Osteoporos Int (2012) 23:2239–2256
DOI 10.1007/s00198-012-1964-3

REVIEW

A systematic review of hip fracture incidence and probability of fracture worldwide

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Received: 21 February 2012 / Accepted: 21 February 2012 / Published online: 15 March 2012

Abstract
Summary The country-specific risk of hip fracture and the 10-year probability of a major osteoporotic fracture were determined on a worldwide basis from a systematic review of literature. There was a greater than 10-fold variation in hip fracture risk and fracture probability between countries.
Introduction The present study aimed to update the available information base available on the heterogeneity in the risk of hip fracture on a worldwide basis. An additional aim was to document variations in major fracture probability as determined from the available FRAX models.
Methods Studies on hip fracture risk were identified from 1950 to November 2011 by a Medline OVID search. Evaluable studies in each country were reviewed for quality and representativeness and a study (studies) chosen to represent that country. Age-specific incidence rates were age-standardised to the world population in 2010 in men, women and both sexes combined. The 10-year probability of a major osteoporotic fracture for a specific clinical scenario was computed in those countries for which a FRAX model was available.
Results Following quality evaluation, age-standardised rates of hip fracture were available for 63 countries and 45 FRAX models available in 40 countries to determine fracture probability. There was a greater than 10-fold variation in hip fracture risk and fracture probability between countries.
Conclusions Worldwide, there are marked variations in hip fracture rates and in the 10-year probability of major osteoporotic fractures. The variation is sufficiently large that these cannot be explained by the often multiple sources of error in the ascertainment of cases or the catchment population. Understanding the reasons for this heterogeneity may lead to global strategies for the prevention of fractures.

Keywords Fracture probability · FRAX · Hip fracture incidence · Hip fracture risk · Osteoporosis

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Introduction

The clinical manifestation of osteoporosis is in the fractures that arise. Hip fractures are a useful surrogate for determining the international burden of osteoporosis. Although they account for less than 20% of all osteoporotic fractures [1, 2], they account for the majority of fracture-related health care expenditure and mortality in men and women over the age of 50 years [1–4]. In addition, the vast majority of hip fracture cases come to medical attention and require hospital facilities. As a result, much more is known of the epidemiology of hip fracture than for other fractures associated with osteoporosis.

A variety of studies have examined hip fracture rates in different regions of the world [5–11]. Greater than 10-fold differences have been found, largely on the basis of register studies undertaken on a regional or national level and at different calendar years. The aim of the present study was to provide the most accurate assessment of hip fracture risk in all countries for which data were available. In addition, we wished to examine the heterogeneity of major fracture probability in those countries where a FRAX model was available.

Methods

Literature survey

We updated a systematic search conducted by Cauley et al. on behalf of the International Task Force for the ISCD IOF FRAX Initiative [12, 13]. This was a Medline OVID search covered between 1 January 1950 and 10 May 2010. Details regarding the search strategy and MeSH terms used are provided in Cauley et al. [12, 13]. The three primary concepts were: fracture, incidence and the country or their related terms. The three concepts were searched singly, and then merged together through the AND term. The information base was updated by the International Osteoporosis Foundation using the same search terms with a cut-off date of 7 November 2011. Additional sources were reviews by Kanis et al. [14] and Cheng et al. [5]. We also supplemented this search by hand-searching the references of all papers to identify any additional articles of interest. In several instances additional information was provided by the authors of papers to aid in the assessment of study quality or to provide additional detail not reported in the original publication.

Exclusion and inclusion criteria

Abstracts and full papers identified by the search were reviewed. We included non-English articles. All papers that reported age- and sex-specific incidence rates of hip fracture in a general population were eligible for a more detailed review. Further exclusion criteria comprised data that could not be standardised to the world population (age categories incomplete from the age of 50 years or age categories >10 years), an uncertain population base or ill-defined cases.

For the remaining studies, a quality assessment, originally developed by Cauley et al. [13], was adapted to provide three grades:

> Good: Evidence includes consistent results from well-designed, well-conducted studies in representative populations. Selection of hip fracture cases was based on health care records, and the methodology was well described. At least four of the following criteria should be met: prospective study, study population representative of the entire population, study duration of 1 year or more and adequate definition of fracture or use of ICD codes, ethnicities defined when applicable.
>
> Fair: Evidence is sufficient to determine effects on outcomes, but the strength of the evidence is limited by the number, quality or consistency of the individual studies, i.e. studies that did not meet the criteria for either good or poor and met some but not all quality criteria.
>
> Poor: Evidence is insufficient to assess the effects on outcomes because of limited number or power of studies, important flaws in their design or conduct, gaps in the chain of evidence or lack of information. Criteria were: a retrospective study, study duration of less than 1 year, not population based, inadequate definition of fracture and abstract only available or no definition of ethnicities provided where relevant.

Where assessment was not possible, the study was discarded.

Selection criteria

From the publications available, one dataset was chosen to characterise hip fracture risk in that country which could be a single study or the mean of several studies where appropriate. Criteria for selecting a study or studies over others to represent a country are listed below and details are provided in the Appendix.

1. FRAX model available
2. National rather than regional data
3. Higher quality
4. Most recent study
5. Mean of several regional estimates
6. Sole study available
7. Additional details supplied by the author, see notes in tables

Where a FRAX model was available for a particular country, the hip fracture rates used for FRAX were selected since these used recent data were available and had been vetted previously for quality or consistency [13, 14]. Notwithstanding, recent publications, appearing between May 2010 and November 2011 (search cut-off dates) were reviewed to determine the adequacy of the data used for the FRAX models. In the case of China, more recent regional data had been published [15] and were preferentially selected for this report. For Belgium, we used more extensive national estimates (2005–2007 rather than 2006) supplied by the same author [16, 17], M Hiligsmann 2011, personal communication]. For Italy, we used recent national data for 2007 [18] rather than the four regional estimates used in FRAX (version 3.4) [14].

In the absence of a FRAX model, national studies were preferred over regional estimates. For regional estimates, the most recent and higher quality studies were preferred. In four instances, several studies of comparable quality were available and we used the mean value of these estimates (Brazil, four estimates [10, 19–21]; Croatia, three estimates in two reports [22, 23]; Greece, three estimates [9, 24, 25]; Russia, two studies [26] Olga Yershova and Olga Lesnyak 2010, personal communication]; Poland, three studies [27, 28] Edward Czerwinski and Roman Lorenc 2011, personal communication] and Spain, five estimates [14]). For Argentina, China, Iran, Malaysia, Morocco, Norway, Poland, Sweden, Thailand and the UK, we used a single regional estimate but in each instance a review of alternate sources showed that the estimate we chose did not substantially differ from alternate estimates. Sources of information are given in Table 3 of the Appendix.

Data analysis

Incidence (rates/100,000) was assembled by age and by sex. Where possible, 5-year age categories were used. Where 5-year age intervals were not available, 10-year intervals were used (intervals of greater than 10 years were an exclusion criterion). For each country, age- and sex-specific rates were used to compute age-adjusted incidence of hip fracture in men, women and men and women combined adjusted to the world population. UN data were used for population demography in 5-year groups for the year 2010 [29]. In the case of Singapore and USA, hip fracture rates were available by ethnic origin. For the purposes of this study, population-weighted means were used and applied to the total population on the recommendation of the Working Group of the IOF Committee of Scientific Advisors. For Israel, incidence was available by race in a single study and a population-weighted mean was used [30]. A total of 72 studies from 63 countries were selected for the calculation of standardised incidence. Details of each study are given in Table 3 of the Appendix.

Probability estimates

For those countries where a FRAX model was available, we computed the 10-year probability of a major osteoporotic fracture (hip, clinical vertebral, forearm or humeral fracture) using version 3.5 of FRAX (http://www.shef.ac.uk/FRAX/). Since FRAX provides individual rather than population-based probabilities, we chose the clinical scenario of an individual aged 65 years with a prior fragility fracture (and no other clinical risk factors) at the threshold of osteoporosis as judged by BMD at the femoral neck (i.e. a T-score of −2.5 SD). The body mass index was set at 24 kg/m^2. Estimates were made for men and women. Note that the T-score in men is calculated using the same reference range as that used in women.

As of November 2011, 45 FRAX calculators were available for the 40 countries listed in Table 1. Note that five models (flagged in Table 1) were not yet published at the cut-off date but were released online at the beginning of 2012. One of these was a surrogate model (Sri Lanka) derived from the fracture hazard of expatriate Indians living in Singapore and the death hazard for Sri Lanka. The models for Belgium, Czech Republic, Lebanon and Italy were updated with improved or more recent epidemiology and were also released online at the start of 2012. For USA and Singapore, fracture probabilities were available by ethnic origin. For the purposes of this study, means were used weighted by population size in addition to ethnic-specific probabilities.

Table 1 FRAX models available

Region	Country
Asia	China, Hong Kong, Japan, Philippines, Russian Federation[a], South Korea, Singapore (models for Chinese Malay and Indian ethnicities), Sri Lanka (surrogate)[a] and Taiwan
Europe	Austria, Belgium[b], Czech Republic[b], Denmark, Finland, France, Germany, Hungary, Italy[b], Malta, Netherlands, Norway[a], Poland, Romania, Slovakia[a], Spain, Sweden, Switzerland and UK
Middle East	Jordan, Lebanon[b], Tunisia and Turkey
North America	Canada, Mexico and the US (separate Caucasian, Black, Hispanic, and Asian calculators available)
Latin America	Argentina, Colombia and Ecuador[a]
Oceania	Australia and New Zealand

[a] New model, online January 2012

[b] Updated model, online January 2012

Table 2 Categorisation and colour coding for world standardised annual hip fracture rates (/100,000) in men, women and both sexes combined

		Incidence /100,000			FRAX probability (%)	
Colour	Category	Women	Men	Men and women	Men	Women
Red	High	>300	150+	>250	>15	>15
Orange	Moderate	200–300	100–150	150–250	10–15	10–15
Green	Low	<200	<100	<150	<10	<10

Additional categories for 10-year probabilities of a major fracture are also given

Colour coding

For the purposes of cartography, we colour coded hip fracture incidence according to categories of risk designated as high, medium or low (red, orange or green, respectively) in men, women and men and women combined. The risk categories were arbitrary but selected to approximate tertiles of the distribution (Table 2). For categories of fracture probability, we used the same thresholds for men and women.

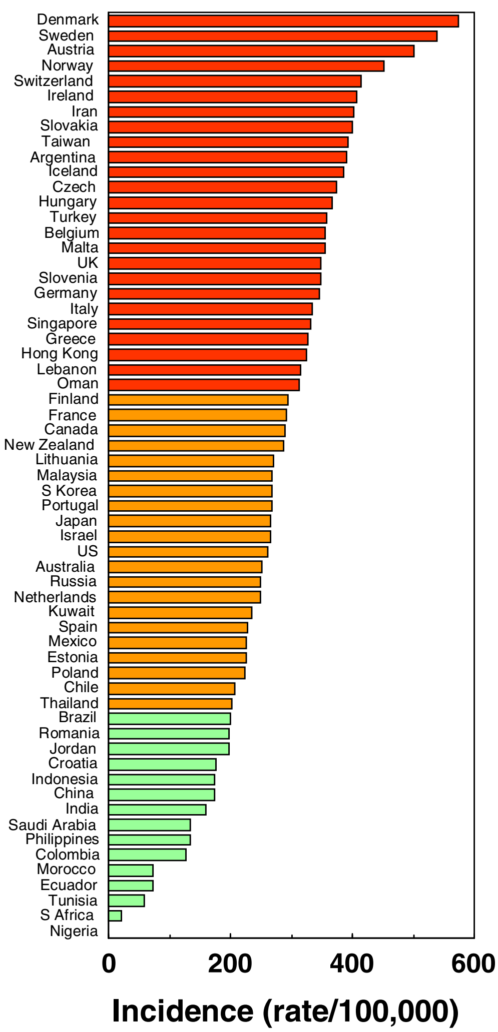

Fig. 1 Age-standardised annual incidence of hip fractures in women (/100,000) according to country together with the colour codes

Results

Hip fracture risk

A total of 72 studies from 63 countries were selected for inclusion into the hip fracture resource. Studies selected are summarised in Tables 4, 5 and 6 of the Appendix together with the selection criteria and quality grades. There was a marked heterogeneity in hip fracture risk between countries. In women (Fig. 1), the lowest annual age-standardised incidences were found in Nigeria

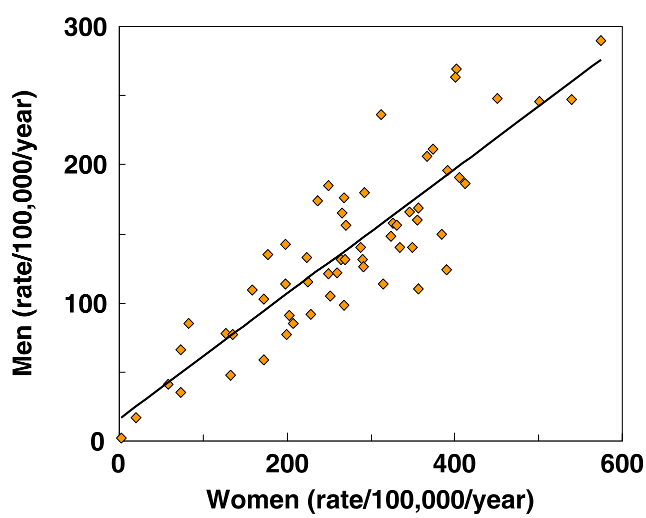

Fig. 2 World standardised hip fracture rates (/100,000/year) in men and women

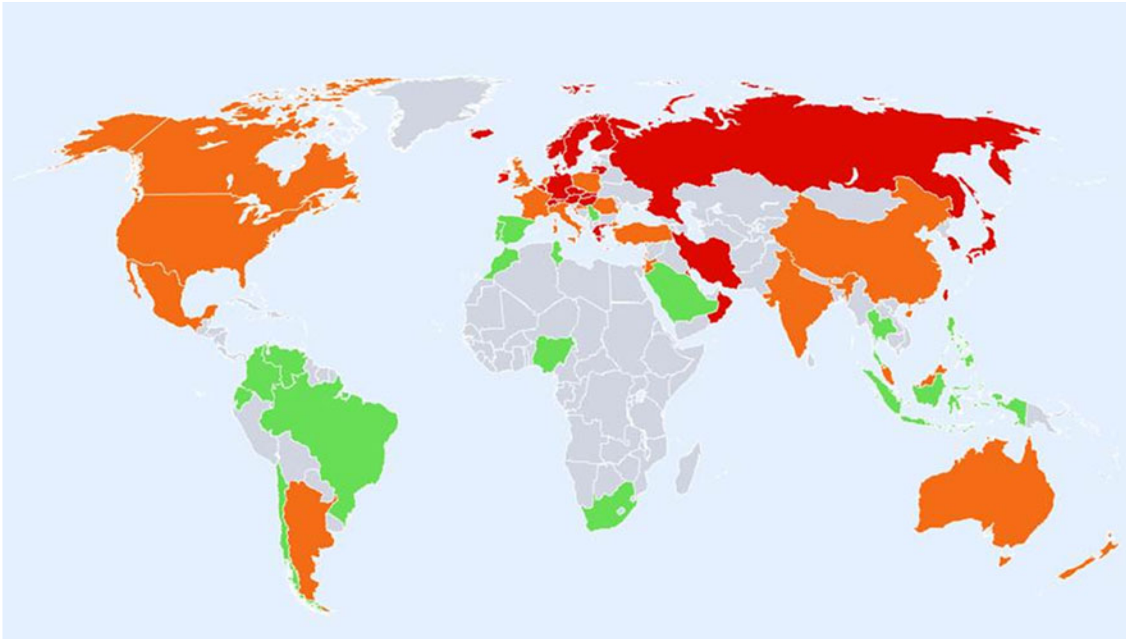

Fig. 3 Hip fracture rates for men in different countries of the world categorised by risk. Where estimates are available, countries are colour coded *red* (annual incidence >150/100,000), *orange* (100–150/100,000) or *green* (<100/100,000)

(2/100,000), South Africa (20), Tunisia (58) and Ecuador (73). The highest rates were observed in Denmark (574/100,000), Norway (563), Sweden (539) and Austria (501). Numerical data for other countries are given in Tables 4, 5 and 6 of the Appendix. Discounting the estimates from Nigeria (poor quality) and South Africa

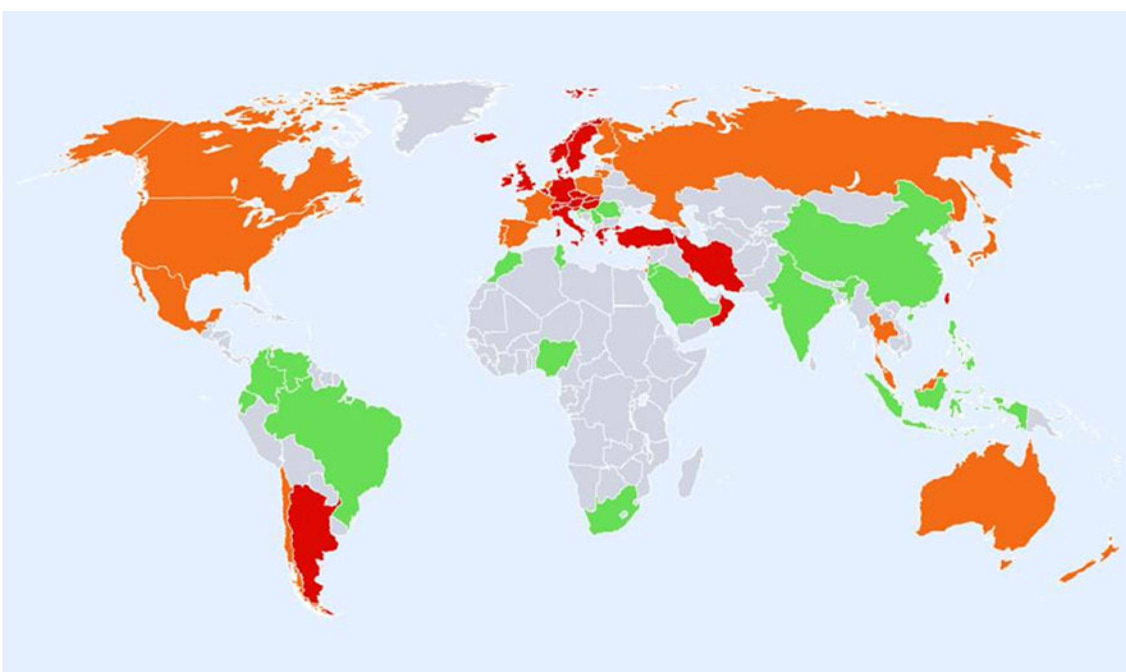

Fig. 4 Hip fracture rates for women in different countries of the world categorised by risk. Where estimates are available, countries are colour coded *red* (annual incidence >300/100,000), *orange* (200–300/100,000) or *green* (<200/100,000)

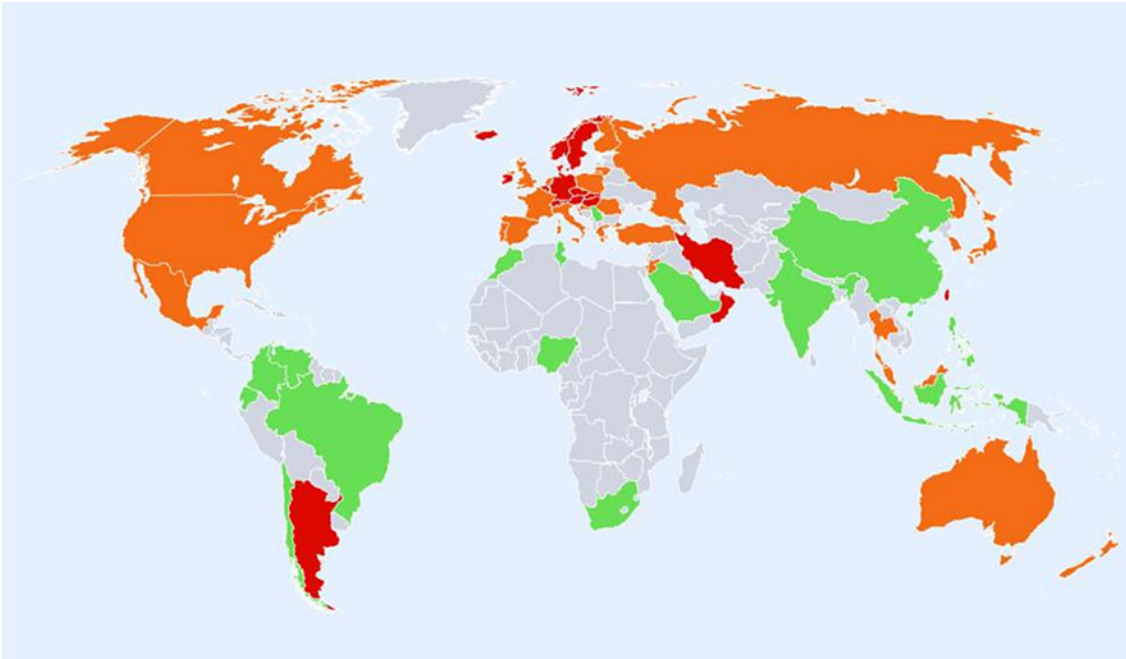

Fig. 5 Hip fracture rates for men and women combined in different countries of the world categorised by risk. Where estimates are available, countries are colour coded *red* (annual incidence >250/100,000), *orange* (150–250/100,000) or *green* (<150/100,000)

(rates for 1957–1963), there was approximately a 10-fold range in hip fracture incidence.

Within countries, the age-standardised incidence of hip fracture in men was approximately half that noted in women (Fig. 2). Thus where higher rates were observed in women, higher rates were found in men and vice versa. Omitting the studies from Africa, the highest annual incidence in men was seen in Denmark (290/100,000) and the lowest in Ecuador (35/100,000). There was a significant correlation between the rates in men and women (r=0.82; p<0.001). The correlation was similar when only high quality studies or only national studies were considered (data not shown).

The geographic distribution by fracture risk is shown for men, women and men and women combined in Figs. 3, 4 and 5, respectively. In men (Fig. 3), there was a swathe of high-risk countries extending from North Western Europe (Iceland, Ireland, Finland, Denmark, Sweden and Norway), both eastwards to the Russian Federation and downwards through to central Europe (Belgium, Germany, Austria and Switzerland) and thereafter to the south west (Greece, Hungary, Czech Republic and Slovakia) and onwards to Iran, Kuwait and Oman. Other high-risk countries for men were Singapore, Malta, Japan, Korea and Taiwan.

Regions of moderate risk included Oceania, China and India, Argentina and the countries of North America. If ethnic-specific rates were considered in USA, then the Hispanic, Asian and Black populations of men would be colour coded green. Low-risk countries included Latin America with the exception of Argentina, Africa and Saudi Arabia, the Iberian Peninsula and two countries in South East Asia (Indonesia and Thailand).

In women there was a broadly similar pattern as that seen in men. A notable difference in the distribution of high risk was that Russia was represented as moderate risk in women rather than high risk (in men). Also, the swathe of high-risk countries in Europe and beyond was more consolidated extending from North Western Europe (Iceland, UK, Ireland, Denmark, Sweden and Norway) through to central Europe (Belgium, Germany, Austria and Switzerland Italy) and thereafter to the south west (Greece, Hungary, Czech Republic, Slovakia, Slovenia) and onwards to Lebanon, Oman and Iran. Other high-risk countries for women were Hong Kong, Singapore, Malta and Taiwan. If ethnic-specific rates were considered in USA, then Hispanic, Asian and Black populations would be colour coded green but Caucasian women coded at high risk.

Regions of moderate risk included Oceania, the Russian Federation, the southern countries of Latin America and the countries of North America. Low-risk regions included the northern regions of Latin America, Africa, Jordan and Saudi Arabia, India, China, Indonesia and the Philippines. It is notable that in Europe, the majority of countries were

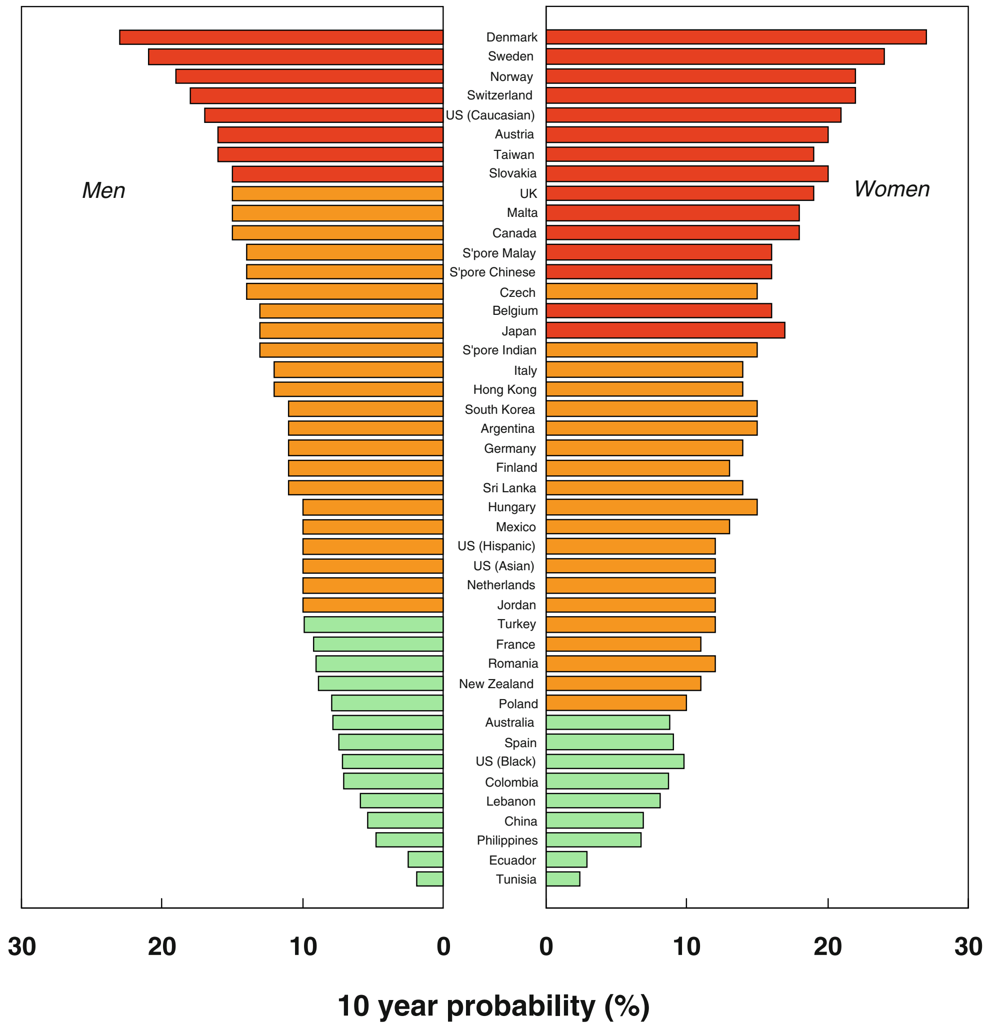

Fig. 6 Ten-year probability of a major fracture (in percent) in men and women aged 65 years with a prior fragility fracture (and no other clinical risk factors) at the threshold of osteoporosis as judged by BMD at the femoral neck (i.e. a T-score of −2.5 SD). The body mass index was set at 24 kg/m^2

categorised at high or moderate risk. Low risk was identified only in Croatia and Romania.

The consolidated map using age- and sex-standardised hip fracture rates is shown in Fig. 5. Note that the thresholds for categories of risk differ from those used in men and those used in women (which also differ from each other—see Table 1). With this proviso, the general pattern remained similar. Discordances in classification were relatively few. In the consolidated map, two countries coded low risk had been previously coded at intermediate risk (men in India and China). At the other extreme, one country coded as high risk had been previously coded at intermediate risk (men and women in Argentina).

As might be expected, there were more discordances in the moderate risk category. Six countries coded at moderate risk had been previously coded at low risk (men in Portugal, Thailand and Spain; women in Croatia, Jordan and Romania). Twelve countries coded at moderate risk had been previously coded at high risk (women in Hong Kong, Turkey, Italy, Lebanon and the UK; men in Kuwait, Japan, Russia, South Korea and Finland; men and women from Greece and Singapore).

FRAX

A total of 45 country and/or ethnic models were available for inclusion into the distribution of fracture probability. The FRAX models used are summarised in Table 7 of the Appendix. There was a marked heterogeneity in the 10-year probability of a major fracture between countries. In men (Fig. 6), the lowest probabilities were found in Tunisia (1.9%), Ecuador (2.5%), Philippines (4.8%) and China (5.4%). The highest rates were observed in Denmark (23%), Sweden (21%), Norway (19%) and Switzerland (18%). Numerical data for other countries is given in Table 7 of the Appendix. Thus, there was a greater than 10-fold range in fracture probability.

Fracture probabilities were consistently higher in women than in men but the difference was relatively

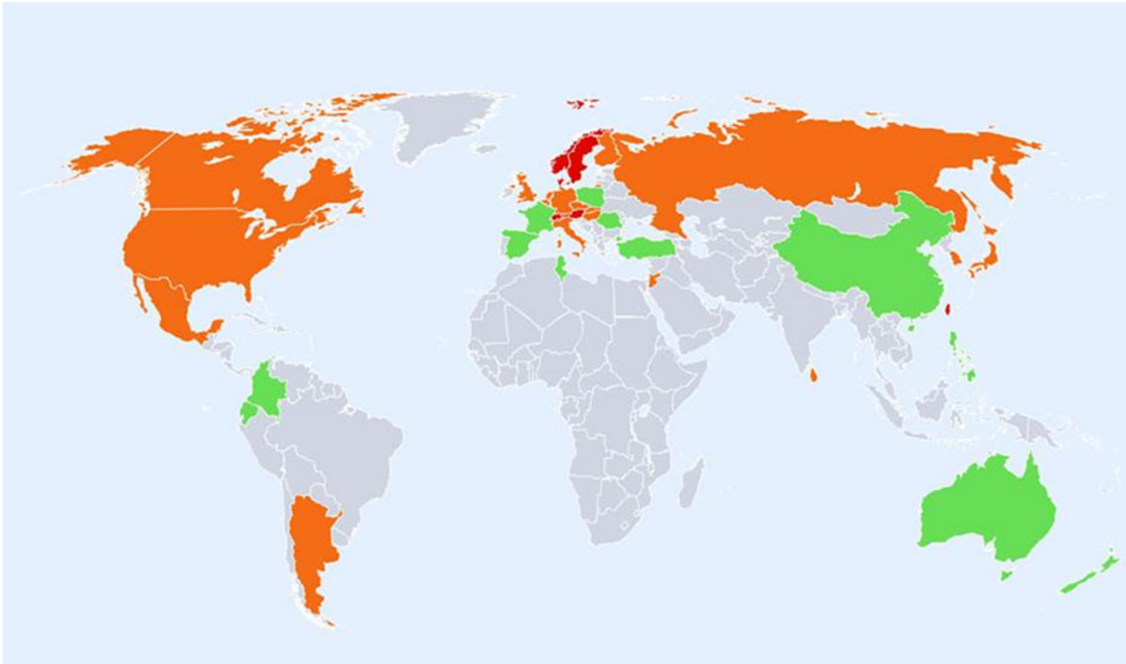

Fig. 7 Ten year probability of a major osteoporotic fracture for a man aged 65 years with a prior fragility fracture (and no other clinical risk factors) at the threshold of osteoporosis as judged by BMD at the femoral neck (i.e. a T-score of −2.5 SD). Probability in different countries is categorised as high (*red*, >15%), moderate (*orange*, 10–15%) and low (*green*, <10%)

modest. On average, probabilities were 23% higher in women than in men. This contrasts, therefore, with hip fracture incidence which was twofold higher in women than in men. As expected, there was a close correlation between probabilities in men and those in women (r= 0.88; p<0.001).

The geographic distribution by fracture risk is shown in men and women in Figs. 7 and 8, respectively. High-risk

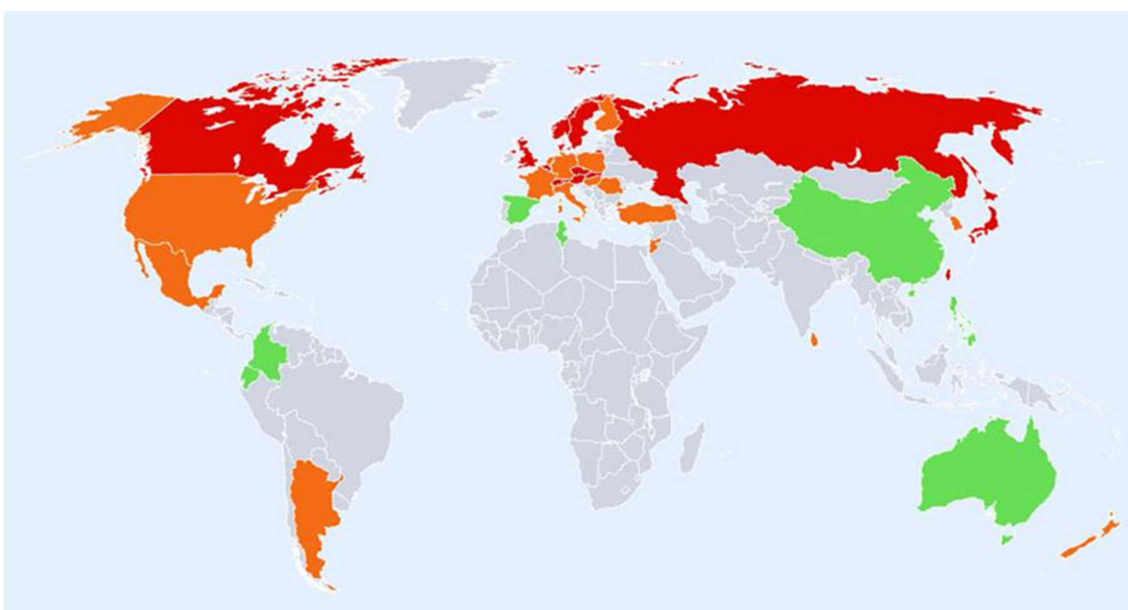

Fig. 8 Ten-year probability of a major osteoporotic fracture for a woman aged 65 years with a prior fragility fracture (and no other clinical risk factors) at the threshold of osteoporosis as judged by BMD at the femoral neck (i.e. a T-score of −2.5 SD). Probability in different countries is categorised as high (*red*, >15%), moderate (*orange*, 10–15%) and low (*green*, <10%)

regions for men were Taiwan, Austria, USA (Caucasian), Switzerland, Norway, Sweden and Denmark. Those at low risk included Africa (Tunisia), Oceania, the Latin American countries of Ecuador and Colombia and several European countries (Spain, Poland, Romania, France and Turkey). Other countries at low risk were China, Lebanon, Philippines and the US Black population.

The general pattern of fracture probability in women was similar to that in men (Fig. 8). Discordances in classification were relatively few. Five countries coded as low risk in men were at intermediate risk for women (Poland, New Zealand, Romania, France and Turkey). Seven countries coded as moderate risk in men were coded at high risk in women (Japan, Belgium, Singapore, Canada, Malta, UK and Slovakia).

Discussion

The principal finding of the present study is that there is a remarkable variation in the risk of hip fracture worldwide. Age-standardised rates varied approximately 10-fold in both men and women. The difference in incidence between countries was much greater than the differences in incidence between sexes within a country. These findings confirm conclusions derived from earlier work [5–10, 31] but extend the information base considerably. Whereas a recently published structured review provided information on 32 countries [5], the present systematic review identified 62 countries for which hip fracture rates were available. The greater capture of information provides a more detailed map on which to place ecological patterns. In the case of age- and sex-standardised rates for example (see Fig. 5), there appears to be a crescent of high-risk countries beginning in Northern Europe (Iceland, Ireland, Norway and Sweden) that runs through middle Europe (Denmark Belgium, Germany, Switzerland and Austria) and then extends south-eastwards through eastern Europe (Hungary, Czech Republic and Slovakia) and beyond (Oman and Iran). Other high-risk countries (Malta, Argentina and Taiwan) escape this pattern. Hypotheses to explain the heterogeneity in risk will need to take these patterns into account.

The present study also reports the heterogeneity in fracture probability for 45 countries and/or ethnic groups with a FRAX model available. Probability is computed from the hazards of death and fracture and differs fundamentally from incidence—a point often unrecognised [32]. FRAX computes probabilities for individuals and not (normally) for a nation so that, for the expression of fracture probability, we chose a clinical scenario of an individual with a prior fragility fracture and a femoral neck T-score for BMD of −2.5 SD. The choice of scenario is somewhat arbitrary but of clinical relevance. We chose the age of 65 years in order to avoid a marked effect of the death risk on the estimate of probability. The 10-year probability of a 'major osteoporotic fracture' (hip, clinical spine, forearm and humerus) varied markedly in the different countries. As in the case of hip fracture incidence, there was a greater than 10-fold range in fracture probability. There was some, though not complete, concordance between FRAX-based probabilities and hip fracture incidence reflecting, in part, the effect of the heterogeneity of mortality in different regions [3, 14].

Although probability estimates were lower in men than in women, the difference was modest (lower by 23%) compared to the twofold difference in age-standardised hip fracture risk. The closer approximation between sexes for the probability estimate arises because the risk of hip and other osteoporotic fractures is more or less identical in men and women of the same age and femoral neck BMD [33–35]. The clinical scenario chosen incorporated a BMD (as well as a prior fragility fracture). The somewhat higher probability estimates in women reflects mainly the lower death risk in women compared with men.

There are many well-recognised limitations in this type of analysis, particularly for register studies that include selection bias, the over identification of cases (double counting), inaccurate reporting or coding of fractures and errors in the denominator catchment population, particularly in regional rather than national studies. The question arises to what extent might heterogeneity of risk be accounted for by these artefacts. Several considerations suggest that these errors, though significant, have a minor effect in explaining the heterogeneity in a worldwide perspective. For example, a large prospective study undertaken in 14 regions in six different countries in Europe using standardised methodology demonstrated variability in hip fracture incidence of the same magnitude as that reported in the present study [9]. Analysis of the potential errors of any one estimate was ±10%, which pales into insignificance against the 1,000% differences in fracture risk. This study was a regional study but national register studies in Europe have shown similar findings [31].

Another limitation is the assumption that regional estimates of hip fracture risk are representative of the country in question. In addition to large variations in fracture rates around the world, fracture rates may vary within countries. In addition to ethnic-specific differences [3, 12, 13, 30], up to twofold differences in hip fracture incidence have been reported using common methodology with higher rates in urban communities than rural areas in Argentina [36], Turkey [9], Sweden [37], Norway [38–40], Switzerland [41], Croatia [23] and in USA [42, 43]. The concern is perhaps less where several regional estimates have been used. In the present study, the majority of studies chosen (60%) were national rather than regional estimates. In further 10 countries, the regional estimate was consistent with other regional estimates made within a few years (Argentina, China, Iran, Malaysia, Morocco, Norway, Poland, Sweden, Thailand and UK). In five countries with multiple regional surveys, we used a mean value where studies were of comparable quality (Brazil, Croatia, Greece, Spain and Russia). This left 11 regional surveys (18% of countries) where we had to rely on a single regional estimate. The analysis of national rather than regional data did not alter our principal findings.

Notwithstanding, in some regions of the world, not all hip fracture cases come to medical attention. The risk estimate for Russia took this into account [26], but the problem has also been identified in other countries (not included in the present study). The underreporting of hip fracture cases has been observed in Georgia (75% not hospitalised), Kazakhstan (50% not hospitalised), Kyrgyzstan (50% not hospitalised) and Moldova (uncertain proportion) [44]. The likely reason is that facilities for surgical management are limited so that hospital admission is not required. Moreover, patients are required to pay for their prosthesis. Thus substantial errors may arise that lead to underreporting of hip fracture cases.

In addition to the large geographic variation reported in the incidence of hip fracture throughout the world, the age- and sex-specific incidence of fracture is changing. This has been well characterised for hip fracture but also noted at other sites of fracture [45, 46]. Estimates of incidence trends have varied widely and variously reported an increase, plateau and decrease, in age-adjusted incidence rates for hip fracture among both men and women. Studies in Western populations, whether in North America, Europe or Oceania, have generally reported increases in hip fracture incidence through the second half of the last century, but those studies continuing to follow trends over the last two decades have found that rates stabilise, with age-adjusted decreases being observed in certain centres. In contrast, the mortality hazard has continued to decrease in most regions of the world. In other countries (e.g. Japan, China, Turkey, Mexico and Hispanic Americans from California), age-adjusted hip fracture rates continue to rise [15, 47–50]. In the majority of countries, there is scanty information available. Thus both national and regional estimates undertaken several years ago may not be representative of current risks. Again, it is useful to place this in perspective. Just over half the studies in the present study (52%) were conducted in 2005 or thereafter and a further 28% at or after the year 2000 (see Tables 4, 5, and 6 of the Appendix). On average, secular changes approximate 1% per annum [44, 46, 47] and if operative are likely to introduce accuracy errors of 10% or less. All these considerations indicate that there are multiple sources of error inherent in this type of analysis but that their magnitude does not undermine the principal finding of 10-fold differences in the risk of hip fracture risk and in 10-year fracture probability worldwide.

The question arises why fracture risk varies so much. The reasons are not known. The trends in incidence strongly suggest environmental rather than genetic factors. This view is supported by changes in risk in immigrant populations. For example, Blacks in USA have lower fracture probabilities than Caucasians, but the incidence of hip fracture in US Blacks is much higher than in African Blacks [12, 13]. A similar 'acclimatisation' is seen in the Japanese population of Hawaii [51] and the higher fracture probabilities among Chinese living in Hong Kong and Singapore compared with mainland China (see Table 7 of the Appendix).

Many risk factors for osteoporosis, and in particular for hip fracture, have been identified which include a low body mass index, low BMD, low calcium intake, reduced sunlight exposure, early menopause, smoking, alcohol consumption, physical activity levels, migration status obesity and, somewhat unexpectedly, obesity. These may have important effects within communities but do not explain differences in risk between communities [9]. The factor which best predicts this is socioeconomic prosperity that in turn may be related to low levels of physical activity or an increased probability of falling on hard surfaces [8]. This is plausible, but only a hypothesis. Paradoxically, socioeconomic prosperity may protect against hip fractures within countries [52]. The contrast between ecological and population risk factors is not uncommon and in the context of hip fracture, for example, is noted with calcium nutrition where countries with the higher calcium intakes have the greater hip fracture risk [53, 54]. It will be important to determine whether these and other factors are causally related to the heterogeneity of fracture risk. If such factors can be identified and are reversible, the primordial prevention of hip fracture might be feasible in those communities with presently low rates.

Acknowledgments This paper was reviewed and endorsed by the Committee of Scientific Advisors of the International Osteoporosis Foundation and we thank the Committee for their helpful review. We are grateful to the many researchers who have supplied supplementary or unpublished data for this study. These include M Morosano (Argentina), Peter Ebeling P (Australia), M Hiligsmann (Belgium), W Leslie (Canada), Pablo Riedemann and Oscar Neira (Chile), Xu Ling, Weibo Xia, S Cummings (China), B Abrahamsen (Denmark), CH Orces (Ecuador), R Sund and H Kroger (Finland), Kristin Siggeirsdottir and Vilmundur Gudnason (Iceland), D Dhanwal and C Cooper (India), Errol Hutagalung and Gunawan Tirtarahardja (Indonesia), Carmel Silke, Bryan Whelan, Bernie McGowan (Ireland), Efteem Azar (Jordan), Marija Tamulaitienė and Vidmantas Alekna (Lithuania), A Schembri (Malta), Abdellah El Maghraoui (Morocco), Julie Li-Yu (Philippines), Edward Czerwinsi and Roman Lorenc (Poland), Daniel Grigorie (Romania), Olga Yershova and Olga Lesnyak (Russian Federation), Siok Bee Chionh and Derrick Heng (Singapore), P Masaryk (Slovakia), Leith Zakraoui (Tunisia), G Riera-Espinoza (Venezuela).

Conflicts of interest None.

Appendix

Table 3 Studies used to compute age-standardised hip fracture incidence

Country	Citation	Notes
Argentina	Morosano M, Masoni A, Sánchez A (2005) Incidence of hip fractures in the city of Rosario, Argentina. Osteoporos Int 16: 1339–1344	Supplementary information from authors
Australia	Crisp A, Dixon T, Jones, Ebeling P, Cumming R (2012) Declining incidence of osteoporotic hip fracture in Australia. Manuscript in preparation	Supplementary information from Australian Institute of Health and Welfare
Austria	Dimai H P (2008) Personal communication Dimai HP, Svedbom A, Fahrleitner-Pammer A, et al. (2011) Epidemiology of hip fractures in Austria: evidence for a change in the secular trend. Osteoporos Int22: 685–692	Supplementary information Statistic Austria
Belgium	Hiligsmann M, personal communication, June 2011	Update of FRAX model with more extensive data
Brazil	Silveira C, Medeiros M, Coelho-Filho JM et al. (2005) Incidência de fratura do quadril em area urbana do Nordeste brasileiro. Cad. Saúde Pública. 21: 907–912 Komatsu RS, Ramos LR, Szejnfeld A (2004) Incidence of proximal femur fractures in Marilia, Brazil. J Nut Health Aging. 8: 362 Shwartz 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 Castro da Rocha FA, Ribeiro AR (2003) Low incidence of hip fractures in an equatorial area. Osteoporos Int 14:496–499	Average taken of all data from Brazil
Canada	Leslie WD, O'Donnell S, Lagacé C et al. (2010) Osteoporosis surveillance expert working group. Population-based Canadian hip fracture rates with international comparisons. Osteoporos Int. 21: 1317–1322 Leslie WD, Lix LM, Langsetmo L et al. (2011) Construction of a FRAX® model for the assessment of fracture probability in Canada and implications for treatment. Osteoporos Int 22: 817–827	Supplementary information from WB Leslie
Chile	Pablo Riedemann and Oscar Neira, personal communication 4th Oct 2011	Source: Health Ministry, June 2010
China	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 Ling X, Aimin, L, Xihe Z, Xaioshu C, Cummings SR (1996) Very low rates of hip fracture in Beijing, Peoples Republic of China. The Beijing Osteoporosis Project. Am J Epidemiol 144; 901–907 Yan L, Zhou B, Prentice A, Wang X, Golden MH (1999) Epidemiological study of hip fracture in Shenyang, People's Republic of China. Bone 24: 151–155 Zhang L, Cheng A, Bai Z, Lu Y, Endo N, Dohmae Y, Takahashi HE (2000) Epidemiology of cervical and trochanteric fractures of the proximal femur in 1994 in Tangshan, China. J Bone Miner Metab 18: 84–88	Mean of Schwartz 1999, Ling 1996, Yan 1999 and Zhang 2000 used in FRAX model
	Xia W-B, He SL, Xu L et al. (2011) Rapidly increasing rates of hip fracture in Beijing, China J Bone Miner Res. Sep 28. doi: 10.1002/jbmr.519	Xia 2011 used for hip fracture incidence with supplementary data from S Cummings 2011
Colombia	Juan Jose Jaller (2009), personal communication	Survey of all (five) hospitals in region
Croatia	Matković V, Kostial K, Simonović I, Buzina R, Brodarec A, Nordin BE (1979) Bone status and fracture rates in two regions of Yugoslavia. Am J Clin Nutr. 32: 540–549 Karacić TP, Kopjar B (2009) Hip fracture incidence in Croatia in patients aged 65 years and more. Lijec Vjesn. 2009; 131: 9–13	Mean incidence derived from two regions in Matković 1979 (Podravina Podravina and Istra) and national data in Karacić 2009
Czech	Stepan JJ, Vaculik J, Pavelka K, Zofka J, Johansson H, Kanis JA (2012) Hip fracture incidence between years 1981 and 2009 and construction of a FRAX® model for the assessment of fracture probability in the Czech Republic. Calcif Tiss Int, (in press)	Additional data, Jan Stepan, personal communication, 2011

Table 3 (continued)

Country	Citation	Notes
Denmark	Abrahamsen B, Vestergaard P (2010) Declining incidence of hip fractures and the extent of use of anti-osteoporotic therapy in Denmark 1997–2006. Osteoporosis Int 21: 373–80	Additional data from the Danish National Board of Health, accessed October 2009
Ecuador	Orces CH (2009) Epidemiology of hip fractures in Ecuador. Rev Panam Salud Publica. 25: 438–442. PMID: 19695134	Additional data supplied by author
Estonia	Haviko T, Maasalu K, Seeder J (1996) The incidence of osteoporotic fractures at the University Hospital of Tartu, Estonia. Scand J Rheumatol Suppl. 103: 13–15	Data available on women only
Finland	Kröger H (2008) Personal communication	Additional data from Reijo Sund, National Research and Development Centre for Welfare and Health
France	Couris CM, Chapurlat RD, Kanis JA et al. (2011) FRAX® probabilities and risk of major osteoporotic fracture in France. Osteoporos Int, Dec 17. [Epub ahead of print] PMID: 22179418	
Germany	Icks A, Haastert B, Wildner M, Becker C, Meyer G (2008) Trend of hip fracture incidence in Germany 1995–2004: a population-based study. Osteoporos Int 19: 1139-1145	
Greece	Dretakis EK, Giaourakis G, Steriopoulos K (1992) Increasing incidence of hip fracture in Crete. Acta Orthop Scand. 63: 150–151 Paspati I, Galanos A, Lyritis GP (1998) Hip fracture epidemiology in Greece during 1977-1992. Calcif Tissue Int 62: 542–547	Mean of three studies used
	Elffors I, Allander E, Kanis JA, et al. (1994) The variable incidence of hip fracture in southern Europe: the MEDOS Study. Osteoporos Int 4: 253–263	
Hong Kong	Tsang SWY, Kung AWC. Kanis JA, Johansson H, Oden A (2009) Ten-year fracture probability in Hong Kong southern Chinese according to age and BMD femoral neck T-scores. Osteoporos Int. 20: 1939-1945	
Hungary	Péntek M, Horváth C, Boncz I, Falusi Z, Tóth E, Sebestyén A, Májer I, Brodszky V, Gulácsi L (2008) Epidemiology of osteoporosis related fractures in Hungary from the nationwide health insurance database, 1999-2003.Osteoporos Int; 19: 243–249	
Iceland	Kristin Siggeirsdottir and Vilmundur Gudnason, personal communication, 15th Aug 2011	
India	Dhanwal D, Siwach R, Dixit V, Mithal A, Cooper C (2011) Incidence of hip fracture in Rohtak, North India. Osteoporos Int 22 (Suppl 4): S629–S630	Supplementary information from D Dhanwal and C Cooper
Indonesia	Errol Hutagalung and Gunawan Tirtarahardja, personal communication, 5th Oct 2011	Data from Department of Health and Bureau of Statistics, Indonesia
Iran	Soveid M, Serati AR, Masoompoor M (2005) Incidence of hip fracture in Shiraz, Iran. Osteoporos Int 16: 1412–1416	
Ireland	Bernie McGowan Personal communication 18 Oct 2011 McGowan, B, Casey M, Silke C , Whelan B, Bennett K (2012) Hospitalizations for fracture and associated costs between 2000 and 2009 in Ireland: a trend analysis. Submitted for publication	Data from The Economic and Social Research Institute (ESRI) and Irish Central Statistics Office
Israel	Levine S, Makin M, Menczel J, Robin G, Naor E, Steinberg R (1970) Incidence of Fractures of the Proximal End of the Femur in Jerusalem: A study of ethnic factors. J Bone Joint Surg Am 52:1193–1202	The different ethnicities amalgamated
Italy	Piscitelli P, Brandi ML, Chitano G, Johannson H, Kanis JA, Black DM (2012) Updated Fracture Incidence Rates for the Italian Version of FRAX®. Osteoporos Int, submitted	
Japan	Orimo H, Sakata K (2006) The 4th nationwide survey for hip fracture in Japan (in Japanese). Japan Medical Journal 4180: 25–30	
Jordan	Azar ES Abulmajeed S, Masri BK, Kanis JA (2011) The prevalence of osteoporotic hip fractures in Jordan. Osteoporos Int 22 (Suppl 5): S715	Additional data from Efteem Azar, personal communication, 2010
Kuwait	Memon A, Pospula WM, Tantawy AY, Abdul-Ghafar S, Suresha A, Al-Rowaih A (1998) Incidence of hip fracture in Kuwait. Int J Epidemiol 27:860–865	Kuwaiti data i.e., expatriates excluded
Lebanon	Sibai AM, Nasser W, Ammar W, Khalife MJ, Harb H, Fuleihan GE (2011) Hip fracture incidence in Lebanon: a national registry-based study with reference to standardized rates worldwide. Osteoporos Int 22: 2499–2506	

Table 3 (continued)

Country	Citation	Notes
Lithuania	Marija Tamulaitienė, Vidmantas Alekna, personal communication 2011	
Malaysia	Personal communication, 2010 Siok Bee Chionh and Dr Derrick Heng, Director of Epidemiology at the Ministry of Health, Singapore	Expatriates living in Singapore
Malta	Schembri A. Public Health Medicine, Department of Health Information and Research 95, G'Mangia Hill, G'Mangia PTA1313	Hospital survey
Mexico	Johansson H, Clark P, Carlos F, Oden A, McCloskey EV, Kanis JA (2011) Increasing age and sex specific rates of hip fracture in Mexico. Osteoporos Int. 22: 2359–2364	
Morocco	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 16:597–602 Abdellah El Maghraoui personal communication, 20th Oct 2011	
Netherlands	Lalmohamed, A, Welsing PMJ, Lems WF et al. (2011) Calibration of FRAX ® 3.1 to the Dutch population with data on the epidemiology of hip fractures. Osteoporos Int, doi 10.1007/s00198-011-1852-2	Source: National Office for Statistics, CBS
New Zealand	Brown P, McNeill R, Rawan E, Willingale J (2007) The burden of osteoporosis in New Zealand: 2007–2020. Osteoporosis New Zealand Inc	Death and fracture hazard of the white population
Nigeria	Adebajo AO, Cooper C, Evans JG (1991) Fractures of the hip and distal forearm in West Africa and the United Kingdom. Age Ageing 20: 435–438	
Norway	Emaus N, Olsen LR, Ahmed LA et al. (2011) Hip fractures in a city in Northern Norway over 15 years: time trends, seasonal variation and mortality: the Harstad Injury Prevention Study. Osteoporos Int 22: 2603–2610	National data to be shortly available from H Meyer
Oman	Shukla J, Khandekar R (2008) Magnitude and determinants of osteoporosis in adult population of South Sharqiya region of Oman. Saudi Med J 29: 984–988	
Philippines	Julie Li-Yu (2010) Personal communication	Insurance claims data for a segment of the population
Poland	Czerwiński E, Kanis JA, Osieleniec J et al. (2011) Evaluation of FRAX to characterize fracture risk in Poland. Osteoporos Int 22: 2507–2512 Jaworski M, Lorenc RS (2007) Risk of hip fracture in Poland. Med Sci Monit 13:206–210	Supplementary information from Edward Czerwinski and Roman Lorenc, 2011
Portugal	de Pina MF, Alves SM, Barbosa M, Barros H (2008) Hip fractures cluster in space: an epidemiological analysis in Portugal. Osteoporos Int 19:1797–1804	
Romania	Daniel Grigorie, 2011 Personal communication	National hospital discharge register (National School of Public Health)
Russia	Lesnyak O, Ershova O, Belova K et al. (2012). The development of a FRAX model for the Russian Federation. Submitted Arch Osteoporos Olga Yershova, Olga Lesnyak, personal communication, 2010	Combined data 2008-2010 from Yaroslavl and Pervouralsk
S Africa	Solomon L. Osteoporosis and fracture of the femoral neck in the South African Bantu (1968) J Bone Joint Surg 50: 1–13	Bantu population
S Korea	Lim S, Koo BK, Lee EJ et al. (2008) Incidence of hip fractures in Korea. J Bone Miner Metab 26:400-405	
Saudi Arabia	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: 536–538	
Serbia	Lesić A, Bumbasirević M, Jarebinski M, Pekmezovic T (2005) Incidence of hip fractures in the population of Belgrade during the period 1990-2000. Projections for 2020. Acta Chir Iugosl 52: 95–99	
Singapore	Siok Bee Chionh and D Heng D Personal communication, 2009	Source: Heng D, Director of Epidemiology, Ministry of Health.
Slovakia	Masaryk P, Piestany, Slovakia personal communication 2010	Source: National Institute of Rheumatic Diseases
Slovenia	Dzajkovska B, Wertheimer AI, Mrhar A (2007) The burden-of-illness study on osteoporosis in the Slovenian female population. Pham World Sci 29: 404–411	Data available for women only

Table 3 (continued)

Country	Citation	Notes
Spain	Diez A, Puig J, Martinez MT, Diez JL, Aubia J, Vivancos J (1989) Epidemiology of fractures of the proximal femur associated with osteoporosis in Barcelona, Spain. Calcif Tissue Int 44: 382–386	Mean value of 5 regional studies
	Sosa M, Segarra MC, Hernández D, González A, Limiñana JM, Betancor P (1993) Epidemiology of proximal femoral fracture in Gran Canaria (Canary Islands). Age Ageing 22: 285–288	
	Elffors L, Allander E, Kanis JA et al. (1994) The variable incidence of hip fracture in southern Europe: the MEDOS study. Osteoporos Int 4: 253–263	
	Sanchez MI, Sangrador GO, Blanco IS et al. (1997) Epidemiologia de la fractura osteoporotica de cadera en la provincial de Zamora. Rev Esp Salud Publica 71: 357–367	
Sweden	Kanis JA, Johnell O, Oden A et al. (2000) Long-term risk of osteoporotic fracture in Malmo. Osteoporos Int 11: 669–674	
Switzerland	Lippuner K, Johansson H, Kanis JA, Rizzoli R (2009) Remaining lifetime and absolute 10-year probabilities of osteoporotic fracture in Swiss men and women. Osteoporos Int. 20: 1131–1140	Source: Swiss Federal Office of Statistics
Taiwan	Shao CJ, Hsieh YH, Tsai CH, Lai KA (2009) A nationwide seven-year trend of hip fractures in the elderly population of Taiwan. Bone 44: 125–129	
Thailand	Lau EM, Suriwongpaisal P, Lee JK et al. (2001) Risk factors for hip fracture in Asian men and women: the Asian osteoporosis study. J Bone Miner Res 16: 572–580	
Tunisia	Leith Zakraoui, personal communication, June 2010 based on a PhD thesis (A Laatar) and an unpublished report by Ahmed Laatar & Leïth Zakraoui (2010) [Incidence de la fracture de l'extrémité supérieure du fémur en Tunisie. Etude épidémiologique nationale.] Incidence of upper femoral fractures in Tunisia. A National epidemiological study. Service de Rhumatologie Hôpital Mongi Slim–La Marsa	Survey of orthopaedic services
Turkey	Tuzun S, Eskiyurt N, Akarırmak U et al. (2012) Incidence of Hip Fracture and Prevalence of Osteoporosis in Turkey: The FRACTURK Study. Osteoporosis International. 23: 949–955	
UK	Singer BR, McLauchlan GJ, Robinson CM, Christie J (1998) Epidemiology of fractures in 15,000 adults. The influence of age and gender. J Bone Joint Surg 80B:243–248	
US	Ettinger B, Black DM, Dawson-Hughes B, Pressman AR, Melton LJ 3rd (2010) Updated fracture incidence rates for the US version of FRAX. Osteoporos Int 21: 25–33	All ethnicities merged
Venezuela	Riera-Espinoza G, Lopez D, Kanis JA (2008) Life-Time risk of hip fracture and incidence rates in Carabobo, Venezuela. Osteoporos Int 19 (Suppl 2): S356	Additional data supplied by author

Table 4 Categorisation and colour coding for world standardised annual hip fracture rates (/100,000) in men, women and both sexes combined

		Incidence/100,000		
Colour	Category	Women	Men	Men and women
Red	High	>300	150+	>250
Orange	Moderate	200–300	100–150	150–250
Green	Low	<200	<100	<150

Table 5 World age-standardised hip fracture rates (/100,000) and risk categories

Country	Source	Year	Quality	Catchment	Selection criteria[a]	F	Risk	M	Risk	M + F	Risk
Argentina	Morosano et al, 2005	2001–2002	G	R	1, 3, 7	390	H	124	M	264	H
Australia	Australian Institute of Health and Welfare PC	2006–2007	G	N	1, 2, 7	252	M	105	M	183	M
Austria	Dimai 2009	2001–2005	G	N	1, 4, 7	501	H	246	H	380	H
Belgium	Hiligsmann 2011	2005–2007	G	N	1, 4, 7	356	H	169	H	268	H
Brazil	Silveira et al. 2005	2001–2002	P	R	5	199	L	77	L	141	L
	Castro da Roca 2004	1996–2000	F	R							
	Schwartz et al. 1999	1990–1992	P/F	R							
	Komatsu et al. 2004	1994	F	R							
Canada	Leslie et al. 2010, 2011	2005	G	N	1, 2, 4, 7	290	M	131	M	215	H
Chile	Riedemann and Neira 2011	2006	G	N	3, 4	207	M	85	L	149	L
China	Xia 2011	2002–2006	G	R	4,7	173	L	103	M	140	L
Colombia	Jaller 2011		F	R	6	127	L	78	L	104	L
Croatia	Matkovic et al. 1979	1968–1973	F	R	5	177	L	135	M	157	M
	Matkovic et al. 1979	1968–1973	F	R							
	Karacic and Kopjar 2009	2003	P	N							
Czech	Stepan et al. 2012	2008–2009	G	N	1, 6, 7	374	H	211	H	297	H
Denmark	Abrahamsen et al. 2010	2004	G	N	1, 2, 7	574	H	290	H	439	H
Ecuador	Orces 2009	2005	F/G	N	1, 7	73	L	35	L	55	L
Estonia	Haviko et al. 1996	1991–1994	P	R	6	225	M	-		-	
Finland	Kröger H 2009	2000–2006	G	N	1, 2, 7	293	M	180	H	239	M
France	Couris et al. 2011	2004	G	N	1, 2, 4	291	M	126	M	212	M
Germany	Icks et al. 2008	2003–2004	G	N	1, 2, 4	346	H	166	H	261	H
Greece	Dretakis et al.,1992	1986	F	R	5	326	H	158	H	247	M
	Paspati et al. 1998	1992	P	R							
	Elffors et al. 1994	1988	G	R							
Hong Kong	Tsang et al. 2009	2000–2004	G	N	1, 4	324	H	148	M	240	M
Hungary	Péntek et al. 2008	1999–2003	G	N	1, 2	367	H	206	H	291	H
Iceland	Siggeirsdottir and Gudnason 2010	2008	G	N	1, 2, 3, 4	385	H	150	H	273	H
India	Dhanwal et al. 2011	2009	G	R	6	159	L	109	M	135	L
Indonesia	Hutagalung and Tirtarahardja 2011	2007–2010	G	R	2, 6	173	L	59	L	119	L
Iran	Soveid et al. 2005	2000–2003	F	R	3	402	H	269	H	339	H
Ireland	McGowan et al. 2011	2008–2010	G	N	2	406	H	191	H	304	H

H high, *M* moderate, *L* low (see table above for thresholds of risk), *G* good, *F* fair, *P* poor, *N* national, *R* regional, *1* FRAX model available, *2* national rather than regional data, *3* higher quality than other studies, *4* most recent study, *5* mean of several regional estimates, *6* sole study available, *7* additional details supplied by the author, see notes in tables

[a] Selection criteria—see "Methods"

Table 5 (continued)

Country	Source	Year	Quality	Catchment	Selection criteria[a]	F	Risk	M	Risk	M + F	Risk
Israel	Levine et al. 1970	1957–1966	F	R	6	265	M	131	M	201	M
Italy	Piscitelli et al. 2011	2007	G	N	1, 2, 7	334	H	140	M	242	M
Japan	Orimo and Sakata 2006	2002	G	N	1	266	M	165	H	218	M
Jordan	Azar et al. 2011	2008	G	N	1, 6	198	L	114	M	158	M
Kuwait	Memon et al. 1998	1992–1998	F	R	6	236	M	174	H	207	M
Lebanon	Sibai et al. 2011	2007	G	N	1, 3, 4	315	H	114	M	196	M
Lithuania	Tamulaitienė and Alekna 2011	2010	F	N	6	270	M	156	H	216	M
Malaysia	Chionh and Heng 2010	2007–2009	G	R	3, 4	269	M	114	M	205	M
Malta	Schembri 2010	2003–2007	G	N	1, 2, 4	355	H	160	H	263	H
Mexico	Johansson et al. 2011	2000–2006	G	N	1, 2	225	M	115	M	173	M
Morocco	Al Maghraoui 2011	2006–2009	P	R	4	73	L	66	L	69	L
Netherlands	Lalmohamed et al. 2012	2005	G	N	1, 2	249	M	121	M	188	M
New Zealand	Brown et al. 2007	2003–2005	G	N	1, 2, 4	288	M	140	M	218	M
Nigeria	Adebajo et al. 1991	1998–1999	P	R	6	2	L	2	L	2	L
Norway	Emaus et al. 2011	1994–2008	G	R	3, 4	563	H	262	H	420	H
Oman	Shukla and Khandekar 2008	2002–2007	F	R	6	312	H	236	H	276	H
Philippines	Li-Yu 2010	2001–2005	F	N	1, 2, 6	133	L	48	L	93	L
Poland	Czerwinski and Lorenc 2011	2008	F	R	1	224	M	133	M	181	M
Portugal	De Pina et al. 2008	2000–2002	G	N	2	268	M	98	L	188	M
Romania	D Grigorie 2011	2005–2009	G	N	1, 2 6, 7	198	L	142	M	172	M
Russia	Lesnyak et al. 2011	2008–2009	G	R	3, 4	249	M	185	H	219	M
S Africa	Solomon 1968	1957–1963	F	R	6	20	L	17	L	19	L
S Korea	Lim et al. 2008	2001–2004	G	N	1, 2, 3	268	M	176	H	224	M
Saudi Arabia	Al Nuaim et al. 1995	1990–1991	F	R	6	135	L	77	L	107	L
Serbia	Lesic et al. 2005	1990–2000				184		88		139	
Singapore	Chionh and Heng 2009 PC	2007–2009	G	N	1, 4, 7	331	H	156	H	248	M
Slovakia	P Masaryk 2011 PC	2007	G	N	1, 2, 6	401	H	263	H	335	H
Slovenia	Dzajkovska et al. 2007	2003	F	N	2, 6	349	H	-		-	
Spain	Diez et al. 1989	1984	G	R	1, 5	228	M	92	L	164	M
	Sosa et al. 1993	1990	F	R							
	Elffors et al. 1994	1989	G	R							
	Elffors et al. 1994	1989	G	R							
	Sanches et al. 1997	1991	F	R							
Sweden	Kanis et al. 2000	1991	G	R	1, 7	539	H	247	H	401	H
Switzerland	Lippuner et al. 2005 and 2009	2000	G	N	1, 2	413	H	186	H	306	H
Taiwan	Shao et al. 2009	2002	G	N	1	392	H	196	H	299	H
Thailand	Lau et al. 2001	1997	F	R	4	203	M	91	L	150	M
Tunisia	Zakraoui 2010	2001	P	N	1, 6	58	L	41	L	50	L
Turkey	Tuzun et al. 2011	2009	G	N	1, 2	357	H	110	M	240	M
UK	Singer et al. 1998	1992–1993	G	R	1	349	H	140	M	250	M
US	Ettinger et al. 2010	year	G	N	1	260	M	122	M	195	M
Venezuela	Riera-Espinoza 2008	2005–2006	F	R	6, 7	150	L	45	L	100	L

Table 6 Ethnic-specific rates in USA

US Asian	158	L	92	L	127	L	G
US Black	136	L	76	L	108	L	G
US Caucasian	316	H	143	M	234	M	G
US Hispanic	167	L	84	L	28	L	G

Table 7 Ten-year probabilities of a major osteoporotic fracture and categories of risk in men and in women with a prior fragility fracture (and no other clinical risk factors) at the threshold of osteoporosis as judged by BMD at the femoral neck (i.e. a T-score of −2.5 SD)

	Men Major	Women Major
Tunisia	1.9	2.4
Ecuador[a]	2.5	2.9
Philippines	4.8	6.7
China	5.4	6.9
Lebanon[a]	7.0	9.1
Colombia	7.1	8.7
US (Black)	7.2	9.8
Spain	7.4	9.0
Australia	7.8	8.8
Poland	7.9	10.
New Zealand	8.9	11
Romania	9.0	12
France	9.2	11
Turkey	9.9	12
Jordan	10	12
Netherlands	10	12
US (Asian)	10	12
US (Hispanic)	10	12
Mexico	10	13
Hungary	10	15
Sri Lanka[a]	11	14
Finland	11	13
Germany	11	14
Argentina	11	15
South Korea	11	15
Hong Kong	12	14
Italy[b]	12	14
Czech[b]	12	16
Singapore Indians	13	15
Japan	13	17
Belgium[b]	13	16
Russia[a]	13	21
Singapore Chinese	14	16
Singapore Malay	14	16
Canada	15	18
Malta	15	18
UK	15	19
Slovakia[a]	15	20
Taiwan	16	19
Austria	16	20
US (Caucasian)	17	21
Switzerland	18	22
Norway[a]	19	22
Sweden	21	24
Denmark	23	27

The body mass index was set at 24 kg/m^2. The data are sorted by probability of major fracture in men. Risk category is divided into three: low (red; probability in percent <10), intermediate (orange; 10–15) and high (>15)

[a] New model, online January 2012

[b] Updated model, online January 2012

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