-Nuaim AR, Kremli M, Al-Nuaim M, Sandkgi S (1995) Incidence of proximal femur fracture in an urbanized community in Saudi Arabia. Calcif Tissue Int 56(6):536–538
45. Abolhassani F, Moayyeri A, Naghavi M, Soltani A, Larijani B, Shalmani HT (2006) Incidence and characteristics of falls leading to hip fracture in Iranian population. Bone 39:408–413