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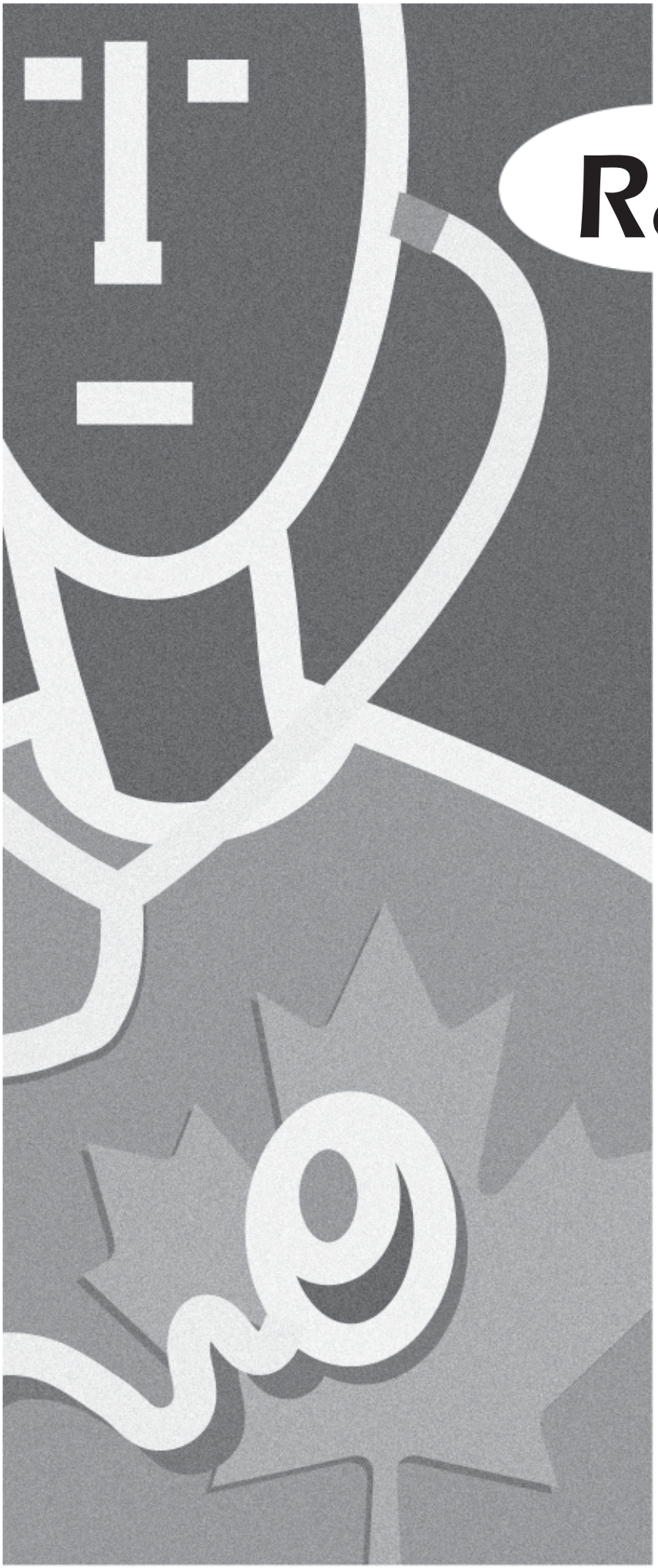

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Medication use among pregnant women

Didier Garriguet

Abstract

Objectives

This study examines medication use among women aged 15 to 49, comparing pregnant women with their non-pregnant contemporaries. A portrait of women who used medication during pregnancy is also presented.

Data sources

Analysis is based on data from the 1994/95 through 2002/03 National Longitudinal Survey of Children and Youth (NLSCY), as well as the 2003 Canadian Community Health Survey (CCHS) and the 1996/97 National Population Health Survey (NPHS).

Analytical techniques

Estimates of medication use are based on cross-sectional data. Logistic regression was used to determine factors associated with use of medication.

Main results

Medication use among women aged 15 to 49 has risen over the last 10 years. Although the proportion of pregnant women who used medications increased, it remained below the figure for other women the same ages. Over one-quarter of women (27%) were taking prescription medications while pregnant.

Keywords

drug prescriptions, fetus, non-prescription drugs, pregnancy

Author

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The impact of a pregnant woman's behaviour on her baby's development is no longer debated. The risks associated with smoking and drinking during pregnancy are well-known and have been extensively documented.[1-7] It is also recommended that pregnant women consult a health care professional before taking any medications, even those available without a prescription.

Drugs are rarely tested on pregnant women because of the potential risks to the fetus.[8] Knowledge about the effects of drugs on the unborn child comes from, among other sources, clinical trials, cohort or case studies, and drug registries that are generally maintained by pharmaceutical companies. Such studies have examined not only the effects of medication on pregnant women, but also possible influences on the infant, such as prematurity, low birth weight, mortality and fetal malformations.[9] Information on long-term effects is more limited.

The US Food and Drug Administration (FDA), has defined five categories for classifying the risk of medications for use during pregnancy. These are based on whether or not the medications have been tested, and if they pose a risk to the fetus.[10] Medications tested on women

Methods

Data sources

Estimates of use of medication during pregnancy are based on longitudinal data from the first five cycles of the National Longitudinal Survey of Children and Youth, conducted from 1994/95 through 2002/03. Comparisons of medication use among pregnant women and other women of reproductive age are based on data from the 1996/97 National Population Health Survey (NPHS) and the 2003 Canadian Community Health Survey (CCHS).

The NLSCY, a longitudinal survey, was introduced in 1994/95 to follow and provide a portrait of children aged 0 to 11 through to age 25. The survey is conducted every two years. A cross-sectional component for children aged 0 to 1 is also conducted every two years; this sample is followed over three cycles, until the children reach age 5.

Factors associated with medication use (prescription or non-prescription) among pregnant women were determined with pooled data from cycles 1 through 5. In total, 20,738 biological mothers who had always lived with their child were selected. The cross-sectional response rates were: 86.3%, cycle 1 (1994/95); 90.4%, cycle 2 (1996/97); 85.2%, cycle 3 (1998/99); 74.2%, cycle 4 (2000/01); and 74.0%, cycle 5 (2002/03). The children were selected from the Labour Force Survey or the birth register (only for children aged 1 selected in cycle 3). For more information about the NLSCY methodology, consult the Statistics Canada Web site.[11]

The NPHS, which began in 1994/95, collects information about the health of Canadians every two years. The survey covers household and institutional residents in all provinces and territories, except people living on Indian reserves and Canadian Forces bases, and in some remote areas.

For each of the first three NPHS cycles (1994/95, 1996/97 and 1998/99), two cross-sectional files were produced: General and Health. The General file contains socio-demographic and some health information for each member of participating households (collected using the General questionnaire). The Health file contains additional, in-depth health information (collected using the Health questionnaire) about one randomly selected household member, as well as the information from the General file about that individual. Starting in 2000/01, the NPHS became strictly longitudinal, and the General and Health questionnaires were combined.

For the first three NPHS cycles, two cross-sectional response rates were calculated: household and individual. The household response rate is the percentage of households where at least the General questionnaire was completed for the randomly selected respondent. The individual response rate is the percentage of responding households for which the Health questionnaire was completed for the randomly selected respondent. In 1996/97, the household response rate was 82.6%, and the individual response rate was 95.6%. More detailed descriptions of the NPHS design, sample and interview procedures can be found in published reports.[12,13]

The proportions of women of childbearing age who had consumed medications in the month before their 2003 interview were calculated based on data from women aged 15 to 49 who were part of the CCHS cycle 2.1 sub-sample.

The CCHS, conducted every two years, was designed to collect cross-sectional information about the health of the Canadian population. The CCHS and its sub-samples cover the household population aged 12 or older in the provinces and territories, except residents of Indian reserves, Canadian Forces bases, and some remote areas. Data collection for cycle 2.1 began in January 2003 and ended in December of that year. The response rate was 81.2%, which produced a sub-sample of 38,072. A description of the CCHS methodology is available in a published report.[14]

Analytical techniques

Pregnant women's use of medication, alcohol and cigarettes between 1993 and 2002 was estimated using cross-sectional NLSCY data based on their child's year of birth.

Differences in medication use by type of medication were calculated using cross-sectional data from the 1996/97 NPHS and the 2003 CCHS. Significant differences between use by pregnant women and by other women of reproductive age were determined with the Bonferroni test; the significance level was set at $p < 0.05$.

The proportions of women who had consumed medications in the month before the 1996/97 NPHS interview were calculated based on data for 22,778 women aged 15 to 49 for whom information on medication use and factors that may have influenced that use were available. Records for 56 respondents were excluded from this analysis because the women did not give a "yes" response when asked if they were pregnant, or there was no response. Another 60 women were excluded from the calculations of medication use by type.

Logistic regression was used to determine factors associated with use of medication in the month before the CCHS and NPHS interviews. The following characteristics of the mother were examined: pregnancy status, province of residence, age, chronic condition(s), immigrant status, education, and household income. The reference group was generally defined as the largest group in the population. Household income was the exception; "highest" was used as the reference group.

Pooled observations based on cross-sectional data from the first five NLSCY cycles were used to determine factors associated with prescription and non-prescription medication use. Logistic regression was then used to identify characteristics associated with taking medication during pregnancy. The data were weighted using the total cross-sectional weights available for each cycle, representing children between the ages of 0 and 1 at the time of the survey interview. The characteristics used were the same as those from the CCHS and NPHS, with the addition of lone-parent household and collection cycle. Pregnancy status was excluded because only mothers who had given birth to the child were considered.

Because of low rates of partial non-response, non-responses for data from the NLSCY were ignored. The analyses included only biological mothers who responded to questions about medication use. Cases of non-response for a chronic condition, for example, were imputed as not having the characteristic.

"Missing" data from the CCHS and the NPHS about medication use or the type of medication were excluded from calculations of prevalence rates and from the logistic regression analysis. Because of very low partial non-response rates, missing data were excluded for the presence of a chronic condition, education level and immigration status. In total, 186 records from the CCHS were excluded because of missing data on medication use; 85 NPHS records were excluded. Another 145 CCHS and 175 NPHS records, for which data were missing for one of the other questions, were also excluded. A "missing" category was created for household income for cases of non-response to this question (13% for the CCHS and 19% for the NPHS). The analysis reflects 9,826 records for women of childbearing age from the CCHS and 22,518 from the NPHS.

Differences in rates of use for different medications, differences between types of medications, and differences between odds ratios were calculated using the bootstrap method, which accounts for survey design effects.[15,16] The bootstrap method was also used to test differences between rates of use in 1993/94 and 2001/02. Level of significance was set at $p < 0.05$.

and considered to have a remote possibility of harming the fetus are in Category A. Two possibilities comprise Category B: animal studies have not indicated a risk to the fetus and controlled studies in women are not available, or animal studies have shown an adverse effect, but controlled studies in women did not. Category C covers medications that have been tested on animals and indicated a fetal risk, as well as those drugs for which the effects remain unknown. Drugs that present a fetal risk, but whose benefits represent an acceptable risk for the mother, are in Category D. Drugs that remain dangerous to the mother are in Category X. A recent US study found that just under 5% of pregnant women consumed drugs in categories D or X, and nearly 38% had taken medications in Category C.[10]

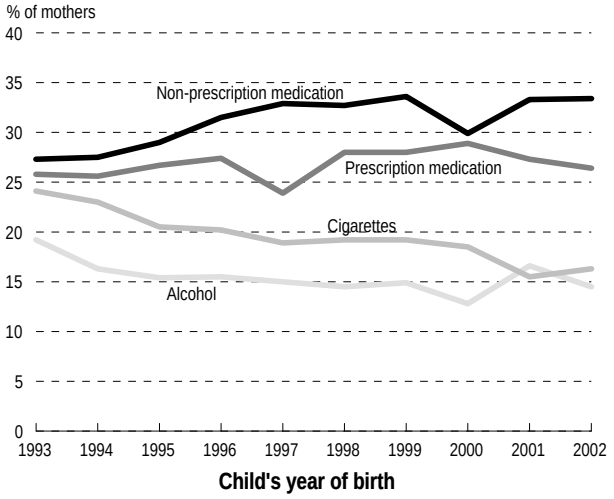
Medication use among the general population in Canada has increased in recent years.[17] According to Statistics Canada's Survey of Household Spending, each household spent an average of $268 for prescription medications in 2003, up from $198 in 1997. Even when the higher actual cost of medications is taken into account, this represents a 21% increase over the period.[18]

This study of medication use among pregnant women aged 15 to 49 is based on data from the first five cycles (1994/95 to 2002/03) of the National Longitudinal Survey of Children and Youth (NLSCY) (see *Methods*, *Definitions* and *Limitations*). Data from the 2003 Canadian Community Health Survey (CCHS) and the 1996/97 National Population Health Survey (NPHS) were the basis for a comparison of medication use among women by pregnancy status, as well as the types of medications used.

Rise in medication use

Unlike smoking and alcohol consumption, which have both declined among pregnant women over the last 10 years, medication use by this group has increased (Chart 1). This rise is attributable to growing use of *non-prescription* medications. The percentage of women who reported taking such medications while they were pregnant rose from 27% in 1993 to 33% in 2003. Use of *prescription* medication remained relatively stable at around 26%, although it reached 29% in 2000.

Chart 1
Percentage of mothers who smoked cigarettes or used alcohol or medication during pregnancy, by child's year of birth, Canada excluding territories, 1993 to 2002



Data source: *1994/95 to 2002/03 National Longitudinal Survey of Children and Youth*

Pregnant women and health care professionals are generally aware of the risks posed by medications. Despite the rise in use over the last several years, according to the 2003 CCHS, when factors such as province of residence, household income, and the mother's age, education, immigrant status, and possible chronic conditions were taken into account, the odds of medication use for pregnant women were one-sixth of those of non-pregnant women (Appendix Table A). In the CCHS, medication use was defined as having taken any type of medication in the month before the survey interview. Respondents were not asked specifically about prescription and non-prescription medications.

Similar differences were found using data from the 1996/97 NPHS. When controlling for the same characteristics, the odds of medication use by pregnant women were one-fifth the odds among other women of childbearing age.

Most commonly used medications

Of course, the effects of medications can vary depending on their type.[19,20] Detailed information on the types of medication used is available from both the 2003 CCHS and the 1996/97 NPHS. As expected, use of most types of medication was lower among pregnant women (Table 1). Pain relievers were the medications most commonly used by pregnant women, with 42% reporting having taken them in the month before the 2003 interview. Stomach (11%) and cold remedies (10%) completed the trio of medications most commonly used during pregnancy.

In 2003, the most commonly consumed medications for women who were not pregnant were also pain relievers (79%), followed by cold medications (28%) and oral contraceptives (22%).

Between 1996/97 and 2003, the proportion of pregnant women who had taken medication in the month before their survey interview increased overall, and for most types of medication. Antibiotics and asthma medications were the exceptions.

Table 1
Percentage of women who used medication in past month, by pregnancy status and type of medication, Canada, 1996/97 and 2003

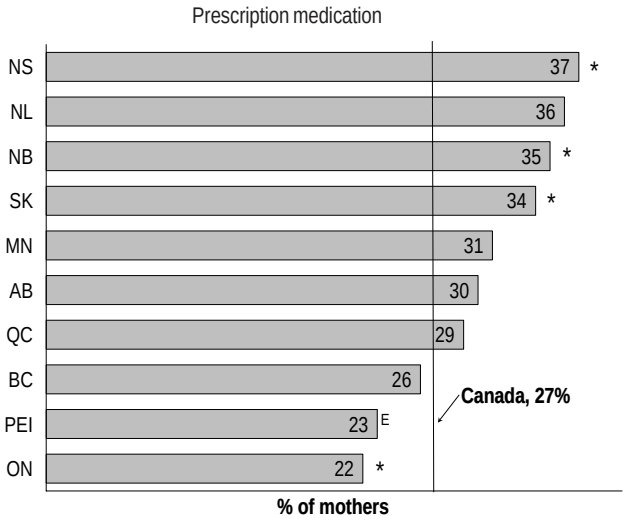
	1996/97 NPHS		2003 CCHS	
	Pregnant: Yes	No†	Pregnant: Yes	No†
Medication use in past month	**57.1***	**84.6**	**62.2***	**88.8‡**
Pain relievers	40.5*	72.5	42.2*	78.6‡
Cough/Cold remedies	6.1*E	20.7	10.2*E	27.7‡
Birth control pills	1.7*E	17.9	F	21.8‡
Penicillin or other antibiotics	12.0E	11.1	8.5E	11.0
Allergy	2.2*E	9.7	3.2*E	14.9‡
Stomach remedies	9.1E	7.8	11.3E	13.2‡
Codeine/Demerol/Morphine	F	6.1	F	8.4‡
Asthma	4.2E	6.0	3.6*E	6.8
Antidepressants	F	4.5	F	7.1‡
Other	13.5*E	20.9	22.9	27.7‡

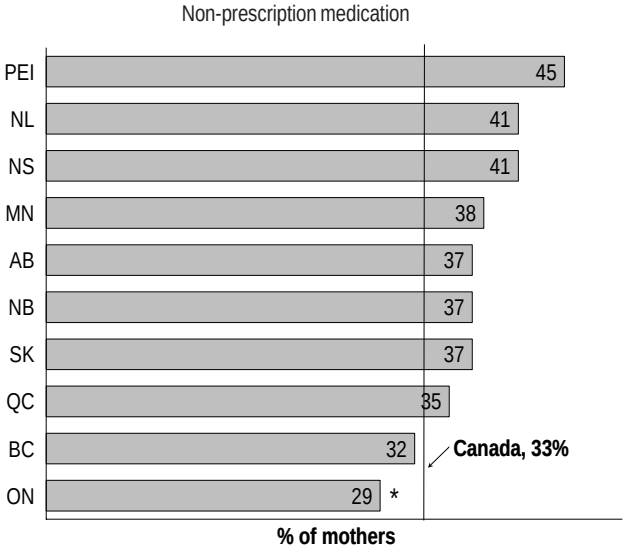
Data sources: *1996/97 National Population Health Survey; 2003 Canadian Community Health Survey*
† Reference category
** Significantly different from estimate for reference category (p < 0.05)*
‡ Significantly different from estimate for 1996/97 (p < 0.05)
E Coefficient of variation 16.6% to 33.3% (interpret with caution)
F Coefficient of variation greater than 33.3% or sample size less than 10 (suppressed because of extreme sampling variability)

Provincial profile

Among mothers of children born in 2001 or 2002, use of *prescription* medications during pregnancy in Canada averaged 27% (Chart 2). Three provinces had rates significantly above the national average: Nova Scotia (37%), New Brunswick (35%) and

Chart 2
Percentage of mothers who used medication during pregnancy, births in 2001 or 2002, by province, household population, Canada excluding territories





Data source*: 2002/03 National Longitudinal Survey of Children and Youth*
Note: *Based on records for 2,661 children.*
** Significantly different from estimate for Canada (p < 0.05)*
E Coefficient of variation 16.6% to 33.3% (interpret with caution)

Saskatchewan (34%). Ontario (22%) was the only province where the average was significantly below the national figure.

There was generally no significant difference in use of prescription medication between mothers of infants born in 1993 or 1994 and mothers of those born in 2001 or 2002. Two provinces, however, differed from the others, with significant increases in the proportion of women who consumed prescription medication during pregnancy: Saskatchewan and British Columbia (Appendix Table B).

Non-prescription medications were consumed during pregnancy by about one-third (33%) of mothers of children born in 2001 or 2002. The only significant provincial difference was in Ontario, where the proportion was low at 29% (Chart 2).

Between 1993/94 and 2001/02, the proportion of women who took non-prescription medications while they were pregnant rose from 27% to 33%. Increases were significant in three provinces: Newfoundland and Labrador, Prince Edward Island, and Québec (Appendix Table B).

The mother's age

More and more, women are waiting longer to have children. Over the last two decades, the average age of first-time mothers rose from 26.9 years to 29.6.[21] And between 1993/94 and 2001/02, the proportion of pregnant women aged 35 to 39 who used prescription medications rose significantly, from 20% to 30% (Table 2). However, when province of residence, chronic conditions, education, immigrant status and family status were considered, the mother's age was not significantly related to the use of *prescription* medications during pregnancy (Appendix Table C).

There was a significant association between the age of pregnant women and their use of *non-prescription* medications. When the other characteristics were taken into account, pregnant women aged 35 or older had relatively low odds of using non-prescription drugs, compared with those aged 25 to 29 (Appendix Table C). As well, between 1993/94 and 2001/02, the proportion of 30- to 39-year-old women who used non-prescription medications during pregnancy increased: from 28% to 34% for those aged 30 to 34, and from 19% to 35% for those aged 35 to 39 (Table 2).

Table 2
Percentage of mothers who took medication during pregnancy, by type of medication, mother's age group and child's year of birth, 1994/95 and 2002/03

	Prescription		Non-prescription	
	Child born in:		Child born in:	
Mother's age group	1993/94	2001/02	1993/94	2001/02
Younger than 25	29.8	28.3	26.9	29.9
25 to 29†	23.7	27.2	30.2	33.9
30 to 34	27.6	23.5	28.3	34.0*
35 to 39	20.3	29.8*	18.6	35.4*
40 or older	F	37.0E	F	25.8E

Data source: *1994/95 and 2002/03 National Longitudinal Survey of Children and Youth*
Note: *Based on records for 4,031 (1994/95) and 2,661 (2002/03) children.*
** Significantly different from 1993/94 estimate ($p < 0.05$)*
E Coefficient of variation 16.6% to 33.3% (interpret with caution)
F Coefficient of variation greater than 33.3% (suppressed because of extreme sampling variability)

Chronic conditions and other factors

A variety of factors can be related to medication use by pregnant women, and these factors themselves may be interrelated. However, as might be expected, even when controlling for other possible influences, pregnant women who had at least one chronic condition had significantly higher odds of medication use (with or without prescription), compared with those who reported no chronic conditions (Appendix Table C).

The proportion of immigrant women who consumed medications while pregnant, regardless of the type of medication, was significantly lower than that for Canadian-born women.

The proportion of lone-parent mothers who took prescription medications during pregnancy was lower than that among other pregnant women.

The mother's level of education was associated only with taking non-prescription medications. The odds of a pregnant woman without postsecondary education taking such medication were low, compared with the odds for those with at least some postsecondary education.

Definitions

The National Longitudinal Survey of Children and Youth (NLSCY), which follows children over time, also considered the mother's behaviour during pregnancy. The Canadian Community Health Survey (CCHS) and the National Population Health Survey (NPHS) both asked women between the ages of 15 and 49 if they were pregnant at the time of the interview.

Medication use during pregnancy was based on the following NLSCY questions: "Have you taken prescription medications since becoming pregnant with this child?" and "Have you taken over-the-counter medication since becoming pregnant with this child?"

In addition to medication use, the NLSCY asked the biological mother of the selected child if she had smoked cigarettes or consumed alcohol during her pregnancy. *Tobacco use* reflects mothers who said "yes" to "Did you smoke during your pregnancy with this child?" Those who gave any reply other than "never" to "How frequently did you consume alcohol during your pregnancy with this child (e.g., beer, wine, liquor)?" were placed in the *alcohol use during pregnancy* category.

The CCHS and NPHS measured *medication use in the previous month*, meaning the month before the survey interview. Women were considered to have used medication in the previous month if they responded "yes" at least once when asked about 21 specific medications or said "yes" to taking any "other medications." The same medications were listed on both surveys, although the CCHS question presented more examples. The medications listed in Table 1, based on the CCHS, were obtained from responses to the following questions (*italics* indicate details not asked in the NPHS):

"Over the past month, have you taken:

- analgesics such as Aspirin or Tylenol (includes arthritis medications and anti-inflammatories)?"
- cold/flu remedies?"
- birth control pills?"
- penicillin or other antibiotics?"
- allergy medications *such as Reactine or Allegra*?" (Sudafed was also given as an example in the NPHS)
- medications for stomach ailments?"
- codeine, Demerol or morphine?"
- asthma medication *such as an inhaler or a nebulizer*?"
- antidepressants *such as Prozac, Paxil or Effexor*?"

Other medication(s) includes weight loss pills, heart and hypertension medications, diuretics, steroids, insulin, pills to control diabetes, sleeping pills, laxatives, hormone replacement therapy, thyroid medication, or any other medication.

In the NLSCY, the presence of *chronic conditions* among mothers was established by asking about long-term health problems. In cycle 1, this list contained 21 conditions; an "other" category captured conditions not mentioned in the list. For the CCHS, the mothers' chronic conditions were established based on positive responses to the question listing 30 conditions. The NPHS asked if a specialist had diagnosed any chronic condition from a list of 20; these conditions were all included in the CCHS list. Both questions about chronic conditions included an "other" category.

Five categories were used for the *mother's age*: younger than 25; 25 to 29; 30 to 34; 35 to 39; and 40 or older. The CCHS and NPHS recorded the age of the time of the interview, while the NLSCY used the mother's age when her child was born.

For all three surveys, *education* reflects the highest level attained by the mother at the time of the interview: less than secondary graduation; secondary school graduation; and at least some postsecondary.

Household income was based on the number of people in the household and total household income from all sources in the 12 months before the interview. The groupings apply to all three surveys.

Household income group	People in household	Total household income
Lowest	1 or 2	Less than $15,000
	3 or 4	Less than $20,000
	5 or more	Less than $30,000
Middle	1 or 2	$15,000 to $59,999
	3 or 4	$20,000 to $79,999
	5 or more	$30,000 to $79,999
Highest	1 or 2	$60,000 or more
	3 or more	$80,000 or more

For the NLSCY, household income, education, and living in a lone-parent household are variables observed at the time of the interview, 6 to 18 months after the birth of the child.

In the NPHS, *immigrant status* is based on country of birth (other than Canada); in the CCHS and NLSCY, not being a Canadian citizen at birth equals immigrant status.

Lone-parent family refers to a child living with one parent at the time of the NLSCY interview.

Limitations

The sampling unit for the National Longitudinal Survey of Children and Youth (NLSCY) is the child. This analysis used information about the biological mothers of the selected children. Only live births were considered; therefore, medication use or other behaviours during pregnancy that may have resulted in stillbirths were excluded. In addition, neither the precise medication used, nor its type, can be determined from the NLSCY data. Some women may have considered folic acid or prenatal vitamins as medications, even if they were following physician and/or Health Canada recommendations.[22-23] The NLSCY did not measure the use of folic acid or prenatal vitamins among pregnant women.

All data are based on self-reports and are thus subject to recall errors and errors resulting from misunderstanding questions. Given the gap in time between the pregnancy and the survey interviews, it is possible that some women may have incorrectly recalled certain details of their medication use. As well, some household characteristics at the time of the interview may have differed from those at the time of the woman's pregnancy.

Both the Canadian Community Health Survey (CCHS) and the National Population Health Survey (NPHS) asked women if they were pregnant at the time of the interview, and about their use of medication in the previous month. It is possible that some women may have been pregnant, but were not yet aware of their condition.

The distinction between prescription and non-prescription medication is not always precise. Sometimes the same medication can either be purchased over the counter or obtained with a doctor's prescription.

Household income, by contrast, was not significantly associated with pregnant women's use of either type of medication.

Concluding remarks

Medication use among women of reproductive age has increased over the last 10 years. Pregnant women are no exception to this trend, and most of the increase in this group reflects growing use of non-prescription medications. Medication use among pregnant women did, however, remain lower than that for other women in their childbearing years.

Not surprisingly, women who reported at least one chronic condition had higher odds of medication use during pregnancy, whether the medication was obtained with or without a prescription. A significant rise of 16 percentage points was noted in use of non-prescription medication among pregnant women aged 35 to 39, distinguishing this age group from the others.

While many medications present little risk to pregnant women, health care professionals and women themselves must be aware of the risks and benefits associated with any drugs considered for use during pregnancy. ●

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Appendix

Table A
Adjusted odds ratios relating medication use to pregnancy status and other selected characteristics, by timing of medication use, female household population aged 15 to 49, Canada, 1996/97 and 2003

	Took medication in past month			
	1996/97 NPHS		2003 CCHS	
	Adjusted odds ratio	95% confidence interval	Adjusted odds ratio	95% confidence interval
Pregnant				
Yes	0.22*	0.15, 0.31	0.16*	0.10, 0.26
No†	1.00	...	1.00	...
Province				
Newfoundland and Labrador	1.19	0.71, 2.00	0.78	0.43, 1.41
Prince Edward Island	1.22	0.72, 2.05	1.08	0.58, 2.01
Nova Scotia	1.39	0.84, 2.30	1.11	0.62, 1.98
New Brunswick	1.17	0.77, 1.77	1.40	0.80, 2.43
Québec	0.72*	0.56, 0.92	0.77	0.52, 1.13
Ontario†	1.00	...	1.00	...
Manitoba	1.58*	1.24, 2.00	0.82	0.49, 1.38
Saskatchewan	0.84	0.54, 1.31	1.11	0.65, 1.89
Alberta	1.21*	1.07, 1.38	1.05	0.69, 1.58
British Columbia	0.90	0.66, 1.21	0.65*	0.45, 0.95
Yukon/NorthwestTerritories/Nunavut	..		0.77	0.48, 1.24
Age group				
Younger than 25	0.95	0.74, 1.23	1.30	0.85, 2.02
25 to 29†	1.00	...	1.00	...
30 to 34	0.83	0.65, 1.07	0.68	0.45, 1.02
35 to 39	0.73*	0.57, 0.95	0.87	0.54, 1.39
40 or older	0.81	0.63, 1.04	0.71	0.47, 1.07
Chronic condition(s)				
Yes	2.62*	2.21, 3.10	3.40*	2.60, 4.44
No†	1.00	...	1.00	...
Education				
Less than secondary graduation	1.00	0.82, 1.21	0.55*	0.39, 0.77
Secondary graduation	0.88	0.72, 1.08	0.85	0.59, 1.23
Postsecondary or higher†	1.00	...	1.00	...
Household income				
Lowest	0.66*	0.48, 0.91	0.66	0.40, 1.08
Middle	0.83	0.65, 1.06	0.85	0.63, 1.15
Highest†	1.00	...	1.00	...
Immigrant status				
Yes	0.61*	0.49, 0.75	0.46*	0.33, 0.64
No†	1.00	...	1.00	...

Data sources: *2003 Canadian Community Health Survey; 1996/97 National Population Health Survey*
Notes: *Based on 9,826 (CCHS) and 22,518 (NPHS) women aged 15 to 49. A "missing" category for household income was included in the model, but the odds ratios are not shown.*
† Reference category
** Significantly different from estimate for reference category ($p < 0.05$)*
... Not applicable

Table B

Percentage of mothers who took medication during pregnancy, by child's year of birth, type of medication and province, household population, Canada excluding territories, 1993/94 and 2001/02

	Prescription		Non-prescription	
	Child born in:		Child born in:	
	1993/94	2001/02	1993/94	2001/02
Newfoundland and Labrador	35.6‡	36.4	23.4	40.8†
Prince Edward Island	26.7E	23.2E	26.3	45.1†
Nova Scotia	35.9‡	37.3‡	40.8‡	41.0
New Brunswick	35.1‡	35.2‡	29.6	37.4
Québec	28.1	28.6	22.4‡	34.5†
Ontario	25.0	22.0‡	27.8	29.5‡
Manitoba	31.2	30.7	36.9‡	37.6
Saskatchewan	22.9	33.9†‡	30.9	36.7
Alberta	24.8	29.9	32.9	37.2
British Columbia	17.1‡	26.3†	23.6	31.6

Data source: *1994/95 and 2002/03 National Longitudinal Survey of Children and Youth*
Note: *Based on records for 4,031 (1994/95 and 2,661 (2002/03) children.*
† Significantly different from estimate for 1993/94 (p < 0.05)
‡ Significantly different from estimate for Canada (p < 0.05)
E Coefficient of variation between 16.6% to 33.3% (interpret with caution)

Table C

Adjusted odds ratios relating medication use during pregnancy to selected characteristics, mothers of children born between 1993 and 2002, household population, Canada

	Prescription		Non-prescription	
	Adjusted odds ratio	95% confidence interval	Adjusted odds ratio	95% confidence interval
Province				
Newfoundland and Labrador	1.57*	1.28, 1.92	0.84	0.68, 1.04
Prince Edward Island	0.85	0.67, 1.08	0.99	0.80, 1.22
Nova Scotia	1.29*	1.09, 1.52	1.42*	1.20, 1.67
New Brunswick	1.40*	1.17, 1.66	1.03	0.87, 1.22
Québec	1.10	0.96, 1.27	0.84*	0.73, 0.96
Ontario†	1.00	…	1.00	…
Manitoba	1.18	1.00, 1.39	1.12	0.96, 1.32
Saskatchewan	1.08	0.93, 1.26	1.05	0.90, 1.23
Alberta	1.08	0.92, 1.26	1.17*	1.01, 1.35
British Columbia	0.81*	0.69, 0.96	0.87*	0.75, 0.99
Age group				
Younger than 25	1.13	0.99, 1.29	0.88	0.77, 1.01
25 to 29†	1.00	…	1.00	…
30 to 34	0.96	0.85, 1.08	0.94	0.84, 1.05
35 to 39	1.09	0.94, 1.27	0.80*	0.70, 0.93
40 or older	1.26	0.89, 1.79	0.59*	0.42, 0.81
Chronic condition(s)				
Yes	2.09*	1.91, 2.28	1.41*	1.28, 1.55
No†	1.00	…	1.00	…
Education				
Less than secondary graduation	0.89	0.76, 1.03	0.79*	0.69, 0.92
Secondary graduation	0.90	0.78, 1.03	0.79*	0.70, 0.90
Postsecondary or higher†	1.00	…	1.00	…
Household income				
Lowest	1.14	0.93, 1.38	0.83	0.69, 1.01
Middle	0.99	0.87, 1.12	0.95	0.84, 1.08
Highest†	1.00	…	1.00	…
Immigrant status				
Yes	0.72*	0.62, 0.84	0.67*	0.58, 0.77
No†	1.00	…	1.00	…
Lone-parent family				
Yes	0.82*	0.70, 0.97	0.98	0.83, 1.15
No†	1.00	…	1.00	…
NLSCY cycle				
1 (1994/95)	0.90	0.78, 1.05	0.76*	0.65, 0.89
2 (1996/97)	1.08	0.93, 1.26	0.91	0.79, 1.06
3 (1998/99)	0.95	0.83, 1.09	1.01	0.88, 1.15
4 (2000/01)	1.11	0.94, 1.31	0.90	0.77, 1.06
5 (2002/03)†	1.00	…	1.00	…

Data source: *1994/95 to 2002/03 National Longitudinal Survey of Children and Youth*
Note: *Based on records of 20,738 children.*
** Significantly different from estimate for reference category (p < 0.05)*
† Reference category
… Not applicable

Survival from cancer—up-to-date predictions using period analysis

Larry F. Ellison and Laurie Gibbons

Abstract

Objectives

This period analysis provides Canadian predictions of the short- and long-term relative survival of people recently diagnosed with cancer. Long-term period and cohort-based estimates are also compared.

Data sources

Data are from the Canadian Cancer Registry, the Canadian Mortality Data Base, and Statistics Canada life tables.

Analytical techniques

Relative survival analyses were conducted using the life-table method; expected survival proportions were derived using the Ederer II approach. Period analysis estimates were based on the survival experience of cancer cases followed up in 2002. The cohort analyses involved people diagnosed in 1997 (5-year survival) or 1992 (10-year survival). National estimates exclude Québec.

Main results

Relative survival ratios were highest for thyroid (5-year, 97.7%) and prostate (95.2%) cancer and lowest for pancreatic cancer. Survival for many forms of cancer is higher than previously estimated by cohort-based analysis. The largest increases in 10-year relative survival were predicted for cancers of the prostate (13.0%) and rectum (9.7%). The largest predicted increases for 5-year survival were for cancers of the cervix uteri (5.4%) and rectum (4.5%), and for leukemia (3.7%).

Keywords

epidemiological methods, neoplasms, prognosis, registries

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Long-term survival rates are important outcome measures for people with cancer. Survival rates are widely used to monitor progress in cancer care,[1,2] or to compare quality of care between different populations.[3,4] Cancer survival statistics can also have a strong impact on a clinician's management of the disease, as well as on a patient's coping strategies.[5]

The traditional way of estimating cancer survival has been to use a cohort-based method in which only people diagnosed within defined calendar years and with the potential to be followed over the full duration of interest are included in the analysis. Long-term survival estimates derived using this approach pertain to the survival experience of people diagnosed many years ago. Since most cancer deaths occur during the first few years after diagnosis, cohort survival estimates essentially reflect the clinical outcomes achieved at that time. When there has been a subsequent change in prognosis, these estimates will not reflect the long-term survival experience expected for newly diagnosed individuals. Consequently, both patients and their physicians may be unduly discouraged.[6]

Data sources and Limitations

Data sources

Cancer incidence data are from the Canadian Cancer Registry (CCR). The CCR is a dynamic, person-oriented, population-based database maintained by Statistics Canada. It contains cases diagnosed from 1992 onward. The information comprising the CCR is based on reports from every provincial/territorial cancer registry.[7] A detailed description of the CCR, including data sources, methodology and accuracy, is available on Statistics Canada's Web site.[8] Mortality data are from the Canadian Mortality Data Base, also maintained by Statistics Canada. These data are based on information provided by the vital statistics registrars in each province and territory. Canadian and provincial life tables from Statistics Canada were also used for this analysis.

Limitations

In the context of cancer, relative survival is defined as the ratio of the observed survival for a group of people with cancer to the survival that would have been expected for members of the general population who are assumed to be free of cancer and otherwise have the same characteristics affecting survival as those with cancer.[9]

This analysis used the common matching variables of age, sex, and calendar time, and also considered province of residence at diagnosis. Other potential factors were not matched, because the CCR does not contain the information and/or because population life tables were not available. Ideally, people diagnosed with lung cancer (or another smoking-related cancer) would also be matched by smoking status to members of the general population, because most people diagnosed with lung cancer are smokers or ex-smokers and smoking is known to reduce life expectancy. While the relative survival ratio (RSR) for lung cancer would likely have been higher if such data were available, a previous study found that adjusting the expected survival for the excess mortality related to smoking increased estimates of relative survival by 1% or less.[9]

An empirical evaluation of the period method for 5-year survival using data from the CCR concluded that the method provides more up-to-date estimates than traditional cohort-based methods.[10] Although a similar evaluation for 10-year survival will not be possible until over 20 years of case registration and mortality follow-up have been completed for the CCR, empirical evaluations of longer term survival conducted elsewhere have found period analysis estimates to be more up-to-date than those produced using traditional methods.[5,6,11-14] In one study, period analysis was reported to advance the detection of progress in 10-, 15-, and 20-year survival rates of newly diagnosed cancer cases by 5 to 10, 10 to 15, and 15 to 20 years, respectively.[12]

A very small percentage of cases diagnosed in 2002 may not relate to an individual's first primary invasive tumour because the record linkage of the historical National Cancer Incidence Reporting System (1969 to 1991) to the CCR did not extend past 2001 (see *Analytical techniques*). Based on an analysis of 2001 data, this means that approximately 1% of the cases in 2002 would otherwise have been omitted from the study. This would likely have reduced the overall 10-year period RSR by about 0.3%.

All expected survival proportions for Prince Edward Island and the territories were derived from Canadian life tables. Stable estimates for single ages could not be produced for these areas because of small population counts. This substitution should not introduce bias in national estimates as these areas combined accounted for 0.9% of all eligible cases from 1992 to 2002.

Another traditional cohort-based method of survival analysis, known as complete analysis,[15] is not discussed in this article for the sake of brevity. Complete analysis includes only people diagnosed within a defined calendar period. However, unlike cohort analysis, it includes people who do not have the potential to be followed over the full duration of interest. While complete analysis provides more up-to-date long-term survival estimates than cohort analysis, the estimates are still not as up-to-date as those produced using period analysis.[6,10,13,14]

Stage of disease at diagnosis and information about treatment received are not available in the CCR.

A new method of survival analysis, known as period analysis, was introduced to derive more up-to-date estimates of long-term survival.[15,16] The results from period analysis exclusively reflect the survival experience in the most recent period for which data are available (see *Analytical techniques*). The rationale for this approach is analogous to that of using period life tables to estimate current life expectancy. Empirical evaluations of period analysis have shown that the method does indeed provide better predictions of survival for the recently diagnosed[5,6,10-14,17] than does cohort analysis.

This article presents predictions of the short- and long-term relative survival of Canadians recently diagnosed with cancer (see *Data sources and Limitations*). Predictions are based on period analysis, and are shown by sex and by age group for all cancer sites combined, as well as by sex for 20 selected cancer sites. Long-term period estimates are compared with the latest available cohort-based estimates. A brief discussion of international period analysis predictions is also included (see *The international picture*).

Predicting long-term survival

The period analysis estimate of the 5-year relative survival ratio (RSR) for all invasive cancers combined was 62.3%. This is based on the follow-up experience of cancer cases in 2002, the latest year for which follow-up data were available (Table 1). This means that people recently diagnosed with invasive cancer will be, on average, 62.3% as likely to be alive five years after diagnosis as members of the general population who have the same main characteristics affecting survival as the people with cancer. The corresponding 1-, 3- and 10-year period survival estimates were 76.2%, 66.2% and 57.7%, respectively.

The assumption underlying period analysis is that the cross-sectional follow-up experience of cases in 2002 will provide a good approximation of the longitudinal survival to be experienced by recently diagnosed persons. Period estimates may be overly optimistic if advances in early detection or therapy do not increase the chance of cure, but merely postpone death due to cancer.[5] But this theoretical concern has been found to be irrelevant in practice.[5,6,10-14,17] In fact, period estimates have often been shown to be slightly pessimistic, albeit more up-to-date, than estimates from traditional cohort methods. This observation has been attributed to ongoing improvements in conditional survival probabilities resulting from advances in early detection or therapy, or both.[5]

Sex, age and cancer site

For all invasive cancers combined, RSRs from period analysis were generally slightly higher among females than among males. Period RSRs were also inversely related to age; that is, the best prognoses, or the highest estimates, were in the youngest age group. Breast cancer is a noteworthy exception: the five-year RSR was lowest in the youngest (15-to-39) and oldest (80-to-99) age groups; otherwise, it

Table 1
Period analysis, relative survival ratios for all cancer sites combined, by sex and by age group, based on follow-up in 2002, Canada†

	Survival							
	1-year		3-year		5-year		10-year	
	Relative survival ratio	95% confidence interval	Relative survival ratio	95% confidence interval	Relative survival ratio	95% confidence interval	Relative survival ratio	95% confidence interval
	%		%		%		%	
Overall	**76.2**	**75.9, 76.4**	**66.2**	**65.9, 66.5**	**62.3**	**62.0, 62.6**	**57.7**	**57.3, 58.0**
Sex								
Male	75.1	74.8, 75.5	65.2	64.8, 65.7	61.7	61.2, 62.1	57.8	57.3, 58.3
Female	77.3	77.0, 77.7	67.2	66.8, 67.6	63.1	62.7, 63.5	57.7	57.3, 58.2
Age group								
15 to 44	91.2	90.7, 91.8	83.1	82.5, 83.8	79.6	78.9, 80.3	74.9	74.1, 75.6
45 to 54	85.1	84.6, 85.7	74.7	74.0, 75.3	70.6	69.9, 71.3	64.4	63.7, 65.2
55 to 64	80.7	80.2, 81.2	70.0	69.4, 70.5	65.5	64.9, 66.1	59.0	58.3, 59.7
65 to 74	75.5	75.1, 76.0	65.3	64.7, 65.8	61.1	60.5, 61.7	56.4	55.7, 57.1
75 to 99	63.5	62.9, 64.0	53.9	53.2, 54.5	51.0	50.2, 51.7	50.3	49.3, 51.3

***Data source**: Canadian Cancer Registry*
† Excluding Québec

Analytical techniques

Incident cancer case data for this study were obtained from the Canadian Cancer Registry (CCR) database as of December 2004. Cancer cases were defined based on the *International Classification of Diseases for Oncology, Third Edition*.[18] Analyses were restricted to records of first primary invasive tumours. The pre-1992 tumour history of individuals on the CCR from 1992 to 2001, if any, was obtained by linking the CCR data with its predecessor, the National Cancer Incidence Reporting System, a fixed, tumour-oriented database containing cases as far back as 1969. Supplementary information available for 1992 to 2002 Ontario data was also used.

Cancer cases diagnosed in Québec were not included in this analysis, partly because the method of ascertaining the date of diagnosis in this province clearly differed from that of the other provincial cancer registries.[19] For the remaining provinces and territories, records were excluded when the year of birth was unknown (0.02%). A total of 958,520 people aged 15 to 99 (20 to 99 for cancer of the bones and joints) were diagnosed with a first primary invasive tumour in Canada (excluding Québec) from 1992 to 2002. People identified as having died but whose year of death was not recorded (n=96) were excluded, as were those whose diagnosis was established either through autopsy only (n=2,187) or death certificate only (n=17,526). For a small percentage of subjects with missing information on day/month of diagnosis and/or day/month of death, the survival time was estimated. The algorithm used has been described elsewhere.[19] Mortality follow-up was determined through record linkage to the Canadian Mortality Data Base, and from information reported by provincial/territorial cancer registries.[20] For deaths reported by a provincial registry but not confirmed by record linkage, it was assumed that the individual died on the date submitted by the reporting province. At the time of the analysis, registration of new cases and mortality follow-up were complete through December 31, 2002.

Using period analysis, short- and long-term predictions of relative survival of individuals recently diagnosed with cancer were derived for all cancers combined and for 20 selected cancer sites. A period analysis is defined by the survival experience of people in a recent time interval. Estimates are obtained by left truncation of observations at the beginning of that period and right censoring at the end of the period. In this study, the period method used follow-up in 2002 exclusively. The survival probability during the first year after diagnosis was estimated from the person-time at risk and events (death or censoring) of individuals diagnosed in 2001 and 2002 whose first year after diagnosis included some part of 2002. Similarly, the conditional probability in the 2nd, 3rd, and up to the 10th year after diagnosis was estimated from the survival experience of persons diagnosed in, respectively, 2000 and 2001, 1999 and 2000, and so on, to 1992 and 1993.

For context, the period estimates of survival were compared with estimates derived using cohort analysis. A cohort-based analysis is defined by the time interval in which people are diagnosed. Depending on the analysis, the cohort method in this study involved people diagnosed in 1997 (5-year survival) or 1992 (10-year survival) and potentially followed to the end of 2002. For background, the number of diagnosed cases eligible for survival analysis, the percentage that were male, and the median age at diagnosis were calculated by cancer site for diagnosis years 1992, 1997 and 2002 (Appendix Table A).

Cancer registries prefer to use relative survival for reporting because it provides a measure of survival corrected for the effect of other independent causes of death.[21,22] Relative survival analyses

Data used to calculate cohort and period 10-year relative survival estimates

	Year of diagnosis	Follow-up year										
		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Cohort analysis	1992	1	1,2	2,3	3,4	4,5	5,6	6,7	7,8	8,9	9,10	10
Period analysis	1992											10
	1993											9,10
	1994											8,9
	1995											7,8
	1996											6,7
	1997											5,6
	1998											4,5
	1999											3,4
	2000											2,3
	2001											1,2
	2002											1

Years of follow-up since diagnosis

... continued

Analytical techniques - concluded

were based on algorithms (i.e., survival.sas, survival_period.sas) written in SAS by Paul Dickman,[23] with some minor adaptations. The algorithms use a life table (actuarial) approach: relative survival ratios (RSRs) are calculated at discrete points during the follow-up, generally by taking the product of interval-specific (conditional) estimates over sub-intervals of the follow-up. Observation time for each individual is split into multiple observations, one for each sub-interval of follow-up time. Attained age and attained period are monitored by the algorithm so that the appropriate expected probabilities of death, estimated by the Ederer II approach,[24] are used. Observations are collapsed over calendar year(s) at time of diagnosis (cohort) or calendar year(s) of follow-up (period) depending on the desired method of analysis.

For this analysis, three-month sub-intervals were used for the first year of follow-up, six-month sub-intervals up to the fifth year of follow-up, and one-year sub-intervals for the 6th through 10th years. More intervals were used in the first year of follow-up because the actuarial method assumes an approximately even distribution of deaths within each interval, and mortality is often highest during the first year. Expected survival proportions were derived from sex-specific complete and abridged provincial life tables produced by Statistics Canada. Data from the 1990-1992 complete life tables[25] were used for patient follow-up in 1992 and 1993, and data from 1995-1997 complete life tables[26] were used for follow-up from 1994 to 1998. Because the 2000-2002 complete life tables had not been published when this analysis was conducted, expected survival for follow-up from 1999 to 2002 was derived from 1995-1997 and 2000-2002 abridged life tables and the 1995-1997 complete life tables using a method suggested by Dickman et al.[27] This method was also used to extend the 1990-1992 set of complete provincial life tables from age 85 to age 99. Cases with the same date of diagnosis and death (not including those previously excluded because they were diagnosed through autopsy only or death certificate only) were assigned one day of survival, as the program automatically excludes cases with zero days of survival. Asymmetric observed survival confidence intervals were formed from standard errors estimated using Greenwood's method[28] and the log (-log) transformation. Confidence intervals for RSRs were derived by dividing the observed survival limits by the corresponding expected survival proportion. This general approach has previously been used to publish Canadian national and provincial cohort survival estimates for 49 cancer sites.[29]

was quite similar across the remaining groups (data not shown).

Among the sites analyzed, five-year period RSRs were highest for thyroid (97.7%) and prostate cancer (95.2%), followed by skin melanoma (89.5%) and cancers of the breast (87.5%) and corpus uterus (86.2%) (Table 2). The five-year prognosis was poorest for pancreatic cancer (6.6%), then cancers of the esophagus (13.2%), lung and bronchus (15.5%), brain (23.4%) and stomach (24.0%). When other survival durations (1-, 3- and 10-year) were considered, the relative ranking of the cancer sites remained quite similar. Only modest absolute differences were observed between the 1- and 10-year rates for cancers of the thyroid (1.2%) and prostate (6.5%). But the differences were quite large for multiple myeloma (51.2%) and ovarian cancer (39.6%). For the 20 sites studied, the average site-specific difference between the 1- and 10-year rates was 20.9%.

Period–Cohort differences

Before period analysis was introduced to cancer survival research, predictions of the survival experience of recently diagnosed patients were necessarily derived using a cohort-based analysis. For this study, the most up-to-date cohort analysis estimates of long-term survival available were based on the experience of cases diagnosed in 1992 (10-year) and 1997 (5-year). For all invasive cancers combined, the 5-year cohort-based RSR was 60.3%; the 10-year ratio was 52.1% (Table 3). These estimates are about 2 and 6 percentage points lower, respectively, than the most recent period-based estimates. Similar differences have been reported elsewhere. One study found period estimates to be 1% and 7% higher than cohort estimates for 5- and 10-year survival,[30] while another reported increases of 4% and 7%.[31]

Table 2
Period analysis, relative survival ratios, by cancer site and sex, based on follow-up in 2002, Canada†

	Survival duration							
	1-year		3-year		5-year		10-year	
	Relative survival ratio	95% confidence interval	Relative survival ratio	95% confidence interval	Relative survival ratio	95% confidence interval	Relative survival ratio	95% confidence interval
	%		%		%		%	
Oral (buccal cavity and pharynx)	**80.5**	**78.9, 82.1**	**67.4**	**65.5, 69.2**	**63.4**	**61.3, 65.4**	**55.5**	**53.4, 57.7**
Male	79.5	77.4, 81.4	66.8	64.4, 69.0	62.7	60.2, 65.1	54.6	51.9, 57.3
Female	82.5	79.7, 85.1	68.5	65.2, 71.6	64.6	61.1, 68.0	57.3	53.5, 61.0
Esophagus	**37.4**	**34.4, 40.3**	**15.2**	**13.2, 17.3**	**13.2**	**11.3, 15.3**	**11.5**	**9.6, 13.7**
Male	39.7	36.3, 43.2	15.6	13.2, 18.2	13.5	11.2, 16.1	12.4	9.9, 15.2
Female	31.3	26.0, 36.6	13.7	10.4, 17.5	12.1	8.9, 15.8	9.6	6.7, 13.2
Stomach	**44.8**	**42.7, 46.9**	**27.4**	**25.6, 29.2**	**24.0**	**22.2, 25.8**	**22.5**	**20.6, 24.5**
Male	44.7	42.0, 47.3	26.7	24.5, 29.0	22.2	20.0, 24.4	21.1	18.7, 23.5
Female	45.1	41.7, 48.5	28.6	25.6, 31.8	27.2	24.1, 30.4	25.0	21.8, 28.5
Colon	**78.6**	**77.7, 79.4**	**65.6**	**64.6, 66.6**	**61.3**	**60.2, 62.4**	**58.7**	**57.4, 60.1**
Male	78.6	77.4, 79.8	65.9	64.4, 67.3	60.9	59.3, 62.5	58.8	56.9, 60.7
Female	78.5	77.3, 79.7	65.3	63.9, 66.7	61.7	60.1, 63.2	58.7	56.9, 60.6
Rectum	**85.9**	**84.8, 87.0**	**71.1**	**69.6, 72.5**	**65.0**	**63.4, 66.6**	**60.4**	**58.5, 62.3**
Male	86.9	85.5, 88.2	71.6	69.7, 73.4	64.7	62.6, 66.7	60.0	57.5, 62.5
Female	84.3	82.5, 86.0	70.2	67.9, 72.4	65.4	62.9, 67.9	60.9	58.0, 63.8
Pancreas	**20.5**	**18.9, 22.2**	**7.9**	**6.9, 9.0**	**6.6**	**5.6, 7.6**	**6.0**	**5.0, 7.0**
Male	21.2	18.9, 23.6	9.0	7.4, 10.7	7.0	5.6, 8.6	7.2	5.6, 9.0
Female	20.0	17.8, 22.3	6.9	5.7, 8.4	6.1	4.9, 7.5	4.9	3.7, 6.3
Lung and bronchus	**37.3**	**36.5, 38.1**	**19.3**	**18.7, 19.9**	**15.5**	**15.0, 16.1**	**12.4**	**11.9, 13.0**
Male	34.7	33.6, 35.7	16.6	15.8, 17.4	13.3	12.6, 14.0	10.9	10.2, 11.6
Female	40.6	39.4, 41.8	22.9	21.9, 23.9	18.5	17.5, 19.4	14.2	13.4, 15.1
Skin melanoma	**97.0**	**96.3, 97.7**	**92.3**	**91.2, 93.3**	**89.5**	**88.2, 90.8**	**87.6**	**86.0, 89.2**
Male	96.1	94.9, 97.1	90.6	88.9, 92.1	86.8	84.7, 88.7	84.7	82.2, 87.1
Female	98.0	97.0, 98.8	94.1	92.7, 95.4	92.4	90.7, 93.9	90.7	88.6, 92.6
Breast	**97.2**	**96.9, 97.5**	**91.9**	**91.4, 92.4**	**87.5**	**86.9, 88.1**	**79.6**	**78.8, 80.4**
Female	97.2	96.9, 97.5	91.9	91.4, 92.4	87.5	86.9, 88.2	79.7	78.9, 80.5
Cervix uteri	**88.7**	**86.8, 90.4**	**79.1**	**76.8, 81.2**	**75.7**	**73.2, 78.0**	**71.6**	**69.0, 74.0**
Corpus uteri	**94.1**	**93.1, 95.0**	**88.8**	**87.4, 90.0**	**86.2**	**84.6, 87.6**	**84.5**	**82.6, 86.3**
Ovary	**73.2**	**71.2, 75.2**	**51.0**	**48.8, 53.2**	**40.5**	**38.3, 42.7**	**33.6**	**31.5, 35.8**
Prostate	**98.4**	**98.1, 98.7**	**96.5**	**96.0, 97.0**	**95.2**	**94.5, 95.9**	**91.9**	**90.9, 93.0**
Bladder (including in situ)	**86.3**	**85.1, 87.4**	**78.4**	**76.9, 79.8**	**75.0**	**73.4, 76.7**	**71.6**	**69.6, 73.5**
Male	86.8	85.4, 88.1	79.2	77.5, 80.9	76.1	74.1, 78.0	73.3	70.9, 75.6
Female	85.0	82.5, 87.2	76.0	73.0, 78.7	72.2	68.9, 75.2	66.9	63.3, 70.5
Kidney and renal pelvis	**78.3**	**76.7, 79.8**	**70.6**	**68.8, 72.4**	**65.8**	**63.8, 67.7**	**61.2**	**59.0, 63.4**
Male	77.4	75.3, 79.4	70.4	68.0, 72.6	64.4	61.9, 66.9	59.5	56.6, 62.3
Female	79.7	77.2, 82.0	71.0	68.2, 73.7	67.8	64.7, 70.8	63.7	60.3, 67.0
Brain	**45.6**	**43.1, 48.0**	**27.0**	**25.0, 29.1**	**23.4**	**21.4, 25.4**	**18.9**	**17.1, 20.7**
Male	44.7	41.4, 47.9	25.0	22.4, 27.7	20.6	18.2, 23.1	16.8	14.6, 19.1
Female	46.7	42.9, 50.4	29.7	26.4, 33.1	27.1	23.9, 30.4	21.7	18.8, 24.7
Thyroid	**98.7**	**98.1, 99.2**	**97.8**	**96.9, 98.5**	**97.7**	**96.7, 98.7**	**97.5**	**96.1, 98.7**
Male	96.3	94.1, 97.8	95.5	92.9, 97.5	93.6	90.3, 96.3	91.2	87.0, 94.8
Female	99.3	98.8, 99.7	98.4	97.5, 99.1	98.9	97.9, 99.8	99.3	97.9,100.5
Non-Hodgkin's lymphoma	**77.0**	**75.7, 78.2**	**67.5**	**66.0, 68.9**	**61.5**	**60.0, 63.1**	**52.0**	**50.3, 53.6**
Male	76.5	74.7, 78.2	65.5	63.5, 67.4	59.1	57.0, 61.2	50.2	47.9, 52.5
Female	77.6	75.7, 79.3	69.7	67.6, 71.7	64.2	62.0, 66.4	54.0	51.6, 56.4
Multiple myeloma	**72.3**	**69.7, 74.6**	**48.7**	**46.0, 51.4**	**33.9**	**31.3, 36.6**	**21.1**	**18.7, 23.6**
Male	72.0	68.5, 75.2	50.0	46.3, 53.7	36.9	33.2, 40.7	24.9	21.2, 28.8
Female	72.6	68.8, 75.9	47.2	43.3, 51.0	30.9	27.3, 34.6	17.6	14.7, 20.8
Leukemias	**65.7**	**63.9, 67.5**	**54.5**	**52.6, 56.4**	**49.3**	**47.3, 51.3**	**41.2**	**39.1, 43.3**
Male	66.3	63.8, 68.6	54.7	52.2, 57.2	48.0	45.4, 50.6	40.1	37.4, 42.8
Female	64.9	61.9, 67.7	54.2	51.2, 57.2	51.0	47.9, 54.1	42.7	39.5, 46.0

***Data source**: Canadian Cancer Registry*
† Excluding Québec

A comparison of sex-specific differences in survival using both cohort and period analyses indicated that previously observed differences in overall relative survival between the sexes are likely to be diminished among recently diagnosed cases. Sex-specific *cohort* estimates of the RSR for all invasive cancers combined were lower among males for both 5- (3.9% difference) and 10-year (5.6% difference) survival. But differences in sex-specific *period* estimates were much smaller for 5-year (1.5% difference), and virtually non-existent for 10-year, survival. This may be partly due to the large predicted increase in prostate cancer survival. When sex-specific cancers including breast cancer were omitted from the period analysis, RSRs were approximately 3% lower among males for both survival lengths studied (data not shown).

An age gradient for 5- and 10-year relative survival was observed for both cohort and period analyses. RSRs for all cancer sites combined were highest for people who were aged 15 to 44 when diagnosed, and lowest for those aged 75 to 99. The fact that

Table 3
Comparison of most recent period and cohort analysis estimates† of 5- and 10-year relative survival, by sex, by age group, and by cancer site, Canada‡

	5-year survival					10-year survival				
	Period analysis		Cohort analysis			Period analysis		Cohort analysis		
	Relative survival ratio	95% confidence interval	Relative survival ratio	95% confidence interval	Period-cohort difference§	Relative survival ratio	95% confidence interval	Relative survival ratio	95% confidence interval	Period-cohort difference§
	%		%			%		%		
Overall	**62.3**	**62.0, 62.6**	**60.3**	**59.9, 60.6**	**2.1**	**57.7**	**57.3, 58.0**	**52.1**	**51.6, 52.5**	**5.6**
Sex										
Male	61.7	61.2, 62.1	58.4	57.8, 58.9	3.3	57.8	57.3, 58.3	49.4	48.7, 50.1	8.4
Female	63.1	62.7, 63.5	62.3	61.7, 62.8	0.8	57.7	57.3, 58.2	55.0	54.4, 55.7	2.7
Age group										
15 to 44	79.6	78.9, 80.3	75.8	74.8, 76.7	3.8	74.9	74.1, 75.6	67.6	66.6, 68.7	7.2
45 to 54	70.6	69.9, 71.3	68.1	67.2, 69.0	2.5	64.4	63.7, 65.2	56.4	55.3, 57.5	8.1
55 to 64	65.5	64.9, 66.1	62.2	61.4, 63.0	3.3	59.0	58.3, 59.7	50.5	49.6, 51.4	8.5
65 to 74	61.1	60.5, 61.7	58.5	57.8, 59.3	2.5	56.4	55.7, 57.1	49.6	48.8, 50.5	6.8
75 to 99	51.0	50.2, 51.7	51.2	50.3, 52.1	-0.2	50.3	49.3, 51.3	49.1	47.6, 50.6	1.2
Cancer site										
Oral (buccal cavity and pharynx)	63.4	61.3, 65.4	62.0	59.5, 64.5	1.4	55.5	53.4, 57.7	54.5	51.7, 57.3	1.0
Esophagus	13.2	11.3, 15.3	12.7	10.4, 15.3	0.5	11.5	9.6, 13.7	9.6	7.1, 12.6	1.9
Stomach	24.0	22.2, 25.8	23.0	20.9, 25.2	1.0	22.5	20.6, 24.5	17.3	15.2, 19.6	5.2
Colon	61.3	60.2, 62.4	60.0	58.6, 61.4	1.3	58.7	57.4, 60.1	55.3	53.5, 57.1	3.5
Rectum	65.0	63.4, 66.6	60.6	58.5, 62.6	4.5	60.4	58.5, 62.3	50.7	48.2, 53.2	9.7
Pancreas	6.6	5.6, 7.6	6.4	5.3, 7.7	0.1	6.0	5.0, 7.0	5.5	4.3, 6.9	0.5
Lung and bronchus	15.5	15.0, 16.1	15.4	14.7, 16.2	0.1	12.4	11.9, 13.0	11.7	11.0, 12.4	0.7
Skin melanoma	89.5	88.2, 90.8	90.1	88.4, 91.6	-0.6	87.6	86.0, 89.2	85.1	82.7, 87.3	2.6
Breast (male and female)	87.5	86.9, 88.1	86.5	85.7, 87.3	1.0	79.6	78.8, 80.4	74.7	73.6, 75.9	4.9
Cervix uteri	75.7	73.2, 78.0	70.3	67.3, 73.1	5.4	71.6	69.0, 74.0	67.1	63.8, 70.2	4.5
Corpus uteri	86.2	84.6, 87.6	86.3	84.4, 88.1	-0.1	84.5	82.6, 86.3	83.8	81.2, 86.3	0.6
Ovary	40.5	38.3, 42.7	38.9	36.1, 41.6	1.7	33.6	31.5, 35.8	32.7	29.8, 35.6	0.9
Prostate	95.2	94.5, 95.9	92.5	91.5, 93.5	2.7	91.9	90.9, 93.0	79.0	77.3, 80.6	13.0
Bladder (including in situ)	75.0	73.4, 76.7	76.4	74.4, 78.4	-1.4	71.6	69.6, 73.5	71.6	68.7, 74.4	0.0
Kidney and renal pelvis	65.8	63.8, 67.7	63.5	61.0, 65.9	2.3	61.2	59.0, 63.4	57.1	54.0, 60.1	4.1
Brain	23.4	21.4, 25.4	22.8	20.4, 25.2	0.6	18.9	17.1, 20.7	17.6	15.3, 20.0	1.3
Thyroid	97.7	96.7, 98.7	95.8	94.1, 97.3	1.9	97.5	96.1, 98.7	93.3	90.8, 95.6	4.2
Non-Hodgkin's lymphoma	61.5	60.0, 63.1	58.7	56.8, 60.6	2.8	52.0	50.3, 53.6	44.5	42.2, 46.8	7.5
Multiple myeloma	33.9	31.3, 36.6	32.5	29.3, 35.7	1.5	21.1	18.7, 23.6	18.1	15.0, 21.5	3.0
Leukemias	49.3	47.3, 51.3	45.6	43.2, 48.0	3.7	41.2	39.1, 43.3	38.6	35.9, 41.4	2.6

***Data source**: Canadian Cancer Registry*
†The cohort analysis relative survival ratios and 95% confidence intervals were based on follow-up to 2002 of cases diagnosed in 1997 (5-year) or 1992 (10-year). The period method involved the survival experience in 2002 only of cases diagnosed from 1997 to 2002 (5-year) or cases diagnosed from 1992 to 2002 (10-year).
‡ Excluding Québec
§ Absolute difference between period and cohort analysis relative survival ratios. Positive values indicate that the period estimate was higher.

The international picture

Period analysis predictions of relative survival for people newly diagnosed with cancer have only been published for a small number of countries.[30-33] Although these studies covered different periods, included different age ranges, and used site groupings that were not necessarily uniform, some general comparisons with the results of this new period analysis can be made.

Period estimates for the United States, based on data collected by the Surveillance, Epidemiology, and End Results (SEER) program of the National Cancer Institute, were published for 1998.[30] While the SEER program is not a nationwide cancer registry (data were collected from nine population-based cancer registries), it is the most comprehensive source of information on cancer incidence and survival in the United States.[30] In general, Canada appears to have slightly higher relative survival ratios (RSRs) than the SEER registries, although it should be noted that the Canadian results are based on more recent data. The RSR estimates for Canada were much higher than the US ratios for multiple myeloma (5-year: 33.9% versus 29.5% and 10-year: 21.1% versus 12.7%), but were considerably lower for ovarian cancer (40.5% versus 55.0%, and 33.6% versus 49.3%).

Canadian RSRs compare even more favourably with those derived from Swedish cancer registry data.[31] In particular, relative survival for prostate cancer is vastly higher in Canada than in Sweden (5-year: 95.2% versus 79.5%; 10-year: 91.9% versus 59.3%). Similar differences in prostate cancer RSRs exist between Sweden and the United States and have been attributed to earlier and more extensive use of prostate-specific antigen testing in the United States.[31]

relative survival is poorer, for many forms of cancer, among those diagnosed at an older age has previously been noted.[34,35] Potential explanations include less therapy as a result of a higher level of co-morbidity, a less favourable stage distribution, and less aggressive treatment (independent of co-morbidity) among older patients.[34]

Ten-year age-specific period RSRs were higher than corresponding estimates derived using the cohort method. Period estimates were 6.8% to 8.5% higher in the first four age groups, but only 1.2% higher for the 75-to-99 age group. A similar pattern was seen for 5-year survival: RSRs were virtually identical for the elderly, but 2.5% to 3.8% higher in the first four age groups using the period method. This indicates that the disparity in long-term cancer survival between those younger than 75 at diagnosis and those at or over this age has widened. The same conclusion was reached in a recent study based on data collected by the Surveillance, Epidemiology, and End Results (SEER) program of the National Cancer Institute in the United States.[34] This study also reported that the proportion of cancer patients receiving surgery increased from 70% in 1986-1990 to 75% in 1996-2000 in the youngest age group, but actually dropped from 55% to 49% among those aged 75 or older. It may be that differences in therapy by age have become more divergent.

Site-specific, period versus cohort

Period estimates of 5- and 10-year relative survival were similar to or greater than the corresponding cohort estimates for every cancer site studied, though differences between period and cohort estimates were less pronounced for 5-year survival (Table 3). Predicted increases in survival varied by cancer site. In some cases, the reasons for these increases were not apparent, but likely reflected several factors, including improvements in treatment and earlier or increased diagnosis. As previously suggested,[31] it is also possible that, with certain forms of cancer, a diagnostic shift towards more favourable histopathological subtypes could have played a role.

For eight of the sites studied, the period estimate for 10-year survival was at least 4% higher and did not fall within the 95% confidence interval of the cohort estimate. However, for seven sites (bladder, pancreas, corpus uteri, lung, ovary, oral cavity, and brain), there was little to no difference between the estimates (1% or less). The largest increases in 10-year survival were predicted for prostate cancer (13.0%), rectal cancer (9.7%) and non-Hodgkin's lymphoma (7.5%); the next largest were for stomach (5.2%), breast (4.9%) and cervical cancer (4.5%). The largest predicted increases for 5-year relative survival were for cancers of the cervix uteri (5.4%) and rectum (4.5%), and for leukemia (3.7%). When period analysis suggests little or no change in survival, simply knowing that the survival rates are unlikely to change is worthwhile information.

It is likely that the predicted increase in 10-year prostate cancer survival is due to the continued effect of prostate specific antigen (PSA) testing. Widespread use of this test has led to increased incidence and survival rates for prostate cancer in Canada[36,37] and elsewhere.[38-40] Results from ongoing clinical trials of the PSA test[41] should determine whether its use as a screening tool has resulted in a true decrease in mortality from prostate cancer.

The anticipated increase in the long-term relative survival of those diagnosed with non-Hodgkin's lymphoma may partly result from improved treatment. Specifically, the use of autologous stem cell transplantation and, more recently, the addition of monoclonal antibodies to the standard chemotherapy regimen, have been shown to improve survival in patients with various forms of the disease.[42-44] It is likely that survival from non-Hodgkin's lymphoma will continue to increase as ongoing research into monoclonal antibodies results in the development and implementation of new treatment protocols. Expected gains in rectal cancer survival may be due in part to the increased use of radiotherapy and general improvements in surgical technique.

Five-year RSRs for breast cancer have been steadily increasing among women since at least the mid-1980s.[29,45] A concurrent steady decrease in breast cancer mortality[46] suggests that there has been a tangible improvement in prognosis. The increase predicted in this study probably reflects a continuation of this trend. A combination of early diagnosis from mammography screening and improved treatment is likely behind the positive change, although the relative impacts of each have yet to be quantified. Data from organized breast screening programs have shown steady increases in participation throughout the 1990s.[47]

Recent advances in the treatment of cervical cancer have likely contributed to the increase in long-term survival predicted using period analysis. In particular, the administration of cisplatin-based chemotherapy during radiotherapy began to be offered as a treatment for women who received radiotherapy for locally advanced cervical cancer after it was shown to improve overall survival.[48-50] While the continued widespread use of the Pap test as a screening tool[46] has resulted in decreased mortality rates for cervical cancer, most cancers detected by this test are in the pre-invasive stage and thus would not be reflected in these survival estimates.

Concluding remarks

Estimates of long-term survival for cancer are strongly affected by the survival in the first few years after diagnosis because this is when most cancer deaths occur. Period estimates of survival during the first few years after diagnosis are exclusively based on the survival of individuals diagnosed in recent years. By contrast, the calculation of survival during the first few years after diagnosis for long-term cohort estimates is based on the survival of persons diagnosed many years ago. This is the main reason why period estimates of long-term survival are more up-to-date than cohort estimates.

Using the cross-sectional experience of cases followed-up in 2002 results in more up-to-date predictions of long-term relative survival ratios (RSRs) for recently diagnosed people than would relying solely on the survival experience of a cohort of cases diagnosed in 1997 (5-year) or 1992 (10-year). When survival has improved, period estimates will be higher than cohort estimates. And when survival rates have remained constant, period and cohort survival rates will be similar.

The period analysis conducted in this study suggests that the long-term survival of Canadians recently diagnosed with cancer will be higher—for many forms of cancer—than previously estimated by cohort analysis. The 5- and 10-year RSRs for all invasive cancer sites combined were predicted to be 62.3% and 57.7%, respectively; about 2 and 6 percentage points higher than previously determined.

Predicted increases in survival varied greatly by cancer site. The largest predicted increases in 10-year relative survival were for prostate (13.0%) and rectal (9.7%) cancer. Differences between period and cohort estimates were less pronounced for 5-year survival. The largest increases for 5-year RSRs were for cancers of the cervix uteri (5.4%)

and rectum (4.5%), and for leukemia (3.7%). For sites such as the esophagus and pancreas, RSRs are expected to remain virtually constant.

How well the period analysis estimates obtained in this study actually predict the long-term survival of people recently diagnosed with cancer will remain unknown for quite some time. Estimates of survival may be even higher than reported here if improvement in survival continues. The up-to-date estimates do, however, provide a more realistic outlook of long-term cancer survival. ●

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Appendix

Table A

Number of cases, percentage male and median age at diagnosis, by cancer site and year of diagnosis, Canada,‡ 1992, 1997 and 2002

	Year of diagnosis								
	1992			1997			2002		
	Number of cases	% male	Median age at diagnosis	Number of cases	% male	Median age at diagnosis	Number of cases	% male	Median age at diagnosis
All cancers	**76,946**	**53**	**68**	**84,493**	**52**	**68**	**95,299**	**52**	**67**
Oral (buccal cavity and pharynx)	2,128	71	64	1,975	69	65	2,109	66	63
Esophagus	712	72	68	839	70	69	902	72	70
Stomach	1,808	64	70	1,804	65	71	1,775	62	71
Colon	6,789	51	71	7,247	50	72	8,265	50	72
Rectum	3,037	62	69	3,265	60	69	3,931	60	68
Pancreas	1,696	50	70	1,861	48	72	1,963	47	72
Lung and bronchus	10,782	64	68	11,226	59	69	12,161	55	70
Skin melanoma	2,161	52	54	2,605	51	55	3,016	52	57
Breast (male and female)	11,227	1	63	12,666	1	61	13,981	1	60
Cervix uteri	1,053	0	46	1,043	0	45	1,011	0	46
Corpus uteri	1,975	0	66	2,239	0	65	2,564	0	64
Ovary	1,278	0	63	1,360	0	65	1,590	0	63
Prostate	11,368	100	72	12,456	100	71	14,900	100	69
Bladder (including in situ)	3,087	76	71	3,499	74	71	3,515	75	72
Kidney and renal pelvis	1,755	62	65	1,990	63	66	2,362	61	64
Brain	1,094	60	59	1,245	56	58	1,303	57	60
Thyroid	956	22	44	1,215	23	46	2,153	22	46
Non-Hodgkin's lymphoma	2,749	53	64	3,414	53	64	3,763	54	65
Multiple myeloma	874	54	70	1,047	54	71	1,097	54	71
Leukemias	1,931	59	68	2,074	58	68	2,281	58	68

***Data source**: Canadian Cancer Registry*
† After survival analysis exclusions
‡ Excluding Québec

The effect of universal influenza immunization on vaccination rates in Ontario

Jeff C. Kwong, Christie Sambell, Helen Johansen, Thérèse A. Stukel and Douglas G. Manuel

Abstract

Objectives

This article examines the association between introduction of Ontario's Universal Influenza Immunization Program and changes in vaccination rates over time in Ontario, compared with the other provinces combined.

Data sources

The data are from the 1996/97 National Population Health Survey and the 2000/01 and 2003 Canadian Community Health Survey, both conducted by Statistics Canada.

Analytical techniques

Cross-tabulations were used to estimate vaccination rates for the total population aged 12 or older, for groups especially vulnerable to the effects of influenza, and by selected socio-demographic variables. Z tests and multiple logistic regression were used to examine differences between estimates.

Main results

Between 1996/97 and 2000/01, the increase in the overall vaccination rate in Ontario was 10 percentage points greater than the increase in the other provinces combined. Increases in Ontario were particularly pronounced among people who were: younger than 65, more educated, and had a higher household income. Between 2000/01 and 2003, vaccination rates were stable in Ontario, while rates continued to rise in the other provinces. Even so, Ontario's 2003 rates exceeded those in the other provinces.

Keywords

preventive health services, community health services, population-based health planning

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Annual influenza epidemics are responsible for substantial morbidity and mortality and impose a considerable economic burden on society in terms of health care costs and lost productivity.[1] Influenza is highly contagious and infects 10% to 25% of the population each year.[2] While most healthy adults and children recover, in vulnerable populations such as the elderly and people with chronic medical conditions, influenza can lead to serious complications, and even death.[3]

Prevention through vaccination is the cornerstone of influenza management. Seasonal flu shots are recommended for people at high risk of complications.[4,5] Vaccination is both safe and effective, reducing the number of cases by up to 70% in healthy adults[6] and 50% in the elderly.[7]

Methods

Data sources

This analysis was based on data from the 1996/97 National Population Health Survey (NPHS) and the first two cycles of the Canadian Community Health Survey (CCHS), conducted in 2000/01 (cycle 1.1) and 2003 (cycle 2.1). These Statistics Canada surveys cover the household population. Members of the Canadian Forces and residents of Canadian Forces bases, Indian reserves and some remote areas, as well as residents of institutions (nursing homes, prisons, etc.), are excluded. This study compares people aged 12 or older who lived in Ontario with those who lived in the other nine provinces (combined).

National Population Health Survey

Since 1994/95, the biennial NPHS has collected cross-sectional and longitudinal data, for the most part, through telephone interviews. For the cross-sectional component, socio-demographic data and basic health information were collected for each member of a household and stored in the General file. Additional health information, including data on influenza vaccination, was collected for one randomly selected household member and stored in the Health file. Details of the NPHS design and sampling techniques have been described previously.[8] The 1996/97 NPHS was conducted from June 1996 to August 1997; the overall response rate was approximately 83%. This analysis used data from the Health file for 73,402 respondents aged 12 or older, weighted to represent a population of approximately 24.6 million.

Canadian Community Health Survey

The CCHS, which began in 2000/01, is a cross-sectional survey conducted through telephone and in-person interviews over a two-year repeating cycle. Data on influenza vaccination were collected in 2000/01 (cycle 1.1) and in 2003 (cycle 2.1). Data collection for cycle 1.1 took place over 12 months starting in September 2000, but questions about influenza vaccination were asked only in the fourth quarter (June to August 2001). These questions were asked in all four quarters for cycle 2.1 (January to December, 2003). Details of the CCHS design and sampling techniques have been described previously.[9] The response rate for cycle 1.1 was approximately 85%; for cycle 2.1, 81%. The samples used in this study comprise 35,187 respondents aged 12 or older for cycle 1.1, and 133,026 respondents aged 12 or older for cycle 2.1, weighted to represent 25.9 million and 26.5 million individuals, respectively. Selected characteristics of the sample population surveyed in 2003 are presented in Appendix Table A.

Analytical techniques

Based on NPHS and CCHS data, cross-tabulations were used to estimate the proportion of people aged 12 or older who reported that they had had a flu shot in the previous year, by selected socio-demographic characteristics, and by risk group for influenza immunization (seniors and people of any age with specific chronic conditions). In the unadjusted analysis, Z tests were used to examine the proportions vaccinated in 1996/97 versus 2000/01, and 2000/01 versus 2003, and to compare the absolute changes in vaccination rates over time in Ontario with the corresponding changes in the other provinces combined. In the adjusted analysis, multiple logistic regression was used to model the effect of the introduction of the Universal Influenza Immunization Program (UIIP) in Ontario on vaccination status, stratified by age group and chronic condition status. The unit of analysis was the individual respondent; the response variable was their influenza vaccination status; the main predictor variable was the interaction between presence of the UIIP (Ontario versus other provinces) and time (1996/97 versus 2000/01 or 2000/01 versus 2003); and the potential confounders were age, sex, province, household income, education, smoking status, and having a regular doctor. The p value of the interaction term between UIIP presence and time was used to test the significance of the change in vaccination rates over time in Ontario compared with the change in other provinces. Separate analyses stratified by age group (12 to 49, 50 to 64, and 65 or older) and the presence of one or more chronic medical conditions were conducted.

Because of the multi-stage design of the NPHS and CCHS, the bootstrap technique[10] was used to calculate coefficients of variation and to test the statistical significance of differences. A significance level of $p < 0.05$ was used. However, the large sample sizes resulted in small changes in the proportion vaccinated being statistically significant, so only changes greater than 5 percentage points were considered "clinically significant."

Despite the benefits, influenza vaccination rates have remained relatively low. A national consensus conference in 1993 set a target coverage rate of 70% for seniors and for all adults with chronic medical conditions.[11] Results from the 1996/97 National Population Health Survey indicated that 51% of seniors and 21% of 20- to 64-year-olds with chronic conditions had had a flu shot in the previous year.[12]

By 2000, most provinces and territories had publicly funded programs to offer free flu shots to seniors, people with chronic medical conditions, and health care workers.[13] In July that year, Ontario established a universal influenza immunization program (UIIP) to provide free vaccinations to the entire population aged six months or older.[14] This was the first large-scale program of its kind in the world, and Ontario remains the only province in Canada to have such a policy.

This study evaluates the effect of Ontario's UIIP on vaccination rates. Data from the National Population Health Survey (NPHS) and the Canadian Community Health Survey (CCHS) were used to assess whether the introduction of UIIP was associated with a greater increase in vaccination rates in Ontario than occurred in the other provinces (see *Methods, Definitions* and *Limitations*). Risk groups and population subgroups that experienced the most and least change in vaccination rates associated with UIIP introduction are identified.

Initial effect (1996/97 versus 2000/01)

Between 1996/97 (pre-UIIP) and 2000/01 (post-UIIP), the percentage of Ontario residents aged 12 or older who had a flu shot rose from 18% to 36%. The increase for the other provinces combined was from 13% to 21% (Table 1) (see "Flu shots—National and provincial/territorial trends" in this issue for the percentages vaccinated in individual provinces). Therefore, UIIP introduction in Ontario was associated with an additional 10 percentage-point absolute increase in the overall proportion vaccinated, compared with the other provinces combined.

In Ontario, the 20-to-64 age group had the largest increase in the percentage immunized, while in the

Definitions

Ontario's Universal Influenza Immunization Program (UIIP) was officially announced in July 2000, but since influenza vaccines are not available until October, the start of the program was defined as October 2000.

Respondents to the 1996/97 National Population Health Survey and the 2000/01 and 2003 Canadian Community Health Survey were asked, "Have you ever had a flu shot?" If they said "yes," they were asked when they had last been vaccinated. Those who stated that they had received a flu shot within the last year were considered to be actively immunized.

To determine *chronic condition* status, respondents were asked if they had any "long-term conditions that had lasted or were expected to last six months or more and that had been diagnosed by a health professional," and a list of conditions was read to them. Those who reported heart disease, diabetes, cancer, effects of stroke, asthma, or emphysema/chronic bronchitis were considered to have a condition for which influenza immunization is recommended.

Two sets of *age groups* were considered: 1) 12 to 19, 20 to 49, 50 to 64, 65 to 74, 75 to 84, 85 or older and 2) 12 to 49, 50 to 64, 65 or older.

Risk groups were defined as high or low. People aged 65 or older and 12- to 64-year-olds with at least one chronic condition were deemed high risk. Individuals aged 12 to 64 with no chronic conditions were considered low risk.

Education was defined as the highest level attained: less than secondary graduation, secondary graduation, or at least some postsecondary.

Household income was based on the number of people in the household and total income from all sources in the previous 12 months:

Household income group	People in household	Total household income
Lowest	1 or 2	Less than $15,000
	3 or 4	Less than $20,000
	5 or more	Less than $30,000
Lower-middle	1 or 2	$15,000 to $29,999
	3 or 4	$20,000 to $39,999
	5 or more	$30,000 to $59,999
Upper-middle	1 or 2	$30,000 to $59,999
	3 or 4	$40,000 to $79,999
	5 or more	$60,000 to $79,999
Highest	1 or 2	$60,000 or more
	3 or more	$80,000 or more

Three *smoking status* categories were considered: never, former, or daily/occasional.

Respondents were asked if they had a *regular medical doctor.*

Table 1
Percentage vaccinated for influenza in past year, by selected characteristics, household population aged 12 or older, Ontario and other provinces, 1996/97 and 2000/01

	Ontario			Other provinces			Difference in change
	1996/97	2000/01	Percentage-point change	1996/97	2000/01	Percentage-point change	(Ontario–other provinces)
	%			%			
Total	**18.1**	**36.0**	**17.9***	**12.7**	**20.8**	**8.1***	**9.8***
Sex							
Male	17.0	32.2	15.2*	11.0	17.9	6.9*	8.3*
Female	19.1	39.6	20.5*	14.3	23.6	9.3*	11.2*
Age group							
12-49	9.3	27.0	17.7*	5.6	11.5	5.9*	11.8*
12-19	15.8	28.7	12.9*	5.6	9.4	3.8*	9.1*
20-49	8.0	26.6	18.6*	5.6	11.9	6.3*	12.3*
50-64	20.5	41.6	21.1*	14.6	22.6	8.0*	13.1*
65+	59.5	72.5	12.9*	46.0	63.2	17.2*	-4.2
65-74	54.3	69.5	15.2*	42.2	57.8	15.6*	-0.4
75-84	69.6	78.7	9.1*	54.0	71.0	17.0*	-7.9*
85+	67.2	73.4	6.2	44.0	70.5	26.5*	-20.4*
Chronic condition†							
At least one	37.5	56.3	18.8*	27.3	37.8	10.4*	8.4*
None	14.3	31.3	17.0*	10.0	17.0	7.1*	10.0*
Education							
Less than secondary graduation	24.8	40.3	15.5*	16.2	24.3	8.1*	7.4*
Secondary graduation	17.3	33.1	15.8*	11.5	17.9	6.4*	9.5*
At least some postsecondary	14.9	34.8	19.9*	10.9	19.9	8.9*	11.0*
Household income							
Lowest	21.8	33.1	11.3*	15.7	21.9	6.2*	5.1
Lower-middle	22.4	40.4	18.0*	14.2	23.7	9.5*	8.4*
Upper-middle	16.5	37.7	21.2*	10.7	19.4	8.7*	12.5*
Highest	12.0	33.3	21.3*	10.3	19.3	8.9*	12.3*
Smoking status							
Never	17.7	34.8	17.0*	12.9	20.6	7.6*	9.4*
Former	23.2	42.3	19.0*	17.0	25.9	8.9*	10.2*
Daily/Occasional	12.9	29.2	16.3*	8.0	13.9	5.9*	10.3*
Has regular doctor							
Yes	18.8	37.9	19.0*	14.3	24.1	9.7*	9.3*
No	6.7	18.5	11.8*	4.3	8.0	3.7*	8.1*

Data sources: *1996/97 National Population Health Survey, cross-sectional sample, Health file; 2000/01 Canadian Community Health Survey, cycle 1.1, fourth quarter*
† Heart disease, effects of stroke, diabetes, cancer, asthma, emphysema/chronic bronchitis
** Significantly different from 0 at 0.05 level (unadjusted analysis using Z test)*

other provinces combined, the increase was greatest among seniors, especially those aged 85 or older. In fact, for people aged 65 or older, the increase in vaccination rates between 1996/97 and 2000/01 in the other provinces exceeded that in Ontario. This was probably because the 1996/97 rate for Ontario seniors had been much higher than that in the other provinces (60% versus 46%), and as a result, further gains were harder to achieve. Even so, in 2000/01, the percentage of Ontario seniors who had had a flu shot was still well above that in the other provinces: 72% versus 63%.

Introduction of universal influenza immunization was also associated with significantly greater increases in vaccination rates for Ontario residents with chronic conditions (heart disease, effects of stroke, diabetes, cancer, asthma, and emphysema/chronic bronchitis). Among Ontarians with any of these conditions, the vaccination rate rose from 38% to 56%; in the other provinces combined, the figure went from 27% to 38%. Vaccination rates for people without these conditions were lower, but again, the increase in Ontario exceeded that in the other provinces.

An examination of the data for each age group, with and without chronic conditions, shows that vaccination rates were higher in Ontario than in the other provinces in both 1996/97 and 2000/01 (Table 2). Ontario's UIIP was associated with significantly greater increases in vaccination rates for people aged 12 to 64, whether or not they had a chronic condition. Adjusting for potential confounders (age, sex, education, household income, smoking status, having a regular doctor, and province) in a multivariate analysis did not change these results. However, for seniors with a chronic condition, the increase in the vaccination rate in the other provinces was actually greater than that in Ontario.

A socio-economic gradient was evident. The difference between the increases in Ontario vaccination rates versus those in the other provinces widened at higher levels of education and household income (Table 1). For instance, among people in the lowest income households, the vaccination rate in Ontario rose 5 percentage points more than did the rate in the other provinces combined, a difference that was not significant. However, among people in the highest income households, the increase in Ontario's rate exceeded that in the other provinces by 12 percentage points.

Table 2
Percentage vaccinated for influenza in past year, by age group and presence of chronic condition(s),† household population aged 12 or older, Ontario and other provinces, 1996/97 and 2000/01

Age group and chronic condition	Ontario			Other provinces			Difference in change (Ontario–other provinces)
	1996/97	2000/01	Percentage-point change	1996/97	2000/01	Percentage-point change	
	%			%			
12-49							
At least one chronic condition	17.7	39.3	21.6*	12.8	18.4	5.6*	16.0*‡
No chronic condition	8.2	25.2	16.9*	4.7	10.4	5.8*	11.2*‡
50-64							
At least one chronic condition	39.5	58.3	18.7*	26.9	35.5	8.6*	10.1*‡
No chronic condition	15.9	36.4	20.5*	11.7	18.7	7.0*	13.5*‡
65+							
At least one chronic condition	68.7	81.6	12.9*	52.3	70.9	18.6*	-5.8‡
No chronic condition	54.4	66.4	12.0*	42.9	58.4	15.6*	-3.5‡

Data sources: *1996/97 National Population Health Survey, cross-sectional sample, Health file; 2000/01 Canadian Community Health Survey, cycle 1.1, fourth quarter*
† Heart disease, effects of stroke, diabetes, cancer, asthma, emphysema/chronic bronchitis
** Significantly different from 0 at 0.05 level (unadjusted analysis using Z test)*
‡ Significantly different from 0 at 0.05 level (adjusted analysis using logistic regression that controlled for age, sex, education, household income, smoking status having a regular doctor, and province)

Sustained UIIP effect (2000/01 versus 2003)

Between 2000/01 and 2003, Ontario's overall vaccination rate was stable, whereas the rate in the other provinces combined rose by 2 percentage points (Table 3). As well, in the other provinces, clinically significant increases in vaccination rates occurred among those aged 50 to 64 and people with at least one chronic condition. This contrasted with no clinically significant change or slight decreases for these groups in Ontario. Even so, in 2003, vaccination rates among Ontarians in both of these groups were still substantially above the corresponding figures for the other provinces combined.

A more detailed picture of the changes in influenza immunization rates between 2000/01 and 2003 emerges when the presence of chronic

Table 3
Percentage vaccinated for influenza in past year, by selected characteristics, household population aged 12 or older, Ontario and other provinces, 2000/01 and 2003

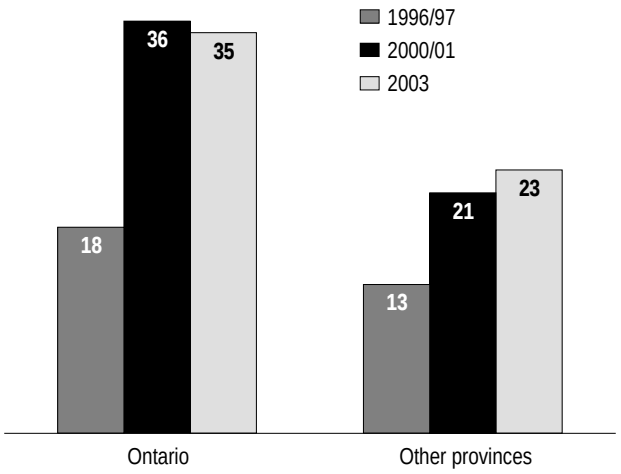
	Ontario			Other provinces			Difference in change
	2000/01	2003	Percentage-point change	2000/01	2003	Percentage-point change	(Ontario–other provinces)
	%			%			
Total	**36.0**	**35.1**	**-0.9**	**20.8**	**22.8**	**2.0***	**-2.8***
Sex							
Male	32.2	31.4	-0.8	17.9	20.5	2.6*	-3.4*
Female	39.6	38.6	-1.0	23.6	25.0	1.4*	-2.4
Age group							
12-49	27.0	24.0	-3.0*	11.5	12.1	0.6	-3.7*
12-19	28.7	28.1	-0.6	9.4	10.0	0.6	-1.3
20-49	26.6	23.0	-3.6*	11.9	12.6	0.6	-4.2*
50-64	41.6	45.5	3.8*	22.6	29.3	6.7*	-2.8
65+	72.5	74.2	1.8	63.2	62.8	-0.4	2.2
65-74	69.5	70.7	1.2	57.8	58.7	0.9	0.3
75-84	78.7	79.8	1.1	71.0	68.3	-2.7	3.8
85+	73.4	78.4	5.0	70.5	70.8	0.3	4.7
Chronic condition†							
At least one	56.3	55.0	-1.3	37.8	42.4	4.6*	-5.9*
None	31.3	30.4	-0.9	17.0	18.3	1.3*	-2.2*
Education							
Less than secondary graduation	40.3	41.0	0.7	24.3	26.5	2.2*	-1.5
Secondary graduation	33.1	33.3	0.2	17.9	19.5	1.6	-1.4
At least some postsecondary	34.8	33.2	-1.7	19.9	21.8	2.0*	-3.7*
Household income							
Lowest	33.1	38.5	5.3	21.9	24.4	2.5	2.8
Lower-middle	40.4	40.1	-0.3	23.7	24.7	0.9	-1.3
Upper-middle	37.7	36.0	-1.7	19.4	22.1	2.7*	-4.4*
Highest	33.3	30.8	-2.5	19.3	20.5	1.2	-3.6*
Smoking status							
Never	34.8	34.9	0.1	20.6	22.1	1.5	-1.4
Former	42.3	40.8	-1.4	25.9	27.6	1.7*	-3.2*
Daily/Occasional	29.2	26.0	-3.2*	13.9	15.3	1.4	-4.7*
Has regular doctor							
Yes	37.9	36.8	-1.1	24.1	26.0	1.9*	-3.0*
No	18.5	16.5	-2.0	8.0	8.1	0.1	-2.0

Data source: *2000/01 Canadian Community Health Survey, cycle 1.1, fourth quarter; 2003 Canadian Community Health Survey, cycle 2.1*
† Heart disease, effects of stroke, diabetes, cancer, asthma, emphysema/chronic bronchitis
** Significantly different from 0 at 0.05 level (unadjusted analysis using Z test)*

conditions is considered for each age group (Table 4). For people aged 50 to 64, rates in Ontario increased only among those without chronic conditions, whereas in the other provinces, rates rose for everyone in this age range. When the effects of age, sex, education, household income, smoking status, having a regular doctor, and province were taken into account, the other provinces experienced greater increases in vaccination rates for people aged 12 to 64 with chronic conditions, compared with Ontario. On the other hand, among seniors without chronic conditions, the increase in Ontario surpassed the change in other provinces.

Since 2000/01, Ontario has sustained, but has generally not increased, its vaccination rates (Chart 1). At the same time, the other provinces combined have continued to improve influenza vaccination rates among certain subgroups, but have not attained Ontario's levels, even for high-risk groups.

Chart 1
Percentage vaccinated for influenza in past year, household population aged 12 or older, Ontario and other provinces, 1996/97, 2000/01 and 2003



Data sources: *1996/97 National Population Health Survey, cross-sectional sample, Health file; 2000/01 Canadian Community Health Survey, cycle 1.1, fourth quarter; 2003 Canadian Community Health Survey, cycle 2.1*

Table 4
Percentage vaccinated for influenza in past year, by age group and presence of chronic condition(s),† household population aged 12 or older, Ontario and other provinces, 2000/01 and 2003

Age group and chronic condition	Ontario			Other provinces			Difference in change
	2000/01	2003	Percentage-point change	2000/01	2003	Percentage-point change	(Ontario–other provinces)
	%			%			
12-49							
At least one chronic condition	39.3	36.0	-3.4	18.4	21.0	2.6	-5.9‡
No chronic condition	25.2	22.2	-3.0*	10.4	10.8	0.4	-3.4*
50-64							
At least one chronic condition	58.3	59.2	0.9	35.5	45.3	9.8*	-8.9*‡
No chronic condition	36.4	41.0	4.6*	18.7	24.3	5.6*	-1.0‡
65+							
At least one chronic condition	81.6	80.3	-1.3	70.9	71.0	0.1	-1.3
No chronic condition	66.4	69.9	3.5	58.4	57.3	-1.1	4.6‡

Data sources: *2000/01 Canadian Community Health Survey, cycle 1.1, fourth quarter; 2003 Canadian Community Health Survey, cycle 2.1*
† Heart disease, effects of stroke, diabetes, cancer, asthma, emphysema/chronic bronchitis
** Significantly different from 0 at 0.05 level (unadjusted analysis using Z test)*
‡ Significantly different from 0 at 0.05 level (adjusted analysis using logistic regression that controlled for age, sex, education, household income, smoking status, having a regular doctor and province)

Limitations

Because young children and institutionalized seniors are high-risk groups, accurate and ongoing assessment of their vaccination coverage rates is important. However, the National Population Health Survey (NPHS) and the Canadian Community Health Survey (CCHS) do not have influenza immunization data for children younger than 12 or for residents of long-term health care institutions such as nursing homes.

Another limitation of these health surveys is that the information is self-reported, and it is not possible to verify participants' responses. Nonetheless, previous studies have demonstrated that self-reports of influenza immunization status are reasonably accurate.[15-17]

The latest Canadian Immunization Guide[18] recommends vaccination for all people with the following conditions: chronic cardiac and pulmonary disorders, diabetes mellitus, cancer, immunodeficiency, immunosuppression, renal disease, anemia, and hemoglobinopathy. However, the chronic condition status variable in the NPHS and CCHS included only six conditions that fall within these categories: heart disease, effects of stroke, diabetes, cancer, asthma, and emphysema/chronic bronchitis. Therefore, the group identified in this article as having one or more chronic conditions is actually a subset of those for whom vaccination is recommended.

Differences in the timing of the surveys (June 1996 to August 1997 for the NPHS, June to August 2001 for cycle 1.1 of the CCHS - fourth quarter, and January to December 2003 for cycle 2.1 of the CCHS) and the methods of data collection (mainly telephone interviews for the NPHS; a mix of telephone and in-person interviews for the CCHS) may have influenced participant recall. For instance, people may be more likely to remember having had a flu shot if asked during the winter rather than the summer.

The analysis is based on estimates for only three seasons over an eight-year period; annual data are not available. This lack of data prevents a potentially more accurate examination of trends in vaccination rates over time.

Finally, all provinces besides Ontario were considered as a single group, but interprovincial variations in vaccination rates are substantial (see "Flu shots—National and provincial/territorial trends" in this issue). Because the aim was to examine how a universal program affected the proportion of people being vaccinated, the provinces were categorized based on whether they had such a program. The logistic regression model included a province term to account for the heterogeneity in influenza vaccination programs and vaccination rates between provinces.

As of 2003, Ontario and the other provinces combined had reached the 70% target coverage rate for people aged 65 or older who had chronic conditions. Among seniors who did not have chronic conditions, that target was achieved in Ontario, but not in the other provinces combined. For younger people with chronic conditions, Ontario's vaccination rates were higher than those in the other provinces, but well below 70%: 59% versus 45% at ages 50 to 64, and 36% versus 21% at ages 12 to 49.

Concluding remarks

Influenza vaccination rates increased substantially in Canada between 1996/97 and 2003, but after introduction of universal immunization, Ontario saw a sharper increase than that in the other provinces combined.

While the results of this analysis indicate that influenza vaccination rates are rising across the country, the sharp upturn in Ontario between 1996/97 and 2000/01 suggests that introduction of universal immunization in the fall of 2000 had an additional positive impact, especially among groups not typically covered by vaccination programs. It is not known, however, whether it was availability of free flu shots for everyone, greater ease of getting vaccinated, extensive advertising by provincial and local public health bodies, or some other cause, that led to the increase in Ontario's rates.

By 2003, the target coverage rate of 70% had been attained in Ontario for elderly people with and without chronic conditions, while in the other provinces, the target was achieved only for seniors with chronic conditions. For younger people with chronic conditions, immunization rates were well below 70% in all provinces. Thus, even in the context of a universal vaccination program, there is room for improvement. ●

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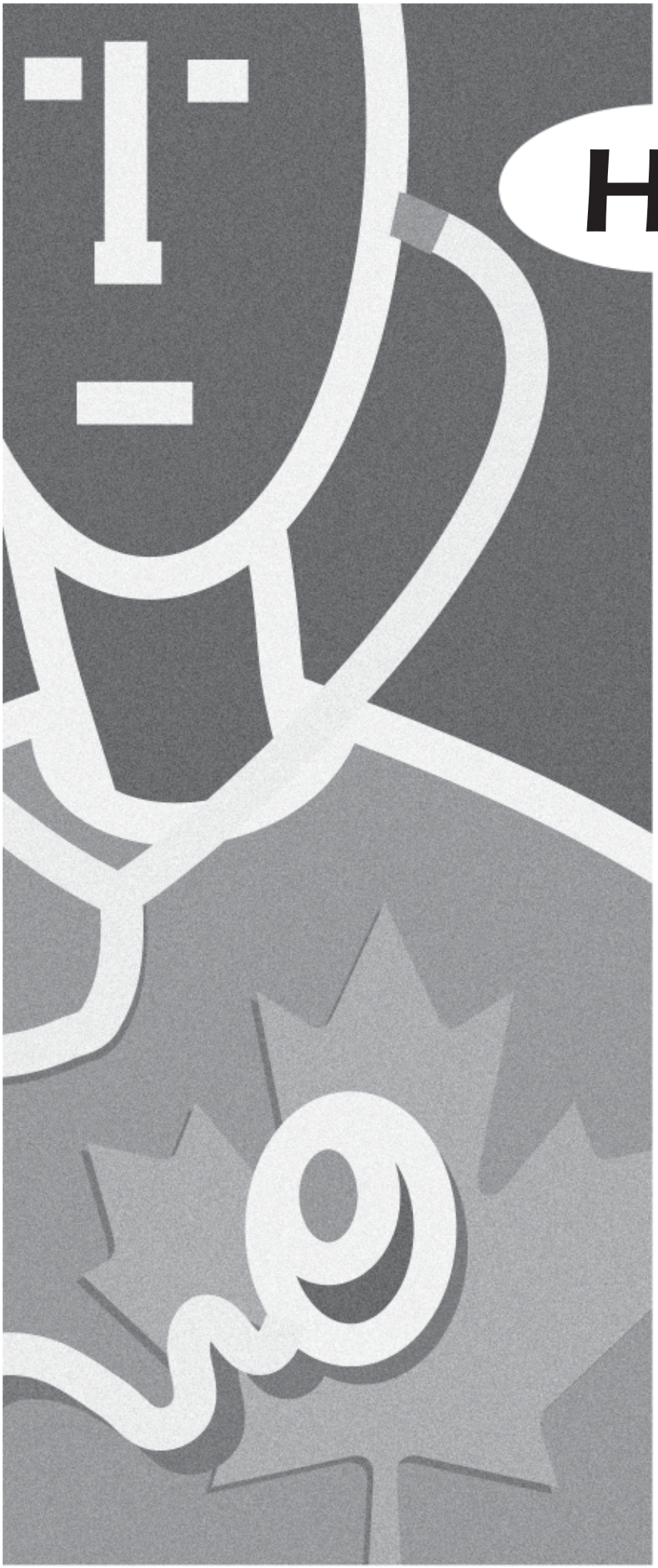
Appendix

Table A
Distribution of selected characteristics, household population aged 12 or older, Ontario and other provinces, 2003

	Ontario			Other provinces		
	Sample size	Estimated population		Sample size	Estimated population	
		'000	%		'000	%
Total	**42,777**	**10,279**	**100.0**	**90,249**	**16,228**	**100.0**
Sex						
Males	19,595	5,048	49.1	41,351	8,006	49.3
Females	23,182	5,231	50.9	48,898	8,222	50.7
Age group						
12-49	23,823	6,773	65.9	50,610	10,475	64.6
12-19	5,826	1,296	12.6	12,533	2,008	12.4
20-49	17,997	5,477	53.3	38,077	8,467	52.2
50-64	9,520	2,048	19.9	20,553	3,429	21.1
65+	9,434	1,458	14.2	19,086	2,323	14.3
65-74	5,226	848	8.2	10,259	1,331	8.2
75-84	3,472	507	4.9	7,002	806	5.0
85+	736	103	1.0	1,825	186	1.1
Influenza vaccination in past year						
Yes	16,861	3,495	35.1	23,278	3,564	22.8
No	24,687	6,461	64.9	63,961	12,064	77.2
Chronic condition†						
At least one	10,108	1,999	19.4	20,087	3,091	19.1
None	32,669	8,280	80.6	70,162	13,136	80.9
Education						
Less than secondary graduation	12,393	2,486	24.6	30,187	4,423	27.9
Secondary graduation	7,999	1,971	19.5	14,508	2,749	17.3
At least some postsecondary	21,779	5,645	55.9	43,862	8,676	54.7
Household income						
Lowest	3,649	653	7.4	10,481	1,363	10.3
Lower-middle	7,317	1,501	17.0	17,644	2,864	21.6
Upper-middle	12,914	2,893	32.8	25,894	4,695	35.5
Highest	13,142	3,770	42.8	19,703	4,322	32.6
Smoking status						
Never	16,150	4,167	40.8	30,751	5,724	35.5
Former	16,736	3,768	36.9	37,541	6,630	41.1
Daily/Occasional	9,619	2,271	22.3	21,439	3,786	23.5
Has regular doctor						
Yes	39,182	9,433	91.8	75,532	13,338	82.2
No	3,573	840	8.2	14,550	2,859	17.6

Data source: *2003 Canadian Community Health Survey, cycle 2.1*
† Heart disease, effects of stroke, diabetes, cancer, asthma, emphysema/chronic bronchitis



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Flu shots — National and provincial/territorial trends

by Helen Johansen, Christie Sambell and Wenxia Zhao

Keywords: immunization, preventive health services, community health services

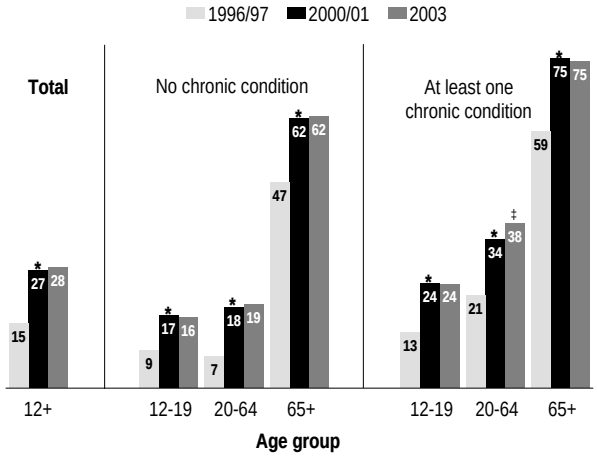
As well as sub-zero temperatures and snowstorms, flu virurses arrive with the Canadian winter. Healthy people usually recover from the fever, cough, headache and other symptoms in less than a week. But some—especially seniors and those with lung or cardiac conditions—may have more severe cases of the flu and may even need to be hospitalized.

Influenza immunization programs were first directed at high-risk groups.[1] In 1993, a national consensus conference recommended that seniors, younger people with serious chronic illnesses, and health care workers receive annual flu shots.[2] A target vaccination rate of 70% was set for seniors and for people of any age with chronic conditions that increase their susceptibility to influenza. Since then, guidelines have become progressively more inclusive. In 2002, the National Advisory Committee on Immunization recommended that, in addition to those in high-risk groups and people in close contact with them, any person who wished to be protected against influenza be offered the vaccine.[3] In 2004, the Canadian Task Force on Preventive Health Care recommended influenza vaccination for healthy adults and children.[4]

Levelling off

In 2003, 28% of Canadians aged 12 or older, an estimated 7.1 million individuals, reported that they had been vaccinated against influenza in the previous year (Chart 1). Although this was up substantially from 15% in 1996/97, it was not a significant change from 27% in 2000/01.

Chart 1
Percentage vaccinated for influenza in past year, by age group and presence of chronic condition(s),† household population aged 12 or older, Canada excluding territories, 1996/97, 2000/01 and 2003



Data sources: 1996/97 National Population Health Survey; 2000/01 Canadian Community Health Survey, cycle 1.1, fourth quarter; 2003 Canadian Community Health Survey, cycle 2.1
† Asthma, chronic bronchitis/emphysema, diabetes, heart disease, cancer, effects of stroke
‡ Significantly different from estimate for 2000/01 ($p < 0.05$)
** Significantly different from estimate for 1996/97 ($p < 0.05$)*

Rises with age

As might be expected, the percentage of people who get flu shots tends to rise with age. In 2003, the lowest proportion was 13% at ages 20 to 34, somewhat below that for 12- to 19-year-olds (17%) (data not shown). At ages 65 to 79, two-thirds of people reported having had a flu shot, and at age 80 or older, three-quarters.

Overall, women were more likely than men to have been immunized: 30% versus 25% (Chart 2). As well, higher percentages of women than men in the age groups from 20 to 64 had been vaccinated. However, at age 80 or older, the

Data sources

The 2000/01 and 2003 estimates for influenza immunization are based on data from Statistics Canada's Canadian Community Health Survey (CCHS), a general health survey that covers the population aged 12 or older living in private households. It does not include residents of Indian reserves, Canadian Forces bases, and some remote areas.

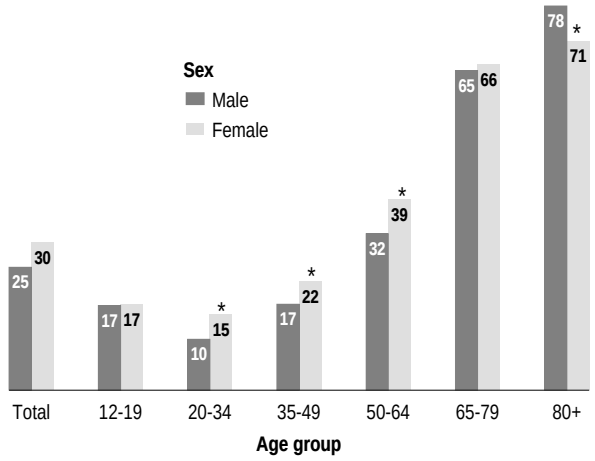
Data collection for cycle 1.1 (2000/01) began in September 2000 and continued over 14 months. The responding sample for cycle 1.1 was 131,535, yielding a response rate of 84.7%. This analysis uses data from the fourth quarter of cycle 1.1 (June to August 2001), in which all respondents were asked about influenza vaccination. The sample consisted of 35,084 respondents aged 12 or older (weighted to represent approximately 25.8 million individuals) who replied to questions about flu shots.

Cycle 2.1 of the CCHS was conducted from January through December 2003. The overall response rate was 80.6%; the total sample size was 131,244 respondents aged 12 or older (weighted to represent 26.6 million individuals) who replied to questions about flu shots. Detailed descriptions of the CCHS design, sample and interview procedures are available in a published report.[5]

The 1996/97 data on flu shots are from the biennial National Population Health Survey (NPHS). Like the CCHS, it covers household and institutional residents in all provinces and territories, except residents of Indian reserves, Canadian Forces bases, and some remote areas. The NPHS has cross-sectional and longitudinal components. This analysis uses cross-sectional data for 70,574 respondents aged 12 or older in 1996/97 (weighted to represent approximately 21.3 million individuals) who replied to questions about flu shots. More detailed descriptions of the NPHS design, sample and interview procedures can be found in published reports.[6,7]

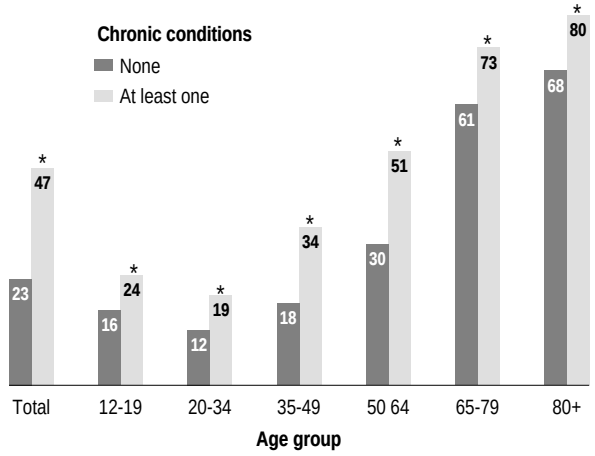
Cross-tabulations were used to estimate national and provincial/territorial percentages of people vaccinated for influenza in the previous year, by age, sex and chronic condition status. Standard errors and coefficients of variation were estimated with the bootstrap technique to account for survey design effects.[8,9] The significance level was set at $p < 0.05$.

Chart 2
Percentage vaccinated for influenza in past year, by age group and sex, household population aged 12 or older, Canada, 2003



Data source: 2003 Canadian Community Health Survey, cycle 2.1
** Significantly different from estimate for male ($p < 0.05$)*

Chart 3
Percentage vaccinated for influenza in past year, by age group and presence of chronic condition(s),† household population aged 12 or older, Canada, 2003



Data source: 2003 Canadian Community Health Survey, cycle 2.1
† Asthma, chronic bronchitis/emphysema, diabetes, heart disease, cancer, effects of stroke
** Significantly different from estimate for those without chronic conditions ($p < 0.05$)*

likelihood for men exceeded that for women: 78% versus 71%.

Added incentive?

In 2003, close to half (47%) of people with at least one selected chronic condition (asthma, chronic bronchitis/emphysema, diabetes, heart disease, cancer, effects of stroke) reported having had a flu shot, about double the figure for those without such conditions (23%). This difference prevailed in all age groups. For instance, 24% of teenagers with chronic conditions had been vaccinated, compared with 16% who did not have a chronic condition. Among seniors aged 80 or older, the comparable percentages were 80% and 68% (Chart 3).

While seniors with a chronic condition had the highest likelihood of vaccination, the only high-risk group with a significant increase between 2000/01 and 2003 was 20- to 64-year-olds with chronic conditions. In 2003, 38% of them reported having had a flu shot, up from 34% in 2000/01 (Chart 1).

By contrast, the percentages of teenagers and seniors, with and without chronic conditions, who had had a flu shot were stable between 2000/01 and 2003.

Provincial trends

Most provinces and territories have offered publicly funded influenza immunization to seniors and people with chronic conditions since at least the mid-1990s.[10,11] By 2003, only Prince Edward Island did not cover these groups, although the province provided free vaccinations to health care workers and residents of acute and long-term care facilities. Since 2000, Ontario has made flu shots available to all provincial residents at no charge. As well, Yukon provides coverage for residents aged 18 or older.

To some extent, provincial variations in the proportion of people receiving a flu shot in 2003 reflected public funding of immunization. At 35%, Ontario's proportion was significantly above the national figure (Table 1). However, the proportion

Table 1

Percentage vaccinated for influenza in past year, by age, presence of chronic condition(s)† and province/territory, household population aged 12 or older, Canada, 1996/97, 2000/01 and 2003

	Total population aged 12 or older			Age 12 or older with at least one chronic condition			Age 65 or older		
	1996/97	2000/01	2003	1996/97	2000/01	2003	1996/97	2000/01	2003
		%			%			%	
Canada (excluding territories)	**15**	**27‡**	**28§**	**31**	**45‡**	**47§**	**51**	**67‡**	**67**
Newfoundland	11*	11*	16§*	31	25*	34§*	47	49*	50*
Prince Edward Island	16	21‡*	23*	36	44	38*	56	65	63
Nova Scotia	19*	23‡*	31§*	43*	45	54§*	60*	71‡	74*
New Brunswick	15	19‡*	22§*	31	41‡	39*	48	62‡*	57*
Québec	8*	18‡*	20§*	17*	33‡*	41§*	34*	59‡*	59*
Ontario	18*	36‡*	35*	38*	56‡*	55*	60*	72‡*	74*
Manitoba	14	22‡*	20*	33	43‡	40*	52	62‡	60*
Saskatchewan	13	19‡*	24§*	27	38‡*	43*	53	63‡	63*
Alberta	15	23‡*	23*	33	37*	37*	59*	69‡	64§*
British Columbia	17*	26‡	27	35	46‡	49	52	68‡	69
Yukon	..	26	21*	..	39	30*	..	66	50*
Northwest Territories	..	25	24*	..	36E	41	..	56E	64
Nunavut	..	24	25	..	46	43E	..	53*	74§

Data sources: *1996/97 National Population Health Survey; 2000/01 Canadian Community Health Survey, cycle 1.1, fourth quarter; 2003 Canadian Community Health Survey, cycle 2.1*

† Asthma, chronic bronchitis/emphysema, diabetes, heart disease, cancer, effects of stroke

‡ Significantly different from estimate for 19956/97 ($p < 0.05$)

§ Significantly different from estimate for 2000/01 ($p < 0.05$)

** Significantly different from estimate for Canada (excludes territories for 1996/97) ($p < 0.05$)*

E Coefficient of variation 16.6% to 33.3% (interpret with caution)

.. Not available

in Nova Scotia was almost as high (31%) and had risen substantially since 2000/01 (from 23%). While percentages were below the national figure in most other provinces and territories, several had seen a significant rise since 2000/01: Newfoundland, Nova Scotia, New Brunswick, Québec and Saskatchewan.

In 2003, two-thirds of seniors reported having had a flu shot the previous year—almost unchanged from 2000/01, but up substantially from 51% in 1996/97. The highest percentages were in Ontario and Nova Scotia, where three-quarters of seniors had been vaccinated; at 50%, Newfoundland and Yukon had the lowest percentage. Proportions were also significantly below the Canadian average in New Brunswick, Québec, Manitoba, Saskatchewan, and Alberta. And in Alberta, the 2003 figure was 64%, a significant drop from 69% in 2000/01.

The proportion of people with chronic conditions who had had a flu shot was significantly above the national figure (47%) in Ontario (55%) and Nova Scotia (54%). Percentages were low in Newfoundland, Prince Edward Island, New Brunswick, Québec, Manitoba, Saskatchewan, Alberta and Yukon. Since 2000/01, immunization rates for this target group had increased significantly in Newfoundland, Nova Scotia and Québec.

Of course, seniors with chronic conditions are the group most vulnerable to the effects of influenza. And not surprisingly, this group was the most likely to be immunized. Overall, 75% reported that they had had a flu shot in the previous year (Table 2). The proportion ranged from 56% in Newfoundland to at least 80% in Ontario and Nova Scotia.

Table 2

Percentage vaccinated for influenza in past year, by age, presence of chronic condition(s) and province/territory, household population aged 12 or older, Canada, 2003

	Ages 12-19		Ages 20-64		Age 65+	
	Without chronic condition(s)	With chronic condition(s)	Without chronic condition(s)	With chronic condition(s)	Without chronic condition(s)	With chronic condition(s)
	%		%		%	
Canada	**16**	**24**	**19**	**38**	**62**	**75**
Newfoundland	7‡*E	12‡*E	8‡*	29‡*	45‡*	56‡*
Prince Edward Island	7‡*E	F	16‡	26‡*	58‡	70‡
Nova Scotia	14‡E	27E	20‡	46*	68*	82*
New Brunswick	11‡*E	30E	15‡*	28‡*	50‡*	66‡*
Québec	5‡*	12‡*E	12‡*	31‡*	53‡*	68‡*
Ontario	27*	34*	26*	46*	70*	80*
Manitoba	9‡*	10‡*E	10‡*	28‡*	53‡*	74‡
Saskatchewan	8‡*E	20‡E	14‡*	31‡*	59‡	70‡*
Alberta	14‡	19‡	17‡*	29‡*	61‡	70‡*
British Columbia	11*	18‡E	19‡	37‡	63‡	77‡
Yukon	F	F	19‡	30‡	48‡E	53‡E
Northwest Territories	28E	F	17‡	35‡	59	70
Nunavut	F	F	25*	36E	69E	F

Data source: 2003 Canadian Community Health Survey, cycle 2.1
† Asthma, chronic bronchitis/emphysema, diabetes, heart disease, cancer, effects of stroke
‡ Significantly different from estimate for Ontario ($p < 0.05$)
** Significantly different from estimate for Canada ($p < 0.05$)*
E Coefficient of variation 16.6% to 33.3% (interpret with caution)
F Coefficient of variation greater than 33.3% (suppressed because of extreme sampling variability)

Ontario and Nova Scotia

Although most provinces offer free influenza vaccination to high-risk groups, only in Nova Scotia did figures for those groups match Ontario, where coverage is universal (see "The effect of universal influenza immunization on vaccination rates in Ontario" in this issue). In 2003, 80% of Ontario seniors with chronic conditions and 82% in Nova Scotia reported that they had had a flu shot in the previous year (Table 2). The percentages were lower for seniors without chronic conditions, but not significantly different: 70% in Ontario and 68% in Nova Scotia.

In both provinces, 46% of 20- to 64-year-olds with chronic conditions had been vaccinated for influenza. However, among people in this age range who did not have a chronic condition, the percentage in Ontario (26%) was significantly above that in Nova Scotia (20%). As well, the proportion of 12- to 19-year-olds without a chronic condition who had a flu shot tended to be higher in Ontario.

Table 3

Reasons for not being vaccinated for influenza in past year, household population aged 65 or older, Canada excluding territories, 1996/97, 2000/01 and 2003

	1996/97	2000/01	2003
Seniors not vaccinated ('000)	1,567	1,146	1,150
Reason (%)			
Unnecessary	71	64*	66
Did not get around it	12	13	11†
Previous bad reaction	9	9	13†
Doctor said unnecessary	6	6	6
Fear	3	3E	6†
Not available	2E	F	1
Other	2E	7*	1†

Data sources: 1996/97 National Population Health Survey; 2000/01 Canadian Community Health Survey, cycle 1.1, fourth quarter; 2003 Canadian Community Health Survey, cycle 2.1
Note: Because more than one answer was accepted, totals add to more than 100%.
† Significantly different from estimate for 2000/01 (p < 0.05)
** Significantly different from estimate for 1996/97 (p < 0.05)*
E Coefficient of variation 16.6% to 33.3% (interpret with caution)

The questions

Respondents to the 1996/97 National Population Health Survey and the 2000/01 (cycle 1.1) and 2003 (cycle 2.1) Canadian Community Health Survey were asked: "Have you ever had a *flu shot*?" If they replied affirmatively, they were asked when they had had their last shot: less than one year ago; one year to less than two years; and two years or more. Respondents aged 65 or older who indicated that they had not been vaccinated in the past year were asked why not. Proxy responses were not accepted for these questions.

The presence of *chronic conditions* was determined by asking respondents if they had any "long-term conditions that had lasted or were expected to last six months or more and that had been diagnosed by a health professional." A list of conditions was read to respondents. Those who reported asthma, chronic bronchitis/emphysema, diabetes, heart disease, cancer, or effects of a stroke were considered to have a condition for which influenza vaccination was recommended.

Six *age groups* were considered: 12 to 19, 20 to 34, 35 to 49, 50 to 64, 65 to 79, and 80 or older.

Health care workers were defined based on the North American Industry Classification System (NAICS)'97-(C): Ambulatory Health Care Services (code 621), Hospitals (622), and Nursing and Residential Care Facilities (623).[12]

Not necessary

About a third of seniors reported in 2003 that they had not had a flu shot the previous year. Their most common reason for not being immunized was that they thought it was unnecessary (66%) (Table 3). Despite widespread publicity about the importance of annual vaccination, there was no significant increase over 2000/01.

Relatively few seniors cited "a previous bad reaction" (13%) or "did not get around to it" (11%) as their reason for not being vaccinated in 2003. About 6% reported "fear of immunization."

Fewer than half of health care workers

Since flu shots have been available, health care workers have been targeted for immunization. In 2003, 46% of people in health care industries (ambulatory health care services, hospitals, and

Table 4

Percentage of health care workers vaccinated for influenza in past year, by age, province/territory and sex, household population aged 20 or older, Canada, 2003

	Total	Men	Women
Health care workers ('000)	1,283	256	1,027
Vaccination rate (%)	**46**	**45**	**46**
Age group			
20-34	34*	33	42*
35-49	47	48	41
50-64	55*	56*	54*
65+	61*	57*E	72
Province/Territory			
Newfoundland	32*	53†E	24*E
Prince Edward Island	50	79E	46
Nova Scotia	54	54E	54
New Brunswick	35*	F	38
Québec	33*	35*	33*
Ontario	56	56*	56*
Manitoba	31*	23*E	33*
Saskatchewan	40	25†*E	44
Alberta	41	43E	41
British Columbia	50	54	49
Yukon	F	F	F
Northwest Territories	40E	53E	35E
Nunavut	45E	F	44E

Data source: 2003 Canadian Community Health Survey, cycle 2.1
† Significantly different from estimate for women (p < 0.05)
** Significantly different from estimate for Canada (excluding territories) (p < 0.05)*
E Coefficient of variation 16.6% to 33.3% (interpret with caution)
F Coefficient of variation greater than 33.3% (suppressed because of extreme sampling variability)

nursing and residential care facilities) reported having had a flu shot in the past year (Table 4). Among the provinces, the proportions of health care workers who had been vaccinated ranged from a high of 56% in Ontario to a low of 31% in Manitoba. Newfoundland, New Brunswick and Québec also had percentages below the national figure.

Limitations

The data in this analysis pertain to the household population; excluding residents of long-term health care facilities may bias the results, especially for seniors. And even for the household population, those who participated in the surveys may have been healthier and more likely than non-respondents to engage in health-promoting behaviour such as getting flu shots.

The data were self-reported; no independent source was available to verify if respondents who said that they had received a flu shot had actually done so. Nor is it known if people who reported having received a professional diagnosis of a chronic condition actually did have the condition.

The *Canadian Immunization Guide* recommends annual vaccination for people with medical conditions that place them at high risk of flu-related complications.[3] These conditions are: chronic cardiac and pulmonary disorders (including bronchopulmonary dysphasia, cystic fibrosis and asthma), diabetes mellitus, cancer, immunodeficiency, immunosuppression, renal disease, anemia and hemoglobinopathy. Because the National Population Health Survey (NPHS) and the Canadian Community Health Survey (CCHS) did not collect information on all of these conditions, the group identified in this article as having a chronic condition that heightened their susceptibility to influenza complications is a subset of the actual target population.

The 2003 Canadian Community Health Survey (CCHS) data on flu shots pertain to all survey respondents (131,244), whereas the 2000/01 data apply to only the fourth quarter of data collection (35,084), and the 1996/97 National Population Health Sruvey (NPHS) data, to 66,435 respondents. As well, the fourth quarter of the 2000/01 CCHS was conducted during the summer, which may have yielded responses different from those that would have been obtained in the winter.

In the 1996/97 NPHS, residents of Yukon and the Northwest Territories were not asked about influenza immunization.

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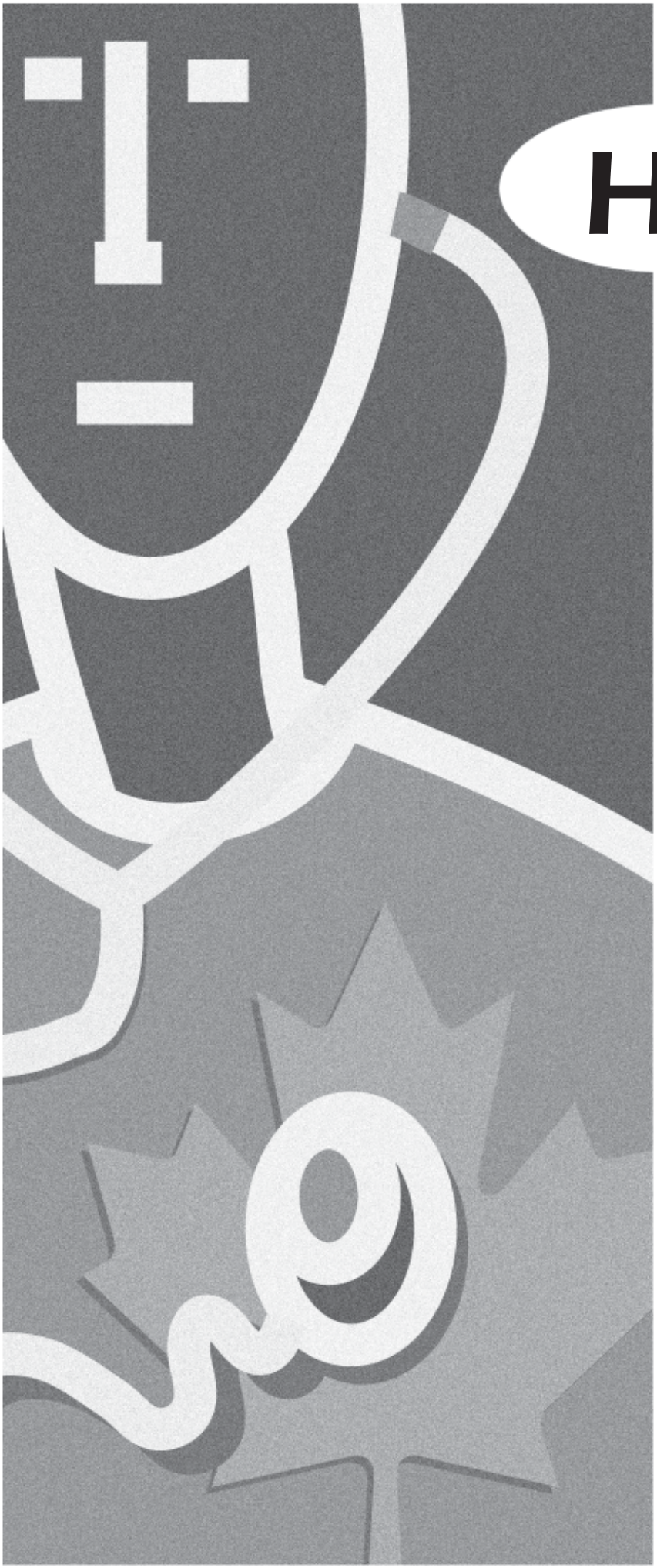

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