Osteoporos Int (2009) 20:1363–1367
DOI 10.1007/s00198-008-0787-8

ORIGINAL ARTICLE

The incidence and risk of hip fracture in Poland

E. Czerwinski · J. A. Kanis · B. Trybulec · H. Johansson · P. Borowy · J. Osieleniec

Received: 17 June 2008 / Accepted: 23 October 2008 / Published online: 14 November 2008

Abstract
Summary This study determined the incidence and probability of hip fractures in Poland based on verified hospital discharge notes from all of Poland. In the over-50-year-old population, hip fracture incidence was found to be 89/100,000 for men and 156/100,000 for women. Poland is among the countries with the lowest hip fracture risk in Europe.
Introduction It is recommended that intervention thresholds should be based on an assessment of absolute fracture risk. Probability of hip fracture is calculated from the incidence of hip fracture in a given population and the incidence of death. The aim of this study was to determine the incidence and the absolute risk of hip fracture for men and women in Poland.
Methods The study was based on National Health Fund data from all of Poland for the year 2005. Hospital discharge notes reporting an incident fracture were identified from among all those containing a matching ICD code. Lifetime and 10-year fracture probabilities were calculated taking into account the mortality risk and BMD.
Results In 2005, there were 17,625 hip fractures diagnosed in Poland which was 30.2% less than the number of hospital discharge notes containing such a diagnosis in that year. In the over-50-year-old population, hip fracture incidence was found to be 89/100,000 for men and 165/100,000 for women. In the 50–65-year band, hip fracture incidence was higher in men than in women. The remaining lifetime probability of hip fracture at the age of 50 years was 2.0% for men and 4.5% for women which are among the lowest in Europe.
Conclusion Hip fracture incidence and thus the probability of hip fracture risk in Poland is amongst the lowest in Europe. The authors recommend establishing a standard method for determining hip fracture incidence in a given country in order to standardize data.

Keywords Fracture incidence · Fracture risk · Hip fracture · Intervention threshold · Osteoporosis · Prevention · Proximal femur fracture

Funding None of the authors has received or will receive any compensation in relation to this study.

E. Czerwinski (✉) · B. Trybulec
Department of Bone and Joint Diseases, FHS,
Jagiellonian University Medical College,
Kopernika 32,
31-501 Krakow, Poland
e-mail: czerwinski@kcm.pl

J. A. Kanis · H. Johansson
WHO Collaborating Centre for Metabolic Bone Disease,
University of Sheffield Medical School,
Sheffield, UK

E. Czerwinski · P. Borowy · J. Osieleniec
Krakow Medical Centre,
Krakow, Poland

Introduction

Fractures constitute the most significant clinical consequence of osteoporosis. Their prevention is therefore the main goal of treatment, and the key issue is the identification of patients at risk for fracture for whom treatment should be implemented. In many countries, including Poland, intervention threshold have been based on the WHO 1994 densitometric diagnostic criteria [1]. This approach is less than optimal because 50–70% of fractures occur in individuals who do not meet the −2.5 *T*-score threshold [2–4]. For this reason, the WHO and IOF recommend assessing the absolute fracture risk and that the 10-year probability of fracture be used as the metric to identify

patients who require treatment [5, 6]. Individual risk can be calculated using the known population risk, the patient's BMD and clinical risk factors such as BMI, parental history of hip fracture, prior history of fragility fracture, long-term use of oral glucocorticoids, rheumatoid arthritis, other secondary causes of osteoporosis, current smoking, and an average intake of alcohol of three or more units daily [7]. Recently, computer-based algorithms (FRAX®) have been published (http://www.shef.ac.uk/FRAX) that provide 10-year probabilities of hip fracture and a major osteoporotic fracture (clinical spine, hip, humerus, and forearm). The FRAX® tools increase the sensitivity to detect those at high risk of fracture [8, 9] and form the basis on which intervention thresholds are developed [5, 6, 10–12]. A necessary prerequisite for the development of FRAX® tools in any country is information on the epidemiology of fracture and death and several models are available [7].

The most complete models available are from the UK, Sweden, Japan, and the USA since the epidemiology of the relevant fractures is established [7, 13]. In several other countries (France, Spain, Italy, China, Turkey), FRAX® models are based on hip fracture risk alone and use assumptions to derive the relevant risk functions for the other major fractures. The application of these models to a country which is not yet accommodated in FRAX® is problematic since there are large, up to tenfold, differences in hip fracture incidence between populations (for example, 67/10,000 in women over 50 years of age for Malta compared to 504/10,000 for Sweden [14]). When heterogeneity of deaths is considered, there are up to 15-fold differences in 10-year fracture probabilities standardized to Sweden (set at 1.0)—for example, 0.08 for Chile compared to 1.24 for Norway [15].

Some data are available for Poland but are based either on discharge data from 10% of hospitals [16] or on a single province and extrapolated to the whole country [17]. The aim of the present study was to determine hip fracture incidence in Poland on a national basis and to calculate the 10-year hip fracture probabilities for men and women.

Methods

The study of hip fracture incidence was based on the National Health Fund registry of treatment service. This register contains patient hospital discharge notes, which constitute the basis for financial settlement between the National Health Fund central office and the hospital service. For this analysis, we used data from the period between January 1, 2005 and December 31, 2005. The hip fractures were identified from the corresponding ICD-10 codes of proximal femur fracture: S72.0 (femoral neck fracture), S72.1 (per trochanteric fracture), and S72.2 (subtrochanteric fracture). The appearance of one of these codes in the discharge notes does not necessarily mean that a new fracture was the reason for hospital admission since the patient could have been transferred from a different hospital or could have been repeatedly admitted for many other reasons. In order to avoid double counting, we analyzed the treatment procedures as reported in the Polish National Health Fund register. A fracture was identified if there were procedures indicating active treatment including fracture reduction, fixation, endoprosthesis implantation, etc. We also eliminated repeated admissions of the same patient in that year. The Polish population data necessary for the calculations was obtained from the Central Statistical Office website (http://www.stat.gov.pl). Incidence was computed in men and women by 5-year age intervals.

Lifetime and 10-year probabilities of proximal femur fracture were computed from the hazard function of hip fracture and death as detailed elsewhere [15].

For the 10-year probability, two hazard functions are used: the hazard function for death and the hazard function for hip fracture. In addition to this, the relationship between femoral neck BMD and risk of hip fracture was used [18]. The incidences of hip fractures from Poland showed in this paper form the hazard function of hip fractures, while the hazard function of death are taken from WHO (1999).

Risk of a major osteoporotic fracture (clinical spine, hip, forearm, or humerus) was computed indirectly from the hip fracture incidence from Poland, and the ratio between hip fracture incidence and other sites in Sweden (Malmö) [19]. The relationship between femoral neck BMD and risk of fracture was taken from a previously published meta-analysis that examined the gradient of fracture risk as a function of age and femoral neck BMD [15]. *T*-scores for BMD were derived from the NHANES III data for Caucasian women aged 20–29 years.

Results

Between January 1, 2005 and December 31, 2005, 24,626 men and women with a discharge diagnosis of hip fracture were identified in Poland. After verifying data with procedure records indicating fracture treatment, we identified 17,625 records. After eliminating repeat admissions of the same patient, a total number of 17,199 cases of hip fracture remained. This figure is 30.2% less than the number of hospitalizations. As of December 31, 2005, the population of Poland was 38,157,055 of which 12,033,939 were over 50 years and of these 6,820,545 were women.

The crude hip fracture incidence in all adults and in adults aged 50 years or more is shown in Table 1. There were 15,888 proximal femur fractures in this group including 50.44% femoral neck fractures, 43.96% pertro-

Table 1 Crude incidence (rate/100,000) of hospital discharges for hip fracture and incidence of hip fracture

Age group (years)	Discharges	Fractures
All	65	45
Adults aged ≥18	80	56
Men and women aged ≥50	187	132
Women aged ≥50	234	165
Men aged ≥50	126	89

chanteric fractures, and 5.6% subtrochanteric fractures. Fractures in women aged 50 years or more were 1.85 times more frequent than in men (165/100,000 vs. 89/100,000). Incidence of hip fracture by age and sex is shown in Table 2. As expected, hip fracture incidence increased exponentially with age with a correlation coefficient of 0.999 in women. Fracture incidence in women roughly doubled for each successive 5-year age band. Compared with the age range of 50–54 years, hip fracture incidence increased 1.68-fold in the 55–59-year-old group. The successive increment was 1.80 in the 60–64-year age group (see Table 2). Fractures in men were less frequent, and the increase in fracture incidence with age was smaller compared to women. The increase was approximately 1.5-fold for each successive 5-year age band. Between the ages of 50 and 64 years, fractures in men were more frequent than in women. Incidence was similar in the age range 65–69 years, but thereafter the female/male ratio increased progressively with age.

Lifetime and 10-year hip fracture probability in Poland

Lifetime hip fracture risk was 2.0% for men at age 50 years and 4.5% for women. The 10-year hip fracture risk was 0.3% for men at age 50 years and 0.2% for women and rose progressively with age (Table 3).

Lifetime and 10-year fracture probabilities rose with decreasing *T*-score at the femoral neck and with increasing age (Tables 4 and 5). At a *T*-score of −3.0 SD, the 10-year probability of hip fracture was 5.6% for men age 80 years and 6.3% for women. Note that the *T*-score given in the table is the measurement at the start of the time period. Fracture probabilities of hip fracture are given in Table 4 and for a major osteoporotic fracture in Table 5.

Table 2 Hip fracture incidence per 100,000 for men and women according to age and a comparison between genders

Age (years)	Men		Women		Female/male ratio
	Incidence	Increase coefficient	Incidence	Increase coefficient	
50–54	28.86		15.82		0.55
55–59	38.66	1.34	26.58	1.68	0.69
60–64	57.62	1.49	47.76	1.80	0.83
65–69	85.05	1.48	86.36	1.81	1.02
70–74	125.04	1.47	167.78	1.94	1.34
75–79	199.16	1.59	319.80	1.91	1.61
80–84	338.12	1.70	614.52	1.92	1.82
85+	665.57	1.97	1,138.26	1.85	1.71

Table 3 Lifetime and 10-year risk of hip fracture and a major osteoporotic fracture in Poland

Fracture site	Gender	Probability of fracture from 50 to death (%)	10-year probability of fracture (%)			
			50	60	70	80
Hip	Men	2.0	0.3	0.6	1.1	2.1
	Women	4.5	0.2	0.6	1.9	4.3
Major	Men	5.8	1.3	2.8	2.5	3.7
	Women	13.0	2.4	3.0	5.5	7.7

Discussion

This paper describes the incidence of hip fracture in Poland based on national data, rather than on regional data or on a sample of hospitals [16, 17]. The robustness of the data depends on a number of assumptions common to register studies such as that all hip fractures are admitted to hospital, that all hospitals are included, and that the correct ICD-10 code has been applied [20]. The data for this study cover all hospitals in Poland (including military hospitals) because the National Health Fund reimburses procedures nationwide and there are no private facilities that treat patients with hip fracture. It is possibile that some patients with hip fracture refuse hospital admission or are hospitalized but

Table 4 Femoral neck BMD (*T*-score) and lifetime and 10-year probability of proximal femur fracture

Femoral neck *T*-score	Probability of hip fracture from 50 to death (%)	10-year probability of hip fracture (%)			
		50	60	70	80
Men					
−4.0	21.8	4.4	8.0	10.0	10.8
−3.0	11.4	2.0	3.4	4.4	5.6
−2.0	5.5	0.9	1.4	1.9	2.8
−1.0	2.6	0.4	0.6	0.8	1.4
0.0	1.2	0.2	0.2	0.3	0.7
1.0	0.5	0.1	0.1	0.1	0.3
Women					
−4.0	29.8	1.8	5.3	11.2	14.3
−3.0	16.5	0.9	2.1	4.3	6.3
−2.0	8.3	0.4	0.8	1.6	2.7
−1.0	4.0	0.2	0.3	0.6	1.1
0.0	1.9	0.1	0.1	0.2	0.5
1.0	0.9	0.0	0.0	0.1	0.2

Table 5 Femoral neck BMD (*T*-score) and lifetime and 10-year probability of a major osteoporotic fracture

Femoral neck *T*-score	Probability of other osteoporotic fracture from 50 to death (%)	10-year probability of other osteoporotic fracture (%)			
		50	60	70	80
Men					
−4.0	26.0	5.8	12.5	12.5	14.9
−3.0	15.9	3.3	7.1	6.6	8.6
−2.0	10.0	2.1	4.4	3.6	4.9
−1.0	6.8	1.5	2.9	2.2	2.8
0.0	5.0	1.1	2.1	1.4	1.6
1.0	3.9	0.9	1.5	1.0	1.0
Women					
−4.0	37.4	5.0	9.7	16.7	20.8
−3.0	25.3	3.7	5.7	9.0	10.8
−2.0	17.4	2.9	3.6	5.3	5.5
−1.0	12.7	2.4	2.5	3.4	2.9
0.0	9.9	2.1	1.8	2.4	1.5
1.0	8.1	1.8	1.3	1.7	0.8

decline surgery. Schwartz et al. reported missing cases due to non-operative treatment which varied from 2% in Toulouse, France, to 49% in Porto, Portugal [20]. Operative treatment is the method for treating hip fractures in Poland and, although some cases may have been missed, the figure is likely to be low since the majority would be detected by the procedure verification where conservative treatment was also recorded. We would have missed immediately fatal fractures such as patients in road traffic accidents, but the numbers are likely to be few. The vast majority of fractures at 94.4% comprised femoral and trochanteric fractures, and the remainders were subtrochanteric fractures, consistent with other studies [21].

A source of further error in assessing the number of hip fracture arises when a diagnosis of hip fracture in the discharge notes is automatically considered as a new fracture. This double counting may arise when patients are transferred to a different hospital, for example, for rehabilitation or for treatment of complications of the fracture or problems related to comorbidity. In the present study, we verified the discharge data based on the treatment given and thereby excluded repeat admissions. In the absence of these measures, the apparent incidence would be inflated by 30%. The overestimate of fracture incidence due to this error is similar to that assumed in Europe (32%) [14] and by Wildner and Clark in 2001 whose estimate was 5–30% in Germany [22], but much higher than that reported in Sweden [19]. In the latter study, double counting overestimated hip fracture incidence by 14%, a figure that increased with age. Many reports on hip fracture incidence ingnore the possibility of double counting [14, 15, 23, 24].

A number of authors have verified discharge data based on treatment given using ICD procedure codes or, like us, procedure codes used in the given country [21, 25, 26]. Some have additionally verified operation protocols and radiographs [20]. It appears necessary to establish standards for hip fracture incidence assessment. We believe that register studies should, wherever possible, be based on data from the entire country with verification of discharge notes that exclude double counting.

The present results differ from previous estimates of hip fracture in Poland. A survey by Johnell et al. reported a crude rate of 109/100,000 [14] which is lower than our estimate (165/100,000) but was from 1990, and it is probable that age- and sex-specific rates have increased [15]. A survey by Roszkowska et al., based on 10% hospital discharge data for the year 1995, reported an intermediate incidence (138/100,000) [16]. The most recent study gave a much higher estimate than our own (283/100,000) [17] but was based on discharge data from a single province (Mazowieckie) and then extrapolated to the whole country. Also, no treatment verification was performed and double counting was not excluded. When this is taken into account, the differences between the regional and national estimates are small.

The incidence of hip fractures in Poland is one of the lowest in Europe. Lower figures have been found only in Malta and Yugoslavia [14], whereas much higher figures are reported for other countries, including Germany [20], the Netherlands [14], UK [27], and Sweden [14]. Such large differences in hip fracture incidence are difficult to explain but have been noted in a prospective study of incidence that showed a 13-fold difference in incidence between regions in Europe using a common methodology [28]. It is of interest that in those countries with lower rates the sex ratio of incidence is also lower. The female-to-male ratio varies from near unity in rural Turkey, where the incidence is very low [28], to 3.36 in England and Wales [27]. An intermediate rate was noted in the present study (1.41).

Poland has a relatively poor life expectancy. Average life expectancy in women at the age of 75 years is 10.5 years compared to 12.6 years in Australia, 14.2 years in France, 14.4 years in Japan and 12 years in Spain [15]. The low hip fracture incidence in Poland together with poor life expectancy gives rise to one of the lowest lifetime and 10-year fracture probabilities in Europe. The lifetime fracture probability for women aged 50 years (4.5%) was 6.6 times lower than in Sweden (28.5%) [15] and 1.7 times lower than in Hungary (7.4%). Similarly, the 10-year probability of fracture in women age 70 years (1.1%) is 3.7 times lower than in Sweden (3.9%) [15] and 1.7 times lower than in Hungary (1.8%) [15]. There is an increasing use of fracture probabilities to direct intervention which

might suggest that fewer patients would require treatment in Poland than in many other European countries. On the other hand, the cost of fractures and intervention also differ and these need to be accounted for in determining intervention thresholds for Poland based on fracture probability.

Acknowledgments We are grateful to the President of the National Health Fund in Warsaw, the Director of the Department of Reports and Analysis of the National Health Fund in Warsaw and Dariusz Dzielak for assistance in gathering data.

Conflicts of interest None.

References

1. WHO Study Group (eds) (1994) Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. Technical Report 843, Geneva
2. Marshall D, Johnell O, Wedel H (1996) Meta-analysis of how well measures of bone mineral density predict occurrence of osteoporotic fractures. Br Med J 312:1254–1259
3. Burger H, de Laet CE, van Daele PL et al (2000) Risk factors for increase bone loss in an elderly population: the Rotterdam Osteoporosis Study. Am J Epidemiol 147(9):871–879
4. Siris ES, Chen YT, Abbott TA et al (2004) Bone mineral density thresholds for pharmacological intervention to prevent fracture. Arch Intern Med 164(10):1108–1112
5. Kanis JA, Burlet N, Cooper C et al (2008) European guidance for the diagnosis and management of osteoporosis in postmenopausal women. Osteoporos Int 9:399–428
6. Kanis JA, Johnell O, Oden A et al (2008) FRAX and the assessment of fracture probability in men and women from the UK. Osteoporos Int 19:385–397
7. Kanis JA on behalf of the World Health Organization Scientific Group (2008) Assessment of osteoporosis at the primary health-care level. Technical report. WHO Collaborating Centre, University of Sheffield, UK
8. Kanis JA, Johnell O, Oden A et al (2001) Ten year risk of osteoporotic fracture and the effect of risk factors on screening strategies. Bone 30:251–258
9. Kanis JA, Oden A, Johnell O et al (2007) The use of clinical risk factors enhances the performance of BMD in prediction of hip fractures in men and women. Osteoporos Int 18:1033–1046
10. Prevention, clinical assessment and therapy of osteoporosis for women after menopause, for men after age 60. Dachverbandes der deutschsprachigen osteologischen Fachgesellschaften. (2006) (http://www.lutherhaus.de/dvo-leitlinen, accessed 4 December 2006)
11. Dawson-Hughes B, Tosteson AN, Melton LJ 3rd, National Osteoporosis Foundation Guide Committee et al (2008) Implications of absolute fracture risk assessment for osteoporosis practice guidelines in the USA. Osteoporos Int 9:449–458
12. Brown JP, Josse RG, Scientific Advisory Council of the Osteoporosis Society of Canada (2002) Clinical practice guidelines for the diagnosis and management of osteoporosis in Canada. Canadian Med Assoc Journal 167(Suppl.):1–22
13. Kanis JA, Johnell O, Oden A et al (2005) Intervention threshold for osteoporosis in men and women: a study based on data from Sweden. Osteoporos Int 16:6–14
14. Johnell O, Gullberg B, Allander E et al (1992) The apparent incidence of hip fracture in Europe: a study of national register sources. Osteoporos Int 2:298–302
15. Kanis JA, Johnell O, De Laet C et al (2002) International variations in hip fracture probabilities: implications for risk assessment. J Bone Miner Res 17:1239–1244
16. Roszkowska H, Goryński P, Wojtyniak B (1998) Hospitalizacja z powodu złamania szyjki kości udowej w Polsce w latach 1979–1995 wg płci, wieku i miejsca zamieszkania. Postepy Osteoartrologii 10:150–156
17. Jaworski M, Lorenc RS (2007) Risk of hip fracture in Poland. Med Sci Monit 13:206–210
18. Johnell O, Kanis JA, Oden A et al (2005) Predictive value of BMD for hip and other fractures. J Bone Miner Res 20(7):1185–1194
19. Kanis JA, Johnell O, Oden A et al (2000) Long term risk of osteoporotic fracture in Malmo. Osteoporos Int 11:669–674
20. 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
21. Lonnroos E, Kautiainen H, Karppi R et al (2006) Increased incidence of hip fractures. A population based-study in Finland. Bone 39:623–627
22. Wildner M, Clark DE (2001) Hip fracture incidence in East and West Germany: reassessment ten years after Unification. Osteoporos Int 12:136–139
23. Chevalley T, Guilley E, Herrmann F et al (2007) Incidence of hip fracture over a 10-year period (1991–2000): reversal of a secular trend. Bone 40:1284–1289
24. Lesic A, Jarebinski M, Pekmezovic T et al (2007) Epidemiology of hip fractures in Belgrade, Serbia Montenegro, 1990–2000. Arch Orthop Trauma Surg 127:179–183
25. Reginster JY, Gillet P, Gosset C (2001) Secular increase in the incidence of hip fractures in Belgium between 1984 and 1996: need for a concerted public health strategy. Bull World Health Organ 79:942–946
26. Zingmond DS, Soohoo NF, Silverman SL (2006) The role of socioeconomic status on hip fracture. Osteoporos Int 17:1562–1568
27. van Staa TP, Dennison EM, Leufkens HG et al (2001) Epidemiology of fractures in England and Wales. Bone 29:517–522
28. Elffors I, Allander E, Kanis JA (1994) The variable incidence of hip fracture in southern Europe: the MEDOS Study. Osteoporos Int 4:253–263