<<st2>>ORIGINAL ARTICLE

<<rrh>>International Lifetime Risk of Total Hip Replacement for OA

<<lrh>>Ackerman et al

<<title>>Lifetime Risk of Primary Total Hip Replacement Surgery for Osteoarthritis From 2003 to 2013: A Multinational Analysis Using National Registry Data

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Objective. To compare the lifetime risk of total hip replacement (THR) surgery for osteoarthritis (OA) between countries, and over time.

Methods. Data on primary THR procedures performed for OA in 2003 and 2013 were extracted from national arthroplasty registries in Australia, Denmark, Finland, Norway, and Sweden. Life tables and population data were also obtained for each country. Lifetime risk of THR was calculated for 2003 and 2013 using registry, life-table, and population data.

Results. In 2003, lifetime risk of THR ranged from 8.7% (Denmark) to 15.9% (Norway) for females, and from 6.3% (Denmark) to 8.6% (Finland) for males. With the exception of females in Norway (where lifetime risk started and remained high), lifetime risk of THR increased significantly for both sexes in all countries from 2003 to 2013. In 2013, lifetime risk of THR was as high as 1 in 7 women in Norway, and 1 in 10 men in Finland. Females consistently demonstrated the highest lifetime risk of THR at both time points. Notably, lifetime risk for females in Norway was approximately double the risk for males in 2003 (females 15.9% [95% confidence interval (95% CI) 15.6–16.1], males 6.9% [95% CI 6.7–7.1]), and 2013 (females 16.0% [95% CI 15.8–16.3], males 8.3% [95% CI 8.1–8.5]).

Conclusion. Using representative, population-based data, this study found statistically significant increases in the lifetime risk of THR in 5 countries over a 10-year period, and substantial between-sex differences. These multinational risk estimates can inform resource planning for OA service delivery.

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<<hd1>>**INTRODUCTION**

Total hip replacement surgery (THR) is an effective procedure for reducing pain and improving function in people with advanced hip osteoarthritis (OA) (1), with a range of studies providing evidence of cost-effectiveness (2). However, aging populations, projected growth in demand for THR (3–6), and predicted health workforce shortages in orthopedic surgery (7,8) all underscore the importance of using contemporary, population-level data to plan for future service provision.

Lifetime risk analysis is a method for quantifying disease burden and associated health care utilization that is commonly used in the cancer and cardiovascular fields (9,10). In the context of joint replacement surgery, the lifetime risk of THR refers to the probability of having this procedure within a person's lifetime. In contrast to THR incidence or utilization rates (11–13), the lifetime risk statistic provides a cumulative measure of risk that incorporates population life expectancy and all-cause mortality. As lifetime risk estimates are expressed simply as percentages, these data are also easier for policymakers, clinicians, and consumers to understand and use.

Only limited data are available internationally on the lifetime risk of THR for OA, from the UK (14) and our earlier research in Australia (15). To date, no studies have compared the lifetime risk of THR between countries, although this epidemiological work is important for monitoring geographical patterns of disease burden and identifying potential under- or overprovision of surgery. In the UK, Culliford et al (14) obtained data on THR utilization from a general practitioner research database that comprised health care data from 433 general practices. They reported a substantial increase in the lifetime risk of THR for women (4.0–11.1%) and men (2.2–6.6%) from 1991 to 2006. In Australia, Bohensky et al (15) used health system administrative data to calculate the lifetime risk of THR for people in the state of Victoria. They found that lifetime risk increased from 8.5% to 10.3% for women over the 9-year study period (1999–2008), with a smaller increase for men (9.3–9.9%).

Worldwide, over 40 arthroplasty registries operate at national, regional, or institutional levels (16). Many countries have longstanding and well-validated national arthroplasty registries with established methods for data capture in both public and private hospital settings (17). National registries offer a unique opportunity to estimate the lifetime risk of THR in multiple countries, using population-level data to maximize precision, and we have previously used this approach to estimate lifetime risk of knee replacement for OA in 5 countries (18). Using national arthroplasty registry data, the present study aimed to quantify and compare the lifetime risk of primary THR for OA in Australia, Denmark, Finland, Norway, and Sweden; evaluate change in lifetime risk of primary THR for OA in each country over a 10-year period; and examine trends in age- and sex-specific utilization rates of primary THR performed for OA.

<<significance&innovations>>

<<hd1>>**MATERIALS AND METHODS**

<<hd3>>**Study design and data sources.** A multinational, population-level analysis of observational data was undertaken and reported according to the Reporting of Studies Conducted Using Observational Routinely-Collected Health Data statement (19) (see Supplementary Table 1, available on the *Arthritis Care & Research* web site at http://onlinelibrary.wiley.com/doi/10.1002/acr.23197/abstract). Arthroplasty registry data, life-table data, and population data were sourced for each country, as summarized in Figure 1.<<F1>> The included countries (Australia, Denmark, Finland, Norway, and Sweden) were selected for their longstanding and comprehensive national arthroplasty registries. Each registry reports 100% coverage of all hospitals performing hip replacement surgery (17,20–23) and over 95% completeness for hip replacement procedures at the national level (17,21–24). The years 2003 and 2013 were chosen in accordance with the most recent life-table data available for all 5 countries.

We obtained data on all primary THR procedures performed for OA from January 1, 2003 to December 31, 2003 and January 1, 2013 to December 31, 2013 from the national arthroplasty registries in each of the 5 countries. Given that hip resurfacing surgery (HRS) is performed in some countries for younger people with higher activity levels (25), we also obtained data on all primary hip HRS procedures performed for OA in each country for the specified time periods. Registry statisticians had full access to individual-level registry data and oversaw the data extraction procedures for this study. De-identified aggregate data on the number of surgical procedures and the number of patients receiving THR and HRS in each year were obtained from the Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR), the Danish Hip Arthroplasty Register, the Finnish Arthroplasty Register, the Norwegian Arthroplasty Register, and the Swedish Hip Arthroplasty Register. These registries collect data from public and private hospitals. Details of the data collection and validation procedures (including validation of diagnoses) for each registry have been reported elsewhere (17,22,26,27). Registry data extracted for each country included sex, age, and operation type (THR and HRS).

Life-table data for 2003 and 2013 (stratified by sex) were obtained online from the Australian Bureau of Statistics (28,29), Statistics Denmark (30), Statistics Norway (31), and Statistics Sweden (32). Life-table data for Finland were obtained from Eurostat, the statistical office of the European Union (33). Life tables use all-cause mortality rates to estimate the number of people alive at each year of age (range 0–100 years) for a hypothetical cohort of 100,000 people. Data on the population of each country (by age and sex) and on life expectancy for 2003 and 2013 were obtained from the

above sources and from the Organisation for Economic Co-operation and Development (OECD) statistics website (OECD.Stat) (34), respectively.

<<hd3>>**Ethics approval.** Ethics approval for accessing Australian registry data was obtained from The University of Melbourne Human Research Ethics Committee. Institutional approval was obtained from the AOANJRR Data Review Committee. The study was also approved by the Nordic Arthroplasty Register Association. Individual ethics approval was not required for Denmark, Finland, Norway, or Sweden, consistent with local legislation permitting use of aggregate registry data for research purposes.

<<hd3>>**Data analysis.** Data were categorized into predetermined age groups by year for analysis: <40, 40–49, 50–59, 60–69, 70–79, and ≥80. The statistical approach used to calculate the lifetime risk of primary THR was based on methods reported previously (35) and is summarized in Supplementary Figure 1 (available on the *Arthritis Care & Research* web site at http://onlinelibrary.wiley.com/doi/10.1002/acr.23197/abstract). This approach was used to account for potential differences in population size and life expectancy between countries. Simultaneous bilateral THR was counted as 1 THR procedure to avoid potential overestimation of lifetime risk. Where staged (sequential) bilateral THR procedures were performed within the same year, only the first procedure performed in each year was included in the data set.

The lifetime risk of THR was calculated for each age group by dividing the total number of people having THR procedures in that year by the age group–specific and sex-specific population, and then multiplying these rates by the total number of people expected to be alive at the beginning of the interval. The lifetime risk of THR was calculated for 2003 and 2013, with separate calculations undertaken for females and males due to known sex differences in hip OA prevalence and THR rates (12,36). We estimated 95% confidence intervals (95% CIs) using a Poisson model (35,37). Changes in lifetime risk of THR over time and comparison of lifetime risk estimates between countries were analyzed descriptively, using calculated CIs. Although we obtained data on HRS, the lifetime risk of HRS was not calculated due to the small number of procedures performed in each country. However, a sensitivity analysis was undertaken to estimate the combined lifetime risk of THR and HRS in 2003 and 2013 in Australia, Finland, and Sweden (using the same methods as for the THR-only analyses) and these results are shown in Supplementary Table 2 (available on the *Arthritis Care & Research* web site at http://onlinelibrary.wiley.com/doi/10.1002/acr.23197/abstract). Denmark and Norway were not

included in the sensitivity analysis as <10 HRS procedures were performed in these countries in 2003 and 2013.

Similar to previous methods (13,38), overall age-specific and sex-specific utilization rates for THR were also calculated and expressed per 100,000 population for each country in 2003 and 2013, by summing the count of procedures from each registry and dividing by the relevant population (with regard to sex and age group) for that year. Where bilateral (either simultaneous or staged) THRs were performed, these were counted as 2 procedures to avoid underestimating THR utilization rates.

<<hd1>>**RESULTS**

<<hd3>>**Population characteristics and demographics of THR for OA.** Table 1 shows the population characteristics for each country.<<T1>> While population size in 2013 ranged from 5.1 million (for Norway) to 23.1 million (for Australia), sex distribution and life expectancy were similar across the countries. In all countries, females had a longer life expectancy than males and all countries reported an increase in life expectancy from 2003 to 2013.

Table 1 also shows demographic data relating to primary THR utilization. In 2003 and 2013, over half the THR procedures in each country were performed for females. Notably, the proportion of THRs performed for females was considerably higher in Norway (70.5% in 2003 and 65.5% in 2013) than for the other countries (range 54.5–58.1% in 2003, and 53.3–56.6% in 2013). There was little change in the proportion of THRs performed for people ages ≤60 years in each country from 2003 to 2013 (Table 1).

<<hd3>>**Comparison of lifetime risk of THR for OA between countries.** Table 2 shows the lifetime risk of THR for females and males in each country in 2003 and 2013.<<T2>> Some between-country variation in lifetime risk was observed, particularly for females. In 2003, the lifetime risk of THR for females ranged from 8.7% in Denmark to 15.9% in Norway. Lifetime risk for males ranged from 6.3% in Denmark to 8.6% in Finland. Across all 5 countries, females consistently had a higher lifetime risk of surgery. This trend was most notable in Norway, where lifetime risk of THR for females was more than double the risk for males in 2003 (females 15.9% [95% CI 15.6–16.1], males 6.9% [95% CI 6.7–7.1]).

In 2013, the lowest lifetime risk for females was evident in Denmark and the greatest lifetime risk for females was in Norway (Table 2). For males, the lowest lifetime risk of THR was in Norway and the highest lifetime risk was in Finland. Similar to the 2003 data, females consistently

demonstrated a higher lifetime risk of THR across all countries in 2013, compared to males. The difference in lifetime risk between sexes was again greatest in Norway, where the risk for females in 2013 was almost double the risk for males (females 16.0% [95% CI 15.8–16.3], males 8.3% [95% CI 8.1–8.5]).

<<hd3>>**Changes in lifetime risk of THR for OA over time.** With the exception of Norway (where lifetime risk started high and remained high), each country demonstrated a significant increase in the lifetime risk of THR for females over time (Table 2). As shown in Figure 2, the greatest absolute increase in lifetime risk for females over the 10-year period was seen in Australia (increase of 3.4%) and Denmark (increase of 3.0%), while Norway had the smallest absolute change (increase of 0.1%).<<F2>> All 5 countries demonstrated a significant increase in the lifetime risk of THR for males over time (Table 2). Figure 2 shows that Australia and Denmark had the greatest absolute increase (increases of 2.9% and 2.7%, respectively), while Norway had the smallest absolute increase (increase of 1.4%). Sensitivity analysis incorporating both THR and HRS data produced similar results with regard to between-country variation and significant increases in lifetime risk over time (see Supplementary Table 2, available on the *Arthritis Care & Research* web site at http://onlinelibrary.wiley.com/doi/10.1002/acr.23197/abstract).

<<hd3>>**Age-specific utilization rates for THR performed for OA.** Except for females in Norway, all countries demonstrated an increase in their overall THR utilization rate for both sexes over time (Table 3).<<T3>> In each country, the highest THR utilization rate was attributable to people ages 70–79 years, and this rate was evident for both sexes at both time points (Table 3). Across the countries, females ages 70–79 years in Finland experienced the highest rate of THR (1,081 procedures per 100,000 population in 2013). This rate was over 1.5 times higher than the utilization rate for similarly aged females in Australia, Denmark, and Sweden in 2013. Females in Norway ages 60–69 years and those ages ≥80 years had a higher THR utilization rate in 2003 and 2013, compared to their female counterparts in the other countries. As shown in Table 3, utilization rates for people ages ≤50 years remained low in all countries.

<<hd1>>**DISCUSSION**

Our research design has uniquely generated estimates for the burden of THR, using validated national arthroplasty registry data from 5 countries. These data deepen our understanding of the changing burden of advanced hip OA and THR at an international level. THR provision is a proxy measure for hip OA disease burden, and until national OA disease registries are established (as has been achieved for other diseases), population-level disease burden can only be reliably quantified

using surgical utilization data. These lifetime risk estimates can be used by individual countries to inform public health policy and for resource planning (for example, to forecast hospital resources and surgical workforce requirements and future costs of THR to the health system).

We found that the lifetime risk of THR increased significantly over time for males in all 5 countries, and for females in all countries except Norway. The rise in lifetime risk could potentially reflect changes in clinical practice, as well as higher-level policy changes. In Finland, the increased lifetime risk of THR over time can be partly explained by the introduction of hip resurfacing procedures in the early 2000s, which led to a broadening of THR indications to include younger OA patients (39). Increased awareness among referring medical and patient communities of the value of THR (in terms of cost-effectiveness and successful quality of life and functional outcomes) may have driven growth in surgery in all countries, although this assumption would be difficult to evaluate. Improvements in prosthesis longevity might also impact a surgeon's decision to operate, and a patient's decision to undergo surgery, with excellent 15-year prosthesis survival rates now reported (40–42). From a health system perspective, Denmark, Finland, and Sweden have all introduced national treatment guarantees (43) that specify maximum waiting times for health care. These policies may have allowed previous unmet need for joint replacement surgery to be addressed. In Australia, the introduction of government initiatives and financial incentives in 1999–2000 meant that the proportion of people with private health insurance increased rapidly, from 38% of people ages >15 years in 1998 to 51% in 2001 (44). These policy changes have probably also improved access to elective surgical procedures such as THR. Data on waiting times, referral patterns, and surgical decision-making could also be helpful for understanding trends in lifetime risk, but unfortunately are not currently available at national levels to support international comparisons. In theory, disease-related factors may have contributed to the observed rise in lifetime risk, although the Global Burden of Disease Study reported minimal change in the age-standardized prevalence of hip OA from 1990 to 2010 (45). Occupational factors may also influence THR risk over time, with several work-related risk factors for hip OA now recognized (46,47).

Females in Norway were the only group that did not demonstrate an increase in lifetime risk over the study period. Strikingly, lifetime risk of THR for this group was high in 2003 (15.9%) and remained high in 2013 (16.0%). We do not have a clear explanation for this finding, but it could relate to sex-specific preferences for surgery, particularly in light of the low lifetime risk estimates for Norwegian males in 2003 and 2013. We are aware that THR for pediatric hip disease is more commonly performed for females in Norway (27), and that Norway performs a higher proportion of THR surgeries for hip dysplasia than other Scandinavian countries (48). However, as our THR data

were restricted to procedures performed for OA, this pediatric trend is unlikely to have contributed to our findings. Other studies reporting data from the Norwegian Arthroplasty Register have shown a high annual incidence of THR among females for 1996–2000 (49) and 2006–2008 (50), although lifetime risk calculations have not been undertaken previously.

In contrast to our lifetime risk of total knee replacement findings (18), we found relatively little between-country variation in the lifetime risk of THR. Lifetime risk of THR in 2013 ranged from 11.7% to 16.0% for females, and from 8.3% to 11.0% for males. This finding may signify a degree of international consensus on the indications for THR, although such consensus has been questioned in the past (51). Another explanation could be the similar prevalence of hip OA in Australasia and Europe, as demonstrated in the Global Burden of Disease Study (prevalence for females 0.9% in Australasia versus 1.2% in Europe; prevalence for males 0.7% in Australasia versus 0.8–0.9% in Europe) (45). Hip OA is known to have a strong genetic component and is particularly linked to European genetic variants (52). This linkage is relevant for the Scandinavian countries as well as for Australia, which has a long history of European migration (68% of Australians report at least 1 type of European ancestry) (53).

We found substantial sex differences in the lifetime risk of THR in all countries at both time points. The most likely explanation for this finding is that globally, hip OA is more common in females than males (45). The Global Burden of Disease Study reported the mean age-standardized prevalence of hip OA as 0.98% for females and 0.70% for males (45). Data from all 5 included countries showed that >50% of primary THR procedures for OA were performed for females (range 54.5–70.5% in 2003, and 53.3–65.5% in 2013). As our analyses incorporate life-table data (which estimate the number of males and females alive at each year of age), the greater lifetime risk of THR among females will also partly relate to longer life expectancy. In 2013, life expectancy in the included countries was 4–6 years longer for females, compared to males. Sex differences were most evident in Norway, where lifetime risk for females was approximately double the risk for males in 2003 and 2013. This finding is consistent with earlier research on THR incidence; an analysis of Norwegian registry data reported that the incidence rate of primary THR for women was 2 times higher than for men in 1996–2000 (49) and 1.7 times higher in 2006–2008 (50).

Utilization rates for all countries were highest for the age group 70–79 years in 2003 and 2013, and particularly for females in Finland. In Finland there was a marked jump in THR utilization rates from the age group 60–69 years to the age group 70–79 years (from 340 to 1,081 procedures per 100,000 population for females in 2013, and from 311 to 926 procedures per 100,000 population for

males). However, this increase was offset by lower utilization rates for the age group ≥80 years, compared to the other countries. This tendency to operate a decade earlier (on people ages 70–79 years rather than ≥80 years) could reflect earlier hip OA development and/or progression among Finns involved in heavy labor since early childhood (e.g., in forestry and farming). While all countries showed an increase in utilization rates for all age groups >40 years, utilization rates for the age groups 40–49 years and 50–59 years remained low at both time points. Directly comparing national THR utilization rates between studies is difficult, due to variation in data sources and methods, including differing years of analysis. Lohmander et al (49) compared incidence rates for primary THR due to hip OA in Denmark, Finland, Iceland, Norway, and Sweden from 1996 to 2000. The study found that annual THR incidence rates were highest for people ages 75–79 years in all countries except for Finland, where the highest incidence rate was attributed to the age group 70–74 years. A more recent study using OECD health data reported THR utilization rates up to the year 2011 for a range of countries including Australia, Denmark, Finland, Norway, and Sweden. However, the analyses were not stratified by sex and were only reported for the age groups <65 and ≥65 years (38).

A key strength of our study design was the use of nationally representative data from 5 countries with longstanding, comprehensive, and clinically accurate arthroplasty registries. Together, these countries performed >40,000 primary THRs for OA in 2003 and >59,000 primary THRs for OA in 2013. The combined populations of these countries totaled over 43 million people in 2003 and 48 million in 2013. Consequently, the large pooled sample size enabled precise estimates of lifetime risk to be generated, as evidenced by our narrow 95% CIs. Our study used a statistical approach that is relatively new within musculoskeletal epidemiology, which allowed us to incorporate life expectancy and all-cause mortality in our calculations. In this way, the results are more informative for future health care planning than traditional THR incidence or utilization rates, which are based purely on observed numbers of procedures performed and population size and provide a more simplistic picture of growth in THR use over time. The standardized lifetime risk approach also enabled the age structure of populations to be taken into account. This consideration is important when comparing changes over time, given aging populations, and given that provision of THR is highly age-related. When calculating lifetime risk, we purposely counted THR procedures at the patient level (rather than the procedure level) to avoid overestimation where bilateral procedures were undertaken for patients within the same year. We also acknowledge the limitations of this research. We were unable to evaluate annual changes in lifetime risk as annual life-table data were not available for all countries. We included all patients who received a primary THR for OA in 2003 or 2013 (regardless of whether they had previously received a contralateral primary THR), as

from a clinical perspective these patients are still at risk of having surgery in the specified years. This approach reflects the challenges of estimating lifetime risk for diseases that occur at more than 1 time or bodily location (54). We also recognize that our methods focus on THR provision rather than population unmet need for THR. Lastly, we acknowledge there may be some between-country variation in the coding of diagnoses and hip replacement procedures that cannot be accounted for in the analyses.

In conclusion, this study has identified significant increases in the lifetime risk of THR for OA in 5 high-income countries over a 10-year period. Substantial sex differences were also observed, with females consistently demonstrating the highest lifetime risk of THR in each country in 2003 and 2013. While THR utilization rates for people ages ≤50 years remained low in all countries, males and females ages 70–79 years demonstrated the highest utilization rate in all countries in 2003 and 2013. These data allow us to better comprehend the changing burden of advanced hip OA and its surgical management at an international level, and can be used to inform the planning of health service delivery to meet growing population demand.

<<hd1>>**ACKNOWLEDGMENTS**

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AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be submitted for publication. Dr. Ackerman had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study conception and design. Ackerman, Bohensky, de Steiger, Brand, Garellick.

Acquisition of data. de Steiger, Eskelinen, Fenstad, Furnes, Graves, Haapakoski, Mäkelä, Mehnert, Nemes, Overgaard, Pedersen, Garellick.

Analysis and interpretation of data. Ackerman, Bohensky.

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Figure 1. Overview of data sources. THR = total hip replacement; HRS = hip resurfacing surgery; * = no HRS procedures were performed in Denmark in 2003 and only 2 procedures were performed in 2013; # = Statistical Office of the European Union; † = <10 HRS procedures were performed in Norway in 2003 and 2013

Figure 2. Change in lifetime risk of total hip replacement for osteoarthritis, 2003–2013. For the lifetime risk estimates, simultaneous bilateral THR was counted as 1 THR procedure to avoid potential overestimation of lifetime risk. Where staged bilateral THR procedures were performed within the same year, only the first procedure was included in the data set.

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Significance & Innovations

- Lifetime risk analysis is a method for quantifying disease burden and associated health care utilization.
- This study is the first to use population-based arthroplasty registry data to estimate the lifetime risk of primary total hip replacement (THR) for osteoarthritis at the national level, and to compare lifetime risk between countries and over time.
- A significant increase in the lifetime risk of THR over a 10-year period was observed for males in Australia, Denmark, Finland, Norway, and Sweden, and for females in each country except Norway, where lifetime risk was high in 2003 and remained high in 2013.

- These data deepen our understanding of the changing burden of hip osteoarthritis at an international level and can support evidence-informed resource planning and public health policy around joint replacement provision.

Table 1. Population characteristics and demographics of total hip replacement (THR) for osteoarthritis*

	Population data				Registry data		
Country	Population, no.	Female	Life expectancy male, years	Life expectancy female, years	Primary THR, no.†	Female‡	<60 years‡
Australia							
2003	19,720,737	50.4	77.8	82.8	15,031	54.5	18.9
2013	23,125,868	50.2	80.1	84.3	25,943	53.3	22.1
Denmark							
2003	5,387,174	50.5	75.0	79.8	4,809	58.1	18.2
2013	5,605,836	50.4	78.3	82.4	7,035	56.0	16.6
Finland							
2003	5,219,732	51.1	75.1	81.9	4,908	57.5	17.3
2013	5,451,270	50.8	78.0	84.1	7,034	55.9	19.2
Norway							
2003	4,552,252	50.4	77.1	82.1	5,302	70.5	12.9
2013	5,051,275	49.8	79.8	83.8	6,266	65.5	15.1
Sweden							
2003	8,975,670	50.5	78.0	82.5	10,057	57.3	18.1
2013	9,644,864	50.1	80.2	83.8	13,295	56.6	17.7

* Values are percentages unless indicated otherwise. Data on population life expectancy at birth were obtained from OECD.Stat.

† Bilateral procedures performed within the same year were counted as 2 THRs for this table.

‡ Proportion of those who received primary THR at each time point.

Table 2. Lifetime risk of total hip replacement (THR) for osteoarthritis by sex*

Country	Females	Males
Australia		
2003	9.3 (9.1–9.4)	7.6 (7.4–7.8)
2013	12.6 (12.4–12.8)	10.5 (10.3–10.7)
Denmark		
2003	8.7 (8.5–8.9)	6.3 (6.2–6.5)
2013	11.7 (11.5–11.9)	9.0 (8.9–9.2)
Finland		
2003	12.5 (12.3–12.7)	8.6 (8.5–8.8)
2013	14.6 (14.4–14.9)	11.0 (10.8–11.2)
Norway		
2003	15.9 (15.6–16.1)	6.9 (6.7–7.1)
2013	16.0 (15.8–16.3)	8.3 (8.1–8.5)
Sweden		
2003	10.9 (10.7–11.1)	8.2 (8.0–8.3)
2013	13.1 (12.8–13.3)	10.0 (9.8–10.1)

* Values are the lifetime risk as percentages (95% confidence interval). Simultaneous bilateral THR was counted as 1 THR procedure to avoid potential overestimation of lifetime risk. Where staged bilateral THR procedures were performed within the same year, only the first procedure was included in the data set.

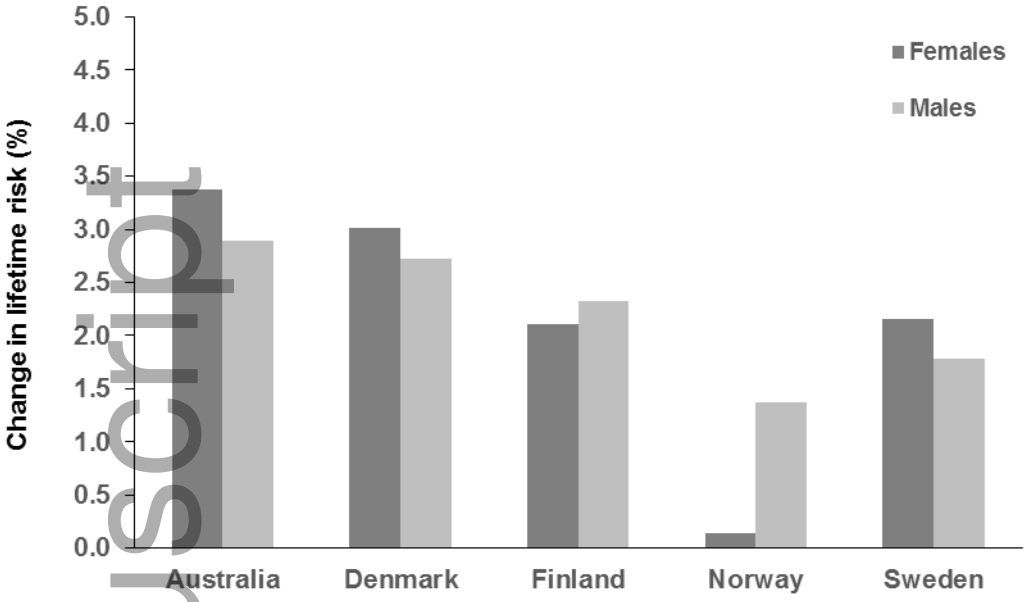
Table 3. Age- and sex-specific utilization rates for total hip replacement (THR) due to osteoarthritis*

	Per 100,000 population, years						
Country	**Overall**	**<40**	**40–49**	**50–59**	**60–69**	**70–79**	**≥80**
Australia							
Females 2003	82	1	18	87	284	508	349
Females 2013	119	2	30	136	381	632	427
Males 2003	70	1	20	91	287	440	326
Males 2013	105	2	41	162	357	532	390
Denmark							
Females 2003	103	0	23	90	315	559	296
Females 2013	140	1	31	112	380	660	400
Males 2003	76	1	18	96	277	416	288
Males 2013	111	1	38	124	334	509	384
Finland							
Females 2003	106	0	14	88	327	1,020	139
Females 2013	142	1	31	144	340	1,081	207
Males 2003	82	1	14	95	316	825	113
Males 2013	116	2	40	142	311	926	170
Norway							
Females 2003	163	0	14	131	524	953	520
Females 2013	163	0	31	136	498	938	478
Males 2003	69	0	14	71	253	472	327
Males 2013	85	0	21	101	294	463	354
Sweden							
Females 2003	127	1	20	123	376	586	321
Females 2013	156	1	34	155	413	686	375
Males 2003	97	1	24	118	311	487	311
Males 2013	120	1	42	150	354	515	321

* The overall utilization rate was calculated using the total number of procedures for females (or males) as the numerator and the number of females (or males) in the population as the denominator. Age-specific

utilization rates were calculated using the number of procedures for each age group as the numerator and the age-specific population as the denominator. Bilateral procedures performed within the same year were counted as 2 THRs for calculating utilization rates to avoid underestimating the true utilization of THR.

Obtained for all countries • Registry data (by age and sex) • Life tables data (by age and sex) • Population data (by age and sex)	**Australia** Australian Orthopaedic Association National Joint Replacement Registry (2003 and 2013 THR and HRS data) Australian Bureau of Statistics (2003 and 2013 life tables)
Denmark Danish Hip Arthroplasty Register (2003 and 2013 THR* data) Statistics Denmark (2003 and 2013 life tables)	**Finland** Finnish Arthroplasty Register (2003 and 2013 THR and HRS data) Eurostat[#] (2003 and 2013 life tables)
Norway Norwegian Arthroplasty Register (2003 and 2013 THR[†] data) Statistics Norway (2003 and 2013 life tables)	**Sweden** Swedish Hip Arthroplasty Register (2003 and 2013 THR and HRS data) Statistics Sweden (2003 and 2013 life tables)



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