

# Hip and knee replacement

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## Abstract

### Objectives

This article examines trends in hip and knee replacement surgery between 1981/82 and 1998/99, focussing on procedures involving seniors. It also presents 1998/99 data on readmissions within 30 days.

### Data sources

Data on hip and knee replacement are from the Hospital Morbidity Database for 1981/82 through 1998/99. The Person-oriented Information Database is used to examine readmissions in 1998/99. Supplementary data on arthritis are from the 1998/99 National Population Health Survey.

### Analytical techniques

Hospitalization rates were calculated by dividing the number of hip and knee surgery separations by the population estimates for the relevant age/sex group and multiplying by 100,000. Population estimates for 1998 were used to calculate age-adjusted hospitalization rates.

### Main results

Between 1981/82 and 1998/99, the numbers and rates of hip and knee replacement increased substantially, while length of stay for both procedures declined. By 1998/99, knee replacements outnumbered those for hip. Both procedures had relatively low in-hospital mortality and post-surgery complication rates.

### Key words

hospital separation records, hospital utilization, length of stay, surgical procedures

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Hip and knee arthrosis are among the most common degenerative joint diseases. They cause substantial pain and functional impairment since they affect the largest weight-bearing joint systems in the body. Osteoarthritis is the leading cause of degenerative joint disease and can have not only physical, but also social, psychological and economic consequences for those affected.<sup>1</sup> The resulting pain and disability can limit mobility, contribute to social isolation and depression, and decrease functional independence.<sup>2</sup> Since the population aged 65 or older is growing in number and as a proportion of the total population, the prevalence of osteoarthritis—a condition that is more common among the elderly—is expected to increase substantially over the next three decades.<sup>3</sup>

Hip replacement has long been an option for seniors suffering from osteoarthritis. Advances in prosthesis design and in surgical and anesthetic techniques have also made knee replacement less risky for the elderly.<sup>4-6</sup> The decision to have joint replacement surgery generally occurs when drug therapy and/or less invasive surgical procedures are no longer effective. Hip and knee replacements have the potential to transform patients' quality of life by

## Methods

### Data sources

The data in this article are from the Hospital Morbidity Database, maintained by Statistics Canada between 1981/82 and 1994/95, and by the Canadian Institute for Health Information (CIHI) since 1995/96. The information in this database comes from the admission/separation form completed by hospitals at the end of each stay when a patient is "separated," either as a discharge or a death. The file contains data on all inpatient cases separated from general and allied special care hospitals during the fiscal year. A patient may be admitted and discharged several times during a year; therefore, the statistics are a count of separations and not individual patients.

This analysis presents numbers and rates of hip and knee replacements for people aged 20 or older, but because the majority undergoing joint replacement are aged 65 or older, the article focusses on seniors. During the 1981/82-to-1998/99 period, there were 158,093 hip replacements and 128,834 knee replacements among the population aged 65 or older.

Supplementary information about the prevalence of arthritis is from the 1998/99 National Population Health Survey (NPHS), conducted by Statistics Canada. The NPHS, which began in 1994/95, collects information about the health of Canadians every two years. It covers household and institutional residents in all provinces and territories, except persons living on Indian reserves, on Canadian Forces bases and in some remote areas.

The NPHS has both a cross-sectional and a longitudinal component. The 1998/99 (cycle 3) cross-sectional household component is made up mostly of longitudinal respondents and their cohabitants. To keep the 1998/99 sample representative, infants born in 1995 or later and immigrants who entered Canada after 1994 were randomly selected. To replace sample lost to attrition, individuals in dwellings that were part of the original sampling frame, but whose household members did not respond in 1994/95, were contacted and asked to participate. The response rate at the household level for 1998/99 was 88.2%. The response rate for the randomly selected respondents aged 0 or older in these households was 98.5%. The sample size of the cross-sectional file in 1998/99 was 17,244. The sample size for the population aged 65 or older in the 1998/99 NPHS was 2,851.

NPHS data are stored in two files. The General file contains socio-demographic and some health information for each member of participating households. The Health file contains in-depth health

information that was collected for one randomly selected household member, as well as the information in the General file pertaining to that person. The information on arthritis is from the Health file of the cross-sectional component of the 1998/99 NPHS. A more detailed description of the NPHS design, sample and interview procedures can be found in published reports.<sup>7-9</sup>

Population estimates used to calculate rates were provided by Statistics Canada's Demography Division.

Statistics Canada's Person-oriented Information (POI) database, a subset of CIHI's Hospital Morbidity Database, was used to examine readmissions within 30 days of hip and knee replacement. The database contains patient identification numbers, making it possible to determine readmissions of the same individual (patient names are not provided to Statistics Canada). In 1998/99, there were 1,056,123 hospital separations among people aged 65 or older. After excluding non-residents and invalid records, 1,032,985 person-linked records remained, representing a linkage rate of 98%.

### Analytical techniques

Hospitalization rates were calculated by dividing the number of hip and knee replacement separations by the population estimates for the relevant age/sex group and multiplying by 100,000. Confidence intervals were calculated to assess the variation in rates between 1981/82 and 1998/99 for each province. Two-sided Z-tests were employed to determine the statistical difference between each provincial rate and the national rate in 1998/99. Two tailed t-tests were used to test mean differences in the length of stay between 1981/82 and 1998/99, and between each province and the national level.<sup>10</sup>

Rates for hip and knee surgery were age-adjusted to the 1998 Canadian population for both sexes. Provincial age-adjusted rates were compared with the national level. The provincial rates refer to patients who were residents of the province in which the surgery was performed (see *Limitations*). In 1998/99, non-residents accounted for less than 2% of separations for hip and knee replacements.

In the 1998/99 person-linked hospital file, 11,523 patients aged 65 or older had hip replacement surgery, and 13,429, knee replacement surgery. The initial admission to hospital is an "index" admission. For index cases readmitted within 30 days of their discharge, the first three diagnostic codes and the first three surgical codes were examined to determine the leading reasons for readmission.

reducing chronic pain and increasing the ability to function independently.<sup>11,12</sup> Major improvements have been noted for management of pain, sleep and disability.<sup>2,13,14</sup>

This article examines trends in hip and knee replacement surgery among Canadian adults for the period from 1981/82 to 1998/99. Because the majority of people undergoing such procedures are seniors, the analysis focusses on the population aged 65 or older. For both hip and knee replacement, annual numbers and rates are presented for Canada, by province and by senior age groups (see *Methods*, *Limitations* and *Definitions*). Total hospital days and average length of stay over the same period are provided. A subset of the national hospital morbidity database that contains person identification numbers was used to examine hospital readmissions within 30 days of hip or knee replacement.

### Steady rise

Between 1981/82 and 1998/99, the number of hospital separations for hip and knee replacement

rose steadily and sharply (Table 1). Among people aged 20 or older, there were 18,516 separations for hip replacement in 1998/99, about triple the 6,339 recorded in 1981/82. The figures for knee replacement reveal an even larger increase, from 1,730 to 19,818.

The age-adjusted rates per 100,000 population aged 20 or older also rose dramatically. The rate for hip replacement went from 41.7 in 1981/82 to 81.5 in 1998/99. The increase for knee replacement was from 11.4 to 87.3 per 100,000.

The hip replacement rate approximately doubled for both men and women. For knee replacement, the increase was much steeper, and differed by sex. The rate rose approximately tenfold among men and sevenfold among women.

### Majority seniors

The majority of hip and knee replacements are performed on seniors. In 1998/99, people aged 65 or older accounted for two-thirds of all hospital separations for hip replacement and nearly three-quarters for knee replacement. Older seniors (75

Table 1  
Selected indicators for hip and knee replacement, population aged 20 or older, Canada excluding territories, 1981/82 to 1998/99

Hip replacement	1981/82	1986/87	1991/92	1998/99	Knee replacement	1981/82	1986/87	1991/92	1998/99
<b>Both sexes</b>					<b>Both sexes</b>				
Number of separations	6,339	11,355	15,415	18,516	Number of separations	1,730	5,175	11,108	19,818
Age-adjusted rate/100,000 population	42.8	68.3	81.4	83.5	Age-adjusted rate/100,000 population	11.7	31.2	58.5	89.4
% of separations:					% of separations:				
65+	61.0	64.6	66.4	67.5	65+	62.9	70.3	74.7	73.3
75+	25.2	27.5	30.0	33.0	75+	24.1	28.1	29.6	31.7
<b>Men</b>					<b>Men</b>				
Number of separations	2,663	4,655	6,224	7,951	Number of separations	543	1,762	4,221	7,908
Age-adjusted rate/100,000 population	39.4	62.6	73.9	80.1	Age-adjusted rate/100,000 population	8.2	24.3	50.7	80.9
% of separations:					% of separations:				
65+	55.7	59.1	59.5	60.7	65+	59.1	66.8	72.8	72.7
75+	19.1	21.3	24.3	26.1	75+	21.7	26.4	26.0	29.2
<b>Women</b>					<b>Women</b>				
Number of separations	3,676	6,700	9,191	10,565	Number of separations	1,187	3,413	6,887	11,910
Age-adjusted rate/100,000 population	45.2	72.4	87.0	85.6	Age-adjusted rate/100,000 population	14.6	36.7	64.8	97.1
% of separations:					% of separations:				
65+	64.8	68.5	71.0	72.6	65+	64.7	72.1	75.9	73.7
75+	29.6	31.8	33.8	38.2	75+	25.2	28.9	31.8	33.3

**Data source:** Hospital Morbidity Database, 1981/82, 1986/87, 1991/92 and 1998/99

**Note:** Hip replacement refers to Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures codes 93.51 or 93.59 for primary or secondary surgical procedure; knee replacement refers to code 93.41 for primary or secondary surgical procedure.

or older) represented about one-third of both types of surgery.

In 1981/82, neither procedure had ranked among the top 10 surgeries for seniors. By 1998/99, total knee replacement was the third most common procedure for those aged 65 or older; hip replacement was in sixth position (data not shown). Among senior women, knee replacement ranked second, and hip replacement, fourth. For senior

men, knee replacement ranked fifth, and hip replacement, seventh.

### Hip replacement

In 1998/99, a total of 12,492 hip replacements were performed on seniors, up from 3,865 in 1981/82 (Appendix Table A). The age-adjusted rate per 100,000 population aged 65 or older was 335.3 in 1998/99, more than double the 1981/82 rate of

## Limitations

In this study, the selection of hip and knee surgery cases is based on the first two surgical procedures listed in the discharge abstract. In most provinces, the designation of a surgical procedure as primary or secondary reflects the importance of the procedure and its role in the length of hospital stay and hospital care costs. The majority of hip and knee replacements are encompassed by the selection criteria.

Rates of hip and knee replacement are calculated based on the total population aged 20 or older, and for seniors aged 65 or older. It was not possible to exclude people who had already had the procedure from the denominators.

The figures refer only to people who were residents of the province in which the surgery was performed. Not all provincial databases contain information about residents who obtain hospital services outside their home province. Therefore, people who may have had joint replacement surgery in another province may not be counted. But excluding patients who had their surgery in another province should have little impact on the results, as less than 2% of hip or knee replacement surgery involved out-of-province residents.

Health numbers are assigned by provincial ministries of health. Patients who move from one province to another are assigned new health numbers. Consequently, patients discharged from hospitals in different provinces during the same year may have been counted twice.

This analysis excludes the Northwest Territories, the Yukon and Nunavut. The number of hip and knee replacements performed in the North is small and should not substantially affect the results.

Hospital records are based on fiscal years, but the population estimates used to calculate rates refer to a specific point in the calendar year. However, since the size of the population changes very little in a single year, any effect should be minimal and should not affect the validity of results.

NPHS estimates of the prevalence of arthritis are based on self-reports of a diagnosis of "arthritis/rheumatism" by a health care professional and may not correspond to the prevalence of osteoarthritis or rheumatoid arthritis that would be obtained from administrative data or clinical records.

Length of stay refers to the total number of days for a separation. With the hospital morbidity file, it was not possible to sum the total length of stay for a specific case if a patient was transferred to another hospital. An ICES study did attempt to examine both acute care days and rehabilitation facility days in Ontario to obtain a different perspective on length-of-stay patterns.<sup>15</sup> Acute care hospitals that have the option of transferring patients could be expected to have shorter stays than those without that option. In the national hospital morbidity file, it is not possible to distinguish between acute care hospitals and hospitals that serve primarily as rehabilitation facilities.

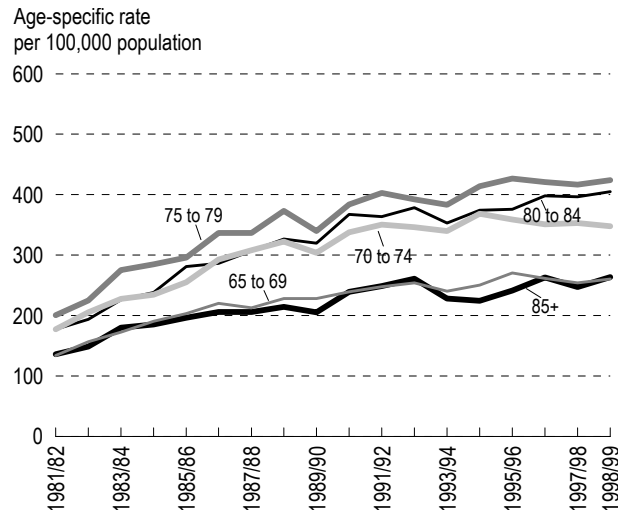
Hospital readmission within 30 days is a limited measure of complications from surgery, because it does not account for the patient's status before and after admission. Pre-admission comorbidity refers to a condition that usually has an important influence on the patient's length of stay and/or influences the management/treatment of a patient while in hospital. Post-admission comorbidity describes a condition arising *after* admission that influences the management/treatment of the patient while in hospital. In this analysis, it was not possible to examine pre- or post-admission comorbidity because five provinces do not provide the data.

The readmission of patients who had joint replacement may be totally unrelated to that surgery. For example, although pulmonary embolism is a potentially serious complication of hip or knee surgery, the condition may also arise as a result of a number of other diseases.

In this analysis, mortality associated with joint replacement refers only to in-hospital mortality. People who were discharged and died outside hospital would not be reflected in mortality rates.

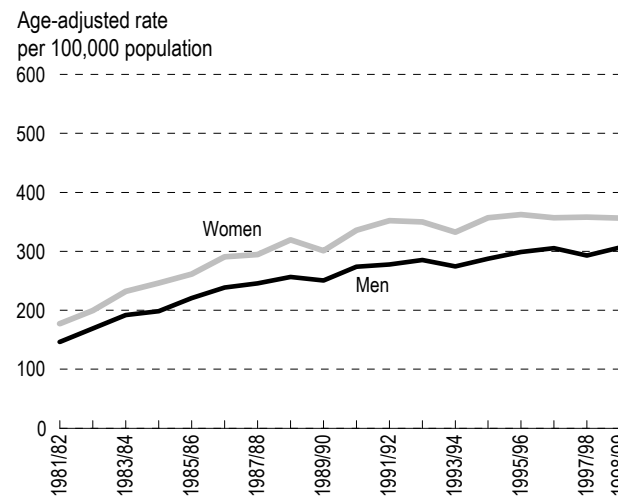
164.6. Hip replacement rates increased among all senior age groups, but throughout the period were highest at ages 75-to-79 (Chart 1). The rate rose sharply among both sexes, although it was consistently higher for women (Chart 2).

**Chart 1**  
Hip replacement rates, by age group, population aged 65 or older, Canada excluding territories, 1981/82 to 1998/99



**Data source:** Hospital Morbidity Database, 1981/82 to 1998/99  
**Note:** Hip replacement refers to Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures codes 93.51 or 93.59 for primary or secondary surgical procedure.

**Chart 2**  
Age-adjusted hip replacement rates, by sex, population aged 65 or older, Canada excluding territories, 1981/82 to 1998/99

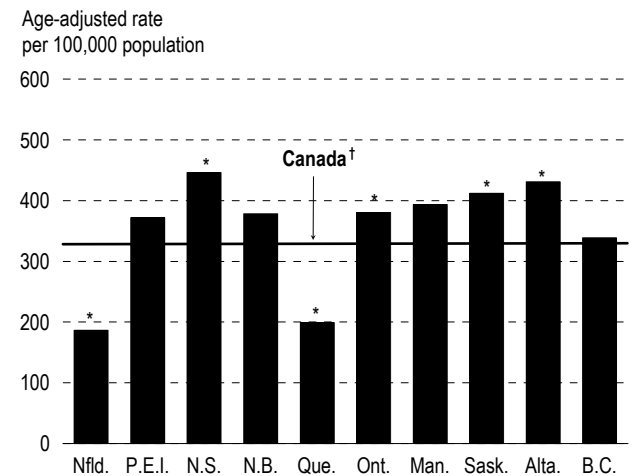


**Data source:** Hospital Morbidity Database, 1981/82 to 1998/99  
**Note:** Hip replacement refers to Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures codes 93.51 or 93.59 for primary or secondary surgical procedure.

In 1998/99, hip replacement rates were significantly higher for all senior female age groups compared with their male counterparts (data not shown). This may reflect sex differences in the prevalence of osteoarthritis or in the functional limitations imposed by osteoarthritic disease.

Although the hip replacement rate among seniors rose in all provinces (Appendix Table B), provincial differences were substantial. In 1998/99, age-adjusted rates were significantly higher than the national level in Nova Scotia, Alberta, Saskatchewan and Ontario (Chart 3). Rates in Newfoundland and Québec were significantly below the national figure.

**Chart 3**  
Age-adjusted hip replacement rates, population aged 65 or older, Canada and provinces, 1998/99



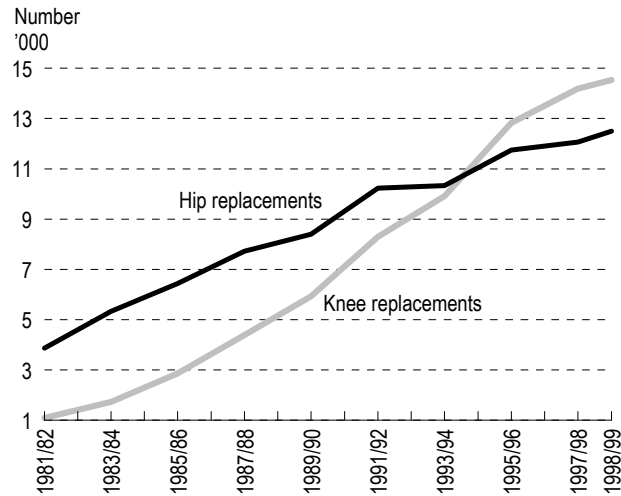
**Data source:** Hospital Morbidity Database, 1981/82 to 1998/99  
**Notes:** Hip replacement refers to Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures codes 93.51 or 93.59 for primary or secondary surgical procedure.  
† Excludes territories  
\* Significantly different from rate for Canada ( $p \leq 0.05$ )

### Knee replacements exceed hip replacements

A total of 14,529 knee replacements were performed on seniors in 1998/99, up from just 1,089 in 1981/82 (Appendix Table C). In fact, since the mid-1990s, the annual number of knee replacements has exceeded hip replacements (Chart 4). This contrasts with the situation in the early 1980s, when relatively few elderly people had knee replacements, reflecting the novelty of the surgery at the time. The age-

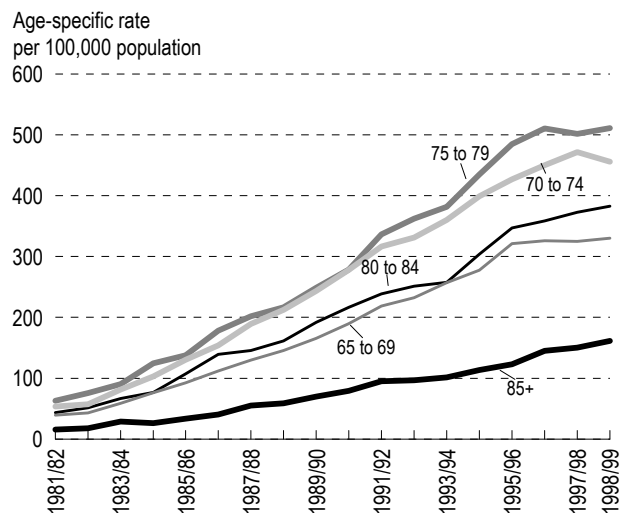
adjusted rate for knee replacement rose dramatically over the period, from 45.9 to 389.9 per 100,000 population aged 65 or older. Rates increased among all senior age groups, even the most elderly (Chart 5).

**Chart 4**  
Hospital separations for hip and knee replacement, population aged 65 or older, Canada excluding territories, 1981/82 to 1998/99



**Data source:** Hospital Morbidity Database, 1981/82 to 1998/99  
**Note:** Hip replacement refers to Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures codes 93.51 or 93.59 for primary or secondary surgical procedure; knee replacement refers to code 93.41 for primary or secondary surgical procedure.

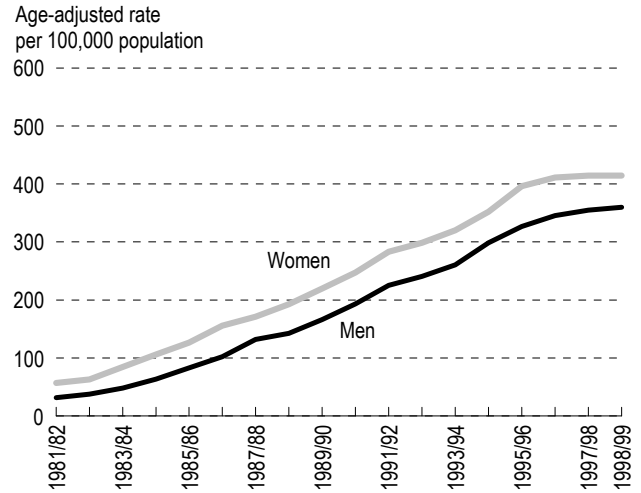
**Chart 5**  
Knee replacement rates, by age group, population aged 65 or older, Canada excluding territories, 1981/82 to 1998/99



**Data source:** Hospital Morbidity Database, 1981/82 to 1998/99  
**Note:** Knee replacement refers to Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures code 93.41 for primary or secondary surgical procedure.

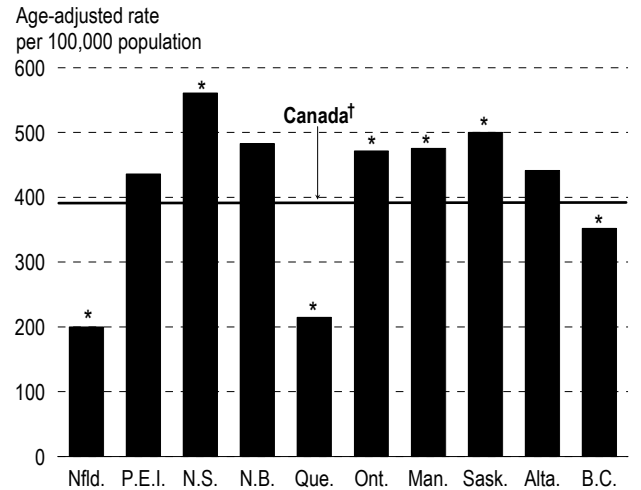
This sharp increase was evident for both sexes, with women having a consistently higher rate of knee replacement than did men (Chart 6). In 1998/99, the rates for knee replacement were

**Chart 6**  
Age-adjusted knee replacement rates, by sex, population aged 65 or older, Canada excluding territories, 1981/82 to 1998/99



**Data source:** Hospital Morbidity Database, 1981/82 to 1998/99  
**Note:** Knee replacement refers to Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures code 93.41 for primary or secondary surgical procedure.

**Chart 7**  
Age-adjusted knee replacement rates, population aged 65 or older, Canada and provinces, 1998/99



**Data source:** Hospital Morbidity Database, 1981/82 to 1998/99  
**Notes:** Knee replacement refers to Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures code 93.41 for primary or secondary surgical procedure.  
† Excludes territories  
\* Significantly different from rate for Canada ( $p \leq 0.05$ ).

significantly higher for women in all senior age groups except 85-or-older (data not shown).

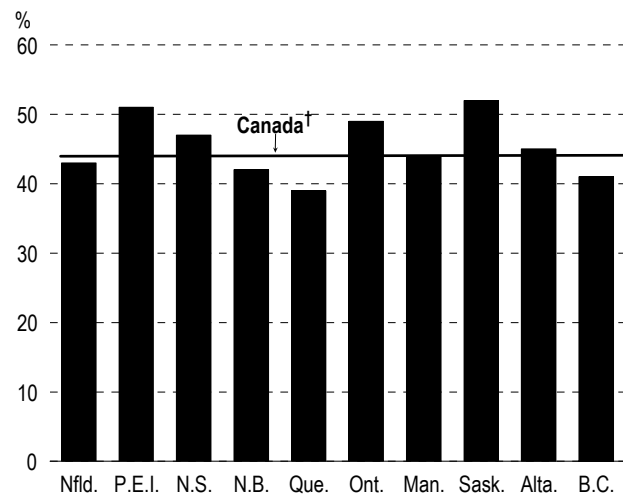
The rate of knee replacement among seniors rose in all provinces, although provincial differences were marked. By 1998/99, four provinces had rates significantly above the national level: Nova Scotia, Saskatchewan, Manitoba and Ontario; rates in Québec, Newfoundland and British Columbia were significantly lower (Chart 7).

### Prevalence of arthritis

Higher rates of hip and knee replacement among senior women than among senior men may reflect the higher prevalence of arthritis/rheumatism among women. According to the 1998/99 National Population Health Survey (NPHS), 52% of women aged 65 or older reported having arthritis/rheumatism, compared with 35% of men. This disparity prevailed in all senior age groups except 85-or-older (data not shown).

It appears, however, that arthritis is not a major factor in provincial disparities in joint replacement rates, as there were no statistically significant differences between provinces in the prevalence of

Chart 8  
Prevalence of arthritis, household population aged 65 or older, Canada and provinces, 1998/99



**Data source:** 1998/99 National Population Health Survey, cross-sectional sample, Health file

**Notes:** There were no statistically significant differences in prevalence of arthritis among provinces ( $p \leq 0.05$ , adjusted for multiple comparisons).

† Excludes territories

### Definitions

Joint replacement, a common treatment for osteoarthritis, is most successful in large joints such as the hip and knee. Hip or knee replacement is typically recommended when more conservative and less invasive treatments (medications, physical therapy, for example) fail to provide adequate relief from the pain and loss of mobility associated with deterioration of the joint. The surgery involves removing the damaged joint and replacing it with a plastic and/or metal prosthesis.

In accordance with the *Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures* codes,<sup>16</sup> hip replacement was defined as the presence of procedure codes 93.51 (with use of methyl methacrylate) or 93.59 (other total hip replacement). Knee replacement was defined as 93.41 total knee replacement (geomedic) (polycentric). These codes correspond to the clinical modification of the *International Classification of Diseases, 9th revision (ICD-9)*.<sup>17</sup> Some studies have excluded patients with various comorbidities;<sup>18</sup> however, because information on comorbidities was not available on the national file, all cases of total hip or knee replacement were selected for this analysis.

National Population Health Survey respondents were asked if they had “long-term conditions that have lasted or are expected to last six months or more and that have been diagnosed by a health professional.” One of the listed conditions was arthritis/rheumatism. Respondents who answered “yes” were defined as having arthritis (see *Limitations*).

the condition (Chart 8). Therefore, the low rates of joint replacement in Newfoundland and Québec, and the high rates in Nova Scotia, Ontario and Saskatchewan, do not coincide with the prevalence of arthritis in those provinces. This conclusion is supported by a study that found the prevalence of arthritis by region in Ontario to be poorly associated with joint replacement surgery rates.<sup>19</sup>

### Shorter hospital stays

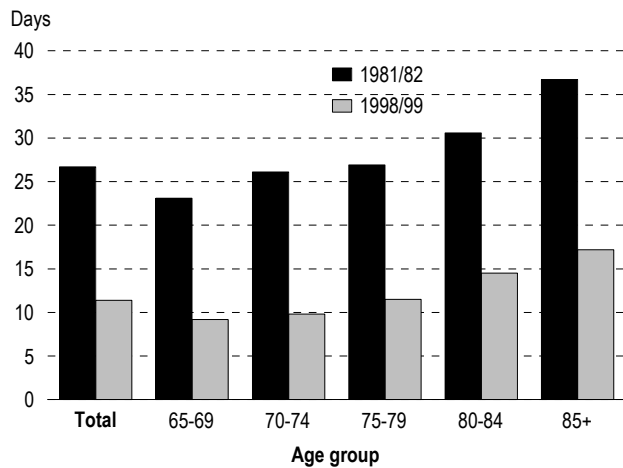
Over the last two decades, average lengths of stay for all types of hospitalization have decreased.<sup>20</sup> Hip and knee replacement followed this trend, even among seniors.

The average length of stay for hip replacement among patients aged 65 or older was more than halved between 1981/82 and 1998/99, falling from 26.7 to 11.4 days (Appendix Table E). For knee

replacement, the decrease was even greater: from 25.6 to 9.1 days (Appendix Table F).

Not surprisingly, stays tend to be longer for older patients. In 1998/99, 65- to 69-year olds undergoing hip replacement averaged 9.2 days in hospital; for those aged 85 or older, the time stretched to 17.2

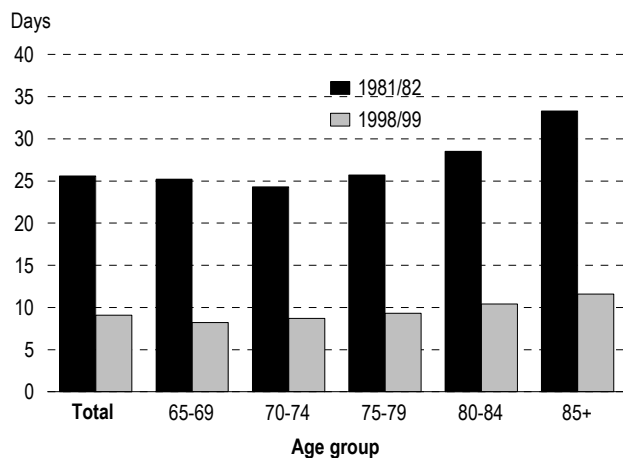
Chart 9  
Average length of stay for hip replacement, by age group, population aged 65 or older, Canada excluding territories, 1981/82 and 1998/99



Data source: Hospital Morbidity Database, 1981/82 to 1998/99

Note: Hip replacement refers to Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures codes 93.51 or 93.59 for primary or secondary surgical procedure.

Chart 10  
Average length of stay for knee replacement, by age group, population aged 65 or older, Canada excluding territories, 1981/82 and 1998/99



Data source: Hospital Morbidity Database, 1981/82 to 1998/99

Note: Hip replacement refers to Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures codes 93.51 or 93.59 for primary or secondary surgical procedure.

### In-hospital mortality and readmission

In-hospital mortality associated with hip and knee replacement is low. In 1998/99, about 1.5% of hip replacement patients and 0.5% of knee replacement patients aged 65 or older died in hospital within 30 days of the surgery. Moreover, not all of these deaths were attributable to the joint replacement, as patients may have had other conditions that influenced the outcome.

Complications were also infrequent among seniors undergoing joint replacement. The most common complications associated with hip replacement were mechanical problems with an internal orthopedic device (3.2%) or dislocation of the hip (1.4%). Infection and thromboembolism were relatively uncommon, reflecting the use of prophylactic drugs and various measures to reduce risk. For knee replacement, the most frequent complication was infection and inflammatory reaction related to the device.

### In-hospital mortality and selected complications within 30 days of hip or knee replacement, population aged 65 or older, Canada excluding territories, 1998/99

	Hip		Knee	
	Number	%	Number	%
In-hospital mortality	174	1.51	73	0.54
<b>Complications involving readmission</b>				
Mechanical complications, internal orthopedic device	363	3.15	46	0.34
Dislocation (hip)	164	1.42	...	...
Infection/Inflammatory reaction, device-related	61	0.53	73	0.54
Hemorrhage/Hematoma	64	0.56	43	0.32
Thromboembolism (deep vein thrombosis)	40	0.35	52	0.39
Pulmonary embolism	45	0.39	36	0.27
Other complications of internal prosthetic device	41	0.36	49	0.36
Cardiac, procedure-related	11	0.10	15	0.11
Respiratory, procedure-related	10	0.09	10	0.07

Data sources: 1998/99 Hospital Morbidity Database; 1998/99 Person-oriented Information Database

Notes: Mortality may be underestimated because some patients may have died from surgery-related causes, but outside hospital. Some complications may be attributable to conditions that existed before surgery, for example, pulmonary embolism.

... Not applicable



declined dramatically between 1981/82 and 1998/99 (Charts 9 and 10).

For both types of surgery, average stays for seniors varied by province. In 1998/99, the average for hip replacement ranged from 9.8 days in Alberta to 15.6 days in New Brunswick. Average stays for knee replacement ranged from 7.9 days in Ontario to 13.5 days in Prince Edward Island. These differences could be partly related to the age composition of the population undergoing surgery, the availability of care after surgery (formal and informal), as well as to distances between communities and hospitals.

### Concluding remarks

Between 1981/82 and 1998/99, the annual number of hip and knee replacements rose sharply, to rank among the 10 most common surgeries performed on elderly people in Canadian hospitals. The marked increase was evident for both sexes and in all senior age groups, with rates being consistently higher for women. By the mid-1990s, knee replacements had surpassed those for the hip, which likely reflects improvements in anesthetic and surgical techniques that have made knee replacement less risky for older patients.

Although hospitalization rates for hip and knee replacement rose across the country, differences among the provinces were substantial. The availability of orthopedic surgeons is sometimes proposed as a reason for provincial disparities in surgery rates. However, a 2001 study found little or no relationship between the supply of orthopedic surgeons and the rate of hip and knee surgery.<sup>21</sup> Other factors that might contribute to provincial variations include the availability of hospital beds, competition for operating theatres, hospital management decisions about the purchase of medical devices, and prevailing views among specialists about the most appropriate treatment.<sup>22-24</sup> Patient factors such as awareness of treatment options, and differences in the psychological, social and economic factors that influence the demand for health services may also be important.<sup>25</sup>

It is likely that the number of hip and knee replacements will rise in the next decade. The population aged 65 or older is expected to increase; consequently, even if current surgery rates remain stable, demographic changes may lead to a considerable upturn in the number of procedures. In addition, as surgical techniques improve and awareness of the success of the procedures grows, demand may increase. ●

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## Appendix

Table A

**Hospital separations and age-specific rates for hip replacement, population aged 65 or older, Canada excluding territories, 1981/82 to 1998/99**

	Age group					
	Total	65-69	70-74	75-79	80-84	85+
<b>Number of separations</b>						
1981/82	3,865	1,137	1,130	874	458	266
1982/83	4,532	1,346	1,352	1,015	518	301
1983/84	5,328	1,488	1,550	1,286	629	375
1984/85	5,780	1,651	1,659	1,376	695	399
1985/86	6,443	1,806	1,866	1,480	852	439
1986/87	7,338	2,034	2,185	1,743	899	477
1987/88	7,718	2,060	2,342	1,812	1,005	499
1988/89	8,509	2,301	2,470	2,088	1,110	540
1989/90	8,395	2,390	2,352	1,982	1,129	542
1990/91	9,589	2,556	2,696	2,330	1,346	661
1991/92	10,232	2,687	2,928	2,509	1,391	717
1992/93	10,564	2,769	3,026	2,483	1,506	780
1993/94	10,336	2,635	3,089	2,442	1,462	708
1994/95	11,215	2,763	3,464	2,655	1,612	721
1995/96	11,747	3,009	3,434	2,819	1,683	802
1996/97	11,949	2,931	3,391	2,900	1,820	907
1997/98	12,061	2,881	3,432	3,015	1,849	884
1998/99	12,492	2,971	3,415	3,211	1,906	989
<b>Rate per 100,000 population</b>						
1981/82	164.6	134.0	177.3	200.7	177.2	136.1
1982/83	187.2	156.5	205.5	224.7	193.6	148.7
1983/84	215.4	172.6	227.5	275.2	225.8	180.2
1984/85	226.9	190.7	234.7	285.0	238.4	185.1
1985/86	244.9	203.1	255.2	296.1	281.1	196.3
1986/87	269.8	220.0	292.5	336.9	286.4	206.0
1987/88	274.3	212.7	307.9	336.9	306.8	205.9
1988/89	293.6	228.2	322.5	373.4	326.7	214.2
1989/90	279.9	227.9	304.1	339.6	319.7	205.2
1990/91	310.6	239.0	337.5	383.6	367.1	239.5
1991/92	321.0	247.5	350.7	402.7	363.4	249.0
1992/93	322.9	254.2	346.2	392.5	378.3	261.0
1993/94	308.6	240.0	339.9	383.3	353.2	228.2
1994/95	327.8	250.6	368.2	413.9	374.0	224.4
1995/96	336.0	270.7	359.1	426.7	376.0	241.1
1996/97	334.9	261.3	351.0	421.0	398.0	263.3
1997/98	330.4	253.9	352.9	416.6	396.6	247.2
1998/99	335.3	260.5	347.5	424.2	404.8	263.7

**Data source:** Hospital Morbidity Database, 1981/82 to 1998/99

**Notes:** Hip replacement refers to Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures codes 93.51 or 93.59 for primary or secondary surgical procedure. Rate for total population aged 65 or older is age-adjusted.

Table B  
Hospital separations and age-adjusted rates for hip replacement, population aged 65 or older, Canada and provinces, 1981/82 to 1998/99

	Canada†	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.
<b>Number of separations</b>											
1981/82	3,865	19	48	198	99	373	1,665	203	200	362	698
1982/83	4,532	38	53	216	124	431	1,985	215	259	475	736
1983/84	5,328	46	113	234	164	577	2,214	217	342	520	901
1984/85	5,780	46	66	259	185	573	2,477	257	347	582	988
1985/86	6,443	62	80	356	210	667	2,706	293	473	626	970
1986/87	7,338	76	75	388	194	831	2,957	285	493	734	1,305
1987/88	7,718	64	82	372	204	952	3,198	337	445	704	1,360
1988/89	8,509	56	68	423	206	997	3,537	292	490	861	1,579
1989/90	8,395	65	75	407	236	1,066	3,650	312	567	824	1,193
1990/91	9,589	100	75	423	292	1,221	4,160	325	581	942	1,470
1991/92	10,232	109	70	436	276	1,282	4,528	420	553	993	1,565
1992/93	10,564	90	70	486	324	1,363	4,717	403	516	1,087	1,508
1993/94	10,336	124	79	468	293	1,506	4,275	398	525	1,007	1,661
1994/95	11,215	109	69	494	297	1,487	4,862	452	599	1,250	1,596
1995/96	11,747	131	74	505	353	1,552	4,984	463	651	1,238	1,796
1996/97	11,949	126	87	507	363	1,463	5,089	505	686	1,342	1,781
1997/98	12,061	116	70	497	362	1,574	5,277	570	617	1,211	1,767
1998/99	12,492	115	65	555	369	1,805	5,384	614	619	1,231	1,735
<b>Age-adjusted rate per 100,000 population</b>											
1981/82	164.6	38.9	325.1	218.2	138.4	65.1	193.4	165.3	174.1	221.0	234.8
1982/83	187.2	81.5	349.3	230.7	171.1	72.8	223.2	173.0	219.7	280.4	238.0
1983/84	215.4	98.5	723.3	244.0	222.3	95.1	244.0	171.5	282.7	298.8	284.5
1984/85	226.9	94.1	413.3	260.2	244.6	92.5	264.5	199.2	280.1	324.5	302.6
1985/86	244.9	121.8	496.8	352.5	272.7	104.5	279.6	220.4	372.9	335.8	284.9
1986/87	269.8	151.1	455.7	373.6	244.3	127.1	294.8	210.1	381.7	380.3	367.3
1987/88	274.3	123.5	496.1	350.4	249.6	141.5	307.5	244.0	336.3	351.1	366.6
1988/89	293.6	105.2	410.1	390.0	247.1	142.2	329.7	207.8	365.2	416.2	412.5
1989/90	280.0	118.8	446.1	370.6	276.5	145.7	328.2	218.0	415.1	383.7	300.1
1990/91	310.6	184.1	435.9	376.4	335.9	161.7	361.7	224.3	417.7	425.4	356.6
1991/92	321.0	197.0	406.0	381.3	308.6	164.7	380.9	285.0	390.3	430.3	366.1
1992/93	322.9	159.0	400.8	419.0	358.4	171.3	384.5	269.9	359.7	454.3	343.7
1993/94	308.6	214.1	442.2	397.3	319.1	184.8	339.1	266.0	360.8	407.9	368.6
1994/95	327.8	187.1	391.1	415.5	319.5	179.1	377.4	298.6	408.8	490.7	344.4
1995/96	336.0	220.8	410.3	421.4	377.2	182.9	377.8	303.5	438.2	472.9	377.1
1996/97	334.9	210.9	487.4	417.4	382.6	168.5	376.9	329.4	459.5	499.3	365.1
1997/98	330.4	189.9	385.4	405.4	374.8	176.9	381.5	368.7	414.2	436.2	352.6
1998/99	335.3	186.7*	371.9	446.2*	378.0	199.0*	380.1*	393.7	412.1*	430.7*	338.8

Data source: Hospital Morbidity Database, 1981/82 to 1998/99

Notes: Hip replacement refers to Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures codes 93.51 or 93.59 for primary or secondary surgical procedure. Differences in rates between Canada and each province tested for 1998/99 only.

† Excludes territories

\* Significantly different from rate for Canada ( $p \leq 0.05$ )

Table C  
**Hospital separations and age-specific rates for knee replacement, population aged 65 or older, Canada excluding territories, 1981/82 to 1998/99**

	Age group					
	Total	65-69	70-74	75-79	80-84	85+
<b>Number of separations</b>						
1981/82	1,089	333	339	275	112	30
1982/83	1,259	369	375	341	138	36
1983/84	1,728	507	555	421	185	60
1984/85	2,269	659	729	602	223	56
1985/86	2,862	824	952	687	324	75
1986/87	3,639	1,035	1,151	922	438	93
1987/88	4,391	1,255	1,440	1,086	477	133
1988/89	5,005	1,469	1,628	1,212	548	148
1989/90	5,929	1,734	1,883	1,450	677	185
1990/91	6,958	2,030	2,223	1,692	795	218
1991/92	8,301	2,374	2,642	2,097	914	274
1992/93	9,008	2,531	2,896	2,292	1,000	289
1993/94	9,909	2,820	3,276	2,433	1,066	314
1994/95	11,284	3,064	3,757	2,790	1,309	364
1995/96	12,823	3,570	4,085	3,205	1,554	409
1996/97	13,664	3,659	4,348	3,517	1,641	499
1997/98	14,187	3,689	4,589	3,633	1,739	537
1998/99	14,529	3,767	4,483	3,871	1,802	606
<b>Rate per 100,000 population</b>						
1981/82	45.9	39.3	53.2	63.1	43.3	15.3
1982/83	51.8	42.9	57.0	75.5	51.6	17.8
1983/84	69.1	58.8	81.5	90.1	66.4	28.8
1984/85	88.1	76.1	103.1	124.7	76.5	26.0
1985/86	107.5	92.6	130.2	137.4	106.9	33.5
1986/87	132.8	111.9	154.1	178.2	139.5	40.2
1987/88	154.6	129.6	189.3	201.9	145.6	54.9
1988/89	171.0	145.7	212.5	216.8	161.3	58.7
1989/90	196.6	165.3	243.4	248.4	191.7	70.0
1990/91	223.4	189.8	278.3	278.6	216.8	79.0
1991/92	258.5	218.6	316.4	336.6	238.8	95.2
1992/93	273.6	232.4	331.3	362.3	251.2	96.7
1993/94	294.0	256.9	360.5	381.9	257.6	101.2
1994/95	328.5	277.9	399.3	435.0	303.7	113.3
1995/96	365.8	321.2	427.2	485.1	347.2	123.0
1996/97	382.2	326.1	450.0	510.6	358.8	144.9
1997/98	388.2	325.1	471.8	502.0	373.0	150.2
1998/99	389.9	330.3	456.2	511.3	382.8	161.6

**Data source:** Hospital Morbidity Database, 1981/82 to 1998/99

**Notes:** Knee replacement refers to Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures code 93.41 for primary or secondary surgical procedure. Rate for total population aged 65 or older is age-adjusted.

Table D  
Hospital separations and age-adjusted rates for knee replacement, population aged 65 or older, Canada and provinces, 1981/82 to 1998/99

	Canada†	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.
<b>Number of separations</b>											
1981/82	1,089	2	12	12	23	111	589	50	52	66	172
1982/83	1,259	7	7	21	39	124	630	41	65	125	200
1983/84	1,728	6	6	24	55	219	841	63	85	152	277
1984/85	2,269	22	13	66	68	247	1,128	95	119	188	323
1985/86	2,862	22	14	115	74	307	1,368	114	201	257	390
1986/87	3,639	12	26	172	131	408	1,627	136	223	320	584
1987/88	4,391	16	21	226	169	475	2,042	167	265	376	634
1988/89	5,005	12	16	299	134	592	2,338	214	307	391	702
1989/90	5,929	26	40	323	174	624	2,809	217	463	530	723
1990/91	6,958	30	44	272	219	860	3,305	203	505	564	956
1991/92	8,301	48	44	346	261	1,023	4,040	233	529	707	1,070
1992/93	9,008	71	55	359	283	1,103	4,266	292	587	823	1,169
1993/94	9,909	76	53	431	300	1,329	4,449	411	590	936	1,334
1994/95	11,284	111	64	491	315	1,516	5,119	449	690	1,188	1,341
1995/96	12,823	117	57	676	369	1,599	5,780	494	645	1,365	1,721
1996/97	13,664	158	54	655	438	1,643	6,152	546	764	1,495	1,759
1997/98	14,187	124	61	650	452	1,732	6,507	689	773	1,403	1,796
1998/99	14,529	123	76	685	466	1,953	6,698	730	737	1,263	1,798
<b>Age-adjusted rate per 100,000 population</b>											
1981/82	45.9	3.7	83.6	12.6	32.3	18.3	67.8	41.1	44.1	40.4	58.3
1982/83	51.8	13.5	45.2	21.5	51.7	20.4	70.8	33.4	55.5	73.5	65.6
1983/84	69.1	12.4	40.1	24.1	73.5	35.4	91.5	48.1	69.5	88.0	89.0
1984/85	88.1	43.7	84.2	67.2	90.2	38.7	119.2	73.2	95.7	104.1	99.2
1985/86	107.5	43.4	88.5	112.7	94.7	46.7	140.0	85.7	157.8	137.0	114.1
1986/87	132.8	24.0	161.7	164.7	164.9	59.8	161.5	100.4	172.3	164.8	164.8
1987/88	154.6	28.9	129.9	211.0	206.7	68.9	194.8	120.4	200.0	185.6	170.2
1988/89	171.0	22.1	97.6	275.1	160.3	81.7	216.3	152.8	228.6	186.9	181.9
1989/90	196.6	46.2	240.1	290.5	203.7	84.0	250.9	151.9	339.0	248.2	179.7
1990/91	223.4	52.3	258.6	240.5	250.7	112.9	285.0	139.7	363.7	252.5	230.0
1991/92	258.5	84.3	255.5	301.0	291.2	129.9	337.0	158.2	374.9	305.2	248.7
1992/93	273.6	121.2	321.2	308.7	311.9	136.7	345.6	196.1	409.8	343.8	264.3
1993/94	294.0	129.1	310.6	366.7	326.1	160.7	350.3	274.0	408.7	378.5	294.5
1994/95	328.5	187.3	371.8	414.2	339.4	180.2	395.1	297.4	475.1	465.4	288.2
1995/96	365.8	195.1	330.9	567.6	396.3	186.6	435.8	324.8	438.5	521.2	361.2
1996/97	382.2	261.7	311.6	544.6	464.3	189.0	452.8	359.4	523.3	553.1	360.3
1997/98	388.2	202.8	351.3	534.1	472.4	193.4	468.3	452.9	527.1	504.7	358.8
1998/99	389.9	199.7*	435.8	560.9*	482.9	214.5*	471.5*	475.3*	500.4*	441.4	352.0*

Data source: Hospital Morbidity Database, 1981/82 to 1998/99

Notes: Knee replacement refers to Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures code 93.41 for primary or secondary surgical procedure. Differences in rates between Canada and each province tested for 1998/99 only.

† Excludes territories

\* Significantly different from rate for Canada ( $p \leq 0.05$ )

Table E

Number of hospital days and average length of stay for hip replacement, by age group, population aged 65 and older, Canada excluding territories, 1981/82 to 1998/99

	Age group					
	Total	65-69	70-74	75-79	80-84	85+
<b>Number of days</b>						
1981/82	103,009	26,236	29,480	23,529	14,009	9,755
1982/83	114,779	27,951	31,185	28,760	15,473	11,410
1983/84	130,221	30,288	35,861	32,423	18,381	13,268
1984/85	137,304	32,999	36,165	33,689	20,288	14,163
1985/86	145,915	35,713	38,994	35,238	21,177	14,793
1986/87	163,662	37,826	45,186	42,231	24,475	13,944
1987/88	173,663	38,621	47,624	41,379	28,576	17,463
1988/89	187,829	42,628	48,774	48,797	29,052	18,578
1989/90	174,855	45,493	44,062	41,192	29,036	15,072
1990/91	199,651	43,115	50,221	48,938	34,612	22,765
1991/92	203,054	43,818	51,049	49,911	35,910	22,366
1992/93	199,589	40,608	49,630	47,347	36,024	25,980
1993/94	168,799	34,988	46,136	39,347	32,133	16,195
1994/95	163,866	33,343	46,321	41,071	27,816	15,315
1995/96	162,684	33,518	43,665	39,454	29,818	16,229
1996/97	152,059	29,738	38,279	34,684	31,282	18,076
1997/98	139,558	27,973	34,272	34,789	26,847	15,677
1998/99	142,055	27,240	33,370	36,805	27,649	16,991
<b>Average number of days</b>						
1981/82	26.7	23.1	26.1	26.9	30.6	36.7
1982/83	25.3	20.8	23.1	28.3	29.9	37.9
1983/84	24.4	20.4	23.1	25.2	29.2	35.4
1984/85	23.8	20.0	21.8	24.5	29.2	35.5
1985/86	22.6	19.8	20.9	23.8	24.9	33.7
1986/87	22.3	18.6	20.7	24.2	27.2	29.2
1987/88	22.5	18.7	20.3	22.8	28.4	35.0
1988/89	22.1	18.5	19.7	23.4	26.2	34.4
1989/90	20.8	19.0	18.7	20.8	25.7	27.8
1990/91	20.8	16.9	18.6	21.0	25.7	34.4
1991/92	19.8	16.3	17.4	19.9	25.8	31.2
1992/93	18.9	14.7	16.4	19.1	23.9	33.3
1993/94	16.3	13.3	14.9	16.1	22.0	22.9
1994/95	14.6	12.1	13.4	15.5	17.3	21.2
1995/96	13.8	11.1	12.7	14.0	17.7	20.2
1996/97	12.7	10.1	11.3	12.0	17.2	19.9
1997/98	11.6	9.7	10.0	11.5	14.5	17.7
1998/99	11.4	9.2	9.8	11.5	14.5	17.2

Data source: Hospital Morbidity Database, 1981/82 to 1998/99

Note: Hip replacement refers to Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures codes 93.51 or 93.59 for primary or secondary surgical procedure.

Table F

Number of hospital days and average length of stay for knee replacement, by age group, population aged 65 and older, Canada excluding territories, 1981/82 to 1998/99

	Age group					
	Total	65-69	70-74	75-79	80-84	85+
<b>Number of days</b>						
1981/82	27,889	8,404	8,222	7,068	3,195	1,000
1982/83	31,362	8,755	8,689	9,042	3,849	1,027
1983/84	40,513	11,409	13,066	9,874	4,485	1,679
1984/85	52,501	15,271	16,669	13,681	5,627	1,253
1985/86	61,432	17,048	19,117	15,574	7,781	1,912
1986/87	75,746	20,857	23,556	19,335	9,650	2,348
1987/88	86,846	22,847	27,508	21,953	11,430	3,108
1988/89	96,458	26,352	30,329	24,122	12,273	3,382
1989/90	106,968	29,222	32,913	26,721	14,137	3,975
1990/91	123,314	32,681	37,602	32,852	15,816	4,363
1991/92	137,115	37,311	41,837	35,817	16,410	5,740
1992/93	134,770	34,837	42,239	35,820	16,546	5,328
1993/94	134,325	35,094	43,628	34,262	16,180	5,161
1994/95	142,510	37,400	46,435	35,096	18,327	5,252
1995/96	141,321	36,699	43,221	35,505	19,704	6,192
1996/97	138,414	34,455	42,436	36,742	17,527	7,254
1997/98	134,652	32,476	42,639	34,772	18,087	6,678
1998/99	131,730	30,778	39,162	36,038	18,703	7,049
<b>Average number of days</b>						
1981/82	25.6	25.2	24.3	25.7	28.5	33.3
1982/83	24.9	23.7	23.2	26.5	27.9	28.5
1983/84	23.4	22.5	23.5	23.5	24.2	28.0
1984/85	23.1	23.2	22.9	22.7	25.2	22.4
1985/86	21.5	20.7	20.1	22.7	24.0	25.5
1986/87	20.8	20.2	20.5	21.0	22.0	25.2
1987/88	19.8	18.2	19.1	20.2	24.0	23.4
1988/89	19.3	17.9	18.6	19.9	22.4	22.9
1989/90	18.0	16.9	17.5	18.4	20.9	21.5
1990/91	17.7	16.1	16.9	19.4	19.9	20.0
1991/92	16.5	15.7	15.8	17.1	18.0	20.9
1992/93	15.0	13.8	14.6	15.6	16.5	18.4
1993/94	13.6	12.4	13.3	14.1	15.2	16.4
1994/95	12.6	12.2	12.4	12.6	14.0	14.4
1995/96	11.0	10.3	10.6	11.1	12.7	15.1
1996/97	10.1	9.4	9.8	10.4	10.7	14.5
1997/98	9.5	8.8	9.3	9.6	10.4	12.4
1998/99	9.1	8.2	8.7	9.3	10.4	11.6

Data source: Hospital Morbidity Database, 1981/82 to 1998/99

Note: Knee replacement refers to Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures code 93.41 for primary or secondary surgical procedure.