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Vol. 14 No. 1

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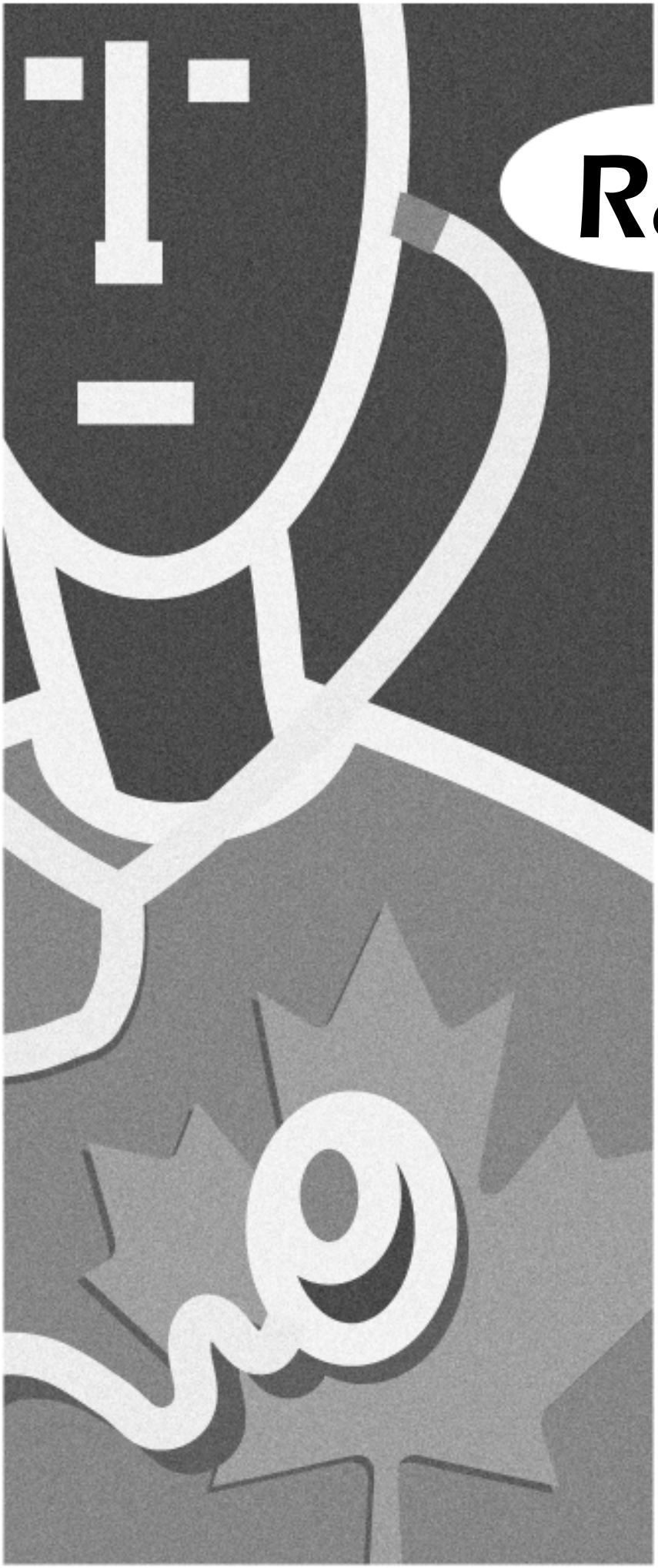

Research Articles

In-depth research and analysis in the fields of health and vital statistics

Moderate alcohol consumption and heart disease

Kathryn Wilkins

Abstract

Objectives

This article examines patterns of alcohol consumption in relation to a subsequent new diagnosis of or death from heart disease.

Data sources

The analysis is based on longitudinal data from the first three cycles of the National Population Health Survey (NPHS), conducted by Statistics Canada in 1994/95, 1996/97 and 1998/99. The data are from a sample of 3,379 women and 2,635 men from the household population, who, in 1994/95, were aged 40 or older and reported that they had not been diagnosed with heart disease. Cause of death was established with information from the Canadian Mortality Database.

Analytical techniques

Descriptive data were produced using bivariate frequencies. Multiple logistic regression was used to examine associations between level of alcohol consumption reported in 1994/95 and a subsequent diagnosis of or death from heart disease.

Main results

Women reporting moderate alcohol consumption—two to nine drinks in the past week—had significantly lower odds of receiving a new diagnosis of or dying from heart disease between 1994/95 and 1998/99, compared with women who reported lifetime abstinence. No association between alcohol consumption and subsequent heart disease emerged for men.

Key words

alcohol drinking, risk factors, longitudinal studies, health surveys

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Numerous prospective studies have indicated that moderate alcohol consumption is protective against ischemic heart disease.[1-7] Research suggests that the association between alcohol use and heart disease is U-shaped; that is, people who consume up to two to three drinks per day have lower heart disease rates than non-drinkers, and people who have more than four to six drinks per day have a higher risk of heart disease than non-drinkers. The biological mechanisms are not thoroughly understood, but alcohol appears to have a favourable effect on lipid production, and it may prevent the formation of arterial clots.[2,8-10]

While studies focusing on alcohol use in relation to illness and mortality have been carried out in several European countries, the United States and parts of Asia, analysis based on Canadian data remains limited.[11] The National Population Health Survey (NPHS) provides data for a nationally representative sample of people followed since 1994/95, which allows an examination of the association between levels of alcohol consumption and subsequent health among Canadians.

Methods

Data source

This article is based on longitudinal data from the first three cycles of the National Population Health Survey (NPHS), 1994/95 through 1998/99. Cause of death was established with information from the Canadian Mortality Database.

The NPHS, which began in 1994/95, collects information about the health of the Canadian population every two years. It covers household and institutional residents in all provinces and territories, except persons on Indian reserves, on Canadian Forces bases, and in some remote areas. The NPHS has both longitudinal and cross-sectional components. Respondents who are part of the longitudinal component will be followed for up to 20 years.

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, which was collected for one randomly selected household member, as well as the information in the General file pertaining to that individual.

Among individuals in the longitudinal component in 1996/97 and 1998/99, the person providing in-depth health information about himself or herself for the Health file was the randomly selected person for the household in cycle 1 (1994/95), and was usually the person who provided information on all household members for the General file in cycles 2 and 3, if judged knowledgeable enough to do so.

The 1994/95 non-institutional sample for the 10 provinces consisted of 27,263 households, of which 88.7% agreed to participate. After application of a screening rule to keep the sample representative,[12] 20,725 households remained in scope. In 18,342 of these households, the selected person was aged 12 or older. Their response rate to the in-depth health questions was 96.1%, or 17,626 respondents. Of these 17,626 randomly selected respondents, 17,276 were eligible for re-interview in 1996/97, and 16,677 were still alive in 1998/99. A response rate of 93.6% was achieved for the longitudinal panel in 1996/97, and a response rate of 88.9%, based on the entire panel, was achieved in 1998/99. Of the 16,168 respondents in 1996/97, full information (that is, general and in-depth health information for the first two cycles of the survey or an outcome of death or institutionalization) was available for 15,670. The corresponding number for 1998/99 was 14,619 respondents.

More detailed descriptions of the NPHS design, sample, and interview procedures can be found in published reports.[12,13]

Analytical techniques

Cause of death was established by linking NPHS records for respondents who were reported to be deceased with Statistics Canada's Canadian Mortality Database. The linkage was carried out at Statistics Canada, using customized computer code to match records on personal identifiers. All records linked in this way, as well as records that could not be machine-linked because of mismatching information, were reviewed manually. People reported to be deceased for whom records could not be linked to the mortality database were excluded from the analysis.

The analysis was restricted to people aged 40 or older with no diagnosis of heart disease in 1994/95; the sample numbered 6,819. The following were excluded from the initial sample of 6,819 respondents: individuals who reported in 1994/95 that they had been diagnosed with heart disease (n = 620) or that they did not know if they had been diagnosed (n = 7); pregnant women (n = 16), because alcohol consumption during pregnancy may be less than usual; people for whom data on diagnosis of heart disease were not available for cycles 2 or 3 (n = 3); and deceased individuals for whom data on cause of death were unavailable (n = 159). The resulting sample size of 6,014 individuals comprised 3,379 women (Appendix Table A) and 2,635 men (Appendix Table B). Records for 33 women and 50 men were excluded from multivariate analysis because of other missing information.

Cross-tabulations were used to estimate bivariate relationships between level of alcohol consumption in 1994/95 and a new diagnosis of or death attributed to heart disease sometime after the cycle 1 interview in 1994/95 but before the cycle 3 interview in 1998/99. To enhance statistical power, diagnosis of heart disease and death attributed to heart disease were combined to comprise the outcome variable.

Multiple logistic regression was used to model associations between a new diagnosis of heart disease or death due to heart disease and level of alcohol consumption, while controlling for factors related to heart disease risk: age, household income, education, diagnosis of diabetes or high blood pressure, family history of heart disease, physical activity, body mass index, smoking history, and hormone replacement therapy (women only). The model was also controlled for self-perceived health. This variable was included because it is a powerful predictor of heart disease and death, probably because it reflects an awareness of changes in health before they are clinically detectable.[14,15]

All independent variables except those reflecting family medical history of heart disease were based on data collected in 1994/95. Information on family history of heart disease was collected in 1998/99 only. Interaction terms between each level of alcohol consumption and years of smoking were explored in preliminary multivariate models.

In multivariate analysis, heart disease/death due to heart disease was the dependent variable; records for respondents who reported that they had not been diagnosed with heart disease, or whose deaths were due to other causes, were coded to 0, and those with a diagnosis of or death attributed to heart disease were coded to 1.

All estimates from cross-tabulations and logistic regression were weighted to represent the Canadian population aged 40 or older in 1994/95. To account for survey design effects, standard errors and coefficients of variation were estimated with the bootstrap technique.[16-18]

This article examines the association between moderate alcohol consumption and heart disease, a leading cause of illness and death in Canada. The mortality rate from heart disease has fallen dramatically over the past few decades; however, according to vital statistics data, heart disease—of which ischemic heart disease is the major component—was the leading cause of death in 1998 (Appendix Table C).

Measuring alcohol consumption

Before questions about alcohol use were asked, interviewers read the following information to respondents: "When we use the word *drink*, it means one bottle or can of beer or a glass of draft, one glass of wine or a wine cooler, or one straight or mixed drink with one and a half ounces of hard liquor."

Information from a series of questions was used to define levels of *alcohol consumption.* Because of the considerable differences in alcohol consumption between men and women, the categories were defined differently by sex.

- *Lifetime abstainer* (a report of never having had a drink) was used as the reference category for both sexes in univariate and bivariate analysis (Appendix Tables A, B, D and E) and for women in multivariate analysis.
- *Former drinkers* comprised people who reported that they had not had a drink in the past year, but that they had consumed at least 1 drink before the past year. This category was used for both sexes in univariate and bivariate analysis, and for women in multivariate analysis. For men, because of the small sample size of lifetime abstainers and resultant statistical instability (see *Limitations*), the reference category for multivariate analysis was broadened to also include those who reported no drinking in the past year but prior consumption that had never regularly exceeded 12 drinks per week. In the multivariate analysis for men, "former drinkers" included only those who reported no drinking in the past year, but regular consumption of more than 12 drinks per week at some time prior to the past year.

For people who reported that they had had at least 1 drink in the past 12 months, level of consumption was derived from the number of drinks during the week before the survey:

- *Occasional* drinkers were those who reported no drinks in the past week.
- *Light* consumption was defined as 1 drink in the past week.
- *Moderate* consumption was defined as 2 to 9 drinks in the past week for women, and 2 to 14 for men, consistent with the sex-specific weekly upper limits recommended in the *Canadian Guidelines on Low-Risk Drinking.*[19]
- *Heavy* drinking was defined as 10 drinks or more in the past week for women; 15 or more, for men.

The analysis is based on data from a sample of household residents aged 40 or older in 1994/95 and who, at that time, reported they had never been diagnosed with heart disease. Data on reported alcohol consumption were studied in relation to a new diagnosis of heart disease or death attributed to ischemic heart disease between 1994/95 and 1998/99 (see *Methods, Measuring alcohol consumption, Definitions* and *Limitations*). Multivariate analysis controls for the effects of other relevant factors, selected based on a review of the literature,[20-24] as well as availability on the NPHS: age, household income, education, self-perceived health, a diagnosis of diabetes or high blood pressure, family history of heart disease, leisure-time physical activity, body mass index, and smoking history. Given the recent report that indicated an adverse effect of long-term hormone replacement therapy (HRT) in relation to coronary heart disease,[25] HRT was also included for women.

Heart disease, alcohol consumption

Among people aged 40 or older in 1994/95 who did not report a diagnosis of heart disease at that time, an estimated 73,000 (n=42) were confirmed to have died from ischemic heart disease, and an additional 706,000 (n=437) reported a new diagnosis of "heart disease" by 1998/99. Similar percentages of women (7%) and men (8%) were reported to have been diagnosed with, or to have died from,

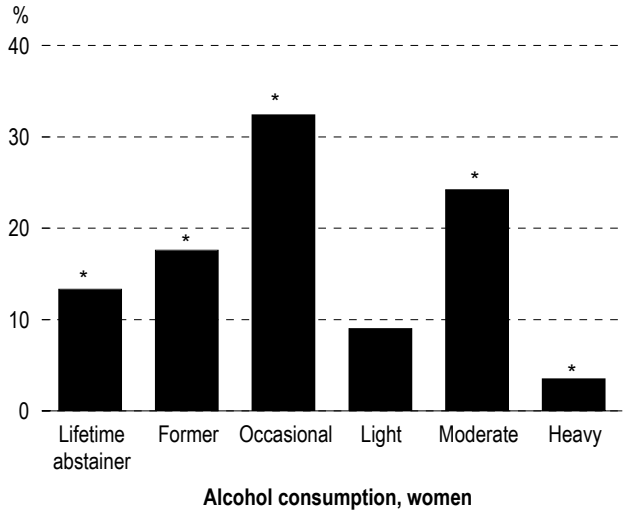
Table 1
New diagnosis of or death due to heart disease between 1994/95 and 1998/99, household population aged 40 or older with no diagnosis of heart disease in 1994/95, by sex, Canada excluding territories

	Women			Men		
	Sample size	Estimated population		Sample size	Estimated population	
		'000	%		'000	%
Total	**3,379**	**5,356**	**100.0**	**2,635**	**4,900**	**100.0**
No diagnosis of heart disease	3,134	4,980	93.0	2,401	4,496	91.8
Diagnosis of or death due to heart disease	245	375	7.0	234	404	8.2

Data source: *1994/95, 1996/97, and 1998/99 National Population Health Survey, longitudinal sample, Health file*
Notes: *Based on samples of 3,379 women and 2,635 men aged 40 or older with no diagnosis of heart disease in 1994/95. Deaths attributed to heart disease are based on records for which cause of death was available.*

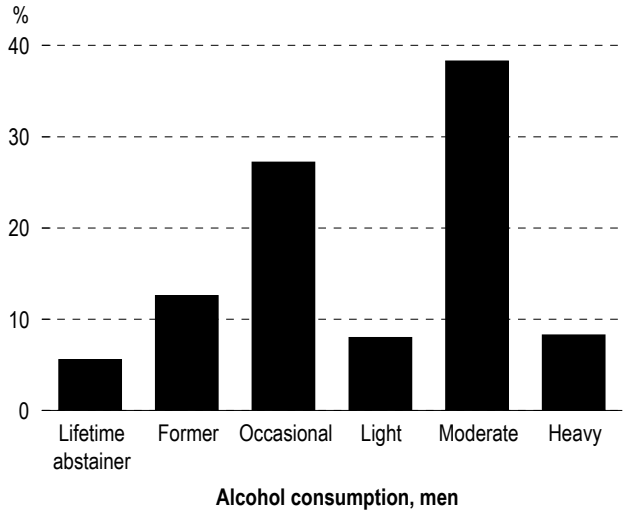
heart disease (Table 1). These figures underestimate the actual extent of heart disease mortality in the household population, because deaths for which the cause was unavailable were excluded from the analysis.

Chart 1
Level of alcohol consumption among women aged 40 or older with no diagnosis of heart disease, household population, Canada excluding territories, 1994/95



Data source: *1994/95, 1996/97 and 1998/99 National Population Health Survey, longitudinal sample, Health file*
** Significantly different ($p < 0.05$) from estimate for men in corresponding category (Chart 2)*

Chart 2
Level of alcohol consumption among men aged 40 or older with no diagnosis of heart disease, household population, Canada excluding territories, 1994/95



Data source: *1994/95, 1996/97 and 1998/99 National Population Health Survey, longitudinal sample, Health file*

Reported alcohol consumption differed substantially by sex. In 1994/95, lifetime abstinence was more common among women than men (13% versus 6%) (Charts 1 and 2, Appendix Tables A and B). A higher proportion of women than men reported drinking occasionally, while higher proportions of men reported moderate or heavy consumption. Men were also more likely than women to report exceeding the recommended weekly maximum during the previous week (9 drinks for women and 14 for men), although relatively few men or women reported heavy drinking. (See also *Drinking patterns*.)

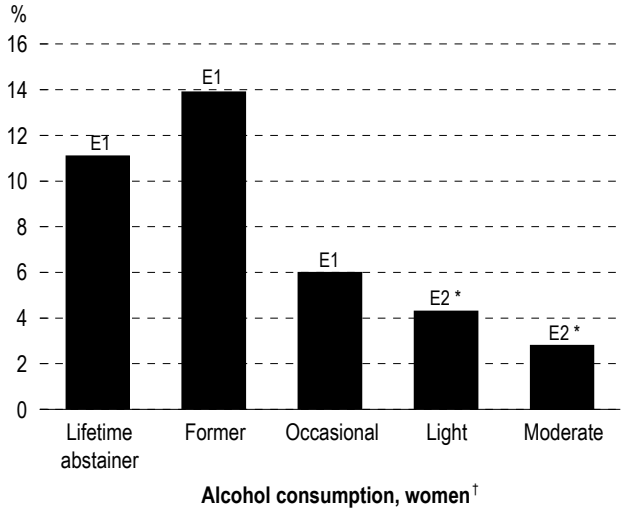
Protective effect for women

Among women aged 40 or older who reported light (one drink) or moderate drinking (two to nine drinks) in the week before the 1994/95 interview, the rates of diagnosed heart disease or death due to heart disease over the next four years were significantly lower than the rate among women who reported lifetime abstinence (Appendix Table D). For men, though, heart disease rates did not differ significantly by level of alcohol consumption (Appendix Table E). However, interpretation of this finding is limited by the instability of the estimate for male lifetime abstainers. Most previous studies have reported a protective effect of moderate drinking for both sexes.[1-7]

Among women, heart disease morbidity or mortality rates in former drinkers—that is, those who reported having at least one drink in their life, but none in the previous year—were significantly higher than rates for women who reported any level of alcohol consumption in the past week (data not shown). These findings are consistent with previous research, and support the premise that former drinkers may include people already at risk of heart disease.[3]

Although the NPHS data for women suggest a lower likelihood of heart disease in association with light or moderate alcohol consumption, the U-shaped relationship between level of consumption and risk of disease noted in previous research[1,3-6,8,26-31] was not observed (Chart 3). This was presumably because of the small sample size

Chart 3
New diagnosis of or death due to heart disease between 1994/95 and 1998/99 among women aged 40 or older with no diagnosis of heart disease in 1994/95, by level of alcohol consumption, household population, Canada excluding territories



Data source: *1994/95, 1996/97 and 1998/99 National Population Health Survey, longitudinal sample, Health file*
† Heavy drinkers not shown (coefficient of variation greater than 33.3%)
E1 Coefficient of variation between 16.6% and 25.0%
E2 Coefficient of variation between 25.1% and 33.3%
** Significantly different from "Lifetime abstainer" (p < 0.05)*

of women who reported alcohol consumption at levels associated with a higher risk of disease.

Of course, factors other than alcohol use influence heart disease risk, many of which were taken into account in this analysis: age, household income, education, self-perceived health, diagnosis of diabetes or heart disease, leisure-time physical activity, body mass index, smoking, and for women, hormone replacement therapy. Even when adjusting for these other risk factors, the protective association between moderate alcohol intake of two to nine drinks per week and a diagnosis of or death due to heart disease persisted for women (Table 2). No similar protective association was found for men (Table 3).

A meta-analysis of prospective studies of heart disease morbidity and mortality has suggested that for women, the optimal protective effect of alcohol occurs at 10 grams per day (equivalent to just under one drink), and consumption of up to 31 grams (approximately 2.5 drinks) is still protective.[1]

Table 2
Adjusted odds ratios for new diagnosis of or death due to heart disease among women aged 40 or older with no diagnosis of heart disease in 1994/95, by selected characteristics in 1994/95, household population, Canada excluding territories, 1994/95 to 1998/99

	Adjusted odds ratio	95% confidence interval
Alcohol consumption		
Lifetime abstainer (never drank)†	1.0	…
Former (1+ drink in lifetime, 0 in past year)	1.2	0.7, 2.1
Occasional (1+ drink in past year, 0 in past week)	0.7	0.4, 1.3
Light (1 drink in past week)	0.6	0.2, 1.4
Moderate (2-9 drinks in past week)	0.4*	0.2, 0.9
Heavy (10+ drinks in past week)	0.8	0.3, 2.2
Age group		
40-54†	1.0	…
55-69	3.4*	2.0, 5.7
70+	5.6*	3.3, 9.6
Household income		
Lower	0.9	0.6, 1.4
Upper†	1.0	…
Education		
Less than secondary graduation†	1.0	…
Secondary graduation or more	0.8	0.5, 1.2
Self-perceived health		
Excellent/Very good/Good	0.4*	0.3, 0.7
Fair/Poor†	1.0	…
Diabetes		
Yes	1.9	1.0, 3.9
No†	1.0	…
High blood pressure		
Yes	1.2	0.8, 2.0
No†	1.0	…
Family history of heart disease‡		
Yes	3.5*	2.0, 6.1
No†	1.0	…
Leisure-time physical activity		
Inactive†	1.0	…
Moderate/Active	0.5*	0.4, 0.8
Body mass index		
Acceptable (< 25.0)†	1.0	…
Overweight (25.0-29.9)	0.6*	0.4, 0.9
Obese (30+)	0.7	0.5, 1.2
Years of daily smoking	1.0	1.0, 1.0
Hormone replacement therapy		
Yes	0.9	0.5, 1.6
No†	1.0	…

Data source: *1994/95, 1996/97 and 1998/99 National Population Health Survey, longitudinal sample, Health file*
Notes: *Based on a sample of 3,346 women aged 40 or older with no diagnosis of heart disease in 1994/95; 33 were excluded because of missing values. "Unknown" categories for household income, education, family history of heart disease, leisure-time physical activity, body mass index and hormone replacement therapy were included in the model, but their odds ratios are not shown.*
† Reference category
‡ Collected in 1998/99 only
** Significantly different from reference category (p < 0.05)*
… Not applicable

Drinking patterns

Some research has indicated that the relationship between alcohol consumption and heart disease varies according to consumption patterns, with a protective effect associated with regular small amounts rather than the whole amount in one weekly session.[10,32] Similarly, the findings of an ecological study carried out in Sweden showed a negative relationship, observed in women but not men, between wine consumption and ischemic heart death.[33] The researchers suggest that women's typical consumption patterns—drinking in moderation with meals—together with their preference for wine rather than spirits or beer may partially account for this finding.

Although information on the type of alcohol consumed is not available from the National Population Health Survey (see *Limitations*), the survey does include questions intended to measure heavy episodic drinking and daily drinking patterns. The frequency of heavy episodic drinking (consuming five or more drinks on one occasion, at least once each month during the past year) was much more common among men (14%) than women (2%) (data not shown). However, when a variable reflecting heavy episodic drinking was included in the multivariate models, there was no significant association with heart disease for either sex (data not shown).

The *Canadian Guidelines on Low-Risk Drinking* recommend an upper daily limit of two drinks.[19] Although the difference between the sexes for daily drinking patterns was not as great as it was for heavy episodic drinking, the percentage of men (25%) reporting more than two drinks on at least one day during the past week considerably exceeded the percentage of women reporting this pattern (10%) (data not shown). However, similar percentages of men (30%) and women (27%) reported alcohol consumption for the previous week that fell within the daily recommended limit. When alcohol consumption was coded to reflect these patterns (that is, at least one drink in the past week, but no more than two drinks on any day), only among women did an association with heart disease emerge. The odds of diagnosed heart disease or heart disease death were significantly lower in women who reported consuming at least one drink during the week, but no more than two drinks on any day during the past week, compared with women who reported lifetime abstinence.

Adjusted odds ratios for new diagnosis of or death due to heart disease among household population aged 40 or older with no diagnosis of heart disease in 1994/95, by drinking pattern and sex, Canada excluding territories, 1994/95 to 1998/99

	Women		Men	
Drinking pattern	Adjusted odds ratio	95% confidence interval	Drinking pattern	Adjusted odds ratio	95% confidence interval
Lifetime abstainer (never drank)†	1.0	...	Abstainer (lifetime abstainers and former drinkers who never regularly drank >12 drinks/week)†	1.0	...
Former (1+ drink in lifetime, 0 in past year)	1.2	0.7, 2.1	Former (at some time regularly drank > 12 drinks/week, 0 in past year)	1.8	0.8, 4.3
Occasional (1+ drink in past year, 0 in past week)	0.7	0.4, 1.3	Occasional (1+ drink in past year, 0 in past week)	1.5	0.8, 2.7
Within recommended daily limit (1+ drink in past week, no more than 2 drinks/day in past week)	0.4*	0.2, 0.9	Within recommended daily limit (1+ drink in past week, no more than 2 drinks/day in past week)	1.8	1.0, 3.6
Exceeded recommended daily limit (>2 drinks at least 1 day in past week)	0.7	0.3, 1.5	Exceeded recommended daily limit (> 2 drinks at least 1 day in past week)	0.9	0.5, 1.9

Data source: *1994/95, 1996/97 and 1998/99 National Population Health Survey, longitudinal sample, Health file*
Notes: *Based on samples of 2,585 men and 3,346 women aged 40 or older with no reported diagnosis of heart disease in 1994/95; 33 women and 50 men were excluded because of missing variables. Except for variables reflecting alcohol consumption in the context of recommended daily limits, the full model includes all variables (Appendix Tables F and G). "Unknown" categories for household income, education, family history of heart disease, leisure-time physical activity, body mass index and hormone replacement therapy were included in the model, but their odds ratios are not shown.*
† Reference category
** Significantly different from reference category ($p < 0.05$)*
··· Not applicable

Table 3
Adjusted odds ratios for new diagnosis of or death due to heart disease among men aged 40 or older with no diagnosis of heart disease in 1994/95, by selected characteristics in 1994/95, household population, Canada excluding territories, 1994/95 to 1998/99

	Adjusted odds ratio	95% confidence interval
Alcohol consumption		
Abstainer (lifetime abstainers and former drinkers who never regularly drank > 12 drinks/week)†	1.0	…
Former (at some time regularly drank > 12 drinks/week, 0 in past year)	1.9	0.8, 4.4
Occasional (1+ drink in past year, 0 in past week)	1.5	0.8, 2.7
Light (1 drink in past week)	1.7	0.7, 4.3
Moderate (2-14 drinks in past week)	1.6	0.8, 3.0
Heavy (15+ drinks in past week)	0.7	0.3, 1.9
Age group		
40-54†	1.0	…
55-69	2.3*	1.4, 3.7
70+	4.3*	2.4, 7.5
Household income		
Lower	0.9	0.5, 1.4
Upper†	1.0	…
Education		
Less than secondary graduation†	1.0	…
Secondary graduation or more	0.9	0.6, 1.4
Self-perceived health		
Excellent/Very good/Good	1.0	0.6, 1.7
Fair/Poor†	1.0	…
Diabetes		
Yes	2.4*	1.2, 5.0
No†	1.0	…
High blood pressure		
Yes	1.3	0.8, 2.2
No†	1.0	…
Family history of heart disease‡		
Yes	3.6*	2.1, 6.2
No†	1.0	…
Leisure-time physical activity		
Inactive†	1.0	…
Moderate/Active	0.6*	0.4, 0.9
Body mass index		
Acceptable (< 25.0)†	1.0	…
Overweight (25.0-29.9)	1.5*	1.0, 2.2
Obese (30+)	1.8*	1.1, 3.0
Years of daily smoking	1.0	1.0, 1.0

Data source: *1994/95, 1996/97 and 1998/99 National Population Health Survey, longitudinal sample, Health file*
Notes: *Based on a sample of 2,585 men aged 40 or older with no diagnosis of heart disease in 1994/95; 50 were excluded because of missing values. Because of rounding, some confidence intervals with 1.0 as lower/upper limit are significant. "Unknown" categories for household income, education, family history of heart disease, leisure-time physical activity and body mass index were included in the model, but their odds ratios are not shown.*
† Reference category
‡ Collected in 1998/99 only
** Significantly different from reference category ($p < 0.05$)*
… Not applicable

Another meta-analysis, which focussed on non-fatal myocardial infarction, reported that as little as half a drink per day can confer the full protective effect.[5] In the NPHS analysis, the lower odds of heart disease or heart disease death for women reporting two to nine drinks in the past week (compared with lifetime abstainers) corroborates the findings of these meta-analyses.

Age, health status predict heart disease

As expected, the risk of heart disease was higher beyond middle age, and age was strongly predictive of heart disease in both sexes. Women in the 55-to-69 age group had over three times the odds of receiving a new diagnosis of or dying from heart disease, compared with women aged 40 to 54 (Table 2). For elderly women, the odds were over five times as high. The pattern was similar among men, with those aged 55 to 69 and 70 or older having over two and four times the odds, respectively, of receiving a new diagnosis of or dying from heart disease, compared with 40- to 54-year-old men (Table 3).

Not surprisingly, several variables reflecting health status were significantly associated with heart disease. Women who reported that their overall health was excellent, very good or good had less than half the odds of receiving a new diagnosis of or dying from heart disease over the next four years, compared with women reporting that their health was fair or poor. This association with self-perceived health was not found for men. But for men reporting diabetes in 1994/95, the odds of a new diagnosis of heart disease or heart disease death were over twice as high as for men without diabetes. Insufficient statistical power likely explains why the odds ratio for diabetes did not attain significance for women.

Some researchers have suggested that controlling for variables that are influenced by alcohol intake, and are thus intermediate in the causal pathway between alcohol and heart disease, may result in an underestimate of the association between alcohol and heart disease.[1,34] To test the effect of two possible intermediate variables on the odds ratio estimates for alcohol, the variables for diabetes and high blood pressure were excluded from multivariate

logistic regressions. The odds ratio estimates for alcohol consumption remained unchanged (data not shown).

Family medical history

Family medical history was strongly predictive of heart disease for both sexes (Tables 2 and 3). People who reported (a) parent(s) or sibling(s) with heart disease had over three times the odds of being diagnosed or dying from the condition, compared with those without such a family medical history. Although this finding is consistent with previous reports,[35,36] recall bias may partly account for the association that emerged in the NPHS data (see *Limitations*).

Lifestyle: BMI and physical activity

A protective association between physical activity and heart disease emerged. Men and women who reported in 1994/95 that they were at least moderately active in their leisure time had about half the odds of receiving a diagnosis of or dying from heart disease, compared with people who were inactive.

Body mass index (BMI) in 1994/95 was significantly associated with a diagnosis of or death from heart disease in the next four years, but in different directions for men and women (Tables 2 and 3). Men who were overweight or obese in 1994/95 had higher odds of a subsequent diagnosis of heart disease. However, women categorized as

Definitions

National Population Health Survey (NPHS) respondents were asked if they had any of a number of "long-term health conditions that have lasted or are expected to last six months or more and that have been diagnosed by a health professional." Interviewers read a list of conditions, including heart disease, diabetes and high blood pressure. For this analysis, *heart disease* was defined as a diagnosis of heart disease reported in 1996/97 or 1998/99, or death due to ischemic heart disease (*International Classification of Diseases, Ninth Revision* [ICD-9],[37] underlying cause-of-death codes 410 through 414), among respondents who reported in 1994/95 that they had not been diagnosed with heart disease. *Diabetes* and *high blood pressure* were measured by reported diagnosis for each condition in the 1994/95 interview.

Three *age groups* were established: 40 to 54, 55 to 69, and 70 or older.

Household income was based on household size and total household income from all sources in the 12 months before the interview. The following groups were derived:

Household income group	Number of people in household	Total household income
Lower	1 or 2	Less than $15,000
	3 or 4	Less than$20,000
	5 or more	Less than $30,000
Upper	1 or 2	$15,000 or more
	3 or 4	$20,000 or more
	5 or more	$30,000 or more

Education was categorized as less than high school graduation, and high school graduation or more.

Respondents rated their health as excellent, very good, good, fair or poor. For this analysis, two categories of *self-perceived health* were established: excellent/very good/good, and fair/poor.

The 1998/99 NPHS asked respondents about the medical history of their immediate family. For this analysis, *family history of heart disease* was considered to be present if the respondent reported that at least one first-degree relative (biological parent[s] and/or biological sibling[s]) had ever had heart disease.

Two levels of *leisure-time physical activity* were defined: active/moderate (1.5 or more kilocalories per kilogram of body weight per day) and inactive (less than 1.5 kilocalories per kilogram of body weight per day). An example of a moderate level of activity would be walking for an hour, four times per week. A person who reported only gardening or yardwork for an hour per week would be categorized as inactive.

Body mass index (BMI) is calculated by dividing weight in kilograms by the square of height in metres. Three BMI levels were defined for this analysis, based on the World Health Organization's standards:[38] acceptable (under 25.0), overweight (25.0 to 29.9), and obese (30.0 or higher).

Smoking status was determined by asking individuals if they smoked cigarettes daily, occasionally, or not at all. Three groups were established: never, former, and current daily or occasional (less than daily). A continuous variable reflecting the reported number of years of daily smoking was used for multivariate analysis.

Use of *hormone replacement therapy* was determined by asking women aged 30 or older if they had taken "hormones for menopause or aging symptoms" in the month before the 1994/95 NPHS interview.

Limitations

An important methodological feature of research on alcohol consumption is differentiating between two types of non-drinkers: lifetime abstainers and former drinkers. It is preferable to use lifetime abstainers, rather than all non-drinkers, as the reference category for comparisons, because former drinkers may have quit because of poor health.[39] In this analysis of NPHS data, however, the small sample (n=16) of male lifetime abstainers who reported a new diagnosis of heart disease or who died from heart disease resulted in an estimate with a coefficient of variation greater than 33.3%. Therefore, to avoid statistical instability due to small cell size, multivariate modelling was conducted using a reference category that grouped men who were lifetime abstainers with those reporting that they had had no drinks in the past year and had never regularly consumed more than 12 drinks per week. Former heavy drinkers—those who reported that they had regularly consumed more than 12 drinks per week and were more likely to have quit for health reasons—were grouped separately. The upper limit of 12 drinks per week for prior consumption was necessitated by the wording of the NPHS question. Respondents who reported that they had not had a drink in the previous 12 months were then asked if they had ever had a drink. Those who answered "yes" were asked if they "ever regularly drank more than 12 drinks per week."

The lack of complete information on alcohol use before the 1994/95 interview limited the precision with which respondents could be classified. Because differences in the duration of exposure to alcohol could not be considered in the analysis, the consumption categories were not entirely homogeneous. This heterogeneity of exposure within variable categories likely weakened the association between the independent and dependent variables.

Categorization of respondents into alcohol consumption levels was based partly on the reported number of drinks consumed during the week before their NPHS interview in 1994/95. Respondents whose alcohol use during that week was atypical of their usual consumption may have been misclassified.

It would have been preferable to use a multivariate model, such as the Cox proportional hazards model, that incorporates the timing of the occurrence of the outcome variable. While the date of death was available from the NPHS, information on the date of onset or diagnosis of heart disease (n=437) was not. Therefore, the dependent variable (a reported diagnosis of heart disease or death attributed to ischemic heart disease) was defined as a dichotomous variable, and logistic regression was used to model its relationship to the selected covariates.

The four-year follow-up interval, 1994/95 to 1998/99, may be too brief for the full effect of associations between variables to emerge. Also, excluding 159 deaths for which data on cause of death were not yet available limited the statistical power of the analysis. Because ischemic heart disease is a major cause of death, it is likely that a substantial number of the excluded cases were due to heart disease. For these reasons, the analysis may underestimate associations that would appear over a longer period, or when more complete data become available.

Family history of heart disease is an important risk factor. However, unlike the data for all other independent variables, which were collected in 1994/95, data on family medical history were not collected until 1998/99. Therefore, this information might be subject to recall bias, which might partially account for the strong association observed between family medical history and a new diagnosis of heart disease. Recall bias would occur if people reporting a diagnosis of heart disease were more likely to recall a family history of such problems, compared with people not reporting heart disease. Because data on family medical history were not collected until cycle 3, this information was not available for people who had died or who had moved into an institution by that time.

Not all factors known to be associated with incident heart disease could be examined. For example, the NPHS does not collect data on diet, aspirin use, or biological and physical measures such as blood lipids.

The data are self- (or proxy-) reported, and the degree to which they are biased because of reporting error is unknown. In particular, reporting error may affect the accuracy of information about socially sensitive behaviours, such as alcohol consumption or smoking. A tendency of heavy drinkers to underestimate alcohol consumption would contribute to misclassification and dilute associations between high alcohol use and heart disease. To minimize reporting error in data related to chronic conditions (including heart disease), respondents were instructed to report only conditions that had been "diagnosed by a health professional." However, reported diagnoses are not validated with clinical information. Validation studies of self-reports of a diagnosis of heart disease or other conditions made by a doctor have reported accuracy rates at levels of 80% and 84%.[40,41] It is not known what effect the wording "diagnosed by a health professional" (rather than a doctor) might have on the validity of the data.

NPHS respondents are asked if they have "heart disease," but no information is collected on the specific type. Therefore, while a reported diagnosis may refer to coronary artery disease, which has been protectively linked with alcohol consumption, it could also refer to other manifestations of heart disease, such as dilated cardiomyopathy, dysrhythmias and hypertensive cardiovascular disease, for which alcohol is a risk factor.[39,42] The need to use the all-inclusive report of "heart disease" as the dependent variable likely dilutes the estimate of association between alcohol and coronary artery disease.

Combining deaths attributed to heart disease with reported diagnoses of heart disease further contributes to the non-specificity of the outcome variable. Although it would have been preferable to limit the outcome to confirmed fatalities due to ischemic heart disease, the low number (42) precluded this option.

The failure of interaction terms to achieve statistical significance in multivariate regression may have been partially due to insufficient statistical power. For example, in a model of new heart disease or death due to heart disease for men, an interaction term between the variables occasional alcohol consumption and years of smoking fell just short of the designated significance level of 0.05 (odds ratio = 1.02; p = 0.06).

Finally, although a lively debate has emerged about the protective effects of wine compared with other alcoholic beverages,[33,43-45] no information on the type of alcohol consumed is available from the NPHS.

overweight, with a BMI in the 25.0-to-25.9 range, had significantly lower odds of a new diagnosis of heart disease, relative to women with a lower BMI. Even for women with a BMI of 30.0 or more, no positive association with heart disease emerged.

Previously published research indicates that being overweight is a major risk factor for heart disease and for death due to coronary heart disease; however, the follow-up period has usually been longer than four years. For example, in two major prospective studies, people were studied for 10 and 14 years, respectively.[46,47] Despite the shorter follow-up period for the NPHS, the findings for women were not anticipated. Further analysis of the NPHS data revealed that the negative association in women between BMI and subsequent heart disease diagnosis was most pronounced in the 55-to-69 age group (data not shown).

Research has firmly established smoking as a risk factor for heart disease.[22-24] In preliminary analysis of the NPHS data, unadjusted for the effects of other influences, there was a significant positive association between years of smoking and heart disease (data not shown). This finding underscored the importance of controlling for other variables, including smoking, when studying the association between heart disease and alcohol consumption. In full multivariate models, smoking was not significantly related to heart disease, possibly because of its correlation with other variables such as income, education, and the biomedical risk factors included. Interaction terms between smoking and level of alcohol use were explored, but because none was statistically significant, they were excluded from the final models (see *Limitations*).

The availability of information on hormone replacement therapy (HRT) from the NPHS is an advantage that has been lacking in previous research.[21] Because of the role that HRT may play in relation to heart disease, it is important to account for the influence of HRT in multivariate analysis. However, no significant association between heart disease and HRT was observed, perhaps because the analysis did not differentiate between users of estrogen alone and users of combined therapy, or perhaps because of insufficient statistical power (only 14% of women reported using HRT; Appendix Table A).

Concluding remarks

Longitudinal data from the National Population Health Survey indicate a protective relationship between moderate alcohol consumption and a subsequent diagnosis of or death attributed to heart disease—for women.

Compared with lifetime abstainers, women who, in 1994/95, reported that they had consumed two to nine drinks in the past week had less than half the odds of receiving a diagnosis of or dying from heart disease over the next four years. Furthermore, women who reported at least one drink during the past week but no more than two drinks on any day had lower odds of a subsequent diagnosis of heart disease or heart disease death, compared with women who had never had a drink. These associations persisted when controlling for the effects of other factors known to influence the risk of heart disease. Given the small size of the survey sample relative to other cohorts that have been studied, it is remarkable that an association between moderate alcohol consumption and heart disease in women emerged within only four years.

In addition to the small sample size, the short follow-up period of the NPHS longitudinal panel may partially explain the apparent lack of an association between level of alcohol consumption and heart disease in men. In previous studies reporting a protective effect of alcohol against heart disease, the period of study has usually been much longer than four years.[21,29-31,48] An exception was a much larger study of over 50,000 men in the United States: after only two years, a strong, inverse relationship emerged between level of alcohol consumption and coronary disease.[49]

The availability of data from future cycles of the NPHS will provide the opportunity for longer follow-up and further study of the relationship between alcohol consumption and subsequent health outcomes for both men and women. ●

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Appendix

Table A

Distribution of selected characteristics, female household population aged 40 or older with no diagnosis of heart disease, Canada excluding territories, 1994/95

	Sample size	Estimated population	
		'000	%
Total	**3,379**	**5,356**	**100.0**
Alcohol consumption†			
Lifetime abstainer (never drank)	486	694	13.0*
Former (1+ drink in lifetime, 0 in past year)	628	901	16.8*
Occasional (1+ drink in past year, 0 in past week)	1,101	1,749	32.7*
Light (1 drink in past week)	311	493	9.2
Moderate (2-9 drinks in past week)	726	1,303	24.3*
Heavy (10+ drinks in past week)	114	190	3.6*
Missing	13	26	0.5
Age group			
40-54	1,449	2,648	49.4
55-69	1,100	1,734	32.4
70+	830	974	18.2
Household income			
Lower	832	998	18.6
Upper	2,390	4,086	76.3
Missing	157	272	5.1
Education			
Less than secondary graduation	1,255	1,785	33.3
Secondary graduation or more	2,115	3,552	66.3
Missing	9	18	0.3
Self-perceived health			
Excellent/Very good/Good	2,832	4,569	85.3
Fair/Poor	547	787	14.7
Diabetes			
Yes	172	255	4.8
No	3,207	5,100	95.2
High blood pressure			
Yes	658	905	16.9
No	2,721	4,450	83.1
Family history of heart disease‡			
Yes	1,082	1,795	33.5
No	1,854	2,871	53.6
Missing	443	690	12.9
Leisure-time physical activity			
Inactive	2,167	3,413	63.7
Moderate/Active	1,147	1,796	33.5
Missing	65	147	2.7
Body mass index			
Acceptable (< 25.0)	1,733	2,747	51.3
Overweight (25.0-29.9)	1,037	1,693	31.6
Obese (30.0+)	547	812	15.2
Missing	62	104	1.9
Smoking			
Never	1,549	2,560	47.8
Former	1,028	1,584	29.6
Daily/Occasional	799	1,201	22.4
Missing	3	11	0.2
Hormone replacement therapy			
Yes	435	728	13.6
No	2,920	4,578	85.5
Missing	24	51	0.9

Data source: *1994/95, 1998/99 National Population Health Survey, longitudinal sample, Health file*

Note: *Because of rounding, detail may not add to totals.*

† Significance testing of differences between estimated values for men and women was carried out for alcohol consumption only (see Charts 1 and 2).

‡ Collected in 1998/99 only

** Significantly different from estimate for men in corresponding category (Table B)*

Table B

Distribution of selected characteristics, male household population aged 40 or older with no diagnosis of heart disease, Canada excluding territories, 1994/95

	Sample size	Estimated population	
		'000	%
Total	**2,635**	**4,900**	**100.0**
Alcohol consumption†			
Abstainer (never drank)	142	274	5.6
Former (1+ drink in lifetime, 0 in past year)	418	613	12.5
Occasional (1+ drink in past year, 0 in past week)	705	1,321	27.0
Light (1 drink in past week)	183	387	7.9
Moderate (2-14 drinks in past week)	948	1,861	38.0
Heavy (15+ drinks in past week)	221	401	8.2
Missing	18	42	0.9
Age group			
40-54	1,337	2,791	57.0
55-69	827	1,464	29.9
70+	471	644	13.2
Household income			
Lower	423	627	12.8
Upper	2,086	4,005	81.7
Missing	126	268	5.5
Education			
Less than secondary graduation	1,001	1,563	31.9
Secondary graduation or more	1,628	3,324	67.9
Missing	6	12	0.3
Self-perceived health			
Excellent/Very good/Good	2,248	4,343	88.6
Fair/Poor	387	557	11.4
Diabetes			
Yes	136	239	4.9
No	2,499	4,661	95.1
High blood pressure			
Yes	362	591	12.1
No	2,273	4,309	87.9
Family history of heart disease‡			
Yes	940	1,854	37.8
No	1,139	2,111	43.1
Missing	556	935	19.1
Leisure-time physical activity			
Inactive	1,490	1,811	37.0
Moderate/Active	958	2,683	54.8
Missing	187	406	8.3
Body mass index			
Acceptable (< 25.0)	956	1,829	37.3
Overweight (25.0-29.9)	1,255	2,287	46.7
Obese (30.0+)	408	753	15.4
Missing	16	30	0.6
Smoking			
Never	632	1,465	29.9
Former	1,219	2,181	44.5
Daily/Occasional	783	1,249	25.5
Missing	1	5	0.1

Data source: *1994/95, 1998/99 National Population Health Survey, longitudinal sample, Health file*

Note: *Because of rounding, detail may not add to totals.*

† Significance testing of differences between estimated values for men and women was carried out for alcohol consumption only (see Charts 1 and 2).

‡ Collected in 1998/99 only

Table C
Leading causes of death, population aged 40 or older, by sex, Canada, 1998

Cause of death (ICD-9 code)	Number of deaths	
	Women	Men
Ischemic heart disease (410-414)	19,306	23,541
Cancer of trachea, bronchus or lung (162)	6,188	9,964
Cerebrovascular disease (430-438)	9,074	6,416
Chronic obstructive pulmonary disease (490-496)	4,188	5,800
Pneumonia and influenza (480-487)	4,936	4,032
Breast cancer (174)	4,720	…
Prostate cancer (185)	…	3,664
Colorectal cancer (153, 154)	3,013	3,325
Diabetes (250)	2,842	2,844
Suicide (E950-E959)	†	1,501
Accidental falls (E833-E835, E880-E888)	1,472	1,055
Alzheimer's disease (331.0)	1,914	‡

Data source: *Canadian Vital Statistics Database*
† Did not rank in top 10 causes for women
‡ Did not rank in top 10 causes for men
… Not applicable

Table D
Percentage of women aged 40 or older with no diagnosis of heart disease in 1994/95 who reported new diagnosis of or died from heart disease, by selected characteristics in 1994/95, household population, Canada excluding territories, 1994/95 to 1998/99

	Estimated population	
	'000	%
Total	**374**	**7.0**
Alcohol consumption		
Lifetime abstainer (never drank)†	77E1	11.1E1
Former (1+ drink in lifetime, 0 in past year)	125E1	13.9E1
Occasional (1+ drink in past year, 0 in past week)	105E1	6.0E1
Light (1 drink in past week)	21E2	4.3*E2
Moderate (2-9 drinks in past week)	37E2	2.8*E2
Heavy (10+ drinks in past week)	F	F
Age group		
40-54†	60E1	2.3E1
55-69	165	9.5*
70+	151	15.5*
Household income		
Lower	103E1	10.3E1
Upper†	248	6.1
Education		
Less than secondary graduation†	187	10.5
Secondary graduation or more	188	5.3*
Self-perceived health		
Excellent/Very Good/Good	244	5.4*
Fair/Poor†	131E1	16.7E1
Diabetes		
Yes	F	23.0*E2
No†	317	6.2
High blood pressure		
Yes	116	12.8*
No†	259	5.8
Family history of heart disease‡		
Yes	269	9.4*
No†	53E1	3.0E1
Leisure-time physical activity		
Inactive†	277	8.1
Moderate/Active	77	4.3*
Body mass index		
Acceptable (< 25.0)†	208	7.6
Overweight (25.0-29.9)	94E1	5.5E1
Obese (30+)	64	7.9
Smoking		
Never†	207	8.1
Former	91	5.8
Daily/Occasional	68E1	5.7E1
Hormone replacement therapy		
Yes	35E2	4.8E2
No†	335	7.3

Data source: *1994/95, 1996/97 and 1998/99 National Population Health Survey, longitudinal sample, Health file*
Note: *Based on a sample of 3,379 women aged 40 or older in 1994/95.*
† Reference category
‡ Collected in 1998/99 only
E1 Coefficient of variation between 16.6% and 25.0%
E2 Coefficient of variation between 25.1% and 33.3%
F Coefficient of variation greater than 33.3%
** Significantly different from reference category (p < 0.05)*

Table E

Percentage of men aged 40 or older with no diagnosis of heart disease in 1994/95 who reported new diagnosis of or died from heart disease, by selected characteristics in 1994/95, household population, Canada excluding territories, 1994/95 to 1998/99

	Estimated population	
	'000	%
Total	**404**	**8.2**
Alcohol consumption		
Abstainer (never drank)†	F	F
Former (1+ drink in lifetime, 0 in past year)	64[E1]	10.4[E1]
Occasional (1+ drink in past year, 0 in past week)	118	8.9
Light (1 drink in past week)	41[E2]	10.5[E2]
Moderate (2-14 drinks in past week)	137	7.4
Heavy (15+ drinks in past week)	F	F
Age group		
40-54†	106[E1]	3.8[E1]
55-69	159	10.8*
70+	139	21.6*
Household income		
Lower	57[E1]	9.1[E1]
Upper†	316	7.9
Education		
Less than secondary graduation†	181	11.6
Secondary graduation or more	219	6.6*
Self-perceived health		
Excellent/Very Good/Good	331	7.6*
Fair/Poor†	73[E1]	13.0
Diabetes		
Yes	55[E1]	23.2*[E1]
No†	348	7.5
High blood pressure		
Yes	82	13.8*
No†	322	7.5
Family history of heart disease‡		
Yes	197	9.3*
No†	50[E1]	2.7[E1]
Leisure-time physical activity		
Inactive†	265	9.9
Moderate/Active	108	5.9*
Body mass index		
Acceptable (< 25.0)†	120	6.6
Overweight (25.0-29.9)	203	8.9
Obese (30+)	74[E1]	9.9[E1]
Smoking		
Never†	80[E1]	6.4
Former	213	9.8
Daily/Occasional	111	7.6

Data source: *1994/95, 1996/97 and 1998/99 National Population Health Survey, longitudinal sample, Health file*
Note: *Based on a sample of 2,635 men aged 40 or older in 1994/95.*
† Reference category
‡ Collected in 1998/99 only
E1 Coefficient of variation between 16.6% and 25.0%
E2 Coefficient of variation between 25.1% and 33.3%
F Coefficient of variation greater than 33.3%
** Significantly different from reference category (p < 0.05)*

Table F

Adjusted odds ratios for new diagnosis of or death due to heart disease among women aged 40 or older with no diagnosis of heart disease in 1994/95, by drinking pattern and selected characteristics in 1994/95, household population, Canada excluding territories, 1994/95 to 1998/99

	Odds ratio	95% confidence interval
Drinking pattern		
Lifetime abstainer (never drank)†	1.0	...
Former (1+ drink in lifetime, 0 in past year)	1.2	0.7, 2.1
Occasional (1 drink in past year, 0 in past week)	0.7	0.4, 1.3
Within recommended daily limit (1+ drink in past week, no more than 2 drinks/day in past week)	0.4*	0.2, 0.9
Exceeded recommended daily limit (>2 drinks at least 1 day in past week)	0.7	0.3, 1.5
Age group		
40-54†	1.0	...
55-69	3.4*	2.0, 5.8
70+	5.8*	3.4,10.0
Household income		
Lower	0.9	0.6, 1.4
Upper†	1.0	...
Education		
Less than secondary graduation†	1.0	...
Secondary graduation or more	0.8	0.5, 1.2
Self-perceived health		
Excellent/Very good/Good	0.4*	0.3, 0.7
Fair/Poor†	1.0	...
Diabetes‡	1.9	1.0, 3.9
High blood pressure‡	1.2	0.8, 1.9
Family history of heart disease‡§	3.5*	2.0, 6.1
Leisure-time physical activity		
Inactive†	1.0	...
Moderate/Active	0.5*	0.4, 0.8
Body mass index		
Acceptable (< 25.0)†	1.0	...
Overweight (25.0-29.9)	0.6*	0.4, 0.9
Obese (30+)	0.7	0.5, 1.2
Years of daily smoking	1.0	1.0, 1.0
Hormone replacement therapy		
Yes	0.9	0.5, 1.7
No†	1.0	...

Data source: *1994/95, 1996/97, 1998/99 National Population Health Survey, longitudinal sample, Health file*
Notes: *Based on a sample of 3,346 women; 33 were excluded because of missing values. "Unknown" categories for household income, education, family history of heart disease, leisure-time physical activity, body mass index and hormone replacement therapy were included in the model, but their odds ratios are not shown.*
† Reference category
‡ Reference category is absence of condition
§ Collected in 1998/99 only
** Significantly different from reference category (p < 0.05)*
··· Not applicable

Table G

Adjusted odds ratios for new diagnosis of or death due to heart disease among men aged 40 or older with no diagnosis of heart disease in 1994/95, by drinking pattern and selected characteristics in 1994/95, household population, Canada excluding territories, 1994/95 to 1998/99

	Odds ratio	95% confidence interval
Drinking pattern		
Abstainer (lifetime abstainers and former drinkers who never regularly drank >12 drinks/week)†	1.0	...
Former (at some time regularly drank > 12 drinks/ week, 0 in past year)	1.8	0.8, 4.3
Occasional (1 drink in past year, 0 in past week)	1.5	0.8, 2.7
Within recommended daily limit (1+ drink in past week, no more than 2 drinks/day)	1.8	1.0, 3.6
Exceeded recommended daily limit (> 2 drinks at least 1 day in past week)	0.9	0.5, 1.9
Age group		
40-54†	1.0	...
55-69	2.1*	1.3, 3.4
70+	3.9*	2.2, 6.9
Household income		
Lower	0.9	0.5, 1.4
Upper†	1.0	...
Education		
Less than secondary graduation†	1.0	...
Secondary graduation or more	0.9	0.5, 1.4
Self-perceived health		
Excellent/Very good/Good	1.0	0.6, 1.7
Fair/Poor†	1.0	...
Diabetes‡	2.3*	1.2, 4.8
High blood pressure‡	1.4	0.8, 2.2
Family history of heart disease†§	3.7*	2.2, 6.4
Leisure-time physical activity		
Inactive†	1.0	...
Moderate/Active	0.6*	0.4, 0.9
Body mass index		
Acceptable (< 25.0)†	1.0	...
Overweight (25.0-29.9)	1.5	1.0, 2.2
Obese (30.0+)	1.8*	1.0, 3.0
Years of daily smoking	1.0	1.0, 1.0

Data source: *1994/95, 1996/97, 1998/99 National Population Health Survey, longitudinal sample, Health file*

Notes: *Based on a sample of 2,585 men; 50 were excluded because of missing values. "Unknown" categories for household income, education, family history of heart disease, leisure-time physical activity, body mass index were included in the model, but their odds ratios are not shown. Because of rounding, some confidence intervals with 1.0 as lower/upper limit are significant.*

† Reference category

‡ Reference category is absence of condition.

§ Collected in 1998/99 only

** Significantly different from reference category (p < 0.05)*

··· Not applicable

Ontario hospitals—mergers, shorter stays and readmissions

Claudio E. Pérez

Abstract

Objectives

This article examines the association between readmissions of pneumonia and acute myocardial infarction (AMI) patients to Ontario hospitals in 1998/99, and reductions in length of stay and recent hospital administrative mergers.

Data source

The data are from the 1998/99 Discharge Abstract Database, maintained by the Canadian Institute for Health Information.

Analytical techniques

Cross-tabulations were used to assess unadjusted associations between hospital and patient characteristics and readmission risk. Hierarchical non-linear models were used to calculate odds of readmission, adjusting for hospital and patient characteristics.

Main results

Hospital characteristics that may indicate restructuring—a decrease in mean length of stay or a recent administrative merger—were not associated with readmission of pneumonia or AMI patients within 30 days of discharge. Patients with two or more related hospital admissions in the previous year were at increased risk of readmission.

Key words

acute care, pneumonia, acute myocardial infarction, budget cuts

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Throughout Canada, government health care spending was curtailed in the 1990s. This occurred in the province of Ontario in the latter part of the decade under the mandate of the Health Services Restructuring Commission. As hospital administrators dealt with the realities of "doing more with less," they sought greater efficiency, in part, through hospital closures, administrative mergers, reductions in the number of beds, and shorter lengths of stay for patients requiring acute care.

It has been suggested that in at least some situations reducing the mean length of hospital stays improves efficiency.[1] On the other hand, sudden reductions that are not accompanied by compensatory changes in clinical and hospital management practice may negatively affect patient outcomes or have other unintended consequences.[2,3] Some studies have concluded that shorter stays increase the risk of readmission,[4-7] while others have found no relationship, or even a reduced risk of readmission.[2,8-11]

Using the Discharge Abstract Database maintained by the Canadian Institute for Health Information, this analysis attempts to determine if pneumonia and acute myocardial infarction (AMI) patients admitted to the Ontario hospitals that experienced the sharpest declines in mean length of stay for these and related conditions between 1995/96 and 1998/99 had a higher risk of readmission than did their counterparts in hospitals where declines were less dramatic (see *Data source*, *Analytical techniques* and *Limitations*). It also explores the risk of readmission for patients admitted to hospitals that underwent an administrative merger. Pneumonia and AMI were selected because they involve different organ systems and both have relatively high readmission rates.[12]

Hospital characteristics not associated with readmission

In Ontario in 1998/99, 8.3% of patients who had been hospitalized for pneumonia were readmitted for the same or a related condition within 30 days of their discharge; for AMI patients, the figure was somewhat higher: 13.9%.

Neither of the two variables indicative of hospital restructuring were associated with the risk of readmission (see *Hospital characteristics*). Pneumonia and AMI patients who had been in hospitals where the average length of stay for related conditions had declined were no more or less likely to be readmitted than were patients who had been in hospitals where the average length of stay had increased (Table 1).

Data source

This analysis is part of Statistics Canada's person-oriented information initiative, whereby hospital separation records are linked to obtain information about the health care received by individuals and their eventual health outcomes. The data are from the Discharge Abstract Database (DAD), maintained by the Canadian Institute for Health Information (CIHI). CIHI receives information about separations (discharges or deaths) from hospitals across Canada. Each record contains dates of admission and separation, one or more diagnoses, the major clinical category for each diagnosis, age and sex.

This analysis is based on separation data for individual pneumonia or acute myocardial infarction (AMI) patients who were hospitalized in Ontario and readmitted for a related condition in 1998/99, the most recent year for which data were available. Ontario accounted for 50% of all records from hospitals reporting to the DAD system before 1998/99.

Hospital characteristics

The 1998/99 *mean length of stay* was used to group hospitals into quartiles. Only acute stays (60 days or less) that were related to pneumonia or AMI were used in the calculation. For pneumonia, the quartiles were: less than 5.7 days; 5.7 to less than 6.5 days; 6.5 to less than 7.4 days; and more than 7.4 days. For AMI, the quartiles were: less than 4.8 days; 4.8 to less than 5.5 days; 5.5 to less than 6.2 days; and more than 6.2 days.

Hospitals were classified according to the extent of *change in mean length of stay from 1995/96 to 1998/99*, where the mean was calculated as above. Hospitals were assigned to one of three categories: increase; small decrease (up to 0.75 days for pneumonia and up to 0.53 days for AMI); or large decrease. The two "decrease" categories were formed by splitting all hospitals with declining length of stay into two groups of equal size, hence, the different cut-offs. Hospitals for which the mean length of stay in either year was based on less than 100 separations were assigned a "missing" value because the measure was considered too unstable. If a 1998/99 hospital identification number could not be matched to the 1995/96 file, the change in mean length of stay was considered missing.

Recently merged hospitals were those identified by the Ontario Ministry of Health as having undergone an administrative merger between 1995/96 and 1998/99.[13]

Hospital *volume* was based on the total number of separations in 1998/99 for acute cases related to pneumonia or to AMI. Hospitals were grouped into volume quartiles by number of separations: for pneumonia—less than 117, 117 to 291, 292 to 800, and more than 800; for AMI—less than 160, 160 to 455, 456 to 1,256, and more than 1,256.

The teaching status of a hospital is not indicated in the Discharge Abstract Database. Hospital complexity level was based on the mean complexity of all acute stays in a hospital that were related to pneumonia or AMI. However, teaching hospitals would be expected to admit more complex cases. Case *complexity level*, which is assigned by the Canadian Institute for Health Information, takes into account the number and types of diagnoses listed on separation records. Values of 1 through 4 were given to increasing levels of case complexity, corresponding to "none," "complexity due to chronic conditions," "complexity due to serious conditions," and "complexity due to life-threatening conditions." Hospitals in the 80th percentile (1.64 or more for pneumonia; 1.45 or more for AMI) were defined as being of high complexity.

Table 1
Unadjusted probability of readmission within 30 days of acute index admission for pneumonia or acute myocardial infarction, by hospital characteristics, Ontario, 1998/99

	Pneumonia				Acute myocardial infarction			
		Readmissions within 30 days				Readmissions within 30 days		
	Total index admissions	Number	% of index admissions	Chi-squared†	Total index admissions	Number	% of index admissions	Chi-squared†
Total	**12,159**	**1,011**	**8.3**	**...**	**4,183**	**581**	**13.9**	**...**
Change in mean length of stay, 1995/96 to 1998/99								
Increase	6,604	547	8.3		1,468	213	14.5	
Small decrease	2,700	223	8.3	0.18	1,452	209	14.4	2.84
Large decrease	1,760	151	8.6		1,204	150	12.5	
Missing	1,095	90	...		59	9	...	
Recently merged								
Yes	1,212	92	7.6	0.93	75	11	14.7	0.04
No	10,947	919	8.4		4,108	570	13.9	
Mean length of stay, 1998/99								
Quartile 1 (shortest)	3,548	314	8.9		918	136	14.8	
Quartile 2	2,754	218	7.9	2.87	991	123	12.4	3.81
Quartile 3	2,757	235	8.5		1,369	185	13.5	
Quartile 4 (longest)	3,100	244	7.9		905	137	15.1	
Volume (separations)								
Quartile 1 (smallest)	530	48	9.1		183	27	14.8	
Quartile 2	1,468	108	7.4	3.60	636	79	12.4	1.40
Quartile 3	3,388	270	8.0		1,695	240	14.2	
Quartile 4 (largest)	6,773	585	8.6		1,669	235	14.1	
Complexity level								
High	3,808	308	8.1	0.37	813	105	12.9	0.80
Not high	8,351	703	8.4		3,370	476	14.1	

Data source: *1998/99 Discharge Abstract Database, Canadian Institute for Health Information*
† Used to test for independence between readmission and selected hospital characteristic
··· Not applicable

Similarly, a recent administrative merger was not related to the probability of readmission for either type of patient.

However, other hospital characteristics may influence the probability of readmission. Hospitals with a short average length of stay (regardless of whether it has recently declined) may be more efficient, or they may admit less serious cases than do hospitals where stays tend to be longer. Hospital volume—the number of admissions for the condition in question (in this case, conditions related to pneumonia and AMI)—may reflect access to technology or the severity of cases.[14] Volume may also be associated with bed occupancy rates. Hospitals with higher occupancy rates may discharge patients more quickly to meet the demand for beds, which, in turn, may be associated with readmissions. Further, an institution with a high average level of case complexity may be more likely to treat patients who will need to be readmitted. But as was true for the indicators of restructuring, average length of stay, hospital volume, and hospital complexity level were not related to the likelihood that pneumonia or AMI patients would be readmitted for a related condition within 30 days.

Related admissions important

To examine the association between readmissions and hospital restructuring, the characteristics of patients must also be taken into account[3,11,14-16] (see *Patient characteristics*). Age, for example, might be expected to be associated with the likelihood of readmission. And in fact, in 1998/99, the percentage of pneumonia patients who were readmitted to

Analytical techniques

Hospital separation records may have more than one coded diagnosis. The diagnosis accounting for the greatest part of the hospital stay, or the "most responsible diagnosis," is used in this analysis to classify hospital stays. *International Classification of Diseases, Ninth Revision* (ICD-9 and ICD·9·CM) codes[17,18] were used to identify admissions for pneumonia and acute myocardial infarction (AMI), consistent with other research done in Ontario.[12]

Hospital separation records were grouped by patient, based on a person identifier. Hospital stays for each patient were then grouped into admission episodes, each consisting of an initial, or index, admission and possibly some readmissions (flowchart). An index admission:

- was due to pneumonia or AMI, depending on the analysis;
- occurred between April 1, 1998 and March 31, 1999; and
- was preceded by a "wash-out" period of at least 30 days in which the patient did not have a related admission (the 1997/98 file was checked for related admissions in the 30 days before admissions occurring in April 1998).

A readmission:

- was due to or related to pneumonia or AMI, depending on the analysis; and
- occurred within the 30 days after the discharge date of an index admission (index admissions for which the discharge date was after March 1, 1999 were dropped because readmission information was not available for the full 30-day period).

Only *acute* index admissions (that is, the length of stay was 60 days or less) were retained for analysis. Index admissions were flagged to indicate if they were followed by one or more related admissions within 30 days. Those involving a transfer to or from another hospital were excluded, since the length of stay does not reflect the full amount of time spent in hospital. Patients younger than 2 were excluded.

Based on the above definitions, it is possible to have more than one index admission per patient. However, 98% of all index admissions in this analysis were the patient's only index admission.

A total of 12,159 index admissions for pneumonia, distributed among 171 hospitals, were retained for analysis. Index admissions for AMI totalled 4,183, from 93 hospitals.

Chi-square tests were used to determine unadjusted associations between hospital and patient characteristics and readmission risk.

To calculate the odds of readmission by a hospital's change in mean length of stay (for pneumonia or AMI, depending on the analysis) or by its merger status, while adjusting for other hospital and patient characteristics, hierarchical non-linear models were fitted using the software HLM for Windows, version 5.02.[19,20]

To gain additional insight into the role of hospital and patient characteristics on patient outcomes, similar analyses were conducted with in-hospital deaths as the outcome.

Readmission calculations were based on index admissions; that is, each readmission had to occur within 30 days after an index admission. By contrast, the calculations for in-hospital deaths were based on all separations in 1998/99, whether they were index admissions or readmissions. Consequently, the calculations of percentages and odds ratios for readmission were based on a lower number (denominator) than were the calculations of percentages and odds ratios for deaths.

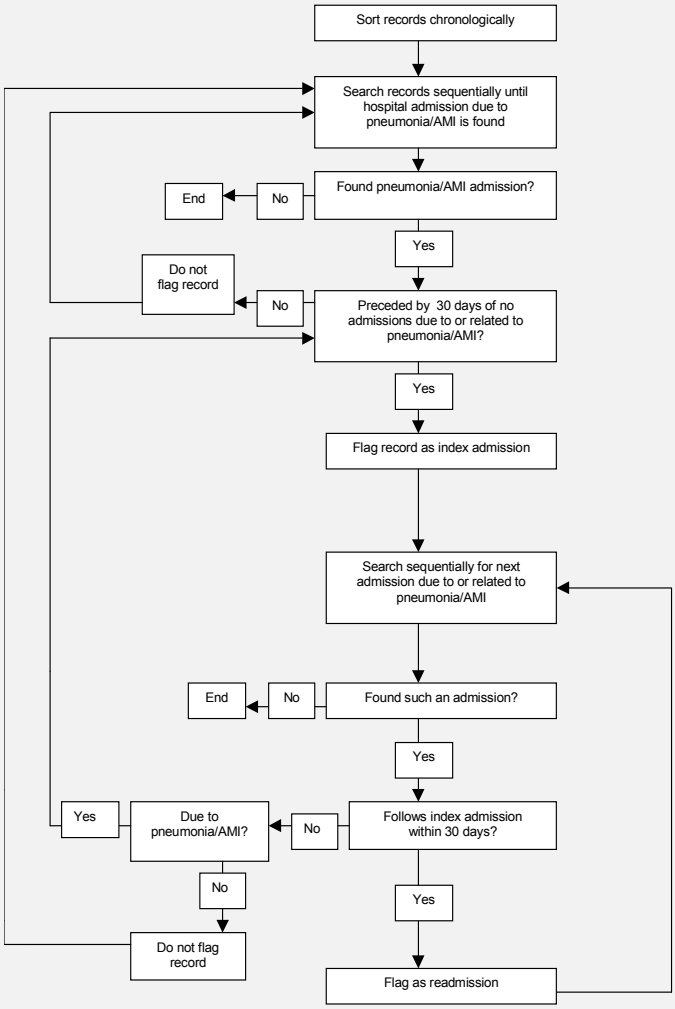

Table 2
Unadjusted probability of readmission within 30 days of acute index admission for pneumonia or acute myocardial infarction, by patient characteristics, Ontario, 1998/99

	Pneumonia				Acute myocardial infarction			
		Readmissions within 30 days				Readmissions within 30 days		
	Total index admissions	Number	% of index admissions	Chi-squared†	Total index admissions	Number	% of index admissions	Chi-squared†
Total	**12,159**	**1,011**	**8.3**	···	**4,183**	**581**	**13.9**	···
Sex								
Male	6,583	576	8.8	3.60	2,949	411	13.9	0.02
Female	5,576	435	7.8		1,234	170	13.8	
Age group								
2-11	2,031	140	6.9					
12-24	442	42	9.5		247‡	36	14.6	
25-44	1,378	101	7.3					
45-59	1,518	132	8.7	13.1*	1,137	165	14.5	0.90
60-74	3,162	258	8.2		1,674	223	13.3	
75+	3,628	338	9.3		1,125	157	14.0	
Related admissions in previous year								
0	10,912	864	7.9		3,799	509	13.4	
1	755	49	6.5	92.4*	231	24	10.4	42.2*
2+	492	98	19.9		153	48	31.4	
Case complexity								
None	9,114	754	8.3		3,523	499	14.2	
Due to chronic conditions	1,907	166	8.7		388	42	10.8	
Due to serious conditions	804	61	7.6	1.16	201	27	13.4	4.50
Due to life-threatening conditions	334	30	9.0		71	13	18.3	
Length of stay								
Quartile 1 (shortest)	2,856	223	7.8		888	120	13.5	
Quartile 2	3,757	322	8.6	5.89	1,565	222	14.2	
Quartile 3	3,021	232	7.7		563	73	13.0	0.73
Quartile 4 (longest)	2,525	234	9.3		1,167	166	14.2	

Data source: *1998/99 Discharge Abstract Database, Canadian Institute for Health Information*
† Used to test for independence between readmission and selected patient characteristic
‡ Ages 2 to 44 combined because of small cell size
** $p \leq 0.05$*
··· Not applicable

hospital within 30 days of discharge was lowest at ages 2 to 11 (less than 7%) and highest at ages 12 to 24 and 75 or older (more than 9%) (Table 2). By contrast, among AMI patients, readmission rates were around 13% or 14%, and the differences between age groups were not statistically significant.

Other research has shown readmissions to be associated with the number of recent related admissions.[14,21,22] In Ontario, too, pneumonia and AMI patients who had had two or more related admissions in the previous year were more likely to be readmitted within 30 days than were those with no related admissions in that period.

Case complexity, which is derived by CIHI from the number and types of diagnoses on each discharge record, indicates additional health problems the patient may be experiencing. Surprisingly, this variable was not associated with readmission risk for either pneumonia or AMI patients. For example, readmission rates of pneumonia patients were between 8% and 9%, regardless of whether the patients had no other health problem or a life-threatening condition.

The probability of readmission did not differ substantially by the length of time that patients had been hospitalized.

Volume significant for pneumonia

Hospital and patient characteristics are not independent. For instance, a recent merger may affect hospital complexity level, and changes in a hospital's average length of stay may reflect the case complexity of individual patients. But even when all the factors were considered simultaneously in multivariate analysis, no significant association emerged between readmissions and the two restructuring variables for pneumonia or AMI patients (Tables 3 and 4).

Hospital volume, however, was significantly associated with readmissions of pneumonia patients, a finding not present in the bivariate analysis.

Patient characteristics

Separation records for which the most responsible diagnosis had an ICD-9 code of 481, 4822, 4823, 4829, 483, 485, 486, or 487 were considered *pneumonia* cases.[17] *Acute myocardial infarction (AMI)* cases were those with an ICD-9 code of 410, or an ICD·9·CM code of 4100, 4101, 4102, 4103, 4104, 4105, 4106, 4107, 4108 or 4109.[17,18]

For all identified hospital stays, the 12-month period preceding the date of admission was searched for *related admissions in the previous year*: 0, 1, or 2 or more. In the pneumonia analysis, related admissions were those for which the most responsible diagnosis was in the major clinical category of respiratory diseases and conditions (for example, pneumonia or bronchitis). For acute myocardial infarction (AMI), related stays referred to all conditions and diseases of the circulatory system. The ICD-9 codes that correspond to these groups are in reference material from the Canadian Institute for Health Information.[23]

For the analysis of pneumonia patients, six age groups were specified: 2 to 11, 12 to 24, 25 to 44, 45 to 59, 60 to 74, and 75 or older. Because AMI is relatively uncommon at younger ages, for the analysis of AMI patients, four age groups were specified: 2 to 44, 45 to 59, 60 to 74, and 75 or older.

Case complexity was based on the number and type of diagnoses on a discharge record (derived by CIHI). Four categories (coded 1 to 4) were established: none, and complexity due to chronic, serious, or life-threatening conditions.

For the bivariate analysis, *length of stay* was grouped into quartiles. For pneumonia, the quartiles were: 0 to 2 days; more than 2 to 4 days; more than 4 to 7 days; and more than 7 to 60 days. For acute myocardial infarction (AMI), the quartiles were: 0 to 4 days; more than 4 to 6 days, more than 6 to 7 days; and more than 7 to 60 days. In the multivariate analysis, this variable was treated as continuous.

Table 3
Adjusted odds ratios for readmission within 30 days of acute index admission for pneumonia, by hospital and patient characteristics, Ontario, 1998/99

	Adjusted odds ratio	95% confidence interval
Hospital characteristics		
Change in mean length of stay, 1995/96 to 1998/99		
Increase†	1.00	...
Small decrease	0.98	0.84, 1.15
Large decrease	1.01	0.87, 1.17
Recently merged		
Yes	0.85	0.70, 1.03
No†	1.00	...
Mean length of stay, 1998/99		
Quartile 1 (shortest)	1.19	0.95, 1.50
Quartile 2	0.99	0.78, 1.25
Quartile 3	1.10	0.88, 1.37
Quartile 4 (longest)†	1.00	...
Volume (separations)		
Quartile 1 (smallest)	1.00	0.54, 1.88
Quartile 2	0.75*	0.62, 0.91
Quartile 3	0.89	0.75, 1.06
Quartile 4 (largest)†	1.00	...
Complexity level		
High	0.94	0.77, 1.14
Not high†	1.00	...
Patient characteristcs		
Sex		
Male	1.12	0.98, 1.27
Female†	1.00	...
Age group		
2- 11†	1.00	...
12-24	1.42	0.98, 2.04
25-44	1.16	0.87, 1.54
45-59	1.34	0.98, 1.82
60-74	1.24	0.98, 1.56
75+	1.43*	1.11, 1.84
Related admissions in previous year		
0†	1.00	...
1	0.73*	0.54, 1.00
2+	2.86*	2.31, 3.55
Case complexity		
None†	1.00	...
Due to chronic conditions	1.01	0.83, 1.22
Due to serious conditions	0.87	0.64, 1.18
Due to life-threatening conditions	0.98	0.64, 1.51
Length of stay	1.01	1.00, 1.03

Data source: *1998/99 Discharge Abstract Database, Canadian Institute for Health Information*
Note: *Because of rounding, some confidence intervals with 1.00 as lower/upper limit are significant.*
† Reference category
** $p \leq 0.05$*
... Not applicable

Patients in hospitals in the second volume quartile (reporting between 117 and 291 pneumonia separations) had significantly lower odds of readmission than did patients in hospitals in the fourth volume quartile (more than 800 pneumonia separations). The association may reflect a referral bias if sicker patients are referred to larger hospitals. It is also possible that clinical and/or hospital management practices differ between larger and smaller institutions.

Table 4
Adjusted odds ratios for readmission within 30 days of acute index admission for acute myocardial infarction, by hospital and patient characteristics, Ontario, 1998/99

	Adjusted odds ratio	95% confidence interval
Hospital characteristics		
Change in mean length of stay, 1995/96 to 1998/99		
Increase†	1.00	...
Small decrease	1.02	0.82, 1.27
Large decrease	0.89	0.71, 1.12
Recently merged		
Yes	1.13	0.64, 2.00
No†	1.00	...
Mean length of stay, 1998/99		
Quartile 1 (shortest)	1.07	0.82, 1.40
Quartile 2	0.86	0.63, 1.19
Quartile 3 and 4 (longest)†	1.00	...
Volume (separations)		
Quartile 1 (smallest)	1.01	0.57, 1.79
Quartile 2	0.83	0.60, 1.15
Quartile 3	0.99	0.76, 1.29
Quartile 4 (largest)†	1.00	...
Complexity level		
High	0.86	0.70, 1.06
Not high†	1.00	...
Patient characteristcs		
Sex		
Male	1.00	0.85, 1.19
Female†	1.00	...
Age group		
2-44†	1.00	...
45-59	1.01	0.68, 1.49
60-74	0.90	0.60, 1.35
75+	0.91	0.63, 1.31
Related admissions in previous year		
0†	1.00	...
1	0.77	0.50, 1.18
2+	3.09*	2.08, 4.58
Case complexity		
None†	1.00	...
Due to chronic conditions	0.75*	0.57, 0.99
Due to serious conditions	0.93	0.63, 1.37
Due to life-threatening conditions	1.37	0.74, 2.55
Length of stay	1.01	0.99, 1.03

Data source: *1998/99 Discharge Abstract Database, Canadian Institute for Health Information*
† Reference category
** $p \leq 0.05$*
··· Not applicable

A US study that controlled for demographic, clinical and hospital characteristics found that the risk of unplanned readmission to the same institution increased with hospital size.[15] However, this applied to heart failure/shock and nutritional/metabolic disorders, not to pneumonia. An Australian study using a range of diagnoses found that the association between hospital size and unexpected readmission to the same hospital varied by urban/rural status.[24] In rural settings, the risk of readmission increased with hospital size, but decreased with hospital size in urban settings. The study, however, did not account for demographic characteristics or clinical factors, such as severity, complexity or even type of diagnosis. In this analysis of 1998/99 Ontario data, it was only when adjusting for the selected patient and hospital factors that the association with volume emerged for pneumonia patients.

When all the factors were taken into account, the odds that pneumonia and AMI patients would be readmitted did not differ significantly by whether they were male or female or by their length of stay in hospital. However, for both pneumonia and AMI patients with at least two related admissions in the previous year, the odds of readmission were about three times the odds for those with no related admissions in that period.

The effect of age on readmission of pneumonia patients was apparently independent of the other factors, as the odds of readmission of those aged 75 or older were significantly high, compared with patients aged 2 to 11. By contrast, the odds of readmission of AMI patients did not vary by age.

In-hospital deaths

The lack of association between many variables and readmission of pneumonia or AMI patients may, to some extent, be explained by the exclusion of the most serious cases that would have had the highest probability of readmission—those that ended in death during hospitalization. In fact, several

Limitations

With regard to patient welfare, "readmission" as defined in this analysis must be interpreted with caution. In the Ontario hospital data on which this study is based, planned readmissions cannot be distinguished from unplanned readmissions. A Manitoba study, however, found that in 1992/93, 75% to 90% of readmissions for selected diagnoses were unplanned.[2]

This analysis tries to reduce unrelated readmissions by including only those involving the same organ system as the index admission. As a result, some readmissions that were a consequence of the index diagnosis, but affected another organ system, were ignored. Conversely, a patient might have been hospitalized more than once for treatment involving the same organ system, even though the hospitalizations were unrelated.

A 30-day period to track readmissions is arbitrary. Yet even when 15 or 60 days was used as the readmission period in hierarchical non-linear models, the hospital restructuring variables were not significantly associated with readmission (data not shown).

Excluding patients who died in hospital during their index admission diluted associations between readmission and some factors, notably age and case complexity, since the most severe cases were not part of the analysis. As well, because out-of-hospital deaths could not be detected, patients who died after they were discharged remained in the group at risk of readmission and were counted as not being readmitted. Had it been possible to adjust the figures to remove patients no longer "eligible" for readmission because of death, the associations might have been stronger.

The omission of index admissions involving a transfer to or from another hospital may systematically exclude particular types of patients whose readmission rates may be different. Indeed, other work has shown that a transfer to a special care unit is significantly predictive of readmission.[25]

A number of characteristics of patients and hospitals that might influence readmission risk were not available. For instance, discharge readiness, access to home care, access to specific therapies, and whether patients were discharged to the home or to an institution could not be taken into account. Some data on the administrative files were used as a proxy for missing variables, but the ability of the proxy variables to capture the information is limited.

Reporting and coding consistency across hospitals is unknown. Studies have shown that approximately 20% to 25% of the "most responsible"diagnoses are not coded accurately, and are often a coexisting condition.[26,27]

Finally, these results pertain only to pneumonia and acute myocardial infarction, and only in Ontario, so the results cannot be generalized to other diagnoses or to other jurisdictions.

demographic variables that were not related to readmission were related to in-hospital death. The odds of dying in hospital were significantly high for older patients, compared with younger ones (Appendix Tables B and C). As expected, the odds of dying were high for patients with additional health problems, compared with those whose cases were not complex. Female pneumonia patients had lower odds of dying in hospital than did their male counterparts, but for female AMI patients, the odds of dying were higher.

As well, one restructuring factor was significantly related to in-hospital deaths of pneumonia patients. Those in recently merged hospitals had significantly lower odds of dying than did pneumonia patients in other hospitals.

Changes in mean length of stay were not associated with in-hospital deaths. However, pneumonia patients in hospitals with relatively short average stays in 1998/99 had significantly low odds of dying, compared with those in hospitals with the longest average stays. And for both pneumonia and AMI patients, the odds of dying were significantly low in hospitals with a high average level of complexity.

Concluding remarks

In this analysis of Ontario data, hospital characteristics that may indicate restructuring—a decrease in average length of stay or a recent merger—were not associated with readmissions of pneumonia or acute myocardial infarction patients. The only association between these two variables and in-hospital deaths was low odds of dying for pneumonia patients in recently merged institutions. Nonetheless, the relationship between hospital restructuring and readmissions is difficult to interpret. The hospital and patient characteristics associated with readmission are complex. Many potentially influential factors are not available from the Discharge Abstract Database (DAD).

Moreover, the outcome variable itself is limited. While it has been suggested that hospitals with lower readmission rates have a higher quality of care,[2,28,29] this assumption is not universally accepted.[30,31] Readmissions may be of four general types:

complication of a previous admission; recurrence of disease; planned treatment; and unrelated new diagnosis.[32] In this analysis, it was not possible to distinguish planned and unplanned readmissions. And even if unplanned readmissions could be identified, in order to reflect an adverse patient outcome, "expected" but unplanned readmissions should be omitted from the analysis.[24] The lack of association between case complexity and readmission may be evidence of this limitation in the outcome variable, particularly when such a strong pattern is observed between in-hospital death and case complexity.

These limitations of the analysis point to data gaps, some of which present an opportunity to improve the DAD system in the future. ●

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Appendix

Table A

Unadjusted probability of in-hospital death for acute hospital admission† for pneumonia or acute myocardial infarction, by hospital and patient characteristics, Ontario, 1998/99

	Pneumonia				Acute myocardial infarction			
		In-hospital deaths				In-hospital deaths		
	Total admissions	Number	% of total admissions	Chi-squared‡	Total admissions	Number	% of total admissions	Chi-squared‡
Total	**13,556**	**1,397**	**10.3**	**...**	**4,858**	**675**	**13.9**	**...**
Hospital characteristics								
Change in mean length of stay, 1995/96 to 1998/99								
Increase	7,404	800	10.8	4.89	1,726	258	15.0	2.18
Small decrease	2,987	287	9.6		1,680	228	13.6	
Large decrease	1,945	185	9.5		1,388	184	13.3	
Missing	1,220	125	10.2		64	5	7.8	
Recently merged								
Yes	1,359	147	10.8	0.43	88	13	14.8	0.06
No	12,197	1,250	10.3		4,770	662	13.9	
Mean length of stay, 1998/99								
Quartile 1 (shortest)	3,845	297	7.7		1,070	152	14.2	
Quartile 2	3,008	254	8.4	78.6*	1,125	134	11.9	10.0*
Quartile 3	3,143	386	12.3		1,580	211	13.4	
Quartile 4 (longest)	3,560	460	12.9		1,083	178	16.4	
Volume (separations)								
Quartile 1 (smallest)	577	47	8.2		213	30	14.1	
Quartile 2	1,601	133	8.3	13.2*	724	88	12.2	6.0
Quartile 3	3,815	427	11.2		1,951	256	13.1	
Quartile 4 (largest)	7,563	790	10.5		1,970	301	15.3	
Complexity level								
High	4,361	553	12.7	39.2*	965	152	15.8	3.5
Not high	9,195	844	9.2		3,893	523	13.4	
Patient characteristics								
Sex								
Male	6,175	599	9.7	4.49*	3,319	370	11.2	66.06*
Female	7,381	798	10.8		1,539	305	19.8	
Age group								
2-11	2,036	5	0.3					
12-24	447	5	1.1		266§	19	7.1	
25-44	1,424	46	3.2					
45-59	1,603	85	5.3	907.12*	1,188	51	4.3	279.79*
60-74	3,480	318	9.1		1,894	220	11.6	
75+	4,566	938	20.5		1,510	385	25.5	
Related admissions in previous year								
0	12,123	1,207	10.0		4,358	558	12.8	
1	872	117	13.4	15.18*	306	76	24.8	43.45*
2+	561	73	13.0		194	41	21.1	
Case complexity								
None	9,577	463	4.8		3,854	331	8.6	
Due to chronic conditions	2,239	332	14.8		489	101	20.7	
Due to serious conditions	1,084	280	25.8	1,709.61*	353	152	43.1	602.37*
Due to life-threatening conditions	656	322	49.1		162	91	56.2	

Data source: *1998/99 Discharge Abstract Database, Canadian Institute for Health Information*

† Comprises index admissions and readmissions

‡ Used to test for independence between in-hospital death and selected hospital or patient characteristic

§ Ages 12 to 44 combined because of small cell size

** $p \leq 0.05$*

··· Not applicable

Table B

Adjusted odds ratios for in-hospital death for pneumonia admission,† by hospital and patient characteristics, Ontario, 1998/99

	Adjusted odds ratio	95% confidence interval
Hospital characteristics		
Change in mean length of stay, 1995/96 to 1998/99		
Increase‡	1.00	...
Small decrease	1.01	0.81, 1.25
Large decrease	0.96	0.77, 1.21
Recently merged		
Yes	0.72*	0.53, 0.97
No‡	1.00	...
Mean length of stay, 1998/99		
Quartile 1 (shortest)	0.64*	0.51, 0.80
Quartile 2	0.75*	0.60, 0.94
Quartile 3	1.08	0.89, 1.32
Quartile 4 (longest)‡	1.00	...
Volume (separations)		
Quartile 1 (smallest)	0.71	0.45, 1.11
Quartile 2	0.82	0.63, 1.05
Quartile 3	1.09	0.87, 1.35
Quartile 4 (largest)‡	1.00	...
Complexity level		
High	0.71*	0.59, 0.87
Not high‡	1.00	...
Patient characteristcs		
Sex		
Male	1.14	1.00, 1.31
Female‡	1.00	...
Age group		
2-11‡	1.00	...
12-24	6.86*	1.32, 35.76
25-44	22.59*	6.15, 82.94
45-59	27.34*	7.17, 104.31
60-74	52.61*	14.02, 197.33
75+	133.11*	35.49, 499.24
Related admissions in previous year		
0‡	1.00	...
1	1.26	1.00, 1.58
2+	1.11	0.78, 1.59
Case complexity		
None‡	1.00	...
Due to chronic conditions	2.55*	2.12, 3.06
Due to serious conditions	6.08*	4.85, 7.63
Due to life-threatening conditions	17.34*	13.55, 22.19

Data source: *1998/99 Discharge Abstract Database, Canadian Institute for Health Information*
† Comprises index admissions and readmissions
‡ Reference category
** $p \leq 0.05$*
··· Not applicable

Table C

Adjusted odds ratios for in-hospital death for acute myocardial infarction admission,† by hospital and patient characteristics, Ontario, 1998/99

	Adjusted odds ratio	95% confidence interval
Hospital characteristics		
Change in mean length of stay, 1995/96 to 1998/99		
Increase‡	1.00	...
Small decrease	0.77	0.57, 1.05
Large decrease	0.74	0.55, 1.00
Recently merged		
Yes	1.61	0.79, 3.27
No‡	1.00	...
Mean length of stay, 1998/99		
Quartile 1 (shortest)	0.93	0.66, 1.29
Quartile 2	0.87	0.60, 1.26
Quartile 3 and 4 (longest)‡	1.00	...
Volume (separations)		
Quartile 1 (smallest)	1.17	0.60, 2.26
Quartile 2	0.96	0.60, 1.54
Quartile 3	0.91	0.61, 1.34
Quartile 4 (largest)‡	1.00	...
Complexity level		
High	0.69*	0.48, 0.98
Not high‡	1.00	...
Patient characteristcs		
Sex		
Male	0.59*	0.49, 0.72
Female‡	1.00	...
Age group		
2-44‡	1.00	...
45-59	0.53	0.27, 1.02
60-74	1.49	0.85, 2.61
75+	3.48*	1.84, 6.56
Related admissions in previous year		
0‡	1.00	...
1	1.93*	1.40, 2.66
2+	1.61	0.96, 2.70
Case complexity		
None‡	1.00	...
Due to chronic conditions	3.40*	2.68, 4.30
Due to serious conditions	10.83*	7.90, 14.84
Due to life-threatening conditions	66.11*	33.82, 129.24

Data source: *1998/99 Discharge Abstract Database, Canadian Institute for Health Information*
† Comprises index admissions and readmissions
‡ Reference category
** $p \leq 0.05$*
··· Not applicable

Hip and knee replacement

Wayne J. Millar

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 dividing 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.[1] The resulting pain and disability can limit mobility, contribute to social isolation and depression, and decrease functional independence.[2] 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.[3]

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.[4-6] 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.[7-9]

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 dividing 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.[10]

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.[11,12] Major improvements have been noted for management of pain, sleep and disability.[2,13,14]

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
Both sexes					**Both sexes**				
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
Men					**Men**				
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
Women					**Women**				
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.[15] 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.

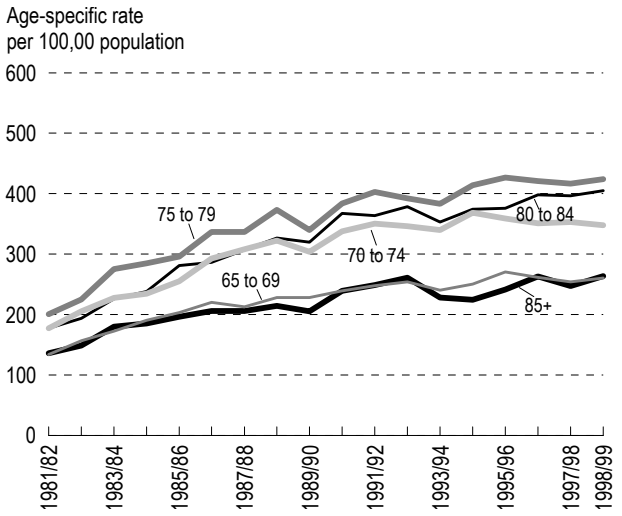
Hospital readmission within 30 days is a limited measure of complications from surgery, because it does not account for the patient's status before and after admission. Pre-admission comorbidity refers to a condition that usually has an important influence on the patient's length of stay and/or influences 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.

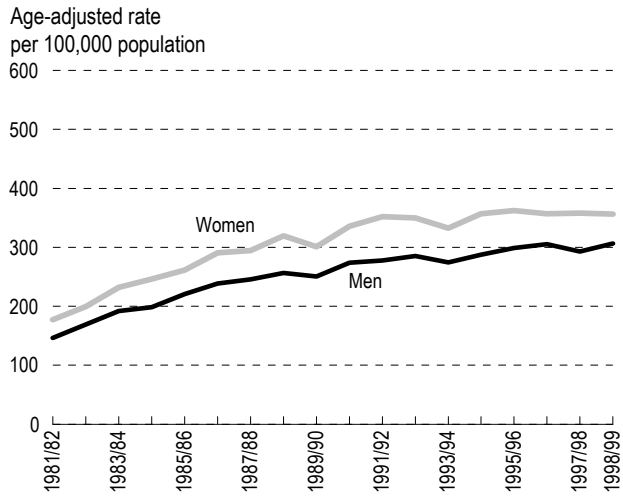
164.6. Hip replacement rates increased among all senior age groups, but throughout the period were highest at ages 75-to-79 (Chart 1). The rate rose sharply among both sexes, although it was consistently higher for women (Chart 2).

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

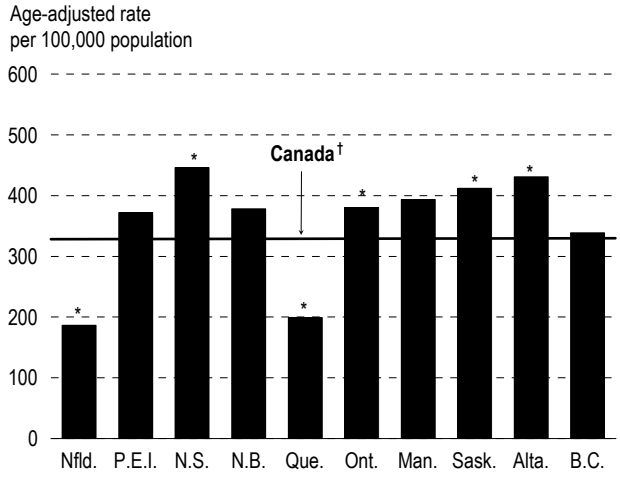


Data source: *Hospital Morbidity Database, 1981/82 to 1998/99*
Note: *Hip replacement refers to* Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures *codes 93.51 or 93.59 for primary or secondary surgical procedure.*

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 osteoarthric 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



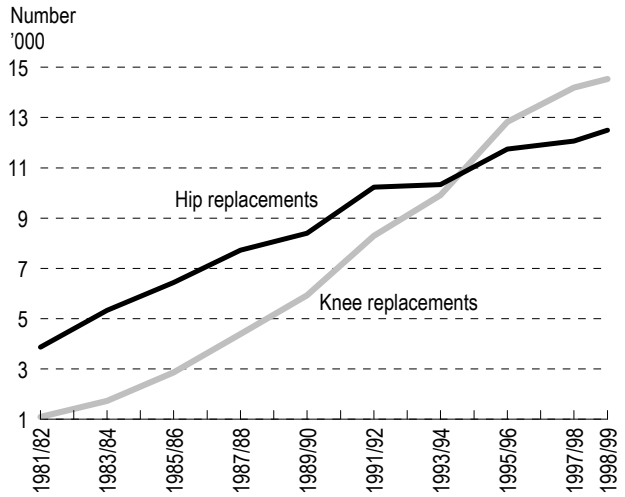
Data source: *Hospital Morbidity Database, 1981/82 to 1998/99*
Notes: *Hip replacement refers to* Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures *codes 93.51 or 93.59 for primary or secondary surgical procedure.*
† Excludes territories
** Significantly different from rate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

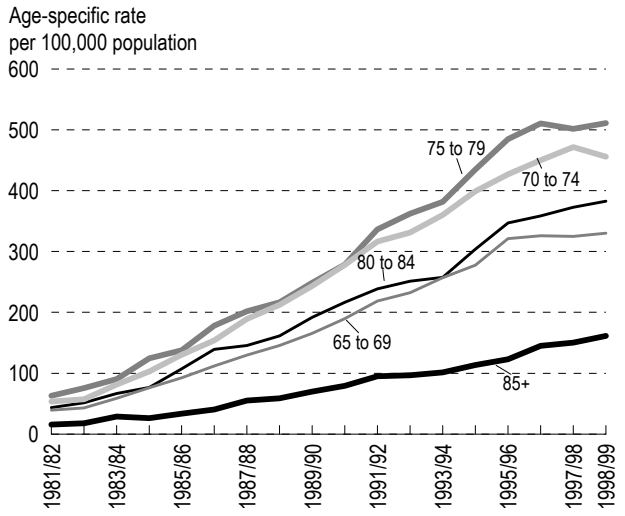
adjusted rate for knee replacement rose dramatically over the period, from 45.9 to 389.9 per 100,000 population aged 65 or older. Rates increased among all senior age groups, even the most elderly (Chart 5).

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.*

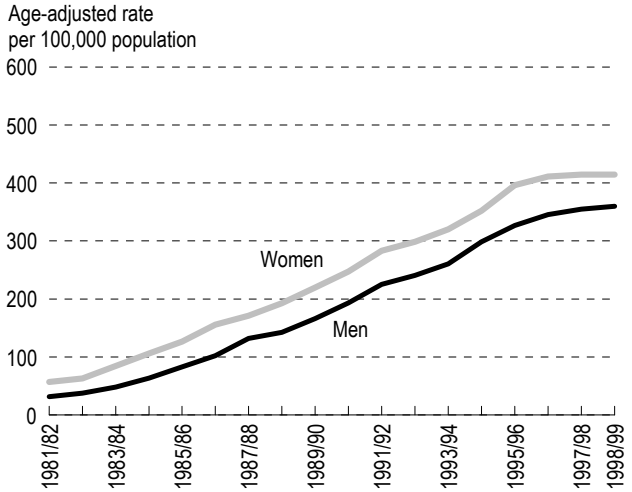
Chart 5
Knee replacement rates, by age group, population aged 65 or older, Canada excluding territories, 1981/82 to 1998/99



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.*

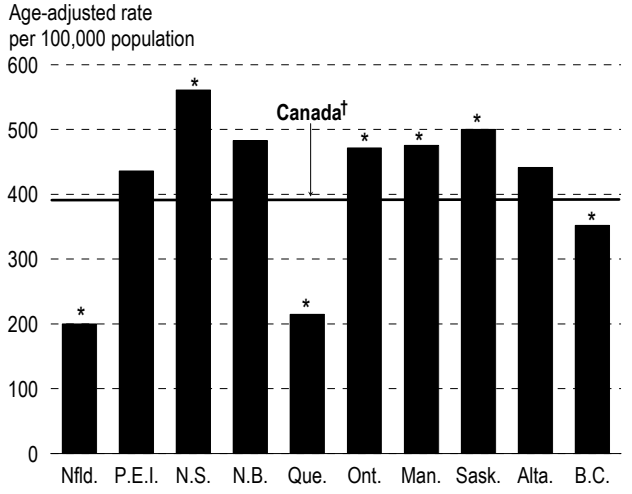
This sharp increase was evident for both sexes, with women having a consistently higher rate of knee replacement than did men (Chart 6). In 1998/99, the rates for knee replacement were

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).

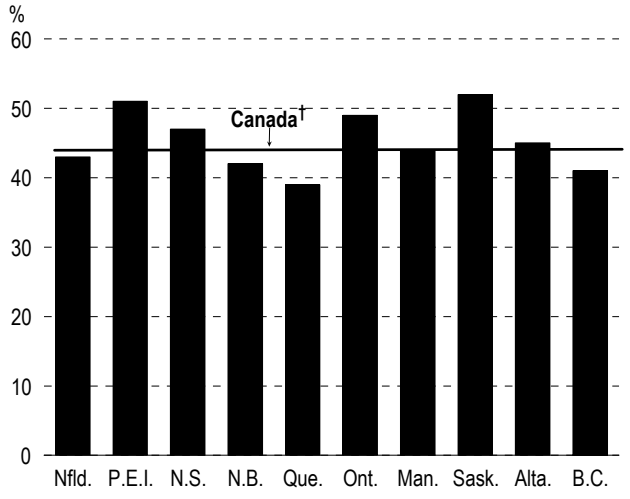
The rate of knee replacement among seniors rose in all provinces, although provincial differences were marked. By 1998/99, four provinces had rates significantly above the national level: Nova Scotia, Saskatchewan, Manitoba and Ontario; rates in Québec, Newfoundland and British Columbia were significantly 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 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.[19]

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,[16] *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).[17] Some studies have excluded patients with various comorbidities;[18] 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*).

Shorter hospital stays

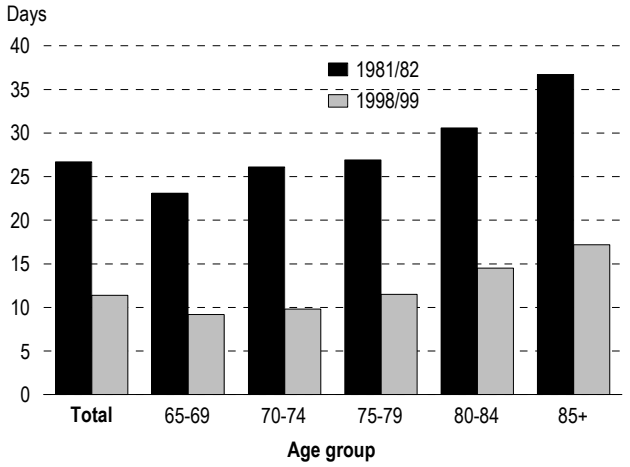
Over the last two decades, average lengths of stay for all types of hospitalization have decreased.[20] Hip and knee replacement followed this trend, even among seniors.

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).

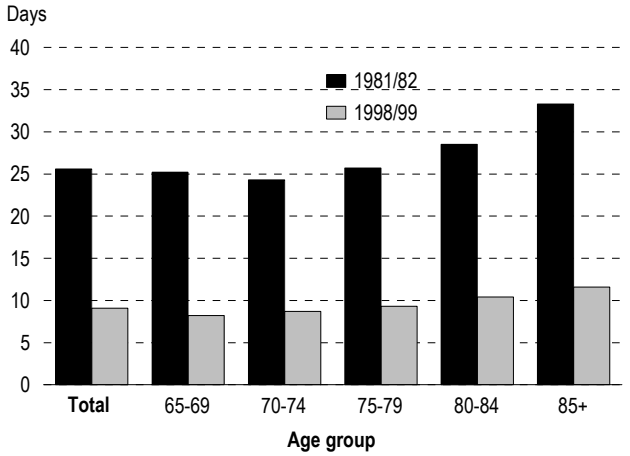
Not surprisingly, stays tend to be longer for older patients. In 1998/99, 65- to 69-year olds undergoing hip replacement averaged 9.2 days in hospital; for those aged 85 or older, the time stretched to 17.2 days. For knee replacement, the range was somewhat narrower: from 8.2 days for the 65-to-69 age group to 11.6 days at age 85 or older (see *In-hospital mortality and readmission*). Yet regardless of the age of patients, average stays for both procedures

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. Morever, 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 morality 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**
Complications involving readmission				
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.[21] 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.[22-24] 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.[25]

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+**
Number of separations						
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
Rate per 100,000 population						
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.
Number of separations											
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
Age-adjusted rate per 100,000 population											
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+**
Number of separations						
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
Rate per 100,000 population						
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.
Number of separations											
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
Age-adjusted rate per 100,000 population											
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+**
Number of days						
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
Average number of days						
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

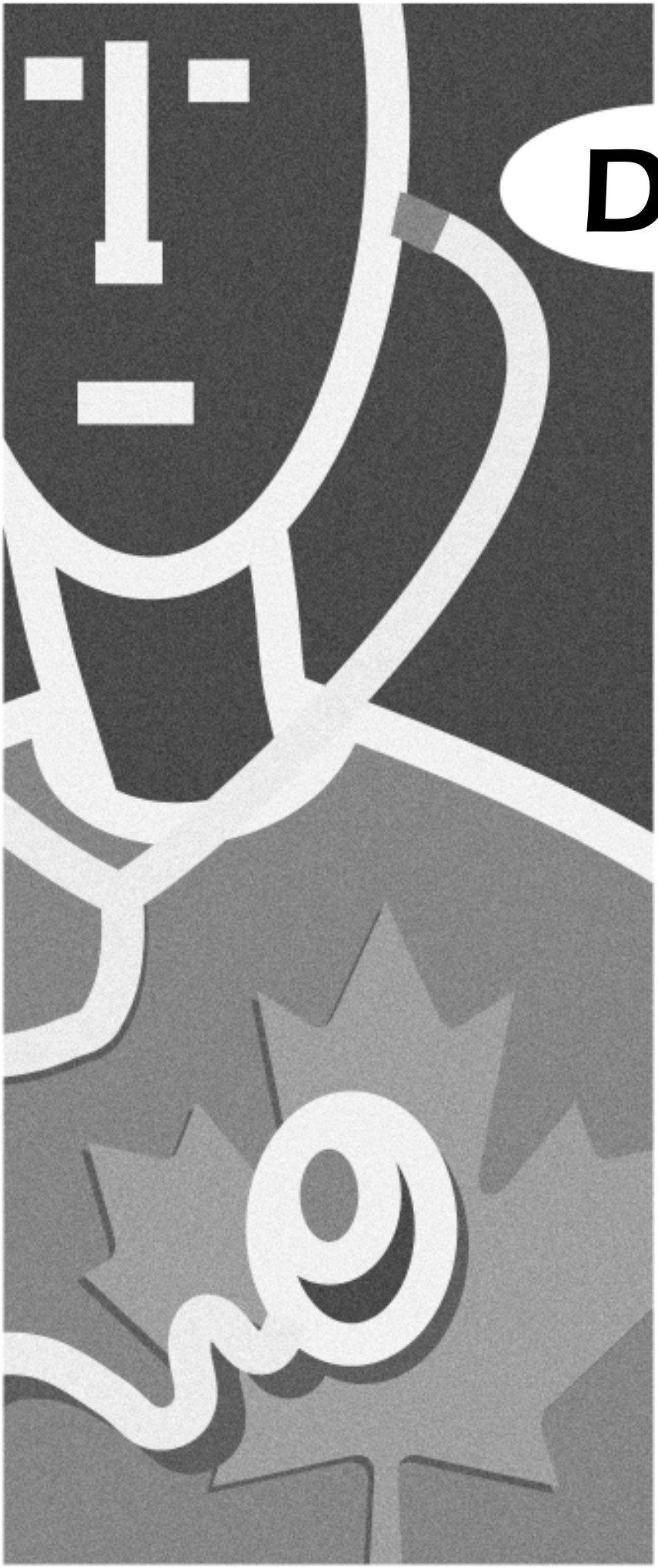
Data source: *Hospital Morbidity Database, 1981/82 to 1998/99*
Note: *Hip replacement refers to* Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures *codes 93.51 or 93.59 for primary or secondary surgical procedure.*

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+**
Number of days						
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
Average number of days						
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.*



Data Releases

Synopses of recent health information produced by Statistics Canada

Health Services Access Survey, 2000/01

Almost one in five Canadians who accessed health care for themselves or a family member in 2000/01 encountered difficulty, ranging from problems obtaining appointments to lengthy waiting times, according to the Health Services Access Survey (HSAS).

In 2000/01, an estimated 23.2 million Canadians aged 15 or older accessed "first-contact services," which cover routine care, health information and immediate care for a minor problem. About 18% of these people, or just under 4.3 million, encountered some kind of difficulty; most commonly, long waits and problems getting an appointment.

About 6.1 million individuals accessed "specialized services," which cover specialist visits, diagnostic tests, and non-emergency surgery. Around 23% of them, an estimated 1.4 million, reported some kind of difficulty. Again, long waits topped the list.

Overall, 40% of people waiting for non-emergency surgery had the operation in less than a month. Close to 10% reported waiting for six months, and about 5%, 35 weeks or more. Waiting times, however, varied by the type of procedure. For example, 54% of individuals requiring cardiac- or cancer-related surgery waited less than a month. Only 20% of those needing joint-replacement or cataract surgery had the operation within a month, and 35% waited more than three months.

The Health Services Access Survey was conducted as a supplement to the Canadian Community Health Survey. The HSAS gathered information at the national level on patterns of use of health care services and self-reported difficulties faced by Canadians aged 15 or older. Interviews took place in all 10 provinces in November and December 2001. The total sample size was 14,210.

The report *Access to Health Care Services in Canada, 2001* (82-575-XIE) is available free on Statistics Canada's Web site (http://www.statcan.ca/). From the "Our products and services" page, select "Free publications," then "Health."

For information about data availability, contact Mario Bédard (613-951-8933; fax: 613-951-4198; mario.bedard@statcan.ca). For more information about the HSAS, or to enquire about concepts, methods or data quality, contact Jean-Marie Berthelot (613-951-3760; fax: 613-951-3959; berthel@statcan.ca), Health Analysis and Measurement Group, Statistics Canada.

Health Indicators, 2002(1)

The first extensive data set from the Canadian Community Health Survey (CCHS) is available in *Health Indicators,* an Internet-based data publication. The CCHS collected information from more than 130,000 individuals aged 12 or older in 136 health regions, covering all provinces and territories.

Produced by Statistics Canada and the Canadian Institute for Health Information, *Health Indicators* contains statistical measures of the health of Canadians and the health care system. These indicators, based on standard definitions and methods, offer comparable information at the national, provincial/territorial and health region level. *Health Indicators*, Vol. 2002, no. 1, contains highlights, maps and data tables from the CCHS for 28 indicators, including dietary practices, heavy drinking, exposure to second-hand smoke, body mass index, leisure-time physical activity, Pap smears, mammography screening, stress, high blood pressure, and diabetes.

This is the second in the *Health Indicators* series to link the Statistics Canada and Canadian Institute for Health Information Web sites, providing all data sources of health indicators in one integrated online publication. *Health Indicators* (82-221-XIE) is available free on Statistics Canada's Web site (http://www.statcan.ca/). From the "Our products and services" page, select "Free publications," then "Health." For more information, contact Jason Gilmore (613-951-7118; jason.gilmore@statcan.ca), Health Statistics Division, Statistics Canada, or Anick Losier (613-241-7860), Canadian Institute for Health Information.

Canadian Community Health Survey: A first look, 2000/01

Although a growing proportion of people are active in their leisure time, the prevalence of obesity has increased, according to results from the Canadian Community Health Survey (CCHS). In 2000/01, almost 2.8 million Canadians aged 20 to 64, or 15%, were obese. This was an increase of more than 500,000 individuals from 1994/95 when the obesity rate among adults was 13%.

Men accounted for two-thirds of the increase in the obese population. In 1994/95, roughly 13% of both men and women aged 20 to 64 were obese. By 2000/01, a gap between the sexes had emerged, with 16% of men and 14% of women in the obese weight range: an estimated 1.5 million men and 1.3 million women.

Obesity rates were above the national level in 51 of the 136 health regions for which 2000/01 data are available. A much smaller number of health regions—13—had obesity levels below the Canadian average. These regions are all in Ontario, Québec and British Columbia and most are close to Montréal, Toronto or Vancouver, where obesity rates ranged from 6% to 12%.

In 2000/01, 7.8 million Canadians aged 20 to 64 reported leisure-time activity that was classified as active or moderately active. They represented 41% of the age group in 2000/01, up from 37% six years earlier.

However, the individuals most in need of physical activity—those who were obese—were the least active. In 2000/01, about 33% of them reported being active or moderately active in leisure-time, a proportion essentially unchanged from 1994/95.

Women have almost caught up with men in leisure-time physical activity. In 1994/95, about 36% of women and 39% of men aged 20 to 64 were physically active. By 2000/01, the gap had narrowed: 41% of women and 42% of men in this age range reported at least moderate physical activity during their leisure time.

Among the health regions, 25 had physical activity levels significantly below the national average, while 55 reported levels above the national average. The latter were mostly in Ontario, Alberta and British Columbia (46 of the 55).

These data are from the first cycle of the Canadian Community Health Survey (CCHS), conducted from October 2000 to November 2001. Information was collected from over 130,000 individuals aged 12 or older in 136 health regions in all provinces and territories. Each collection cycle has two distinct surveys: a health-region-level survey in the first year with a total sample of 130,000, and a provincial-level survey in the second year, with a total sample of 30,000. For more information, or to enquire about concepts, methods or data quality, contact Larry MacNabb (613-951-4269; fax 951-4198; larry.macnabb@statcan.ca), Health Statistics Division, Statistics Canada.

To view other tabulations released from the CCHS, see *Health Indicators* (82-221-XIE), available free on Statistics Canada's Web site (http://www.statcan.ca/). From the "Our products and services" page, select "Free publications," then "Health." For more information, contact Jason Gilmore (613-951-7118; jason.gilmore@statcan.ca), Health Statistics Division, Statistics Canada.

To request custom tabulations, contact the Client Custom Services Unit (613-951-1746).

Deaths, 1999

In 1999, life expectancy at birth reached record highs for both sexes. A man born in 1999 could expect to live 76.3 years; a woman, 81.7 years. The male-female gap in life expectancy narrowed to 5.4 years, down from 5.5 in 1998.

Age-standardized mortality rates from all causes of death fell 2% to 637.7 deaths per 100,000 population. The rate for men continued to exceed that for women: 816.5 versus 505.4 deaths per 100,000 population.

About 36% of deaths in 1999 were due to diseases of the circulatory system. Among these deaths, ischemic heart disease and cerebrovascular disease were the most common causes. Malignant neoplasms (cancer) accounted for 28% of all deaths, with over half (51%) due to lung, colorectal, female breast or prostate cancer.

After declining for five years, Canada's infant mortality rate remained unchanged in 1999: 5.3 deaths per 1,000 live births. The mortality rate for infant boys was 5.7 per 1,000, compared with 4.8

for infant girls. The infant mortality rate declined in most provinces and territories between 1998 and 1999; Manitoba, Ontario and Alberta were the exceptions.

To order *Causes of Death, 1999* (shelf tables, 84F0208XPB, $20), contact Client Custom Services (613-951-1746), Health Statistics Division. Additional shelf tables from the deaths database, *Deaths, 1999* (84F0211XPB, $20), *Leading Causes of Death at Different Ages, 1999* (84F0503XPB, $20), and *Mortality Summary List of Causes, 1999* (84F0209XPB, $20) are now available.

For more information, contact Patricia Tully (613-951-1759; patricia.tully@statcan.ca) or Leslie Geran (613-951-5243; leslie.geran@statcan.ca), Health Statistics Division, Statistics Canada.

Stillbirths, 1999

The number of stillbirths with a gestational age of 28 weeks or more, known as late fetal deaths, rose slightly from 1,079 in 1998 to 1,087 in 1999, halting six straight years of decline. There were 3.2 late fetal deaths for every 1,000 total births (live births plus stillbirths of 28 weeks' or longer gestation) in 1999, up slightly from 3.1 in 1998. Late fetal death rates have been below 4 deaths for every 1,000 total births since 1990.

The perinatal death rate (late fetal deaths plus deaths of live-born infants under one week old) was 6.2 deaths for every 1,000 total births in 1999, unchanged from 1998.

Stillbirth data are also released for gestation periods of 20 or more weeks, which includes a few stillbirths of unknown gestation or a gestation period of less than 20 weeks, but a weight of 500 grams or more. In 1999, there were 2,063 stillbirths of 20 weeks' or longer gestation, up from 1,987 in 1998. The rate rose slightly from 5.8 stillbirths for every 1,000 total births in 1998 to 6.1 in 1999.

Stillbirths of 20 weeks' or longer gestation are more common in multiple-birth pregnancies. In 1999, there were 20.0 stillbirths for every 1,000 babies who were twins, triplets or higher-order multiples. In comparison, there were 5.7 stillbirths for every 1,000 babies who were singletons.

About 46% of stillbirths of 20 weeks' or longer gestation occurred at 20 to 27 weeks, and another 34% at 28 to 37 weeks. The remainder (about 19%) occurred in full-term pregnancies; that is, 38 or more weeks' gestation.

The highest rate of stillbirths of 20 weeks' or longer gestation was among older mothers. In 1999, there were 8.3 stillbirths for every 1,000 total births to women aged 35 and older. Women younger than 20 had the second highest rate of stillbirths: 7.3 for every 1,000 total births. Women aged 20 to 34 had the lowest stillbirth rate: 5.5 for every 1,000 total births.

To order *Births, 1999* (shelf tables, 84F0210XPB, $20) or custom tabulations, call Client Custom Services (613-951-1746), Health Statistics Division.

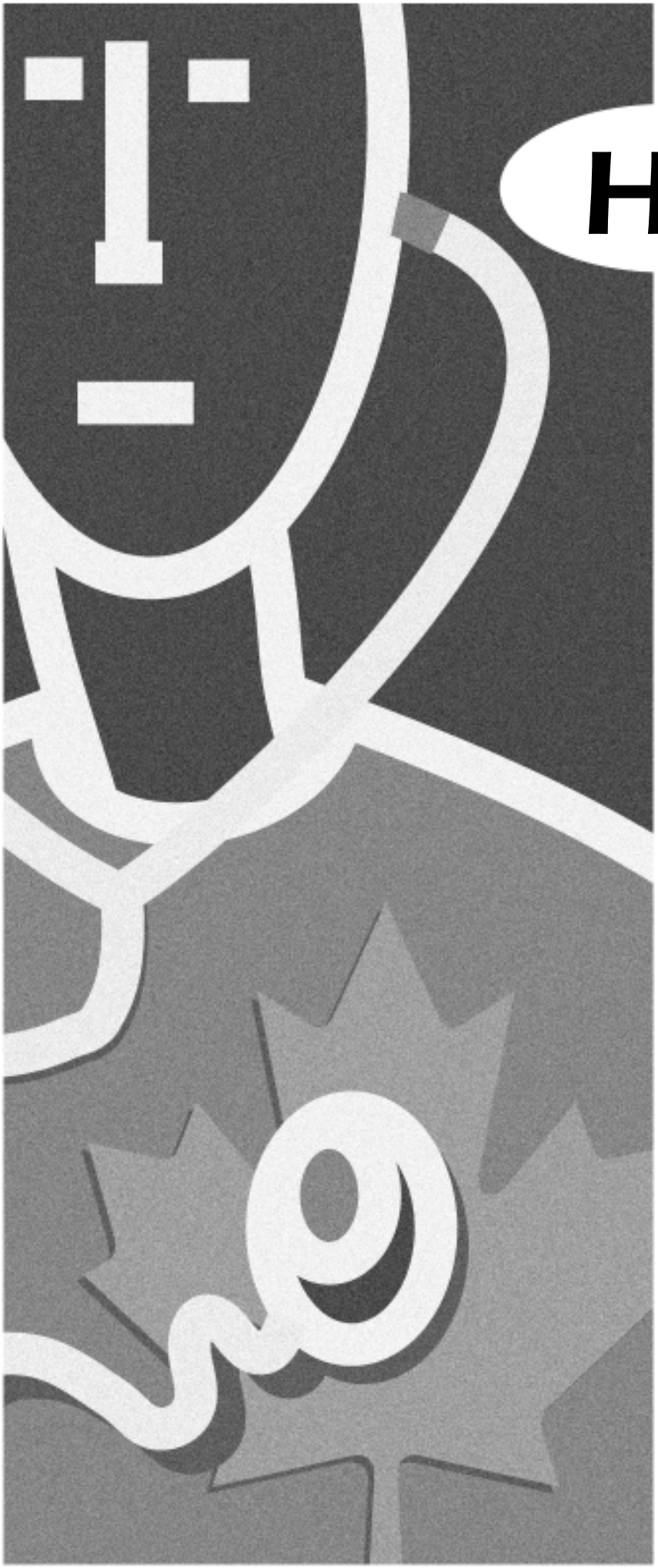
For more information, or to enquire about concepts, methods or data quality, contact Patricia Tully (613-951-1759; patricia.tully@statcan.ca) or Leslie Geran (613-951-5243; leslie.geran@statcan.ca), Health Statistics Division, Statistics Canada.

National Population Health Survey, 2000/01

Data from the household component of the 2000/01 National Population Health Survey (NPHS) are now available. Conducted every two years since 1994/95, the NPHS is a longitudinal survey of the health status, health determinants and health outcomes of Canadians.

The NPHS household panel consists of 17,276 respondents in the 10 provinces. The survey provides information at the national and provincial levels on a wide range of health variables such as alcohol consumption, smoking, chronic conditions, health care utilization, self-perceived health, height, weight, leisure-time physical activity and activity restriction, as well as socio-demographic data.

For more information, or to enquire about concepts, methods or data quality, contact Mario Bédard (613-951-8933; fax: 613-951-4198; mario.bedard@statcan.ca), or France Bilocq (613-951-6956; fax: 613-951-4198; france.bilocq@statcan.ca), Health Statistics Division, Statistics Canada. ●



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Title		Catalogue number	Format	Price (CAN$)†‡
Health Reports	· subscription · single issue	82-003-XPE	Paper	$ 58 $ 20
	· subscription · single issue	82-003-XIE	Internet	$ 44 $ 15
	· supplement (Annual Report)	82-003-XIE 82-003-XPE	Internet Paper	Free $ 20
Health Indicators, electronic publication		82-221-XIE	Internet	Free
Health Statistics at a Glance *(Replaced by Health Indicators, electronic publication)*		82F0075XCB	CD-ROM	$100
Health Regions 2000 – Boundaries, Geographic Information and Population Estimates		82F0082XCB	CD-ROM	$ 60
Guide to Health Statistics *(This provides quick and easy access to health information on Statistics Canada's web site. It can only be used online in html format and cannot be downloaded.)*		82-573-GIE	Internet	Free
Statistical Report on the Health of Canadians		82-570-XIE	Internet	Free
Report on Smoking Prevalence in Canada, 1985 to 1999		82F0077XIE	Internet	Free
Health Care in Canada 2000 – A First Annual Report		82-222-XIE (and http://www.cihi.ca)	Internet	Free
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Cancer Incidence in Canada *(For 1994 to 1996, available through Client Custom Services Unit)*				
Cancer Record, Newsletter for Cancer Registries in Canada		82F0081XIB	Internet	Free
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Life Tables, Canada, Provinces and Territories, 1995-1997 Life Tables, Canada and Provinces, 1990-1992		84-537-XIE 84-537-XPB 84-537-XDB	Internet Paper Diskette	$ 15 $ 40 $ 40

† All prices exclude sales tax.
‡ See inside cover for shipping charges.

Title	Catalogue number	Format	Price (CAN$)†‡
National Population Health Survey			
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User's guide for the public use microdata file			
National Population Health Survey 1998-99 - Household Component	82M0009GPE	Paper	$ 50
National Population Health Survey 1996-97 - Household Component	82M0009GPE	Paper	$ 50
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Information about the National Population Health Survey *(See also section on Microdata files)*	82F0068XIE	Internet	Free
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Registered Nurses Management Data 1998, Shelf Table *(This shelf table can be ordered through the Client Custom Services Unit.)*	83F0005XPB	Paper	$ 25
Occupational Surveillance			
Occupational Surveillance in Canada: Cause-specific mortality among workers, 1965-1991	84-546-XCB	CD-ROM	$500
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Residential Care Facilities, 1997-98 *(These data are available as custom tabulations through the Client Custom Services Unit.)*			
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Health Statistics Division produces shelf tables for the following, from data year 1996.			
General Summary of Vital Statistics	84F0001XPB	Paper	$ 20
Causes of Death	84F0208XPB	Paper	$ 20
Mortality - Summary List of Causes	84F0209XPB	Paper	$ 20
Mortality - Summary List of Causes, 1997	84F0209XIB	Internet	Free
Births	84F0210XPB	Paper	$ 20
Deaths	84F0211XPB	Paper	$ 20
Marriages	84F0212XPB	Paper	$ 20
Divorces	84F0213XPB	Paper	$ 20
Leading Causes of Death	84F0503XPB	Paper	$ 20
(These shelf tables can be ordered through the Client Custom Services Unit.)			
Other			
Validation study for a record linkage of births and deaths in Canada	84F0013XIE	Internet	Free
Postal Code Conversion File Plus (PCCF+) *(To obtain the PCCF+, clients must have purchased the PCCF)*	82F0086XDB	Diskette	Free
Historical Information			
Vital Statistics Compendium, 1996	84-214-XPE 84-214-XIE	Paper Internet	$ 45 $ 33

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‡ See inside cover for shipping charges.

Health Statistics Division provides a custom tabulation service to meet special resource needs and supplement published data on a fee-for-service basis. Custom tables can be created using a variety of health and vital statistics data sources maintained by the Division.

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National Population Health Survey public-use microdata files		Product number	Format	Price (CAN$)†‡
Cycle 4, 2000-01				
Custom tables	Household	82C0013	Price varies with information requirements	
Cycle 3, 1998-99				
Household	Cross-sectional data in Flat ASCII files, User's Guide, data dictionary, indexes, layout, Beyond 20/20 Browser for the Health File	82M0009XCB	CD-ROM	$2,000
Custom tables	Household	82C0013	Price varies with information requirements	
	Institutions	82C0015	Price varies with information requirements	
Cycle 2, 1996-97				
Household	Cross-sectional Flat ASCII Files, Beyond 20/20 Browser for the Health File	82M0009XCB	CD-ROM	$500
Health care institutions	Cross-sectional Flat ASCII File	82M0010XCB	CD-ROM Clients who purchase the 1996/97 Household file will receive the Institutions file free of charge	$250
Custom tables	Household	82C0013	Price varies with information requirements	
	Institutions	82C0015	Price varies with information requirements	
Cycle 1, 1994-95				
Household	Data, Beyond 20/20 Browser Flat ASCII Files, User's Guide	82F0001XCB	CD-ROM	$300
Health care institutions	Flat ASCII Files	82M0010XDB	Diskette	$75
Custom tables	Household	82C0013	Price varies with information requirements	
	Institutions	82C0015	Price varies with information requirements	

† All prices exclude sales tax.
‡ See inside cover for shipping charges.

Canadian Community Health Survey (CCHS)

A new survey, the Canadian Community Health Survey (CCHS), is being conducted by Statistics Canada to provide regular and timely cross-sectional estimates of health determinants, health status and health system utilization for 136 health regions across the country.

The following products are available:
- Health Indicators, updated to include estimates based on CCHS data for 136 health regions
- CANSIM II, including approximately 40 cross-tabulations by health region and province. All CANSIM tables will be accessible through Health Indicators and will be available free of charge.
- Custom tabulations of CCHS data, available on request on a cost-recovery basis.

A public-use CCHS microdata file is planned for release later in the year.

For more information about this survey, visit our web site at http://www. statcan.ca, under "Statistical Methods," followed by "Surveys."

National Population Health Survey (NPHS) Questionnaires

- Household
- Institutions
- North

The NPHS questionnaires are downloadable from Statistics Canada's website at http://www.statcan.ca, under "Statistical methods," followed by "Questionnaires" and "National Population Health Survey" (NPHS).

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For more information, visit our web site at http://www.statcan.ca, under "Canadian Statistics," and then click on "Health."

Statistical Research Data Centres

Statistics Canada, in collaboration with the Social Sciences and Humanities Research Council (SSHRC), has launched an initiative that will help strengthen the country's social research capacity, support policy-relevant research, and provide insights on important issues to the Canadian public. The initiative involves the creation of nine research data centres at McMaster University in Hamilton, the Université de Montréal, Dalhousie University, and the Universities of Toronto, Waterloo, Calgary, Alberta, New Brunswick (Fredericton), and British Columbia. Prospective researchers who wish to work with data from the surveys must submit project proposals to an adjudicating committee operating under the auspices of the SSHRC and Statistics Canada. Approval of proposals will be based on the merit of the research project and on the need to access detailed data. The centres and research projects will be evaluated periodically to assess security standards and the success of analysis resulting from the projects. Researchers will conduct the work under the terms of the *Statistics Act*, as would any other Statistics Canada employee. This means that the centres are protected by a secure access system; that computers containing data will not be linked to external networks; that researchers must swear a legally binding oath to keep all identifiable information confidential; and that the results of their research will be published by Statistics Canada. For more information, contact Garnett Picot (613-951-8214), Business and Labour Market Analysis Division.