(CJRR) CANADIAN JOINT REPLACEMENT REGISTRY

2002 REPORT

TOTAL HIP AND TOTAL KNEE REPLACEMENTS IN CANADA

(INCLUDES 1994/95 TO 1999/2000 DATA)

Canadian Institute
for Health Information

Canadian Joint Replacement Registry (CJRR)
2002 Report

Total Hip and Total Knee Replacements in Canada
(includes 1994/1995 to 1999/2000 data)

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Table of Contents

Executive Summary

- The Canadian Institute for Health Information (CIHI) developed and implemented the Canadian Joint Replacement Registry (CJRR) in collaboration with orthopaedic surgeons from across Canada. The CJRR was developed to identify ways to help improve patient care and the quality of total joint replacement procedures. Canada is one of only a few countries to develop a total joint replacement registry.

- This first report from the CJRR highlights trends and variations for total hip and total knee replacements performed in Canada from 1994/1995 to 1999/2000.

- Over time, the CJRR will monitor the post-surgery performance of the implants used in total joint replacements, with the goal of identifying ways to reduce the need for unnecessary revisions (i.e. repeat surgeries) due to implant wear and breakage. Even a small reduction in revision rates can provide substantial benefits to both patients and the health care system.

- The CJRR is managed by CIHI and provides important information on the total hip and total knee replacements performed in Canada. Data are only collected from patients who agree to participate in this registry.

- A national advisory committee, whose members include orthopaedic surgeons, consumers and representatives from the Canadian Orthopaedic Association, the Canadian Orthopaedic Foundation, the Arthritis Society and Health Canada, provides advice on the registry's development and implementation.

- The CJRR will provide a steady flow of new and necessary information to inform treatment, policy and planning decisions associated with these surgeries. CJRR will also serve as a valuable model for other pan-Canadian initiatives undertaking post-market surveillance or attempting to improve patient outcomes.

- The number of total hip and total knee replacements performed in Canada increased from 32,147 in 1994/1995 to 42,338 in 1999/2000, an increase of 31.7%.

- The number of total knee replacements performed in Canada increased from 15,360 in 1994/1995 to 22,302 in 1999/2000, an increase of 45.2%.

- The number of total hip replacements performed in Canada increased from 16,787 in 1994/1995 to 20,036 in 1999/2000, an increase of 19.3%.

- The age-standardized rate per 100,000 population for total knee replacements in Canada increased by 33.1%, up from 50.5 in 1994/1995 to 67.2 in 1999/2000.

- The age-standardized rate per 100,000 population for total hip replacements in Canada increased by 8.5%, up from 55.0 in 1994/1995 to 59.7 in 1999/2000.

- The consistent upward trend in age-standardized rates over time indicates that an aging population is not the only factor leading to an increase in the number of procedures performed annually. The CJRR will be used to better understand the inter-relationships between the many reasons for these increases.

- In 1999/2000, 89.4% of the total joint replacement surgeries were performed on people 55 years of age or older.

- The majority of total knee replacements (59.8%) and total hip replacements (57.8%) were performed on women in 1999/2000.

- In 1999/2000, total knee replacement rates, per 100,000 population, were lowest in Quebec (34.4) and Newfoundland (35.4) and highest in Nova Scotia (98.7) and Manitoba (94.8). In 1999/2000, total hip replacement rates, per 100,000 population, were lowest in Newfoundland (35.5) and Quebec (36.3) and highest in Nova Scotia (76.4) and Manitoba (74.9).

- Between 1994/1995 and 1999/2000, Manitoba experienced the largest percentage increase in their rates of total knee replacements (104.7%) and total hip replacements (39.5%). During the same time period, the smallest percentage increase in the total knee replacement rates was 2.6% for Saskatchewan.

- Between 1994/1995 and 1999/2000, the rates for total hip replacements deceased in three provinces, Prince Edward Island (down 9.4%), Newfoundland (down 7.8%), and Alberta (down 4.1%).

- Total hip replacement patients had longer average lengths of hospital stay than patients undergoing a total knee replacement in all provinces in 1999/2000.

- Total knee replacement patients had an average length of stay of 8.5 days in 1999/2000, down 30.3% from the average of 12.2 days in 1994/1995.

- Total hip replacement patients had an average length of stay of 10.1 days in 1999/2000, down 25.7% from the average of 13.6 days in 1994/1995.

- In 1999/2000, the average length of stay for total knee replacements was shortest in Ontario (7.4 days) and Nova Scotia (8.1 days) and longest in Prince Edward Island (12.8 days) and Newfoundland (11.9 days).

- In 1999/2000, the average length of stay for total hip replacements was shortest in Ontario (9.0 days) and Alberta (9.2 days) and longest in Prince Edward Island (13.0 days) and Newfoundland (12.8 days).

- Most patients received their surgery in their home province.

- In-hospital mortality rates following total hip replacement (0.7%) and total knee replacement (0.2%) surgeries are low. The risk of in-hospital mortality rate following these surgeries increases with age. For example, among people 85 years of age or older, the in-hospital mortality rate is 4.1% following a total hip replacement and 0.9% following a total knee replacement.

- In 1999/2000, 31.6% of total hip replacement patients received a blood transfusion during surgery compared to 20.3% of total knee replacement patients.

- We know that the quality of total hip and total knee replacement data is reasonably accurate.

- The relative importance of an aging population, trends in the prevalence of osteoarthritis and many other factors on the rates of total hip and total knee replacements is not yet fully understood.

- Similarly, the reasons for variations in provincial rates and lengths of stay for total hip and total knee replacements have not been clearly identified. These variations can likely be explained by several factors, including the age and health of the population, referral patterns, access to care, quality of care and types of implants used.

- Future analysis of CJRR data will improve our understanding of these trends and variations.

- The optimal rate of total hip and total knee replacements to meet the needs of Canadians is not known. The CJRR will be able provide the information needed to estimate appropriate rate ranges for these procedures for various regions and sub-populations. This information will be useful to policy-makers and providers who are planning the delivery of services.

- The proportion of all total joint replacements each year that are revisions and, more importantly, the proportion of primary replacements that result in a revision (the revision rate) are not known for Canada. In order to have meaningful comparisons on quality of care and implant performance, the revision rate and data on processes of care must be collected and analyzed. CJRR will be able provide this information in future reports.

- Detailed operative data is not routinely collected nationally. Therefore, the relative effectiveness of various surgical techniques, operating room environments, practices around antibiotic use and prevention of deep vein thrombosis, as well as fixation methods on clinical outcomes and implant survival is not known. CJRR will be able to address many of these issues by monitoring patients over time.

Introduction

This is the first annual report from the Canadian Joint Replacement Registry (CJRR). The aim of this report is to characterize the basic epidemiology of total hip and total knee replacements performed in Canada according to person (patient demographics), place (provincial and national level data) and time (trends) as well as selected clinical parameters. The total joint replacement data used for this report was obtained from two hospital separation databases managed by the Canadian Institute for Health Information (CIHI), namely the Hospital Morbidity Database and the Discharge Abstract Database. A supplemental report on detailed operative data submitted by orthopaedic surgeons participating in the CJRR is planned for the fall of 2002.

The CJRR is a new national registry that collects information on total hip and total knee replacement surgeries performed in Canada and follows joint replacement recipients over time to monitor patient outcomes including revision rates. Revisions are required when the initial (primary) joint replacement is not functioning properly. The need for revisions can be reduced by improving the long term performance of primary joint replacements. Lower revision rates means fewer patients undergo unnecessary repeat surgeries and the primary surgeries become more cost-effective. The ultimate goal of the CJRR is to improve the quality of care and clinical outcomes of patients through post-market surveillance of orthopaedic implants, improving the quality of surgical practices and the study of risk factors affecting outcomes.

The CJRR is a joint effort between CIHI and the orthopaedic surgeons of Canada. This initiative was championed by CIHI and orthopaedic surgeons from each province and the territories, including representatives of the Canadian Orthopaedic Association and the Canadian Orthopaedic Foundation. A number of other key partners contributed to the successful development and implementation of the CJRR including the Federal, Provincial and Territorial Ministries of Health, the Arthritis Society, the Canadian Arthritis Network and the Ontario Joint Replacement Registry.

A brief history of the development of the CJRR is outlined in Table 1. The CJRR is described in more detail on page 3.

Table 1. History of the Development of the CJRR

Milestones	Date
1. Proposal and Planning	1995
2. Feasibility Study and Report (Phase 1)	May 1996
3. Pilot Study and Report (Phase 2)	August 1997
4. Launch of the CJRR at the COA 2000 Annual Meeting	June 2000
5. Start of Data Submission	May 2001
6. CJRR 2002 Report—Total Hip and Total Knee Replacements in Canada	January 2002
7. Supplemental CJRR Report	September 2002

Background

There were 42,338 total hip and total knee replacements performed in Canada in 1999/2000 compared to 32,147 procedures in 1994/1995, representing a 32% increase over this period. This trend is similar to that observed in the United States, where the number of total hip and total knee replacements increased by 38% from 277,000 procedures in 1991 to 383,000 procedures in 1996.[1] The increasing volume of these procedures is likely due to a number of factors, including the aging of the population and the rising number of joint replacements being performed on younger, more active individuals.

Total joint replacement surgery has evolved dramatically since 1938, when total hip arthroplasty was first introduced. Replacement of a diseased hip or knee can provide significant pain relief and considerable improvement in a patient's functional status and quality of life.[2] Osteoarthritis is the most common cause of joint damage resulting in the need for total hip and total knee replacements. In view of the potential for excellent outcomes following total joint replacement surgeries, these procedures will likely continue to increase in most developed countries as technologies advance and populations age.[3] The number of these procedures carried out each year will be influenced by several factors, including the need for these surgeries and access to health services.

Are we meeting the needs? "Orthopaedic surgeons in Canada are faced with an increasing demand to perform more joint replacement surgeries with less resources", says Dr. Robert Bourne, orthopaedic surgeon at the London Health Sciences Centre and Medical Director of the Ontario Joint Replacement Registry.

Determining the optimal rate for total hip and total knee replacement surgery for regions within Canada requires further research and analysis. The CJRR will be able to provide much of the information required to address this issue. Published estimates vary widely. For example, a recent article published in the Canadian Medical Association Journal included an estimate of the population requirement for total hip replacements in Ontario.[4] The authors concluded that the current need for total hip replacements far exceeds the supply. They report an incident requirement rate of 223 per 100,000 population based on the number of people in Ontario requiring a total hip replacement for their hip pain in 1996. The crude rate of total hip replacements in Ontario for 1999/2000 was 73 per 100,000 population, well below the suggested requirement rate cited in the article. However, the Swedish Total Hip Replacement Register cites a much lower recommended rate of 130 per 100,000 population to meet the needs for total hip replacement procedures and eliminate wait times in Sweden.[5] By comparison in 1999/2000, the crude rate for total hip replacements in Canada was 65 per 100,000 population. As shown later in this report, no countries report total hip replacement rates that meet either of the 'optimal' targets described above.

Over time, the CJRR data will be analyzed to develop a better understanding of the complex relationships between the population-based need for these surgeries, access to services, appropriate wait times and patient outcomes. This information will then be used to provide a more refined understanding of the relationship between the provision of total joint replacement surgery and the health of the population.

Canadian Joint Replacement Registry

Description

The CJRR is a national registry that collects information on patient outcomes and revisions following total hip and total knee replacement procedures performed in Canada. The registry was officially launched at the Canadian Orthopaedic Association annual meeting in June 2000 and has been receiving detailed operative data since May 2001. The CJRR was modelled after the Swedish hip and knee registries, which have been operational since 1975 and 1979, respectively.

The registry is managed by the Canadian Institute for Health Information (CIHI) which obtains important advice from the orthopaedic surgeons and other experts from across Canada who participate on CJRR's Advisory Committee and Research and Development Subcommittee.

Prior to surgery, patients are asked to provide consent to include their surgical data in the CJRR. CJRR only receives data on those patients who provided their consent. Once written patient consent is obtained, the surgeon and/or operating room staff completes a two page data collection form that captures information on patient demographics, the type of replacement, reason for replacement, surgical approach, fixation mode, implant types, antibiotic use, deep vein thrombosis prophylaxis and operating room environment. With the exception of Ontario, the data collection forms are sent directly to CIHI in a confidential and secure manner where data verification and data entry are completed. The detailed joint replacement data are then linked with clinical and administrative hospital data held at CIHI, namely the Discharge Abstract Database and Hospital Morbidity Database.

At the time of this publication, only the province of Ontario has a separate joint replacement registry, the Ontario Joint Replacement Registry (OJRR). Orthopaedic surgeons in Ontario participate in the CJRR through their participation in the OJRR. In Ontario, an expanded list of data elements is collected by orthopaedic surgeons using hand-held computers in the operating room and is then submitted electronically to OJRR. A subset of the Ontario surgical data, which corresponds to the CJRR, is then sent electronically to CIHI for inclusion in the CJRR. As described above, surgeons in all other provinces submit their operative data directly to CIHI. The flow of data into the CJRR is shown in Figure 1 for both the non-provincial and provincial models.

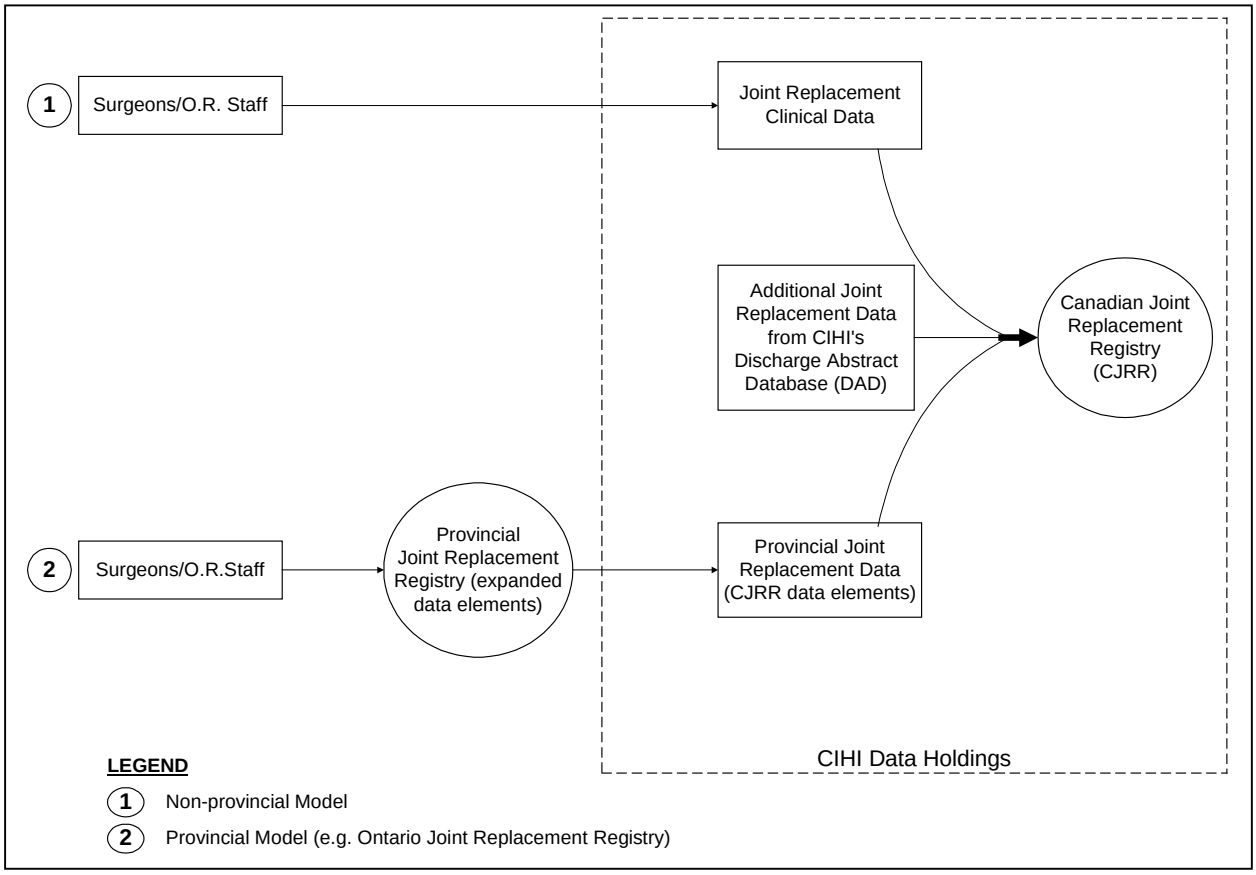


Figure 1. Canadian Joint Replacement Registry (CJRR) Dataflow

The CJRR is a valuable resource for orthopaedic surgeons committed to proactive quality improvement and performance measurement. Participation by orthopaedic surgeons in the CJRR is voluntary and has increased consistently since CJRR started receiving data from surgeons in May 2001. Participating surgeons receive many benefits by participating in the CJRR, including annual reports, special topic reports and feedback on their performance compared to their peers. As an added incentive to participate, surgeons can earn credits towards their Maintenance of Certification (MOC) requirements by participating in the CJRR and reviewing their data compared to their peers. The CJRR will also be a useful resource for health services research studies, policy development and regional planning initiatives. Over the short and long term, the CJRR will provide a wealth of relevant information that can be used to monitor and improve the quality of these increasingly important procedures.

The privacy and confidentiality of patients and surgeons is assured by CIHI's adherence to its rigorous privacy, confidentiality and security policies. CIHI's privacy practices meet federal, provincial and territorial requirements and CIHI is recognized as an experienced and reliable custodian of numerous registries and databases.

Why a National Joint Replacement Registry?

The CJRR will provide the information necessary to measure and improve the performance of total joint replacement surgeries in Canada. Current data sources are not adequate for this purpose. For example, coding of total hip and total knee replacement procedures across Canada does not adequately distinguish between primary and revision surgeries at the present time. Consequently, the proportion of replacements that are revisions, the revision rate, and the reasons for revision cannot readily be determined from existing data sources. In addition, detailed surgical information on the replacement type or procedure is not available. For example, information on fixation modes, surgical approach and implant type is not collected on an ongoing systematic basis.

Data from CJRR's pilot studies indicate that 10–12% of patients may eventually require a subsequent revision as a result of implant wear, loosening or breakage. By comparison, the revision rate for cemented hip implants in Sweden is 7% and that for uncemented implants is 13%. In Sweden, the cemented implant is the predominant type of replacement used for total hip replacements, accounting for 93% of the cases. In the past 5 years, only 8–9% of hip replacements have been revisions.[5] The Swedish Total Hip Register has proven effective in increasing awareness in the orthopaedic community of the risks associated with new implant technologies by identifying optimal surgical techniques and inferior orthopaedic prostheses. The CJRR captures revision surgeries and reasons for revision, and follows joint replacement recipients over time to monitor their outcomes. Therefore, the CJRR can be used to calculate accurate revision rates and to identify the most common reasons for revisions. Through focused analyses of revisions, reasons for revisions and other factors related to the patient, to the implant and to the surgical technique, risk factors that predict revisions can be identified, which in turn, may contribute to decreasing the number of revisions and improving other patient outcomes.

Health Canada has a process in place for the evaluation and approval of medical devices prior to their release in the field. However, post-market surveillance of medical implants and new technologies is largely lacking in Canada. Longitudinal follow-up of joint replacement recipients registered in the CJRR will help delineate the reasons for, and variables affecting implant survival, thus providing an effective mechanism for post-market surveillance of orthopaedic implants. In 1996, the British Medical Journal called for the development of a national arthroplasty registry in the UK and identified it as the best method for assessing orthopaedic implants.[6] The author argues that a minimum follow-up of 10 years is usually required to ascertain the effectiveness of an implant. With the exception of the Charnley low friction arthroplasty, no other prosthesis has had a long-term follow-up in the UK. The UK National Joint Replacement Registry is now in the consultative stages of development. CJRR will provide key information on the post-market performance of various implants.

The CJRR will provide a steady flow of new and necessary information to inform treatment, policy and planning decisions associated with these surgeries. CJRR will also serve as a valuable model for other pan-Canadian initiatives undertaking post-market surveillance or attempting to improve patient outcomes.

Benefits of CJRR

With over 42,000 total joint replacements performed annually in Canada, the CJRR will quickly become one of the largest joint replacement registries in the world and have the statistical power to address key questions by following joint replacement recipients over time. The large number of patients included in the registry will allow for the sub-group analyses and comparisons that are essential to measuring clinical and implant performance in a real-world setting. The CJRR will also provide important information on trends as well as provincial and regional variations in procedure rates, lengths of stay, readmissions, in-hospital mortality and other clinical interventions while in hospital, such as blood transfusions. This information will provide decision-makers with the information required for evidence-based decision-making.

Patient Benefits

The ultimate goal of the CJRR is to improve the quality of care and clinical outcomes of total joint replacement recipients in Canada. Lowering the risk of revision through optimal surgical techniques and effective orthopaedic implants is one way CJRR can result in better patient care and surgical outcomes. In future years, CJRR will also be measuring patient wait times, functional status following surgery, and patient satisfaction.

Surgeon Benefits

Surgeons participating in the registry will receive regular feedback and comparative reports and analyses. These reports will be a relevant source of information for policy, planning and quality of care decision-making. The CJRR information will also enable participating surgeons to engage in quality improvement and performance measurement initiatives with their colleagues practicing across the country. Over time, the CJRR will be able to provide information to surgeons for use in evidence-based decision-making with respect to patient prioritization, surgical technique and implant selection, all of which should lead to improvements in the quality of total hip and total knee replacement surgery.

"The CJRR has the capacity to detect inferior implants as early as possible and communicate the results to the orthopaedic community in a timely fashion", says Dr. Cecil Rorabeck at the London Health Sciences Centre and past president of the Canadian Orthopaedic Association.

Participating surgeons can also earn Continuing Professional Development (CPD) credits towards their Maintenance of Certification (MOC) requirements by submitting operative data to the CJRR and reviewing regular CJRR feedback reports. The CJRR team at CIHI provides surgeons with regular updates on the number of credits earned through their participation in the CJRR. This benefit aids surgeons in the process of meeting the mandatory MOC requirements set by the Royal College of Physicians and Surgeons of Canada. The CJRR team is also exploring other benefits to surgeons who participate, such as the ability to participate in on-line professional learning activities, namely journal clubs.

Benefits for the Health Care System

The CJRR will be a key source of information for policy-makers, planners and health care providers engaged in meeting the need for high quality total hip and total knee replacement surgeries. Data on the regional variations in the need for, access to, and quality of these procedures will be available from the CJRR to inform decision-making. Information from the CJRR will also be useful in the development of evidence-based practice guidelines for total hip and total knee replacement surgeries in Canada. The application of these evidence-based practices will improve the outcomes of these surgeries through a decrease in subsequent morbidity among joint replacement recipients and will provide system-wide cost savings.

Participation in the CJRR

Participation in the CJRR has been steadily increasing since orthopaedic surgeons began submitting operative data in May 2001. Between May 2001 and December 19, 2001, 139 surgeons started participating in the CJRR either directly or through the Ontario Joint Replacement Registry (OJRR). These surgeons represent an estimated 30% of the CJRR eligible orthopaedic surgeons in Canada (excluding Ontario). Furthermore, their annual volumes represent 46% of the total hip and total knee replacements performed in Canada (excluding Ontario) annually. Orthopaedic surgeons in Ontario submit their data to the OJRR, which are then electronically forwarded to CJRR. The OJRR has achieved an impressive participation rate of 97% in the regions where the OJRR has completed its roll out. As shown in Table 2, participation in the CJRR varies by province, with New Brunswick, Newfoundland and Ontario having the highest participation rates.

Table 2. Participation in the Canadian Joint Replacement Registry as of December 21, 2001

Province	Surgeons signed up to participate	Estimated number of surgeons[2]	% Surgeons participating	1999/2000 procedures	Total Hip Replacements[3]	Total Knee Replacements[3]	Total	% Total procedures
British Columbia	34	99	34.3	5,856	1,381	1,375	2,756	47.1
Alberta	14	53	26.4	4,148	533	807	1,340	32.3
Saskatchewan	10	20	50.0	1,735	578	578	1,156	66.6
Manitoba	11	27	40.7	2,252	381	456	837	37.2
Quebec	38	201	18.9	5,707	1,021	1,150	2,171	38.0
Nova Scotia	8	26	30.8	1,871	475	555	1,030	55.1
Newfoundland	9	11	81.8	401	212	230	442	N/A
Prince Edward Island	0	4	0.0	188	-	-	-	-
New Brunswick	14	25	56.0	1,227	411	540	951	77.5
Northwest Territories	∫	∫	∫	34	∫	∫	∫	∫
Nunavut	N/A	0	N/A	-	-	-	-	N/A
Yukon	N/A	0	N/A	-	-	-	-	N/A
Subtotal[1]	**139**	**468**	**29.7**	**23,419**	**5,002**	**5,711**	**10,713**	**45.7**
Ontario[1]	31	32	96.9	N/A	N/A	N/A	N/A	N/A
TOTAL	**170**	**500**	**34.0**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**

[1] Ontario surgeons participate in the CJRR through the OJRR. The OJRR is implemented in a step-wise fashion across Ontario. At the present time, the OJRR has been fully implemented in the Southwest region only and has begun implementation in South Central and Central West regions. Other regions will follow.
[2] Number of surgeons who perform total hip and total knee replacements is not known. This list will be updated as new information becomes available.
[3] Estimated number of total hip and total knee replacements performed each year by surgeons who have agreed to participate in the CJRR.
∫ Numbers are too small.

CJRR provincial representatives and numerous site leaders have been instrumental in promoting the benefits of the registry and, by extension, increasing surgeon participation and commitment for submitting operative data to the CJRR in their respective provinces. The commitment and efforts of these orthopaedic surgeons will continue to be an important influence on CJRR participation rates and the continued success of CJRR.

Methodology and Limitations

Data Sources

Data presented in this report were extracted from CIHI's Hospital Morbidity and Discharge Abstract Databases. The majority of the analyses are based on data from the Hospital Morbidity Database to provide national coverage. Detailed surgical and prostheses data are excluded from the present report as this information is not available from these data sources. A supplemental report with a focus on operative and orthopaedic implant information is planned for the fall of 2002. Information for this supplemental report will be derived from data collected by the CJRR.

Hospital Morbidity Database

The Hospital Morbidity Database provides the number of discharges (including deaths) from a hospital by primary diagnosis and contains all acute care discharges in Canada. This database contains a number of different clinical and demographic data, such as, primary diagnosis, operation, admission date, discharge condition, total days of stay, and age and sex of the patient.

Data are received from general and allied special hospitals, including acute care, convalescence and chronic facilities (with the exception of Ontario) and are downloaded from the Discharge Abstract Database (DAD) for those provinces participating in DAD. Data for the remaining hospitals are submitted separately by the corresponding provinces or territories. Although the Hospital Morbidity Database contains fewer data elements than DAD, it captures 100% of acute care discharges for Canada.

The collection and publication of national hospital morbidity (disease) statistics began in 1960. Beginning in 1994/1995, CIHI assumed responsibility for data collection, processing and editing. Statistics Canada retains the historical series from 1960 to 1994/1995.

Discharge Abstract Database

The Discharge Abstract Database (DAD) was originally developed in 1963 to collect data on hospital discharges in Ontario. Over time, it has expanded to provide national coverage. The database, in its present form contains data from fiscal year 1979/1980 to 2000/01.

This database contains demographic, administrative and clinical data for hospital discharges, including inpatient acute, chronic, rehabilitation as well as day surgeries. CIHI receives data directly from participating hospitals, which represent about 85% of all hospital inpatient discharges in Canada.

Statistics Canada

For the calculation of rates, national and provincial fiscal estimates (October 1) are used. These are special order tabulations provided by the Demography Division, Statistics Canada.

Data Elements and Data Analysis

Joint replacements in this report include total hip and total knee replacements captured through hospital discharge abstracts in Canada. Total hip replacement includes *total hip replacement with methyl methacrylate* and *other total hip replacement*, which correspond to ICD-9-CCP[1] codes 93.51 and 93.59, respectively. Total knee replacement includes *geomedic total knee replacement* and *polycentric total knee replacement* and corresponds to ICD-9-CCP code 93.41.

These codes include both primary and revision procedures as well as elective and emergency surgeries. The estimated proportion of total hip replacements and total knee replacements that consist of emergency procedures is 6% and 1%, respectively. As of April 1, 2000, health care facilities were asked to use a separate CCP code for revisions. This has not been consistently and uniformly implemented in all health care facilities across Canada at this time. Although it is possible to separate primary replacements from revisions by examining the main diagnosis associated with the procedure, this method has limitations ranging from coding errors, in general, to provincial variations in coding, in particular.

Cancelled surgeries are excluded for 1998/1999 and 1999/2000 only. The proportion of cancelled total hip replacements is estimated between 0.7% and 0.8% annually. Similarly, 0.6% to 0.7% total knee replacement surgeries are cancelled on an annual basis. Cancelled surgeries include only those for which an admission has occurred.

The number of procedures does not always equal the number of patients since an individual may undergo a bilateral replacement. In this situation, one patient contributes a count of two procedures. Unless otherwise indicated, the analyses are carried out based on the number of procedures.

In calculating the rates of total hip and total knee replacements, the numerator is based on the number of procedures according to where the patient lives and not where the procedure was performed. Patient residence is reported at the provincial level. Patients with unknown or invalid residence codes were excluded from rate calculations.

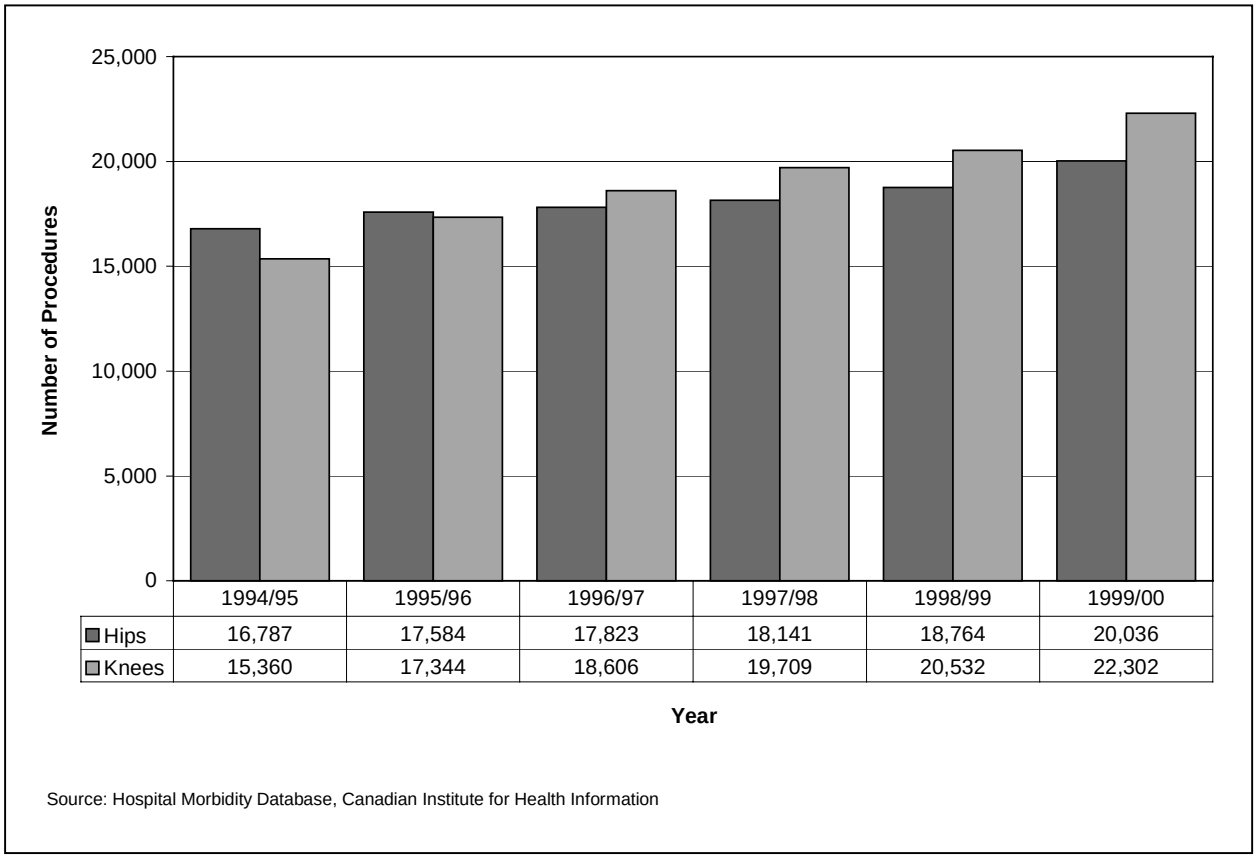
[1] International Classification of Diseases, 9th Revision—Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures

Unless otherwise indicated, rates are adjusted for age and reported separately for men and women. Age-standardization is a statistical method employed to adjust rates for the effect of differences in the age structures of populations being compared. It is generally recommended that age-standardized rates be used for examining trends over time and for comparing rates across populations. After adjusting for age, any differences in rates are due to factors other than age. For example, differences between age-standardized rates of total hip and total knee replacements are caused by factors other than the differences in the age structures of the populations being compared. Sex-specific age-standardized rates are reported to highlight the differences in total hip and total knee replacement rates between men and women.

Results

Trends in Total Hip and Total Knee Replacements in Canada

There were 42,338 total hip and total knee replacements performed in Canada in 1999/2000, up 32% from the 32,147 procedures performed in 1994/1995 (Figure 2). This increase is consistent with that observed in the United States. According to the American Academy of Orthopaedic Surgeons, primary total hip and total knee replacements increased from 277,000 in 1991 to 383,000 in 1996, representing a 38% increase in these procedures.[1]



	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00
Hips	16,787	17,584	17,823	18,141	18,764	20,036
Knees	15,360	17,344	18,606	19,709	20,532	22,302

Source: Hospital Morbidity Database, Canadian Institute for Health Information

Figure 2. Number of Total Hip and Total Knee Replacement Procedures Performed in Canada, 1994/1995 to 1999/2000

There has been a shift in the proportion of total knee replacements compared to total hip replacements in Canada since 1994/1995. In 1994/1995, the majority of procedures were total hip replacements (52%) followed closely by total knee replacements (48%). By 1999/2000, these numbers were reversed to 53% for total knee replacements and 47% for total hip replacements, reflecting the more rapid increase in total knee replacements since 1994/1995. For example, there was a 45% increase in total knee replacements compared with a 19% increase in total hip replacements from 1994/1995 to 1999/2000. Similar increases were observed in the United States where total hip replacements increased by 18% and total knee replacements increased by 53% between 1991 and 1996.[1]

The increase in the number of procedures varied by province/territory for both total hip and total knee replacements, as shown in Table 3 and Table 4. Although variations exist, an increase in the number of procedures is generally observed in each province/territory. Among the provinces, the largest percentage increase is observed in Manitoba where total hip replacements increased by 46% and total knee replacement procedures more than doubled (up 111%) between 1994/1995 and 1999/2000.

Table 3. Number of Total Hip Replacement Procedures Performed in Canada Based on Patient Residence, 1994/1995 and 1999/2000

Province	Total Hip Replacement 1994/1995	Total Hip Replacement 1999/2000	Percentage change
Newfoundland	203[2]	201	- 1.0%
Prince Edward Island	104	104	0.0%
Nova Scotia	734	825	+ 12.4%
New Brunswick	429	511	+ 19.1%
Quebec	2,527	2,979	+ 17.9%
Ontario	6,988	8,433	+ 20.7%
Manitoba	664	967	+ 45.6%
Saskatchewan	821	861	+ 4.9%
Alberta	1,786	1,992	+ 11.5%
British Columbia	2,383	2,931	+ 23.0%
Northwest Territories	1	14	+ 1300.0%[4]
Yukon and Nunavut	8	13	+ 62.5%[4]
Unknown[1]	199[2]	205	--
CANADA	**16,787[3]**	**20,036**	+ **19.3%**

[1] Includes both Canadian and non-Canadian residents.
[2] For Newfoundland and patients with unknown residence, 1995/1996 numbers are used; 1994/1995 data is incomplete.
[3] Total does not add up because 1995/1996 numbers used for Newfoundland and patients with unknown residence.
[4] Percent change should be interpreted with caution as it is based on small numbers.

Source: Hospital Morbidity Database, Canadian Institute for Health Information

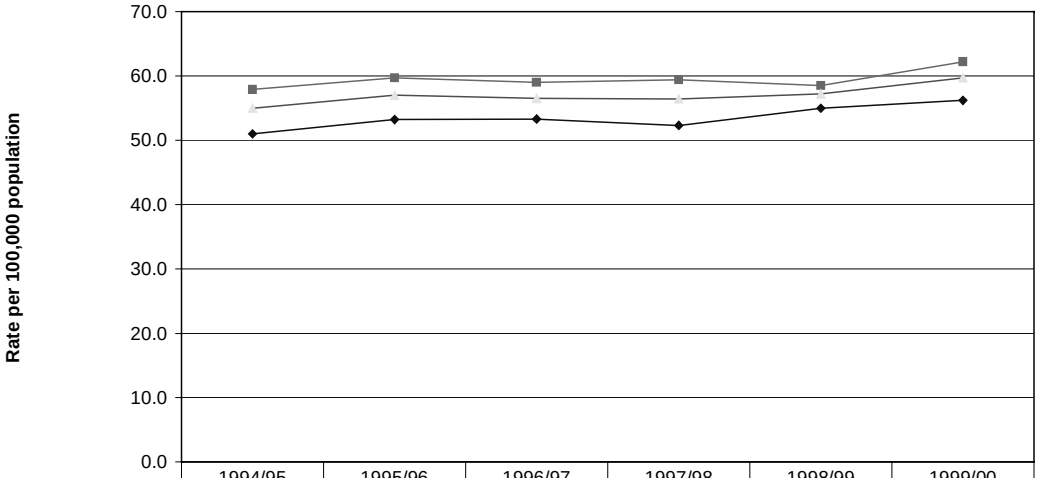
Table 4. Number of Total Knee Replacement Procedures Performed in Canada Based on Patient Residence, 1994/1995 and 1999/2000

Province	Total Knee Replacement 1994/1995	Total Knee Replacement 1999/2000	Percentage change
Newfoundland	175[2]	198	+ 13.1%
Prince Edward Island	88	104	+ 18.2%
Nova Scotia	679	1,039	+ 53.0%
New Brunswick	402	643	+ 59.9%
Quebec	2,146	2,796	+ 30.3%
Ontario	6,839	10,220	+ 49.4%
Manitoba	578	1,217	+ 110.6%
Saskatchewan	840	870	+ 3.6%
Alberta	1,587	1,984	+ 25.0%
British Columbia	1,875	2,970	+ 58.4%
Northwest Territories	*2*	17	+ 750.0%[4]
Yukon and Nunavut	4	30	+ 650.0%[4]
Unknown[1]	176[2]	214	--
CANADA	**15,360[3]**	**22,302**	+ **45.2%**

[1] Includes both Canadian and non-Canadian residents.
[2] For Newfoundland and patients with unknown residence, 1995/1996 numbers are used; 1994/1995 data is incomplete.
[3] Total does not add up because 1995/1996 numbers used for Newfoundland and patients with unknown residence.
[4] Percent change should be interpreted with caution as it is based on small numbers.

Source: Hospital Morbidity Database, Canadian Institute for Health Information

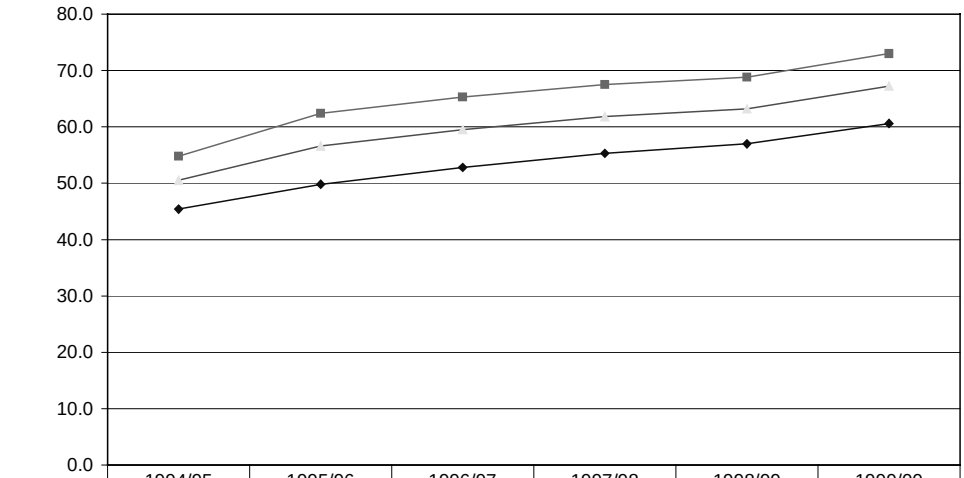
The age-standardized rates for total hip and total knee replacements also increased from 1994/1995 to 1999/2000. Figure 3 shows the age-standardized rates for total hip replacement procedures in Canada from 1994/1995 to 1999/2000. A steady rise is evident for men, women and both sexes combined. The increase is more marked in the case of total knee replacements, as seen in Figure 4. Women are more likely to undergo both types of procedures than were men.



	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00
Males	51.0	53.2	53.3	52.3	55.0	56.2
Females	57.9	59.7	59.0	59.4	58.5	62.2
Both Sexes	55.0	57.0	56.5	56.4	57.2	59.7

Rates calculated based on patients' residence. Patients with unknown residence excluded.
Source: Hospital Morbidity Database, Canadian Institute for Health Information

Figure 3. Age-Standardized Rates (per 100,000 population) by Sex for Total Hip Replacement Procedures, Canada, 1994/1995 to 1999/2000



	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00
Males	45.4	49.8	52.8	55.3	57.0	60.6
Females	54.8	62.4	65.3	67.5	68.8	73.0
Both Sexes	50.5	56.6	59.5	61.8	63.2	67.2

Rates calculated based on patients' residence. Patients with unknown residence excluded.
Source: Hospital Morbidity Database, Canadian Institute for Health Information

Figure 4. Age-Standardized Rates (per 100,000 population) by Sex for Total Knee Replacement Procedures, Canada, 1994/1995 to 1999/2000

Similar to the increases in absolute numbers of total hip and total knee replacement surgeries, Manitoba also experienced the greatest increase in the age-standardized rates for these procedures during the same period (Table 5 and Table 6). Age-standardized rates for total hip replacement procedures decreased in Newfoundland and Prince Edward Island by 8% and 9%, respectively between 1994/1995 and 1999/2000.

Table 5. Age Standardized Rates of Total Hip Replacement Procedures Performed in Canada Based on Patient Residence, 1994/1995 and 1999/2000

Province	Total Hip Replacement 1994/1995	Total Hip Replacement 1999/2000	Percentage change
Newfoundland	38.5[1]	35.5	- 7.8%
Prince Edward Island	70.9	64.2	- 9.4%
Nova Scotia	72.9	76.4	+ 4.8%
New Brunswick	53.7	60.6	+ 12.8%
Quebec	34.0	36.3	+ 6.8%
Ontario	62.1	67.0	+ 7.9%
Manitoba	53.7	74.9	+ 39.5%
Saskatchewan	69.6	70.3	+ 1.0%
Alberta	77.5	74.3	- 4.1%
British Columbia	59.7	64.6	+ 8.2%
CANADA[2]	**55.0**	**59.7**	**+ 8.5%**

[1] For Newfoundland rates, 1995/1996 numbers are used since 1994/1995 data are incomplete.
[2] Patients with unknown residence are excluded. Yukon, Northwest Territories and Nunavut rates are suppressed due to small numbers but included in national average.

Source: Hospital Morbidity Database, Canadian Institute for Health Information

Table 6. Age Standardized Rates of Total Knee Replacement Procedures Performed in Canada Based on Patient Residence, 1994/1995 and 1999/2000

Province	Total Knee Replacement 1994/1995	Total Knee Replacement 1999/2000	Percentage change
Newfoundland	33.6[1]	35.4	+ 5.4%
Prince Edward Island	61.2	67.0	+ 9.5%
Nova Scotia	67.6	98.7	+ 46.0%
New Brunswick	50.8	77.3	+ 52.2%
Quebec	29.0	34.4	+ 18.6%
Ontario	60.9	81.7	+ 34.1%
Manitoba	46.3	94.8	+ 104.7%
Saskatchewan	70.0	71.8	+ 2.6%
Alberta	70.0	75.8	+ 8.3%
British Columbia	46.9	66.0	+ 40.7%
CANADA[2]	**50.5**	**67.2**	**+ 33.1%**

[1] For Newfoundland rates, 1995/1996 numbers are used since 1994/1995 data are incomplete.
[2] Patients with unknown residence are excluded. Yukon, Northwest Territories and Nunavut rates are suppressed due to small numbers but included in national average.

Source: Hospital Morbidity Database, Canadian Institute for Health Information

Persons 85 years and older experienced the highest percent increase in the number of total hip replacement procedures, with a 55% increase among men and a 51% increase among women (Table 7). This partly reflects the greater number of people over the age of 85 years in 1999/2000 compared to 1994/1995. Similarly, there was a 97% increase in the number of total knee replacements performed on men 85 years of age or older and an 80% increase for women of the same age (Table 8). In considering the change in age-specific rates for total hip replacements over the same period, a consistent but more modest increase is observed for men (25%) and women (22%) 85 years of age or older (Table 9). A similar upward trend is also evident for the age-specific rates for total knee replacement procedures, which showed a 59% increase for men and a 46% increase for women in this age group between 1994/1995 and 1999/2000 (Table 10).

The number of total hip replacement procedures performed on younger Canadians also increased between 1994/1995 and 1999/2000, as evidenced by a 44% increase for women and a 28% increase for men in the 45–54 year age group (Table 7). This trend is more evident in the case of total knee replacements where procedures performed on individuals aged 45–54 years showed a 97% increase for women and a 60% increase for men (Table 8). Similar to the older age groups, the increase in the age-specific rates for total hip and total knee replacements among 45–54 year old individuals is consistent with but less pronounced than the increase in the absolute numbers of these procedures (Table 9 and Table 10).

Table 7. Number of Total Hip Replacement Procedures by Age Group and Sex, Canada 1994/1995 and 1999/2000

Age Groups	Males			Females		
	1994/1995	1999/2000	% Change	1994/1995	1999/2000	% Change
<45 years	489	574	+ 17.4%	475	534	+ 12.4%
45–54 years	716	915	+ 27.8%	630	909	+ 44.3%
55–64 years	1,609	1,761	+ 9.4%	1,659	1,843	+ 11.1%
65–74 years	2,475	2,926	+ 18.2%	3,746	3,867	+ 3.2%
75–84 years	1,470	1,984	+ 35.0%	2,798	3,629	+ 29.7%
85+ years	194	301	+ 55.1%	526	793	+ 50.8%
TOTAL	**6,953**	**8,461**	**+ 21.7%**	**9,834**	**11,575**	**+ 17.7%**

Source: Hospital Morbidity Database, Canadian Institute for Health Information

Table 8. Number of Total Knee Replacement Procedures by Age Group and Sex, Canada 1994/1995 and 1999/2000

Age Groups	Males			Females		
	1994/1995	1999/2000	% Change	1994/1995	1999/2000	% Change
<45 years	104	131	+ 26.0%	155	188	+ 21.3%
45–54 years	282	452	+ 60.3%	397	783	+ 97.2%
55–64 years	1,292	1,871	+ 44.8%	1,684	2,517	+ 49.5%
65–74 years	2,754	3,878	+ 40.8%	4,170	5,318	+ 27.5%
75–84 years	1,564	2,396	+ 53.2%	2,597	4,097	+ 57.8%
85+ years	117	231	+ 97.4%	244	440	+ 80.3%
TOTAL	**6,113**	**8,959**	**+ 46.6%**	**9,247**	**13,343**	**+ 44.3%**

Source: Hospital Morbidity Database, Canadian Institute for Health Information

Table 9. Age-specific Rates (per 100,000 population) of Total Hip Replacement Procedures by Sex, Canada 1994/1995 and 1999/2000

Age Groups	Males			Females		
	1994/1995	1999/2000	% Change	1994/1995	1999/2000	% Change
<45 years	4.9	5.7	+ 16.3%	4.9	5.5	+ 12.2%
45–54 years	40.8	43.5	+ 6.6%	35.9	42.9	+ 19.5%
55–64 years	131.1	131.0	- 0.1%	131.8	132.8	+ 0.8%
65–74 years	267.5	295.5	+ 10.5%	335.8	340.9	+ 1.5%
75–84 years	353.2	400.2	+ 13.3%	434.0	480.2	+ 10.6%
85+ years	205.0	255.5	+ 24.6%	236.6	289.0	+ 22.1%
TOTAL	**48.2**	**55.9**	**+ 16.0%**	**66.9**	**75.0**	**+ 12.1%**

Source: Hospital Morbidity Database, Canadian Institute for Health Information

Table 10. Age-specific Rates (per 100,000 population) of Total Knee Replacement Procedures by Sex, Canada 1994/1995 and 1999/2000

Age Groups	Males			Females		
	1994/1995	1999/2000	% Change	1994/1995	1999/2000	% Change
<45 years	1.0	1.3	+ 30.0%[1]	1.6	1.9	+ 18.7%[1]
45–54 years	16.1	21.5	+ 33.5%	22.6	37.0	+ 63.7%
55–64 years	105.3	139.2	+ 32.2%	133.8	181.4	+ 35.6%
65–74 years	297.6	391.7	+ 31.6%	373.8	468.8	+ 25.4%
75–84 years	375.8	483.3	+ 28.6%	402.9	542.1	+ 34.5%
85+ years	123.6	196.0	+ 58.6%	109.7	160.4	+ 46.2%
TOTAL	**42.4**	**59.2**	**39.6%**	**62.9**	**86.4**	**+ 37.4%**

[1] Percent change should be interpreted with caution as it is based on small numbers.

Source: Hospital Morbidity Database, Canadian Institute for Health Information

It is also important to examine the changes in the actual number of total hip and total knee replacements by age group. For example, the 55% increase in the number of total hip replacements performed among men 85 years and older, described above, reflects an increase from 194 procedures to 301 procedures or a total increase of 107 procedures (Table 7). By comparison, the 18% increase in the number of total hip replacements performed among men in the 65–74 age group reflects an increase from 2,475 procedures to 2,926 procedures or a total increase of 451 procedures. This example highlights the importance of reviewing, both, the actual and the percent changes in numbers and age-specific rates for all age-sex and procedure categories when interpreting the changes over time.

Crude rates of total hip and total knee replacement procedures for several countries are presented in Table 11 and Table 12. While Canada has one of the lowest rates of total hip replacements, the rate of total knee replacements falls within the average range. Comparisons of these national crude rates should be done with caution since the rates are not adjusted for differences in the age and sex structures of each country. In addition, with the exception of Sweden, the optimal rates of total hip and total knee replacements have not been estimated for these countries, which makes comparisons even more difficult. Sweden recommends a total hip replacement rate of 130 per 100,000 population to meet the needs for these procedures and eliminate wait times in Sweden.[5] However, this 'optimal' rate cannot be assumed to be applicable in other countries, as there are many factors that influence the population-based need for total hip replacements. The CJRR will contribute key information that will be useful for initiatives attempting to determine appropriate rate ranges for regions and sub-populations within Canada.

Table 11. International Comparison of Crude Rates (per 100,000 population) of Primary Total Hip Replacements[1]

Country	Crude Rate per 100,000	Year	Reference
Australia	74	1999/2000	2001 Annual Report
Finland	93	1999	Acta Orthop Scand 2001;72(5):433-41
New Zealand	119	2000	Personal communication, Toni Hobbs, New Zealand Joint Replacement Register Co-Ordinator, November 2001.
Norway	114 124	1990 2000	Bulletin Hospital Joint Diseases 1999;58(3):139-47 Personal communication, Birgitte Espehaug, Statistician, The Norwegian Arthroplasty Register, December 2001.
Sweden	100	N/A	Acta Orthop Scand 2000;71(2):111-21
United States	52	1996	American Academy of Orthopaedic Surgeons, Musculoskeletal Conditions in the United States. Arthroplasty and Total Joint Procedures. 1999.
Canada	**65**	**1999/2000**	**Canadian Institute for Health Information**

[1] These comparisons do not account for the difference in the age and sex structures of these populations. Only the Canadian rate includes both primary and revision total hip replacements.

Table 12. International Comparison of Crude Rates (per 100,000 population) of Primary Total Knee Replacements[1]

Country	Crude Rate per 100,000	Year	Reference
Australia	81	1999/2000	2001 Annual Report
New Zealand	75	2000	Personal communication, Toni Hobbs, New Zealand Joint Replacement Register Co-Ordinator, November 2001.
Norway	35	2000	Personal communication, Birgitte Espehaug, Statistician, The Norwegian Arthroplasty Register, December 2001.
Sweden	63	1996/1997	Acta Orthop Scand 2000;71(4):378-80
United States	92	1996	American Academy of Orthopaedic Surgeons, Musculoskeletal Conditions in the United States. Arthroplasty and Total Joint Procedures. 1999.
Canada	**72**	**1999/2000**	**Canadian Institute for Health Information**

[1] These comparisons do not account for the difference in the age and sex structures of these populations. Only the Canadian rate includes both primary and revision total knee replacements.

Patient Demographics

The majority of total hip and total knee replacements are performed on individuals 65 years of age and older. The average age of a patient who underwent a total hip replacement in Canada was 68.0 years (69.3 years for women and 66.1 years for men) in 1999/2000. This is nearly identical to Australia, where the average age of a primary total hip replacement recipient is 67.6 years (69.0 years for women and 66.0 years for men).[7] The majority (67%) of Canadian total hip replacement recipients were 65 years or older (Figure 5). In contrast, only 6% of patients who underwent a total hip replacement were younger than 45 years of age.

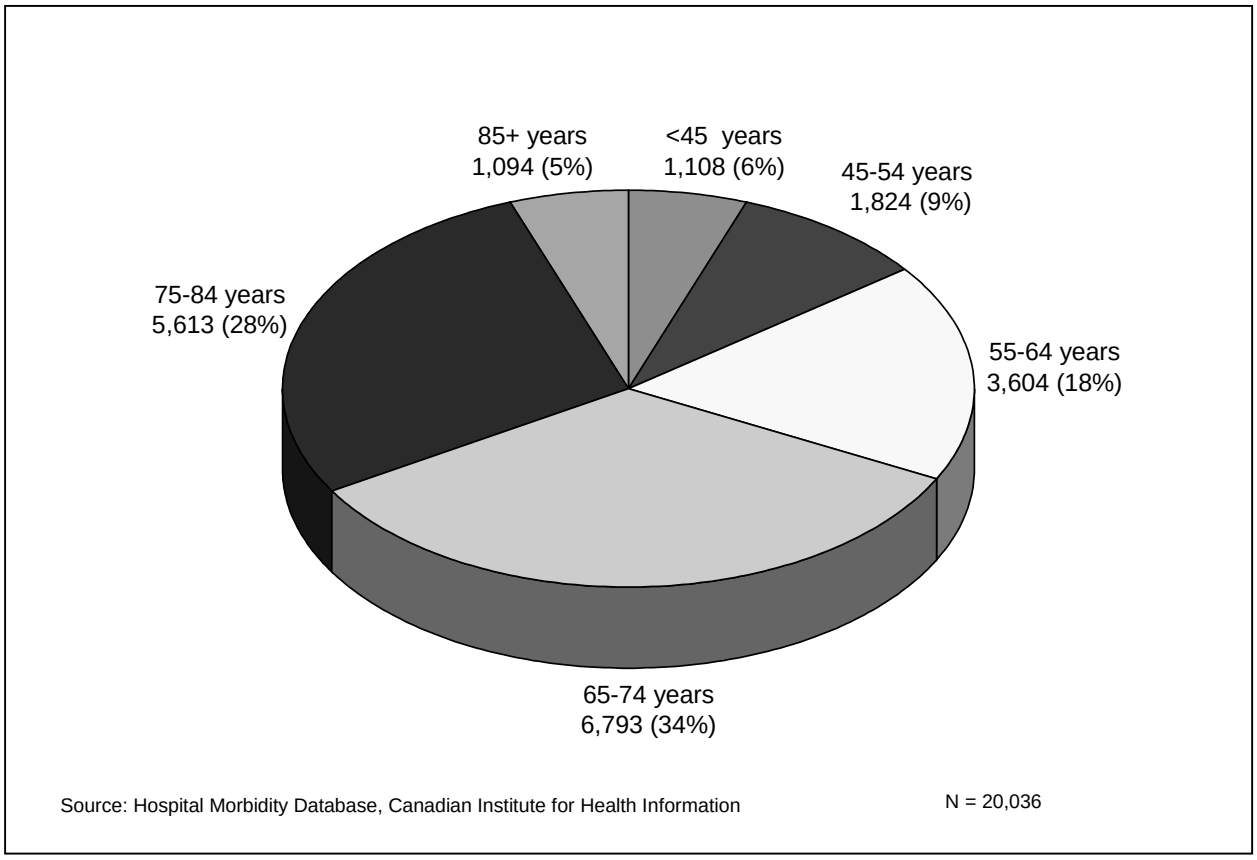


Figure 5. Distribution of Total Hip Replacement Procedures by Patient Age Canada, 1999/2000

Overall, 58% of total hip replacement recipients were women. The ≥65 age group accounted for 71% of the total hip replacements among women and 61% among men. Conversely, the proportion of total hip replacements less than 55 years of age was higher among men (18%) than women (13%) (Figure 6 and Figure 7).

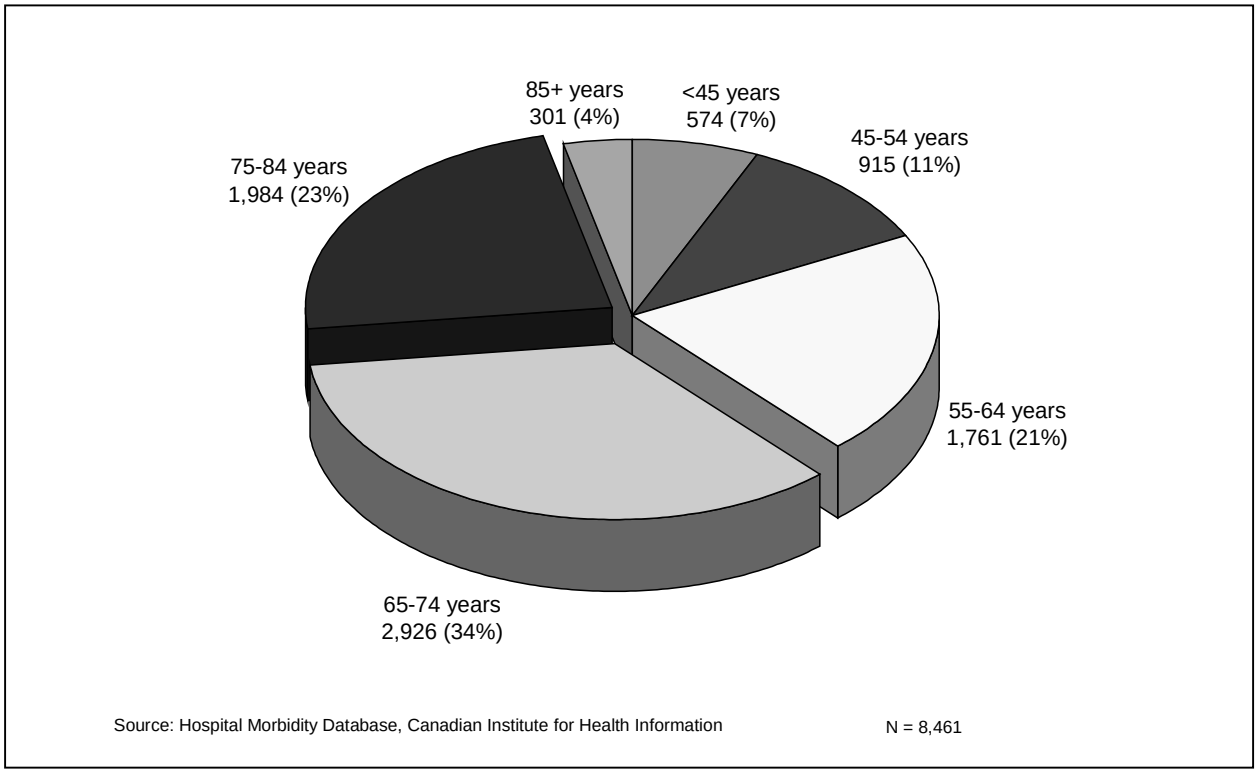


Figure 6. Distribution of Total Hip Replacement Procedures by Patient Age Males, Canada, 1999/2000

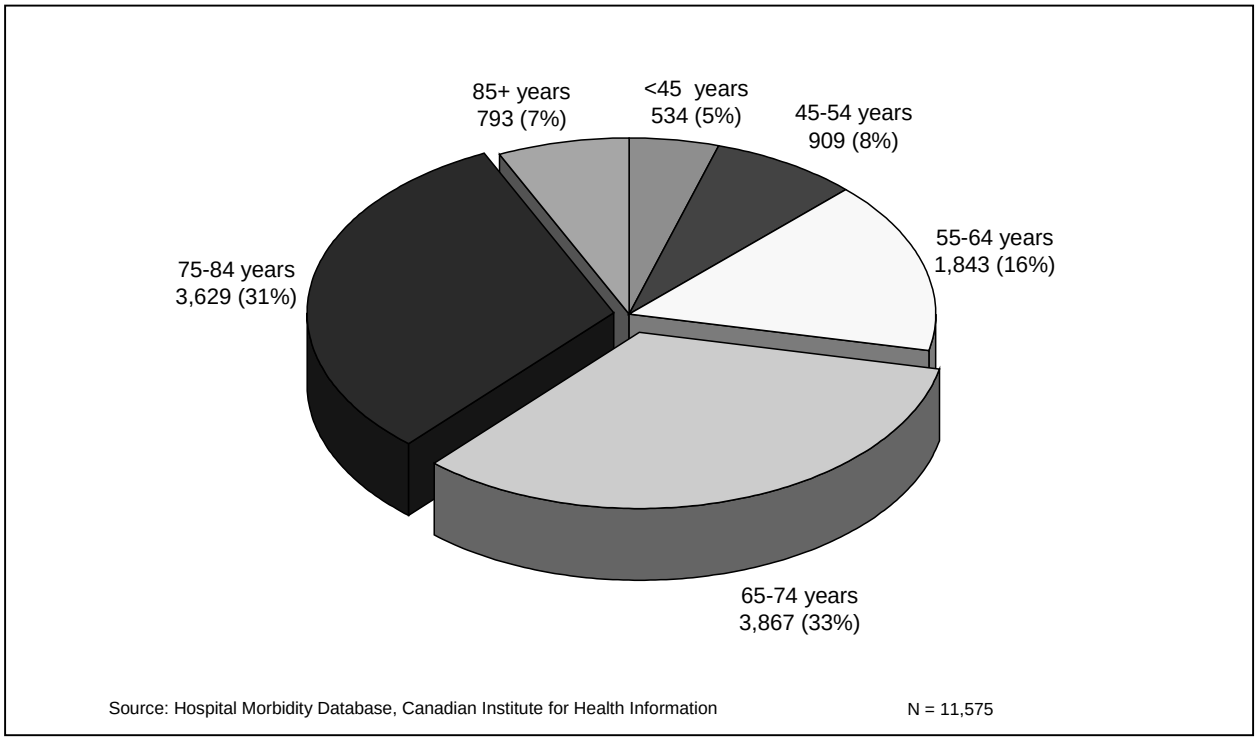


Figure 7. Distribution of Total Hip Replacement Procedures by Patient Age Females, Canada, 1999/2000

Patients receiving a total knee replacement in 1999/2000 were slightly older, on average, than total hip replacement recipients. The average age of a Canadian total knee replacement recipient was 69.5 years (69.7 years for women and 69.2 years for men) in 1999/2000. In Australia, the mean age of a primary total knee replacement patient is 71 years (71.5 women and 70.5 for men).[7]

Patients aged ≥65 years accounted for 83% of the patients receiving a total knee replacement (Figure 8). These procedures were less commonly performed on younger individuals than total hip replacements, with just over 1% of total knee replacement recipients being under the age of 45 years compared to 6% for a total hip replacement.

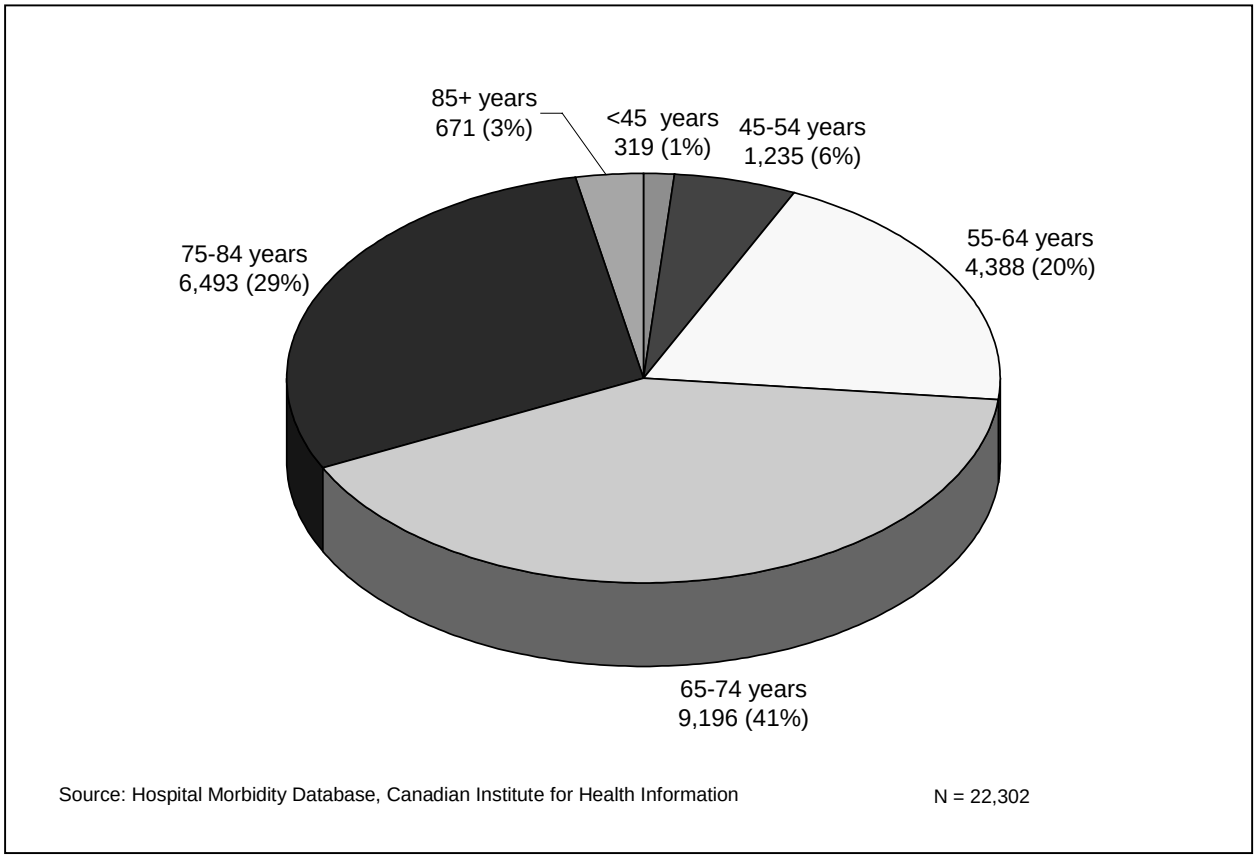


Figure 8. Distribution of Total Knee Replacement Procedures by Patient Age, Canada, 1999/2000

As in the case of total hip replacements, the majority (60%) of total knee replacements were performed on women. In contrast to total hip replacements, however, the age breakdown for total knee replacement procedures is similar for men and women (Figure 9 and Figure 10).

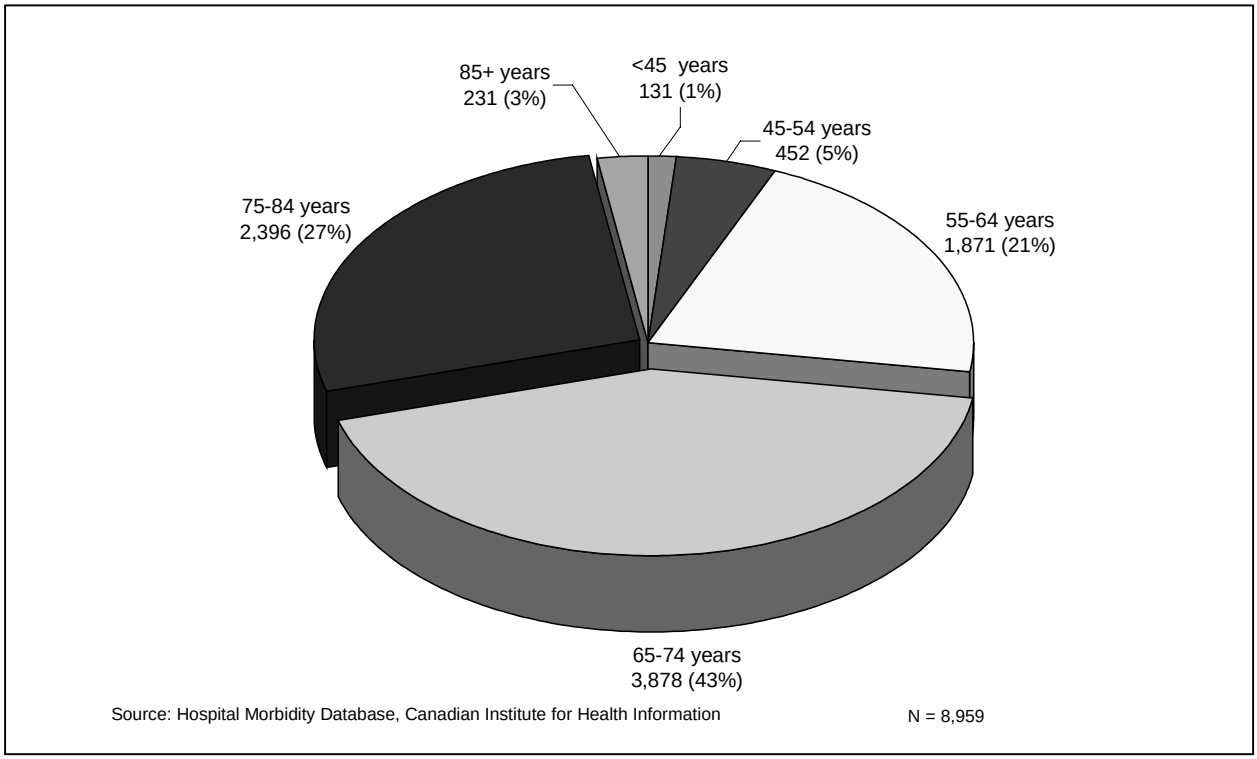


Figure 9. Distribution of Total Knee Replacement Procedures by Patient Age Males, Canada, 1999/2000

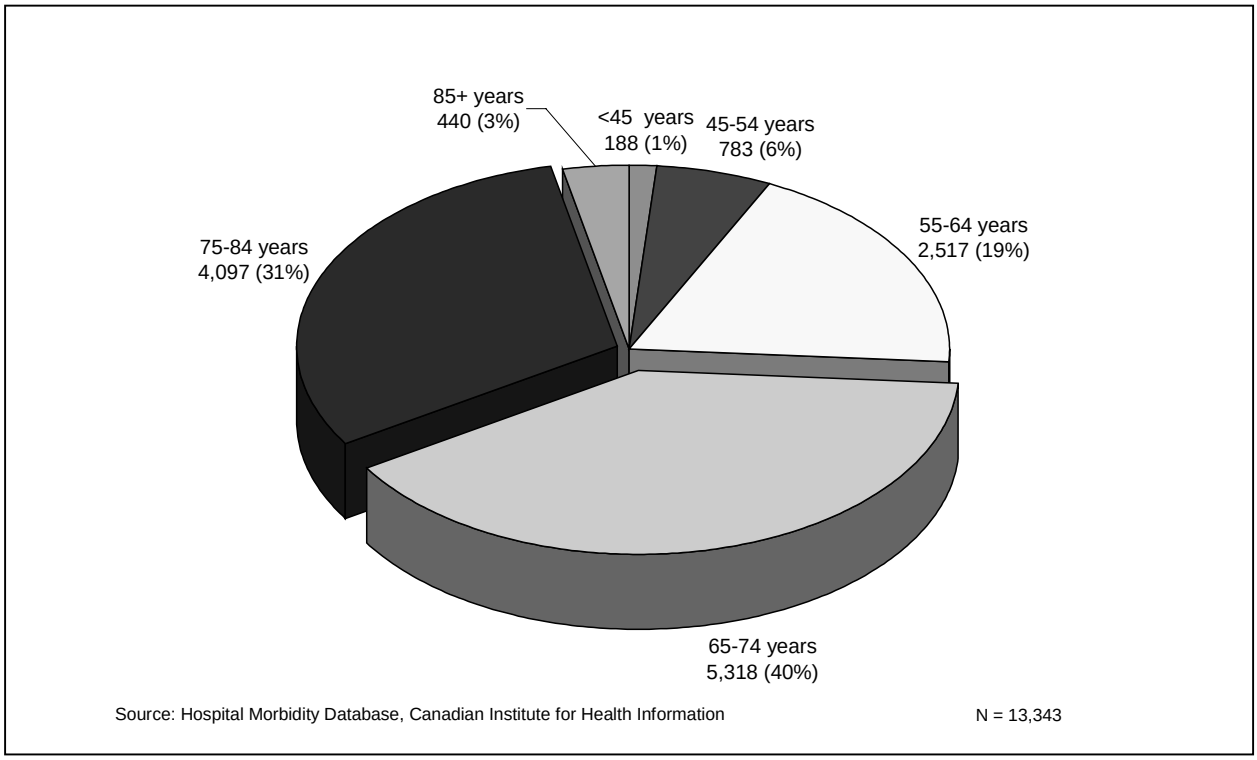
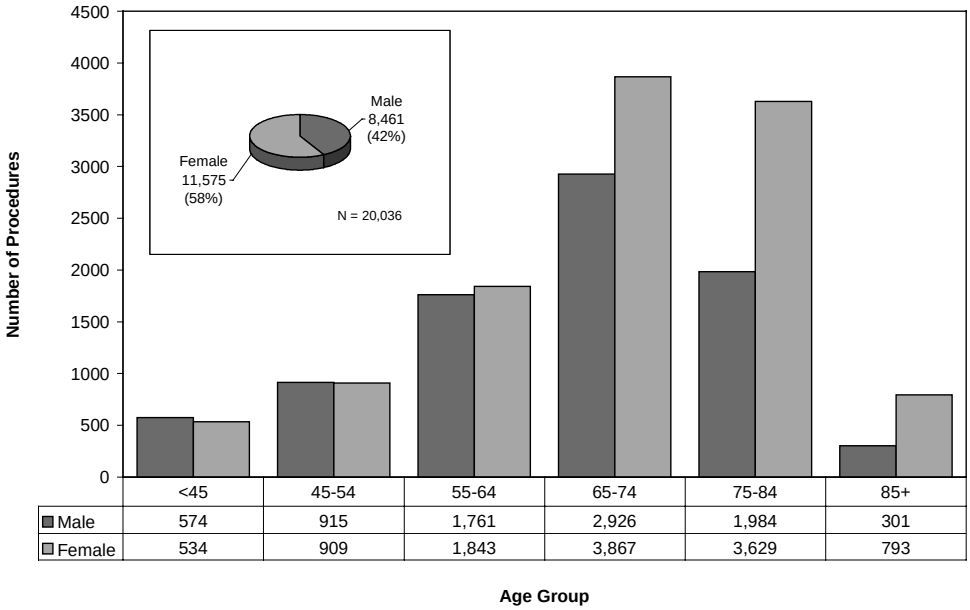


Figure 10. Distribution of Total Knee Replacement Procedures by Patient Age Females, Canada, 1999/2000

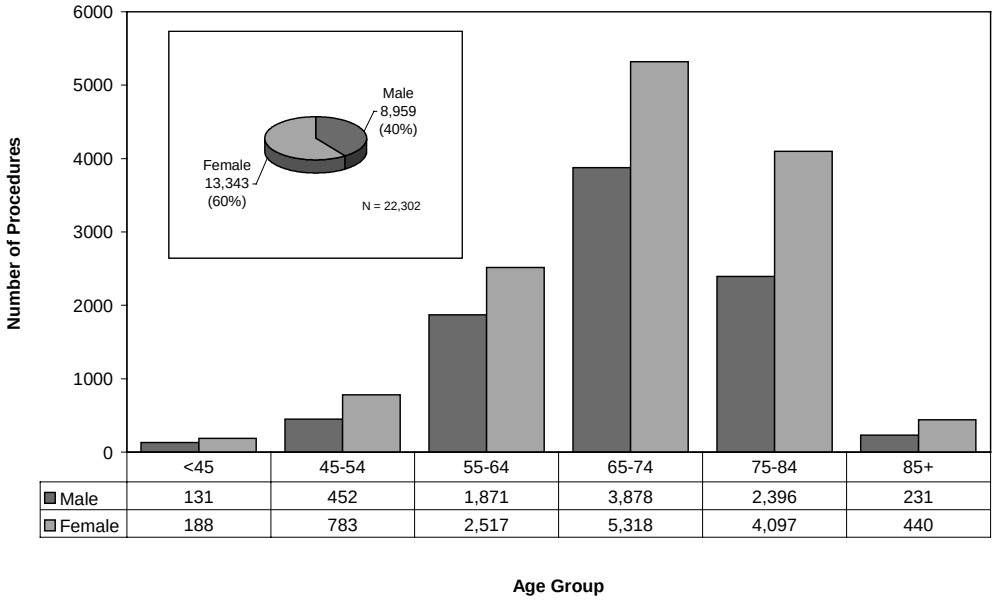
When the absolute number of total hip and total knee replacements are examined by age group and sex, the number of procedures performed on women outnumber men in all age groups except for the <55 age group in the case of total hip replacements (Figures 11 and 12).



	<45	45-54	55-64	65-74	75-84	85+
Male	574	915	1,761	2,926	1,984	301
Female	534	909	1,843	3,867	3,629	793

Source: Morbidity Hospital Database, Canadian Institute for Health Information

Figure 11. Number of Total Hip Replacement Procedures by Age Group and Sex, Canada, 1999/2000



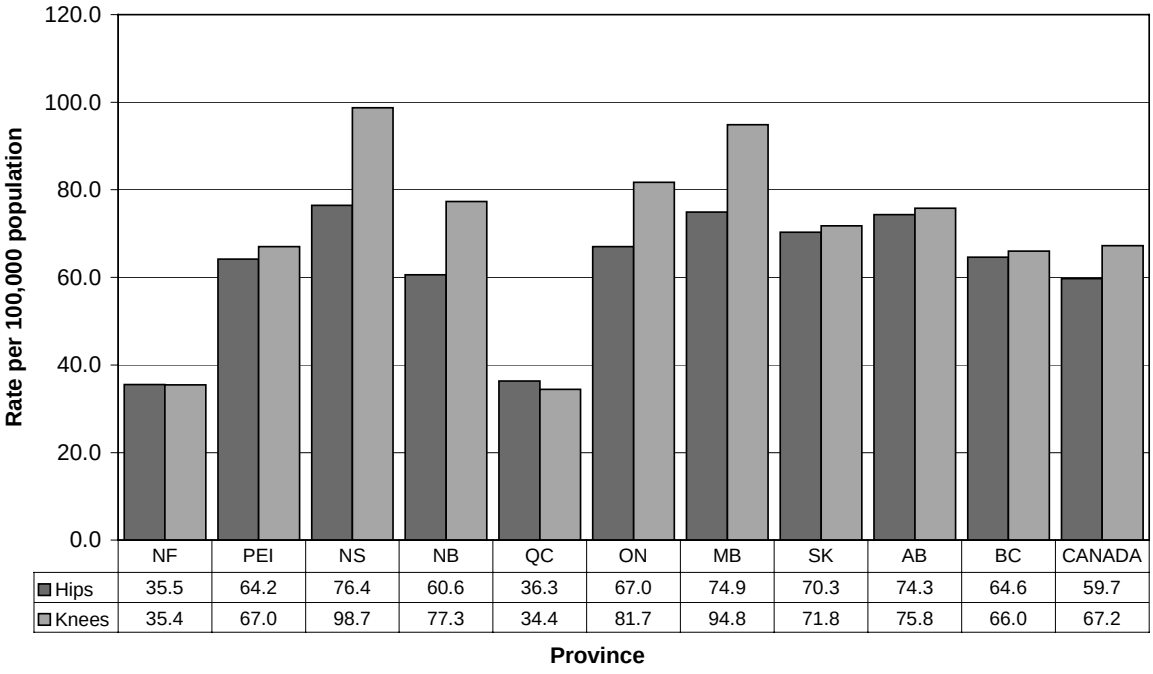
	<45	45-54	55-64	65-74	75-84	85+
Male	131	452	1,871	3,878	2,396	231
Female	188	783	2,517	5,318	4,097	440

Source: Hospital Morbidity Database, Canadian Institute for Health Information

Figure 12. Number of Total Knee Replacement Procedures by Age Group and Sex, Canada, 1999/2000

Provincial Variations

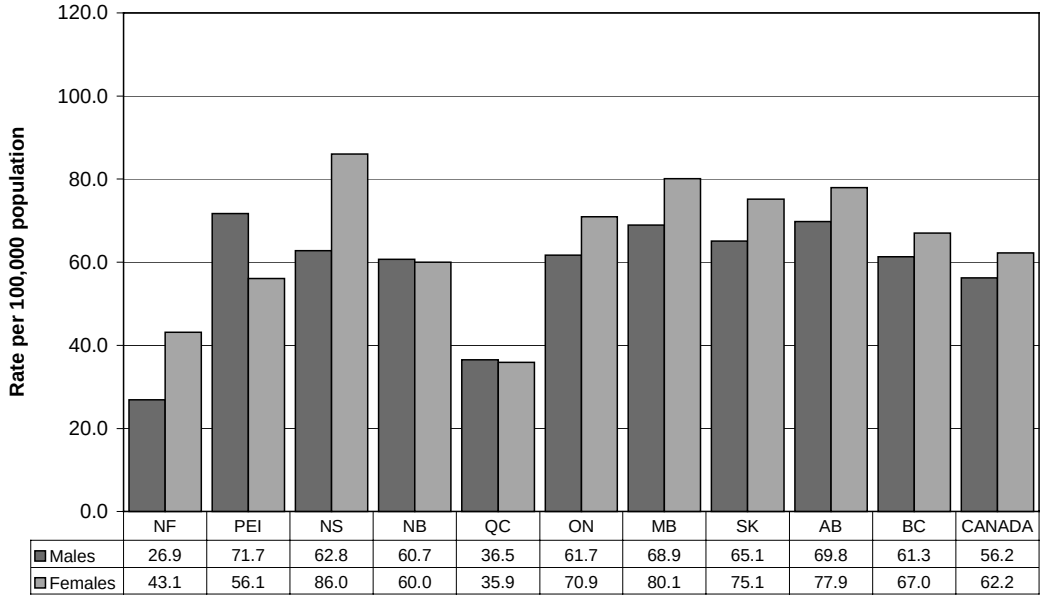
The age-standardized rates for total hip and total knee replacements varies across Canada (Figure 13). Provincial and national age-standardized rates are also reported separately for men and women to illustrate gender differences (Figure 14 and Figure 15). Quebec and Newfoundland have the lowest rates in Canada, Nova Scotia and Manitoba have the highest. This pattern extends to both males and females as well as both sexes combined. The procedure rates in the more populated provinces/territories have a larger influence on the national averages than do the rates in the less populated regions.



	NF	PEI	NS	NB	QC	ON	MB	SK	AB	BC	CANADA
Hips	35.5	64.2	76.4	60.6	36.3	67.0	74.9	70.3	74.3	64.6	59.7
Knees	35.4	67.0	98.7	77.3	34.4	81.7	94.8	71.8	75.8	66.0	67.2

Rates calculated based on patients' residence. Patients with unknown residence excluded (N=419)
Yukon, Northwest Territories and Nunavut rates suppressed due to small numbers but included in national average.
Source: Hospital Morbidity Database, Canadian Institute for Health Information

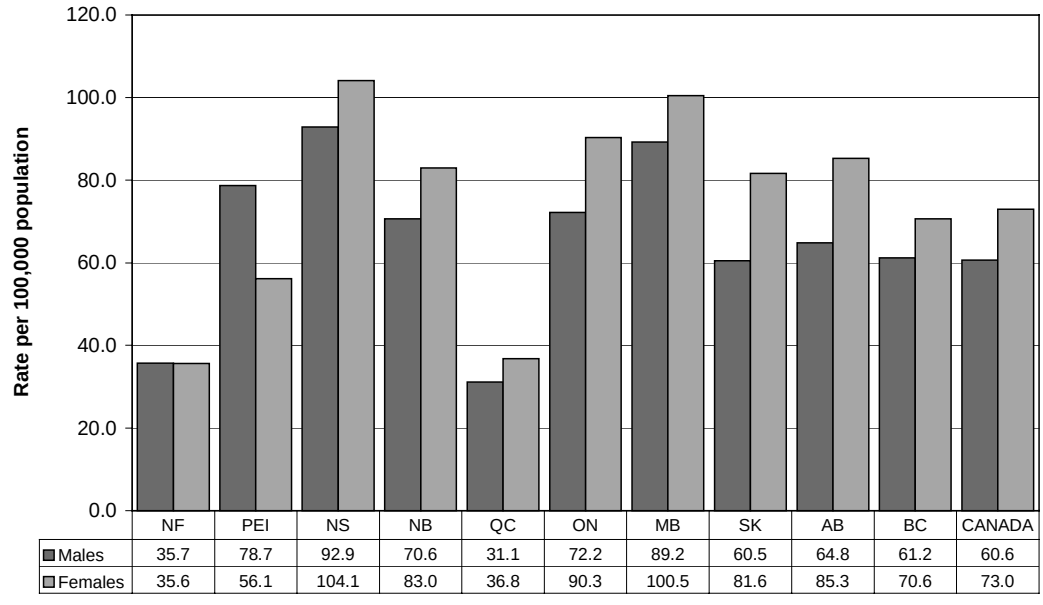
Figure 13. Age-Standardized Rates (per 100,000 population) of Total Hip and Total Knee Replacement Procedures by Province, 1999/2000



	NF	PEI	NS	NB	QC	ON	MB	SK	AB	BC	CANADA
Males	26.9	71.7	62.8	60.7	36.5	61.7	68.9	65.1	69.8	61.3	56.2
Females	43.1	56.1	86.0	60.0	35.9	70.9	80.1	75.1	77.9	67.0	62.2

Rates calculated based on patients' residence. Patients with unknown residence excluded (N=205)
Yukon, Northwest Territories and Nunavut rates suppressed due to small numbers but included in national average.
Source: Hospital Morbidity Database, Canadian Institute for Health Information

Figure 14. Age-Standardized Rates (per 100,000 population) of Total Hip Replacement Procedures for Males and Females, 1999/2000



	NF	PEI	NS	NB	QC	ON	MB	SK	AB	BC	CANADA
Males	35.7	78.7	92.9	70.6	31.1	72.2	89.2	60.5	64.8	61.2	60.6
Females	35.6	56.1	104.1	83.0	36.8	90.3	100.5	81.6	85.3	70.6	73.0

Rates calculated based on patients' residence. Patients with unknown residence excluded (N=214)
Yukon, Northwest Territories and Nunavut rates suppressed due to small numbers but included in national average.
Source: Hospital Morbidity Database, Canadian Institute for Health Information

Figure 15. Age Standardized Rates (per 100,000 population) of Total Knee Replacement procedures for Males and Females, 1999/2000

The reasons for these variations in provincial/territorial rates for total hip and total knee replacements have not been clearly identified. Many factors likely contribute to these variations in the utilization of total joint replacement procedures, including differences in access to care, quality of health services, competing conditions, health human resources and the population prevalence of predisposing clinical conditions such as osteoarthritis. Variations in clinical practice guidelines regarding indications for medical management and surgical treatment of these conditions has also been put forward as a possible explanation for some of this variation.[3] A 1999 Canadian study examined reasons for regional variation in the use of total knee replacement surgery in Ontario. After controlling for age, sex and access to care, opinions or enthusiasms of orthopaedic surgeons for the procedure was found to be an important determinant of geographical variation.[8] The CJRR will provide the data necessary to investigate the reasons for these variations in a more comprehensive way than has been possible to-date.

The absolute number of total hip and total knee replacement procedures performed in 1994/1995 through 1999/2000 is presented in Table 13 and Table 14 for each province, territory and Canada as a whole. The counts are based on where the patient lives rather than where the surgery took place. For example, in 1999/2000, 870 total knee replacements were performed on residents of Saskatchewan.

Table 13. Number of Total Hip Replacement Procedures Performed in Canada Based on Patient Residence, 1994/1995 to 1999/2000

Province	Total Hip Replacement 1994/1995	Total Hip Replacement 1995/1996	Total Hip Replacement 1996/1997	Total Hip Replacement 1997/1998	Total Hip Replacement 1998/1999	Total Hip Replacement 1999/2000
Newfoundland	*	203	205	187	182	201
Prince Edward Island	104	95	109	106	111	104
Nova Scotia	734	749	730	772	841	825
New Brunswick	429	466	488	510	451	511
Quebec	2,527	2,617	2,447	2,611	2,964	2,979
Ontario	6,988	7,110	7,306	7,646	7,916	8,433
Manitoba	664	689	745	828	921	967
Saskatchewan	821	851	922	849	825	861
Alberta	1,786	1,868	1,944	1,741	1,802	1,992
British Columbia	2,383	2,713	2,706	2,659	2,543	2,931
Northwest Territories	1	10	8	9	9	14
Yukon and Nunavut	8	14	7	20	15	13
Unknown[1]	*	199	206	203	184	205
CANADA	**16,787**	**17,584**	**17,823**	**18,141**	**18,764**	**20,036**

[1] Includes Canadian and non-Canadian residents.
*1994/1995 data is incomplete for Newfoundland and for patients with unknown residence.

Source: Hospital Morbidity Database, Canadian Institute for Health Information

Table 14. Number of Total Knee Replacement Procedures Performed in Canada Based on Patient Residence, 1994/1995 to 1999/2000

Province	Total Knee Replacement 1994/1995	Total Knee Replacement 1995/1996	Total Knee Replacement 1996/1997	Total Knee Replacement 1997/1998	Total Knee Replacement 1998/1999	Total Knee Replacement 1999/2000
Newfoundland	*	175	220	186	194	198
Prince Edward Island	88	75	73	81	101	104
Nova Scotia	679	894	906	933	981	1,039
New Brunswick	402	504	565	611	653	643
Quebec	2,146	2,264	2,287	2,427	2,696	2,796
Ontario	6,839	7,693	8,303	9,054	9,580	10,220
Manitoba	578	661	725	911	989	1,217
Saskatchewan	840	778	904	952	931	870
Alberta	1,587	1,782	2,000	1,857	1,729	1,984
British Columbia	1,875	2,329	2,401	2,492	2,499	2,970
Northwest Territories	2	2	13	14	20	17
Yukon and Nunavut	4	11	15	19	15	30
Unknown[1]	*	176	194	172	144	214
CANADA	**15,360**	**17,344**	**18,606**	**19,709**	**20,532**	**22,302**

[1] Includes Canadian and non-Canadian residents.
*1994/1995 data is incomplete for Newfoundland and for patients with unknown residence.

Source: Hospital Morbidity Database, Canadian Institute for Health Information

With the exception of Yukon and Nunavut, the majority of patients have their surgeries in their home province/territory. However, a small proportion of patients receive their total joint replacements in another province/territory. Because no total joint replacements are performed in the Yukon and Nunavut, residents of these two territories must travel to neighbouring provinces, typically Alberta or British Columbia, to have their total hip and total knee replacements.

In the case of total hip replacements, the inter-provincial/territorial movement of patients is depicted in Table 15. Residents of Prince Edward Island were more likely to have their total hip replacement surgery in another province than residents of any other province in Canada. Just over 16% of PEI patients who had a total hip replacement in 1999/2000 travelled to Nova Scotia to have their operation. In contrast, residents of Ontario (0.1%) and Alberta (0.3%) were the least likely to go to another province for their surgery. When considering the number of patients, more residents of British Columbia (N = 63) and Quebec (N = 36) travelled to another province to have their hip replaced than residents of any other province. The majority of patients from British Columbia travelled to Alberta while those from Quebec went to Ontario.

Table 15. Movement of Total Hip Replacement Patients Across Provinces, 1999/2000

Province	Number of patients who had their total hip replacement done in another province	Number out of province total hip replacement patients performed in this province
Alberta	7 (0.3%)	106 (5.1%)
British Columbia	63 (2.2%)	20 (0.7%)
Manitoba	24 (2.5%)	52 (5.3%)
New Brunswick	6 (1.2%)	30 (5.7)
Newfoundland	2 (1.0%)	1 (0.5%)
Nova Scotia	18 (2.2%)	36 (4.3%)
Northwest Territories	3 (21.4%)	**
Nunavut	1 (100%)*	*
Ontario	5 (0.1%)	127 (1.5%)
Prince Edward Island	17 (16.5%)	2 (2.3%)
Quebec	36 (1.2%)	16 (0.5%)
Saskatchewan	21 (2.4%)	28 (3.2%)
Yukon	12 (100%)*	*

* No joint replacements performed in Nunavut and the Yukon
** Numbers are suppressed.
Note: Columns two and three have different totals because Northwest Territories numbers are suppressed and patients with unknown geography codes are not accounted for in the second column.

Source: Hospital Morbidity Database, Canadian Institute for Health Information

When considering the flow of patients into provinces for total hip replacement surgery, New Brunswick (5.7%), Manitoba (5.3%) and Alberta (5.1%) received the highest proportion of out-of-province patients. In absolute numbers, however, Ontario (N = 127) and Alberta (N = 106) received the most out-of-province patients for a total hip replacement.

Table 16 shows the movement of patients who underwent a total knee replacement in Canada in 1999/2000. Prince Edward Island (3.9%) and Saskatchewan (3.7%) had the highest proportion of their residents travel to another province to have their total knee replacements. As with total hip replacement recipients, only a small proportion of residents of Alberta (0.4%) and Ontario (<0.1%) had their procedure out-of-province. More Quebec (N = 51), British Columbia (N = 32) and Saskatchewan (N = 32) residents had their total knee replacements done in another province than patients residing in other provinces. The majority of out-of-province total knee replacement surgeries for Quebec residents were carried out in Ontario and almost all out-of-province patients from British Columbia and Saskatchewan went to neighbouring Alberta to have their total knee replacement surgery. Accordingly, Ontario (N = 135) and Alberta (N = 79) received the highest number of out-of-province patients for a total knee replacement.

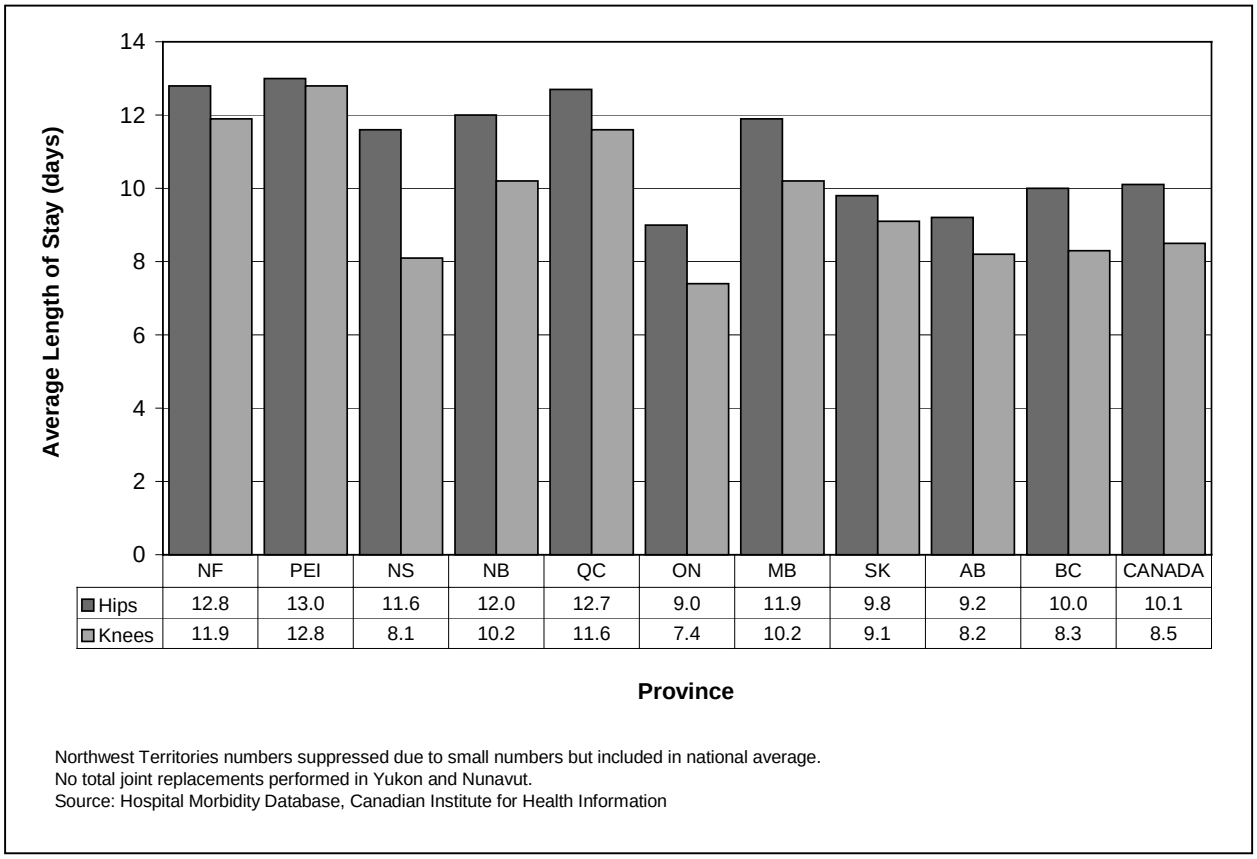
Table 16. Movement of Total Knee Replacement Patients Across Provinces, 1999/2000

Province	Number of patients who had their total knee replacement done in another province	Number out of province total knee replacement patients performed in this province
Alberta	7 (0.4%)	79 (3.9%)
British Columbia	32 (1.1%)	30 (1.0%)
Manitoba	19 (1.6%)	57 (4.6%)
New Brunswick	3 (0.5%)	48 (7.2%)
Newfoundland	3 (1.5%)	6 (3.0%)
Nova Scotia	27 (2.6%)	18 (1.8%)
Northwest Territories	0	**
Nunavut	8 (100%)*	*
Ontario	3 (<0.1%)	135 (1.4%)
Prince Edward Island	4 (3.9%)	1 (1.0%)
Quebec	51 (1.8%)	5 (0.2%)
Saskatchewan	32 (3.7%)	29 (3.4%)
Yukon	22 (100%)*	*

* No joint replacements performed in Nunavut and the Yukon
** Numbers are suppressed.
Note: Columns two and three have different totals because Northwest Territories numbers are suppressed and patients with unknown geography codes are not accounted for in the second column.

Source: Hospital Morbidity Database, Canadian Institute for Health Information

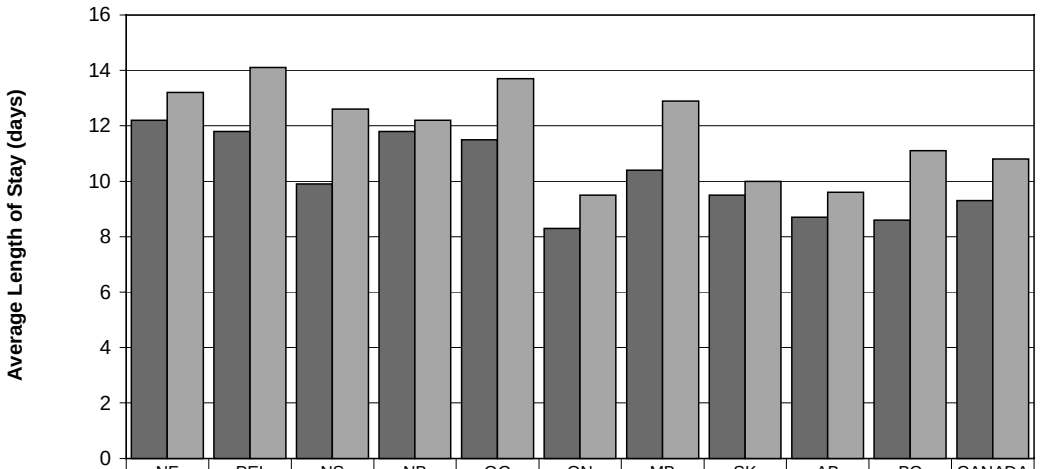
Provincial average lengths of stay for total hip and total knee replacement patients are shown in Figure 16. Total hip replacement recipients have higher lengths of stay than patients undergoing a total knee replacement in all provinces. On average, patients receiving a total hip replacement remain in hospital for 10.1 days compared to 8.5 days those receiving a total knee replacement. Ontario and the western provinces of British Columbia, Alberta and Saskatchewan have shorter average lengths of stay than the national average. By contrast, Prince Edward Island, Newfoundland and Quebec have longer average lengths of stay the national average for these procedures.



	NF	PEI	NS	NB	QC	ON	MB	SK	AB	BC	CANADA
Hips	12.8	13.0	11.6	12.0	12.7	9.0	11.9	9.8	9.2	10.0	10.1
Knees	11.9	12.8	8.1	10.2	11.6	7.4	10.2	9.1	8.2	8.3	8.5

Figure 16. Average Length of Stay for Total Hip and Knee Replacement Patients by Province, 1999/2000

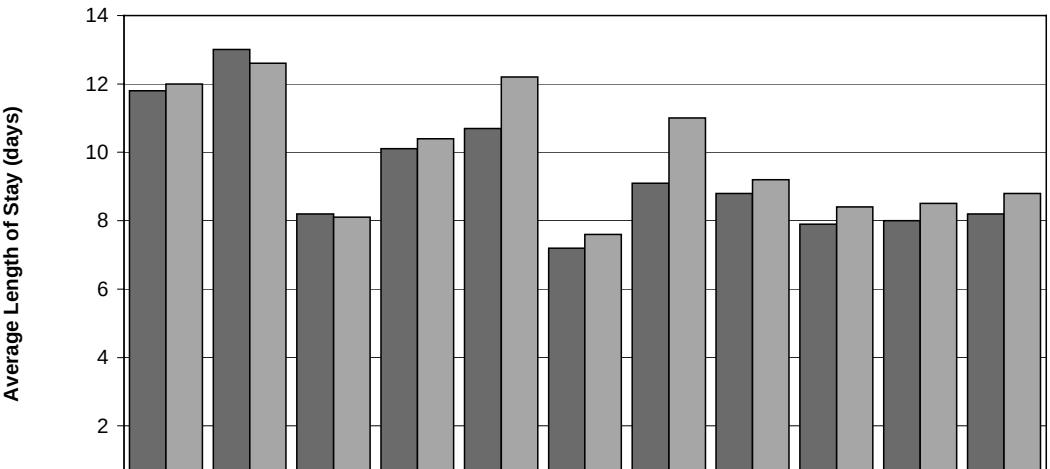
On average, women undergoing a total hip or total knee replacement procedure remain in hospital longer than men undergoing the same procedure in all provinces except in Prince Edward Island in the case of total knee replacements, where males (13.0 days) have somewhat higher average lengths of stay then women (12.6 days) (Figure 17 and Figure 18).



	NF	PEI	NS	NB	QC	ON	MB	SK	AB	BC	CANADA
Males	12.2	11.8	9.9	11.8	11.5	8.3	10.4	9.5	8.7	8.6	9.3
Females	13.2	14.1	12.6	12.2	13.7	9.5	12.9	10.0	9.6	11.1	10.8

Northwest Territories numbers suppressed due to small numbers but included in national average.
No total joint replacements performed in Yukon and Nunavut.
Source: Hospital Morbidity Database, Canadian Institute for Health Information

Figure 17. Average Length of Stay for Total Hip Replacement Patients by Sex and Province, 1999/2000



	NF	PEI	NS	NB	QC	ON	MB	SK	AB	BC	CANADA
Males	11.8	13.0	8.2	10.1	10.7	7.2	9.1	8.8	7.9	8.0	8.2
Females	12.0	12.6	8.1	10.4	12.2	7.6	11.0	9.2	8.4	8.5	8.8

Northwest Territories numbers suppressed due to small numbers but included in national average.
No total joint replacements performed in Yukon and Nunavut.
Source: Hospital Morbidity Database, Canadian Institute for Health Information

Figure 18. Average Length of Stay for Total Knee Replacement Patients by Sex and Province, 1999/2000

There has been a noticeable decrease in the length of stay for total hip and total knee replacements in all provinces since 1994/1995. Nationally, the average length of stay for patients undergoing a total hip replacement decreased by 26% from 13.6 days in 1994/1995 to 10.1 days in 1999/2000. Similarly, total knee replacement recipients now spend on average 8.5 days in hospital compared to 12.2 days in 1994/1995, a decrease of 30%.

Because the lengths of stay for the more complex revision procedures are included in the calculation of the average lengths of stay for total hip and total knee replacement surgeries, the average length of stay for primary procedures alone is likely lower than that reported in this document. Consequently, when considering provincial variations in average lengths of stay, it is important to remember that primary and revision surgeries as well as emergency and elective operations are included in the counts of total hip and total knee replacements. It is, therefore, likely that a portion of this variation is due to differences in the case mix of patients (e.g. primary to revision as well as emergency to elective surgeries) across the provinces.

Processes of Care and Outcomes

In subsequent reports the CJRR will increasingly add more information to this section, as the new CJRR data enables us to report on the processes of care, implant performance and patient outcomes associated with total hip and total knee replacement procedures in Canada. This report provides a brief summary of data on the use of blood transfusions during surgery and in-hospital mortality following total hip and total knee replacement surgeries. The data presented below are from the same data sources used throughout this report.

Almost one-third (32%) of total hip replacement recipients received a blood transfusion in 1999/2000 (Table 17). For the majority of patients (23%), this consisted of an allogeneic transfusion. Autologous transfusion was given to 8% of patients. The most common type of transfusion was whole blood (red cell) among allogeneic transfusion recipients (84%) (Table 17.1).

Table 17. Blood Transfusion During Total Hip Replacement Surgeries[1], 1999/2000

Type of Blood Transfusion	Number of Patients (% of Total Number of Hip Replacement Patients)
Autologous Transfusion	1,408 (8.4%)
Allogeneic Transfusion	3,910 (23.2%)
TOTAL	5,318 (31.6%)

[1] N = 16,840 patients. Quebec hospitals and three Manitoba hospitals do not submit to the Discharge Abstract Database and are, therefore, excluded from this analysis. British Columbia is also excluded since British Columbia hospitals do not submit blood transfusion data.

Source: Discharge Abstract Database, Canadian Institute for Health Information

Table 17.1. Type of Allogeneic Blood Transfusion Among Total Hip Replacement Recipients[1] 1999/2000

Type of Allogeneic Transfusion	Number of Patients (% of Total Number of Patients who Received a Allogeneic Transfusion)
Red Cell	3,293 (84.2%)
Plasma	38 (1.0%)
Albumin	8 (0.2%)
Platelet	4 (0.1%)
Other	222 (5.7%)
>1 type of blood component	345 (8.8%)
TOTAL	**3,910 (100.0%)**

[1] N = 16,840 patients. Quebec hospitals and three Manitoba hospitals do not submit to the Discharge Abstract Database and are, therefore, excluded from this analysis. British Columbia is also excluded since British Columbia hospitals do not submit blood transfusion data.

Source: Discharge Abstract Database, Canadian Institute for Health Information

Blood transfusion practice is somewhat less common for total knee replacement patients (Table 18). Overall, 20% of patients who underwent a total knee replacement received a blood transfusion in 1999/2000. Similar to total hip replacement patients, allogeneic transfusion (14%) was the predominant type of blood transfusion given. Just over 6% of patients received an autologous transfusion. Red cell was also the most frequent component (88%) transfused among allogeneic transfusion recipients (Table 18.1).

Table 18. Blood Transfusion Among Total Knee Replacement Surgeries[1], 1999/2000

Type of Blood Transfusion	Number of Patients (% of Total Number of Total Knee Replacement Patients)
Autologous Transfusion	1,230 (6.5%)
Allogeneic Transfusion	2,603 (13.8%)
TOTAL	**3,833 (20.3%)**

[1] N = 18,848 patients. Quebec hospitals and three Manitoba hospitals do not submit to the Discharge Abstract Database and are, therefore, excluded from this analysis. British Columbia is also excluded since British Columbia hospitals do not submit blood transfusion data.

Source: Discharge Abstract Database, Canadian Institute for Health Information

Table 18.1. Type of Allogeneic Blood Transfusion Among Total Knee Replacement Recipients[1], 1999/2000

Type of Allogeneic Transfusion	Number of Patients (% of Total Number of Patients who Received a Allogeneic Transfusion)
Red Cell	2,287 (87.9%)
Plasma	34 (1.3%)
Albumin	9 (0.3%)
Platelet	5 (0.2%)
Other	122 (4.7%)
>1 type of blood component	146 (5.6%)
TOTAL	**2,603 (100.0%)**

[1] N = 18,848 patients. Quebec hospitals and three Manitoba hospitals do not submit to the Discharge Abstract Database and are, therefore, excluded from this analysis. British Columbia is also excluded since British Columbia hospitals do not submit blood transfusion data.

Source: Discharge Abstract Database, Canadian Institute for Health Information

Post-operative in-hospital mortality is a relatively rare event among recipients of a total hip or total knee replacement (Table 19). Overall, the 1999/2000 mortality rate for total hip and total knee replacement patients was 0.7% and 0.2%, respectively. Comparable mortality rates are reported in the United States for patients who underwent a total hip (0.6%) and total knee (0.3%) replacement procedure between 1993 and 1995.[1]

Table 19. Number of In-Hospital Deaths Among Total Hip and Total Knee Replacement Patients by Age Group, Canada, 1999/2000

Age Group	Total Hip Replacements		Total Knee Replacements	
	Number of Recipients	Number of Deaths[1] (%)	Number of Recipients	Number of Deaths[2] (%)
<75	13,204	37 (0.3%)	14,663	18 (0.1%)
75–84	5,564	50 (0.9%)	6,334	26 (0.4%)
85+	1,090	45 (4.1%)	652	6 (0.9%)
TOTAL	**19,858**	**132 (0.7%)**	**21,649**	**50 (0.2%)**

[1] No deaths occurred in THR patients under the age of 50.
[2] No deaths occurred in TKR patients under the age of 45.

Source: Hospital Morbidity Database, Canadian Institute for Health Information

The risk of post-operative death increases with age. For example, while the in-hospital mortality rate for total hip replacement patients under 75 years of age was 0.3%, this rate increased to 4.1% among patients 85 years and older.

Discussion

This section provides some of the highlights on what is known, what is not known and what efforts are underway that aim to capture the missing information. Over time, this section will be expanded to include information on the inter-relationships between the many factors influencing the rate, lengths of stay and patient outcomes following total hip and total knee replacement surgery.

What We Know

- The number of total hip and total knee replacements performed in Canada increased from 32,147 in 1994/1995 to 42,338 in 1999/2000, an increase of 31.7%.
- The number of total knee replacements performed in Canada increased from 15,360 in 1994/1995 to 22,302 in 1999/2000, an increase of 45.2%.
- The age-standardized rate per 100,000 population for total knee replacements in Canada increased by 33.1%, up from 50.5 in 1994/1995 to 67.2 in 1999/2000.
- The number of total hip replacements performed in Canada increased from 16,787 in 1994/1995 to 20,036 in 1999/2000, an increase of 19.3%.
- The age-standardized rate per 100,000 population for total hip replacements in Canada increased by 8.5%, up from 55.0 in 1994/1995 to 59.7 in 1999/2000.
- In 1999/2000, 89.4% of the total joint replacement surgeries were performed on people 55 years of age or older.
- The majority of total knee replacements (59.8%) and total hip replacements (57.8%) were performed on women in 1999/2000.
- The consistent upward trend in age-standardized rates over time indicates that an aging population is not the only factor leading to an increase in the number of procedures performed annually. The CJRR will be used to better understand the inter-relationships between the many reasons for these increases.
- In 1999/2000, total knee replacement rates, per 100,000 population, were lowest in Quebec (34.4) and Newfoundland (35.4) and highest in Nova Scotia (98.7) and Manitoba (94.8). In 1999/2000, total hip replacement rates, per 100,000 population, were lowest in Newfoundland (35.5) and Quebec (36.3) and highest in Nova Scotia (76.4) and Manitoba (74.9).
- Between 1994/1995 and 1999/2000, Manitoba experienced the largest percentage increase in their rates of total knee replacements (104.7%) and total hip replacements (39.5%). During the same time period, the smallest percentage increase in the total knee replacement rates was 2.6% for Saskatchewan.
- Between 1994/1995 and 1999/2000, the rates for total hip replacements deceased in three provinces, Prince Edward Island (down 9.4%), Newfoundland (down 7.8%), and Alberta (down 4.1%).
- Total hip replacement patients had longer average lengths of hospital stay than patients undergoing a total knee replacement in all provinces in 1999/2000.

- Total knee replacement patients had an average length of stay of 8.5 days in 1999/2000, down 30.3% from the average of 12.2 days in 1994/1995.
- Total hip replacement patients had an average length of stay of 10.1 days in 1999/2000, down 25.7% from the average of 13.6 days in 1994/1995.
- In 1999/2000, the average length of stay for total knee replacements was shortest in Ontario (7.4 days) and Nova Scotia (8.1 days) and longest in Prince Edward Island (12.8 days) and Newfoundland (11.9 days).
- In 1999/2000, the average length of stay for total hip replacements was shortest in Ontario (9.0 days) and Alberta (9.2 days) and longest in Prince Edward Island (13.0 days) and Newfoundland (12.8 days).
- We are able to quantify the outflow of patients from their home province to another province to undergo a total hip or total knee replacement procedure. Similarly, we are also able to measure the inflow of out-of-province patients to have a total hip or total knee replacement surgery. Most patients received their surgery in their home province.
- In-hospital mortality rates following total hip replacement (0.7%) and total knee replacement (0.2%) surgeries are low. The risk of in-hospital mortality rate following these surgeries increases with age. For example, among people 85 years of age or older, the in-hospital mortality rate is 4.1% following a total hip replacement and 0.9% following a total knee replacement.
- In 1999/2000, 31.6% of total hip replacement patients received a blood transfusion during surgery compared to 20.3% of total knee replacement patients.
- We know that the quality of total hip and total knee replacement data is reasonably accurate. The accuracy of hospital health record coding is highest for major surgery and diminishes with the complexity of the information.[3]

What We Don't Know

- The relative importance of an aging population, trends in the prevalence of osteoarthritis and many other factors on the rates of total hip and total knee replacements is not yet fully understood.
- Similarly, the reasons for variations in provincial rates and lengths of stay for total hip and total knee replacements have not been clearly identified. These variations can likely be explained by several factors, including the age and health of the population, referral patterns, access to care, quality of care and types of implants used. Future analyses using CJRR data will improve our understanding of these variations.
- The optimal rate of total hip and total knee replacements to meet the needs of Canadians is not known. The CJRR will be able to take a leadership role in providing the information needed to determine an appropriate rate range for these procedures for various regions and sub-populations. This information can then be used by policy-makers and providers to plan the delivery of services.

- With the exception of Nunavut and the Yukon, where total joint replacements are not performed, we do not know why patients relocate to another province to have their total joint replacement done. CJRR also has the capacity to provide detailed intra-provincial data of the proportion of patients who go outside their home region for these procedures. Future collection of information on wait times for surgery and patient satisfaction will improve our understanding of inter-provincial and inter-regional movement of patients receiving total hip and total knee replacements.
- The proportion of all total joint replacements each year that are revisions and, more importantly, the proportion of primary replacements that result in a revision (the revision rate) are not known for Canada. In order to have meaningful comparisons on quality of care and implant performance, the revision rate and data on processes of care must be collected and analyzed. CJRR will be able provide this information in future reports.
- Detailed operative data is not routinely collected nationally. Therefore, the relative effectiveness of various surgical techniques, operating room environments, practices around antibiotic use and prevention of deep vein thrombosis, as well as fixation methods on clinical outcomes and implant survival is not known. CJRR will be able to address many of these issues by monitoring patients over time.
- The relative effectiveness of currently available hip and knee implants is largely unknown. Although there has been a proliferation of orthopaedic prostheses in the last two decades, post-market surveillance of these devices is not carried out on an ongoing, systematic basis in Canada. CJRR will be able to address this issue by following patients over time to monitor their revision rates associated with various implants.
- With few exceptions, we know little about how many patients are waiting for a total joint replacement in Canada and how long they wait to have their operation once a decision to proceed with surgery is made to have the surgery. The impact of wait times on the pre-operative physical functioning and the post-operative clinical outcomes of joint replacement candidates is also not known. The CJRR team is exploring ways to collect this information, so these questions can be addressed.
- The cost of total joint replacement surgery in Canada and the variations in costs across provinces or health-care facilities is not known.
- The length and impact of rehabilitation care following surgery on the recovery process is not known.
- Information on the relationship between injury (i.e. hip fracture) and total hip replacement is lacking.

What is Happening

- Data captured by the Canadian Joint Replacement Registry will fill many of the information gaps outlined above. One of the unique functions of the CJRR is providing a mechanism for post-market surveillance of orthopaedic implants. A national registry, like CJRR, provides the most effective and pragmatic approach for assessing the quality of orthopaedic prostheses.[6, 9]
- The CJRR captures revision operations and reasons for revision separately from primary surgeries. Revision rates will thus be known and the most common reasons for revisions identified.
- The CJRR will provide a steady flow of new and necessary information to inform treatment, policy and planning decisions associated with these surgeries. CJRR will also serve as a valuable model for other pan-Canadian initiatives undertaking post-market surveillance or attempting to improve patient outcomes.
- Detailed surgical information related to operative techniques, fixation method, antibiotic and deep vein thrombosis prophylaxis is also collected by CJRR, all of which may influence implant failure rates.
- A comprehensive data quality evaluation, based on CIHI's Data Quality Framework, will be carried out on CJRR data.
- In the future, the CJRR may be expanded to include data on wait times, patient prioritization, illness severity, patient functioning at follow-up and patient satisfaction. The addition of any of these data modules would greatly increase the number of policy relevant questions that can be addressed using CJRR data.

Other Joint Replacement Registries

Other national Joint Replacement Registries have been implemented in Sweden, Finland, Norway, Australia and New Zealand. In the United States, the Center for Outcomes Research at the University of Massachussetts Medical School maintains a Hip and Knee Registry. The United Kingdom is also currently in the developmental stages of the UK National Joint Replacement Registry.

The Swedish Knee Arthroplasty Register

The Swedish Knee Arthroplasty Register (SKAR) was established in 1975 and captures approximately 90% of all endoprosthetic knee replacements in Sweden. The aim of the SKAR is to provide early warning of inferior designs and to capture national results in addition to that of highly specialized surgical institutions.[10] Approximately 6,000 patients receive knee replacement surgery each year in Sweden. The SKAR has collected information on more than 65,000 surgeries on 50,000 patients.[11] Information captured by the register consists of patient demographics, type of replacement (i.e. primary vs. revision), reason for replacement, surgical technique, fixation method and implant type. Data collection is paper-based and surgeon participation is voluntary. The outcome indicator chosen by the SKAR is revision as this represents the most objective measurable end point of implant failure. The major accomplishments of the SKAR include the ability to give early warnings on unsuccessful implants, the improvement of prosthetic survival over time and a decrease in revision rates. The SKAR has served as a model for the CJRR.

The Swedish Total Hip Replacement Register

The Swedish Total Hip Replacement Register (STHRR) was started in 1979 and records primary total hip replacements and revisions. The goals of the register are to 1) describe the epidemiology of hip replacement surgery in Sweden and 2) to identify, by study of revisions, risk factors for poor outcomes related to patient, implant and surgical technique.[5] Approximately 10,000 primary total hip replacement operations are performed every year in Sweden and the register has data on more than 200,000 primary and secondary hip replacements.[5,12] The STHRR collects information on type of replacement, reasons for the replacement, surgical and cementing technique, implant type, and preventive measures against infection and deep vein thrombosis. Since 1999, 70% of participating facilities submit their data on a web-based data entry application via the Internet. The remaining facilities continue to submit their data via the paper-based method. The end point for failure, as for the SKAR, is revision. The success of the STHRR is demonstrated by a stepwise reduction in revision rates with associated savings of about one billion Swedish Crowns per year, which is equivalent to approximately $165,000,000 CAD. Participation in the register is based on voluntary input of individual surgeons and clinics.[5]

The Finnish Arthroplasty Register[13]

The Finnish Arthroplasty Register (FAR) was implemented in 1980 and collects data on total hip, total knee and other joint replacements, including elbow, shoulder and ankle. The main goal of the FAR is to study and ensure the quality of prostheses for the safety of the patient. A 1995 analysis estimated that the register included almost 90% of inserted prostheses. Approximately 4,700 primary total hip replacements are performed in Finland annually. It currently holds data on nearly 63,000 primary hip replacements and just over 12,000 revision hip replacements. Participation in the FAR was voluntary at first but became mandatory in 1997. Information is collected on the type of replacement, fixation method, reason for operation, implant type, brand of cement used, systemic antibiotic prophylaxis and primary complications. Revision was identified as the outcome variable to measure prosthesis success.

The Norwegian Arthroplasty Register

The Norwegian Arthroplasty Register (NAR) was established in 1987 to collect information on total hip replacements performed in Norway. The main objectives of the register are to maintain and potentially improve the quality of joint arthroplasty, and to identify inferior implants as early as possible. The specific aims are to describe the epidemiology of joint arthroplasty and to identify factors associated with an increased risk for revision.[14] In 2000, In 1994, the NAR was expanded to include all artificial joints, namely knee, elbow, ankle, toe, finger, shoulder, and wrist. In Norway, roughly 5,500 total hip replacement surgeries are performed each year. The register has collected data on more than 60,000 total hip replacements and 8,500 replacements of other joints so far. Investigations have shown that more than 95% of all joint replacements performed are reported to the register. Data collection forms are filled out by surgeons following surgery and include information on the type of replacement, diagnosis for primary or revision operation, surgical approach, fixation mode, implant type, and antibiotic prophylaxis. Participation of surgeons in NAR is voluntary and the participation rate is practically 100%.[14]

The Australian National Joint Replacement Registry

The Australian National Joint Replacement Registry was launched in 1999. Information is collected on hip and knee replacements, including total and partial replacements. In Australia, more than 40,000 hip and knee replacements are performed each year. The primary objectives of the Australian Registry are to 1) determine demographic and diagnostic characteristics of joint replacement patients and 2) evaluate the effectiveness of different types of orthopaedic implants and surgical techniques.[7] Participating surgeons submit operative data by completing specific registry forms at the time of surgery. Data elements captured on hip and knee replacements include type of replacement, reason for replacement, prosthesis type and fixation mode as well as patient demographic information. The registry has 260 hospitals (out of 300) contributing data on all hip and knee replacements performed in Australia. Surgeon participation in the Registry is voluntary.[15]

The New Zealand National Joint Register[16]

The New Zealand National Joint Register was launched in April 1999 to collect information about total hip and knee replacement surgery, including primary and revision operations. The purpose of the Register is to record technical information about joint replacements and to assess patient satisfaction and function following surgery. In 2000, the registry was further expanded by the addition of shoulder, elbow and ankle surgery. Over 90% of public hospitals were participating in the register by April 1999. Approximately 7,000 total hip and knee replacements are performed each year in New Zealand. By August 1999, the register had collected information on 6,500 total hip and knee surgeries. The Register credits the involvement of operating room nursing staff for the high participation rate. Surgical information is entered on standard data collection forms in the operating room by the OR nurse and verified by the operating surgeon. In addition to patient demographics, information is collected on the type of replacement, main diagnosis for replacement, type of prosthesis used, surgical approach and fixation mode. Written patient consent is obtained prior to data collection. Surgeon participation is voluntary.

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Appendix A

Crude and Age-Standardized Provincial Rates

Table A.1. Crude and Age Standardized Rates of Total Hip Replacement Procedures for Males and Females by Province and Canada, 1999/2000

Province	Male		Female	
	Crude Rate (per 100,000)	ASR[1] (per 100,000)	Crude Rate (per 100,000)	ASR[1] (per 100,000)
Newfoundland	26.1	26.9	48.0	43.1
PEI	75.0	71.7	75.4	56.1
Nova Scotia	64.7	62.8	109.6	86.0
New Brunswick	61.5	60.7	73.7	60.0
Quebec	36.7	36.5	44.2	35.9
Ontario	61.0	61.7	84.5	70.9
Manitoba	69.4	68.9	99.5	80.1
Saskatchewan	70.1	65.1	97.7	75.1
Alberta	57.8	69.8	76.6	77.9
British Columbia	63.8	61.3	81.1	67.0
CANADA	**55.3**	**56.2**	**74.2**	**62.2**

[1]ASR: Age-standardized Rate. Rates calculated based on patients' residence. Patients with unknown residence excluded (N = 205).
Yukon, Northwest Territories and Nunavut rates suppressed due to small numbers but included in national average.

Source: Hospital Morbidity Database, Canadian Institute for Health Information

Table A.2. Crude and Age Standardized Rates of Total Knee Replacement Procedures for Males and Females by Province and Canada, 1999/2000

Province	Male		Female	
	Crude Rate (per 100,000)	ASR[1] (per 100,000)	Crude Rate (per 100,000)	ASR[1] (per 100,000)
Newfoundland	35.1	35.7	38.1	35.6
PEI	80.9	78.7	69.8	56.1
Nova Scotia	93.5	92.9	126.5	104.1
New Brunswick	70.1	70.6	99.9	83.0
Quebec	30.6	31.1	45.2	36.8
Ontario	70.6	72.2	105.7	90.3
Manitoba	90.4	89.2	122.2	100.5
Saskatchewan	65.3	60.5	104.1	81.6
Alberta	51.7	64.8	82.3	85.3
British Columbia	62.5	61.2	84.3	70.6
CANADA	**58.6**	**60.6**	**85.6**	**73.0**

[1]ASR: Age-standardized Rate. Rates calculated based on patients' residence. Patients with unknown residence excluded (N = 214).
Yukon, Northwest Territories and Nunavut rates suppressed due to small numbers but included in national average.

Source: Hospital Morbidity Database, Canadian Institute for Health Information

Appendix B

Canadian Population by Age and Sex

Table B.1. Number of Population by Age Group and Sex in Newfoundland, 1999/2000

Newfoundland	Males (% of Total Population)	Females (% of Total Population)	Total (% of Total Population)
<45 years	174,892 (32.3%)	173,284 (32.0%)	348,176 (64.4%)
45–54 years	40,977 (7.6%)	40,904 (7.6%)	81,881 (15.1%)
55–64 years	24,653 (4.6%)	24,374 (4.5%)	49,027 (9.1%)
65–74 years	16,736 (3.1%)	18,159 (3.4%)	34,895 (6.5%)
75–84 years	8,658 (1.6%)	11,890 (2.2%)	20,548 (3.8%)
85+ years	1,894 (0.3%)	4,249 (0.8%)	6,143 (1.1%)
All ages	267,810 (49.5%)	272,860 (50.5%)	540,670 (100%)

Source: Statistics Canada

Table B.2. Number of Population by Age Group and Sex in Prince Edward Island, 1999/2000

Prince Edward Island	Males (% of Total Population)	Females (% of Total Population)	Total (% of Total Population)
<45 years	44,681 (32.3%)	43,972 (31.8%)	88,653 (64.1%)
45–54 years	9,574 (6.9%)	9,698 (7.0%)	19,272 (13.9%)
55–64 years	6,104 (4.4%)	6,193 (4.5%)	12,297 (8.9%)
65–74 years	4,485 (3.3%)	5,027 (3.6%)	9,512 (7.0%)
75–84 years	2,424 (1.8%)	3,802 (2.8%)	6,226 (4.5%)
85+ years	699 (0.5%)	1,550 (1.1%)	2,249 (1.6%)
All ages	67,967 (49.2%)	70,242 (50.8%)	138,209 (100%)

Source: Statistics Canada

Table B.3. Number of Population by Age Group and Sex in Nova Scotia, 1999/2000

Nova Scotia	Males (% of Total Population)	Females (% of Total Population)	Total (% of Total Population)
<45 years	300,605 (31.9%)	296,154 (31.4%)	596,759 (63.4%)
45–54 years	67,006 (7.1%)	67,435 (7.1%)	134,441 (14.3%)
55–64 years	43,436 (4.6%)	44,498 4.7%)	87,934 (9.3%)
65–74 years	30,166 (3.2%)	35,405 (3.8%)	65,571 (7.0%)
75–84 years	16,629 (1.8%)	26,224 (2.8%)	42,853 (4.5%)
85+ years	4,219 (0.5%)	10,094 (1.1%)	14,313 (1.5%)
All ages	462,061 (49.1%)	479,810 (50.9%)	941,871 (100%)

Source: Statistics Canada

Table B.4. Number of Population by Age Group and Sex in New Brunswick, 1999/2000

New Brunswick	Males (% of Total Population)	Females (% of Total Population)	Total (% of Total Population)
<45 years	244,436 (32.4%)	236,276 (31.3%)	480,712 (63.7%)
45–54 years	54,752 (7.2%)	54,725 (7.2%)	109,477 (14.5%)
55–64 years	33,964 (4.5%)	34,494 (4.6%)	68,458 (9.1%)
65–74 years	23,911 (3.2%)	27,937 (3.7%)	51,848 (6.9%)
75–84 years	13,358 (1.8%)	20,076 (2.7%)	33,434 (4.4%)
85+ years	3,296 (0.4%)	7,769 (1.0%)	11,065 (1.4%)
All ages	373,717 (49.5%)	381,277 (50.5%)	754,994 (100%)

Source: Statistics Canada

Table B.5. Number of Population by Age Group and Sex in Quebec, 1999/2000

Quebec	Males (% of Total Population)	Females (% of Total Population)	Total (% of Total Population)
<45 years	2,373,312 (32.3%)	2,279,531 (31.0%)	4,652,843 (63.2%)
45–54 years	533,561 (7.2%)	539,498 (7.3%)	1,073,059 (14.6%)
55–64 years	346,371 (4.7%)	364,626 (5.0%)	710,997 (9.7%)
65–74 years	242,826 (3.3%)	294,718 (4.0%)	537,544 (7.3%)
75–84 years	110,217 (1.5%)	183,706 (2.5%)	293,923 (4.0%)
85+ years	24,206 (0.3%)	64,864 (0.9%)	89,070 (1.2%)
All ages	3,630,493 (49.3%)	3,726,943 (50.7%)	7,357,436 (100%)

Source: Statistics Canada

Table B.6. Number of Population by Age Group and Sex in Ontario, 1999/2000

Ontario	Males (% of Total Population)	Females (% of Total Population)	Total (% of Total Population)
<45 years	3,819,305 (33.0%)	3,724,561 (32.2%)	7,543,866 (65.2%)
45–54 years	769,682 (6.7%)	787,923 (6.8%)	1,557,605 (13.5%)
55–64 years	503,975 (4.4%)	524,677 (4.5%)	1,028,652 (8.9%)
65–74 years	380,883 (3.3%)	437,127 (3.8%)	818,010 (7.1%)
75–84 years	188,357 (1.6%)	284,445 (2.5%)	472,802 (4.1%)
85+ years	42,836 (0.3%)	100,586 (0.9%)	143,422 (1.2%)
All ages	5,705,038 (49.3%)	5,859,319 (50.7%)	11,564,357 (100%)

Source: Statistics Canada

Table B.7. Number of Population by Age Group and Sex in Manitoba, 1999/2000

Manitoba	Males (% of Total Population)	Females (% of Total Population)	Total (% of Total Population)
<45 years	380,895 (33.3%)	364,430 (31.9%)	745,325 (65.2%)
45–54 years	74,044 (6.5%)	74,156 (6.5%)	148,200 (13.0%)
55–64 years	47,614 (4.2%)	48,655 (4.2%)	96,269 (8.4%)
65–74 years	36,927 (3.2%)	42,287 (3.7%)	79,214 (6.9%)
75–84 years	21,863 (1.9%)	33,193 (2.9%)	55,056 (4.8%)
85+ years	6,302 (0.5%)	13,393 (1.2%)	19,695 (1.7%)
All ages	567,645 (49.6%)	576,114 (50.4%)	1,143,759 (100%)

Source: Statistics Canada

Table B.8. Number of Population by Age Group and Sex in Saskatchewan, 1999/2000

Saskatchewan	Males (% of Total Population)	Females (% of Total Population)	Total (% of Total Population)
<45 years	341,523 (33.3%)	329,185 (32.1%)	670,708 (65.4%)
45–54 years	62,746 (6.1%)	60,711 (5.9%)	123,457 (12.0%)
55–64 years	41,240 (4.0%)	42,241 (4.1%)	83,481 (8.1%)
65–74 years	35,264 (3.5%)	39,207 (3.8%)	74,471 (7.3%)
75–84 years	22,104 (2.2%)	30,722 (3.0%)	52,826 (5.2%)
85+ years	6,654 (0.6%)	13,564 (1.4%)	20,218 (2.0%)
All ages	509,531 (49.7%)	515,630 (50.3%)	1,025,161 (100%)

Source: Statistics Canada

Table B.9. Number of Population by Age Group and Sex in Alberta, 1999/2000

Alberta	Males (% of Total Population)	Females (% of Total Population)	Total (% of Total Population)
<45 years	1,059,773 (35.7%)	1,005,034 (33.9%)	2,064,807 (69.6%)
45–54 years	196,347 (6.6%)	187,651 (6.3%)	383,998 (12.9%)
55–64 years	113,734 (3.8%)	112,920 (3.8%)	226,654 (7.6%)
65–74 years	80,940 (2.7%)	86,693 (2.9%)	167,633 (5.6%)
75–84 years	38,780 (1.4%)	56,326 (1.9%)	95,106 (3.3%)
85+ years	9,587 (0.3%)	20,537 (0.7%)	30,124 (1.0%)
All ages	1,499,161 (50.5%)	1,469,161 (49.5%)	2,968,322 (100%)

Source: Statistics Canada

Table B.10. Number of Population by Age Group and Sex in British Columbia, 1999/2000

British Columbia	Males (% of Total Population)	Females (% of Total Population)	Total (% of Total Population)
<45 years	1,310,032 (32.4%)	1,274,558 (31.5%)	2,584,590 (63.9%)
45–54 years	289,548 (7.2%)	288,462 (7.1%)	578,010 (14.3%)
55–64 years	180,359 (4.5%)	182,440 (4.5%)	362,799 (9.0%)
65–74 years	136,592 (3.4%)	146,604 (3.6%)	283,196 (7.0%)
75–84 years	72,912 (1.8%)	104,785 (2.6%)	177,697 (4.4%)
85+ years	18,007 (0.4%)	37,581 (1.0%)	55,588 (1.4%)
All ages	2,007,450 (49.7%)	2,034,430 (50.3%)	4,041,880 (100%)

Source: Statistics Canada

Table B.11. Number of Population by Age Group and Sex in Canada, 1999/2000

Canada	Males (% of Total Population)	Females (% of Total Population)	Total (% of Total Population)
<45 years	10,089,395 (33.0%)	9,764,909 (32.0%)	19,854,304 (65.0%)
45–54 years	2,104,778 (6.9%)	2,116,556 (6.9%)	4,221,334 (13.8%)
55–64 years	1,344,486 (4.4%)	1,387,730 (4.5%)	2,732,216 (8.9%)
65–74 years	990,155 (3.2%)	1,134,355 (3.7%)	2,124,510 (6.9%)
75–84 years	495,761 (1.6%)	755,692 (2.5%)	1,251,453 (4.1%)
85+ years	117,825 (0.4%)	274,352 (0.9%)	392,177 (1.3%)
All ages	15,142,400 (49.5%)	15,433,594 (50.5%)	30,575,994 (100%)

Source: Statistics Canada

Appendix C

Glossary

Glossary

Age–standardized Rate: a rate that is statistically modified to eliminate the effect of different age distributions in the population over time, or between different populations.

Allogeneic blood transfusion: allogeneic refers to blood transfused to someone other than the donor.

Autologous blood transfusion: autologous refers to transfusions in which the blood donor and transfusion recipient are the same.

Total knee replacement: total knee replacement (TKR), sometimes referred to total knee arthroplasty (TKA), injured or damaged parts of the knee joint are replaced with artificial parts. The procedure is performed by separating the muscles and ligaments around the knee to expose the knee capsule. The capsule is opened, exposing the inside of the joint. The ends of the thighbone (femur) and the shinbone (tibia) are removed, and often the underside of the kneecap (patella) is removed. The artificial parts are then cemented into place. The new knee consists of a metal shell on the end of the femur, a metal and plastic trough on the tibia, and if needed, a plastic button on the kneecap (WCWL Project, Literature Review on Hip and Knee Joint Replacement, 2000).

Total Hip Replacement: total hip replacement (THR or THA) involves the replacement of both the upper femur and the acetabulum. The two parts of the hip joint are removed and replaced with smooth artificial surfaces. This hip is composed of the hip socket (acetabulum, a cup–shaped bone in the pelvis) and the "ball" or head of the femur. The artificial socket is made of high–density plastic, while the artificial ball with its stem is made of a strong stainless steel metal. These artificial pieces are implanted into healthy portions of the pelvis and femur and affixed with a bone cement (methyl methacrylate) or through a cementless procedure in which the implant has a rough surface that the bone grows into over time (WCWL Project, Literature Review on Hip and Knee Joint Replacement, 2000).

Revision: exchange or removal of one or both components. Exchange of liner or head component is not considered a revision (Swedish National Hip Arthroplasty Registry).

Revision Rate: the revision rate is the percentage of primary replacements that have had a subsequent removal or exchange of one or more components.

Percent Revisions: the number of revisions relative to the total number of replacements.