

Epidemiology of hip fractures in 2002 in Rabat, Morocco

Abdellah El Maghraoui · Boris A. Koumba
Imane Jroundi · Lahsen Achemlal · Ahmed Bezza
Mohamed A. Tazi

Received: 31 December 2003 / Accepted: 29 July 2004 / Published online: 28 September 2004
© International Osteoporosis Foundation and National Osteoporosis Foundation 2004

Abstract Hip fracture has never been studied before, either in Morocco or in the adjacent countries of the south bank of the Mediterranean Sea. The aim of this study was to investigate the incidence rate of hip fracture in 2002 in Rabat Province, a large area in the northwest of The Kingdom of Morocco, by the use of register information and medical records collected from the five public hospitals of the region. The hip fracture data were restricted to cervical or trochanteric types. There was a total of 150 hip fractures (83 in women and 67 in men) in the over-50-year-old population in the Province of Rabat during 2002. The age-adjusted 1-year cumulative incidence of hip fracture was 52.1/100,000 [95% confidence interval (CI) 40.9–63.3/100,000] in women and 43.7/100,000 (95% CI 33.3–52.2/100,000) in men. The standardized incidence rate against the 1985 US population was 80.7/100,000 (95% CI 78.5–93.0/100,000) for women and 58.5/100,000 (95% CI 47.9–68.1/100,000) for men. The mean (standard deviation) age of patients with a hip fracture was 70.7 (9.4) years for women and 70.4 (10.0) years for men. The overall female-to-male ratio of hip fracture was 1.19 for age-adjusted hip fracture incidence and 1.30 for standardized incidence. A marked increase in incidence rate was found for both men and women

with increasing age, becoming exponential after the age of 50 years. The mean age for hip fracture was 70.7 (9.4) years in women and 70.4 (10.0) years in men ($P > 0.05$). Women had a cervical-to-trochanteric ratio of 0.97 compared to men, at 1.03. The characteristics of hip fractures described in this study suggest that fragility fractures occur in North Africa, although substantially less frequently than in most European, North American and Asian countries but more frequently than sub-Saharan African countries, in agreement with the north–south gradient observed in the epidemiology of osteoporosis. The low incidence of hip fragility fracture rate is most likely the result of reduced longevity in Morocco.

Keywords Epidemiology · Hip fracture · Incidence · Morocco

Introduction

Fracture of the proximal femur, or hip fracture, is considered the most important osteoporosis-related condition in terms of morbidity, mortality, and cost. As virtually all hip fracture patients present to health services and are readily identified, the incidence of hip fracture is frequently used as an indicator of the prevalence of osteoporosis [1, 2]. The literature on hip fracture incidence is based mainly on white populations in Europe and the USA and some Asian countries. Incidence of hip fracture varies considerably between countries and according to age, gender and ethnic distribution of the population. Highest rates are observed in Scandinavia and in whites in the USA, intermediate rates in Southern Europe countries and Asia and the lowest rates in Africa, where only sparse information about the epidemiology of hip fracture is available. Hip fracture has never been studied before, either in Morocco or in the adjacent countries that constitute the south bank of the Mediterranean Sea.

A. El Maghraoui (✉) · B. A. Koumba · L. Achemlal · A. Bezza
Rheumatology and Physical Rehabilitation Department,
Military Hospital of Mohammed V,
Rabat, Morocco
E-mail: abdellahe@menara.ma
Tel.: +212-61-547190
Fax: +212-37-626179

I. Jroundi
Epidemiology Department,
Rabat Medicine and Pharmacy University,
Rabat, Morocco

M. A. Tazi
Epidemiology Department,
Ministry of Health,
Rabat, Morocco

The aim of this population-based study was to evaluate the incidence rate of hip fracture in the population of the Province of Rabat, a large area of over 2 million people in the north east of Morocco.

Materials and methods

Morocco is a country located in the north west of Africa with a population greater than 31 million (99.2% are Arab/Berber, considered as being of Caucasian ethnicity). Rabat Province (called Rabat-Salé-Zemmour-Zair) is located at a latitude of 34°N 6°W and an altitude of 75 m. Rabat city is the capital of Morocco (Fig. 1). The area of Rabat Province is approximately 9,580 km² (1.4% of Morocco's surface area). There are four distinct seasons: a mild spring and autumn, a hot summer (25°–36°C) and a cold winter (4°–20°C). There are typically approximately 18 h of daylight in summer and 10 h in winter. The mean rainfall is 46.3 mm/year. The economy of Rabat Province is based on Agriculture.

In Morocco, free health care is provided for all people in public hospitals. There is a total of five public hospitals (two university centers and three regional hospitals) located throughout Rabat Province. Most residents of Rabat Province with hip fractures are treated at one of the five public hospitals. Patients who present to another facility are automatically referred to one of these five hospitals. All hospitals are the biggest in their area and situated in the center of town, serving the total population from all social groups and all ages. In each hospital a register is maintained in the inpatient department of all patients who are admitted, and it includes the date, the patient's name, age, and gender, diagnosis of the fracture, and the patient's home address. The admitting doctor is responsible for making the assessment, using both a clinical and a radiological examination, before the entry in the register is made. In addition, there is a medical records office in each hospital, where the original medical records of patients are



Fig. 1 Location of Rabat Province (dark shading), Morocco

routinely kept and organized. In this study the registers of hip fractures from all public hospitals were scrutinized and then confirmed by examination of original medical records for both inclusion and exclusion criteria. We reviewed hip fractures for all patients, using information from hospital registers and medical records. Thirty-six private clinics were identified in the region. None of them had an orthopedic department. However, seven of them had at least an orthopedic surgeon doing vacations. These clinics were contacted: six refused to participate in the study, and examination of the inpatients' register of the clinic that did agree to participate found no hip fractures that corresponded with inclusion and exclusion criteria.

Thus, information about all patients who were resident in Rabat Province and who had sustained a hip fracture from 1 January to 31 December 2002 was obtained from the five public hospitals between May and October 2003. Cases selected were based on the International Classification of Diseases, ninth revision (ICD-9:820.0), corresponding to open and closed cervical and trochanteric fractures of the proximal femur. Cases of hip fracture were limited to those coded as 820, 820.0, 820.2 and 820.8 on the ICD-9 (closed hip fractures). Exclusion criteria were: nonresidents receiving treatment in Rabat, fractures due to major trauma (car crash, for example), fracture below the lesser trochanter; fracture only intersecting the greater trochanter; and fracture due to cancer metastases at the fracture site. If patients were admitted to more than one hospital for the same fracture, they were recorded at only the hospital where surgery was performed. The fractures were classified as either cervical or trochanteric, according to the description in the medical record.

From the population of Rabat in 1994 (Morocco census) and population projections for 2002 developed by the Demographic Study and Research Center of Rabat City, the age-specific and gender-specific annual incidence rates were calculated for age groups 50–54, 55–59, 60–64, 65–70, 70–75, and 75 and over and expressed as fractures/100,000 inhabitants/year as well. We standardized incidence rates of hip fracture to the 1985 US population [3], which had been used in previous reports [4, 5, 6], to enable comparisons with other populations (standardized incidence). We calculated the ratios of hip fracture rates in men versus women based on these age-adjusted rates. The incidence of hip fracture presented here was based only on patients ≥ 50 years of age. For comparison between populations, we selected studies that reported on hip fracture incidence rates and provided sufficient information for the calculation of age-adjusted incidence rates of hip fracture.

Student's *t*-test and the chi-square test were used for statistical analysis. *P* values less than 0.05 were considered to be significant. All calculations were carried out in Microsoft Excel XP for Windows and SPSS version 10.0 (Cary, N.C., USA).

Results

The estimated population of the Province of Rabat was 2,380,000 in 2002. The population aged ≥ 50 years was 312,461 (13.1%). There was a total of 150 hip fractures (83 in women and 67 in men) in the over-50-year-old population in the Province of Rabat during 2002. Age-adjusted 1-year cumulative incidence of hip fracture per 100,000 persons, by age and gender, is shown in Table 1, as are population sizes and the gender ratio of hip fracture patients. The age-adjusted incidence rate of hip fracture was 52.1/100,000 [95% confidence interval (CI) 40.9–63.3/100,000] in women and 43.7/100,000 (95% CI 33.3–52.2/100,000) in men. The standardized incidence rate against the 1985 US population was 80.7/100,000 (95% CI 78.5–93.0/100,000) for women and 58.5/100,000 (95% CI 47.9–68.1/100,000) for men. The use of the standardized incidence rate against the 1985 US population enables the comparison of hip fracture incidence rate with studies in other countries (Table 2). The mean (standard deviation) age of patients with a hip fracture was 70.7 (9.4) years for women and 70.4 (10.0) years for men ($P > 0.05$). A marked increase in incidence rate was found for both men and women with increasing age, becoming exponential after the age of 50 years (Fig. 2). The overall female-to-male ratio of hip fracture was 1.19 for age-adjusted hip fracture incidence and 1.30 for standardized incidence. There was no gender difference for the type of hip fracture. Overall, in both men and women, the number of cervical fractures was the same as that of trochanteric fractures [75 each (50%)]. Women had a cervical-to-trochanteric ratio of 0.97 compared to men, at 1.03. The right hip was fractured in 77 (51.3%) patients and the left hip in 73 (48.7%), equally distributed between both genders. The total number of fractured patients in each month during the observation period was highest in February ($n=20$) and lowest in March and July ($n=8$ each), showing no seasonal trends.

Discussion

This study used hospital register information and medical records to estimate the incidence of hip fracture. The collection of information from hospitals is the only way

to evaluate the incidence of hip fracture in Morocco currently, because hospitals in Morocco are not asked to report hip fracture cases to health authorities routinely. Several methodological issues arise from this kind of study [7]. Not all those with fractures have access to hospitals. Incidence based on hospital data would be underestimated if many hip fractures in Rabat Province were not diagnosed or treated in these hospitals. Moreover, many cases of fractures might have been misclassified or not reported in the discharge file. Schwartz et al. reported that the final estimate of the hip fracture incidence could result in an underestimate or overestimate ranging from 15% lower to 89% higher than the estimated incidence based on the discharge diagnoses alone [8]. However, Rabat, which is the capital of Morocco, is a well-developed city and has the leading public hospitals in the country. It is more common for people resident outside of the city to come to Rabat for health care than for residents of the city to seek care elsewhere. In fact, Avicenna hospital is the biggest hospital in Morocco, where all the serious cases are referred (70% of our cases). Moreover, the Moroccan population is poor, and there is no health insurance program, so, in spite of the fact that there are many private clinics in these regions, almost all individuals cannot afford to pay the cost of treatment for fractures in private clinics and they go to public hospital where health care is free. Moreover, examination of the register of the only clinic that agreed to participate in the study found no hip fracture corresponding to our inclusion and exclusion criteria. It is unlikely, therefore, that significant underreporting of hip fractures due to treatment outside the city or in private clinics would have introduced a large error into the study.

The incidence of hip fracture in Rabat compared with recent studies in other countries, for a population over 50 years of age, is presented in Table 2. This comparison indicates that Rabat has a low incidence of hip fracture.

There is a pronounced geographical variation in the incidence of hip fractures, with rates being highest in Caucasians living in northern Europe, especially Scandinavians [9, 10], followed by rates in Caucasians living in North America [11, 12, 13], south-west Europe [14, 15, 16, 17, 18, 19, 20], South America [21], and Oceania [22, 23]. The rates are intermediate in Asians [24, 25, 26, 27, 28, 29, 30, 31] and lowest in black populations [32,

Table 1 One-year cumulative incidence of hip fracture, by age and gender, in Rabat in 2002. Age-adjusted to the population structure of Rabat (estimated in 2002 from the 1994 Morocco census) expressed per 100,000 population aged > 50 years

Age group (years)	Population		Fracture		Incidence (95% CI)		Female:male
	Female	Male	Female	Male	Female	Male	
50–54	42,587	50,405	3	7	7.0 (0.0–15.0)	13.9 (3.6–24.2)	0.50
55–59	31,827	29,105	4	3	12.6 (0.3–24.9)	10.3 (0.0–22.0)	1.22
60–64	28,158	25,050	21	7	74.6 (42.7–106.5)	27.9 (7.2–48.6)	2.67
65–69	22,108	20,206	5	9	22.6 (2.8–42.4)	44.5 (15.4–73.6)	0.50
70–74	18,821	14,365	16	19	85.0 (43.4–126.7)	132.3 (72.8–191.7)	0.64
> 75	15,782	14,047	34	22	215.4 (143.0–287.9)	156.6 (91.2–222.1)	1.37
Overall	159,283	153,178	83	67	52.1 (40.9–63.3)	43.7 (33.3–52.2)	1.19

Table 2 Incidence (per 100,000/year) of hip fracture among persons > 50 years of age in different populations. Incidence figures are age-adjusted to the 1985 US white civilian population above 50 years of age

Geographic location (ethnicity) [reference]	Year of study	Female	Male	Female:male
Asia				
Hong Kong [28]	1985	353	181	2.0
Tottori prefecture, Japan [24]	1986–1987	202	73	2.8
Honam, Korea [31]	1991	41	48	0.8
Beijing, PR China [30]	1990–1992	85	80	1.0
Shenyang, PR China [26]	1994	87	100	0.8
Kuwait [5]	1998	295	200	1.5
Singapore [6]	1991–1998	402	152	2.6
Oceania				
New Zealand (whites) [22]	1973–1976	620	151	4.1
New Zealand (Maori) [22]	1973–1976	107	182	0.6
Australia [23]	1989–1990	500	182	2.7
USA				
Rochester [13]	1965–1974	510	174	2.9
California (Caucasians) [12]	1983–1984	617	215	2.9
California (Blacks) [12]	1983–1984	241	153	1.6
California (Hispanics) [12]	1983–1984	219	97	2.3
California (Asians) [12]	1983–1984	383	116	3.3
USA [11]	1989	506	179	2.8
South America				
La Platt, Argentina [21]	1989–1990	513	122	4.2
Europe				
Southampton, UK [20]	1986	262	72	3.6
Crete [19]	1986	394	179	2.2
Netherlands [14]	1987	393	154	2.6
Geneva, Switzerland [15]	1987	405	127	3.2
Oslo, Norway [10]	1989	903	384	2.3
Italy [17]	1990	232	81	2.8
Porto, Portugal [18]	1988–1989	423	155	2.7
Canton of Vaud, Switzerland [16]	1991	494	170	2.9
Africa				
Bantu, South Africa [32]	1959–1964	26	38	0.7
Rabat, Morocco (our study)	2002	80	58	1.3

33, 34, 35]. Our finding is in agreement with this north-south gradient observed in the epidemiology of osteoporosis.

Morocco is located in an intermediate area between Europe and sub-Saharan Africa. To the best of our knowledge this is the first study describing fragility fractures in a north African country. Only few studies

have been conducted in sub-Saharan African. Aspray et al. reported no minimal trauma fractures in rural Gambia [33]. Adebajo et al., describing fractures of the hip and distal forearm in western Africa, found no evidence of an age-related increase in the rates of hip and distal forearm fractures in women [34]. However, in a recent study in Cameroon, a rising incidence of hip fractures for people up to 65 years of age, similar to that seen in other countries, was pointed out [35], so one can speculate that the difference between our results and those observed in the Bantu population might be also due to a secular trend, with an increase in the incidence rates from the early 1960s to 2002. In the Arab world, only one study was performed in Kuwait, and it found an incidence similar to that in other Asian countries [5].

The reasons for the low incidence rate in Rabat remain uncertain. Although risk factors for falls and osteoporosis, such as low calcium intake, multiple pregnancies, and prolonged breastfeeding, are common in the Moroccan population, we can speculate about the vitamin D status of Moroccans, which is likely to be adequate as the sunlight is highly constant throughout the year.

Even if ascertainment errors resulted in an underestimate of the numbers of fractures, the incidence in the

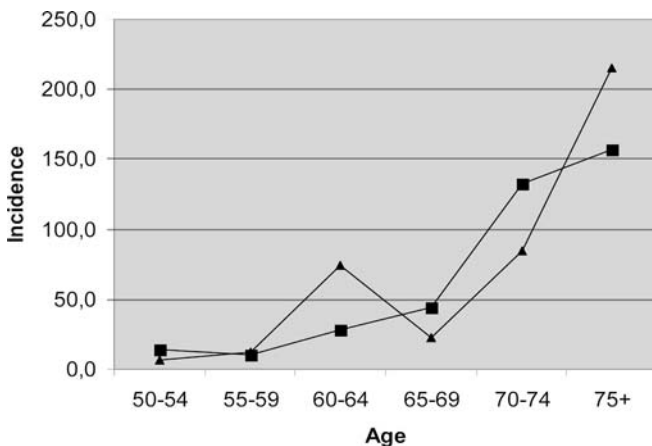


Fig. 2 Hip fracture incidence in Rabat in men (squares) and women (triangles) in 2002

present study is still unlikely to make rates comparable to those reported in countries of the northern bank of the Mediterranean Sea. The most important reason for this is probably reduced longevity: in fact, in Morocco, approximately 33% of the population is less than 15 years of age, while less than 5% is over 65, and the life expectancy is 67.7 years in men and 72.4 in women. Thus, the short life expectancy in Morocco seems to be the main reason for the observed low incidence of hip fracture, which increases enormously in those aged 80 years and older. The envisioned aging of the Moroccan population, and the consequent increase in the number of fractures, should be kept in mind by the public health authorities, which have to take adequate measures to prevent the expected burden of osteoporotic fractures.

The mean age for hip fracture of 70.7 years in women and 70.4 years in men in our study was lower than that of the population in Italian and other Mediterranean studies (72.8–73.9 years in men and 77.4–78.1 years in women). A younger mean age for hip fracture was also found in the Korean study [29], at 67 years for men and women together. The younger mean age for hip fracture probably also reflects the lower life expectancy in Morocco and Asia than in Western populations.

In Finland, life span has risen in men from 53 years in 1970 to 69 years in 1991, with a commensurate increase in fracture incidence [36, 37]. Westernization, with changing lifestyles, may also result in an increase in fracture incidence. A recent multinational study conducted in four Asian countries has shown that the incidence of hip fracture is directly proportional to economic development [25]. With increase in life span, rapid economic development and aging of the population, worldwide projections suggest that hip fracture will be a major health problem in Asia and Africa. The number of elderly individuals is indeed increasing more rapidly in the developing countries, and it has been estimated that 70% of the estimated 6.26 million cases of hip fracture in the year 2050 will occur in these populations [38, 39, 40].

The overall female-to-male ratio for hip fracture incidence was 1.3 in our study and contrasts with that of 2.3–3.6 in the populations of most Western countries and some more affluent countries in Asia (Table 2). A reverse of the gender ratio for hip fracture has also been observed in recent studies in Korea and Beijing, in China, and in two early studies in Africa and Singapore. The reason for this is not clear, and is difficult to investigate, since the causes of hip fracture are rarely reported.

In our study, cervical fractures were as common as trochanteric fractures at all ages in both genders. Overall, the cervical-to-trochanteric (C/T) ratio was 0.97 in women compared with 1.03 in men. A Norwegian study [10] found C/T ratios of 1.4 in women and 1.5 in men, while it was 3.2 in women and 1.6 in men in a Chinese study [26]. Another study from Crete found that the proportion of trochanteric fractures was much higher than that of cervical fractures [19]. The reasons

for these differences in type of fracture with age, gender, and between populations are not clear [41].

The incidence of fracture in our study was equally distributed between the seasons, in contrast with previous reports of high rates in the winter and summer and low in the spring and autumn. It has been suggested that the higher incidence in the summer might be due to increased outdoor activities during better weather. There are a number of reasons why hip fractures might be expected to increase in the winter, including the fact that the ground is wetter and that seasonal decreases in levels of light could reduce visual perception. Reduced bone strength and vitamin D-related muscle weakness caused by vitamin D deficiency due to less sunlight in the winter is another possible explanation. It is possible, therefore, that the Moroccan weather, which is sunny for almost all the year, may explain the lack of seasonal variations in our study.

In summary, the characteristics of hip fractures described in this study suggest that fragility fractures occur in North Africa, although substantially less frequently than in most European, North American and Asian countries but more frequently than in sub-Saharan African countries. The low incidence of hip fragility fracture rate is most likely the result of reduced longevity. Studies are needed to increase awareness of this disease and to monitor the epidemiology of fractures as longevity and the number of elderly population increase and quality of life improves. This combination of factors may, in fact, mean that the incidence of osteoporotic fractures will rise in the near future in Morocco, a possibility that should be kept in mind by the local public health authorities.

Acknowledgements The authors thank the orthopedic departments of the five public hospitals of Rabat Province (Avicenna Hospital, Military Hospital of Mohammed V, Moulay Abdellah Hospital of Salé, Sidi Lahcen Hospital of Temara, Provincial Hospital of Khemisset) for help and assistance during the data collection.

References

1. Cummings SR, Melton LJ III (2002) Epidemiology and outcomes of osteoporotic fractures. *Lancet* 359:1761–1767
2. Lau EMC (2001) Epidemiology of osteoporosis. *Best Pract Res Clin Rheum* 15:335–344
3. Hollmann FW (1993) Current population reports P25–1095. US population estimates, by age, sex, race, and Hispanic origin:1980 to 1991. US Department of Commerce, Economics and Statistics Administration, Bureau of the Census
4. Maggi S, Kelsey JL, Litvak J, Heyse SP (1991) Incidence of hip fractures in the elderly: a cross-national analysis. *Osteoporos Int* 1:232–241
5. Memon A, Pospula WM, Tantawy AY, Abdul-Ghaffar S, Suresh A, Al-Rowaih A (1998) Incidence of hip fracture in Kuwait. *Int J Epidemiol* 27: 860–865
6. Koh LKH, Saw S-M, Lee JJM, et al (2001) Hip fracture incidence rates in Singapore 1991–1998. *Osteoporos Int* 12:311–318
7. Elffors I, 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* 4:253–263

8. Schwartz AV, Kelsey JL, Maggi S, et al (1999) International variation in the incidence of hip fractures: cross-national project on osteoporosis for the World Health Organization Program for Research on Aging. *Osteoporos Int* 9:242–253
9. Rogmark C, Sernbo I, Johnell O, Nilsson, J-Å (1999) Incidence of hip fractures in Malmö, Sweden, 1992–1995: a trend-break. *Acta Orthop Scand* 70:19–22
10. Falch JA, Aho H, Berglund K, Düppe H, Finsen V, Hagstrom I, Jarvinen M, Johnell O, Kaastad TS, Lauritzen JB, et al (1995) Hip fractures in Nordic cities: difference in incidence. *Ann Chir Gynaecol* 84:286–290
11. 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* 83:694–697
12. Silverman SL, Madison RL (1988) Decreased incidence of hip fracture in Hispanics, Asians, and Blacks: California Hospital discharge data. *Am J Public Health* 78:1482–1483
13. Gallagher JC, Melton LJ, Riggs BL, et al (1980) Epidemiology of fractures of the proximal femur in Rochester, Minnesota. *Clin Orthop* 150:163–171
14. Boereboom FTJ, Raymakers JA, de Groot RRM, Duursma SA (1992) Epidemiology of hip fractures in the Netherlands: women compared with men. *Osteoporos Int* 2:279–284
15. Nydegger V, Rizzoli R, Rapin CH, Vasey H, Bonjour JP (1991) Epidemiology of fractures of the proximal femur in Geneva: incidence, clinical and social aspects. *Osteoporos Int* 2:42–47
16. Jequier V, Burnand B, Vader JP, Paccaud F (1995) Hip fracture incidence in the Canton of Vaud, Switzerland, 1986–1991. *Osteoporos Int* 5:191–195
17. Mazzuoli GF, Gennari C, Passeri M, Celi FS, Acca M, Camporeale A, Pioli G, Pedrazzoni M (1993) Incidence of hip fracture: an Italian survey. *Osteoporos Int* [1 Suppl]:S8–9
18. Vaz AL (1993) Epidemiology and costs of osteoporotic hip fractures in Portugal. *Bone* 14:S9
19. Dretakis EK, Giaourakis G, Steriopoulos K (1992) Increasing incidence of hip fracture in Crete. *Acta Orthop Scand* 63:150–151
20. Lau LMC, Cooper C, Wikham C, Donnan S, Barber DJP (1990) Hip fracture in Hong Kong and Britain. *Int J Epidemiol* 19:1119–1121
21. Bagur A, Mautalen C, Rubin Z (1994) Epidemiology of hip fractures in an urban population of central Argentina. *Osteoporos Int* 4:332–335
22. Scott S, Gray DM (1980) The incidence of femoral neck fractures in New Zealand. *N Z J Med* 91:6–9
23. Sanders KM, Seeman E, Ugoni AM, et al (1999) Age- and gender-specific rate of fractures in Australia: a population-based study. *Osteoporos Int* 10:240–247
24. Hagino H, Yamamoto K, Teshima R, Kishimoto H, Kuranobu K, Nakamura T (1989) The incidence of fractures of the proximal femur and the distal radius in Tottori Prefecture, Japan. *Arch Orthop Trauma Surg* 109:43–44
25. Lau EMC, Lee JK, Suriwongpaisal P, et al (2001) The incidence of hip fracture in four Asian countries: the Asian Osteoporosis Study (AOS). *Osteoporos Int* 12:239–243
26. Yan L, Zhou B, Prentice A, Wang X, Golden MHN (1999) Epidemiological study of hip fracture in Shenyang, People's Republic of China. *Bone* 24:151–155
27. Kawashima T (1989) Epidemiology of the femoral neck fracture in 1985, Niigata Prefecture, Japan. *J Bone Miner Metab* 7:118–126
28. Lau E, Cooper C, Donnan S, Barker DJP (1990) Incidence and risk factors for hip fracture in Hong Kong Chinese. In: Christiansen G, Overgaard K (eds) *Proceedings of the Third International Symposium on Osteoporosis*. Osteopress, Copenhagen, pp 66–70
29. Rowe SM, Ryang DH (1993) An epidemiological study of hip fracture in Honam, Korea. *Int Orthop* 17:139–143
30. 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* 144:901–907
31. Hashimoto T, Sakata K, Yoshimura N (1997) Epidemiology of osteoporosis in Japan. *Osteoporos Int* 7 [Suppl 3]:S99–102
32. Solomon L (1968) Osteoporosis and fracture of femoral neck in the South African Bantu. *J Bone Joint Surg* 50B:2–13
33. Aspray TJ, Prentice A, Timothy JC, Yankuba S, Reeve J, Roger MF (1996) Low bone mineral content is common but osteoporotic fractures are rare in the elderly rural Gambian women. *J Bone Miner Res* 11:1009–1025
34. Adebajo AO, Cooper C, Grimley EJ (1997) Fractures of the hip and distal forearm in West Africa and the United Kingdom. *Age Ageing* 20:435–438
35. Zebaze RMD, Seeman E (2003) Epidemiology of hip and wrist fractures in Cameroon, Africa. *Osteoporos Int* 14:301–305
36. Parkkari J, Kannus P, Niemi S, Pasanen M, Järvinen M, Luthje P, et al (1994) Increasing age-adjusted incidence of hip fractures in Finland: The number and incidence of fractures in 1970–1991 and prediction for the future. *Calcif Tissue Int* 55:342–345
37. Huusko TM, Karppi P, Avikainen V, Kautiainen H, Sulkava R (1999) The changing picture of hip fractures: dramatic change in age distribution and no change in age-adjusted incidence within 10 years in Central Finland. *Bone* 24:257–259
38. Melton LJ III (1996) Epidemiology of hip fractures: implications of the exponential increase with age. *Bone* 18 [Suppl 3]:121S–25S
39. Gullberg B, Johnell O, Kanis JA (1997) World-wide projections for hip fracture. *Osteoporos Int* 7:407–413
40. Cooper C, Campion G, Melton LJ III (1992) Hip fractures in the elderly: a world-wide projection. *Osteoporos Int* 2:285–289
41. Mautalen CA, Vega EM, Einhorn TA (1996) Are the etiologies of cervical and trochanteric hip fractures different? *Bone* 18:133S–137S