

## Standardized incidence rates of total hip replacement for primary hip osteoarthritis in the 5 Nordic countries: similarities and differences

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**Background** The national hip registers of the Nordic countries provide an opportunity to compare age- and sex-standardized annual incidence of primary total hip replacement (THR) and types of implants used for primary hip osteoarthritis (OA) in Denmark, Finland, Iceland, Norway and Sweden.

**Methods** The data on THR were from the national total hip replacement registries, and population data were from the national statistics agencies. Annual incidence density per 100,000 was calculated for each 5-year age group and it was age-standardized using the WHO European standard population.

**Results** Crude country-specific annual incidence (all ages) for 1996–2000 varied between 73 and 90. WHO age-standardized annual incidence (all ages) varied between 61 (Finland) and 84 (Iceland). For the ages 50–89, comprising 94–98% of all THRs for OA, annual incidence varied between 217 (Finland) and 309 (Iceland). For Norway, the sex incidence ratio (women/men) was 2, and for the other countries it was between 1.1 and 1.3. The use of uncemented and hybrid replacements was considerably higher in Finland and Denmark than in the other countries.

**Interpretation** We found overall similarity in THR incidence between the 5 Nordic countries, but substantial differences between women and men, and in the use of different types of implant. Population-based, age-standardized and disease-specific information on THR incidence is required in order to properly explore the

causes of differences in provision and practice of THR in different countries, regions and groups, and it will aid in projecting future needs. ■

In spite of the cost-effectiveness and wide acceptance of total hip replacement (THR) as treatment for symptomatic hip OA not relieved by other interventions, considerable variations in practice appear to exist between different regions and countries (Merx et al. 2003). One reason for these variations could be true differences in the prevalence of hip OA in different populations (Hoaglund et al. 1995, Oishi et al. 1998, Nevitt et al. 2002). Other plausible reasons might include (but are not necessarily limited to) differences between countries in healthcare systems, resources and financing, referral practices and prioritization, healthcare professional acceptance, and willingness of patients. Even in the one country, inequalities in access to joint replacement are reflected in varying rates of joint replacement between regions and social groups (Wright et al. 1999, Charlson and Allegrante 2000, Hawker et al. 2000, 2001, 2002, 2004, Hudak et al. 2002, Skinner et al. 2003, Byrne et al. 2004, Dixon et al. 2004, 2006, Yong et al. 2004, Milner et al. 2004, Clark et al. 2004). Comparisons of THR rates between sections of a population, between regions and also

between countries would provide information that would help in our understanding of the reasons for these differences in rates; they would also aid in planning for provision of healthcare services.

Any attempt to compare rates of THR in different countries is confounded by the lack of national data on the usage of THR in many countries, and even more so by the lack of detailed population-based data for THR incidence standardized by diagnosis, age group and sex (Merx et al. 2003). Comparisons based on crude rates without such standardization can be misleading (Ingvarsson et al. 1999, Ostendorf et al. 2002, Merx et al. 2003).

Population-based data on THR practice are available for the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden), and are based on national registries with a very low loss to registration and follow-up (Ingvarsson et al. 1999, Havelin et al. 2000, Lucht 2000, Puolakka et al. 2001, Malchau et al. 2002). Using these data together with population data for each country, we have generated THR incidence rates for each country that are specific for OA, age group, gender, and implant type. For the first time, we present a comparison of diagnosis-specific and age-standardized THR incidence in the 5 Nordic countries.

## Material and methods

We obtained annual numbers of total hip replacements for the years 1996–2000 from the total hip or joint replacement registries in Denmark, Finland, Iceland, Norway and Sweden. The following inclusion criteria were used: primary total hip replacement because of primary OA of the hip. Exclusion criteria were: reoperation or revision of implant, fracture, traumatic dislocation, necrosis of the femoral head, inflammatory arthritis including ankylosing spondylitis, congenital hip dislocation, Legg-Calvé-Perthes' disease, or epiphysiolysis of the femoral head. Dysplastic hips, when specifically diagnosed as such in the registries, were excluded. THR done in private care was included in the numbers reported. Diagnoses used were those reported to the registries by the participating clinics. The proportions of THRs for primary OA out of all primary THRs for this 5-year time period were 76%, 77%, 84%, 72% and 76% for Denmark, Finland,

Iceland, Norway, and Sweden, respectively. Hip dysplasia and sequelae accounted for 2%, 2%, 4%, 8% and 2%, respectively, in these countries. Rheumatoid arthritis and other inflammatory arthritides accounted for between 3 and 8% of all primary THRs, while hip fractures were responsible for the majority of the remainder of the THRs.

Arthroplasties for each year were reported by 5-year age group: younger than 40, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, 85–89, and 90 and over. Data were further stratified with regard to sex and type of implant: cemented, hybrid (either cup or stem uncemented), or uncemented. The national databases for all 5 countries use a personal ID number given to each individual at birth, which is used in all healthcare, national reporting and statistics.

Population statistics for each year (1996–2000) were obtained from Statistics Denmark, Finland, Iceland, Norway and Sweden. WHO European reference population numbers were also used (Muir et al. 1987).

We calculated the yearly age- and sex-specific incidence density rates by dividing the number of cases per year and age group with the corresponding number of person years of observation, approximated by the population reported at December 31 each year. The incidence rates are expressed in terms of 100,000 person years.

We calculated age-standardized incidence rates as a weighted average of age-specific incidence density rates, where the age-specific weights represent the relative distribution of the standard population. We used the WHO European reference population (Muir et al. 1987) as our standard population. Finally, the incidence rates for all age groups were added to generate the age-standardized incidence rate for that country (all ages). This permits a standardized comparison of overall incidence between different populations, and is commonly practiced when comparing, for example, cancer incidence between different countries.

## Results

For the 5-year period 1996–2000, using the inclusion and exclusion criteria described, the number of hip joint replacements in Denmark was 19,536, in

Table 1. Crude incidence rate per year per 100,000 (overall population) of primary THR for primary OA

	Denmark	Finland	Iceland	Norway	Sweden
1996	68	71	80	76	86
1997	70	72	88	84	83
1998	74	71	76	85	92
1999	78	72	82	87	92
2000	80	77	70	93	99

Table 3. Ratios between women and men in average incidence of primary THR for primary OA per 100,000 per year (all implants); 1996–2000 and age group 50–89

	Women/men THR ratio	95% CI
Denmark	1.12	1.07–1.18
Finland	1.15	1.11–1.20
Iceland	1.29	1.18–1.42
Norway	2.03	1.98–2.09
Sweden	1.17	1.14–1.20

Table 2. Average incidence rate per year per 100,000, for 5-year period 1996–2000, of primary THR for primary OA; all implant types. Values within parentheses represent 95% confidence intervals

	Denmark	Finland	Iceland	Norway	Sweden
<i>Women and men</i>					
Age 50–89	219 (208–229)	217 (213–222)	309 (286–331)	275 (261–289)	252 (240–265)
Age 65–79	370 (346–394)	367 (352–382)	513 (474–552)	472 (441–503)	407 (386–428)
Age 75–79	415 (405–426)	369 (344–393)	559 (517–601)	552 (525–580)	467 (451–483)
All ages	74 (69–78)	73 (71–75)	79 (73–85)	85 (80–91)	90 (85–96)
Standardized <sup>a</sup> (all ages)	61 (57–65)	61 (59–62)	84 (77–91)	69 (65–74)	68 (64–72)
<i>Women</i>					
Age 50–89	230 (218–242)	231 (227–236)	346 (320–371)	360 (341–379)	271 (255–287)
Age 65–79	386 (358–413)	392 (373–411)	557 (526–588)	610 (568–653)	429 (400–459)
Age 75–79	432 (411–453)	396 (356–436)	563 (499–626)	685 (644–725)	505 (482–527)
All ages	82 (77–87)	83 (82–85)	93 (86–100)	118 (111–125)	102 (95–109)
Standardized <sup>a</sup> (all ages)	62 (57–66)	60 (60–61)	92 (84–100)	88 (82–94)	71 (66–75)
<i>Men</i>					
Age 50–89	205 (194–216)	200 (192–208)	269 (239–299)	177 (167–187)	231 (222–241)
Age 65–79	350 (326–375)	331 (319–344)	463 (405–520)	303 (281–324)	380 (367–394)
Age 75–79	391 (3801–402)	318 (294–343)	555 (478–631)	364 (342–387)	416 (404–427)
All ages	65 (61–70)	62 (59–65)	66 (59–73)	52 (48–55)	79 (74–83)
Standardized <sup>a</sup> (all ages)	60 (56–64)	60 (58–63)	75 (66–83)	48 (44–51)	65 (62–69)

<sup>a</sup> Age-standardized annual incidence per 100,000 WHO European standard population.

Finland it was 18,784, in Iceland 1,085, in Norway 18,813, and in Sweden 39,977. Crude annual incidence density (using annual data for all primary implants for primary OA and all ages for both men and women) remained essentially constant over the 5-year time period in Finland, decreased in Iceland, and increased by some 20% in Denmark, Sweden, and Norway (Table 1).

The average annual incidence density for the 5-year period 1996–2000 was calculated in order to minimize the influence of year-to-year variations (Table 2). Annual incidence rate was highest for the age group 75–79 for all countries except Finland, which peaked at age group 70–74 (Figure). For these age groups with the highest incidence, the rates varied between 395 THR (Finland) and 559 THR (Iceland) per year per 100,000. Within

the wider age window of 50–89, which comprised 94–98% of all THRs for OA, the average annual incidence for 1996–2000 varied between 217 (Finland) and 309 (Iceland), a 40% difference (Table 2). The average age-standardized annual incidence per 100,000 for 1996–2000 was also calculated by applying the age-specific incidence rates to the WHO European reference population, and varied from 61 (Finland) to 84 (Iceland) (Table 2).

When comparing the average annual incidence rates for 1996–2000 for all implants in the age group 50–89, women showed a higher incidence than men in all countries (Table 2). For Norway, the ratio between the incidence rates for women and men was 2.0, while for the other four countries the ratio varied between 1.1 and 1.3 (Tables 2, 3). The corresponding ratios using incidence age-standard-

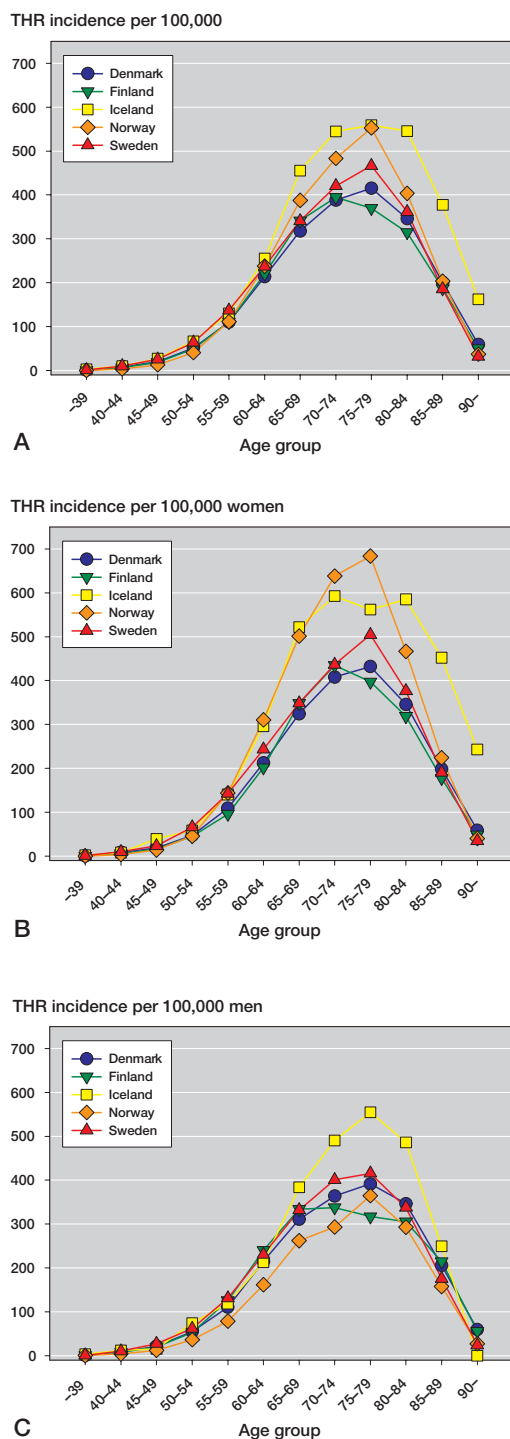


Figure 1. Average incidence rate of primary THR for primary hip OA per 100,000 per year (1996–2000), for different age groups in Denmark, Finland, Iceland, Norway and Sweden. A: average for men and women; B: women; C: men.

ized by the WHO European reference population (all ages) were 1.85 for Norway, and between 1.00 and 1.23 for the other countries (Table 2). These gender-specific differences in THR incidence were consistent for all implant types and all age groups except the youngest.

The use of uncemented and hybrid implants was considerably higher in Denmark and Finland than in the other countries (Table 4). For the age group 50–89, the incidence of uncemented THRs was 71 in Finland, 26 in Denmark, 20 in Norway, 5 in Sweden and 0 in Iceland. For hybrid implants, the incidence was highest in Denmark, low in Sweden and zero in Iceland.

## Discussion

Here we present the first population-based, age-standardized and disease-specific comparison of THR incidence between several countries using primary registry and population data. This is based on the national population-based registries on THR and the national population data in the 5 Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) with a total population of some 25 million. To reduce the influence of annual variation, results were collected for a 5-year period and covered 98,195 primary THR procedures for primary hip OA. Our findings are population-based and do not represent a population subset or clinic sub-sample prone to selection bias, and THR done in private care (less than 10% of the total) was also included. The validity of the registries has been documented. The overall completeness of registration of primary THR has been reported to be 95% or better and does not vary according to sex or age (Ingvarsson et al. 1999, Havelin et al. 2000, Lucht 2000, Söderman 2000, Söderman et al. 2000, Puolakka et al. 2001, Flugsrud et al. 2002, Malchau et al. 2002, Pedersen et al. 2004, Arthursson et al. 2006, Espehaug et al. 2006). Nevertheless, limitations in the accuracy of the data and conclusions may result from inconsistencies or errors in the diagnostic coding entered into the registry. For example, the positive predictive value was reported to be 85% for primary OA as a diagnosis leading to primary THR in Denmark (Pedersen et al. 2004). In comparison, in Iceland the proportion of diag-

Table 4. Average incidence rate per year per 100,000, for the 5-year period 1996–2000, of primary THR for primary OA using cemented, uncemented and hybrid implants

	Age group	Cemented	Un-cemented	Hybrid
<i>Women and men</i>				
Denmark	50–89	131	25.6	61.7
	65–79	254	19.7	95.6
	all ages	43.2	9.6	20.9
Finland	50–89	110	71.2	35.9
	65–79	224	76.3	67.1
	all ages	35.9	24.9	11.9
Iceland	50–89	309	0	0
	65–79	513	0	0
	all ages	79.1	0	0
Norway	50–89	239	19.7	16.4
	65–79	438	11.5	22.5
	all ages	73.0	6.9	5.2
Sweden	50–89	234	4.9	13.1
	65–79	397	1.1	7.5
	all ages	82.4	2.5	5.5
<i>Women</i>				
Denmark	50–89	141	23.0	65.8
	65–79	264	16.9	105
	all ages	49.3	9.1	23.5
Finland	50–89	130	62.9	38.3
	65–79	250	72.4	69.9
	all ages	45.9	23.7	13.7
Iceland	50–89	346	0	0
	65–79	557	0	0
	all ages	79.1	0	0
Norway	50–89	318	21.9	19.8
	65–79	569	12.8	26.0
	all ages	104	7.9	6.6
Sweden	50–89	254	4.1	11.9
	65–79	422	0.7	6.6
	all ages	94.0	2.2	5.4
<i>Men</i>				
Denmark	50–89	120	28.4	56.9
	65–79	243	23.1	84.4
	all ages	37.0	10.1	18.3
Finland	50–89	85.5	81.5	33.3
	65–79	186	82.3	62.8
	all ages	25.5	26.3	10.0
Iceland	50–89	269	0	0
	65–79	463	0	0
	all ages	65.8	0	0
Norway	50–89	147	17.5	12.8
	65–79	275	9.6	17.7
	all ages	41.8	5.8	3.9
Sweden	50–89	211	5.7	14.6
	65–79	368	1.4	8.5
	all ages	70.3	2.6	5.8

nostic errors in the registry was 2% (Ingvarsson et al. 1999). The diagnosis of hip dysplasia leading to THR may be associated with a higher degree of error, but the small proportion registered (2–8% of

all primary THRs) makes it an unlikely source of the differences noted in this report. It thus appears unlikely that there would be systematic differences in the potential sources of error between the registries of the Nordic countries.

As expected, the overall annual incidence of THR for OA was rather similar for these 5 neighboring countries, with a 40% difference between the highest rates (Iceland) and lowest rates (Finland) for the age group between 50 and 89 years. This age range covered some 95% of all THRs for OA. Again, after calculating age-standardized annual incidence rates using the WHO European standard population data, a 38% difference remained between the countries with the highest and lowest rates. Our results for the time period 1996–2000 thus corroborate a previous report that found a markedly higher incidence of THR for OA in Iceland than in Sweden for the observation period 1992–1996 (Ingvarsson et al. 1999). Additional reports have made comparisons of country-specific incidence of THR, confirming significant differences, but these are difficult to interpret because of methodological weaknesses such as lack of diagnosis information, incomplete reporting, lack of age-specific data, and lack of age standardization (Ostendorf et al. 2002, Merx et al. 2003). Our results using the age standardizations show the importance of this aspect of presenting THR incidence data: crude incidence data can be misleading, as shown by comparing the results in Table 2.

The incidence of primary THR for primary hip OA was higher for women than for men in all 5 countries, which is consistent with disabling hip OA being generally estimated to be more common in women than in men. However, the female/male incidence ratio of THR for OA of 2.0 for Norway was considerably higher than for any of the other countries. This gender-specific difference between Norway and the other Nordic countries appears to have been caused by a combination of a higher than average incidence of THR for OA in women in Norway, and a lower than average incidence for men (Figure, Tables 2 and 3). In fact, incidence rates for Norwegian women were the highest, and for Norwegian men the lowest, of the 5 countries (Table 2). The reasons for this difference between countries in sex-specific incidence are not clear, but may be related to a higher relative prevalence

of severe symptomatic hip OA among Norwegian women, to differences in referral practices and patient willingness, or to some other as yet unknown factor. There is very little information available on the possible factors that influence THR rates for primary OA in the Nordic countries.

Significant differences in the underlying prevalence of hip OA between other populations have been documented (Hoaglund et al. 1995, Oishi et al. 1998, Nevitt et al. 2002). Such differences will presumably contribute to differences in incidence of THR for OA, but are again difficult to interpret due, for example, to use of different criteria for OA in these epidemiological studies. It is likely that any population differences in prevalence of OA are related to genetic differences between these different populations, since hip OA is strongly genetically determined, with an estimated heritability in excess of 50% (Spector et al. 1996, Chitnavis et al. 1997, Ingvarsson et al. 2000, Loughlin et al. 2001, Lohmander et al. 2005). Genetic relationships, and differences, between the Nordic populations have been documented, but it is not clear how this might translate into differences in prevalence of severe hip OA leading to THR (Helgasson et al. 2000, 2001).

We also found considerable differences in the use of different implant types between the countries, with a high incidence of uncemented implants in Finland and of hybrid implants in Denmark, compared to the other countries. Considering the similarities between the 5 countries in overall THR usage and healthcare systems, it is difficult to propose a reason for these differences other than local traditions and surgeon preferences influenced by the marketing of implants. For Sweden, it has been suggested that the dissemination of scientific publications and annual THR reports from the national arthroplasty registries has encouraged a decrease in local variation in implant types and surgical techniques used, contributing to a low revision burden in Sweden (Herberts and Malchau 2000, Malchau et al. 2002, annual reports at <http://www.jru.orthop.gu.se/>).

Differences between countries regarding healthcare systems, resources and financing, referral practices, and healthcare professional acceptance all contribute further to differences in rates of joint replacement between countries, regions, social

groups, and sexes. Of those identified as ideal candidates for hip or knee replacement on the basis of symptoms and disease severity, only some patients report themselves as “willing” to undergo joint replacement, which reveals the complexity of trying to predict THR needs from epidemiological data on symptoms, or radiographic changes (Hawker et al. 2000, 2001, 2004, Juni et al. 2003). Population-based, age-standardized and disease-specific information on incidence of THR such as that provided in this report is necessary in order to explore the causes of differences in provision of THR between different countries, regions and groups, and will help in projection of future needs (Pedersen et al. 2005).

#### *Contributions of authors*

SL planned and designed the study, performed statistical analyses and wrote first draft of the manuscript. LBE, PH, TI, UL and TP provided national THR registry data, contributed to study design and revised the manuscript.

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