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Life and Breath:

Respiratory Disease in Canada

Canada

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– Public Health Agency of Canada

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Executive Summary

Over 3 million Canadians cope with one of five serious respiratory diseases – asthma, chronic obstructive pulmonary disease (COPD), lung cancer, tuberculosis (TB), and cystic fibrosis. These and other respiratory diseases such as influenza, pneumonia, bronchiolitis, respiratory distress syndrome and sleep apnea affect individuals of all ages, cultures and backgrounds – from children to parents to grandparents.

Life and Breath, the 2007 Respiratory Disease in Canada report utilizes the most recent available data for the surveillance of chronic respiratory diseases in Canada, and illustrates the need for action to help Canadians breathe easier.

Key Points

1. Canada is facing a wave of chronic respiratory diseases. Since many of these diseases can be tied to an aging population, the number of people with respiratory diseases can be expected to increase. The corresponding increase in demand for services will pose a significant challenge for the health care system.

2. Respiratory diseases exert a significant economic impact on the Canadian health care system. Presently, almost 6.5% of total health care costs were related to respiratory diseases (not including lung cancer). This accounts for nearly $5.70 billion in direct (visible) costs of health care, such as for hospitalization, physician visits, research and drugs, as well as an additional $6.72 billion for less visible (indirect) expenses associated with disability and mortality.

3. The quality of indoor and outdoor air contributes significantly to the exacerbation of symptoms of respiratory diseases. While air quality issues are dependent on geography, and solutions may vary according to locale, action to address air quality issues would make a key contribution to lowering the rising rate of respiratory disease in Canada.

4. The increase in smoking among women in the past 50 years has resulted in an increased prevalence of diseases such as lung cancer and COPD among women.

5. Tobacco remains the most important preventable risk factor for chronic respiratory diseases. One in five Canadians currently smoke cigarettes. In the short term, smoking cessation among adults would have the greatest impact on reducing respiratory diseases, such as lung cancer and COPD.

6. While COPD was once more common in men than women, it is now being reported more in women than in men under age 75. The projected increase in the number of individuals with COPD will have major implications for families and for the delivery of comprehensive hospital and community services.

7. Lung cancer has become a major health issue for women. Both the incidence and mortality rates among older women are increasing, in contrast to the decreases seen among older men.

8. Asthma rates continue to climb. The prevalence of self-reported asthma is higher among women than men and is increasing for both sexes. The data on activity restriction, emergency room visits and hospitalization suggest that many individuals with asthma require help in keeping their disease under control.

9. While Canada's overall tuberculosis (TB) rate is considered low, the rate of TB remains high in Canadian-born Aboriginal peoples and in persons that were born in countries with a high incidence of TB. Challenges to global TB control include the ongoing TB-HIV co-epidemic and the spread of drug-resistant TB strains.

10. Overall, influenza/pneumonia remains a major contributor to deaths and hospitalization among the elderly. It is the leading cause of death from infectious disease in Canada.

11. While cystic fibrosis was once almost exclusively a child's disease, most individuals with this disease are now living into their twenties and thirties. This changing face of cystic fibrosis has major implications for the health care system and the community at large.

12. The decrease in mortality rates for Respiratory Distress Syndrome (RDS) among infants attests to the success of treatment in the modern neonatal intensive care unit. Further improvements in neonatal health will require the prevention of preterm birth, the underlying cause of RDS.

13. The true burden of sleep disordered breathing in Canada is not known, but it is thought to be very common. Sleep disordered breathing is associated with reduced quality of life, decreased cardiovascular health and increased health care utilization, transportation accidents and mortality. Since obesity is a major risk factor for sleep apnea, efforts to promote healthy weights will have the greatest impact on the prevention of this disease..

14. There has been a steady increase in the number of lung transplants performed in Canada, but the number of patients on waiting lists for lung transplantation continues to rise.

Life and Breath demonstrates that Respiratory Disease has a major impact on the lives of millions of Canadians. Please share this report with others so that information about these people, their diseases, and the associated risk factors can help those who make decisions about policies, program and services. Ongoing work on new data sources will continue to provide vital information now and as we face the challenges ahead.

A Final Word

There is no life without breath.

List of Figures and Tables

Chapter 1

Introduction

Introduction

Breathing is one of the most vital functions of the human body. Yet most of us spend very little time thinking about this involuntary action that occurs about 12 times every minute, 24 hours a day, 7 days a week. For Canadians with respiratory disease, breathing is not something to be taken for granted!

Respiratory Disease in Canada highlights the most common respiratory diseases that affect Canadians–asthma, chronic obstructive pulmonary disease (COPD), lung cancer, tuberculosis, cystic fibrosis, respiratory distress syndrome (RDS) and sleep apnea. It also details the most important risk factors–smoking and air quality–and describes the use of lung transplantation in Canada. Respiratory diseases affect all ages–children, teens, adults and seniors. Most of these diseases are chronic in nature and all have a major impact not only on the individual with the disease, but on the family, the community, and the health care system. Several sources contributed data to this report. A brief description of each is provided at the end of this report.

Incidence and Prevalence

Table 1–1 reveals that five serious respiratory diseases affect over three million Canadians. In reality, however, because data are unavailable for other conditions such as influenza, pneumonia, bronchiolitis and RDS, the total number affected by respiratory disease is much higher.

Risk Factors

The two most important preventable risk factors for respiratory disease are tobacco smoke (through personal smoking and exposure to second-hand smoke) and air quality (indoor and outdoor). The slightly less than 5 million individuals who smoke cigarettes increase their risk of developing lung cancer, COPD and asthma[7]. Exposure to second-hand smoke (SHS) affects all Canadians, causing irritation in the eyes, nose and throat, and resulting in lung cancer in adult non-smokers and sudden infant death syndrome (SIDS) in newborns. For individuals with asthma and COPD, exposure to SHS can make symptoms worse. Maternal smoking during pregnancy contributes to preterm birth, the major factor associated with the development of RDS in infants. All Canadians are affected by the quality of the air that they breathe, but the effects are more severe for those who live with a respiratory disease.

Table 1-1 Number of Canadians affected by respiratory diseases

Disease	Estimated Number of Canadians
Asthma - self reported physician diagnosed (prevalence ages 12+ 2005[1], ages 4-11 2000[2])	2,744,000
COPD - self reported physician diagnosed (prevalence ages 35+ 2005)[3]	754,700
Lung cancer (new cases – 2003)[4]	20,560
Tuberculosis (new or reactivated cases - 2005)[5]	1,616
Cystic fibrosis (prevalence from registry- 2002)[6]	3,453

Table 1-2 Economic burden of respiratory disease in Canada, 2000 (in million $)

Disease Category Disease Sub-category	Direct Costs	Indirect Costs
Respiratory diseases	**$3,018.4**	**$2,615.5**
COPD	$696.2*	$1,023.8
Asthma	$705.4*	$840.1
Respiratory infections	**$2,444.8**	**$552.3****
Influenza and Pneumonia	$1,008.6*	$423.8***
Tuberculosis	$28.4*	$101.1**
Malignant neoplasms	**$2,459.5**	**$14,820.2**
Lung cancer	$242.2*	$3,550.0***

Note: Direct costs include hospital, physician, drugs and research. * Research costs are not available at the sub-category level. Indirect costs include mortality and long-term disability where available (** indicates high sampling variability in calculation of costs of long-term disability, *** indicates long-term disability results are not included due to very high sampling variability).

Source: Economic Burden of Illness in Canada, 2000 (preliminary estimates)

Hospitalizations

Individuals with chronic respiratory disease may need to be hospitalized, either for treatment of an acute exacerbation or in the final stage of their disease. In 2004, respiratory diseases, including lung cancer, represented the third most common main diagnosis contributing to the hospitalization of both men and women (Figures 1–1 & 1–2). They were the primary diagnosis for 11.9% of all hospitalizations for men and (excepting pregnancy-related admissions) 10.5% of those for women.

The most common respiratory diseases contributing to hospitalization in 2004 were influenza/pneumonia and COPD. The need for hospitalization for influenza/pneumonia increases when combined with other underlying chronic respiratory conditions, such as asthma, COPD, cystic fibrosis, and lung cancer.

In 2004, asthma, pneumonia and bronchiolitis were frequently listed as one of the first five of a possible 16 diagnoses on the hospitalization record for children under the age of 5 years who were hospitalized (Figure 1–3). Asthma was a contributing factor in approximately 10% of the admissions for children under the age of 5 and 8% for those aged 5 to 14 years.

Asthma and pneumonia made a significant contribution to hospitalizations in those aged 15 to 44 years in 2004 (Figure 1–4). Pneumonia was a common cause of hospitalization among the elderly (Figure 1–5), as was COPD.

Deaths

Respiratory diseases, including lung cancer, are a major cause of death in Canada (37,260 deaths in 2004) (Figures 1–6 and 1–7). The three most common respiratory diseases–lung cancer (17,653 deaths), COPD (9,607), influenza and pneumonia (5,729)–were responsible for the deaths of 32,989 people (17,845 men and 15,144 women) in 2004. Together they contributed to 15.6% of the deaths among men and 13.5% of the deaths among women. Other major respiratory diseases also contribute to mortality in Canada, but in much smaller numbers, either because the case fatality rate is low (such as asthma, with 268 deaths) or because the disease is uncommon (such as cystic fibrosis, with 52 deaths).

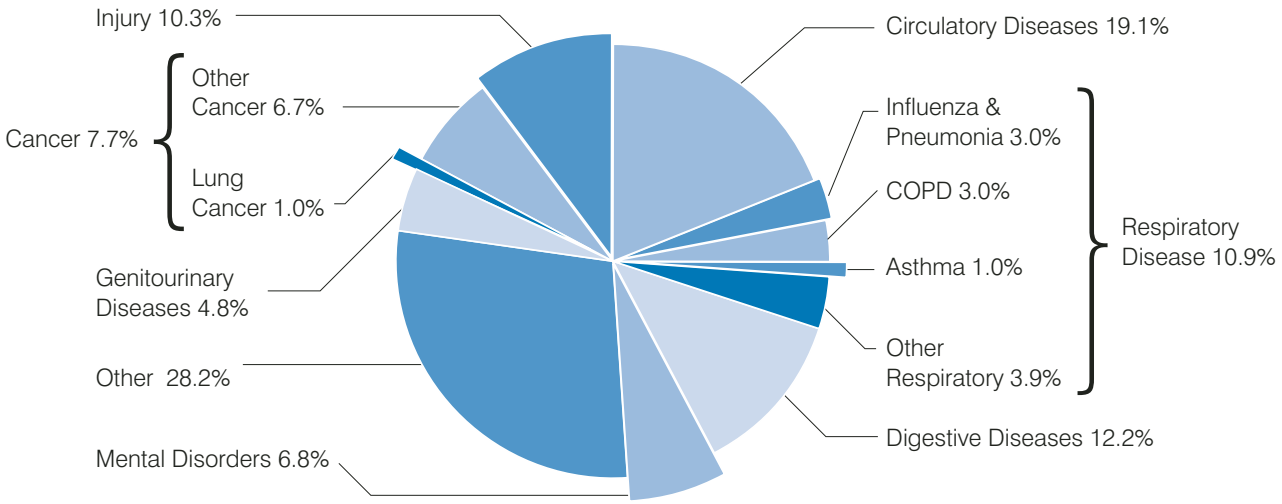
Lung cancer is a major cause of death in the age group 45–64 years (13.1%) (Figure 1–8). COPD and lung cancer also play a significant role in deaths for ages 65 years and over. In the oldest age group, influenza and pneumonia also contribute to a high proportion of deaths.

Health Care Costs

Direct Costs

Direct costs are defined as the value of goods and services for which payment was made and resources used in treatment, care, and rehabilitation related to illness or injury.[8] In 2000, respiratory diseases accounted for over $5.70 billion in direct health care costs, including drugs,

Figure 1-1 Proportion of all hospitalizations* due to specific health problems among men, Canada, 2004/05.



* Hospitalizations for all causes excluding reproductive causes
Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using Hospital Morbidity File (acute and chronic), Canadian Institute for Health Information.

physician care, hospital care and research in Canada. Even without research costs for COPD and asthma, approximately one-quarter of the direct costs for respiratory disease ($1.40 billion) was spent on COPD and asthma.

Among major health problems, respiratory diseases (excluding lung cancer) ranked fourth (10.3%) in the total proportion of direct health care costs. Only neuropsychiatric diseases (17.1%), injuries (15.1%) and cardiovascular diseases (13.6%) ranked higher (Figure 1–9).

Indirect Costs

Indirect costs are defined as the value of economic output lost because of illness, injury-related work disability, or premature death.[9] Indirect costs for respiratory diseases, including mortality and long-term disability (not available for all respiratory diseases; see table 1–2) as measured by loss of productivity, were $6.72 billion in 2000.

Among major health problems in Canada in 2000, respiratory diseases (excluding lung cancer) accounted for 4.0% of indirect health costs. They ranked sixth among health care problems, after musculoskeletal conditions (20.2%), cancer (18.8%), cardiovascular diseases (17.1%), injuries (13.0%) and neuropsychiatric diseases (10.5%) (Figure 1–10).

Total Costs

In total health care costs, including both direct and indirect costs, the proportion spent on respiratory diseases (excluding lung cancer) was 6.4% in 2000 ($8.63 billion). Only five health problems–cardiovascular, musculoskeletal, injuries, cancer and neuropsychiatric diseases–ranked higher (Figure 1–11).

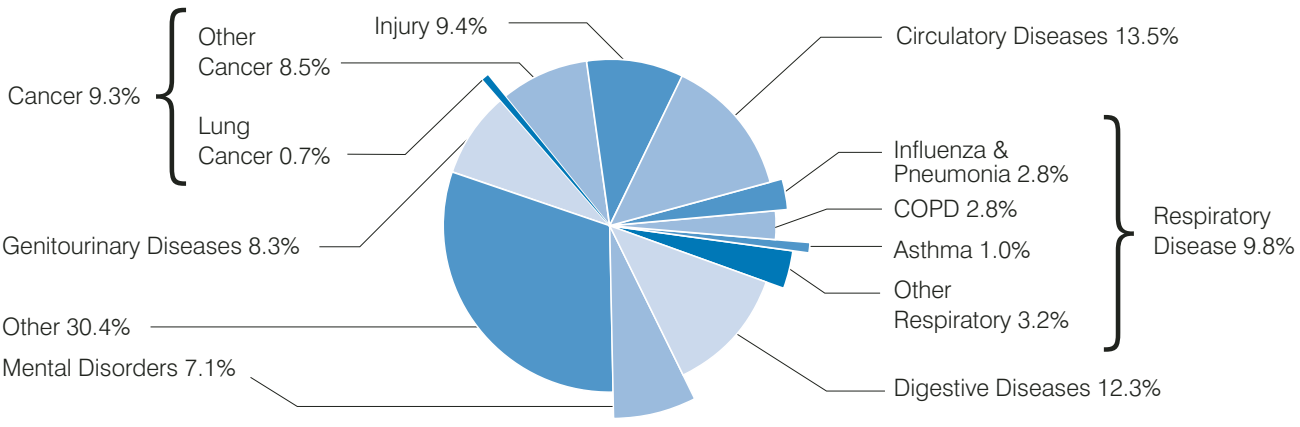
Summary

Almost 3.5 million Canadians must cope with potentially serious respiratory diseases. Only cardiovascular disease and cancer are responsible for more hospitalization and death than respiratory diseases.

Together, these diseases exert a great economic impact on the Canadian health care system, accounting for over $12.42 billion of expenditures in the year 2000. These costs include the direct or visible costs of the health care system. They also include the less visible or indirect expenses of disability (where available) and mortality, which may be even more significant.

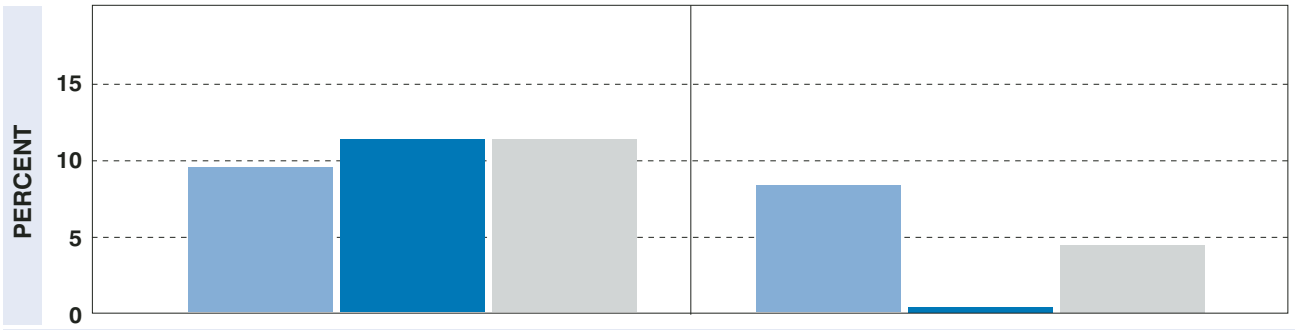
Respiratory Disease in Canada highlights respiratory conditions in Canada. Chapters 2 and 3 review two of the most important risk factors influencing lung health–tobacco smoke and air quality. The seven chapters that follow focus on specific respiratory diseases affecting a significant proportion of the population, and a final chapter presents information on lung transplantation in Canada.

Figure 1-2 Proportion of all hospitalizations* due to specific health problems among women, Canada, 2004/05.



* Hospitalizations for all causes excluding complications of pregnancy and reproductive causes
Source: Centre for Chronic Disease Prevention and Control, PHAC, using Hospital Morbidity File (acute and chronic), Canadian Institute for Health Information.

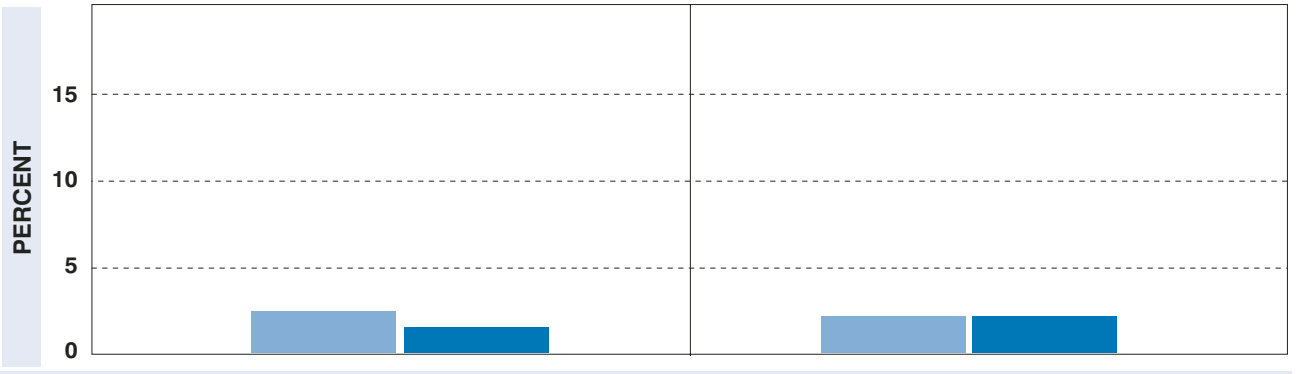
Figure 1-3 Proportion of all hospitalizations due to select respiratory diseases (listed among first five diagnoses), children aged 0 to 14 years by age group, Canada, 2004/05.



		0-4 years	5-14 years
	Asthma	9.9	7.9
	Bronchiolitis	10.9	0.1
	Pneumonia	10.9	4.5

Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Hospital Morbidity File (acute and chronic care), Canadian Institute for Health Information.

Figure 1-4 Proportion of all hospitalizations due to select respiratory diseases (listed among first five diagnoses), adults aged 15 to 44 years by age group, Canada, 2004/05.

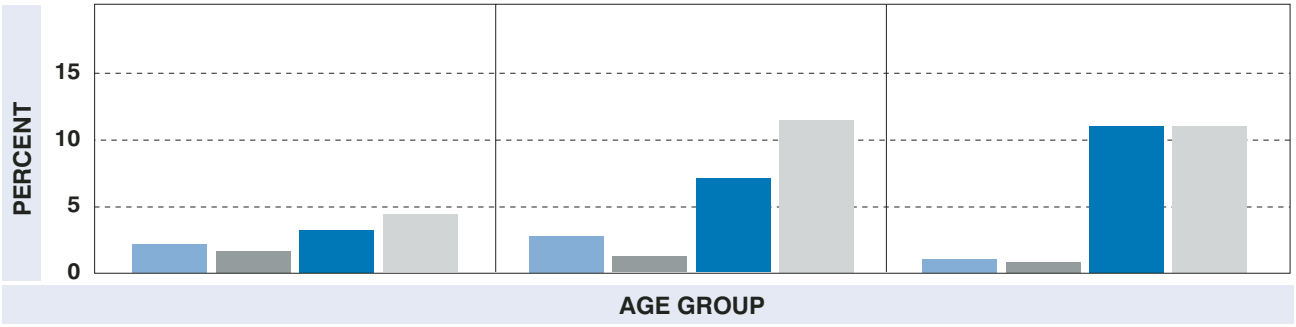


		15-24 years	25-44 years
	Asthma	2.3	2.2
	Pneumonia	1.5	2.2

Note: Pregnancy-related admissions are excluded

Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Hospital Morbidity File (acute and chronic care), Canadian Institute for Health Information.

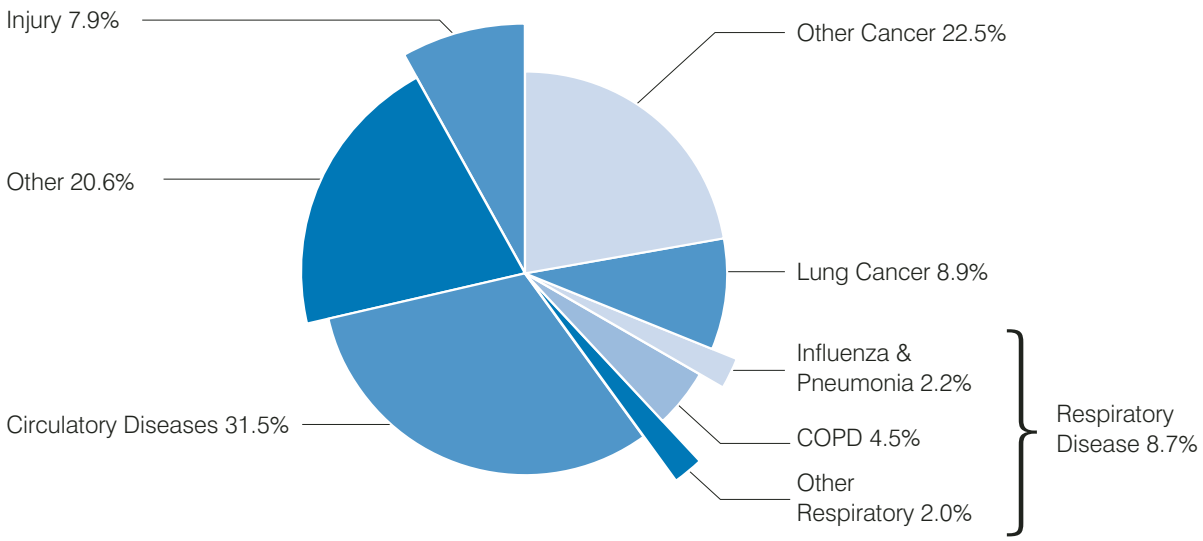
Figure 1-5 Proportion of all hospitalizations due to select respiratory diseases (listed among first five diagnoses), adults aged 45+ years, by age group, Canada, 2004/05.



	45-64 years	65-84 years	85+ years
Lung Cancer	2.1	2.9	1.0
Asthma	1.7	1.2	0.9
Pneumonia	3.2	6.4	10.8
COPD	4.4	11.3	10.8

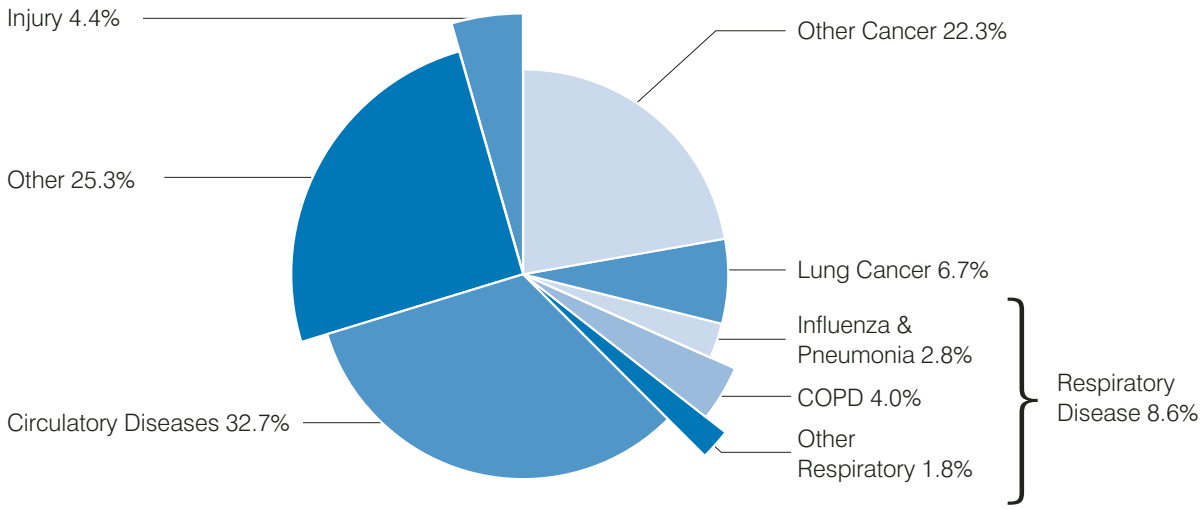
Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Hospital Morbidity File (acute and chronic care), Canadian Institute for Health Information.

Figure 1-6 Proportion of all deaths due to specific health problems among men, Canada, 2004.



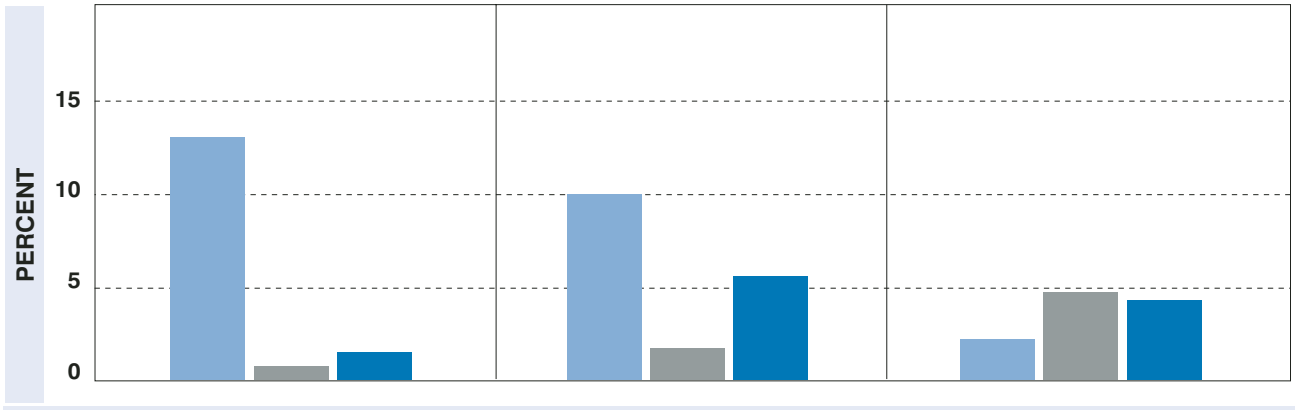
Source: Centre for Chronic Disease Prevention and Control, PHAC, using Hospital Morbidity File (acute and chronic), Canadian Institute for Health Information.

Figure 1-7 Proportion of all deaths due to specific health problems among women, Canada, 2004.



Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using annual mortality data, Statistics Canada.

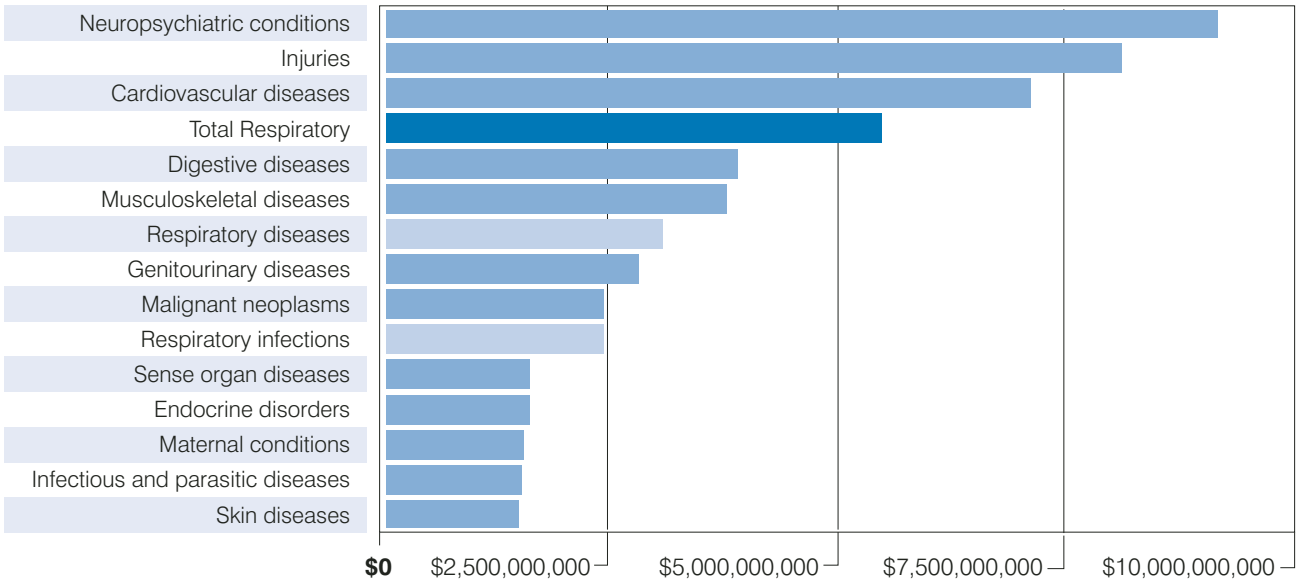
Figure 1-8 Proportion of all deaths due to select respiratory diseases, adults aged 45 + years, by age group, Canada, 2004.



AGE GROUP	45-64 years	65-84 years	85+ years
Lung Cancer	13.1	10.0	2.2
Influenza/Pneumonia	0.9	1.9	4.9
COPD	1.8	5.4	4.5

Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using annual mortality data, Statistics Canada.

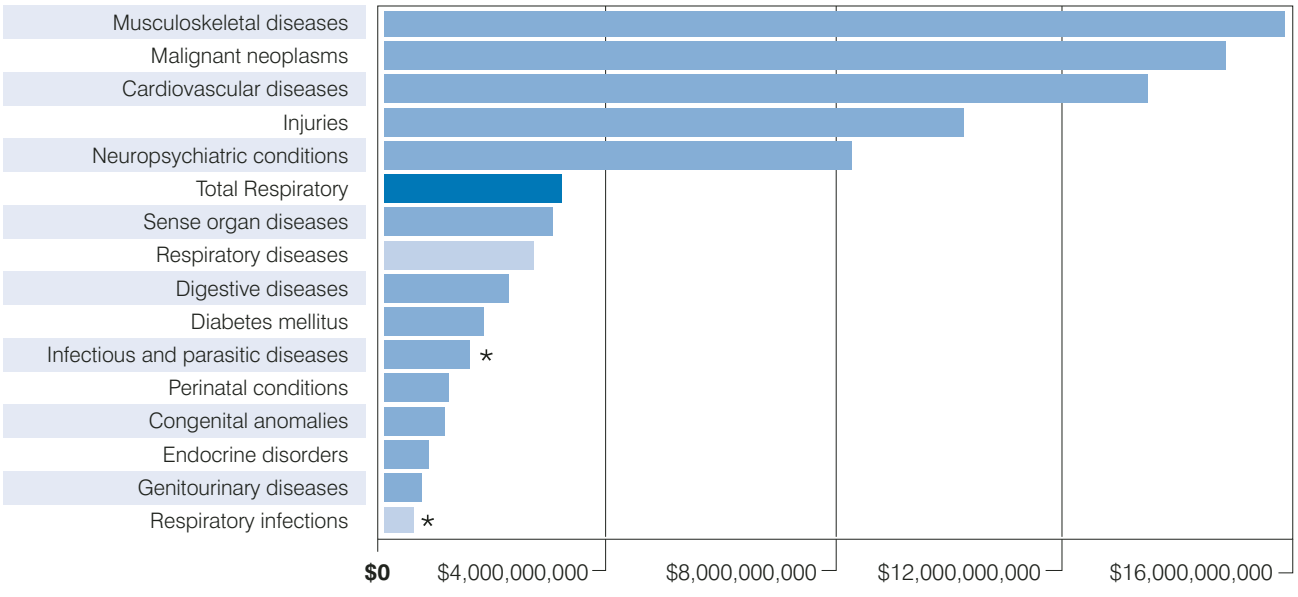
Figure 1-9 Direct health care costs of disease by diagnostic category, Canada, 2000.



Note: Direct costs include hospital, physician, drugs and research. Respiratory infections include lower and upper respiratory infections, otitis media and tuberculosis, Respiratory disease includes asthma, COPD and other diseases of the respiratory system (excluding lower and upper respiratory infections, lung cancer and tuberculosis), Total Respiratory is a sum of Respiratory infections and Respiratory disease (excludes lung cancer).

Source: Economic Burden of Illness in Canada, 2000 (preliminary estimates)

Figure 1-10 Indirect health care costs of disease by diagnostic category, Canada, 2000.

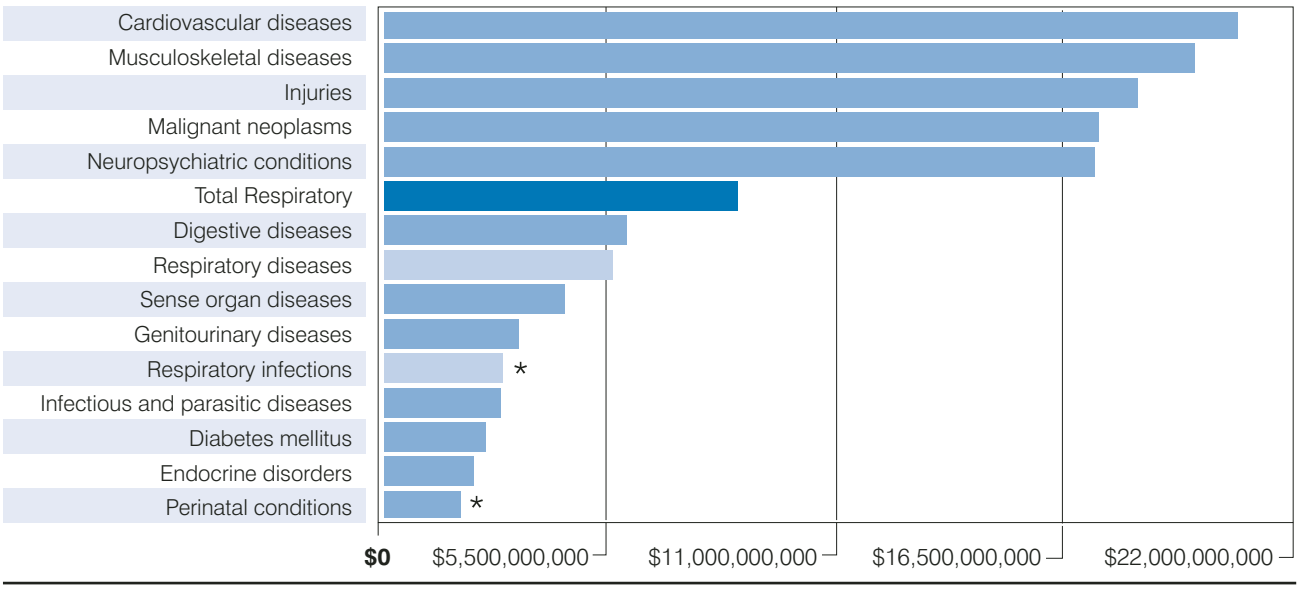


* Long term disability cost estimate component has high level of variability

Note: IIndirect costs include mortality and long term disability. Respiratory infections include lower and upper respiratory infections, otitis media and tuberculosis, Respiratory disease includes asthma, COPD and other diseases of the respiratory system (excluding lower and upper respiratory infections, lung cancer and tuberculosis), Total Respiratory is a sum of Respiratory infections and Respiratory disease (excludes lung cancer).

Source: Economic Burden of Illness in Canada, 2000 (preliminary estimates)

Figure 1-11 Total health care costs of disease by diagnostic category, Canada, 2000.



* Long term disability cost estimate component has high level of variability

Note: Respiratory infections include lower and upper respiratory infections, otitis media and tuberculosis, Respiratory disease includes asthma, COPD and other diseases of the respiratory system (excluding lower and upper respiratory infections, lung cancer and tuberculosis), Total Respiratory is a sum of Respiratory infections and Respiratory disease (excludes lung cancer).

Source: Economic Burden of Illness in Canada, 2000 (preliminary estimates)

1 Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Canadian Community Health Survey 2005, Statistics Canada.

2 Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from National Longitudinal Survey of Children and Youth (Cross-sectional component), Statistics Canada.

3 Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Canadian Community Health Survey 2005, Statistics Canada.

4 Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from the Canadian Cancer Registry, Statistics Canada

5 Canadian Tuberculosis Reporting System. Tuberculosis Prevention and Control, Centre for Infectious Disease Prevention and Control, Public Health Agency of Canada.

6 Canadian Cystic Fibrosis Foundation. Report of the Canadian Patient Data Registry Report 2002. Toronto: The Foundation. Available from: *http://www.ccff.ca/pdf/Lay%20CPDR%20ReportE.pdf*

7 Piipari R, Jaakkola JJK, Jaakkola N, Jaakkola MS. Smoking and asthma in adults. Eur Respir J 2004; 24: 734-739.

8 Public Health Agency of Canada. Economic Burden of Illness in Canada, 2000.

9 Public Health Agency of Canada. Economic Burden of Illness in Canada, 2000.

Chapter 2

Tobacco Use

Tobacco Use

Introduction

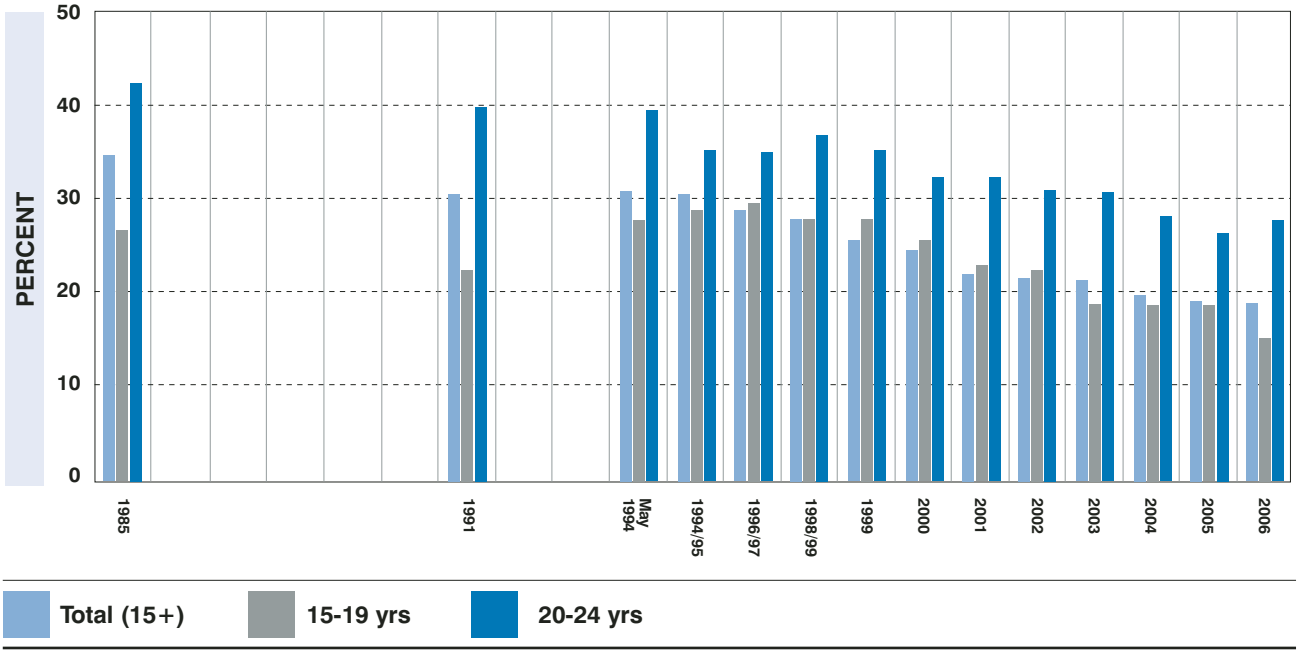
Tobacco use is the most important preventable risk factor for diseases of the lung. More than 13,400 adult deaths from lung cancer and 8,200 adult deaths from respiratory diseases are estimated to have resulted from smoking in 2002. An additional 33 deaths from sudden infant death syndrome (SIDS) arising during the perinatal period were also attributed to tobacco smoke. With its impact on lung disease, tobacco use continues to represent a considerable public health burden. Smoking-attributed mortality for chronic obstructive pulmonary disease (COPD) increased faster than for any other disease between 1989 and 2002, but lung cancer remains the leading cause of death due to smoking.[1, 2]

Exposure to tobacco smoke can be direct, by active smoking, or indirect, by exposure to second-hand smoke (SHS) or maternal smoking during pregnancy. In terms of lung disease, active smoking is causally linked to lung cancer, poor asthma control, acute respiratory illness, chronic obstructive pulmonary disease (COPD) and all major respiratory symptoms (coughing, phlegm, wheezing and dyspnea) among adults. In children and adolescents, active smoking is associated with respiratory symptoms (coughing, phlegm, wheezing and dyspnea) and asthma-related symptoms (e.g., wheezing).[3] Passive smoking is associated with a number of acute respiratory effects affecting both the upper and lower respiratory tract. For instance, studies on adults exposed to SHS have demonstrated a causal association between SHS and eye and nasal irritations, whereas exposure in children is associated with acute lower respiratory tract infections (bronchitis or pneumonia), induction and exacerbation of asthma, chronic respiratory symptoms and middle ear infections. Exposure in utero is associated with reduced lung function in infants and SIDS.[4]

Smokers who quit smoking reduce their tobacco-related morbidity and mortality associated with lung disease. The improvements in health are dramatic and immediate. Oxygen levels in the blood increase to normal within hours as carbon monoxide levels drop. Lung capacity increases within days, and circulation improves within weeks. Risk of stroke and other circulatory diseases diminishes, and the chance of smoking-related heart attack is cut in half within a year. Within a few years, the chance that an ex-smoker will get cancer is reduced by half compared to those who continue to smoke, and within 15 years the risk of a fatal heart attack is almost the same as for a person who has never smoked.[5]

These facts make tobacco reduction strategies the cornerstone of any effort directed at preventing respiratory disease

Figure 2-1 Long term trends in the prevalence of current smokers, 15+ years, 1985-2006, Canada



Sources: 1985/91 General Social Surveys; 1994 Survey on Smoking in Canada, Cycle 1; 1996-97 and 1998-99 National Population Health Surveys; 1999-2006 Canadian Tobacco Use Monitoring Surveys

Prevalence

Smoking among Adults

According to the 2006 Canadian Tobacco Use Monitoring Survey (CTUMS),6 slightly fewer than 5 million people, representing 19% of the population aged 15 years and older, were current daily or non-daily smokers. This represents a decline in smoking prevalence from 35% in 1985 (Figure 2–1), and includes 4% of the Canadian population who reported smoking occasionally or on a non-daily basis. Among the Canadian population, slightly more males (20%) aged 15 years and older were current smokers in 2006 than females (17%).

The rate for First Nations adults on reserve (58.8%) is about triple the rate for Canadians in general.[7] Forty-six percent report smoking daily and almost 13% smoking occasionally. The rate for non-reserve Aboriginal peoples is more than double the Canadian rate (36% report smoking daily and 8% smoke occasionally).[8] Methods and response rates vary between the Canadian surveys of Aboriginal populations. Consequently, results may not be directly comparable to other Canadian surveys (non-Aboriginal and Aboriginal) and may not be generalizable to the Aboriginal people across Canada.

The 14% of Canadians who smoke daily (Figure 2–2) reported smoking on average 15.5 cigarettes per day, slightly less than the 15.7 cigarettes per day reported in 2005 (Figure 2–3). Men continued to smoke more cigarettes than women–16.9 cigarettes per day, compared with 13.8 for females.

Current smokers among First Nations adults on reserve report smoking fewer cigarettes per day (10.5) than other Canadians.[9]

Smoking among Youth

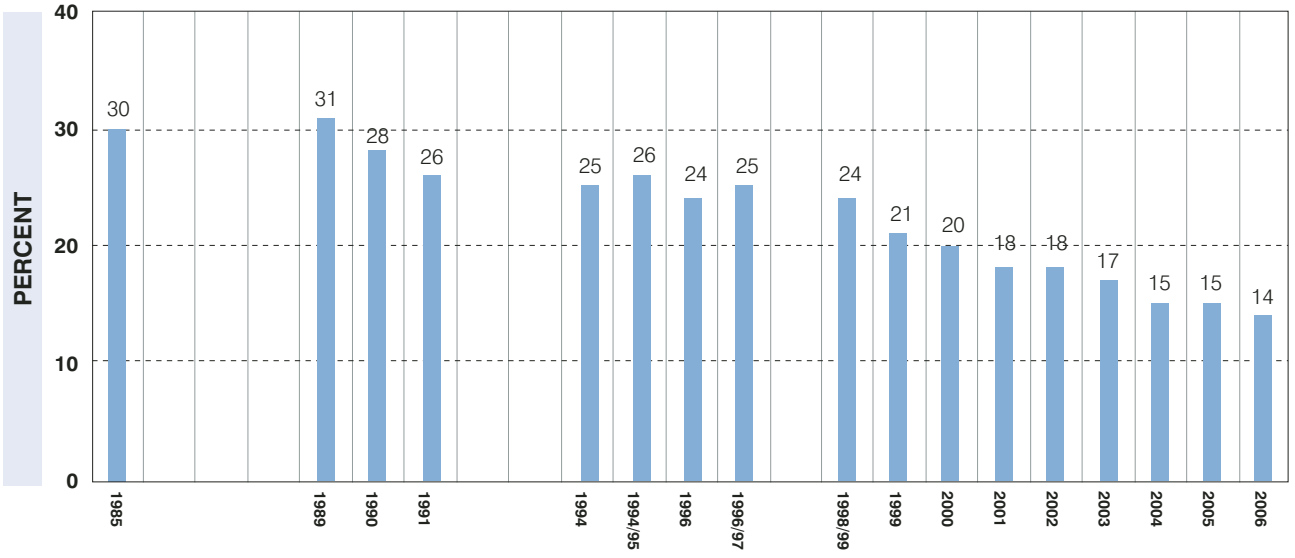
The rate of smoking among youth aged 15–19 years of age was 15% (about 320,000 youths) in 2006 (Figure 2–1), with daily smokers reportedly consuming an average of 12.3 cigarettes per day. Nine percent of youths reported smoking daily (Figure 2–4), and 6% reported smoking occasionally. There was no statistically significant difference in the prevalence of smoking among teen girls (14%) and teen boys (16%). This was the lowest annual smoking rate for teen boys and girls since monitoring of smoking began in 1965.

Smoking among Young Adults

The prevalence of smoking among young adults 20–24 years of age was 27% (about 612,000 young adults) in 2006 (Figure 2–1). Within this age group, a greater proportion (30%) of males smoked than females (24%) (Figure 2–5); among daily smokers, males smoked an average of 3.1 more cigarettes daily (14.2) than their female counterparts (11.1). Young adults still display the highest smoking rates of any age group.

About 70% of First Nations young adults on reserve between 18 and 29 years of age are current smokers.[10] Young adult men smoke more cigarettes daily (10.2) than women of the same age (7.7).

Figure 2-2 Trend in the prevalence of daily smokers, 15+ years, Canada, 1985-2006.



Sources: Gilmore, J. Report on Smoking Prevalence in Canada, 1985 to 1999. (Statistics Canada, Catalogue 82F0077XIE), 2000.
Canadian Tobacco Use Monitoring Survey, 1999 - 2006.

Exposure to Second-hand Smoke (SHS)

In 2006, 15% of Canadian households reported at least one person who smoked inside the home every day or almost every day. Of those households without someone regularly smoking inside the home, 86% did not allow smoking inside their home. Nine percent of children 0–11 years of age (about 355,000 children) were regularly exposed to second-hand smoke at home, a reduction from 26% (1.1 million children) in 1999.

Ninety-four percent of those who worked in the last 12 months reported some kind of smoking restriction in the workplace. Of this total, 44% reported that their workplace was completely smoke-free (compared to 40% of workers in 1994), while only 6% reported no restriction at all. A higher percentage of women than men reported that smoking was restricted in their workplace. Smoking was completely restricted in the workplace for 49% of women, compared to only 40% of men. Approximately 8% of men reported no restrictions in their workplace, compared to only 2% of women (Figure 2–6).

Prevalence of Maternal Smoking in Pregnancy

In 2006, 10% of women between the ages of 20 and 44 who had been pregnant in the previous five years reported smoking during their most recent pregnancy. Seven percent of women reporting a pregnancy in the last five years stated that their spouse smoked regularly. Lower education was associated with higher prevalence of smoking during pregnancy (Figure 2–7).

Health Care Services/Hospitalizations

More than 2.2 million acute care hospital days were attributed to tobacco in 2002, accounting for slightly more than 10% of the total.[11] This estimate includes 46,700 days attributed to exposure to passive smoking. Men used 61% of these days (1,359,159 days, compared to 850,996 for women). The use of acute care hospital days rose with age: over two-thirds of the days (1,510,932) were used by Canadians 60 years and older.

Health Outcomes

In 2002, tobacco smoking was responsible for 750 deaths from pneumonia/influenza and 7,533 deaths from COPD.[12] Slightly more men than women died of smoking-related respiratory illnesses (55% of pneumonia/influenza deaths and 58% of COPD deaths were attributable to smoking). Almost 70% of tobacco-attributable deaths from pneumonia/influenza occurred in Canadians 80 years of age or older.

The estimated 37,209 tobacco-attributable deaths in Canada in 2002 accounted for 16.6% of all Canadian deaths.[13] Cigarette smoking continues to be the primary risk factor for three of the most common causes of death in Canada (lung cancer, ischemic heart disease and respiratory diseases). These three causes accounted for more than two-thirds of all smoking related deaths. Active tobacco smoking resulted in the deaths of 23,259 men; of these, 9,028 were due to lung cancer and 4,788 to respiratory diseases. There were 13,119 smoking-related deaths among women, with 4,373 deaths from lung cancer and 3,494 from respiratory diseases. Tobacco smoking also accounted for 92 infant deaths from conditions (low birth weight, short gestation and sudden infant death syndrome) arising during the perinatal period.

It is estimated that passive smoking resulted in 252 lung cancer deaths in non-smokers aged 15 years and older (157 males and 95 females) in 2002.

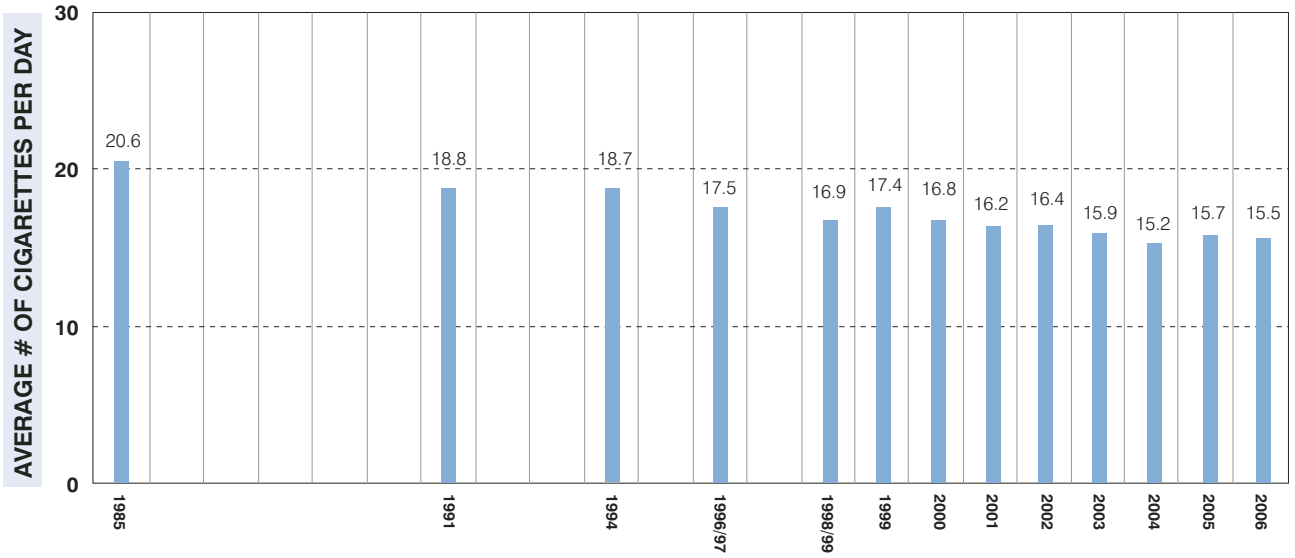
The trends in smoking-attributed mortality, with more males than females dying of tobacco-related causes, reflect smoking behaviour two to three decades ago. Although the prevalence of smoking continues to decline, the Canadian population dynamics (age structure and population growth) account for the increase in the number of deaths from lung cancer and chronic obstructive pulmonary disease.

Economic Costs

In 2002, tobacco use accounted for $17 billion in costs to Canadians.[14] The largest part ($12.5 billion) was in indirect costs for lost productivity due to illness and premature death, including $10.5 billion for long-term disability due to tobacco use. The direct costs attributed to tobacco use were estimated to be $4.4 billion. The bulk of this was $2.5 billion for acute care hospitalizations and $1.4 billion for prescription drugs. The cost of acute care hospitalization translates to over 2.2 million days in hospital due to tobacco, including 46,700 days attributed to exposure to SHS. Direct costs for prevention and research and fire damage were also included in these estimates. A number of smoking-attributable costs were not included because there was no way to estimate their value. These costs included visits of friends and families to sick and dying smokers, and smoking-attributable home health care. In addition, the psychological and emotional costs incurred by the families of dead or dying smokers are incalculable.

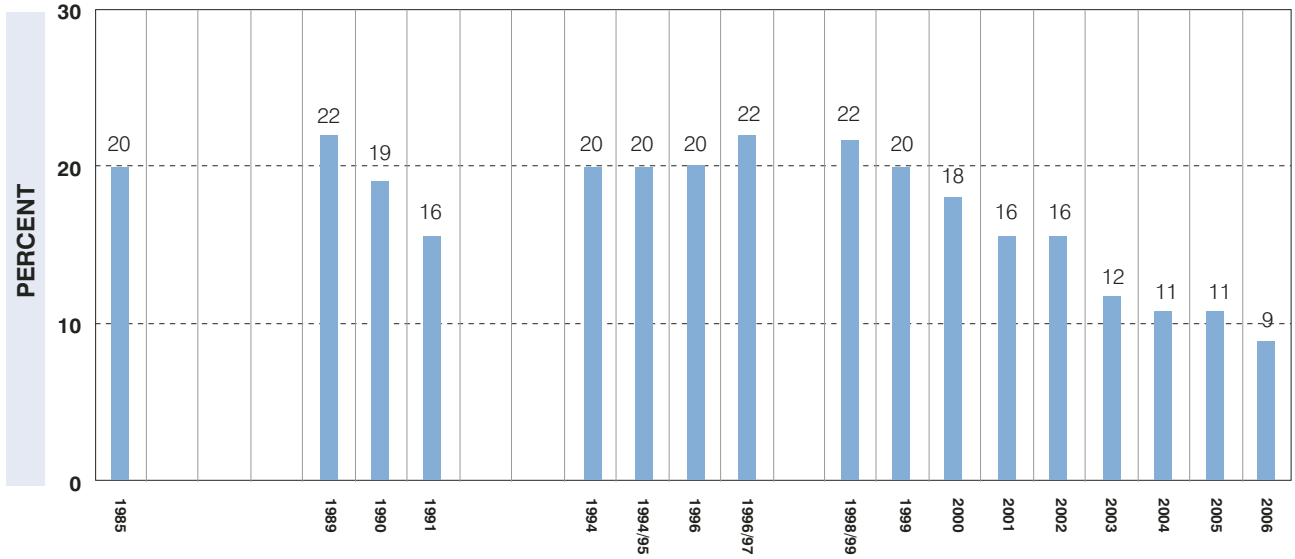
These figures show a steady increase in smoking-attributable costs in Canada since 1966 ($2.0 billion in 1991$).[15]

Figure 2-3 Average number of cigarettes smoked per day, daily smokers, 15+ years, Canada 1985 - 2006



Sources: 1985/91 General Social Surveys; 1994 Survey on Smoking in Canada, Cycle 1; 1996-97 and 1998-99 National Population Health Surveys; 1999-2006 Canadian Tobacco Use Monitoring Surveys

Figure 2-4 Trends in the prevalence of daily smokers, youth 15-19 years, Canada, 1985-2006.



Sources: Gilmore, J. Report on Smoking Prevalence in Canada, 1985 to 1999. (Statistics Canada, Catalogue 82F0077XIE), 2000. Canadian Tobacco Use Monitoring Survey, 1999 - 2006.

Discussion and Implications

Comprehensive, integrated and sustained actions are universally recognized to be key to successful tobacco control strategies. The Federal Tobacco Control Strategy (FTCS), launched by the Government of Canada in April 2001, is one such approach. This Strategy, carried out in close collaboration with partners, is directed at Canadians of all ages. Four mutually reinforcing components have been identified to support achievement of the Strategy's objectives: protection, prevention, cessation, and harm reduction/product modification.

Progress continues to be measured in many areas of tobacco control. Since 2003, smoking among youth aged 15–19 years dropped to a level lower than that of the general population. In 2006, an estimated 15% of youths smoked, versus 19% of Canadians in general. According to the 2004–05 Youth Smoking Survey, 21% of youths in grades 5 to 9 reported ever trying a cigarette, compared to 40% in 1994 (Figure 2–10).[16] The prevalence of current smoking among these students dropped from 7% in 1994 to 2% in 2004–05.

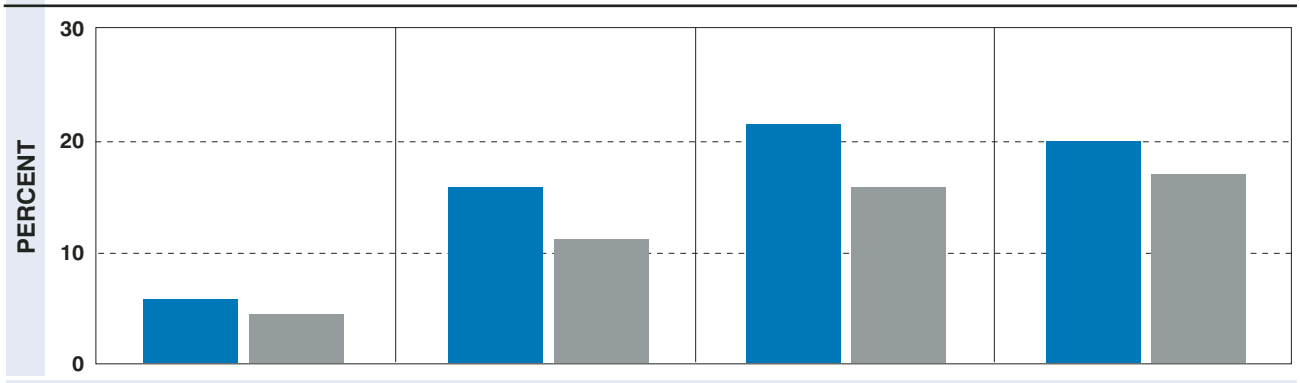
Public opinion in favour of smoking restrictions in public places has also been growing. In 2006, more than two-thirds (69%) of Canadians who expressed their opinion felt that smoking should not be allowed anywhere in restaurants.[17] This is up from 42% in 2001. When examined by smoking status, this opinion was held by 50% of current smokers and 73% of non-smokers. Although those in favour of smoke-free bars and taverns still constitute a minority, their ranks also grew from 26% in 2001 to 49% in 2006. Only 24% of current smokers were of this opinion, compared to 54% of non-smokers.

Most Canadian households voluntarily ban or restrict smoking in their homes. These restrictions have reduced the proportion and number of children exposed to passive smoke in the home. Parental or caregiver smoking not only affects the health of the children, but also sends the message that smoking is an acceptable adult behaviour. Continued efforts are needed so that parents and other family members understand the importance of maintaining a smoke-free environment. In 2006, 25% of Canadians 15 years of age and older reported being exposed to second-hand smoke inside a car or other vehicle in the past month.[18] At the 2007 Canadian Medical Association annual meeting, a resolution was proposed which "urges all levels of government to implement a Canada-wide ban on smoking in vehicles carrying children".[19]

Progress has also been noted in reported workplace restrictions. In 2006, 40% of respondents felt that smoking should not be allowed anywhere in the workplace, indoors or out. This opinion was expressed by 19% of current smokers and 44% of non-smokers. Less than half (46%) of all respondents–including 57% of current smokers and 44% of non-smokers–felt that smoking should be allowed only in designated outdoor areas. In addition to the increase in the prevalence of smoke-free and smoke-restricted workplaces, many provincial and territorial governments have enacted legislation requiring public places to be smoke-free: Northwest Territories, Nunavut, New Brunswick and Manitoba in 2004; Saskatchewan and Newfoundland and Labrador in 2005; Ontario, Quebec and Nova Scotia in 2006.

Nonetheless, Canadian smoking rates remain high among subpopulations, including young adults 20 to 24 years and Aboriginal people. As a result, smoking will continue to cause major health problems. While smoking rates have dropped significantly, the measured health outcomes (morbidity and mortality) have not yet shown the same trends.

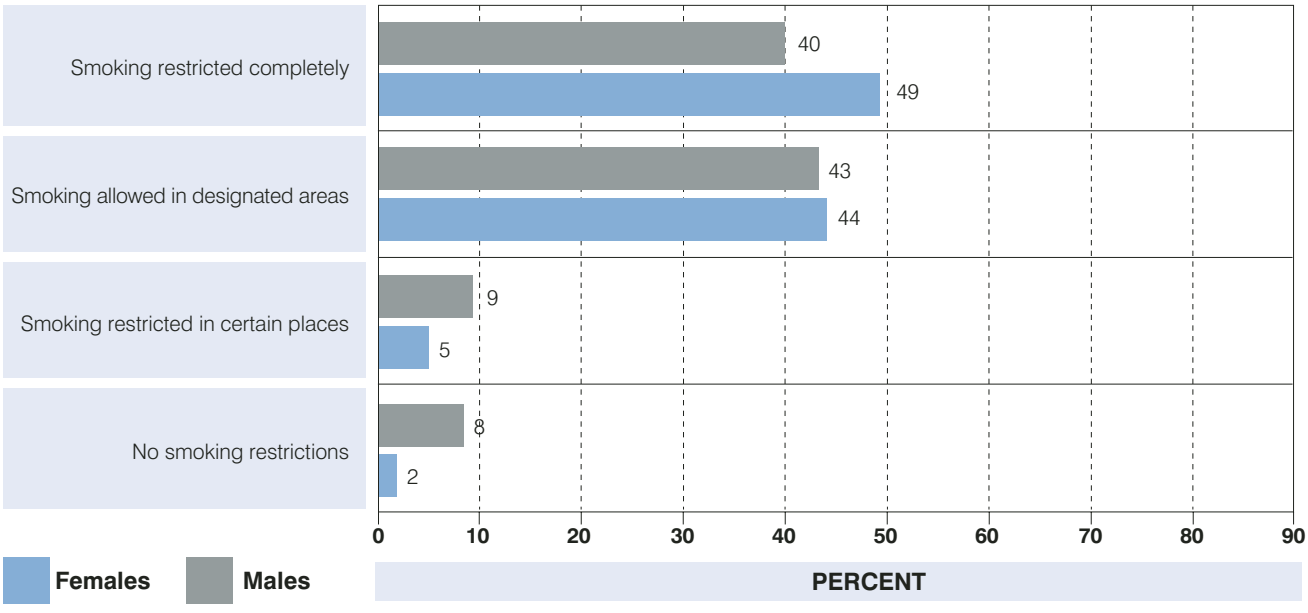
Figure 2-5 Prevalence of daily smoking among youth and young adults by sex and age group, 15-24 years, Canada, 2006.



	15-17 years	18-19 years	20-22 years	23-24 years
Male	6	16	21	20
Females	5	11	16	18

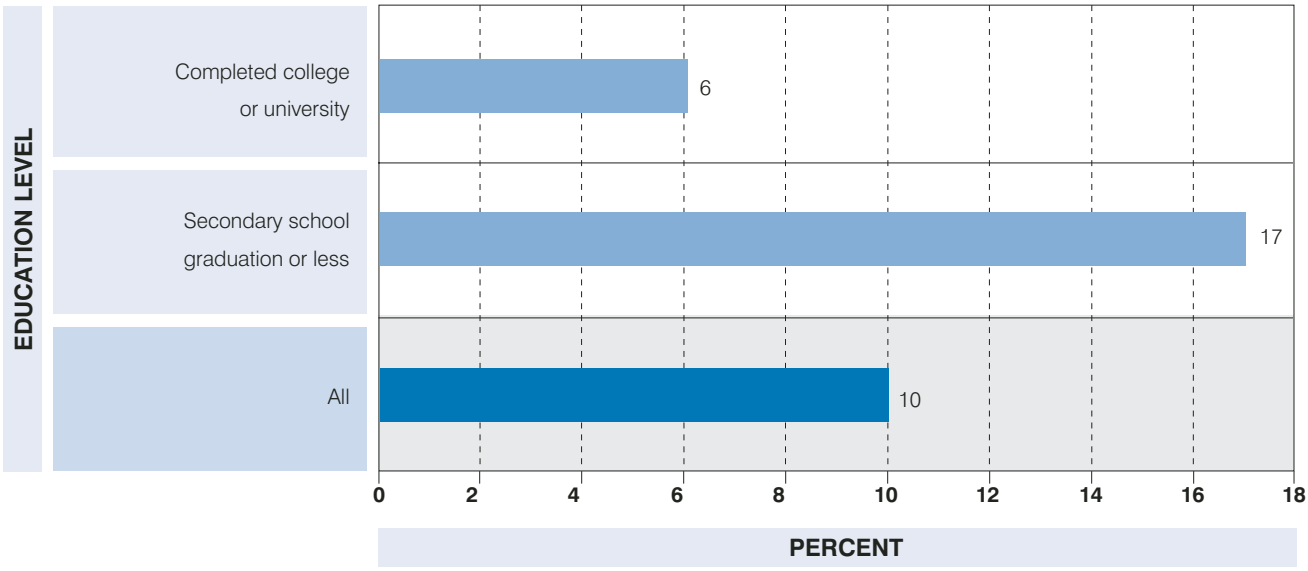
Source: Canadian Tobacco Use Monitoring Survey, February-December 2006.

Figure 2-6 Proportion of adults aged 15+ years who reported workplace smoking restrictions by sex, Canada, 2006.



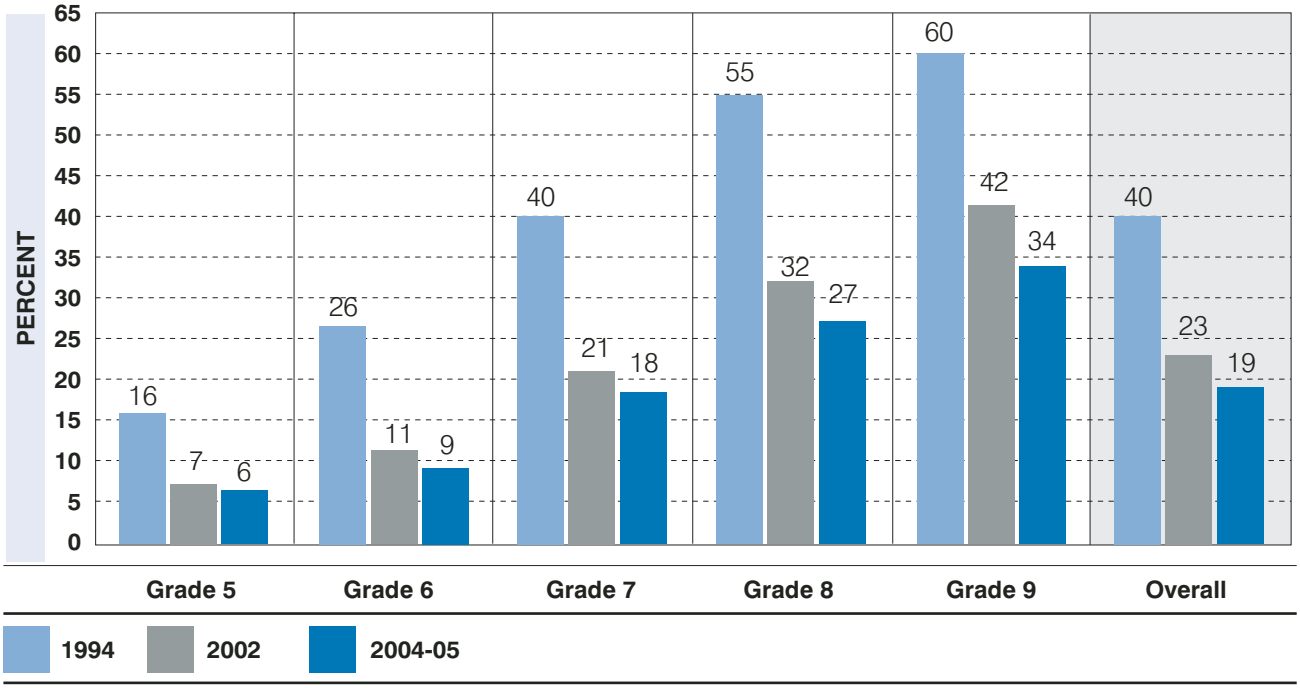
Canadian Tobacco Use Monitoring Survey, February – December 2006.

Figure 2-7 Smoking during their most recent pregnancy* by education level, 20-44 years, Canada, 2006.



* Among women reporting a pregnancy in the last 5 years
Source: Canadian Tobacco Use Monitoring Survey, February-December 2006.

Figure 2-8 Proportion of children in grade 5 to 9 who ever tried smoking a cigarette, Canada, 1994, 2002 & 2004-05.



Source: Youth Smoking Survey, 1994, 2002 & 2004-05.

[1] Kaiserman MJ., Makomaski Illing EM. Mortality attributable to tobacco use in Canada and its regions, 1998. Can J Public Health 2004; 95:1:38-44.

[2] Rehm, J. et al. The costs of substance abuse in Canada 2002. Ottawa: Canadian Centre on Substance Abuse; 2006.

[3] U.S. Department of Health and Human Services. The Health Consequences of Smoking: A report of the Surgeon General. Bethesda, MD: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2004.

[4] National Cancer Institute. Health effects of exposure to environmental tobacco smoke: the report of the California Environmental Protection Agency. Smoking and Tobacco Control Monograph no. 10. Bethesda, MD. U.S. Department of Health and Human Services, National Institutes of Health, HIH Pub. No. 99-4545; 1999.

[5] Health Canada. Healthy living: Rewards of quitting. Ottawa: Health Canada; n.d. [updated 2005 May 1]. Available from: *http://www.hc-sc.gc.ca/hl-vs/tobac-tabac/quit-cesser/ready-pret/reward-gratifiant/index_e.html*

[6] Health Canada. Canadian Tobacco Use Monitoring Survey (2006). Ottawa: Health Canada; n.d. Available from: *http://www.hc-sc.gc.ca/hl-vs/tobac-tabac/research-recherche/stat/ctums-esutc/2006/index_e.html*

[7] First Nations Centre. First Nations regional longitudinal health survey (RHS) 2002/03. Ottawa: The Centre, 2005. Available from *http://rhs-ers.ca/english/pdf/rhs2002-03reports/rhs2002-03-technicalreport-afn.pdf*

[8] Statistics Canada. Aboriginal Peoples Survey 2001

[9] First Nations Centre.

[10] First Nations Centre.

[11] Rehm, J. et al.

[12] Rehm, J. et al.

[13] Rehm, J. et al.

[14] Rehm, J. et al.

[15] Kaiserman MJ, The Cost of Smoking in Canada, 1991. Chronic Diseases in Canada. 1997; 18:1.

[16] Health Canada. 2004-05 Youth Smoking Survey. Available from: *http://www.hc-sc.gc.ca/hl-vs/tobac-tabac/research-recherche/stat/survey-sondage/2004-2005/index_e.html*

[17] Health Canada. Canadian Tobacco Use Monitoring Survey (2006).

[18] Health Canada. Canadian Tobacco Use Monitoring Survey (2006).

[19] Canadian Medical Association. CMA annual meeting resolutions (unconfirmed). Item 91. August 2007. *http://www.cma.ca/index.cfm/ci_id/53612/la_id/1.htm*

Chapter 3

Air Quality

Air Quality

Outdoor (Ambient) Air

Definition

Outdoor air pollution consists of a mixture of gaseous and particulate pollutants. Pollutants of interest with regard to health include ground level ozone (O_3), particulate matter (PM), especially $PM_{2.5}$ (PM with a diameter of < 2.5 microns), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and carbon monoxide (CO). These pollutants may be emitted from, or formed as a result of, many activities, including industrial and manufacturing processes, the combustion of fossil fuels in motor vehicles, and the use of wood-burning stoves.

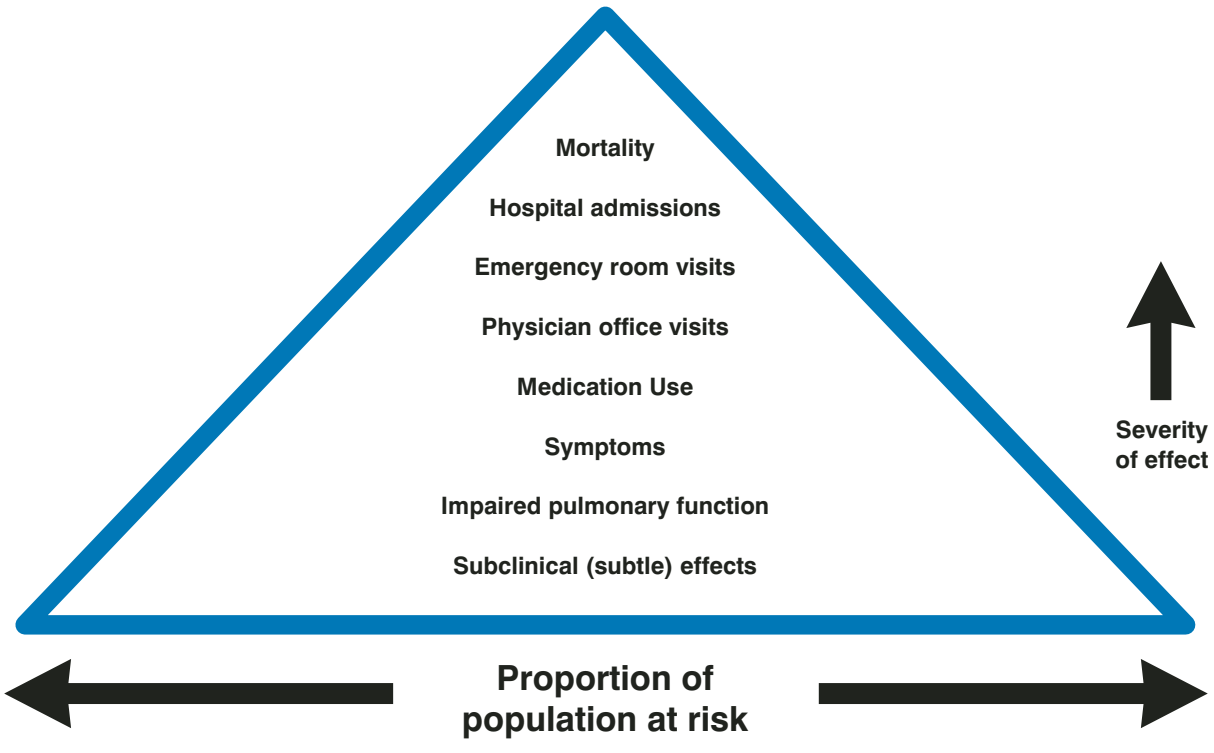
The relationship between air quality and health is complex because of the interplay of numerous factors. Exposure to ambient air pollution has been associated with adverse health outcomes that range from subtle biochemical and physiological changes to difficulty breathing, wheezing, coughing and aggravation of existing respiratory diseases. These effects can result in increased medication use, more visits to doctors or emergency rooms, more hospital admissions and even premature death (Figure 3–1). Certain subgroups of the population who are more sensitive to the effects of air pollution may experience health effects even at very low levels of exposure. Although air quality can affect cardiovascular health and may affect other systems, this chapter focuses on the links between air pollution and respiratory health, with an emphasis on Canadian studies.

Trends

Air pollutants are subject to complex atmospheric chemistry, and the pollutant mix varies both regionally and locally (e.g., within cities). Ambient air quality in Canadian cities and towns is monitored by the National Air Pollution Surveillance Network (NAPS), as well as by local and provincial agencies.

Reductions in emissions from vehicles, electric power generation and industry have reduced levels of several primary air pollutants since the 1980s. Levels of the gaseous pollutants (nitrogen oxides, sulfur oxides and CO) declined from the mid-1970s to the mid-1990s. A rise in sulfur oxide

Figure 3-1 Health effects of air pollution[1]



(SO_x) levels was observed between 1995 and 1998 as emissions from thermal power generators increased; however, levels have declined to 1995 levels since then (Figure 3–2), likely as a result of regulatory measures targeting this pollutant.

Since a decline in PM and O_3 levels from the mid-1970s to mid-1990s, there have been no discernible upward or downward trends for these key components of smog. There was no significant change in O_3 levels between 1991 and 1995. An evaluation of trends in PM2.5 levels (Figure 3–3) is limited by the fact that daily monitors of PM2.5 were not present in all regions of Canada until the 1990s.[3]

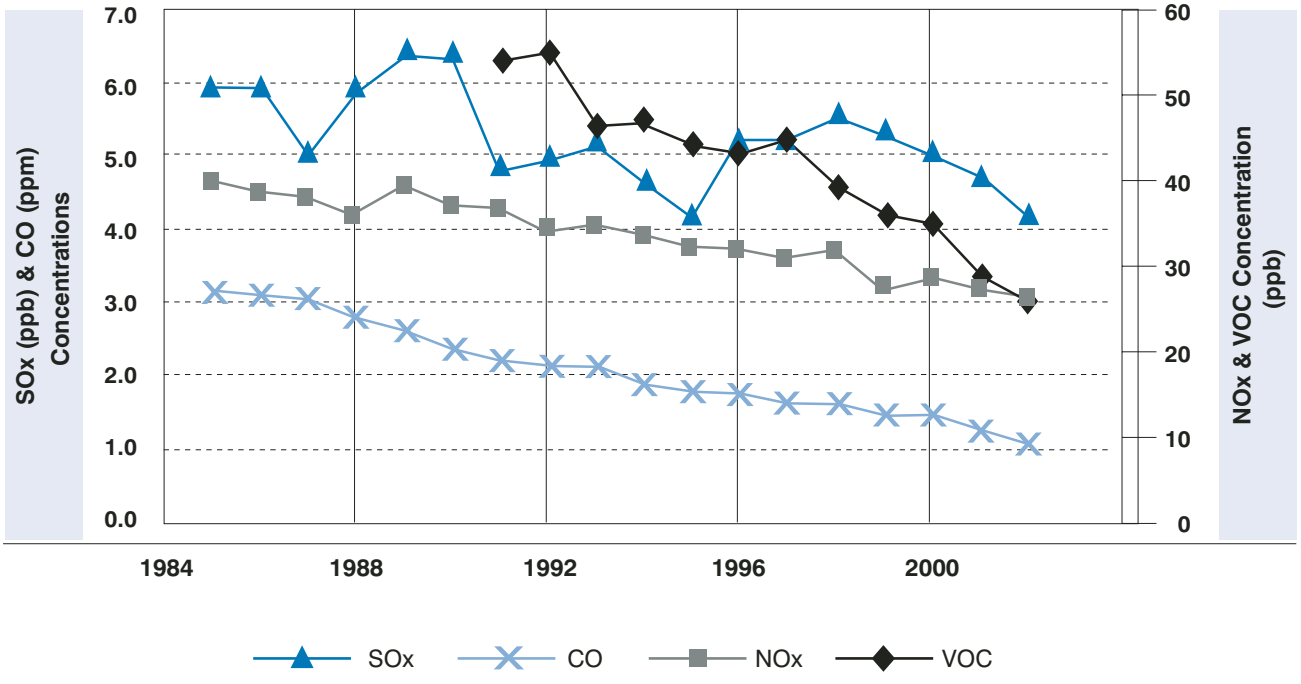
Figure 3–3. Concentrations of average ambient ground-level O_3 across large urban, small urban and non-urban stations in Canada, 1991–2005, and average $PM_{2.5}$ across urban Canadian sites, 1984–2002.[4,5]

Health Outcomes

Health Canada estimates that short-term and long-term exposure to air pollution is responsible for approximately 5,900 premature deaths annually in the eight largest Canadian cities combined. Although this figure is driven by cardiovascular mortality, respiratory conditions are a contributing factor.[6] Many studies have shown an association between acute exposure to air pollutants and mortality in Canadian cities.[7, 8, 9, 10, 11, 12, 13, 14, 15, 16] A link between mortality and long-term exposure to PM is also well documented.[17, 18, 19, 20, 21, 22, 23] In addition, long-term exposures to PM_{10}, $PM_{2.5}$, SO_2 and O_3 have been associated with lung cancer incidence and mortality.[24, 25, 26]

There is strong evidence that exposure to outdoor air pollution exacerbates asthma and, to a lesser extent, COPD. This suggests that some people are especially susceptible to the effects of air pollution. Asthma-related outcomes associated with air pollutants include hospitalization,[27, 28] emergency room visits,[29, 30] incident asthma attacks,[31] asthmatic symptoms[32] and medication use.[33] In controlled human exposure studies, some asthmatics were more sensitive to allergen exposures if previously exposed to NO_2 or O_3.[34, 35, 36, 37] The severity of an asthma attack after viral infection has been associated with higher levels of prior exposure to NO_2.[38] Children living in high O_3 areas who spent more time outdoors and who played three or more sports were more at risk for developing asthma or experiencing increased adverse effects on lung function and respiratory symptoms than those who spent less time outdoors.[39, 40] While significant, these latter findings may be of limited relevance to Canadians as they were found in parts of the U.S. with levels higher than are normal in Canada.

Figure 3-2 Concentrations of gaseous ambient air pollutants in Canada, 1984-2002.[2]



Note: SOx = sulfur oxides, CO = carbon monoxide, NOx = nitrogen oxides, VOC = volatile organic compounds

Exposure to air pollutants has been associated with both hospitalizations for, and exacerbation of, COPD.[41, 42, 43] In addition, air pollution has been associated with the admission of elderly subjects to hospital.[44, 45]

Many studies have documented the sensitivity of children to the adverse effects of air pollution. Increased cough and respiratory symptoms,[46, 47] and physician and hospital visits, [48, 49, 50, 51] have been associated with children's exposure to outdoor air pollution, including traffic-related air pollution. Long-term exposure to acidic particles may have harmful effects on lung growth, development and function.[52] Results from the Children's Health Study in California indicated that chronic exposure to PM was associated with respiratory symptoms and lung function changes; changes in air pollutant levels during adolescence influenced lung function growth and performance, and increasing O_3 levels were associated with school absenteeism.[53, 54, 55, 56, 57]

Pre- and post-natal development has also been associated with maternal exposure to air pollutants.[58, 59, 60, 61, 62, 63, 64]

The Role of the Government of Canada

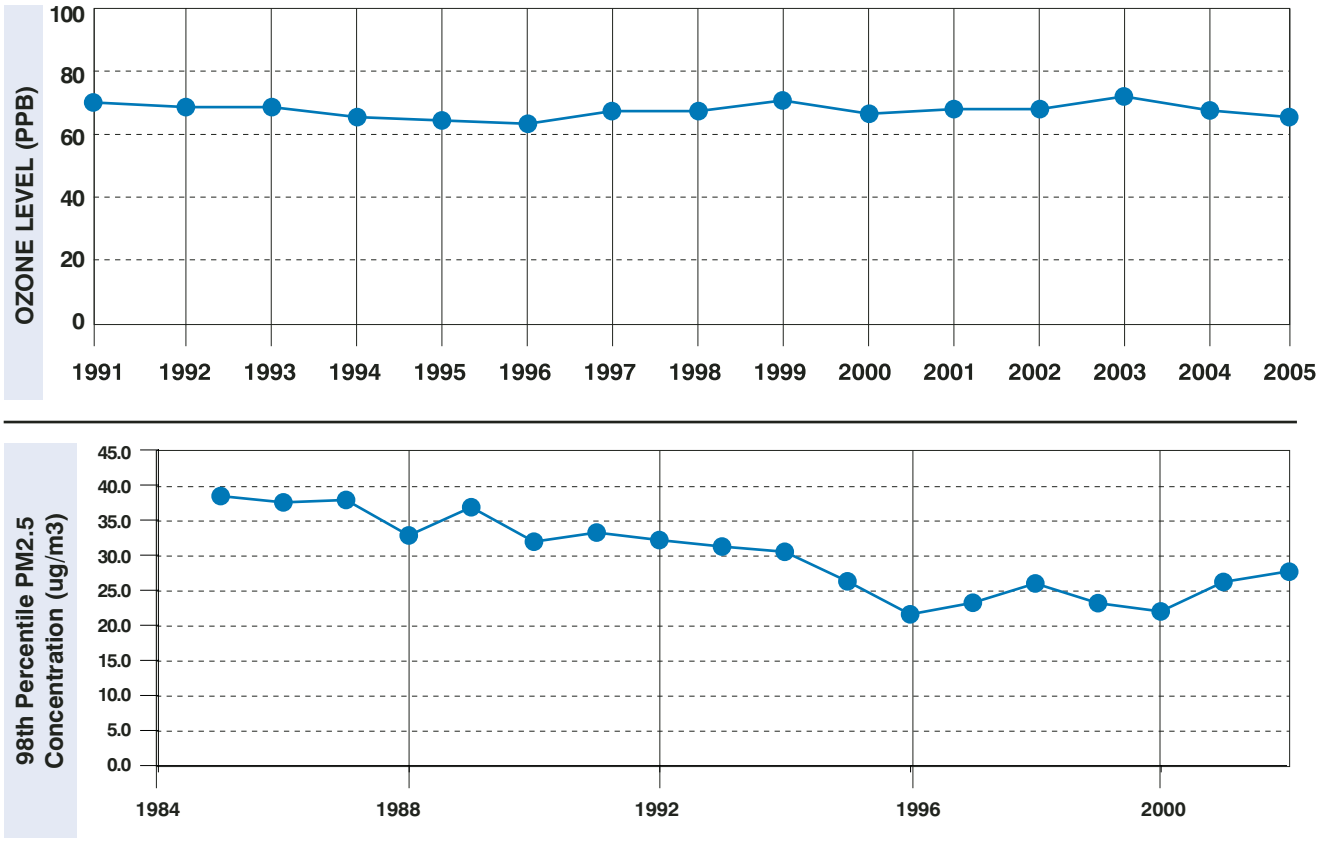
Pollution control programs have considerably reduced the levels of many ambient air pollutants. In Canada, some reductions have been accomplished through new regulations, such as for vehicles and fuel. Canada-Wide Standards and the Ozone Annex to the Canada/United States Clean Air Agreement underlie further improvements.

Ambient Air Guidelines

Air quality objectives are based on recognized scientific principles through the completion of extensive peer-reviewed Science Assessment Documents leading to the development of either Canada-Wide Standards (CWS) or National Ambient Air Quality Objectives (NAAQOs).

NAAQOs have been the benchmark against which Canada assesses the impact of human activities on air quality and ensures that emission control policies protect human health and the environment. Traditionally, the federal government establishes these objectives following recommendations by a

Figure 3-3 Concentrations of average ambient ground-level O_3 across large urban, small urban and non-urban stations in Canada, 1991-2005, and average $PM_{2.5}$ across urban Canadian sites, 1984-2002.[4, 5]



national advisory committee and working group. They may be adopted by provincial governments as objectives or as enforceable standards. The federal government is expected to take more direct control over the setting of these objectives under its Clean Air Regulatory Agenda, retaining their normal purpose but adding a dimension of delineating attainment and non-attainment areas for the purpose of setting rules on the trading of major emissions of NO_2 and SO_2.

The Canada-Wide Accord on Environmental Harmonization and its sub-agreement on Canada-Wide Standards was signed in January 1998 by all Canadian environment ministers except for Quebec. Canada-Wide Standards involve the development of jurisdictional risk management plans to attain the agreed-upon standard to reduce health and environmental risks within a specific timeframe. Provincial and federal stakeholder consultation is a fundamental aspect of the CWS process. Like NAAQOs, Canada-Wide Standards are science-based, but they also explicitly recognize and incorporate a number of other factors, including technical feasibility and economic issues.

Air Quality Index (AQI)

The AQI is a communications tool, which describes the general level of air pollution at a particular place and time using a numerical scale and a qualitative rating, but it does not report the concentrations of individual pollutants.

To address the shortcomings and variations between current AQIs, an agreement was reached in 2002 between governments and other stakeholders to develop a Canadian AQI that would be more health-risk based. This is the first air quality health index of its kind in the world based directly on risk coefficients from epidemiological studies.[65] A cornerstone of this process is the development of relevant and timely messages to help Canadians to safeguard their own health and to motivate change in improving air quality in communities.[66]

Indoor Air

Definition

Results from the Canadian Human Activities Pattern Survey (CHAPS) indicate that adults in Canada spend about 90% of their time indoors.[67] The levels of air pollutants indoors depend on outdoor air pollution, the rate at which indoor air is exchanged with outdoor air (windows opened or closed, presence of an air conditioning system), the presence of sources indoors (combustion appliances, consumer products), and building design and materials.

Indoor air pollutants include biological agents (e.g., mould); combustion products (such as $PM_{2.5}$, CO and NO_2) from appliances that burn fossil fuels; volatile organic compounds (VOCs) and formaldehyde emitted from consumer products; and radon, a naturally occurring radioactive gas. It should be noted that tobacco smoke is a major source of several chemical pollutants, including $PM_{2.5}$, CO, and VOCs.

When sources are from the indoor environment, the concentration levels of many pollutants can be higher than outdoors. Thus, while concentrations of NO_2 are usually lower indoors than outdoors when there is no indoor source, indoor concentrations can exceed outdoor levels in homes equipped with gas cooking stoves. [68]

Health Outcomes

Associations have been observed between indoor air pollutants and health effects, primarily in relation to asthma. The U.S. National Academy of Science concluded that the development of asthma can be causally linked to exposure to house dust mites and associated with second-hand smoke (SHS) in preschool-aged children.[69] Similarly, exacerbation of asthma has been causally linked with exposure to cats, cockroaches, house dust mites and SHS in preschool-aged children, and associated with exposure to dogs, fungi or moulds, rhinovirus and high levels of NO_2 and nitrogen oxides (NO_x). A number of other possible associations have been raised but only with limited or suggestive evidence.

Mould: Health Canada recently reviewed the evidence regarding the health effects of mould.[70] Several of the studies reviewed found significant associations between exposure to mould or dampness, and irritative and non-specific respiratory symptoms, as well as the exacerbation and development of respiratory diseases such as asthma. In immunocompromised individuals in hospital settings, airborne exposure to certain fungi was found to be associated with an increased risk of fungal infection. Current knowledge supports the need to prevent damp conditions and mould growth and to remediate any fungal contamination in buildings.

Wood smoke: Exposure to wood smoke may also lead to some health effects, such as impairment of lung defences in children, asthma symptoms and increases in respiratory symptoms, as well as headaches, nausea and dizziness.[71, 72, 73]

Appliances, tobacco smoke, traffic: Elevated indoor levels of CO from sources such as combustion appliances, tobacco smoke, and vehicles in attached garages and nearby roads, can disrupt oxygen transport by haemoglobin, making sensitive individuals such as people diagnosed with coronary disease especially susceptible to adverse health effects.[74] High levels of NO_2 from traffic and indoor combustion sources such as unvented gas stoves increase bronchial responsiveness in both asthmatics and healthy individuals and increase response to inhaled allergens in asthmatics.[75]

Formaldehyde and VOCs: Formaldehyde is a gas emitted from off-gassing of wood-based materials such as plywood and particle board and some paints and varnishes. It is also emitted by combustion sources such as wood stoves. Exposure to formaldehyde causes irritation to the airways and the eyes.[76] Many consumer products, including cleaners, aerosols and fragrances, as well as construction materials emit VOCs that may persist in the air, triggering effects including skin, eye, and respiratory tract irritations, headaches, nausea and dizziness.[77]

Radon: Radon is a radioactive gas that arises from the natural breakdown of uranium in soils and rocks. In confined spaces like basements and underground mines, radon can accumulate to high concentrations. Radon is a well-known human carcinogen, and indoor exposure to this gas is considered to be the second leading cause of lung cancer after smoking.[78, 79]

Burden of Disease and Health Care Costs

Estimating the burden of disease associated with indoor air pollution is difficult because of the lack of exposure data that are representative of the Canadian population and because of our limited knowledge of quantitative exposure–response relationships. As a result, we cannot quantify health care costs associated with indoor air pollution in Canada.

Guidelines And Resources

Canada's Exposure Guidelines for Residential Indoor Air Quality were developed in the late 1980s by the former Federal-Provincial Advisory Committee on Environmental and Occupational Health (CEOH).[80] Its report summarizes the key health effects of 19 substances and recommends limit values or controls. Health Canada is reassessing the scientific basis of the guidelines. A revised guideline for formaldehyde was published on Health Canada's website[81] in 2006, and a new guideline on moulds was issued in 2007.[82] Health Canada's residential indoor air quality guidelines are on-line, along with fact sheets and several scientific reports.[83]

A guide published by Canada Mortgage and Housing Corporation (CMHC) in 1993 gives Canadians practical advice on improving and maintaining residential air quality.[84] More recently, CMHC and Health Canada jointly published a guidebook on radon for Canadian homeowners.[85] Health Canada has also developed a guidebook outlining ways of recognizing and managing fungal contamination in public buildings (with the exception of hospitals and industrial plants).[86]

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1 Stieb DM, Pengelly LD, Arron N, Taylor SM, Raizenne M. Health effects of air pollution in Canada: expert findings for the Canadian Smog Advisory Program. Can Respir J 1995;2(3):155-60.

2 Environment Canada. National Air Pollution Surveillance Network. Available from: *http://www.etc-cte.ec.gc.ca/NAPS/index_e.html*.

3 Environment Canada. "Government of Canada five-year progress report: Canada-wide standards for particulate matter and ozone [homepage on the Internet]. Ottawa: Environment Canada; c2007 [updated January 2007]. Available from: *http://www.ec.gc.ca/cleanair-airpur/caol/pollution_issues/cws/toc_e.cfm*.

4 Environment Canada. National Air Pollution Surveillance Network. Available from: *http://www.etc-cte.ec.gc.ca/NAPS/index_e.html*.

5 Environment Canada. "Government of Canada five-year progress report: Canada-wide standards for particulate matter and ozone [homepage on the Internet]. Ottawa: Environment Canada; c2007 [updated January 2007]. Available from: *http://www.ec.gc.ca/cleanair-airpur/caol/pollution_issues/cws/toc_e.cfm*.

6 Judek S, Jessiman B, Stieb D. Estimated number of excess deaths in Canada due to air pollution. [available online] Health Canada. [Cited September, 2005]; Available from *http://www.hc-sc.gc.ca/ahc-asc/media/nr-cp/2005/2005_32bk2_e.html*.

7 Burnett RT, Goldberg MS. Size-fractionated particulate mass and daily mortality in eight Canadian cities. In: Health Effects Institute. Revised analyses of time-series studies of air pollution and health. Special report. Health Effects Institute, Boston MA. 2003. pp.85-89.

8 Stieb DM, Judek S, Burnett RT. Meta-analysis of time-series studies of air pollution and mortality: update in relation to the use of generalized additive models. J Air Waste Manag Assoc 2003 Mar;53(3):258-61.

9 Goldberg MS, Burnett RT, Yale JF, Valois MF, Brook JR. Associations between ambient air pollution and daily mortality among persons with diabetes and cardiovascular disease. Environ Res 2006; 100(2): 255-67.

10 Finkelstein MM, Jerrett M, DeLuca P, Finkelstein N, Verma DK, Chapman K, et al. Relation between income, air pollution and mortality: a cohort study. CMAJ 2003 Sep;169(5):397-402.

11 Finkelstein MM, Jerrett M, Sears MR. Traffic air pollution and mortality rate advancement periods. Am J Epidemiol 2004 Jul;160(2):173-7.

12 Jerrett M, Burnett RT, Brook J, Kanaroglou P, Giovis C, Finkelstein N, et al. Do socioeconomic characteristics modify the short term association between air pollution and mortality? Evidence from a zonal time series in Hamilton, Canada. J Epidemiol Community Health 2004 Jan;58(1):31-40.

13 Vedal S, Brauer M, White R, Petkau J. Air pollution and daily mortality in a city with low levels of pollution. Environ Health Perspect 2003 Jan;111(1):45-52.

14 Villeneuve PJ, Burnett RT, Shi Y, Krewski D, Goldberg MS, Hertzman C, et al. A time-series study of air pollution, socioeconomic status, and mortality in Vancouver, Canada. J Expo Anal Environ Epidemiol 2003 Nov;13(6):427-35.

15 Goldberg MS, Burnett RT. Revised analysis of the Montreal time series study. In: Health Effects Institute. Revised analyses of time-series studies of air pollution and health. Special Report. Health Effects Institute, Boston MA. 2003. pp.113-131.

16 Burnett RT, Stieb D, Brook JR, Cakmak S, Dales R, Raizenne M, Vincent R, Dann T. Associations between short-term changes in nitrogen dioxide and mortality in Canadian cities. Arch Environ Health. 2004 May; 59(5):228-36.

17 Pope CA 3rd, Burnett RT, Thun MJ, Calle EE, Krewski D, Ito K, et al. Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. JAMA 2002 Mar;287(9):1132-41.

18 Dockery DW, Pope CA 3rd, Xu X, Spengler JD, Ware JH, Fay ME, et al. An association between air pollution and mortality in six U.S. cities. N Engl J Med 1993 Dec;329(24):1753-9.

19 Pope CA 3rd, Thun MJ, Namboodiri MM, Dockery DW, Evans JS, Speizer FE, et al. Particulate air pollution as a predictor of mortality in a prospective study of U.S. adults. Am J Respir Crit Care Med 1995 Mar;151(3 Pt 1):669-74.

20 Health Effects Institute. Reanalysis of the Harvard six cities study and the American Cancer Society study of particulate air pollution and mortality: a special report of the Institute's particle epidemiology reanalysis project. Cambridge (MA): Health Effects Institute; 2000.

21 Abbey DE, Nishino N, McDonnell WF, Burchette RJ, Knutsen SF, Lawrence Beeson W, et al. Long-term inhalable particles and other air pollutants related to mortality in nonsmokers. Am J Respir Crit Care Med 1999 Feb;159(2):373-82.

22 McDonnell WF, Nishino-Ishikawa N, Petersen FF, Chen LH, Abbey DE. Relationships of mortality with the fine and coarse fractions of long-term ambient PM10 concentrations in nonsmokers. J Expo Anal Environ Epidemiol 2000 Sep-2000 Oct;10(5):427-36.

23 Lipfert FW, Perry HM Jr, Miller JP, Baty JD, Wyzga RE, Carmody SE. The Washington University-EPRI veterans' cohort mortality study: preliminary results. Inhal Toxicol 2000;12 Suppl 4:41-73.

24 Beeson WL, Abbey DE, Knutsen SF. Long-term concentrations of ambient air pollutants and incident lung cancer in California adults: results from the AHSMOG study. Environ Health Perspect 1998 Dec;106(12):813-23.

25 Abbey DE, Nishino N, McDonnell WF, Burchette RJ, Knutsen SF, Lawrence Beeson W, et al. Long-term inhalable particles and other air pollutants related to mortality in nonsmokers. Am J Respir Crit Care Med 1999 Feb;159(2):373-82.

26 Pope CA 3rd, Burnett RT, Thun MJ, Calle EE, Krewski D, Ito K, et al. Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. JAMA 2002 Mar;287(9):1132-41.

27 Lin M, Chen Y, Burnett RT, Villeneuve PJ, Krewski D. The influence of ambient coarse particulate matter on asthma hospitalization in children: case-crossover and time-series analyses. Environ Health Perspect 2002 Jun;110(6):575-81.

28 Lin CA, Chen Y, Burnett RT, Villeneuve PJ, Krewski D. Effect of short-term exposure to gaseous pollution on asthma hospitalisation in children: a bi-directional case-crossover analysis. J Epidemiol Community Health 2003 57:50-55.

29 Jaffe DH, Singer ME, Rimm AA. Air pollution and emergency department visits for asthma among Ohio Medicaid recipients, 1991-1996. Environ Res 2003 Jan;91(1):21-8.

30 Lwebuga-Mukasa JS, Oyana T, Thenappan A, Ayirookuzhi SJ. Association between traffic volume and health care use for asthma among residents at a U.S.-Canadian border crossing point. J Asthma 2004;41(3):289-304.

31 Desqueyroux H, Pujet JC, Prosper M, Squinazi F, Momas I. Short-term effects of low-level air pollution on respiratory health of adults suffering from moderate to severe asthma. Environ Res 2002 May;89(1):29-37.

32 McConnell R, Berhane K, Gilliland F, London SJ, Vora H, Avol E, et al. Air pollution and bronchitic symptoms in Southern California children with asthma. Environ Health Perspect 1999 Sep;107(9):757-60.

33 von Klot S, Wolke G, Tuch T, Heinrich J, Dockery DW, Schwartz J, et al. Increased asthma medication use in association with ambient fine and ultrafine particles. Eur Respir J 2002 Sep;20(3):691-702.

34 Barck C, Sandstrom T, Lundahl J, Hallden G, Svartengren M, Strand V, et al. Ambient level of NO2 augments the inflammatory response to inhaled allergen in asthmatics. Respir Med 2002 Nov;96(11):907-17.

35 Peden DB, Setzer RW Jr, Devlin RB. Ozone exposure has both a priming effect on allergen-induced responses and an intrinsic inflammatory

action in the nasal airways of perennially allergic asthmatics. Am J Respir Crit Care Med 1995 May;151(5):1336-45.

36 Michelson PH, Dailey L, Devlin RB, Peden DB. Ozone effects on the immediate-phase response to allergen in the nasal airways of allergic asthmatic subjects. Otolaryngol Head Neck Surg 1999 Feb;120(2):225-32.

37 Chen LL, Tager IB, Peden DB, Christian DL, Ferrando RE, Welch BS, et al. Effect of ozone exposure on airway responses to inhaled allergen in asthmatic subjects. Chest 2004 Jun;125(6):2328-35.

38 Chauhan AJ, Inskip HM, Linaker CH, Smith S, Schreiber J, Johnston SL, et al. Personal exposure to nitrogen dioxide (NO2) and the severity of virus-induced asthma in children. Lancet 2003 Jun; 361(9373):1939-44.

39 Gauderman WJ, McConnell R, Gilliland F, London S, Thomas D, Avol E, et al. Association between air pollution and lung function growth in Southern California children. Am J Respir Crit Care Med 2000 Oct;162(4 Pt 1):1383-90.

40 McConnell R, Berhane K, Gilliland F, London SJ, Islam T, Gauderman WJ, et al. Asthma in exercising children exposed to ozone: a cohort study. Lancet 2002 Feb;359(9304):386-91.

41 Chen Y, Yang Q, Krewski D, Shi Y, Burnett RT, McGrail K. Influence of relatively low level of particulate air pollution on hospitalization for COPD in elderly people. Inhal Toxicol 2004 Jan;16(1):21-5.

42 Desqueyroux H.,Pujet J. C., Prosper M,Le Moullec Y, Momas I. Effects of air pollution on adults with chronic obstructive pulmonary disease. Arch Environ Health 2002b Nov-Dec 57(6):554-60.

43 Schikowski T, Sugiri D, Ranft U, Gehring U., Heinrich J,Wichmann H E, Kramer U. Long-term air pollution exposure and living close to busy roads are associated with COPD in women. Respir Res 2005; 6(1):152.

44 Chen Y, Yang Q, Krewski D, Burnett RT, Shi Y, McGrail KM. The effect of coarse ambient particulate matter on first, second, and overall hospital admissions for respiratory disease among the elderly. Inhal Toxicol 2005 Nov; I 17(12): 649-55.

45 Yang Q, Chen Y, Shi Y, Burnett RT, McGrail KM, Krewski D. Association between ozone and respiratory admissions among children and the elderly in Vancouver, Canada. Inhal Toxicol 2003 Nov;15(13):1297-308.

46 Brauer M, Hoek G, Van Vliet P, Meliefste K, Fischer PH, Wijga A, et al. Air pollution from traffic and the development of respiratory infections and asthmatic and allergic symptoms in children. Am J Respir Crit Care Med 2002 Oct;166(8):1092-8.

47 Janssen NA, Brunekreef B, van Vliet P, Aarts F, Meliefste K, Harssema H, et al. The relationship between air pollution from heavy traffic and allergic sensitization, bronchial hyperresponsiveness, and respiratory symptoms in Dutch schoolchildren. Environ Health Perspect 2003 Sep;111(12):1512-8.

48 Burnett RT, Smith-Doiron M, Stieb D, Raizenne ME, Brook JR, Dales RE, et al. Association between ozone and hospitalization for acute respiratory diseases in children less than 2 years of age. Am J Epidemiol 2001 Mar;153(5):444-52.

49 Lin M, Stieb DM, Chen Y. Coarse particulate matter and hospitalization for respiratory infections in children younger than 15 years in Toronto: a case-crossover analysis. Pediatrics 2005 Aug;116(2):e235-40.

50 Raizenne M, Dales R, Burnett R. Air pollution exposures and children's health. Can J Public Health 1998 May-1998 Jun;89 Suppl 1:S43-8, S47-53.

51 Yang Q, Chen Y, Shi Y, Burnett RT, McGrail KM, Krewski D. Association between ozone and respiratory admissions among children and the elderly in Vancouver, Canada. Inhal Toxicol 2003 Nov;15(13):1297-308.

52 Raizenne M, Neas LM, Damokosh AI, Dockery DW, Spengler JD, Koutrakis P, et al. Health effects of acid aerosols on North American children: pulmonary function. Environ Health Perspect 1996 May;104(5):506-14.

53 Avol EL, Gauderman WJ, Tan SM, London SJ, Peters JM. Respiratory effects of relocating to areas of differing air pollution levels. Am J Respir Crit Care Med 2001 Dec;164(11):2067-72.

54 Gauderman WJ, McConnell R, Gilliland F, London S, Thomas D, Avol E, et al. Association between air pollution and lung function growth in Southern California children. Am J Respir Crit Care Med 2000 Oct;162(4 Pt 1):1383-90.

55 Peters JM, Avol E, Gauderman WJ, Linn WS, Navidi W, London SJ, et al. A study of twelve Southern California communities with differing levels and types of air pollution. II. Effects on pulmonary function. Am J Respir Crit Care Med 1999 Mar;159(3):768-75.

56 Peters JM, Avol E, Navidi W, London SJ, Gauderman WJ, Lurmann F, et al. A study of twelve Southern California communities with differing levels and types of air pollution. I. Prevalence of respiratory morbidity. Am J Respir Crit Care Med 1999 Mar;159(3):760-7.

57 Gilliland FD, Berhane K, Rappaport EB, Thomas DC, Avol E, Gauderman WJ, et al. The effects of ambient air pollution on school absenteeism due to respiratory illnesses. Epidemiology 2001 Jan;12(1):43-54.

58 Liu S, Krewski D, Shi Y, Chen Y, Burnett RT. Association between gaseous ambient air pollutants and adverse pregnancy outcomes in Vancouver, Canada. Environ Health Perspect 2003 Nov;111(14):1773-8.

59 Bobak M. Outdoor air pollution, low birth weight, and prematurity. Environ Health Perspect 2000 Feb;108(2):173-6.

60 Lipfert FW, Zhang J, Wyzga RE. Infant mortality and air pollution: a comprehensive analysis of U.S. data for 1990. J Air Waste Manag Assoc 2000 Aug;50(8):1350-66.

61 Maisonet M, Bush TJ, Correa A, Jaakkola JJ. Relation between ambient air pollution and low birth weight in the Northeastern United States. Environ Health Perspect 2001 Jun;109 Suppl 3:351-6.

62 Parker JD, Woodruff TJ, Basu R, Schoendorf KC. Air pollution and birth weight among term infants in California. Pediatrics 2005 Jan;115(1):121-8.

63 Wang X, Ding H, Ryan L, Xu X. Association between air pollution and low birth weight: a community-based study. Environ Health Perspect 1997 May;105(5):514-20.

64 Wilhelm M, Ritz B. Residential proximity to traffic and adverse birth outcomes in Los Angeles county, California, 1994-1996. Environ Health Perspect 2003 Feb;111(2):207-16.

65 Stieb DM, Doiron MS, Blagden P, Burnett RT. Estimating the public health burden attributable to air pollution: an illustration using the development of an alternative air quality index. J Toxicol Environ Health A. 2005 Jul 9-23;68(13-14):1275-88.

66 Further information is available at www.aqhi.gc.ca.

67 Leech JA, Wilby K, McMullen E. It's about time: The Canadian Human Activity Pattern Survey [CHAPS]. 1997.

68 WHO International Programme on Chemical Safety. Nitrogen dioxide: Environmental Health Criteria 189. Geneva: World Health Organization, 1997.

69 The Institute of Medicine (IOM) of the National Academies (U.S.), 2000. "Clearing the air: asthma and indoor air exposures (2000)." ISBN 0-309-06496-1 (*http://books.nap.edu/books/0309064961/html/index.html*)

70 Health Canada. Fungal contamination in public buildings: health effects and investigation methods [monograph on the Internet]. Ottawa: Health Canada; 2004 [updated 2005 Aug 3]. Available from: *http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/air/fungal-fongique/fungal-fongique_e.pdf*.

71 Lévesque B, Allaire S, Gauvin D, Koutrakis P, Gingras S, Rhainds M, et al. Wood-burning appliances and indoor air quality. Sci Total Environ 2001; 281 (1-3);47-62.

72 Honicky RE, Osbourne JS 3rd, Akpom CA. Symptoms of respiratory illness in young children and the use of wood-burning stoves for indoor heating. Pediatrics 1985; 75 (3); 587-93.

73 Butterfield, P. et al. Woodstoves and indoor air: the effects on preschoolers' upper respiratory systems. J Env Health 1989; 52 (3); 172-3.

74 WHO International Programme on Chemical Safety. Carbon Monoxide: Environmental Health Criteria 213. Geneva: World Health Organization, 1999.

75 WHO International Programme on Chemical Safety. Nitrogen Dioxide: Environmental Health Criteria 189. Geneva: World Health Organization, 1997.

76 WHO International Programme on Chemical Safety. Formaldehyde: Environmental Health Criteria 89. Geneva: World Health Organization, 1989.

77 Wolkoff P, Wilkins CK, Clausen PA, Nielsen GD. Organic compounds in office environments – sensory irritation, odor, measurements and the role of reactive chemistry. Indoor Air 2006; 16: 7-19.

78 Lubin JH, Boice JD. Lung cancer risk from residential radon: meta-analysis of eight epidemiologic studies. J Natl Cancer Inst 1997;89(1):49-57.

79 Lyman, GH. Radon. In: Bardana EF, Montanaro A, editors. Indoor Air Pollution and Health. New York: Marcel Dekker; 1997.

80 Health Canada, 1995. Exposure guidelines for residential indoor air quality. a report of the Federal-Provincial Advisory Committee on Environmental and Occupational Health [monograph on the Internet]. Ottawa: Health Canada, 1995. Available from: *http://www.hc-sc.gc.ca/ewh-semt/pubs/air/exposure-exposition/index_e.html*.

81 Health Canada. Residential Indoor Air Quality Guideline: Formaldehyde. Ottawa: Health Canada; 2006.

82 Health Canada. Residential Indoor Air Quality Guidelines: Moulds. Ottawa: Health Canada; 2007.

83 Available at Health Canada's Health and Air Quality website: *www.hc-sc.gc.ca/air*.

84 Canada Mortgage and Housing Corporation. The clean air guide: how to identify and correct indoor air problems in your home. Ottawa: CMHC; 2002.

85 Health Canada and Canadian Mortgage and Housing Corporation. Radon. A Guide for Canadian Homeowners [monograph on the Internet]. Ottawa: Health Canada and Canada Mortgage and Housing Corporation; 2007. Available from: *https://www03.cmhc-schl.gc.ca/b2c/b2c/mimes/pdf/61945.pdf*.

86 Health Canada. Fungal contamination in public buildings: health effects and investigation methods [monograph on the Internet]. Ottawa: Health Canada; 2004 [updated 2005 Aug 3]. Available from: *http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/air/fungal-fongique/fungal-fongique_e.pdf*.

Chapter 4

Occupational Respiratory Disease

Occupational Respiratory Disease

Introduction

Occupational respiratory diseases are caused by workplace exposure to irritating or toxic substances that may cause acute or chronic respiratory ailments. In Canada, as in other developed countries, there have been significant changes in the prevalence of occupational respiratory diseases over the past 30 years. Pneumoconiosis (lung disease resulting from inhalation of inorganic dust in mines and other work places) has declined. Although Canada is rich in minerals, and mining continues to be relatively common in many parts of the country, pneumoconiosis has declined both as a cause of recorded mortality and hospital admissions (Figures 4–1 and 4–2). Occupational asthma is now the most frequently compensated occupational lung disease through workplace compensation.

Pneumoconiosis

Pneumoconiosis includes silicosis, coal workers' pneumoconiosis, and asbestosis, as well as historically less common diseases such as talc-related lung disease, siderosis, stannosis, bauxite lung (from aluminum), graphite lung and lung disease from beryllium. Even including hypersensitivity pneumonitis from organic dusts, yearly hospital admission rates in Canada have been only 1 or 2 per 100,000 population since the early 1990s, with mortality rates below 0.25 per 100,000 population, and less than 0.5 per 100,000 population among those 35 years of age and older. Figure 4–3 shows the rates for hospital admissions among those 35 and older, separated into hypersensitivity pneumonitis and various pneumoconiosis. There has been a decline in admission rates for all pneumoconiosis except asbestosis over time, as might be expected with better preventive measures at work. Reasons for lower rates of hypersensitivity pneumonitis are unclear, but they may be related to better control of exposures for some causes of hypersensitivity pneumonitis, such as in farmers' lung. These trends, similar to those reported in the United States, likely reflect improved occupational hygiene conditions in mines, better dust control, and better use of respiratory protective measures.

Asbestosis is an irreversible condition caused by inhaled asbestos fibres. Given the long latency of asbestosis and reduced exposure in the past 20 years, a further decline in hospitalizations may eventually be expected for this disease.

Mesothelioma is a malignant tumour affecting the lining of the chest or abdomen caused by asbestos exposure. Figures were not available for mesothelioma under the ICD coding system until the introduction of ICD 10 codes in 2001, and there are no current national estimates for this complication of asbestos exposure, as ICD 10 codes were not implemented in all provinces until 2006. However, the numbers of (pleural) mesothelioma cases reported by Cancer Care Ontario (Figure 4–4) have demonstrated the marked rise associated with asbestos exposure decades earlier.

Beryllium disease results from the inhalation of beryllium dust. Although provincial compensation data indicate that chronic beryllium disease has not been commonly reported, this condition may have been under-recognized and sometimes misdiagnosed as sarcoidosis. The increased use of beryllium in manufacturing, and the recent introduction of the beryllium lymphocyte proliferation test for diagnostic use and for medical surveillance of beryllium-exposed workers, may increase the diagnosis of chronic beryllium disease.

Conditions due to inhalation of chemicals, fumes or gases

In contrast to the trends for pneumoconiosis, hospital admissions rates for respiratory conditions due to inhalation of chemicals, fumes or gases remained steady from 1979 to 2004 (Figure 4–5). Respiratory conditions resulting from the inhalation of chemicals, fumes or gases were responsible for 7 deaths between 2000 and 2004. The specific causes and exposures leading to these hospital admissions and deaths are not identified in the hospitalization database. The exposures which may lead to these respiratory conditions include acute occupational or non-occupational accidental exposures to respiratory irritants such as may result from fires; spills of chemicals such as acids; mixing of cleaning chemicals such as bleach and ammonia; and gases such as nitrogen oxides from silos, or phosgene.

Occupational Asthma

In many Canadian jurisdictions, as in other industrialized nations, occupational asthma (asthma attributable to occupational exposures) is the most common of the chronic occupational lung diseases compensated for by workers compensation. Data on occupational asthma are not routinely collected as there is no specific ICD code that defines it in the hospital admissions and mortality data.

In the absence of a specific ICD code, hospital admissions and mortality due to occupational asthma can be estimated by linkage with other databases, such as compensation data. However, these likely underestimate true cases of occupational asthma, since not all cases are clinically recognized or have compensation claims submitted. The

limited Canadian (Ontario) data reported from linkage of compensation data with hospital admissions and mortality have suggested significantly increased rates of hospitalization for asthma (28-fold) and respiratory diseases (5-fold) among those compensated for occupational asthma, though approximately 50% less than that occurring in tertiary asthma clinic patients.[1] National data are not available on rates of confirmed occupational asthma.

Limited data from asthma questionnaires have suggested that up to 36% of adult-onset asthma in Canada may have an occupational component.[2] An American Thoracic Society analysis of published studies suggests an occupational contribution in 10%-15% of asthma overall.[3]

Previous Ontario compensation data indicated relatively stable rates of occupational asthma between 1993 and 2002 (Figure 4-6). While there has been a trend to falling rates of total adult hospital admissions and mortality from asthma, this does not necessarily reflect a reduction in incidence or in the socio-economic effects of occupational asthma or work-aggravated asthma.

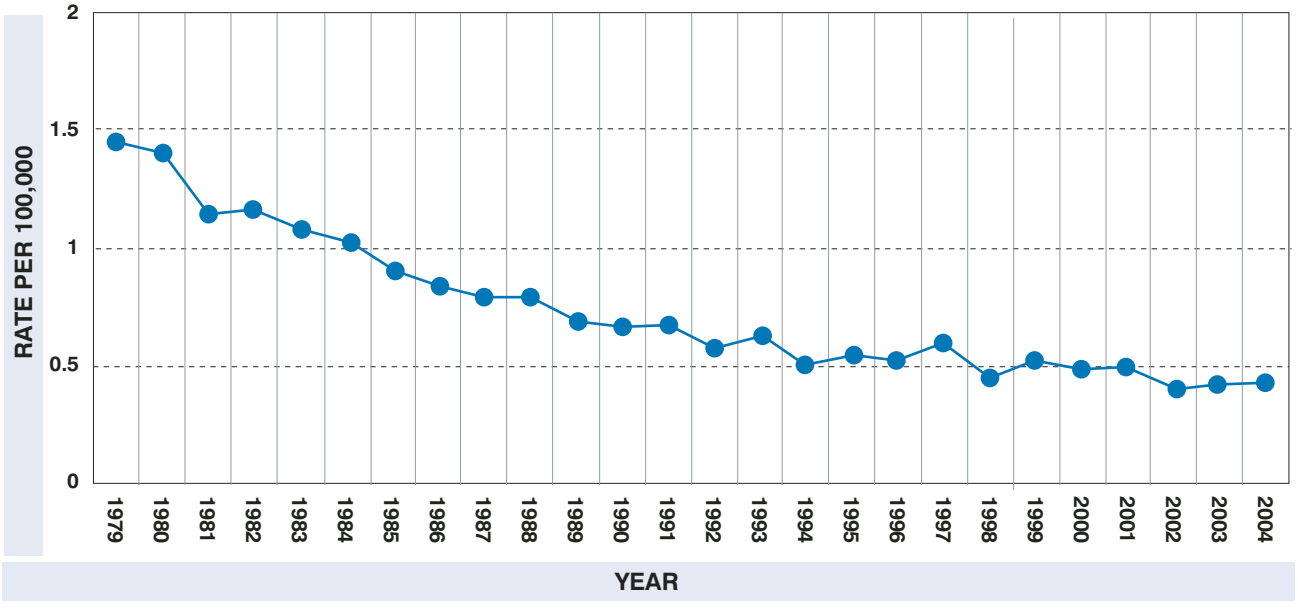
Other occupational lung diseases

Other occupational lung diseases for which ICD codes currently cannot provide diagnostic information include occupational lung cancer (from agents such as asbestos, chromium, radon), and occupational chronic obstructive lung disease (attributable to occupational exposures in an estimated 15% of cases).3 Numbers available from compensation boards are likely to be markedly underestimated.

Summary

In summary, the information available has provided encouraging information as to declining rates of pneumoconiosis in Canada but has raised concerns as to increased rates of hospital admissions and mortality from respiratory exposures to chemicals and other agents. Before preventive measures can be taken, however, further definition will be required. Other diseases of concern which cannot be evaluated from the available ICD coding system for mortality and hospitalization include work-related asthma, chronic obstructive lung diseases and occupational lung cancer.

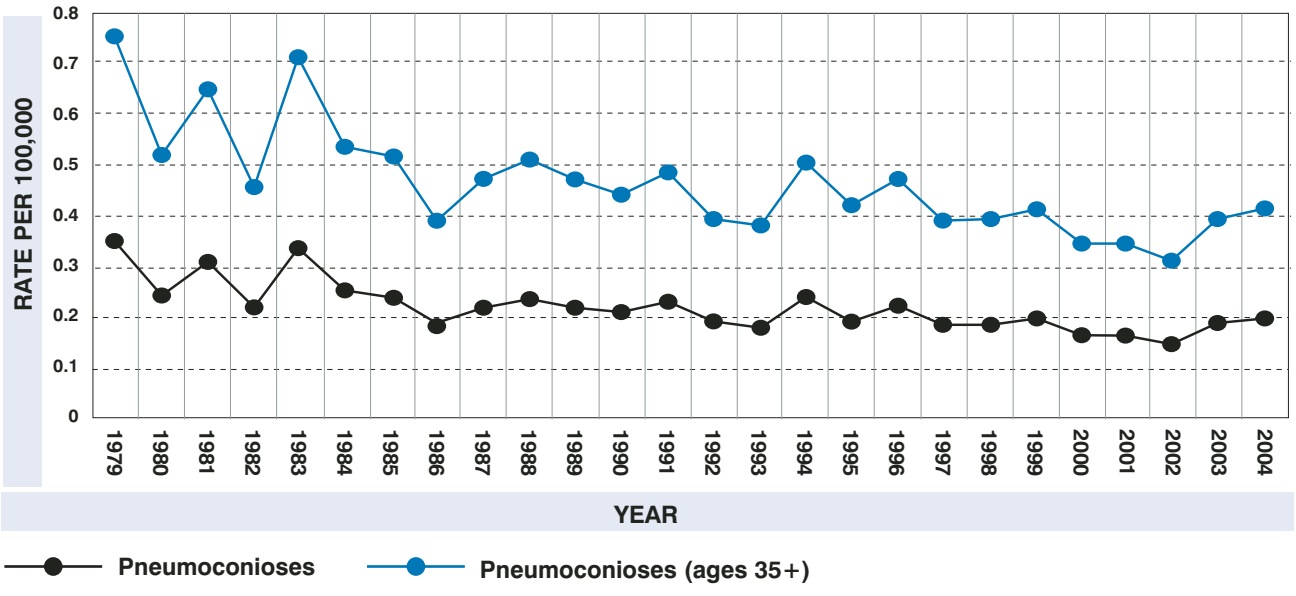
Figure 4-1 Pneumoconioses hospitalization rates (per 100,000), Canada*, 1987-2004 (age-standardized to 1991 Canadian population).



* Data for territories unavailable prior to 1993 and data for Nunavut not available for 2002.

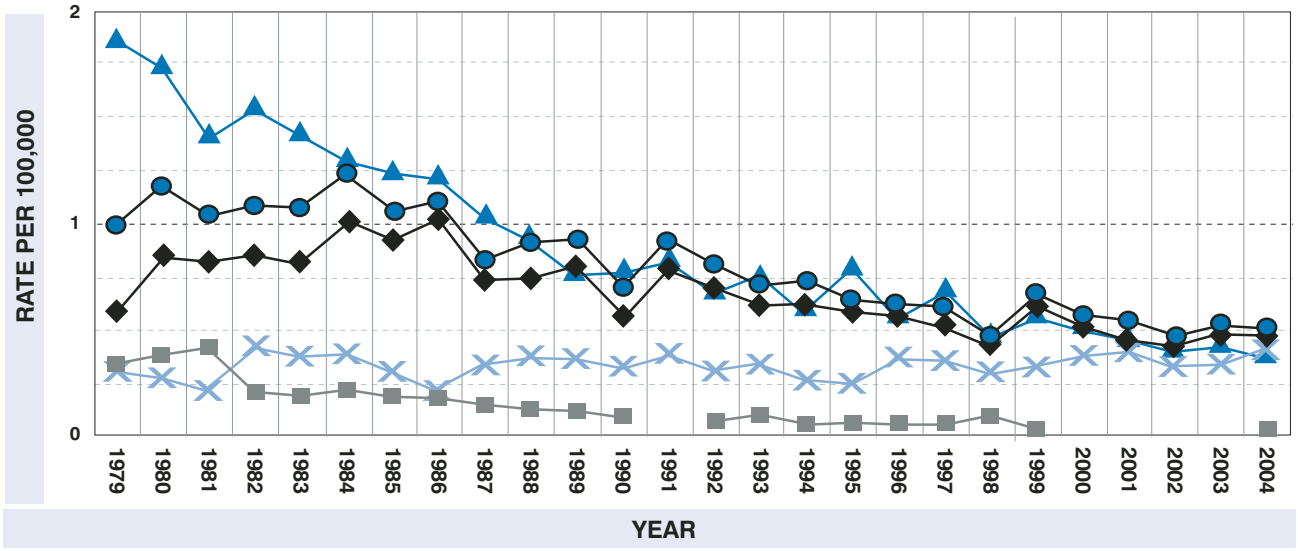
Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Hospital Morbidity File (acute and chronic), Canadian Institute for Health Information.

Figure 4-2 Pneumoconioses mortality rates (per 100,000), Canada, 1987-2004 (age- standardized to 1991 Canadian population).



Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using Statistics Canada annual mortality data.

Figure 4-3 Pneumoconioses and hypersensitivity pneumonitis hospitalization rates (per 100,000), Canada*, 1987-2004, aged 35+ years, (age-standardized to 1991 Canadian population)

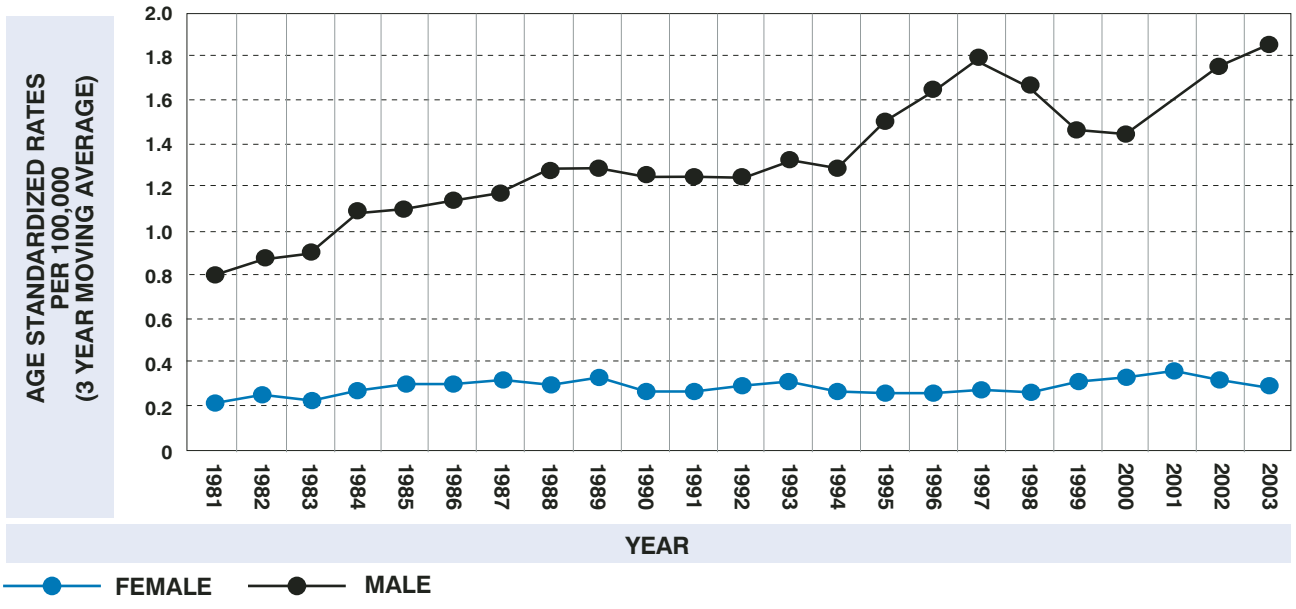


* Data for territories unavailable prior to 1993 and data for Nunavut not available for 2002.

Note: Rates based on less than 5 cases are suppressed

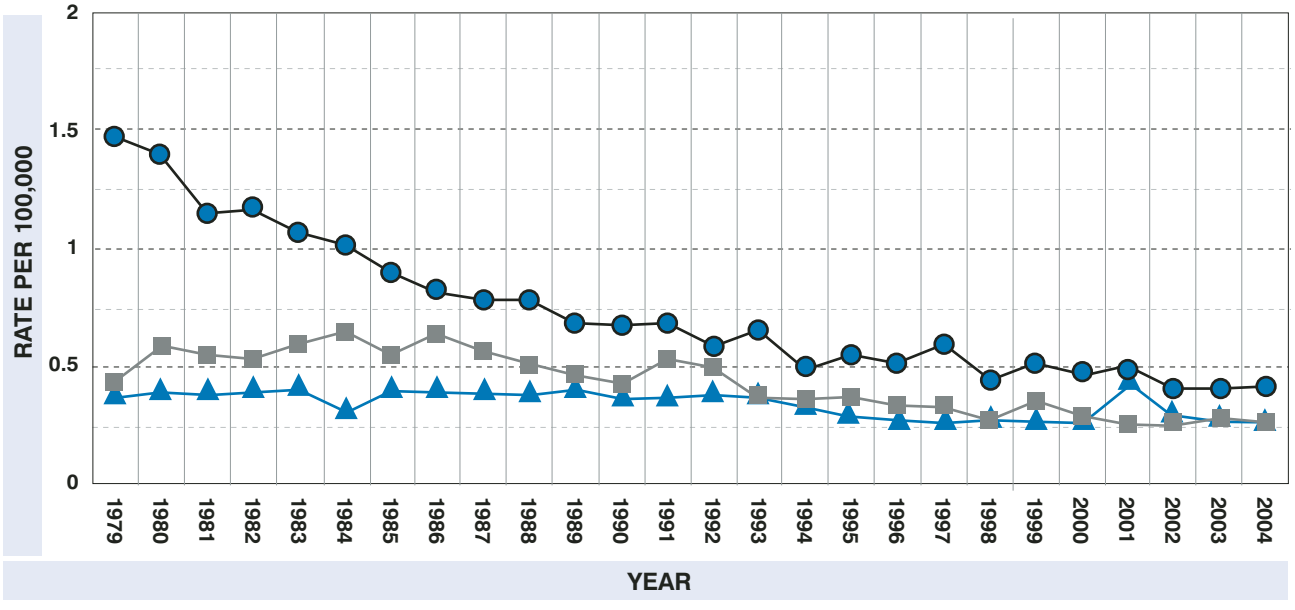
Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Hospital Morbidity File (acute and chronic), Canadian Institute for Health Information.

Figure 4-4 Ontario Mesothelioma Incidence Rate, 3 year moving average, by Sex, 1980-2004



Source: Cancer Care Ontario (Ontario Cancer Registry 2006). Age-standardized to Canada 1991

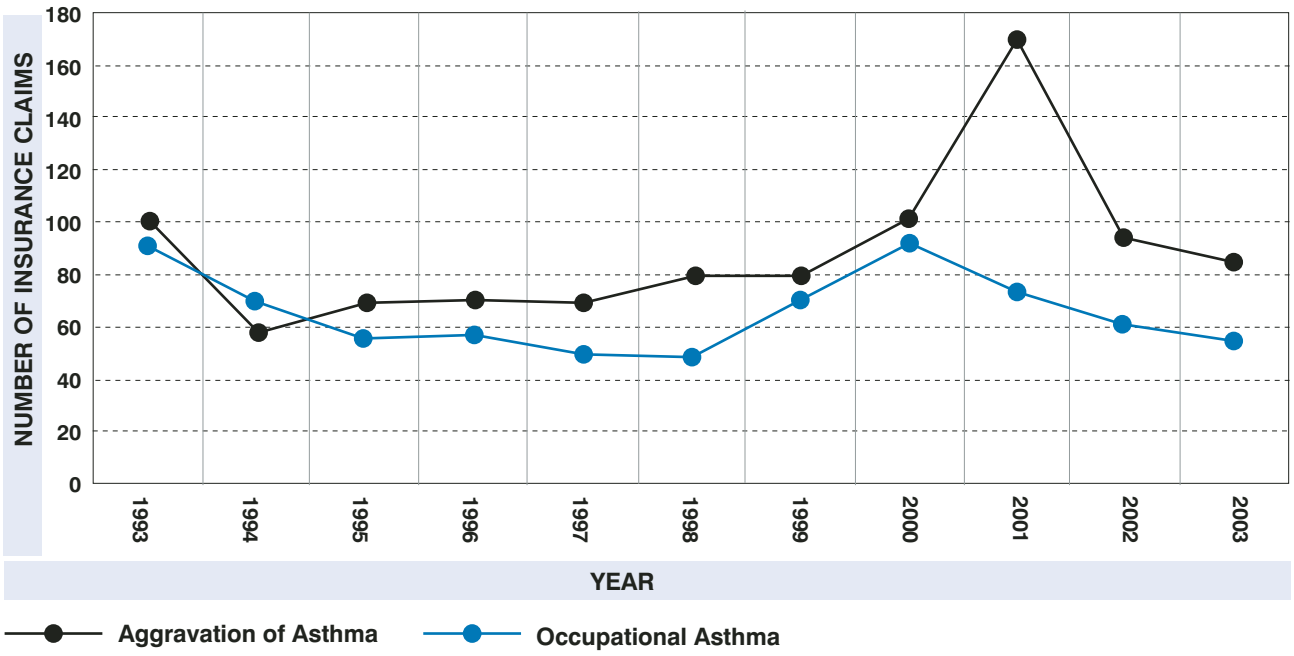
Figure 4-5 Occupational respiratory disease hospitalization rates (per 100,000), Canada*, 1979-2004 (age-standardized to 1991 Canadian population).



* Data for territories unavailable prior to 1993 and data for Nunavut not available for 2002

Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Hospital Morbidity File (acute and chronic), Canadian Institute for Health Information.

Figure 4-6 Ontario Workplace Safety and Insurance Board, Occupational Asthma and Aggravation of Asthma Claims, Accident Data, 1993 to 2003*



* with permission from Ontario Workplace Safety and Insurance Board (WSIB)

Note: peak of aggravation of asthma claims in 2001 coincided with a strike of cleaners in schools

Source: Ontario WSIB's Occupational Disease Information and Surveillance System

1 Liss GM, Tarlo SM, Macfarlane Y, et al. Hospitalization among workers compensated for occupational asthma. Am J Respir Crit Care Med 2000; 162:112-118.

2 Johnson AR, Dimich-Ward HD, Manfreda J, et al. Occupational asthma in adults in six Canadian communities. Am J Respir Crit Care Med 2000; 162:2058-2062.

3 Balmes J, Becklake M, Blanc P, et al. American Thoracic Society Statement: Occupational contribution to the burden of airway disease. Am J Respir Crit Care Med 2003; 167:787-797.

Chapter 5

Asthma

Asthma

Introduction

Asthma is a chronic health disorder affecting a substantial proportion of children and adults worldwide. It is characterized by cough, shortness of breath, chest tightness and wheeze. Asthma symptoms and attacks (episodes of more severe shortness of breath) usually occur after exercise or exposure to allergens, viral respiratory infections ("colds"), irritant fumes or gases. These exposures cause an inflammation of the airway wall and an abnormal narrowing of the airways, which lead to asthma symptoms. Effective treatment can prevent the onset of symptoms in response to these triggers and can control symptoms once they occur.

Risk Factors

Longitudinal studies suggest that susceptibility to childhood asthma is determined during fetal development and in the first three to five years of life. A number of possible risk factors have been suggested for the development of asthma. They include the following:

- family history of allergy and allergic disorders (including hay fever, asthma and eczema)[1]
- high exposure of susceptible children to airborne allergens (pets, house dust mites, cockroaches, mould) in the first years of life[2]
- exposure to tobacco smoke, including in utero exposure[13]
- frequent respiratory infections early in life[4]
- low birthweight and respiratory distress syndrome (RDS)[5]

The onset of asthma in adults may result from occupational exposures to low molecular weight sensitizers such as isocyanates, or following exposure to infectious agents, allergens or pollution.[6] It is unlikely that atmospheric pollution is a primary cause of asthma unless other factors are present. Indeed, most evidence suggests that air pollution is a trigger for worsening asthma. Among women, other possible risk factors include smoking, obesity and hormonal influences.[7]

Prevalence

Among Canadian children between the ages of 4 and 11 years, 15.6% (485,700 children) have ever been diagnosed with asthma (Table 5–1). The prevalence of physician-diagnosed asthma among Canadians 12 years of age and over is 8.3% overall (2.2 million Canadians). Of off-reserve Aboriginal people 12 years of age and over, 11.9% have asthma (Table 5–2). Since 1994–95, the prevalence of physician-diagnosed asthma has been consistently higher among young boys than girls, but the reverse is true among adult women and men (Figure 5–1, 5–2, 5–3). The true prevalence of asthma may differ from estimates provided in population surveys, which rely on self-reporting of physician-diagnosed asthma: some individuals with asthma may not yet have been diagnosed and others may be misdiagnosed.

An asthma attack can be a frightening event, with feelings of suffocation, breathlessness, and loss of control; it can also be life-threatening. In 2005, 70.8% of individuals with asthma 12 years of age and over reported that they had had asthma symptoms or an attack or used medications for asthma in the previous 12 months (Figure 5–3).

Between 1994–95 and 2005, the prevalence of physician-diagnosed asthma increased by 60% among women in the 35–44 year age group and 80% among women aged from 45–64 years (Figure 5–4). Prevalence also increased by 41% among men in the 35–44 year age group (Figure 5–5).

Services/Hospitalizations

Most asthma can be well controlled with medication and environmental controls allowing the individual to lead a full active life. Poor asthma control often results in time away from school, work, sports or other activities that affect quality of life. One measure of poor asthma control is visits to emergency rooms and/or hospitalizations for an asthma problem.

Hospitalizations

Hospitalization rates for asthma among children and young adults have decreased since 1987 (Figure 5–6). Hospitalization rates have also decreased among older adults since 1987, especially among those over 65 years of age (Figure 5–7). While this decline likely reflects improved disease control, another factor influencing is the downsizing in the hospital sector, which has reduced the availability of beds.

Asthma continues to be a major cause of hospitalization for children in Canada. When listed as one of the first five diagnoses on the hospitalization record, asthma contributed to 10% of all admissions in the 0–4 year age group and 8% of all admissions in the 5–14 year age group in 2004 (see Figure 1–3).

Children younger than 5 years of age had the highest hospitalization rates for asthma in 2004. Rates among boys were higher than for girls in the under-15 age group, but this reversed in older age groups (Figure 5–8). Hospitalization rates among middle-aged women were more than twice those of middle-aged men.

Table 5-1 Prevalence of physician-diagnosed asthma (ever) among children aged 4-11 years, Canada, 2000.

AGE GROUP (YEARS)	BOYS		GIRLS		TOTAL	
	%	Number	%	Number	%	Number
4-7	18.2	142,000	10.6	79,500	14.5	221,500
8-11	19.6	160,200	13.4	104,000	16.6	264,200
4-11	18.9	302,200	12.1	183,500	15.6	485,700

Numbers are rounded to the nearest 100.
Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from National Longitudinal Survey of Children and Youth (cross-sectional component), Statistics Canada.

Table 5-2 Prevalence of physician-diagnosed asthma, men and women aged 12+ years, Canada, 2005.

AGE GROUP (YEARS)	MEN		WOMEN		TOTAL	
	%	Number	%	Number	%	Number
12-19	11.9	203,800	11.4	186,500	11.7	390,300
20-44	6.9	396,500	10.1	580,200	8.5	976,700
45-64	5.1	210,800	9.2	387,700	7.2	598,500
65+	6.8	117,900	8.1	176,200	7.5	294,100
12+	7.0	929,000	9.7	1,330,700	8.3	2,259,700
Aboriginal people off reserve 12+	9.9	29,800	13.8	42,000	11.9	71,800

Numbers are rounded to the nearest 100.
Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Canadian Community Health Survey, Statistics Canada.

Emergency Visits

Emergency room (ER) visits for asthma vary during the course of the year, peaking during the third week in September for all age groups. While respiratory tract infections often precipitate asthma symptoms, visits for respiratory tract infections tend to peak in mid-winter. The cause for this phenomenon is unknown at this time (Figure 5-9).

Health Outcomes

Deaths

Although deaths from asthma are uncommon among children and young adults, even one death is unacceptable for a disease that is fully treatable. The higher number of deaths among women over age 65 reflects the higher asthma mortality rate among women and the higher number of women compared to men in this age group (Figure 5-10). Asthma mortality rates have been decreasing in all age groups since 1987, particularly in the 65+ age group (Figure 5-11 and Figure 5-12).

Discussion and Implications

While asthma is often considered a children's disease, it is common among Canadians of all age groups. Children and teens do have the highest prevalence of asthma and the highest hospitalization rates. In terms of number of people affected, however, the disease actually affects more adults than children. The prevalence among adults is increasing and is cause for concern. Further research is needed to identify the factors responsible for increased prevalence, as well as to study the primary prevention of asthma in individuals at risk.

Sex of the individual appears to be a factor in the prevalence of physician-diagnosed asthma. The condition is more common among young boys than girls and among adult women than men. This could be because women visit their physicians more often and are therefore more likely to be diagnosed. However, the difference may be due to the effect of the smaller airways of boys compared to girls and in women compared to men, hormonal influences and variable sensitivity to irritants and allergens.

The data on emergency room visits and hospitalization suggest that asthma control is improving in the population. One critical factor in control is the appropriate use of Asthma Practice Guidelines by physicians. Another critical element for effective control is the active involvement of individuals with asthma and their families. Many asthmatics need help in utilizing management strategies such as asthma action plans. Adequate training of asthma educators, funding for asthma education and increased access to this service could improve the effective control of symptoms and the appropriate use of health services by individuals with asthma. Efforts need to continue in order to further improve asthma control in the population.

Reducing exposure to airborne contaminants at school and in the workplace, as well as to second-hand smoke, house dust mites, animal dander and moulds, may help reduce the risk of asthma for sensitive individuals. It may also decrease symptoms and attacks among those with asthma.

While individuals can take personal responsibility for some preventive measures, other solutions require the collaborative efforts of government, industry and business. Legislation, policies and voluntary co-operation need to be part of a concerted effort to decrease school and workplace contaminants and improve air quality.

The current asthma surveillance system in Canada provides ongoing data on prevalence, hospitalization and death. The addition of in-depth population surveys on asthma, combined with improved use of provincial/territorial health administrative databases for surveillance, would provide additional meaningful information to policy makers.

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1 Global Strategy for Asthma Management and Prevention, Global Initiative for Asthma (GINA) 2006. Available from: *http://www.ginasthma.org*.

2 ibid.

3 ibid.

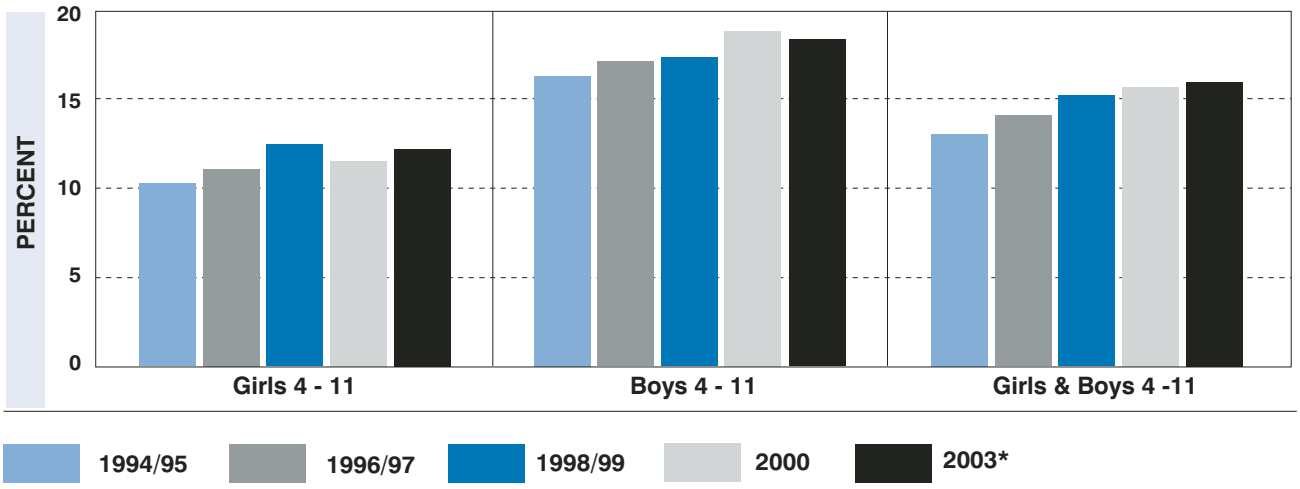
4 ibid.

5 Shaubel D et al. Neonatal characteristics as risk factors for preschool asthma. J Asthma 1996; 33:4:255-64.

6 Pearce N et al. Is allergen exposure the primary cause of asthma? Thorax 2000;424-431.

7 Chen Y et al. Increased effects of smoking and obesity among female Canadians: The National Population Health Survey, 1994/95. Am J Epidemiol 1999;150:3:255-63.

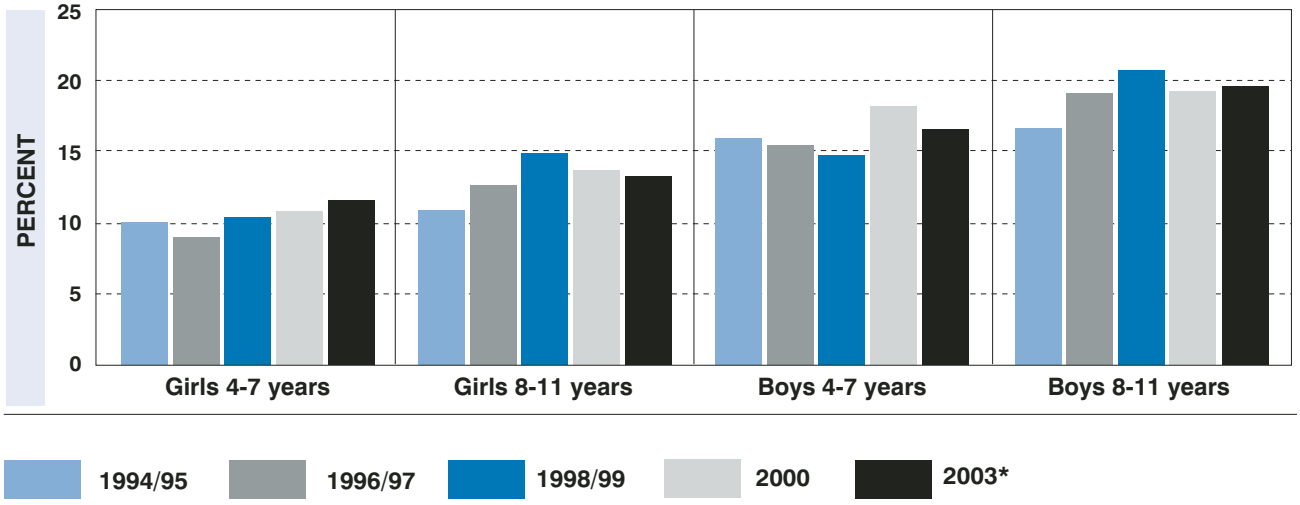
Figure 5-1 Prevalence of physician diagnosed asthma (ever), children aged 4-11 years, Canada, 1994/95 to 2003.



Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from National Longitudinal Survey of Children and Youth (cross-sectional component), Statistics Canada.

* For 2003, the cross sectional component included only ages 5 and under. Ages 7 and over are from the longitudinal component, and individuals age 6 were not included in either samples.

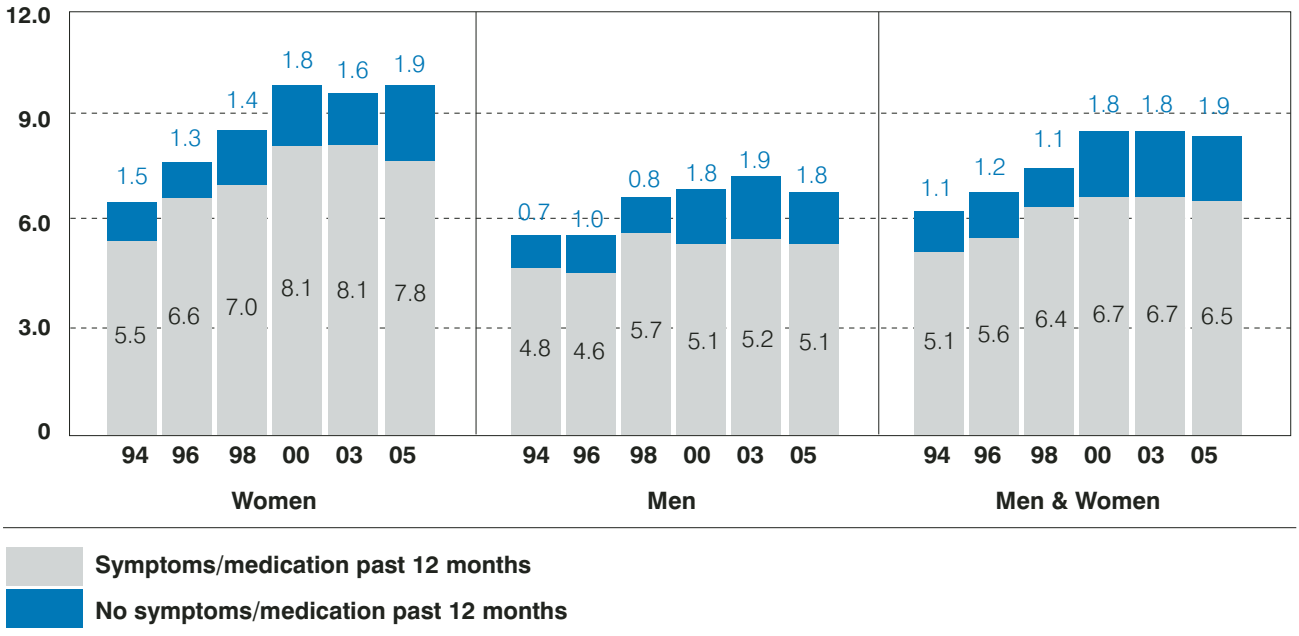
Figure 5-2 Prevalence of physician diagnosed asthma (ever), children aged 4-11 years by age group, Canada, 1994/95 to 2003.



Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from National Longitudinal Survey of Children and Youth (cross-sectional component), Statistics Canada.

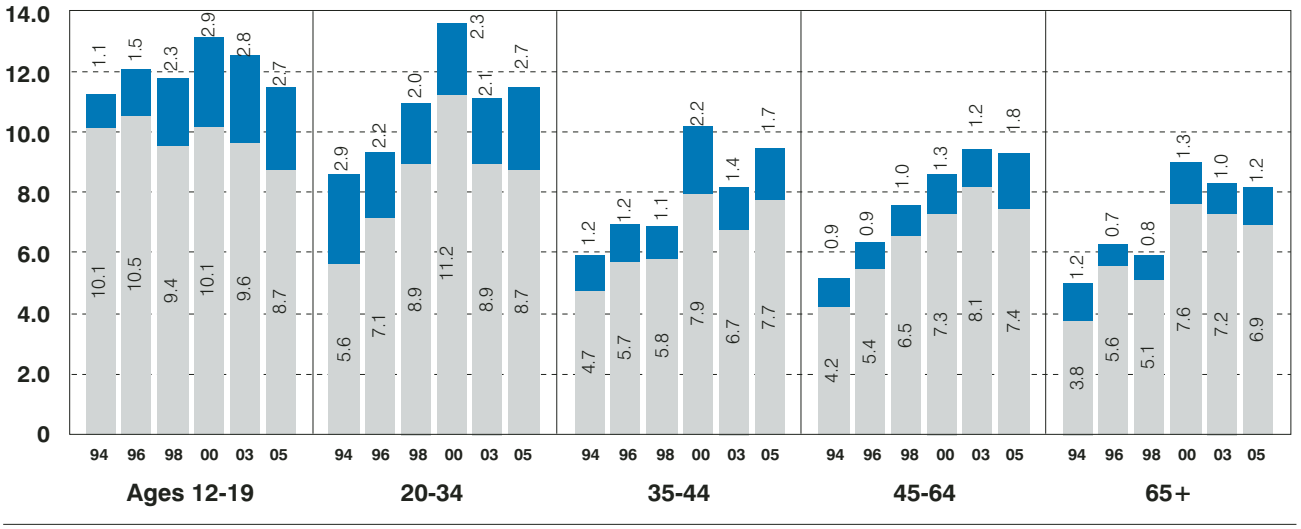
* For 2003, the cross sectional component included only ages 5 and under. Ages 8 and over are from the longitudinal component, and age 4-7 includes only 4-5.

Figure 5-3 Prevalence of physician-diagnosed asthma by recent symptom or medication use, men and women aged 12+ years, Canada, 1994 - 2005.



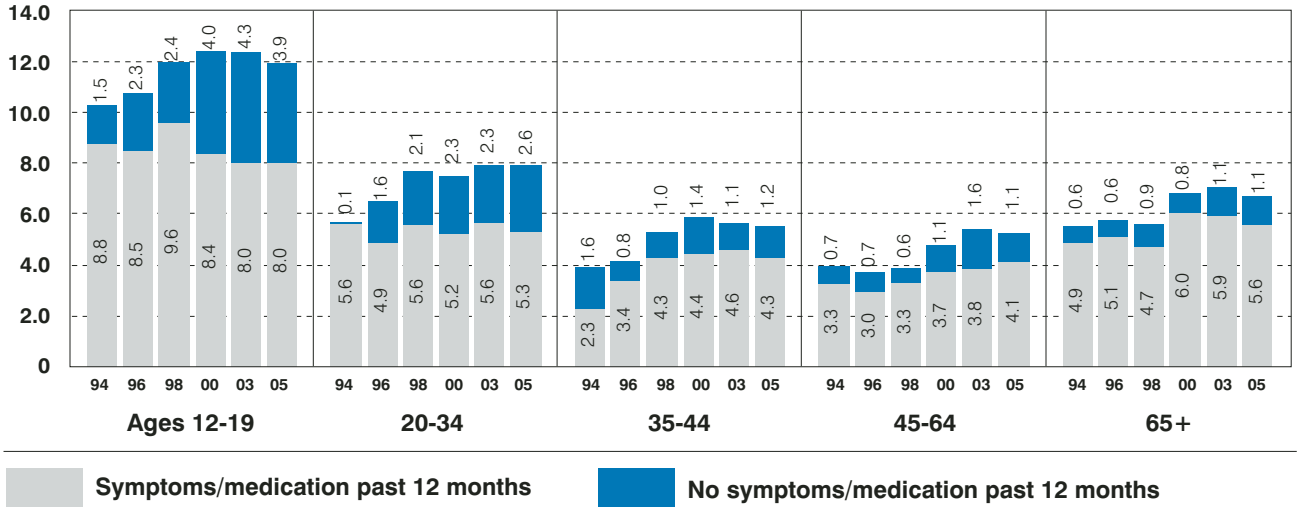
Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from National Population Health Survey (general share file) 1994, 1996, 1998 and Canadian Community Health Survey 2000-01, 2003, 2005 (Statistics Canada).

Figure 5-4 Prevalence of physician-diagnosed asthma by recent symptom or medication use, women aged 12+ years by age group, Canada, 1994 - 2005.



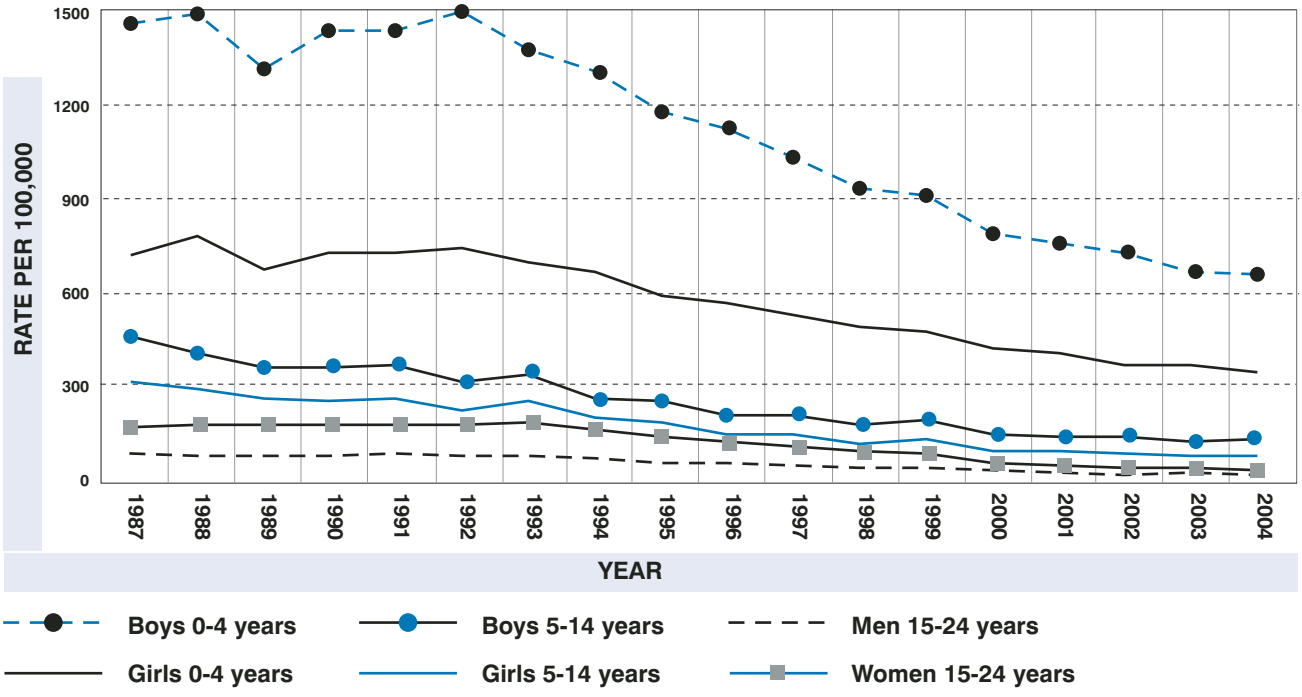
Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from National Population Health Survey (general share file) 1994, 1996, 1998 and Canadian Community Health Survey 2000-01, 2003, 2005 (Statistics Canada).

Figure 5-5 Prevalence of physician-diagnosed asthma by recent symptom or medication use, men aged 12+ years by age group, Canada, 1994 – 2005.



Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from National Population Health Survey (general share file) 1994, 1996, 1998 and Canadian Community Health Survey 2000-01, 2003, 2005 (Statistics Canada).

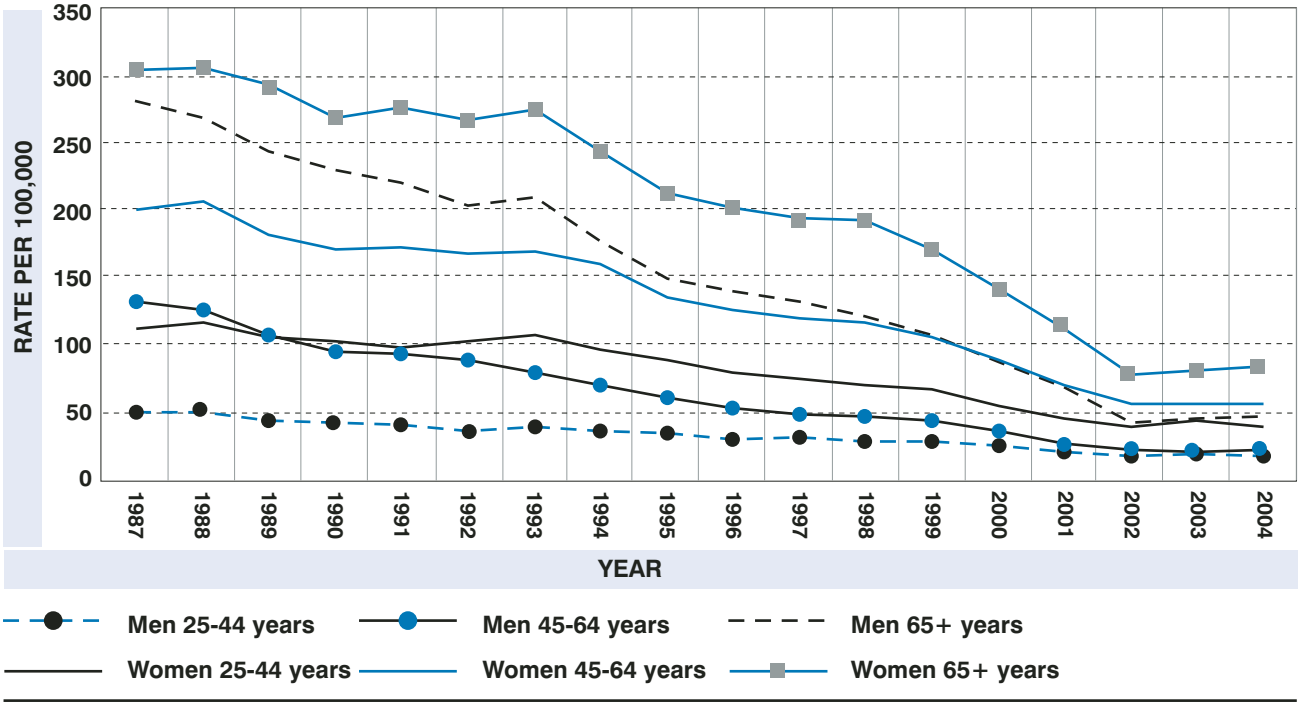
Figure 5-6 Asthma hospitalization rates (per 100,000), children and young adults aged 0 to 24 years by age group and sex, Canada*, 1987/88-2004/05 (age-standardized to 1991 Canadian population).



* Data for territories unavailable prior to 1993 and data for Nunavut not available for 2002.

Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Hospital Morbidity File (acute and chronic), Canadian Institute for Health Information.

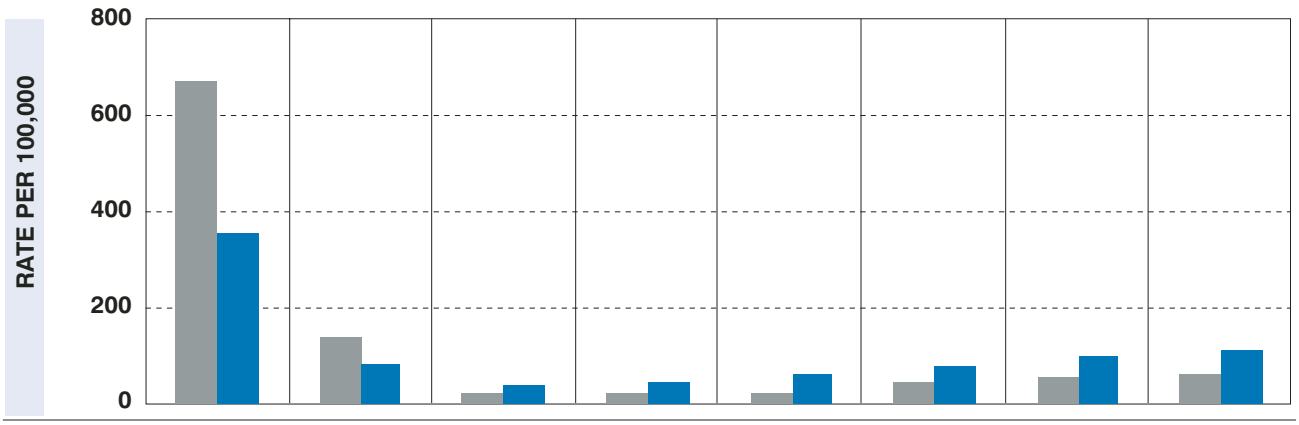
Figure 5-7 Asthma hospitalization rates (per 100,000), adults aged 25+ years, by age group and sex, Canada*, 1987/88-2004/05 (age-standardized to 1991 Canadian population).



* Data for territories unavailable prior to 1993 and data for Nunavut not available for 2002.

Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Hospital Morbidity File (acute and chronic), Canadian Institute for Health Information.

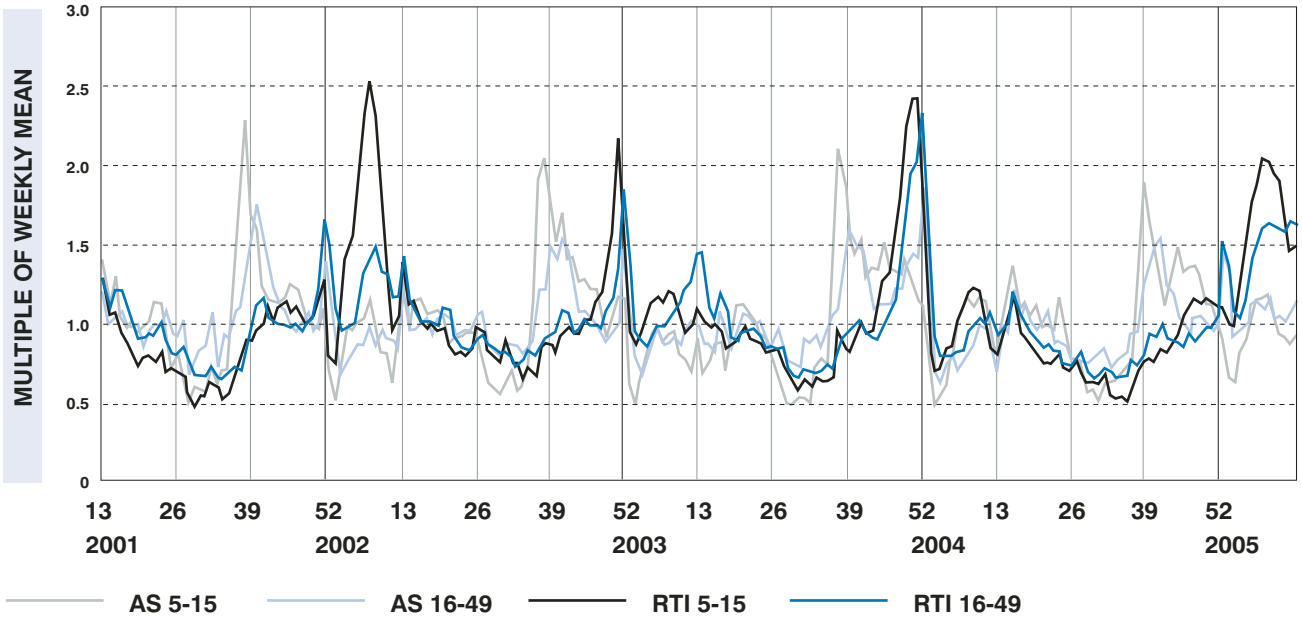
Figure 5-8 Asthma hospitalization rates (per 100,000) by age group and sex, Canada, 2004/05.



	0-4 years	5-14 years	15-24 years	25-44 years	45-64 years	65-74 years	75-84 years	85+ years
Men	664	134	22	19	22	42	56	60
Women	350	83	39	42	56	75	99	108

Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Hospital Morbidity File (acute and chronic), Canadian Institute for Health Information.

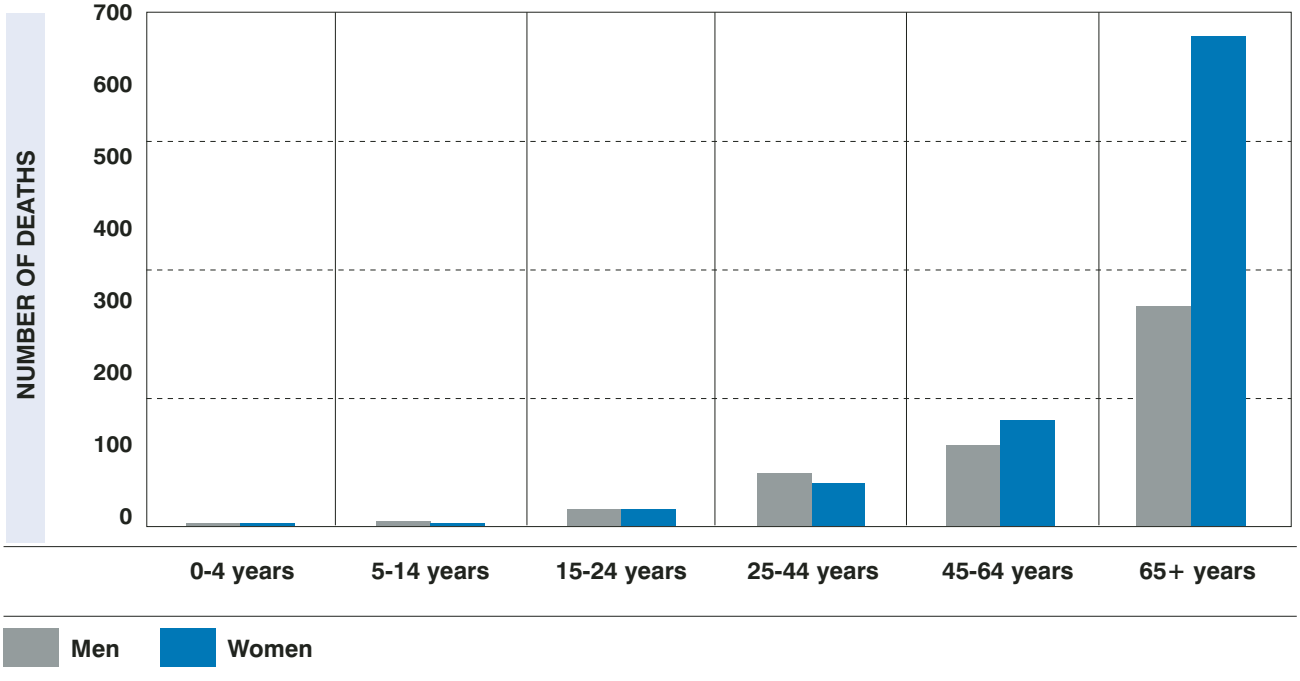
Figure 5-9 ER presentations for asthma and respiratory tract infections by week in Ontario from April 2001 to March 2005, ages 5 to 49 years



Note: AS = ER presentations for asthma, RTI = ER presentations for respiratory tract infections.

Source: Neil Johnston, Firestone Institute for Respiratory Health using data from the CIHI National Ambulatory Care Reporting System file for Ontario from April 2001 to March 2005.

Figure 5-10 Asthma deaths by age group and sex, Canada, 2000-2004.

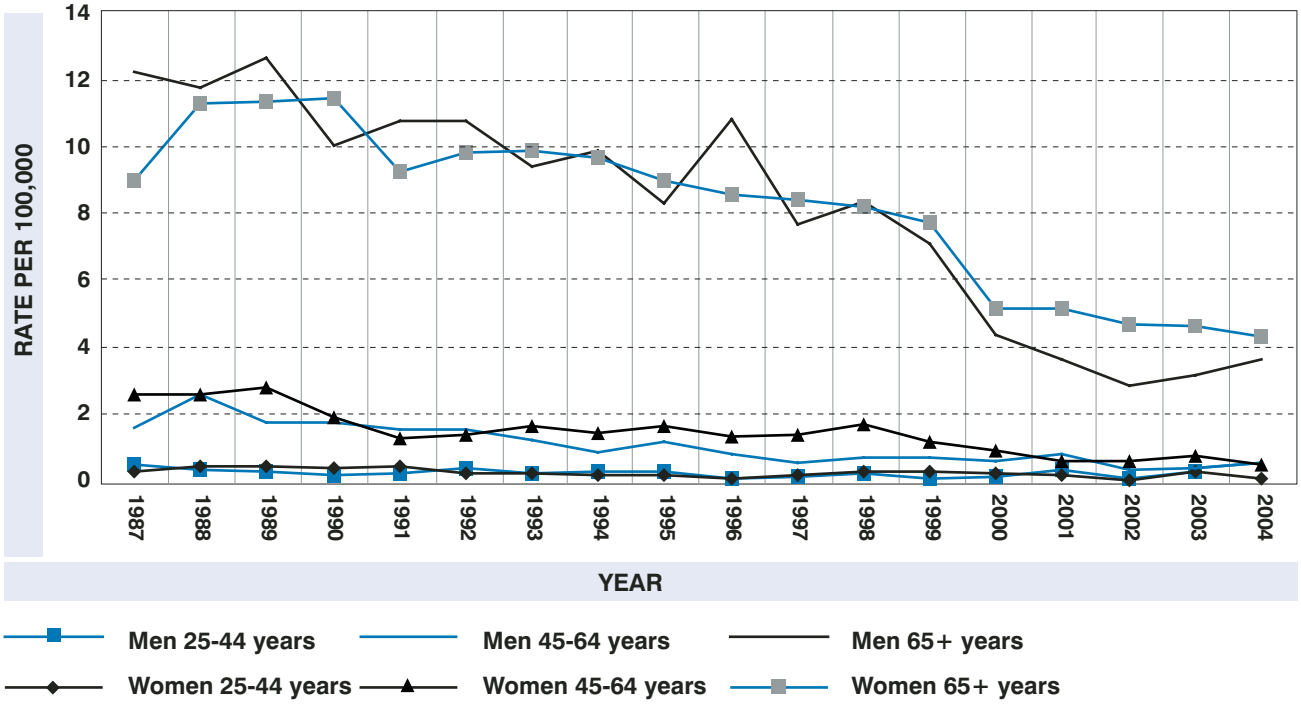


Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using Statistics Canada annual mortality data.

Figure 5-11 Asthma mortality rates (per 100,000), children and young adults aged 0 to 24 years, Canada, 1987-2004 (age-standardized to 1991 Canadian population)

Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using Statistics Canada annual mortality data.

Figure 5-12 Asthma mortality rates (per 100,000), adults aged 25+ years by age group and sex, Canada, 1987-2004 (age-standardized to 1991 Canadian population).



Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using Statistics Canada annual mortality data.

Chapter 6

COPD

COPD

Introduction

Chronic obstructive pulmonary disease (COPD) is a chronic disease characterized by shortness of breath, cough and sputum production.[1] Its symptoms do not usually appear in people younger than age 55. The changes to the lung, however, begin many years earlier. Chronic bronchitis and emphysema are the two most common underlying processes that contribute to COPD.

COPD progresses slowly over a period of years. Increasing disease severity is associated with more frequent exacerbations, further reductions in airflow and premature death. As the disease advances, shortness of breath limits the activity levels of individuals and reduces their quality of life. In its more severe stages, the effects of the disease are felt more frequently, often resulting in further reductions in airflow and premature death. Families also face two challenges: first, of providing an increasing level of care; and second, watching the progression of the disease in their loved one. The costs associated with COPD–loss of productivity and the need for additional services–affect the family, the health care system and the community as a whole.

Risk Factors

Several modifiable risk factors contribute to COPD.[2] In 80% to 90% of cases, cigarette smoking is the principal underlying cause. The contribution of primary smoking is very clearly established, and exposure to second-hand smoke (SHS) likely also plays an important, if less well defined, role. Another major risk factor is occupational exposure to dusts (e.g., cadmium dust, gold dust, coal dust, grain dust) and some fumes. Exposure to non-specific dust is likely to add to the effect of smoking. Outdoor air pollution is associated with increased symptoms among those with COPD, including shortness of breath. Repeated childhood respiratory tract infections and childhood exposure to second-hand smoke (SHS) lead to reduced levels of respiratory function, which may predispose to COPD. A genetic deficiency of alpha-1-antitrypsin, an anti-protease which protects the lung tissue from damage, is also associated with an increased risk of COPD.

Table 6-1 Prevalence of physician-diagnosed COPD, adults aged 35+ years, by sex, Canada, 2005.

AGE GROUP (YEARS)	MEN		WOMEN		Total	
	%	Number	%	Number	%	Number
35-44	1.6	41,900	2.5	61,700	2.0	103,700
45-54	2.7	63,200	4.0	98,100	3.4	161,200
55-64	4.1	72,000	6.0	105,300	5.0	177,300
65-74	6.7	71,500	7.2	84,600	7.0	156,100
75+	11.8	80,800	7.5	75,500	9.3	156,400
35+	3.9	329,500	4.8	425,300	4.4	754,700
Aboriginal people off reserve – 35 + *	7.2	9,900	8.5	12,500	7.9	22,400

Numbers are rounded to the nearest 100.
* = small sample size
Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Canadian Community Health Survey, Statistics Canada.

Prevalence

Of adults over the age of 34 surveyed in the Canadian Community Health Survey (CCHS) of 2005, 4.4% (3.9% of men [329,500] and 4.8% of women [425,300]) reported that they had been diagnosed by a health professional with COPD (includes self-report of COPD, chronic bronchitis or emphysema). Results from the same survey indicate that among Aboriginal people living off reserve, 7.9% have COPD (Table 6–1). Unfortunately, since the early symptoms of the disease are often not recognized, many individuals do not seek treatment. Results from a recent Burden of Obstructive Lung Disease study conducted in Austria indicate that self-reported physician diagnosed COPD may underestimate the prevalence by at least 50% in individuals 40 years of age and over.[3] Consequently, these figures may under-represent the actual prevalence of COPD in the population. In addition, the diagnostic challenges in differentiating between asthma and COPD among older smokers may result in the misclassification of one disease as the other. As a result, data for the older age groups must be interpreted with caution.

The proportion of individuals diagnosed with COPD increases with age. In 2005, a higher proportion of women than men under the age of 75 had been diagnosed with COPD; this trend reversed, however, in the 75+ age group (Table 6–1). The difference between men and women in the older age group is a function of the higher prevalence of smoking in men than in women 50 years ago. The higher prevalence of COPD among younger women may reflect the greater sensitivity of women to the harmful components of tobacco smoke.[4] It may also reflect differences in the health care-seeking behaviours of men and women. Women tend to visit their physicians more often than men and therefore may be diagnosed earlier with COPD.

Table 6-2 Proportion of adults 35 years of age and over with COPD, by sex and smoking status, Canada, 2005.

	MEN	WOMEN	MEN & WOMEN
Current smoker	32.6	34.3	33.6
Former smoker	58.3	43.1	49.9
Non smoker	9.2	22.6	16.7

Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Statistics Canada, Canadian Community Health Survey, Share File.

From 2001 to 2005, the yearly prevalence of self-reported COPD among women and men varies a little, but more years of data are required before a specific trend can be identified (Figures 6–1 and 6–2).

Almost 84% of Canadians over 35 years of age with self-reported COPD were or had been smokers (91% of men; 77% of women) and almost 40% of those were still smoking (Table 6–2).

Hospitalization

Hospitalization may be required in the treatment of COPD, particularly when symptoms worsen from infection. In 2004–05, the average length of stay in hospital for individuals aged 55 and over with COPD was 9.6 days.

In 2004–05, hospitalization rates for COPD increased steadily by age for both men and women after age 55. Rates were higher for men than women, particularly among the elderly. This is consistent with the higher smoking rates among men 40 to 50 years ago (Figure 6–3). While the hospitalization rates for COPD among men have been decreasing (see Figure 6–4), the numbers have been increasing because the number of older men has been increasing.

Hospitalization rates for each age group of men decreased slightly during the 1980s and 1990s, with the exception of men 80 years of age and over (Figure 6–4). The change to more community-based care in the delivery of health services may have contributed to this trend.

In contrast, hospitalization rates between 1989 and 2004–05 for COPD rose in all age groups for women aged over 60 years. This may reflect the increase in smoking among women in the past contributing to COPD now (Figure 6–5). Not only the rate, but the number of women hospitalized with COPD increased in the 1990s, and this trend is expected to continue (Figure 6–6). An increase over time in the number of older women in the population contributes to this trend.

Men aged 55 and over are more likely to be hospitalized for COPD than women of the same age, and men have more frequent hospital visits, either in the form of readmissions or transfers to other institutions (Figure 6–7).

Respiratory viral infections, especially rhinoviruses, are a major cause of COPD exacerbations, with upper respiratory tract infections being associated with over 50% of COPD exacerbations.[5, 6] COPD is the main risk factor for influenza-related hospital admissions and deaths. Based on death certificates, COPD was identified as the underlying cause of death in only 15% of deaths attributable to influenza.[7] However, hospitalization records reveal COPD to have been a diagnosed co-morbidity factor in over 50% of all deaths attributed to influenza.[8] Depending on the severity of the

circulating strain, COPD can account for as much as 50% of all influenza-attributed hospital admissions among seniors.[9]

Emergency room visits in Ontario for COPD in people over age 50 peak in mid-winter and matched the pattern of emergency room visits for respiratory tract infections for people over the age of 50 (Figure 6–8).

Home Care

COPD is a chronic disease that leads to a progressive loss of function. Home care services can enhance the quality of life for individuals with COPD by making it less necessary for them to be hospitalized. The CCHS, 2005, indicated that 16.8 % of individuals with COPD had received home care services in the preceding 12 months. The highest use was among those aged 75+ years (36.7%).

Activity Restriction

Quality of life deteriorates progressively in individuals with COPD. According to the 2005 CCHS, 45.0% of individuals with self-reported COPD reported that they often experienced a restriction in their activity at home, at work, or in other activities, and an additional 24.6% reported an occasional restriction. This has important implications for rehabilitation programs.

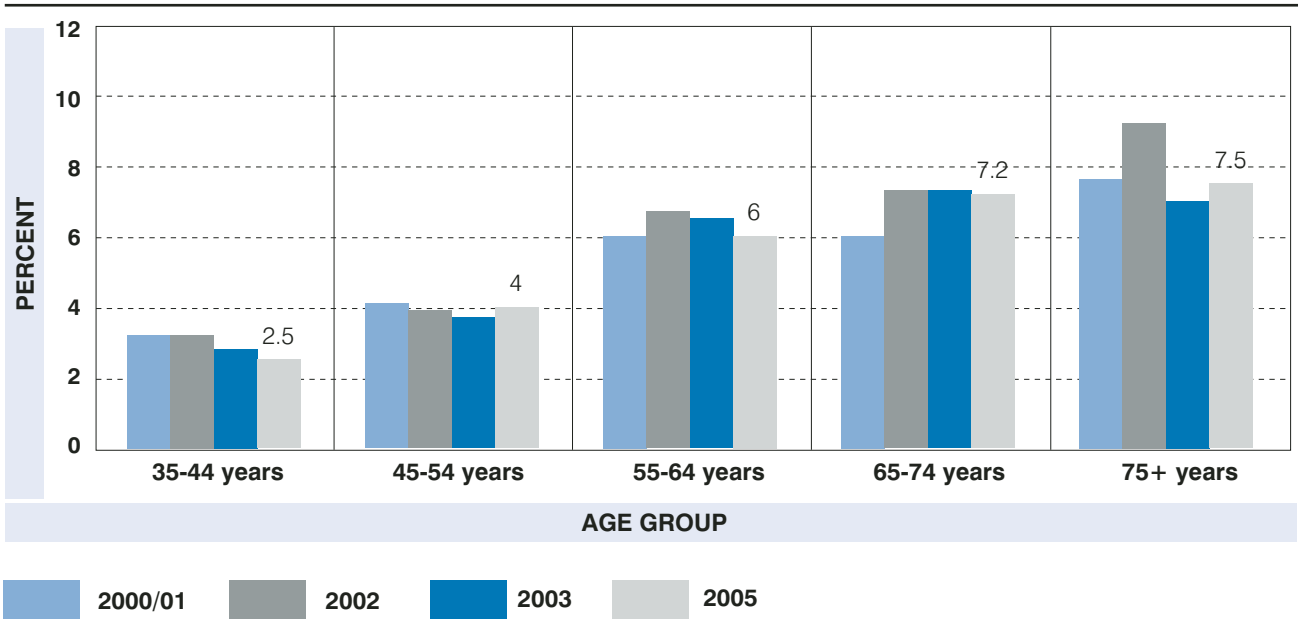
Mortality

In 2004, COPD was the cause for 5,152 deaths among men and 4,455 among women in Canada – 4% of all deaths. The actual mortality rate may be higher because two complications of COPD, pneumonia and congestive heart failure, may be listed as the cause of death for individuals with COPD. The underlying causes of death or comorbidities are not included in the COPD mortality statistics reported here.

In 2004, mortality rates due to COPD increased sharply after age 70, and rates were higher for men than women after this age (Figure 6–9). This difference reflects the higher rate of smoking among men 50 years ago.

Mortality rates due to COPD among women over age 75 increased between 1987 and 1998, particularly for women over the age of 80 years, but these rates stabilized between 1998 and 2004 (Figures 6–10 and 6–11). The increased mortality rate combined with more older women in the population has resulted in a dramatic increase in the number of women dyong of COPD from 1980 to 2004 (Figure 6–12). If present trends continue there will be more women than men dying of COPD by 2008. Rates among men of all ages have decreased slightly during this time period with the biggest decrease among men over age 80 (Figures 6–10 and 6–11).

Figure 6-1 Prevalence of physician-diagnosed COPD, women aged 35+ years, by age group, Canada, 2000/01, 2002, 2003 and 2005.



Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Canadian Community Health Survey, Statistics Canada.

Discussion and Implications

COPD continues to be a common and important health problem among Canadian adults, and the number of individuals with COPD is likely to increase as the population ages. Tackling this challenge will require a strong, co-ordinated response by government, health care providers, volunteer organizations, patient advocacy groups and community organizations.

While in the past COPD was much more common among men than women of all ages, the prevalence of COPD is now higher among women than men in individuals under age 74. This pattern will continue, and with it will come major implications for families and the health care system. Since a high proportion of older women live alone, the need will increase for home care, supportive housing and other community services.

The management of COPD involves the early diagnosis and treatment of symptoms, such as shortness of breath and cough. It also requires efforts to slow the progression of the disease and optimize functional ability.[10] The potential for the greatest gains in preventing COPD lie in smoking prevention and cessation (See also Chapter 2). Cessation of smoking can do a great deal to slow the progression of the disease. Involvement of the individual and family in all aspects of care is essential to improve health outcomes. Programs and services such as home care, home oxygen, supportive housing and pulmonary rehabilitation, provided in a supportive community environment, can meet the needs of individuals with COPD and their families. Improving indoor and outdoor air quality would eliminate several factors that exacerbate symptoms of COPD (See Chapter 3).

The increase in the number of people with COPD will require the expansion of existing services in primary care, emergency, hospital, specialist care, pulmonary rehabilitation, home care and home oxygen use. Providing the optimal level of rehabilitation services in the community will be a particular challenge. Currently, these services are primarily hospital-based. In the future, they will require an increase in funding levels and the re-organization of delivery methods, locations and providers.

Monitoring COPD more effectively will require a more comprehensive surveillance system. While the data from the CCHS give some sense of the number of people who have been diagnosed with COPD, it misses those who are unaware they have the disease. A population survey that includes assessing lung function with spirometry–such as Statistics Canada's planned 2008 Canadian Health Measures Survey–would provide a more complete picture of the prevalence of COPD in the population. In addition, data on the use of health services other than hospital services, such as home care, oxygen therapy and pulmonary rehabilitation, would provide fuller information for the identification of the need for new or enhanced programs and services. Finally, population surveys to assess the impact of the disease and the quality of life of those with COPD would add another dimension to the data on health outcomes.

1 Ferguson GT, Cherniak RM. Management of chronic obstructive pulmonary disease. N Engl J Med 1993; 328(14):1017-22.

2 Silverman EK, Speizer FE. Risk factors for the development of chromic obstructive pulmonary disease medical clinics of North America 1996;80:3:501-22.

3 Schirnhofer L, Lamprecht B, Vollmer WM, Allison MJ, Studnicka M, Jensen RL, Buist AS. COPD prevalence in Salzburg, Austria: results from the Burden of Obstructive Lung Disease (BOLD) Study. Chest. 2007 Jan; 131(1): 29-36

4 Chen Y, Horne SL, Dosman JA. Increased susceptibility to lung dysfunction in female smokers. Am Rev Respir Dis 1991;143:1224-30.

5 Wedzicha JA. Role of Viruses in Exacerbations of Chronic Obstructive Pulmonary Disease. Proc Am Thorac Soc. 2004; 1(2):115-120.

6 Mallia P, Contoli M, Caramori G, Pandit A, Johnston S, Papi A. Exacerbations of asthma and chronic obstructive pulmonary disease (COPD): focus on virus induced exacerbations. Curr Pharm Des. 2007; 13(1):73-97.

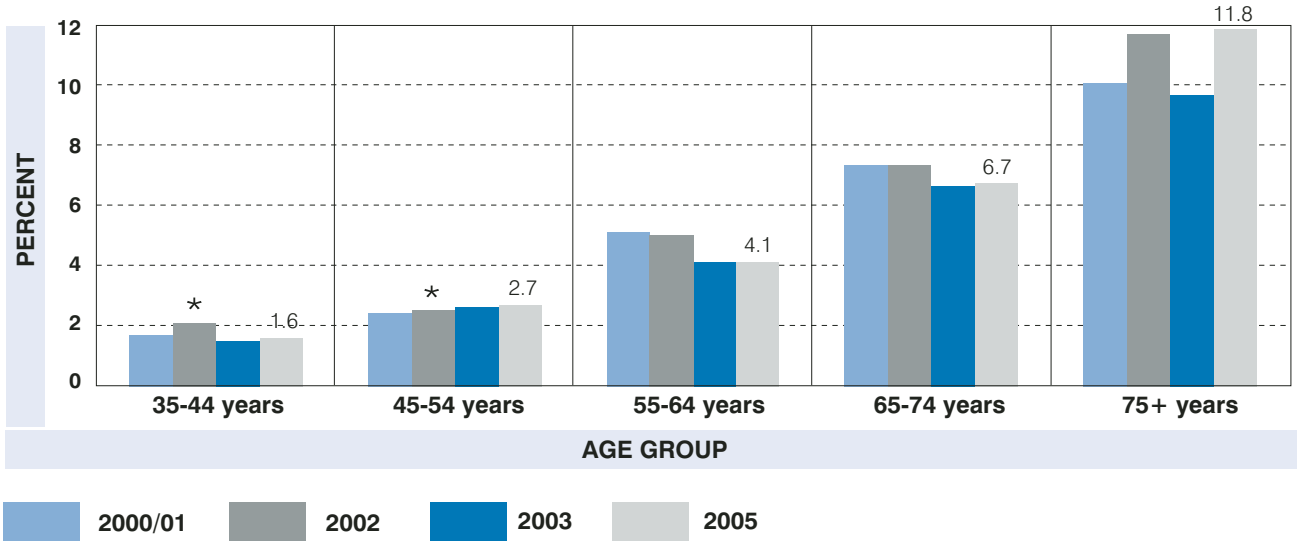
7 Schanzer DL, Tam TWS, Langley JM, Winchester BT. Influenza-Attributable Deaths: Canada 1990-1999. Epidemiol Infect. 2007;(In Press)

8 Schanzer DL, Langley JM, Tam TWS. Co-morbidities associated with influenza-attributed hospital admissions and deaths, 1994-2000, Canada. Presentation delivered at Options for the Control of Influenza VI conference, June 17-23, 2007, Toronto.

9 Ibid

10 Petty TL, ed. Strategies in preserving lung health and preventing COPD and associated diseases: the National Lung Health Education Program (NLHELP). Chest 1998 Suppl;113:2:136S-152S.

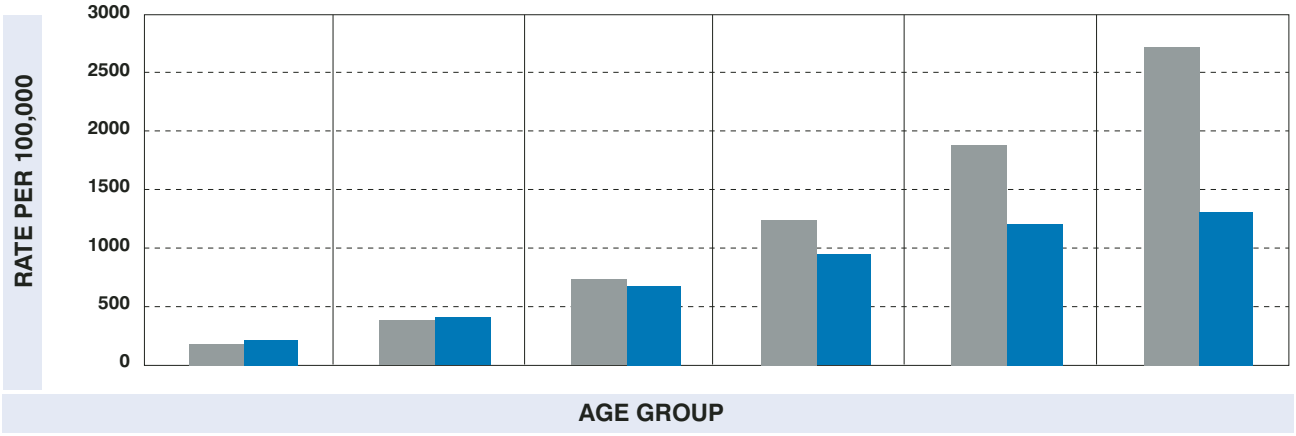
Figure 6-2 Prevalence of physician-diagnosed COPD, men aged 35+ years, by age group, Canada, 2000/01, 2002, 2003 and 2005.



* High sampling variability

Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Canadian Community Health Survey, Statistics Canada.

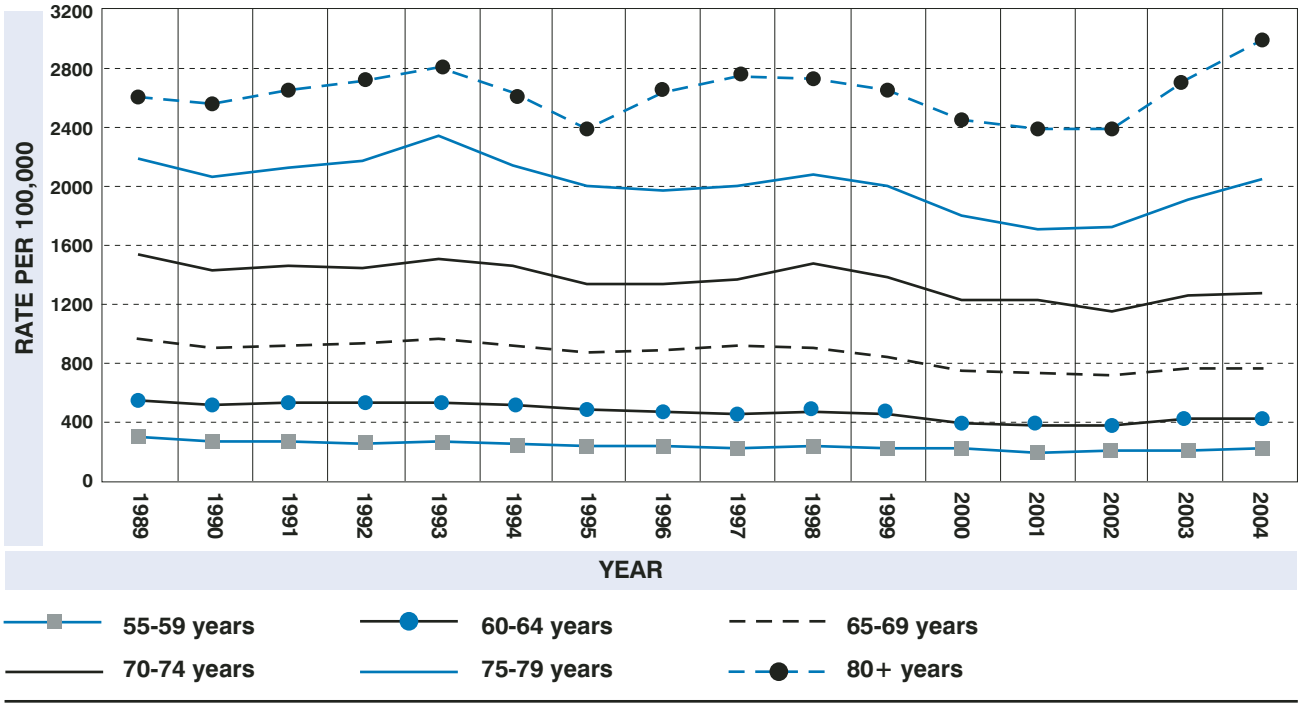
Figure 6-3 COPD hospitalization rates (per 100,000 population), adults aged 55+ years, by age group and sex, Canada, 2003/04.



	55-59 years	60-64 years	65-69 years	70-74 years	75-79 years	80+ years
Men	178.6	388.3	733.9	1238.2	1881.9	2718.5
Women	210.7	403.7	673.9	949.2	1200.4	1311.4

Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Hospital Morbidity File, Canadian Institute for Health Information.

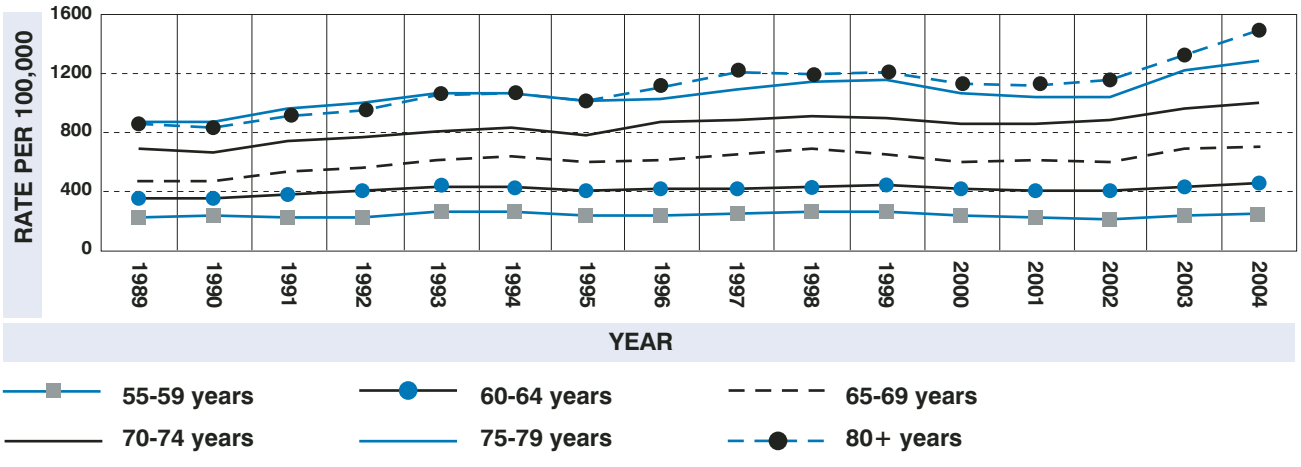
Figure 6-4 COPD hospitalization rates (per 100,000), men aged 55+ years, by age group, Canada*, 1989/90-2004/05.



* Data for territories unavailable prior to 1993 and data for Nunavut not available for 2002.

Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Hospital Morbidity File (acute and chronic), Canadian Institute for Health Information.

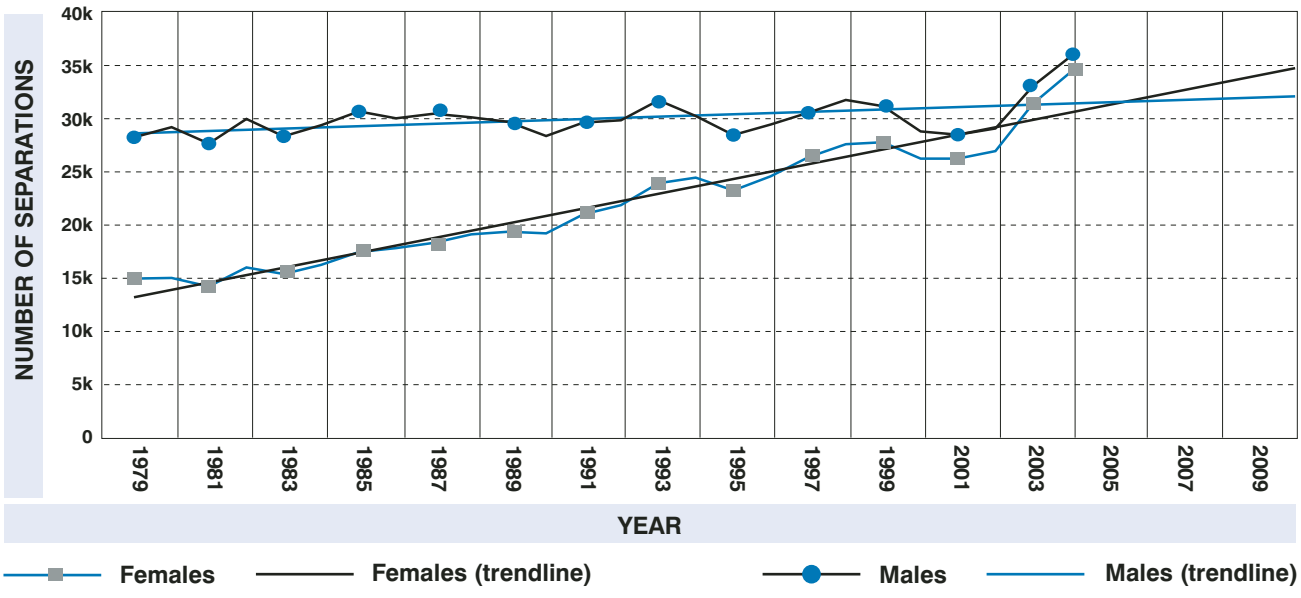
Figure 6-5 COPD hospitalization rates (per 100,000), women aged 55+ years, by age group, Canada*, 1989/90-2004/05.



* Data for territories unavailable prior to 1993 and data for Nunavut not available for 2002.

Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Hospital Morbidity File (acute and chronic), Canadian Institute for Health Information.

Figure 6-6 Actual and projected COPD hospitalizations by sex, Canada*, 1979-2010**

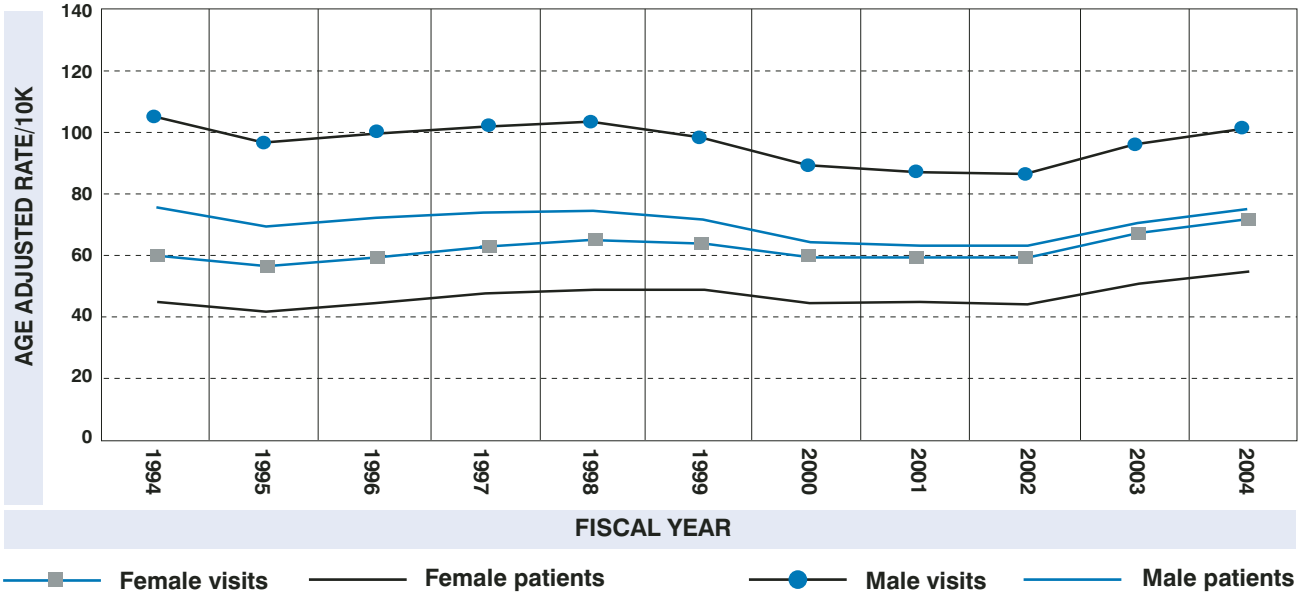


ICD10 codes: J40-J44. Note that the coding schemes for this condition changed in 2000 and this may influence trends.

* Data for territories unavailable prior to 1993 and data for Nunavut not available for 2002.
** Hospitalizations for 2005 to 2010 are projected

Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, 2006 using data from Hospital Morbidity File (acute and chronic), Canadian Institute for Health Information.

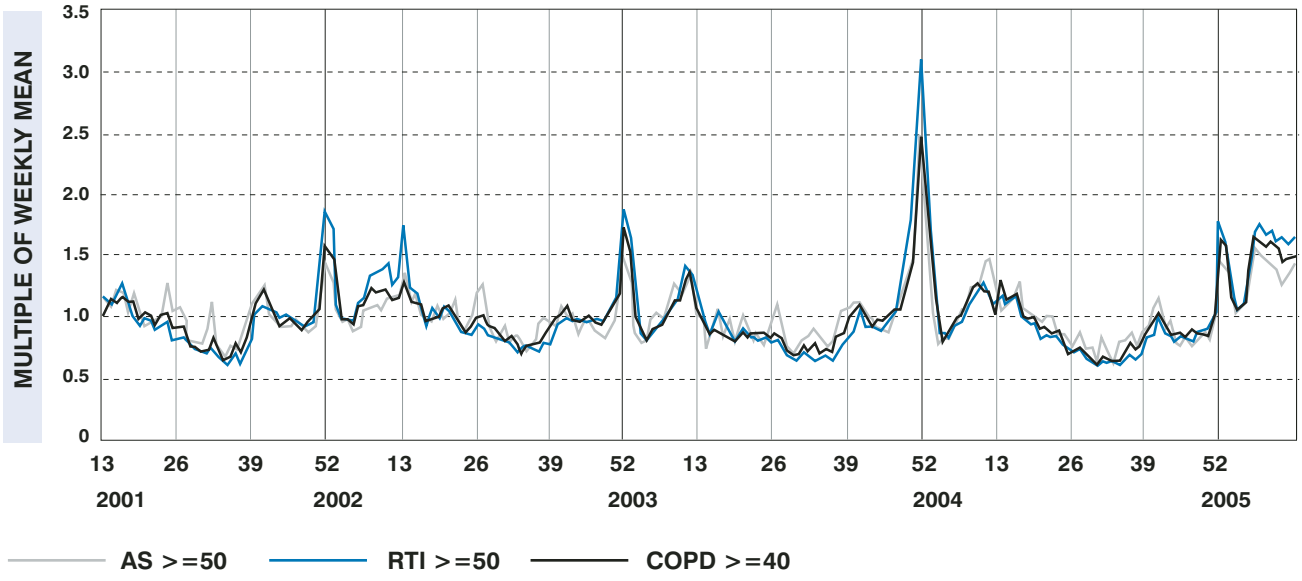
Figure 6-7 COPD hospitalized visits and patients (per 100,000), adults aged 55+ years, Canada, 1994/95 to 2004/05 (age-standardized to 1991 Canadian population).



Note: COPD was defined as the most responsible diagnosis

Data source: Health Person-Oriented Information database Statistics Canada.

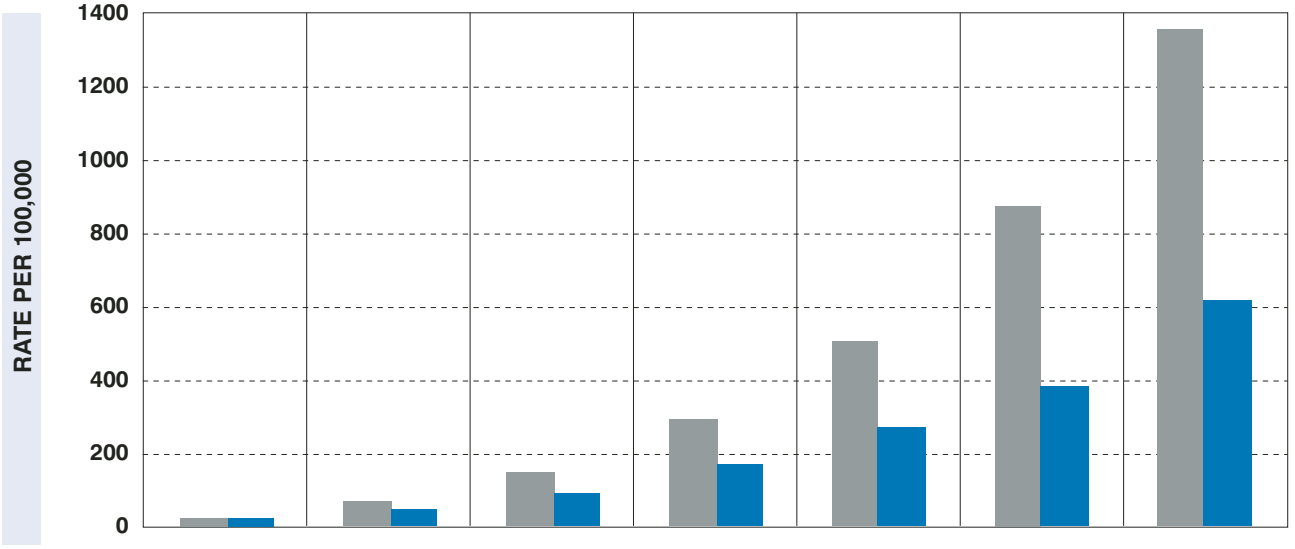
Figure 6-8 ER presentations for COPD and respiratory tract infections by week in Ontario from April 2001 to March 2005 in adults over 50 years of age



Note: AS = ER presentations for asthma, RTI = ER presentations for respiratory tract infections, and COPD = ER presentations for COPD

Source: Neil Johnston, Firestone Institute for Respiratory Health using data from the CIHI National Ambulatory Care Reporting System file for Ontario from April 2001 to March 2005.

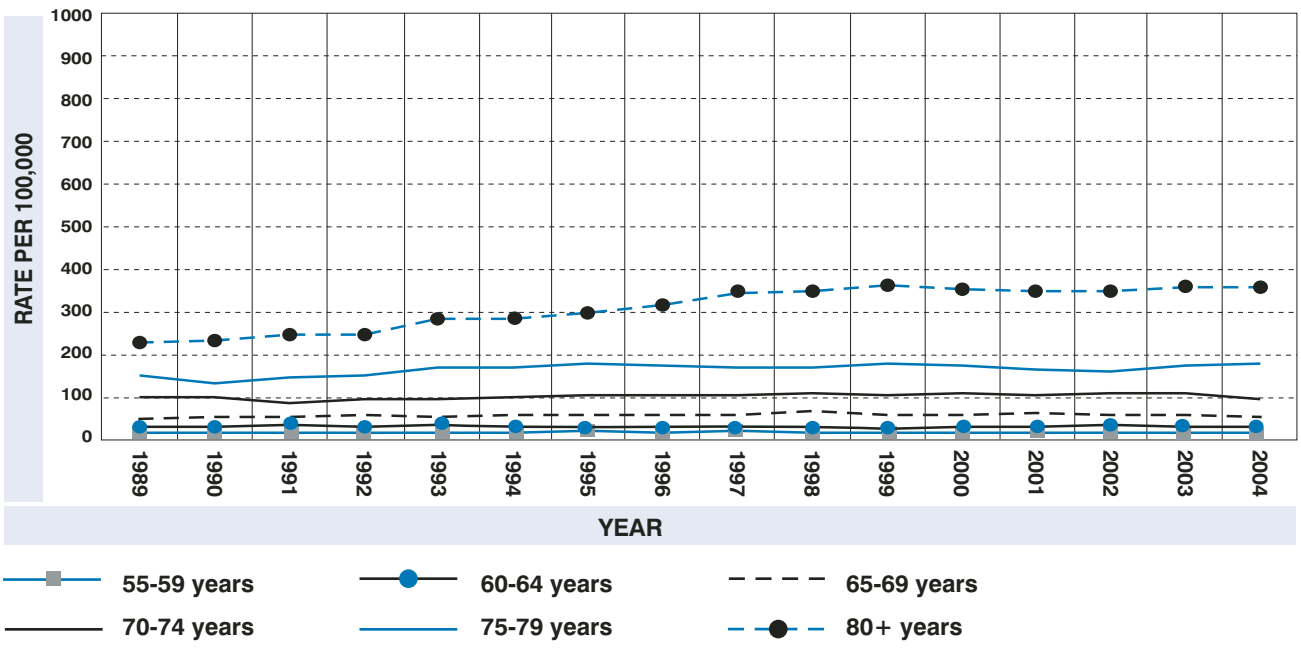
Figure 6-9 COPD mortality rates (per 100,000) by age group and sex, Canada, 2004.



	60-64 years	65-69 years	70-74 years	75-79 years	80-84 years	85-89 years	90+ years
Men	27.7	66.3	145.5	289.9	504.8	880.7	1363.2
Women	22.6	47.2	89.6	171.2	266.1	384.7	624.1

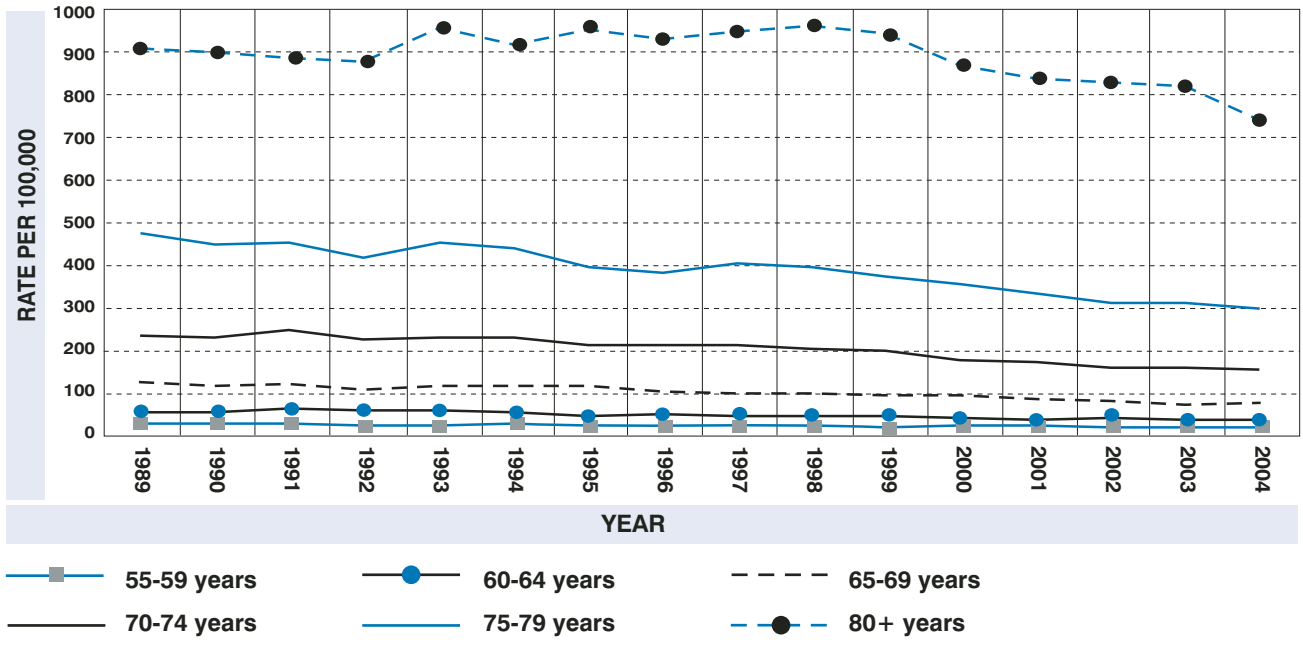
Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using Statistics Canada annual mortality data.

Figure 6-10 COPD mortality rates (per 100,000), women by age group, Canada, 1989-2004 (age-standardized to 1991 Canadian population



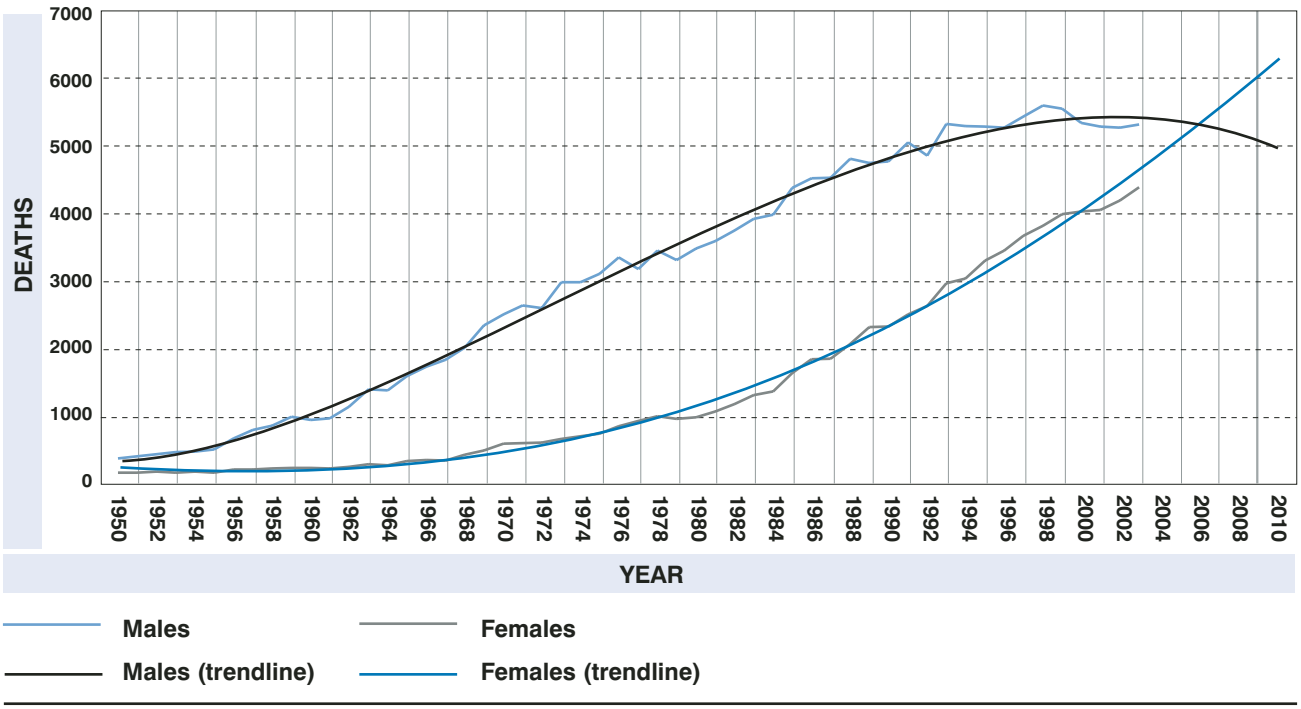
Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using Statistics Canada annual mortality data.

Figure 6-11 COPD mortality rates (per 100,000), men by age group, Canada, 1989-2004 (age-standardized to 1991 Canadian population).



Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using Statistics Canada annual mortality data.

Figure 6-12 Actual and projected number of deaths for COPD by sex, Canada, 1950-2010*



* deaths from 2005 to 2010 are projected.
ICD10 codes: J40-J44. Note that the coding schemes for this condition changed in 1968, 1978 and 2000 and this may influence trends.

Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, 2006 using Statistics Canada, Vital Statistics Data.

Chapter 7

Lung Cancer

Lung Cancer

Introduction

Lung cancer is the leading cause of death due to cancer in Canada. It causes approximately 29% of cancer deaths among men and 22% among women. Treatment consists of various combinations of surgical resection, chemotherapy and radiotherapy. Five-year survival rates are quite high for individuals with localized non-small cell lung cancer tumours.[1] Unfortunately, only a small proportion of lung cancer is localized at the time of diagnosis. Prognosis for individuals with small cell lung cancers is generally poor. No tests or techniques are yet universally accepted for the detection of lung cancer at an early enough stage for intervention to improve the course of the disease. Therefore, screening is not routinely performed for early detection of lung cancer.

Risk Factors

Smoking

Cigarette smoking is the predominant cause of lung cancer. It accounts for at least 80% of all new cases of lung cancer in women and 90% in men.[2] Risk rises sharply with an increase in number of cigarettes smoked per day, and still more with an increase in number of years of smoking.[3, 4] Quitting smoking can prevent further increases in the risk of lung cancer, but the risk among former smokers remains higher than that for lifetime nonsmokers.[5, 6]

A few recent studies[7, 8] have explored whether there might be an elevated risk of lung cancer among those who start smoking earlier in life, independent of duration and amount smoked. The evidence is inconclusive. Further research is required to better understand this possible link.

Pipe and cigar smoking are also linked to lung cancer but each carries smaller risks than for cigarette smoking, possibly due to different inhalation patterns.[9, 10]

Environmental Factors

Second-hand smoke (SHS) is one of the major risk factors for lung cancer among non-smokers since human carcinogens are present in tobacco smoke that is inhaled by bystanders.[11] Several occupational exposures have also been shown to be associated with an increased risk of cancer.[12] These hazards include asbestos, arsenic, polycyclic aromatic hydrocarbons, chromate and chromium, silica, and by-products of mustard gas manufacturing, nickel refining, and uranium mining. Lung cancer risk is also increased by occupational exposure to radon and radon daughter products. Pooled analyses of North American and European studies provide evidence that residential radon exposure is causally related to lung cancer.[13, 14]

Other factors, such as air pollution and history of lung disease may increase the risk of lung cancer. Motor vehicle exhausts and industrial emission releases of polycyclic aromatic hydrocarbons are known to be carcinogenic. Persons with a history of non-malignant lung disease could also be at increased risk of lung cancer.

Nutrition

While many studies have explored the link between nutrition and lung cancer, the strongest scientific evidence supports a reduction in lung cancer risk with the consumption of carrots and green vegetables.[15] A review of studies that relate specific nutrients to risk of lung cancer indicates that high carotenoid consumption probably leads to a decreased risk and that diets high in vitamins C and E may be protective.[16, 17]

Some studies support the hypothesis that a diet high in cholesterol and/or fat, particularly saturated fat, increases the risk of lung cancer, but this has not been consistently found in all studies.[18, 19, 20] The effect observed may be the result of residual confounding by cigarette consumption.[21]

Incidence

In 2007, an estimated 23,300 Canadians–12,400 men and 10,900 women– will develop lung cancer. Of these new cases, 52% will be individuals 70 years old or more, 44% aged 50–69 years, and 5% younger than 50.[22] Although the rate in those 70 years age and over was higher for men, the ratio of men to women was only 1.2 (Figure 7–1).

The incidence rate of lung cancer among men has decreased since 1987, while incidence rates among women have shown a steady increase (Figure 7–2).

Hospitalization

In 2004–05, the rates of hospitalization for lung cancer increased with age from age 45 to the age group 75–79. In men aged 70+ the hospitalization rate was more than twice that in women. However, in people under 50 years of age, the hospitalization rates for women were slightly higher than for men (Figure 7–3).

Since 1987, the age-standardized hospitalization rates have shown a major decrease among men aged 45 to 64 years

and over the age of 65 years. In contrast, rates have decreased only slightly for women 45-64 years old and 65+ (Figure 7-4).

The lower hospitalization rates may be the result of changes in health care provision from inpatient hospital care to more community-based care in addition to changes in the incidence rate.

Mortality

In 2004, 17,653 Canadians died from lung cancer (10,136 men and 7,517 women). While the mortality rate rises steeply after age 65, 29% of lung cancer deaths occurred among individuals under the age of 65 years.

Men over age 70 had twice the death rate of women in 2004. However, in the 50-69 age group, the men-to-women ratio of lung cancer deaths was only 1.3 (Figure 7-5).

Between 1987 and 2004, the mortality rate due to lung cancer in women aged 65+ years increased by 73%, whereas it decreased among men during the same period by 14% (Figure 7-6).

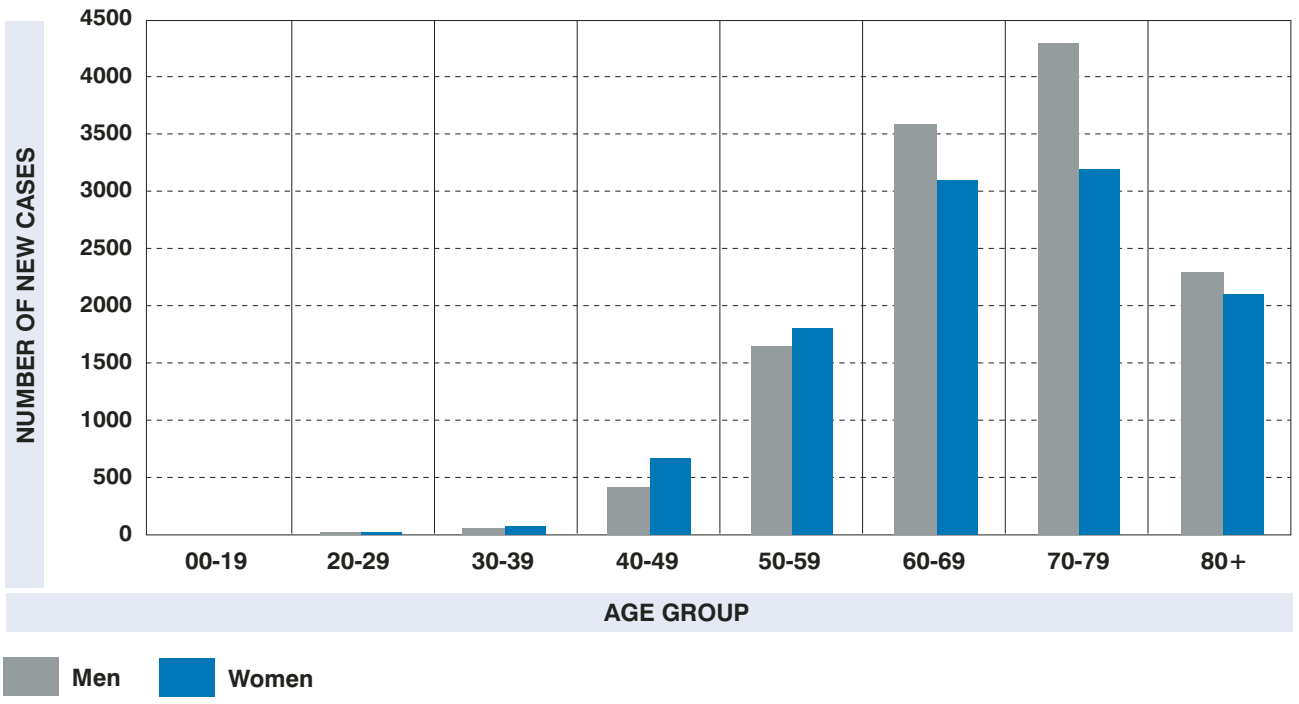
Discussion and Implications

Lung cancer has become a major health issue for women. Both the incidence and mortality rates among older women are increasing, in contrast to the decreases seen among older men. The increase in smoking among women 30 to 40 years ago is now being reflected in these trends.

If progress is to be made in reducing the incidence of lung cancer, it will be by preventing children and teens from starting to smoke and by encouraging those who do smoke to stop. In addition, to reduce lung cancer deaths among non-smokers, it will be necessary to prevent exposure to second-hand smoke (See Chapter 2 – Tobacco use).

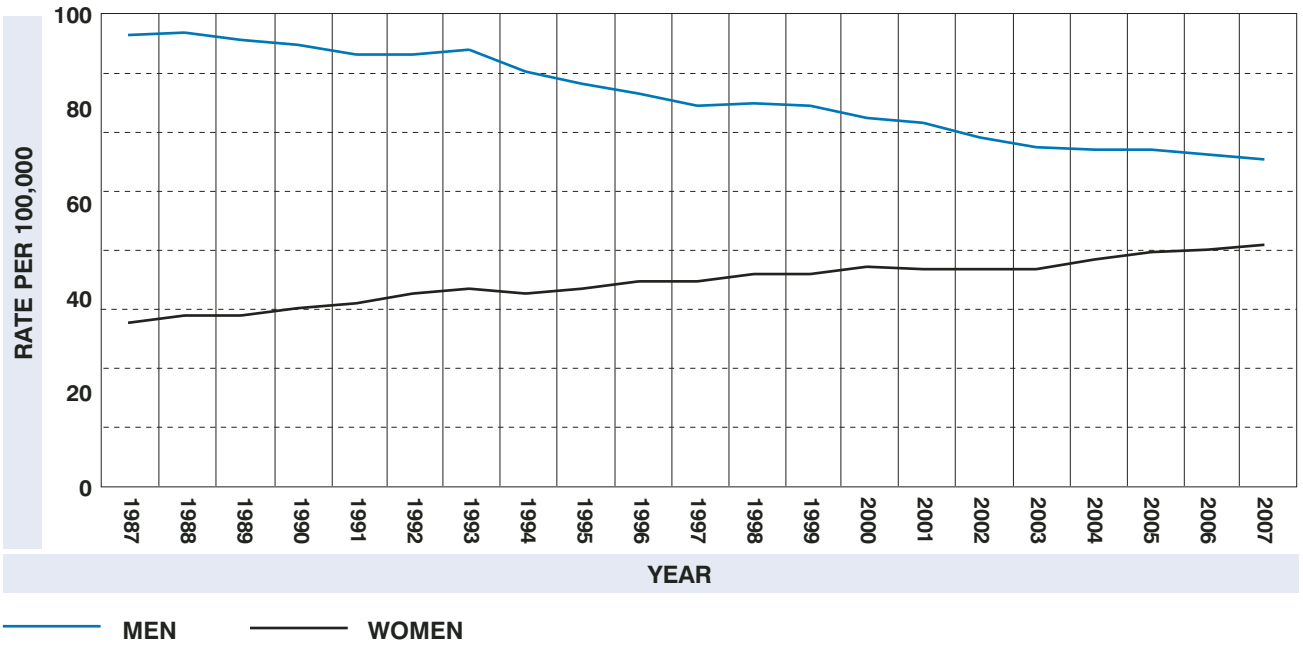
Cancer treatment services are already experiencing difficulty meeting the demand for health care. The projected increase in incidence of lung cancer among women is certain to exacerbate this situation. Greater need is expected for all aspects of cancer care, including diagnosis, staging techniques, radiotherapy, chemotherapy, surgery, education and support. The anticipated need will also place major demands on palliative care services.

Figure 7-1 Number of individuals with newly diagnosed lung cancer, by age group and sex, Canada, 2007.



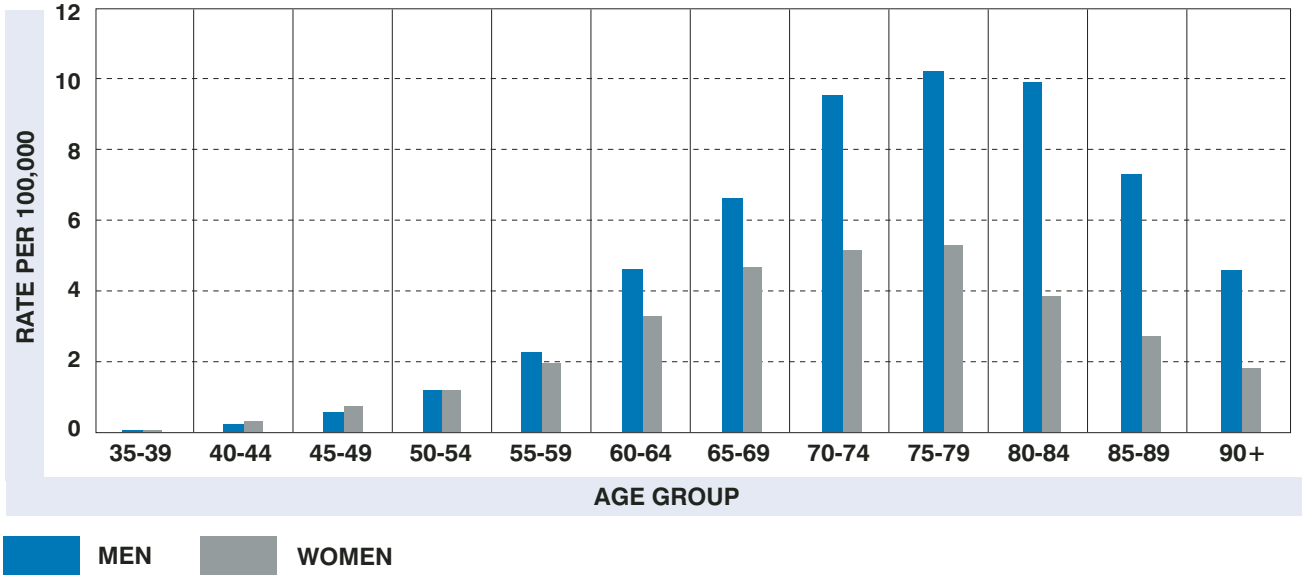
Source: Canadian Cancer Society/National Cancer Institute of Canada. Canadian Cancer Statistics 2007.

Figure 7-2 Lung cancer incidence rates (per 100,000), by sex, Canada, 1987-2007* (age-standardized to 1991 Canadian population).



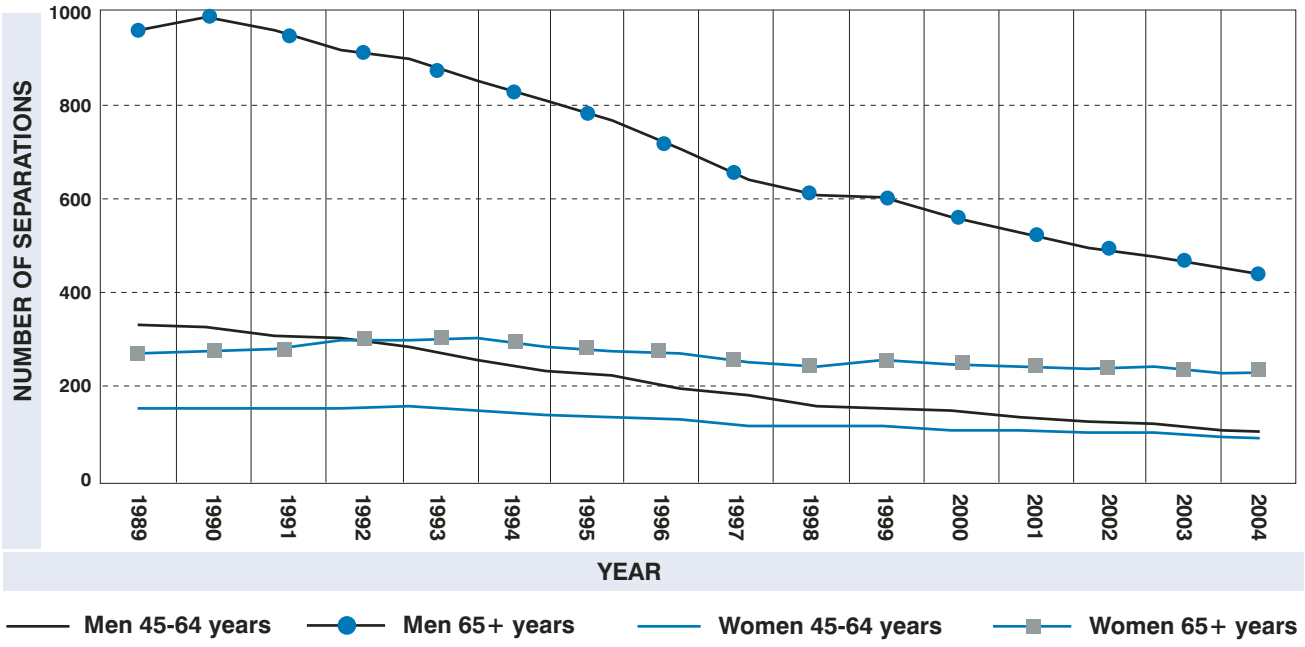
* Incidence from 2004 to 2007 projected
Source: Canadian Cancer Society/National Cancer Institute of Canada. Canadian Cancer Statistics 2007.

Figure 7-3 Lung cancer hospitalization rates (per 100,000), adults aged 35+, by age group and sex, Canada, 2004/05.



Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from Hospital Morbidity File (acute and chronic chare), Canadian Institute for Health Information.

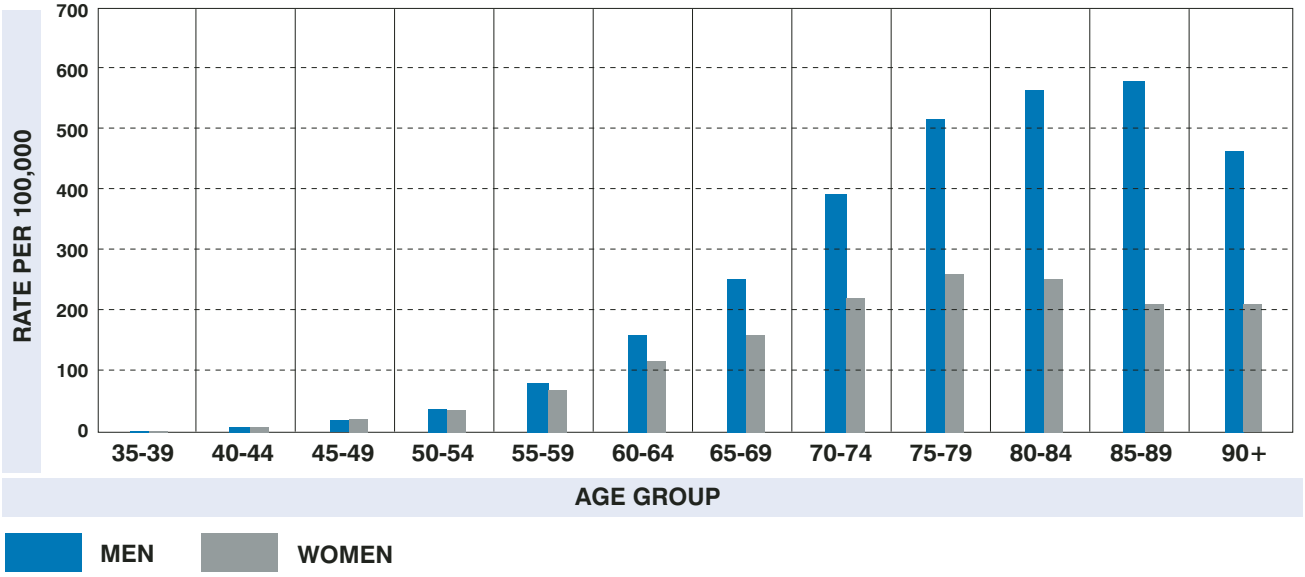
Figure 7-4 Lung cancer hospitalization rates (per 100,000), adults aged 45+ years, by age group and sex, Canada*, 1987/88-2004/05 (age-standardized to 1991 Canadian population).



* Data for territories unavailable prior to 1993 and data for Nunavut not available for 2002.

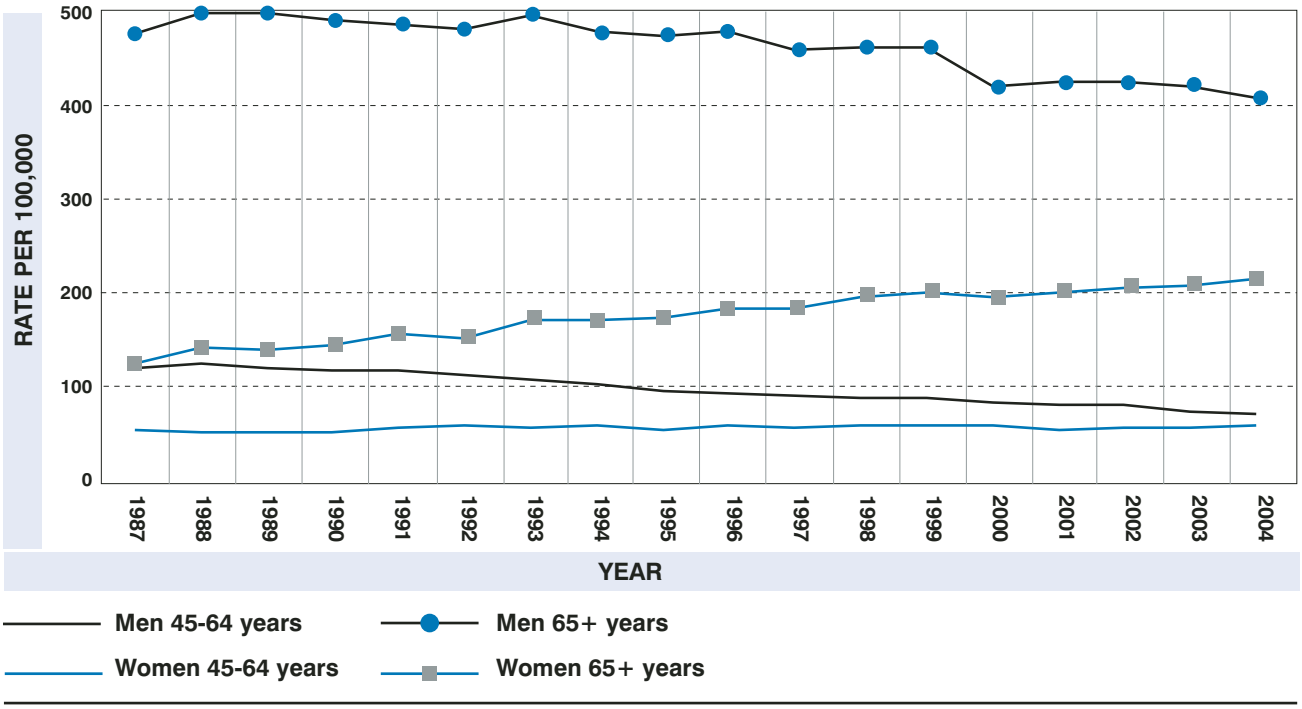
Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada using data from Hospital Morbidity File (acute and chronic care), Canadian Institute for Health Information.

Figure 7-5 Lung cancer mortality rate (per 100,000), adults aged 35+, by age group and sex, Canada, 2004.



Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada using Statistics Canada annual mortality data.

Figure 7-6 Lung cancer mortality rate (per 100,000), adults aged 45+ years, by age group and sex, Canada, 1987-2004 (age-standardized to 1991 Canadian population).



Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada using Statistics Canada annual mortality data.

1 Xie L, Ugnat A-M, Morriss J, Semenciw R, Mao Y. Variation in the treatment and survival of patients with lung carcinoma in Canada. Lung Cancer 2003; 42:127-139.

2 Surgeon General. Reducing the health consequences of smoking: 25 years of progress. Washington, D.C.: U.S. Government Printing Office, 1989.

3 Ibid.

4 Gao YT, Blot WJ, Zheng W, et al. Lung cancer and smoking in Shanghai. Int J Epidemiol 1988;17:277-80.

5 U.S. Department of Health and Human Services. The health consequences of smoking: a report of the Surgeon General. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Centre for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2004.

6 International Agency for Research on Cancer (IARC). IARC Monographs on the Evaluation of Carcinogenic Risks to Humans and their Supplements: A complete list. Tobacco Smoking and Tobacco Smoke Volume 83 (2002)

7 Hegmann K, Fraser A, Keaney R, Moser S, Nilasena D, Sedlars M, et al. The effect of age at smoking initiation on lung cancer risk. Epidemiology 1993;4:5:444-48.

8 Benhamou S, Benhamou E, Tirmarche M, Flamant R. Lung cancer and use of cigarettes: a French case-control study. J Natl Cancer Inst 1985;74:1169-75.

9 Blot WJ, Fraumeni JF. Cancers of the lung and pleura. In: Schottenfeld D, Fraumeni JF, eds. Cancer epidemiology and prevention. 2nd ed. New York: Oxford University Press, 1996:637-65.

10 Boffetta P, Pershagen G, Jockel KH, et al. Cigar and pipe smoking and lung cancer risk: A multicenter study from Europe. J Natl Cancer Inst 1999; 91:697-701.

11 National Cancer Institute. Health effects of exposure to environmental tobacco smoke: the report of the California Environmental Protection Agency. Smoking and Tobacco Control Monograph no. 10. Bethesda, MD. U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute, NIH Publ. No. 99-4645,1999.

12 Blot WJ, Fraumeni JF.

13 Krewski D, Lubin JH, Zielinski JM, et al. Residential radon and risk of lung cancer: a combined analysis of 7 North American case-control studies. Epidemiol 2005;16:137-145.

14 Darby S, Hill D, Auvinen A. Radon in homes and risk of lung cancer: collaborative analysis of individual data from 13 European case-control studies. BMJ 2005;330:226-7.

15 World Cancer Research Fund/American Institute for Cancer Research.

16 Blot WJ, Fraumeni JF.

17 World Cancer Research Fund/American Institute for Cancer Research.

18 Blot WJ, Fraumeni JF.

19 World Cancer Research Fund/American Institute for Cancer Research.

20 Ziegler, Mayne ST, Swanson CA.

21 World Cancer Research Fund/American Institute for Cancer Research.

22 Canadian Cancer Society/National Cancer Institute of Canada. Canadian Cancer Statistics 2007.

Chapter 8

Cystic Fibrosis

Cystic Fibrosis

Introduction

Cystic fibrosis (CF), a chronic fatal respiratory disease, is an autosomal recessive disease, with a carrier rate of 1 in 25.[1] Symptoms usually develop in the first few months to first few years of life. Abnormal mucous is produced in the lungs of individuals with cystic fibrosis; it interferes with their breathing and they are more prone to serious lung infections. They are unable to produce adequate pancreatic enzymes for the digestion of food, leading to malnutrition. While many children in the past died before reaching the age of 20, the median age of survival in Canada has reached 37 years.[2]

Individuals with cystic fibrosis are susceptible to serious lower tract respiratory infections. Usually preceded by viral illnesses, respiratory exacerbations are frequently associated with the common pathogen Staphylococcus aureus and the more serious pathogen Pseudomonas aeruginosa. This increases the rate of destruction of the lung and leads to the development of bronchiectasis.

Successful therapy includes nutritional supplements, pancreatic enzyme supplements, inhaled mucolytics and regular chest physiotherapy. Prompt treatment with antibiotics for respiratory infections is also a critical element of a comprehensive program. More aggressive early treatment with antibiotics and aggressive nutritional programs has helped prolong the lives of individuals with cystic fibrosis and also to improve the quality of their lives.[3]

Cystic fibrosis exerts a tremendous impact on families. Physiotherapy can take up to two hours per day, and adults must perform this task for children who are not old enough to carry out physiotherapy techniques on themselves. In addition, giving inhaled medication can require up to an hour per day. The cost of medication is a significant expense. And the overall concern that a relative with cystic fibrosis might die at an early age, after serious bouts of illness requiring hospitalization, weighs heavily on a family's emotions.

Incidence/Prevalence

The rate of cystic fibrosis among children born in Canada from 1971 to 1987 was 3.7 per 10,000 births. Recent epidemiological analysis has shown a decrease in the rate of cystic fibrosis in Canada to 2.8 per 10,000 births.[4]

According to the Canadian Cystic Fibrosis Foundation Patient Data Registry, 3,453 people–48% of whom were older than 18 years–lived with cystic fibrosis in Canada in 2002: 54% were male and 46% were female (Figure 8–1). Approximately 60% of people with cystic fibrosis are diagnosed in the first year of life, 90% by age 10 years.[5]

Between 1987 and 2002, the number of individuals with cystic fibrosis decreased in the youngest age groups, 0–4 years and 5–9 years, reflecting the decreasing rate of children being born with cystic fibrosis. Increases among the older age groups reflect the improved survival rates (Figure 8–2).

Use of Health Services

Individuals with cystic fibrosis may require hospitalization for aggressive therapy, including intravenous antibiotics during acute exacerbations of symptoms. As the disease progresses, the need for hospitalization increases, as does length of stay.

In 2004, the number of hospitalizations for cystic fibrosis was greatest among individuals in their teen and early adult years. Girls were more likely than boys to be hospitalized, particularly among teens and young adults. The lower number of hospitalizations in the 30+ age groups reflected the smaller number of individuals who survive beyond their 20s (Figure 8–3). Some clinics are using home intravenous antibiotic therapy as an alternative to hospitalization or as a means to decrease the length of stay. However, the long-term benefit of such an approach remains to be demonstrated.

Between 1987 and 2004, hospitalizations for cystic fibrosis decreased among children under the age of 15 years, reflecting improved disease management as well as the declining number of children under age 10 with cystic fibrosis. Hospitalizations among groups 15 years of age and over increased slightly, likely as a result of the increase in the life expectancy (Figure 8–4).

Mortality

While mortality reduces the numbers of individuals with cystic fibrosis above the age of 20, many individuals continue to live with the condition into their 30s. In 2004, there were 52 deaths due to cystic fibrosis in Canada. Between 1995 and 1999, the distribution of the age of death due to cystic fibrosis showed a gradual shift to older age groups. The biggest changes were an increase in deaths over age 40 and a decrease in deaths under age 10. Only seven children who died in the three years from 2002 to 2004 were under the age of 10 (Figure 8–5).

Discussion and Implications

The face of cystic fibrosis has changed radically in the last 20 years. While it was once almost exclusively a child's disease, most individuals with CF are now living into their 20s and 30s, and beyond. Unfortunately, these individuals also experience related health problems, such as male infertility, liver disease and diabetes.

This increase in survival has major implications for the health care system and the community at large. For example, while paediatric respirologists are very familiar with the disease, the number of adult respirologists who have experience in the management of cystic fibrosis patients as they become adults is more limited. Of the 38 cystic fibrosis clinics across Canada, about one-third of which provide care to both children and adults, only 12 are specialized in the care of adults. Since adults with cystic fibrosis will in the near future outnumber children with the disease, the health care system needs to become more responsive to their needs, particularly during the teen-to-adult transition period. It is in this age group that non-respiratory problems, such as diabetes and liver disease, become more troublesome. In addition, more women with CF are staying healthy as they get older, and pregnancy is an emerging management issue. There is also a significant increase in the number of CF patients having children with the use of assisted reproductive techniques.

Families of individuals with cystic fibrosis need significant support to cope with the many stresses imposed by the condition. Education and assistance can help them maintain a normal family life while they cope with the huge physical demands associated with the disease, such as daily physiotherapy and medication. Now that many adults are surviving, flexible and part-time work programs would help them participate more actively in society.

Over the last 50 years, the Canadian Cystic Fibrosis Foundation has established cystic fibrosis clinics across the country to provide a comprehensive range of services to families. The great gains that have been made in treatment and survival are due in a large degree to the work in these clinics. One of their major benefits is the multi-disciplinary team of physicians, nurses, nutritionists and physiotherapists who work closely with families to tailor treatment to individual needs. The challenge now is to ensure that this high quality of service for children continues for adults. The other issue is access. Since most cystic fibrosis clinics are in major cities, children and adults in outlying areas have difficulty achieving full benefit. Eleven of the 38 clinics offer outreach programs and smaller clinics are linked to teaching centres, but more funding is needed to expand the service.

Assistance with the expense of drugs is one very tangible way to provide support to families. Unfortunately, financial support for drugs varies considerably by province. Some provincial programs provide complete support while others have various levels of subsidy. In addition, some provinces provide reimbursement for children's drugs but not for those of adults. As more individuals live into adulthood, this becomes a more influential factor in maintaining a reasonably active and varied life.

Lung transplants are an option during the end stage of cystic fibrosis disease. They have been shown to increase survival and improve quality of life. According to data from the Canadian Institute for Health Information's Canadian Organ Replacement Register, 66.2% of individuals with lung transplants are alive 5 years after their transplant.[6] This option has limitations, however. Transplants are a very resource-intensive therapy and are provided in only a few specialized centres. Many individuals develop graft failure after a few years and require re-transplant in order to remain alive.

Screening of newborns can identify cystic fibrosis in children before symptoms appear. While no treatment exists to prevent the disease, early aggressive treatment can make a difference. Clinical and economic evidence suggest that newborn screening should be adopted as standard of care.[7] However, newborn screening for cystic fibrosis requires the support and facilities of CF clinics and access to genetic counselling for families.

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1 Fitzsimmons SC. The changing epidemiology of cystic fibrosis. Pediatrics 1993;122:1-9.

2 Canadian Cystic Fibrosis Foundation. Report of the Canadian Patient Data Registry 2002. Toronto: The Foundation; [n.d.];4. Available from: *http://www.ccff.ca/pdf/Lay%20CPDR%20ReportE.pdf*

3 Morgan MJ et al. Epidemiologic study of cystic fibrosis: design and implementation of a prospective, multicenter, observational study of patients with cystic fibrosis in the U.S. and Canada. Pediatr Pulmonol 1999;28:4:231-41.

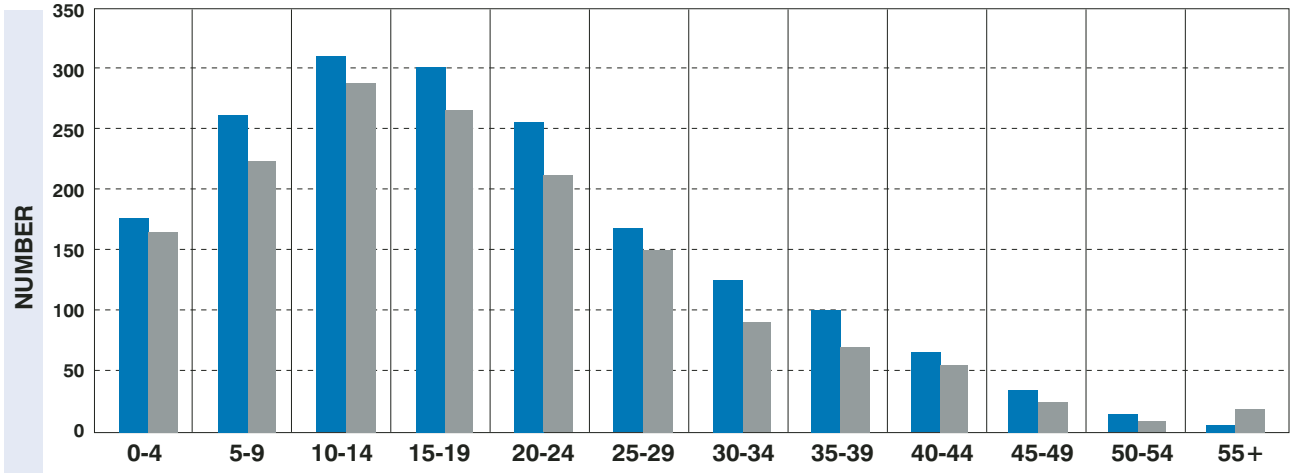
4 Dupuis A, Hamilton D, Cole DEC, Corey C. Cystic fibrosis birth rates in Canada: a decreasing trend since the onset of genetic testing. J Pediatr 2005;147:312-5.

5 Dupuis A, Hamilton D, Cole DEC, Corey C.

6 Canadian Institute for Health Information, Treatment of End-Stage Organ Failure in Canada, 1995 to 2004 (2006 Annual Report). Ottawa: the Institute; 2006.

7 Sims E, Mugford M, Clark A, Aitken D, McCormick J, Mehta G, Mehta A. Economic implications of newborn screening for cystic fibrosis: a cost of illness retrospective cohort study. Lancet 2007;369:1187-1195.

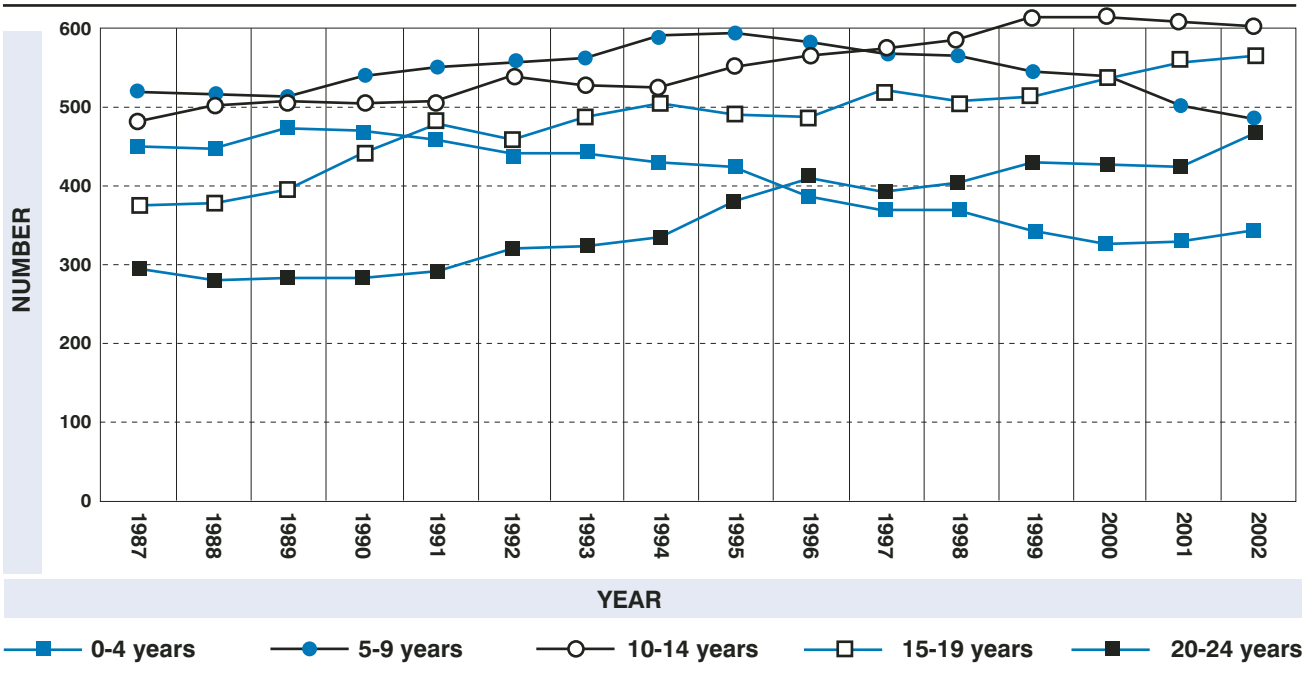
Figure 8-1 Number of individuals with cystic fibrosis by age and sex, Canada, 2002.



	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55+
Males	177	262	311	301	256	169	126	101	66	35	14	6
Females	166	224	288	266	212	151	91	71	56	25	9	19

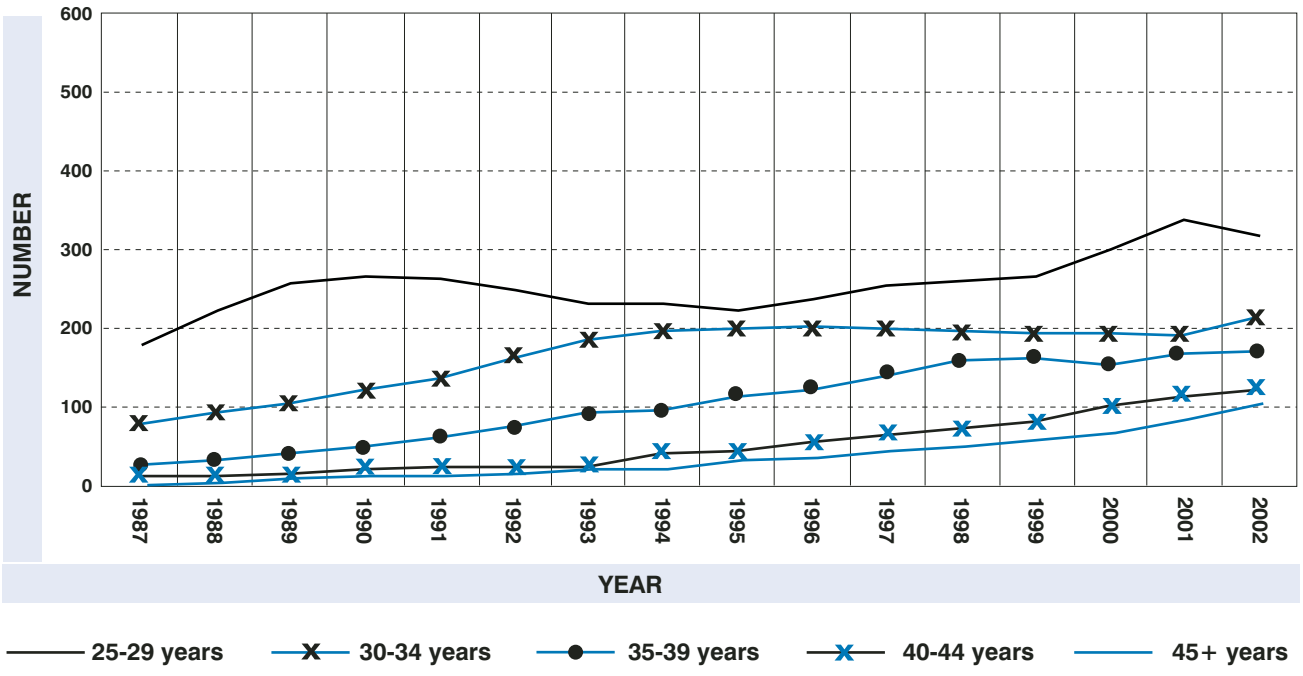
Source: Canadian Cystic Fibrosis Foundation's Canadian Patient Data Registry Report, 2002.

Figure 8-2a Number of individuals with cystic fibrosis by age, Canada, 1988-2002. (0-24)



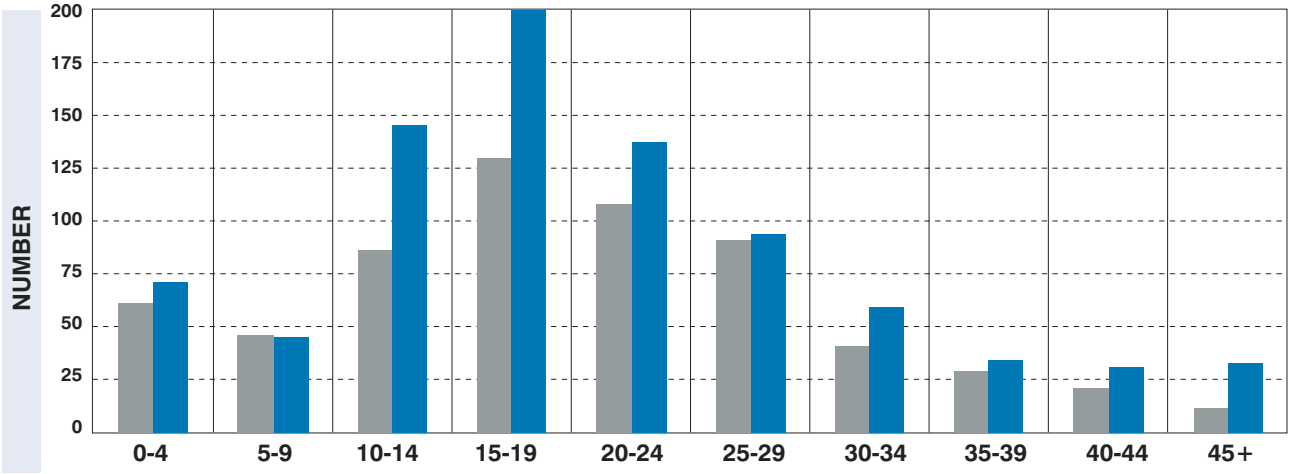
Source: Canadian Cystic Fibrosis Foundation's Canadian Patient Data Registry Report, 2002.

Figure 8-2b Number of individuals with cystic fibrosis by age, Canada, 1988-2002. (25+)



Source: Canadian Cystic Fibrosis Foundation's Canadian Patient Data Registry Report, 2002.

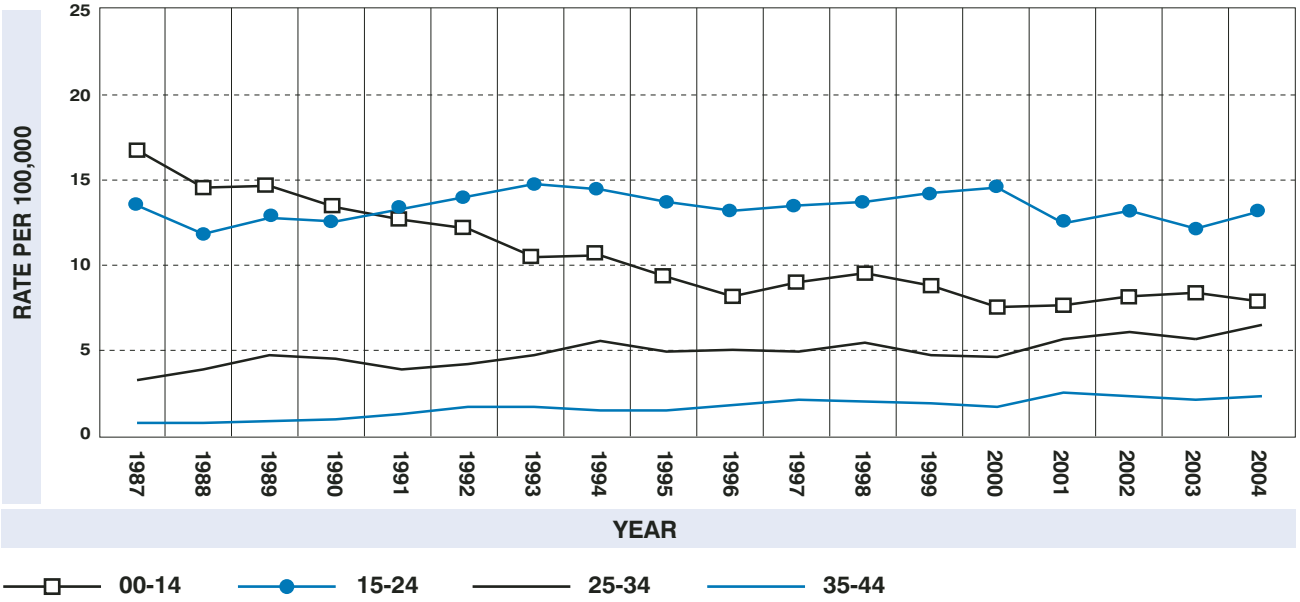
Figure 8-3 Cystic fibrosis hospitalizations by age group and sex, Canada, 2004/05.



	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45+
Males	61	46	86	130	108	91	41	29	21	12
Females	71	45	146	200	137	94	59	34	31	33

Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada using data from Hospital Morbidity File (acute and chronic care), Canadian Institute for Health Information

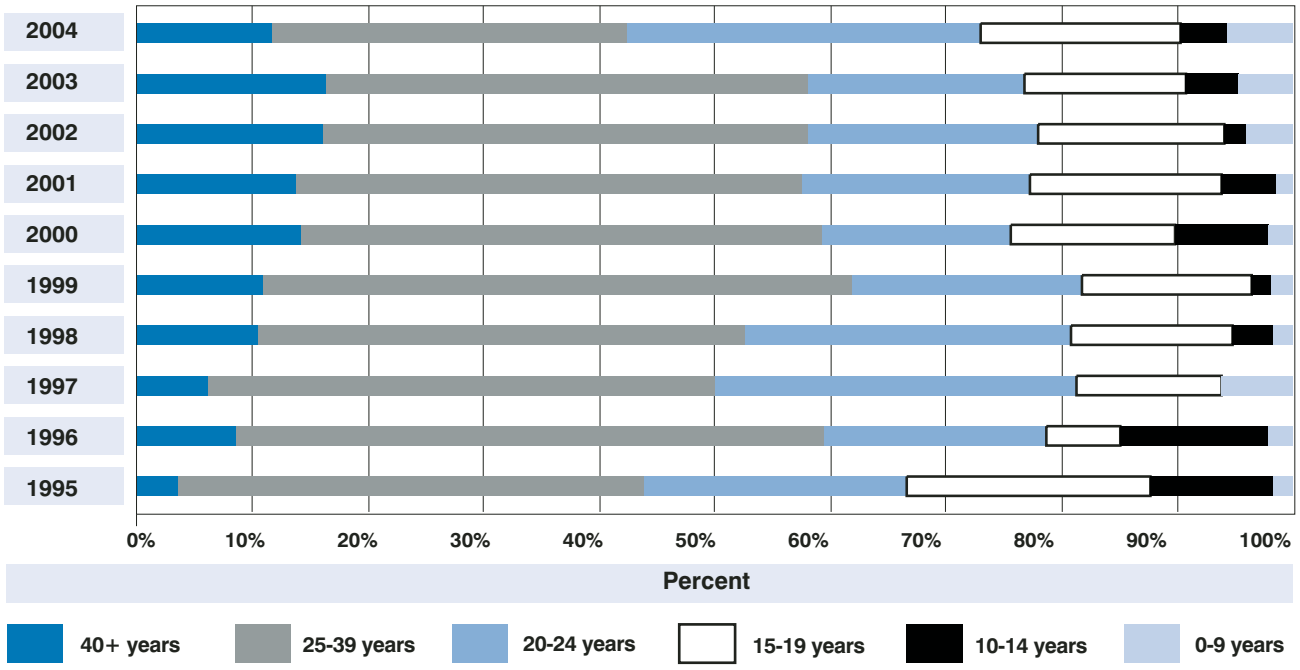
Figure 8-4 Cystic fibrosis hospitalization rates (per 100,000), children and adults aged 0-44 years, by age group, Canada*, 1987/88-2004/05 (age-standardized to 1991 Canadian population).



* Data for territories unavailable prior to 1993 and data for Nunavut not available for 2002.

Source: Centre for Chronic Disease Prevention and Control, Health Canada using data from Hospital Morbidity File (acute and chronic care), Canadian Institute for Health Information.

Figure 8-5 Proportion of deaths caused by cystic fibrosis according to age groups, Canada, 1995-2004.



Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using Statistics Canada mortality data.

Chapter 9

Respiratory Distress Syndrome

Respiratory Distress Syndrome

Introduction

Respiratory Distress Syndrome (RDS), also known as hyaline membrane disease, is a condition associated with severe breathing difficulty seen predominantly in premature infants. RDS is caused by a primary deficiency of surfactant, a substance that coats the alveoli (air sacs) in healthy lungs and prevents them from collapsing during exhalation.[1] As a result of this deficiency, the baby cannot take up enough oxygen.

The maturation of a baby's surfactant system occurs gradually in the third trimester of pregnancy. The point at which the system is sufficiently mature for RDS not to occur varies widely from one baby to another. In most infants the system is mature by about 36 weeks of gestation, but RDS can occur in full-term babies, particularly if the mother is diabetic. Conversely, a few infants of less than 30 weeks' gestation may already have a mature surfactant system.

In its acute phase RDS commonly leads to significant complications. These include bronchopulmonary dysplasia, a chronic respiratory problem secondary to the effect of inflammation on the immature lung.[2] This may lead to prolonged hospitalization and significant post-discharge dependence on technology to assist with breathing. Babies with severe RDS may also develop other neurological complications that are commonly associated with prematurity, such as intraventricular bleeding and periventricular leukomalacia. These complications severely affect the child's development. Babies with RDS are also more likely to be diagnosed and hospitalized with asthma between the ages of 1 and 4 years.[3]

The prognosis for RDS has improved significantly over the last 30 years.[4] The introduction in the 1980s of antenatal steroids that increase surfactant production in the fetus has contributed to this trend. In addition, the availability of a variety of surfactant treatments, which have been shown to be highly effective in decreasing morbidity and mortality, has improved the prognosis for babies who develop RDS.[5]

Risk Factors and Prevention

Reducing premature birth is the most effective preventive method against RDS, but the rate of preterm birth in Canada increased slightly between 2000 and 2004 (Figure 9–1). The exact cause for this increase is unknown, but a contributing factor is the increase in multiple births (birth of more than one infant from one pregnancy).[6] Part of this trend is the increased use of assisted reproductive technologies, which often result in pregnancies with more than one baby. In addition, a higher proportion of births are among older women, who have a higher risk of multiple birth.

Many hypotheses exist to explain the causes of preterm labour, but the underlying cause is often unknown. Nonetheless, some risk factors have been identified, including cigarette smoking, stress, vaginal infection, multiple birth, being under age 20 or over age 35, and inadequate nutrition and weight gain in pregnancy.[7]

Even if preterm birth cannot be prevented, the administration of a very short course (two doses 24 hours apart) of antenatal steroids to the mother has been shown to be highly effective in decreasing the severity and incidence of RDS.[8] Antenatal steroids also decrease the incidence of other important complications of prematurity, including intraventricular hemorrhage and bronchopulmonary dysplasia. According to the Canadian Neonatal Network database, 31.8% of infants under 35 weeks gestation received a complete course of antenatal steroids in 2005; 34.6% received a partial course and 28.5% received no steroids. In 5% of cases, it was unknown whether steroids were used.[9]

Incidence/Prevalence

In the pre-steroid era, RDS was seen in at least 50% of infants weighing between 1,000 and 1,500 g; this figure decreased to 5% in infants between 2,000 and 2,500 g.[10] The use of antenatal steroids has reduced these numbers.[11]

In spite of the advances gained by antenatal steroid use, the risk of RDS remains a reality. Although 66% of infants under 35 weeks gestation received antenatal steroids in 2005,[12] 87% of infants weighing less than 1,500 g still required a period of assisted ventilation,[13] and 44% of infants less than 1,500 g still required treatment with surfactant.[14]

Hospitalization

Since most babies are born in hospital, hospitalization rates can give a fairly accurate indication of the incidence of RDS.

The hospitalization rates for RDS for both boys and girls remained relatively constant from 1994 to 2000. Since then, there has been a slight increase in both sexes (Figure 9–2). The ratio of hospitalizations for RDS among newborn boys to girls in 2004 was 1.4:1.

RDS requires the expenditure of major health financial resources. The need for assisted ventilation comprises one of

the major costs of the care of premature infants. Data from the Canadian Neonatal Network reveal that in 2005 infants of less than 750 g spent an average of 31.6 days on assisted ventilation. Babies weighing between 1,500 and 2,500 g spent less than one day.[15] The average hospital costs in 2002–03 were $117,806 per newborn weighing less than 750 g.[16]

Mortality

Although there have been significant advances in prevention and treatment of RDS the last two decades, this condition remains the major cause of death in babies born prematurely.[17]

Mortality rates from RDS for infants under 1 year old declined steadily between 1987 and 2004. Rates for boys continued to be higher than for girls (Figure 9–3).

Antenatal steroid use and surfactant treatments have contributed to increased survival rates among preterm babies. While the mortality rate for infants weighing 1,000 to 1,500 g was reported as 66% in 1961,[18] it is now less than 4%. Even for babies of less than 750 g, who rarely survived in 1961, survival is now greater than 52%.[19]

Discussion and Implications

RDS is a serious condition that primarily affects prematurely born infants. It has a major impact on the health of the child, induces great stress on the family and requires a considerable expenditure of health care resources.

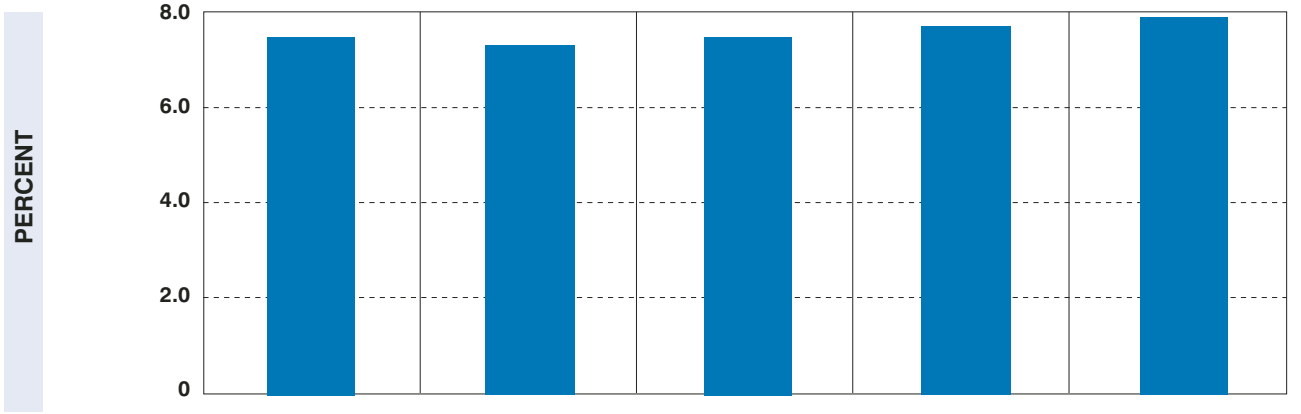
While the decrease in mortality rates does attest to the success of treatment in the modern neonatal intensive care unit, further improvements in neonatal health will require the prevention of preterm birth, the underlying cause of RDS. Unfortunately, the incidence of preterm births is increasing rather than decreasing.

Prevention of preterm birth calls for the enforcement of guidelines governing the use of assisted reproductive technologies to decrease multiple births. The recently established Assisted Human Reproduction Canada will be implementing the Assisted Human Reproduction Act. This legislation will contribute to ensuring the health and safety of women using assisted reproductive technologies and the children born of them. Preventing preterm birth also involves education and supportive public policies to promote healthy lifestyles among all pregnant women. Continued research into the causes of preterm birth aims to provide the basis for effective prevention programs.

Population-based approaches to ensure early intervention and effective management are urgently required to reduce the risk of RDS when preterm birth occurs. Widespread adoption of antenatal steroids for threatened preterm delivery has significantly improved the prognosis for RDS. Despite the known benefits of these steroids, however, many preterm babies still do not receive them. Since the steroids must be started 48 hours prior to birth if they are to be of optimal benefit, it is essential for women to come to the hospital as soon as preterm labour starts. Drugs to stop preterm labour can delay birth long enough to administer antenatal steroids.[20] Therefore, all women must know the signs and symptoms of preterm labour, and health care providers must be ready to respond appropriately.

Adequate surveillance data would improve our understanding of RDS at the population level. Most current information on RDS comes from single- or multiple-centre databases and clinical trials. No systematic approach currently exists for the timely and universal collection of data. Comprehensive population-based data on the incidence and outcome of preterm births and RDS would greatly facilitate the development of research and preventive strategies.

Figure 9-1 Rates of preterm* birth (percent of live births), Canada, 2000-2004.

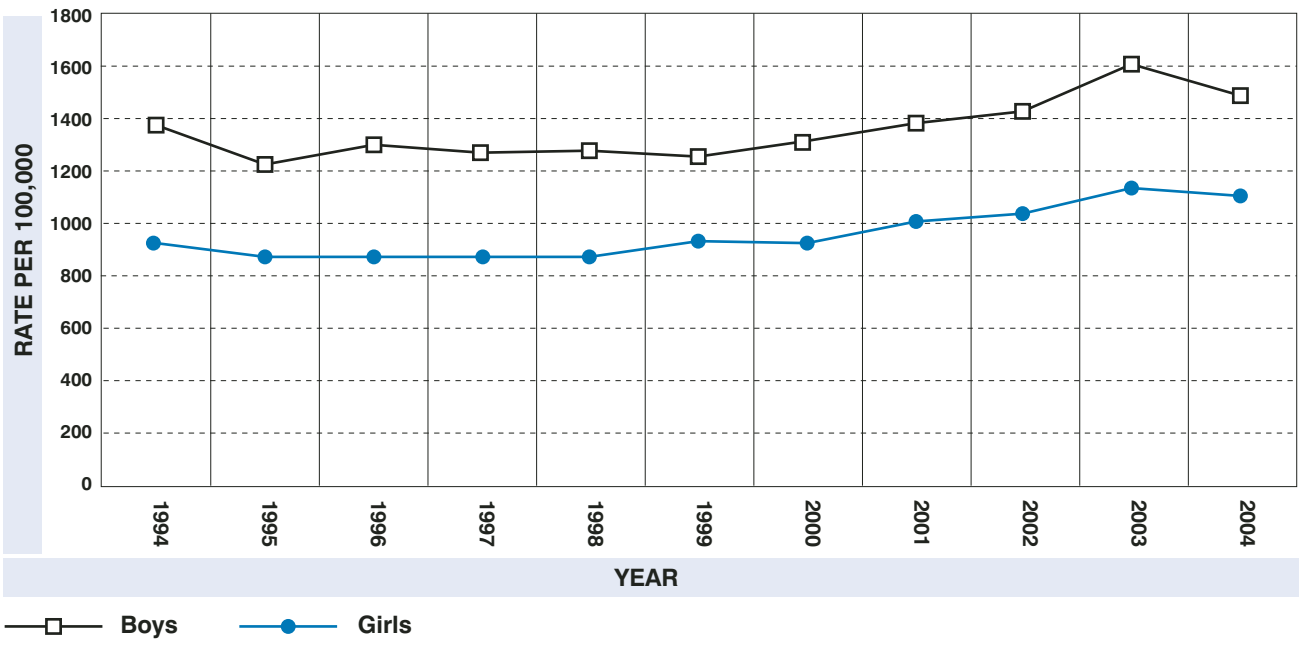


	2000	2001	2002	2003	2004
% livebirths	7.5	7.3	7.5	7.7	7.9

* Gestation less than 37 weeks

Source: Public Health Agency of Canada using Statistics Canada, Canadian Vital Statistics, Birth Database .

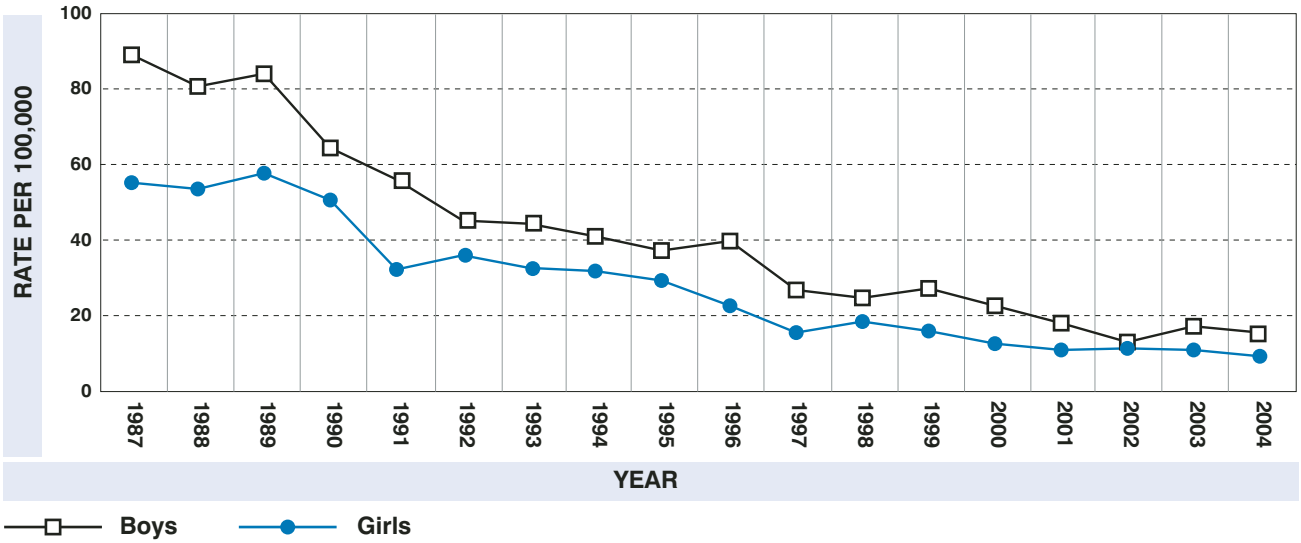
Figure 9-2 Respiratory distress syndrome (RDS)* hospitalization rate (per 100,000), newborns by sex, Canada, 1994/95-2004/05.



* RDS among any of the diagnoses on discharge

Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada using data from Hospital Morbidity File (acute and chronic), Canadian Institute for Health Information.

Figure 9-3 Respiratory distress syndrome (RDS) mortality rates (per 100,000) for infants to age 12 months, Canada, 1987-2004.



Source: Centre for Chronic Disease Prevention and Control - Using Statistics Canada Data.

1 Avery ME, Mead J. Surface properties in relation to atelectasis and hyaline membrane disease. Am J Dis Child 1959; 97:517-23.

2 Abbasi S, Bhutani VK, Gerdes JS. Long-term pulmonary consequences of respiratory distress syndrome in preterm infants treated with exogenous surfactant. J Pediatr 1993;122:446-52.

3 Shaubel D et al. Neonatal characteristics as risk factors for preschool asthma. J Asthma 1996;33(4):255-64.

4 Richardson DK, Gray JE, Gortmaker SL, Goldmann DA, Pursley DM, McCormick MC. Declining severity adjusted mortality: Evidence of improving neonatal intensive care. Pediatrics 1998;102:893-99.

5 Fujiwara T, Chida S, Watabe Y, Maeta H, Morita T, Abe T. Artificial surfactant therapy in hyaline membrane disease. Lancet 1980;i:55-9.

6 Preterm birth: making a difference. [Ottawa:] Best Start Resource Centre in collaboration with the Perinatal Partnership program of Eastern and Southeastern Ontario and the Society of Obstetricians and Gynaecologists of Canada; 2002. p. 5. Available from *http://www.beststart.org/resources/rep_health/index.html*

7 Preterm birth: making a difference. pp. 5-6.

8 Liggins GC, Howie RN. A controlled trial of antepartum glucocorticoid treatment for prevention of the respiratory distress syndrome in premature infants. Pediatrics 1972;50:515-25.

9 Canadian Neonatal Network. Annual Report 2005. p. 81. Available from: *http://www.canadianneonatalnetwork.org/annual.shtml*

10 Usher R. The respiratory distress syndrome of prematurity. Pediatr Clin of North Am 1961;8:525-38

11 Lee KS, Khoshnood B, Wall N, Chang YP, Hsieh HL, Singh JK. Trend in mortality from respiratory distress syndrome in the United States, 1970-1995. J Pediatr 1999;134:434-40.

12 Canadian Neonatal Network. Annual Report 2005. p. 81. Available from: *http://www.canadianneonatalnetwork.org/annual.shtml*

13 Calculated from: Canadian Neonatal Network. Annual Report 2005. p. 12, 56. Available from: http://www.canadianneonatalnetwork.org/annual.shtml

14 Personal Communication/Custom tabulation: Aireen Wingert. Canadian Neonatal Network. July 27, 2007.

15 Canadian Neonatal Network. Annual Report 2005. p. 54. Available from: *http://www.canadianneonatalnetwork.org/annual.shtml*

16 Canadian Institute for Health Information. Giving Birth in Canada: The Costs. Ottawa: The Institute; 2006. p. 30, Figure 14.

17 Stevenson DK, Wright LL, Lemons JA, Oh W, Korones SB, Papile LA, et al. Very low birth weight outcomes of the National Institute of Child Health and Human Development Neonatal Research Network, January 1993 through December 1994. Am J Obstet Gynecol 1998;179:1632-39.

18 Lee KS, Khoshnood B, et al.

19 Canadian Neonatal Network. Annual Report 2005. p. 74. Available from: *http://www.canadianneonatalnetwork.org/annual.shtml*

20 Preterm birth: making a difference, p. 50.

Chapter 10

Sleep Apnea

Sleep Apnea

Introduction

Sleep disordered breathing is an important public health problem. Without adequate high quality sleep people cannot function effectively at home, at work or in the community.

Sleep apnea is the most common of the syndromes described as sleep disordered breathing. It is characterized by episodes of pauses in breathing lasting from 10 to 30 seconds during sleep which sometimes recur hundreds of times a night. With each episode, the brain briefly rouses the sleeper to resume breathing, resulting in a fragmented, poor quality sleep.

The most common form of sleep disordered breathing is **obstructive sleep apnea**. In this form, episodes occur due to a collapse of soft tissue in the back of the throat which closes off the airway. The blockage can be the result of relaxed throat muscles, a narrow airway, a large tongue or extra fatty tissue in the throat.

Central sleep apnea is a rarer type of sleep apnea. In central sleep apnea the part of the brain that regulates breathing doesn't work properly.

Sleep hypoventilation syndrome is another rare type of sleep disordered breathing that occurs when not enough oxygen is absorbed during sleep.

Risk factors

Obstructive sleep apnea occurs when the loss of upper airway muscle tone during sleep is combined with upper airway narrowing.[1] Upper airway size is determined by a variety of factors.

- Obesity is a major risk factor for obstructive sleep apnea. Upper body obesity results in fat deposition both around the airway and in the related soft tissues.
- Hormonal factors influence upper body obesity; this is probably why obstructive sleep apnea is less common in pre-menopausal women than in men or postmenopausal women.
- Increasing age is associated with narrower and possibly more collapsible upper airways.
- Individual variations in jaw, tongue and soft palate size and position contribute to upper airway size. These individual variations are in part genetically determined.[2]

Obstructive sleep apnea is also more common in patients who smoke.

Obstructive sleep apnea in children is usually associated with enlarged adenoids or tonsils. It has been suggested that enlarged adenoids or tonsils during childhood may cause abnormal craniofacial development and a narrower adult upper airway.

Central sleep apnea occurs in patients with brain stem abnormalities caused by infection, inflammation or tumour. In other circumstances, it is present at high altitude or secondary to drug or substance abuse. Central sleep apnea is also caused by prolonged circulation time present in patients with cardiac disease and/or abnormal respiratory control secondary to cerebrovascular disease.

Sleep hypoventilation syndrome usually occurs in association with restrictive lung disease in morbidly obese individuals, or with respiratory muscle weakness, or obstructive lung disease such as COPD.

Prevalence

There is a lack of information on the Canadian prevalence of sleep disordered breathing. The Wisconsin Sleep Cohort Study is a landmark population-based prospective study in which polysomnography (an assessment of the quality of sleep and air flow to the nose and mouth during sleep) was performed on a random sample of middle-aged state employees.[3] Moderate to severe obstructive sleep apnea was present in 4% of men and 2% of women. Population studies suggest that sleep disordered breathing is at least as prevalent in Canada as in other industrialized nations.[4]

Central sleep apnea and sleep hypoventilation syndrome are relatively uncommon, but a form of central sleep apnea is quite common in patients with cardiac or neurological disease. One study suggests that 45% of patients with congestive heart failure have sleep disordered breathing.[5]

The prevalence of sleep disordered breathing in children is not well established. In an Italian study, 1.8% of 1,207 children between the ages of 3 years and 11 years had obstructive sleep apnea.[6] The prevalence of sleep disordered breathing in adolescents appears similar to that in younger children.

Health Outcomes

Sleep disordered breathing impairs cognitive function and reduces quality of life. Sleepiness, the hallmark symptom of obstructive sleep apnea, increases the rate of motor vehicle crashes and work-related accidents. Men and women with moderate or severe obstructive sleep apnea are seven times more likely than individuals without obstructive sleep apnea to have multiple motor vehicle crashes in a 5-year period.[7] These crash rates return to normal with effective treatment.[8]

Clinical trial data now show that obstructive sleep apnea is associated with systemic hypertension and that blood pressure falls when severe obstructive sleep apnea is treated with continuous positive airways pressure (CPAP) therapy.[9] CPAP works by gently blowing pressurized room air through the airway at a pressure high enough to keep the throat open. Obstructive sleep apnea has also been shown to be an independent risk factor for the development of coronary artery disease.[10] Patients with severe obstructive sleep apnea are twice to four times more likely to develop complex arrhythmias, abnormal heart rhythms, than patients without obstructive sleep apnea.[11] Cardiac dysfunction can cause sleep disordered breathing, and obstructive sleep apnea can contribute to systolic and diastolic dysfunction. In direct contrast to the general population, patients with obstructive sleep apnea have an increase in death from cardiac causes when asleep.[12] A long-term observational study has demonstrated an increased risk of both fatal and non-fatal cardiovascular events in untreated men with severe obstructive sleep apnea.[13] Sleep disordered breathing is very common in patients with cerebrovascular disease and is associated with a poorer prognosis. More recent longitudinal data on mortality from stroke found an increasing risk of events with obstructive sleep apnea severity.[14] The causative relationship between obstructive sleep apnea and cerebrovascular disease remains circumstantial because of multiple confounding factors.

Economic Impact

Patients with sleep disordered breathing have elevated health care expenditures for many years prior to diagnosis. Patients with sleep disordered breathing use health care services at approximately twice the rate of control subjects prior to diagnosis, and for up to 10 years prior to the diagnosis of sleep disordered breathing[15, 16] Sleep hypoventilation syndrome is the sleep disordered breathing syndrome associated with the highest health care expenditures because it often requires hospitalization.[17] Direct health care costs of sleep disordered breathing are easier to estimate than indirect costs, which might include effects on the patient's family, decreased work productivity and work-related and transportation-related accidents.[18] The costs for car and other transportation accidents may be substantial. There have been documented railway accidents and fatalities involving Canadian trains operated by personnel with untreated or under-treated sleep disordered breathing.[19] The Canadian railway industry now has rigorous guidelines about employees who have been diagnosed with or impaired by sleep disordered breathing.[20]

CPAP treatment decreases health care expenditures during the first two years after diagnosis of obstructive sleep apnea.[21] The cost-effectiveness of medical treatment is usually assessed by the incremental cost-effectiveness ratio, which is the ratio of the incremental costs associated with treatment divided by the incremental quality-adjusted life years (QALY). In a conservative analysis, which included the economic benefits of a reduction in motor vehicle crashes but did not include any potential cardiovascular benefits, CPAP treatment had an incremental cost-effectiveness ratio of $2,618 per QALY over no treatment.[22] A ratio of less than $10,000/QALY is generally considered extremely cost-effective.

Diagnosis and Treatment

The Canadian Thoracic Society has recently developed national guidelines for the diagnosis and treatment of sleep disordered breathing.[23] As with any medical condition, the diagnosis of sleep disordered breathing starts with history and physical examination. Symptoms of sleep disordered breathing include choking, gasping or snoring during sleep, recurrent awakenings during sleep, unrefreshing sleep, daytime fatigue and impaired concentration. The presence of two or more of these symptoms and the results of polysomnography are used to diagnose the condition. Sleep monitoring results determine the type and severity of the condition.

Conventional CPAP at a fixed pressure is the primary treatment for patients with obstructive sleep apnea. Oral appliances, sometimes called dental appliances, may be an appropriate therapeutic choice for patients with mild-moderate obstructive sleep apnea with minimal daytime symptoms. These devices are intended to treat apnea by keeping the airway open in one of three ways: by pushing the lower jaw forward, by preventing the tongue from falling back over the airway, or by combining both mechanisms. Corrective surgery may be considered for the upper airway in selected patients with obstructive sleep apnea in whom CPAP or oral appliance treatment have been unsuccessful. The intention of surgery is to open the airway sufficiently to eliminate or to reduce obstructions. In order to do this, surgical therapy in adults often must reconstruct the soft tissues (such as the uvula and the palate) or the bony tissues (the jaw) of the throat.

Discussion and Implications

Sleep disordered breathing is common and is associated with reduced quality of life, decreased cardiovascular health and increased health care utilization, transportation accidents and mortality. Though several well-tolerated and effective treatments have been shown to improve quality of life and cardiovascular health and reduce health care utilization and motor vehicle crashes, the majority of Canadians with sleep disordered breathing remain undiagnosed and untreated. Since obesity is a major risk factor for sleep apnea, efforts to promote healthy weights will have the greatest impact on the prevention of this disease.

1 Remmers JE, DeGroot WJ, Sauerland EK, Anch AM. Pathogenesis of upper airway occlusion during sleep. J Appl Physiol 1978;44(6):931-938.

2 Redline S, Tosteson TD, et al. The familial aggregation of obstructive sleep apnea. Am J Respir Crit Care Med 1995;151:682-687.

3 Young T, Palta M, Dempsey J, Skatrud J, Weber S, Badr S. The occurrence of sleep disordered breathing among middle-aged adults. N Engl J Med 1993;328:1230-1235.

4 Keenan SP, Ferguson KA, Chan-Yeung M, Fleetham JA. Prevalence of sleep disordered breathing in a population of Canadian grainworkers. Can Respir J 5(3):184-190, 1998.

5 Javaheri S, Parker TJ, Wexler L, et al. Occult sleep-disordered breathing in stable congestive heart failure. Ann Intern Med 1995;122:487-492.

6 Brunetti L, Rana S, Lospalluti ML, Pietrafesa A, Francavilla R, Fanelli M, and Armenio L. Prevalence of Obstructive Sleep Apnea Syndrome in a Cohort of 1,207 Children of Southern Italy. Chest, Dec 2001;120:1930-1935.

7 Young T, Blustein J, Finn L, Palta M. Sleep-disordered breathing and motor vehicle accidents in a population-based sample of employed adults. Sleep 1997;20(8):608-13.

8 George CF. Reduction in motor vehicle collisions following treatment of sleep apnoea with nasal CPAP. Thorax 2001;56(7):508-12.

1 Robinson GV, Stradling JR, and Davies RJO. Obstructive sleep apnoea/hypopnoea syndrome and hypertension. Thorax, Dec 2004;59:1089-1094.

10 Shahar E, Whitney CW, Redline S, et al. Sleep-disordered breathing and cardiovascular disease: cross-sectional results of the Sleep Heart Health Study. Am J Resp Crit Care Med 2001;163(1):19-25.

11 Mehra R, Benjamin EJ, Shahar E, Gottlieb D J, Nawabit R, Kirchner HL, Sahadevan J, Redline S. Association of nocturnal arrhythmias with sleep-disordered breathing: The Sleep Heart Health Study. Am J Respir Crit Care Med 2006 173:910-916.

12 Gami AS, Howard DE, Olson EJ, Somers VK. Day-night pattern of sudden death in obstructive sleep apnea. N Engl J Med 2005;352(12):1206-14.

13 Marin JM, Carrizo SJ, Vicente E, Agusti AG. Long-term cardiovascular outcomes in mean with obstructive sleep apnoea-hypopnea with or without treatment with continuous positive airway pressure: an observational study. Lancet 2005;365:1046-53.

14 Yaggi HK, Concato J, Kernan WN, Lichtman JH, Brass LM, Mohsenin V. Obstructive sleep apnea as a risk factor for stroke and death. N Engl J Med 2005;353:2034-41.

15 Smith R, Ronald J, Delaive K, Walld R, Manfreda J, Kryger MH. What are obstructive sleep apnea patients being treated for prior to this diagnosis? Chest. 2002;121(1):164-72.

16 Shepertycky MR, Banno K, Kryger, MH. Differences between men and women in the clinical presentation of patients diagnosed with obstructive sleep apnea syndrome. Sleep 2005;28:309-14.

17 Berg G, Delaive K, Manfreda J, Walld R, Kryger MH. The use of health-care resources in obesity-hypoventilation syndrome. Chest. 2001;120(2):377-383.

18 Wittmann V, Rodenstein DO. Health care costs and the sleep apnea syndrome. Sleep Med Rev 2004;8(4):269-79.

19 National Transportation Safety Board. Railroad accident report: Collision of two Canadian National/Illinois Central railway trains near Clarkston, Michigan, November 15, 2001. RAR-02/04. Washington, 2002. Available at: http://www.ntsb.gov/Publictn/2002/RAR0204.pdf

20 Railway Association of Canada. Canadian railway medical rules handbook (for positions critical to safe railway operations. Ottawa: the Association, 2001. Available at: http://www.railcan.ca/documents/circulars/657/2004_11_01_CMR_Handbook_en.pdf

21 Albarrak M Banno K, Sabbagh AA, Delaive K, Walld R, Manfreda J, Kryger MH. Utilization of healthcare resources in obstructive sleep apnea syndrome: a 5- year follow-up study in men using CPAP. Sleep 2005;28:1306-1311.

22 Ayas NT, FitzGerald JM, Fleetham JA, White DP, Schulzer M, Ryan CF, Ghaeli R, Mercer GW, Cooper P, Marra CA. A cost-effectiveness analysis of continuous positive airway pressure (CPAP) therapy versus no CPAP therapy for obstructive sleep apnea hypopnea. Arch Intern Med 2006;166: 977-984.

23 Fleetham J, Ayas N, Bradley D, Ferguson K, Fitzpatrick M, George C, Hanley P, Hill F, Kimoff J, Kryger M, Morrison D, Series F, Tsai W. Canadian Thoracic Society Guidelines: Diagnosis and treatment of sleep disordered breathing in adults. Can Respir J 2006;13(7):387-392.

Chapter 11

Tuberculosis

Tuberculosis

Introduction

Tuberculosis (TB) continues to be a major health problem worldwide. The World Health Organization (WHO) declared tuberculosis a global emergency in 1993 and warned of a specific TB emergency in Africa in 2005. It is estimated that one-third of the world's population is infected with Mycobacterium tuberculosis–the cause of TB. Approximately 9 million new cases of active TB disease develop each year, and almost 2 million persons die of the disease. Expressed otherwise, there is a new case in the world every 4 seconds and a death every 19 seconds. This makes tuberculosis a leading cause of morbidity and mortality–a fact with important implications for Canada due to international travel and immigration from high TB-incidence countries.

Severe epidemics of multidrug-resistant TB (MDR-TB)–the form resistant to at least isoniazid (INH) and rifampin–continue in several regions of the world. There are about half a million new and previously treated MDR-TB cases per year globally. Clusters of extensively drug-resistant TB (XDR-TB)–that is, MDR-TB with additional resistance to two or more kinds of second-line anti-TB drugs–have also been reported. These forms of TB are very difficult and costly to treat and represent a significant challenge to TB control worldwide.

After peaking in the early 1940s, the number of TB cases reported in Canada has shown large declines. From 1994 to 2005, the rate decreased by an average of 3.4% per year to 5.0 per 100,000 population. However, the decline in the rate slowed to only 2.2% annually between 2001 and 2005, and the rate remained constant in 2004 and 2005. In the spirit of the international STOP-TB Partnership's Global Plan,[1] the Canadian TB Committee established a goal to reduce Canada's incidence rate to 3.6 per 100,000 or lower by 2015. This will require further substantial declines of approximately 3% annually.

Most people who are exposed to TB bacteria do not develop TB disease, as the immune system kills or effectively controls the bacteria. A condition in which the bacteria remain alive but inactive in the body is called latent TB infection. A person with latent TB infection has no symptoms, is not sick, and poses no current or immediate risk of spreading the bacteria. However, under certain circumstances, latent TB infection can progress to active (and potentially infectious) TB disease. It is estimated that up to 12% of Canadians have latent TB infection.[2]

Risk Factors for Latent TB Infection and TB Disease

Certain population groups in Canada have an increased risk of TB infection. These groups include:

- those who have come into close contact with individuals with known or suspected active TB,
- people born in or travelling to countries where TB is widespread,
- Aboriginal people who have lived in a community with a high rate of TB disease,
- homeless people,
- residents of some long-term care or correctional facilities, and
- persons who work with any of these groups, such as health care workers.

People with a weakened immune system run a greater risk that infection will develop into TB disease. Conditions that weaken the immune system include HIV infection, treatment with immunity-suppressing drugs, end-stage kidney disease, cancer of the head and neck, diabetes mellitus, silicosis, being underweight, and long-term cigarette smoking. Babies, pre-school children and the elderly are also at greater risk, because their immune systems are weaker than those of healthy adults.

Symptoms of TB Disease

The symptoms of TB disease in the lungs can include a bad cough lasting longer than three weeks, pain in the chest, coughing of blood or sputum, weakness or extreme fatigue, weight loss, lack of appetite, chills, fever and night sweats.

Incidence

Note: All data in this section are provisional until the release of *Tuberculosis in Canada 2005*. For current TB statistics, please see www.publichealth.gc.ca/tuberculosis.

In 2005, 1,616 cases of new and relapsed active cases of tuberculosis were reported in Canada (5.0 per 100,000). Since 1995, the incidence of new active and relapsed tuberculosis cases reported in all of Canada has declined; however, this decline has slowed recently (Figure 11–1).

In 2005, the incidence rates were highest among the 65–74 and 75 and over age groups, but the greatest number of tuberculosis cases reported was among individuals aged 25 to 44 years (Figure 11–2).

In 2005, almost two-thirds (63.0%) of TB cases involved individuals who were born outside of Canada. Of the 1,016 cases who were foreign-born, 329 (32.4%) were from the Western Pacific WHO region (Figure 11–3).

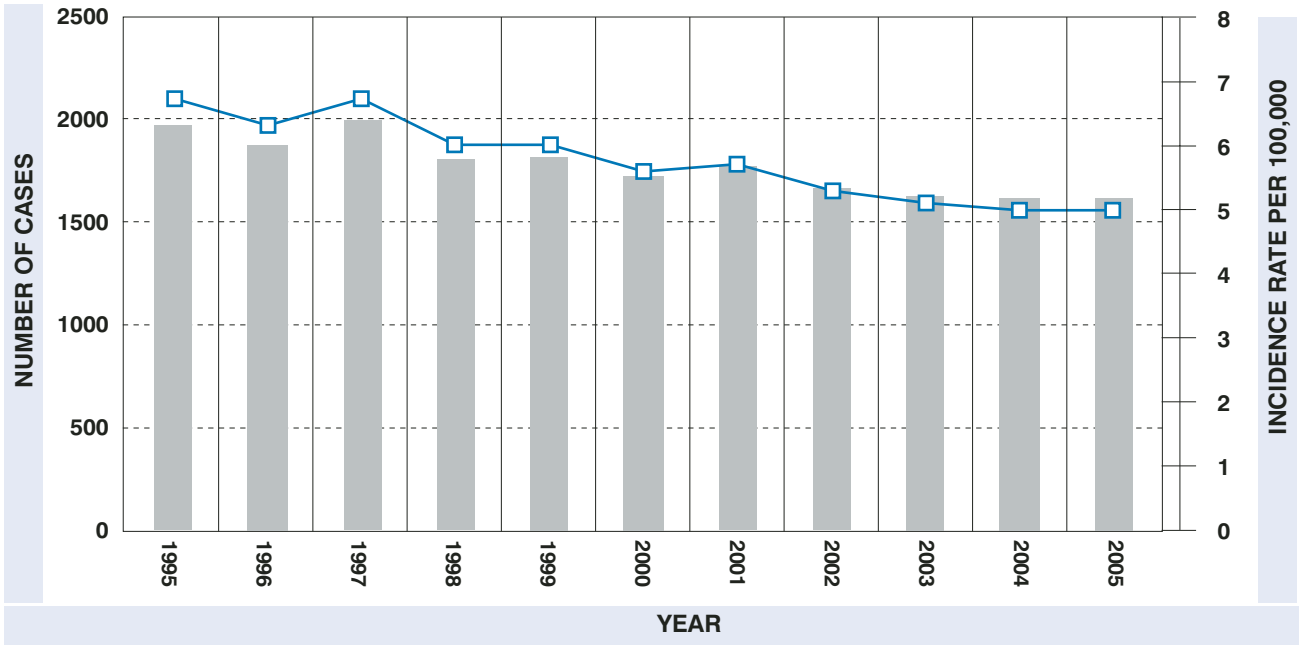
Antibiotic sensitivity testing of 1,308 samples of Mycobacterium tuberculosis and M. tuberculosis complex bacteria in 2005 found 163 (12.5%) to be resistant to one or more first-line anti-TB drugs. Resistance to INH was the most common type of drug resistance reported (8.3%). Multidrug-resistant TB (MDR-TB), a pattern of resistance that greatly complicates treatment, accounted for 1.6% of the samples (Figure 11–4).

Costs

As with most diseases, the costs attributable to tuberculosis in Canada stem from multiple sources. Beside the evident costs of hospitalization, laboratory procedures and medication, there are also less obvious costs, including public health activities, such as contact tracing, maintaining surveillance systems, and supporting immigration-related policies and programs for health screening.

Data on the estimated costs of tuberculosis in Canada are limited. However, a recent report completed for the Public Health Agency of Canada estimated that total TB-related expenditures in Canada were $74 million in 2004, equivalent to $47,290 for every active TB case diagnosed in that year.[3]

Figure 11-1 Number of cases and incidence rate (per 100,000) of reported new active and relapsed tuberculosis cases, Canada, 1995-2005



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
# of Cases	1964	1877	1995	1809	1820	1723	1772	1660	1629	1613	1616
Incidence Rate	6.7	6.3	6.7	6.0	6.0	5.6	5.7	5.3	5.1	5.0	5.0

Source: Tuberculosis Prevention and Control, Public Health Agency of Canada

Discussion and Implications

Canada is considered a low TB-incidence country; yet, because of a number of factors, the public health and economic impact of tuberculosis remains significant among certain high risk groups in Canada:

- First, at least 80% of immigrants to Canada in the past 10 years have come from high TB-incidence countries. While the pre-immigration medical examination process may find active TB disease and prevent immigration until treated, many Canadian immigrants have latent TB infection. TB bacteria are present in their body, but the individuals are not ill and not infectious. While most will never develop active TB disease, some do, often shortly after immigration but sometimes later in life. One study suggests that Canada's contribution to TB control in the source countries of immigrants could reduce the number of future cases of actual TB disease in this country.[4] Also, better tools are needed to diagnose latent TB infection in immigrants after they arrive in Canada. More effective ways to treat those at high risk for progression to active disease are also needed.

- Second, although the total number of TB cases is highest among the foreign-born, Aboriginal people in Canada have higher rates of TB (26.8 per 100,000) than the foreign-born (14.8 per 100,000) and the general population in Canada (5.0 per 100,000).

- Third, the effects of poverty, including crowded housing, are associated with increased TB incidence among some Aboriginal communities and among the urban homeless.

- Fourth, the global spread of the TB-HIV co-epidemic represents another concern. HIV-positive individuals are up to 100 times more likely than HIV-negative individuals to progress from latent TB infection to active TB disease.

- Finally, the prevalence of drug-resistant tuberculosis bacterial strains represents a threat throughout the world and has the potential to increase here in Canada. To address this concern, we need to continue to monitor drug resistance in cases and prevent drug resistance from developing by providing comprehensive TB treatment.

Efforts continue to target many of these risk factors and high-risk groups for the prevention and control of TB in Canada. These activities are co-ordinated and enhanced by the Canadian Tuberculosis Committee, whose members are drawn from all provinces and territories, federal departments involved with TB prevention and control, and various non-governmental health organizations. The sixth edition of *Canadian Tuberculosis Standards*, scheduled for release in 2007, was jointly produced by the Canadian Lung Association/Canadian Thoracic Society and Public Health Agency of Canada as the definitive prevention and control guidelines for Canada. Editions will become available on-line at www.publichealth.gc.ca/tuberculosis or in paper format from Lung Association offices.

The continuous monitoring of TB in Canada remains a critical component of an overall TB control strategy. To this end, the Public Health Agency of Canada and all provinces and territories continue to enhance national tuberculosis case and drug resistance surveillance by collecting more information on risk markers and risk factors for each TB case and by developing a pan-Canadian TB bacteria genotype (fingerprint) database.

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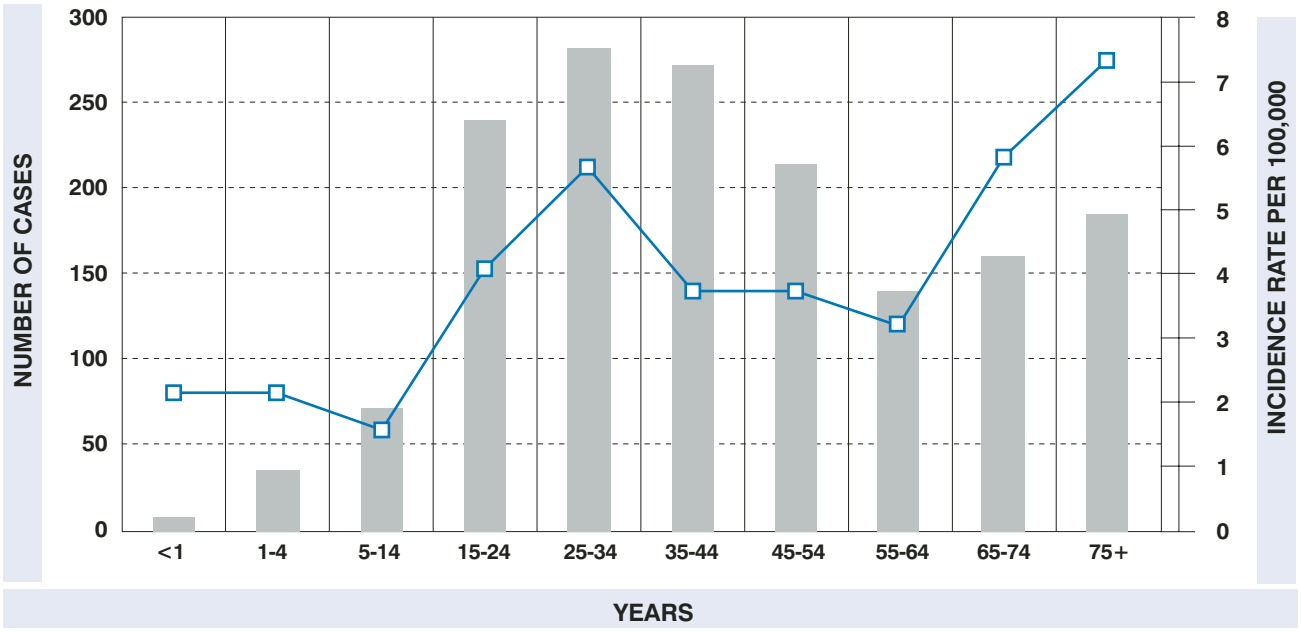
1 Stop TB Partnership and World Health Organization. The global plan to stop TB 2006-2015. Geneva: World Health Organization; 2006.

2 Public Health Agency of Canada. Tuberculosis prevention and control. Unpublished data, 2007

3 Menzies D, Oxlade O, Lewis M. Costs For tuberculosis care In Canada. Ottawa: Public Health Agency of Canada; 2006. http://www.phac-aspc.gc.ca/tbpc-latb/costtb/index_e.html

4 Schwartzman K, Oxlade O, Barr RG, Grimard F, Acosta I, Baez J, Ferreira E, Melgen RE, Morose W, Salgado AC, Jacquet V, Maloney S, Laserson K, Mendez AP, Menzies D. Domestic returns from investment in the control of tuberculosis in other countries. N Engl J Med. 2005 Sep 8;353(10):1008-1020.

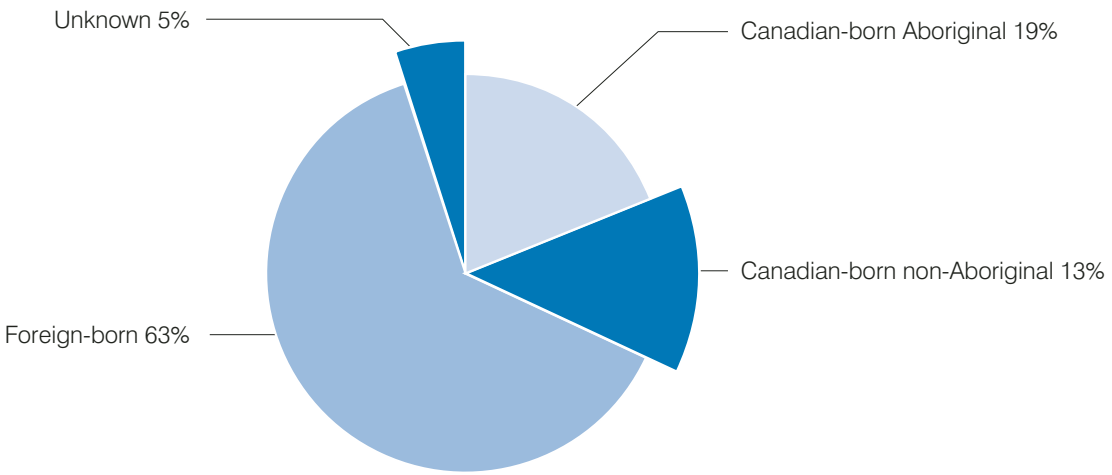
Figure 11-2 Number of cases and incidence rate (per 100,000) of reported new active and relapsed tuberculosis cases by age group, Canada, 2005



	<1	1-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75+
# of Cases	9	36	73	240	282	273	215	140	161	186
Incidence Rate	2.7	2.7	2.0	5.1	7.1	4.7	4.7	4.0	7.3	9.2

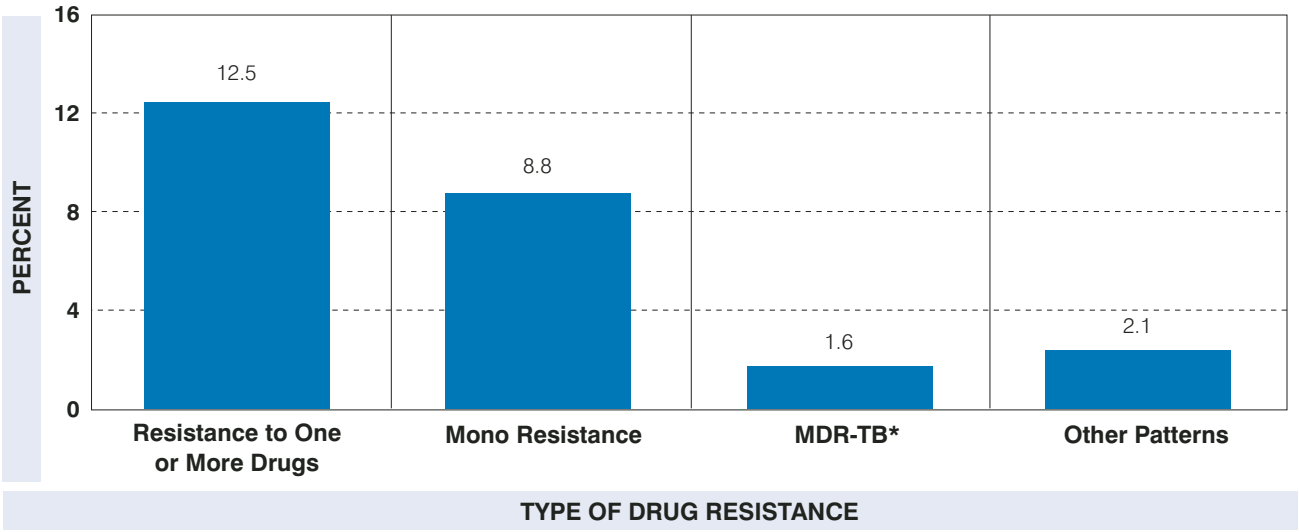
Source: Tuberculosis Prevention and Control, Public Health Agency of Canada

Figure 11-3 Proportion of reported new active and relapsed tuberculosis cases by birthplace, Canada, 2005



Source: Tuberculosis Prevention and Control, Public Health Agency of Canada

Figure 11-4 Overall pattern of reported TB drug resistance in Canada, 2005



* MDR-TB is defined as resistance to at least isoniazid and rifampin

Source: Tuberculosis Prevention and Control, Public Health Agency of Canada

Chapter 12

Lung Transplantation

Lung Transplantation

Introduction

Despite recent medical innovations to alleviate advanced pulmonary conditions, chronic lung diseases continue to result in significant premature mortality in Canada. Moreover, advanced lung disease imposes an enormous burden on Canadians, in quality of life as well as in economic costs for patients, caregivers and society.

Lung transplantation has become an important treatment option for some people with cardiorespiratory diseases. Worldwide over 20,000 single-lung, double-lung and combined heart–lung transplants have been performed in the past 25 years, and approximately 1,400 new transplants are performed annually.[1]

To date, the vast majority of donor lungs have come from deceased donors rather than from living donors. However, deceased donor organ transplantation is constrained by limited supply, in contrast to many advanced medical therapies, which may be limited by economic constraints.

Not all patients with advanced respiratory diseases are candidates for lung transplantation. In order to maximize the potential benefit from the limited donor resources, prospective recipients are evaluated in terms of established criteria that portend a favourable outcome. Broadly speaking, lung transplantation is ideally suited to younger patients with advanced lung disease who have no other therapeutic options. They should have limited prognosis for survival without transplantation (one to two years) and should not have other medical conditions that could unduly limit the success of the transplant or otherwise result in limited survival. Ultimately, each transplant program makes decisions about individual candidates on a case-by-case basis, since even many "non-ideal" patients may derive significant benefit, both in terms of quality and length of life.

The number of people waiting for any kind of lung transplant has more than doubled in the past 10 years. The number of patients on waiting lists for bilateral lung transplantation in Canada has gradually increased over the past decade (Figure 12–1).

Transplant Volumes

The number of lung transplants performed in Canada has steadily increased to 171 in 2006 (Table 12–1). The majority of lung transplants have been performed for emphysema/alpha-1 antitrypsin deficiency, cystic fibrosis and pulmonary fibrosis (Table 12–2). There are five active lung transplant centres in Canada, in Montreal, Toronto, Winnipeg, Edmonton and Vancouver.

Lung transplants are carried out much less frequently than other deceased donor solid organ transplants, less than one third as often as renal and liver transplants, for example. This relates largely to the vulnerability of the lungs to infection or other dysfunction in critically ill potential donors before they are declared brain dead. In the 2004 global experience, one or both lungs were suitable for transplantation in only 28.3% of all deceased donors.[2] A number of important factors affect deceased donor organ donation rates including sociocultural attitudes, public education and promotion, and mortality rates for otherwise healthy younger individuals from causes likely to permit organ donation (e.g., head trauma, intracranial hemorrhage).

Health Outcomes Following Lung Transplantation

In the 25 years since lung transplantation became clinically feasible, advances in areas such as donor–recipient selection, operative technique, postoperative care, immunosuppression regimens and anti-infective prophylactic strategies have resulted in substantial improvements in recipient outcomes. Anticipated survival rates following lung transplantation are approximately 80% at one year and 60% at 5 years.[3] Half of double-lung recipients are expected to survive for 5.6 years, and half of single-lung recipients can expect to survive for 4.3 years.[4] The most important factors associated with mortality in the first 30 days following transplant include primary graft dysfunction, infections and technical problems related to the peri-operative period.[5] The most important factors resulting in late mortality after a transplant include bronchiolitis obliterans, infections, cancer and cardiovascular disease.[6]

Hypertension, dyslipidemia and diabetes are commonly observed in individuals who have received lung transplants. In addition, nearly 50% of lung transplant recipients have evidence of bronchiolitis obliterans syndrome (chronic rejection) at five years.[7] Mild-to-moderate renal dysfunction is common, and up to 7% of lung transplant recipients require renal dialysis or renal transplant within seven years following transplant.[8] It is also becoming apparent that, as with other solid organ transplants, chronic immunosuppression is associated with a high incidence of neoplasms, predominantly skin cancers and lymphomas.[9]

Despite the successes achieved to date in clinical lung transplantation, long-term outcomes remain suboptimal. The major intermediate to long-term complication of lung transplantation resulting in morbidity and mortality is bronchiolitis obliterans (BO). Clinically, BO presents as chronic progressive allograft dysfunction with airflow

limitation as a result of small airways obstruction, thought to be a manifestation of chronic rejection. While uncommon in the first year following transplant, BO incidence increases steadily thereafter. It is present in at least half of long-term lung transplant survivors and is the predominant cause of death after the first year following transplant.

Besides achieving a survival advantage, lung transplant recipients realize substantial improvements in functional capacity and health-related quality of life.[10] More than 80% of lung transplant recipients surviving more than five years report no activity limitations, and approximately 40% return to the workforce.[11] Self ratings for health-related quality of life have been reported to be highly dependent on the incidence of infections, rejection episodes and the onset of BO syndrome.[12]

Health Care Costs

A report commissioned by the British Columbia Transplant Society in 2000 estimated initial inpatient costs in the range of CAN$63,000 for lung transplantation, based on length of stays averaging 26 days (range 13–88 days).[13] This estimate included expenses for nursing units, operating rooms, pharmacy, diagnostic imaging, clinical laboratory services, and allied health and support services. More recent estimates place costs for the initial hospitalization for lung transplantation in the range of CAN$100,000–$150,000.[14] However, monthly costs for care decrease from before to after the transplant actually decrease[15] unless complications develop.

The majority of care following lung transplantation is provided in ambulatory mutlidisciplinary transplant clinics. In the first year following lung transplantation, approximately 50% of lung transplant recipients require re-hospitalization for treatment of rejection, and 10% for other reasons.[16]

Discussion and Implications

There have been slow but steady increases in the number of lung transplants being performed in Canada. Applicants for lung transplants must often deal with strict criteria because the supply is inadequate. An increase in the number of donor organs might make it possible for these criteria to be applied with less stringency. Recent developments could enlarge the donor pool. These include lobar donation from living donors, donation after cardiocirculatory death[17] and, in the longer term, donor organs from other species (xenotransplantation).

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1 Trulock EP, Edwards LB, Taylor DO, Boucek MM, Keck BM, Hertz MI. Registry of the International Society for Heart and Lung Transplantation: Twenty-thrd Official Adult Lung and Heart-Lung Transplant Report—2006. J Heart Lung Transplant. 2006;25:80-892. Available from: http://www.ishlt.org/contentDocuments/lung_adult.ppt

2 Orens JB, Estenne M, Arcasoy S, Conte JV, Corris P, Egan JJ, Egan T, Keshavjee S, Knoop C, Kotloff R, Martinez FJ, Nathan S, Palmer S, Patterson A, Singer L, Snell G, Studer S, Vachiery JL, Glanville AR. International Guidelines for the Selection of Lung Transplant Candidates: 2006 Update—A Consensus Report From the Pulmonary Scientific Council of the International Society for Heart and Lung Transplantation. J Heart Lung Transplant. 2006 Jul; 25: 745-755.

3 ibid

4 Trulock EP, et al.

5 ibid

6 ibid

7 ibid

8 ibid

9 ibid

10 Kugler C, Fischer S, Gottlieb J, Welte T, Simon A, Haverich A, Strueber M. Health-Related Quality of Life in Two Hundred-Eighty Lung Transplant Recipients. The Journal of Heart and Lung Transplantation, Volume 24, Issue 12, Pages 2262-2268.

11 ibid.

12 ibid

13 Kurueger H et al. Inc. Solid organ transplant initial inpatient costs. August 4, 2000.

14 Based on figures supplied informally by BC Transplant and by the Canadian Lung Transplant Study Group (in its meeting at Banff, Alberta, March 2007).

15 Sharples LD, Taylor GJ, Karnon J, Caine N, Buxton M, McNeil K, Wallwork J. A model for analyzing the cost of the main clinical events after lung transplantation. J Heart Lung Transplant 2001;20:474-482.

16 Trulock EP, et al.

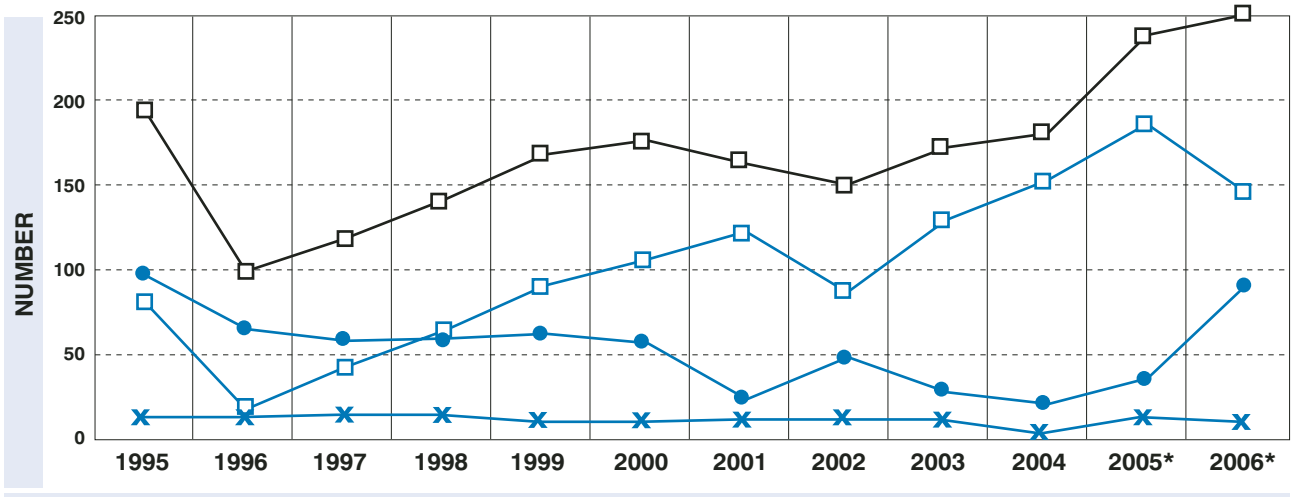
17 Shemie SD, Kn, Ro H Dn J, iarello J, ers-Evans J, ld S, GW, W, D, S, ck B, Do National recommendations for donation after cardiocirculatory death in Canada: Donation after cardiocirculatory death in Canada. CMAJ 2006;175:S1.

Table 12-1 Lung transplants by transplant type, Canada, 1995 to 2006 (number)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total 1995 to 2004	2005*	2006*
Bilateral Lung	45	43	52	46	55	85	82	96	95	98	697	122	141
Single Lung	27	29	34	30	30	34	39	36	21	30	310	17	23
Living-Donor Lobar	0	0	0	0	2	2	4	0	0	4	12	1	1
Heart–Lung	8	4	7	7	5	4	3	7	2	3	50	6	6
Total	**80**	**76**	**93**	**83**	**92**	**125**	**128**	**139**	**118**	**135**	**1,069**	**146**	**171**

* 2005 and 2006 from CORR e-Statistics. *http://secure.cihi.ca/cihiweb/dispPage.jsp?cw_page=reports_corrstats_e*
Source: Canadian Institute for Health Information, Treatment of End-Stage Organ Failure in Canada, 1995 to 2004 (2006 Annual Report).

Figure 12-1 Patients waiting for lung transplants at year end, Canada 1995 to 2006.



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005*	2006*
Bilateral Lung	83	19	44	66	93	108	125	88	131	155	188	147
Single Lung	98	66	60	61	64	58	25	50	29	22	37	94
Heart–Lung	14	14	15	15	11	11	13	12	12	4	14	11
Total	195	99	119	142	168	177	163	150	172	181	239	252

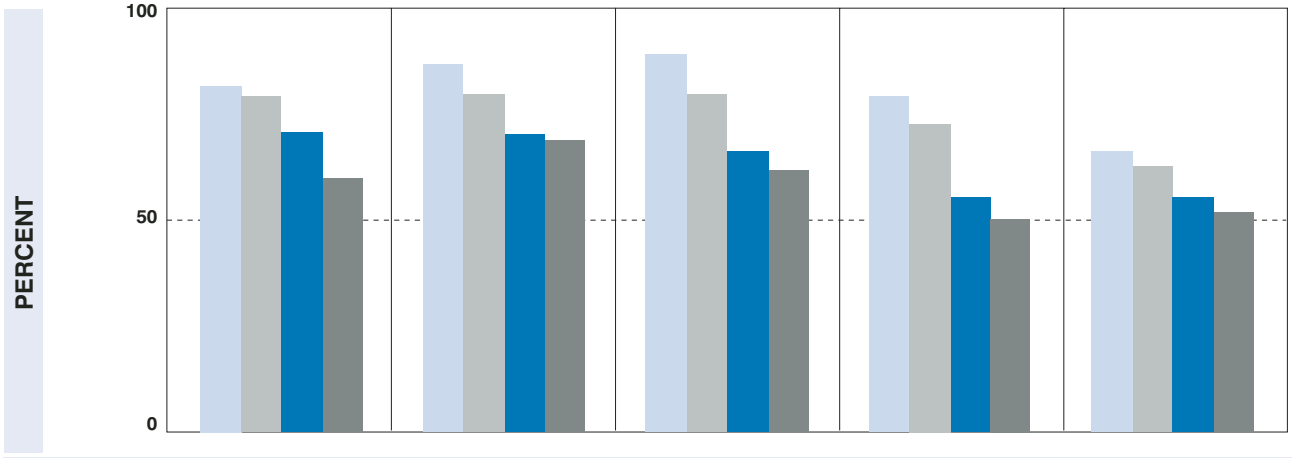
Source: Canadian Institute for Health Information, Treatment of End-Stage Organ Failure in Canada, 1995 to 2004 (2006 Annual Report) (Ottawa: CIHI, 2006). *2005 and 2006 from CORR e-Statistics. *http://secure.cihi.ca/cihiweb/dispPage.jsp?cw_page=reports_corrstats_e*

Table 12-2 Distribution of primary diagnoses for all lung transplant recipients, first grafts, Canada, 1995 to 2004

	Bilateral Lung		Single Lung		Heart-Lung	
	N	%	N	%	N	%
Congenital	13	1.9	1	0.3	22	46.8
Alpha 1 Antitrypsin Deficiency	60	8.7	25	8.1	1	2.1
Cystic Fibrosis	220	32.0	7	2.3	4	8.5
Emphysema/COPD*	130	18.9	157	50.6	4	8.5
Idiopathic Pulmonary Fibrosis	116	16.9	66	21.3	1	2.1
Primary Pulmonary Hypertension	36	5.2	6	1.9	9	19.1
Unknown	10	1.5	5	1.6	1	2.1
Other	102	14.8	43	13.9	5	10.6
Total	**687**	**100.0**	**310**	**100.0**	**47**	**100.0**

* More than one diagnosis can be reported for a patient.
Source: Canadian Institute for Health Information, Treatment of End-Stage Organ Failure in Canada, 1995 to 2004 (2006 Annual Report).

Figure 12-2 Survival following lung transplantation by primary diagnosis, first graft, deceased donor lungs, Canada, 1995 to 1999.



	Alpha 1 Antitrypsin Deficiency (N = 39)	Cystic Fibrosis (N = 85)	Emphysema/COPD (N = 105)	Idiopathic pulmonary Fibrosis (N = 59)	Primary Pulmonary Hypertension (N=27)
3 Months	82.1	87.1	89.5	79.7	66.7
1 Year	79.4	80.0	80.0	72.9	63.0
3 Years	71.2	70.4	66.7	55.7	55.6
5 Years	59.8	69.2	61.9	50.4	51.9

Source: Canadian Institute for Health Information, Treatment of End-Stage Organ Failure in Canada, 1995 to 2004 (2006 Annual Report) (Ottawa: CIHI, 2006).

Glossary

Age-standardization - A technique used to remove as far as possible the effects of differences in age when comparing two or more populations. In this report, rates were applied to five-year age groups in the 1991 Canadian population (the standard population) in order to obtain the overall rate for each year.

Allograft – Tissue or organ transplanted from one person to another.

Alpha 1 antitrypsin (A1AT) deficiency - An inherited disorder associated with retention of the liver-produced protein A1AT in the liver and low levels of A1AT in the serum. In the most severe form of A1AT deficiency, the clinical features consist of early-onset emphysema, neonatal hepatitis, chronic hepatitis, and cirrhosis. However, phenotypic expression throughout life is extremely variable.

Antenatal steroid – Steroid administered before birth with the intention of helping the lungs of a premature fetus to mature.

Asbestosis (ICD 9 code 501; ICD 10 code J61) – An irreversible condition caused by inhaled asbestos fibres, featuring scarring of the lungs. Can lead to COPD.

Asthma (ICD 9 code 493, ICD 10 code J45-J46) - A chronic disorder characterized by symptoms of cough, shortness of breath, chest tightness and wheeze. Prevalence estimates in this report are based on responses to the following questions: For children 5-11 "Has he/she ever had asthma that was diagnosed by a health professional?"; for 12+ "Now I'd like to ask about certain chronic health conditions which you may have. We are interested in long-term conditions which are expected to last or have already lasted 6 months or more and that have been diagnosed by a health professional . . . Do you have asthma?"

Bronchiectasis – Chronic abnormal dilation of the bronchi associated with recurrent respiratory infections.

Bronchiolitis (ICD 9 code 466.1, ICD 10 code J21) - Inflammation of the smaller airways in the lung, usually caused by bacterial or viral infection.

Bronchiolitis obliterans (BO) - Chronic progressive allograft dysfunction with airflow limitation as a result of obstruction of the small airways, thought to be a manifestation of chronic rejection. While uncommon in the first year following transplant, BO incidence increases steadily thereafter. It is present in at least half of long-term lung transplant survivors and is the predominant cause of death after the first year following transplant.

Bronchopulmonary dysplasia - Changes to a baby's lungs following severe respiratory distress in preterm infants who have been treated with oxygen and mechanical ventilation.

Chronic obstructive pulmonary disease (COPD) (ICD 9 code 490-492, 496; ICD 10 code J40-44) - A chronic disease with shortness of breath, cough and sputum production, also referred to as chronic bronchitis and emphysema. Prevalence estimates in this report were derived by combining responses to the following questions: "Now I'd like to ask about certain chronic health conditions which you may have. We are interested in long-term conditions which are expected to last or have already lasted 6 months or more and that have been diagnosed by a health professional" ". . . chronic bronchitis," " . . . emphysema," " . . . chronic obstructive pulmonary disease (COPD)."

COPD projections (hospitalization and mortality) – Simple projections created using the trendline feature in spreadsheet software. Available data were fit to a curve using linear or polynomial regression as indicated and the trend was projected to 2010.

Co-morbidity – Co-existence of two or more diseases or conditions.

Continuous positive airway pressure (CPAP) – The delivery of slightly pressurized air through a mask to increase the amount of air breathed without increasing the effort of breathing. Used in the treatment of obstructive sleep apnea and COPD.

Current smoker - includes daily smokers and non-daily smokers (also known as occasional smokers). Determined from the response to the question "At the present time do you smoke cigarettes every day, occasionally, or not at all?"

Cystic fibrosis (ICD 9 code 277.0, ICD 10 code E84) - A chronic genetic disease that causes individuals to produce abnormal mucous in the lungs that interferes with breathing and affects the ability of the pancreas to produce sufficient enzymes needed for the digestion of food.

Daily smoker - refers to those who respond "every day" to the question "At the present time do you smoke cigarettes every day, occasionally or not at all?"

Dyspnea – Shortness of breath, difficulty or laboured breathing.

Emphysema – A chronic respiratory disease featuring overinflation of air sacs (alveoli) in the lungs causing a decrease in lung function. (See also Chronic obstructive pulmonary disease.)

Exacerbation – An increase or worsening of the severity of symptoms.

High sampling variability – Population surveys include only a sample of the population. This sample may or may not be representative of the population as a whole. If the number of people who answer a question is very small, then the estimate of what is happening in the population based on this number may not be accurate. A measure of the degree of accuracy is the co-efficient of variance. When the co-efficient of variance exceeds a certain level, interpretation requires caution because the actual value could vary considerably from the estimate obtained in the survey. In this report, the following values were used to define high sampling variability:

0 – 16.5% = reliable estimate
16.5% – 25.0% = high sampling variability of estimate
> 25.1% = estimate not used for this report

Hospitalization diagnosis – Each time an individual leaves hospital (discharge, transfer or death) a record is completed listing one or more diagnoses that contributed to the hospital stay. The condition responsible for the length of stay in hospital is listed as the most responsible diagnosis. Up to 15 other conditions may also be listed. This report uses the most responsible diagnosis for all analyses unless otherwise indicated.

Hypersensitivity pneumonitis (extrinsic allergic alveolitis) – (ICD 9 495; ICD10 J67) - An inflammation of the lung caused by the body's immune reaction to small airborne particles such as bacteria, mould, or fungi.

Immunosuppression - Suppression of the body's natural defence system; usually necessary to prevent organ transplant rejection.

Incidence (or incidence rate) - The number of new cases that occur in the population at risk during a specific time period. (Incidence rate is the number of new cases divided by number of at risk individuals in the population, commonly during a one-year period and is typically expressed per 100,000 population.

Influenza (ICD 9 code 487, ICD 10 code J10-J11) – Infection by the influenza virus, causing mild to severe respiratory symptoms.

International Classification of Disease (ICD) - The global standard to report and categorize diseases, health-related conditions and external causes of disease and injury in order to compile useful health information related to deaths, illness and injury (mortality and morbidity). The 9th revision of the ICD (ICD 9) was used after 1979 until the 10th revision, which was phased in from 1999 to 2001.

ICD Codes for complications of pregnancy (ICD9 code 630-676; ICD 10 code O00-O99)
ICD Codes for reproductive causes ICD-9, V20-V39, ICD-10 Z30-Z39

Isocyanates - Petrochemical-based precursors for the manufacture of flexible and rigid polyurethane (PUR) foams, a family of polymers.

Low birthweight – Live births weighing less than 2500g.

Lung cancer (ICD 9 code 162, ICD 10 code C33-C34) – A malignant tumour with abnormal growth of lung tissue.

Mesothelioma - A malignant tumour affecting the lining of the chest or abdomen.

Mortality diagnosis – For the purpose of this report, the diagnosis most responsible for death according to the death certificate.

Neonatal – Pertaining to age from birth to 28 days.

Occasional smoker - also referred to as non-daily smoker, refers to those who respond "Occasionally" to the question "At the present time do you smoke cigarettes every day, occasionally or not at all?"

Oximetry – Non-invasive test to measure the amount of oxygen in the blood.

Polysomnography – A sleep study to assess quality of sleep and air flow to the nose and mouth; used to diagnose sleep apnea.

Pneumonia (ICD 9 code 480-486, ICD 10 code J12-J18) - Inflammation of lung, usually caused by bacterial or viral infection.

Pneumoconiosis (ICD 9 code 011.4,495, 500-505; ICD 10 code J60-J66) - Includes silicosis, coal workers' pneumoconiosis, and asbestosis, as well as historically less common diseases such as talc-related lung disease, siderosis, stannosis, bauxite lung (from aluminum), graphite lung and lung disease from beryllium.

Pulmonary Fibrosis - Chronic lung inflammation with progressive scarring of the alveolar walls.

Pulmonary Hypertension - Elevated blood pressure in the pulmonary arteries from constriction; causes problems with the blood flow in the lungs and makes the heart work harder.

Preterm birth rate - The proportion of live births with a gestational age at birth of less than 37 completed weeks (259 days or less) in a specific place and time.

Prevalence (point prevalence) - The proportion of the population who report a behaviour or have a health problem at a particular time.

Quality adjusted life year (QALY) – A measure of the value of health. A year of life is adjusted for its quality or its value. A year in perfect health is considered equal to 1.0 QALY. The value of a year in ill health would be discounted.

Respiratory distress syndrome (RDS) (ICD 9 code 769; ICD 10 code P22.0) – A condition of newborns, also known as hyaline membrane disease, that results in breathing difficulties due to a deficiency of lung surfactant, which coats the alveoli (airs sacs) to prevent them for collapsing as the baby exhales.

Respiratory syncytial virus (RSV) – A virus that causes both upper and lower respiratory symptoms. It is the underlying cause of most cases of bronchiolitis and pneumonia in children under 2 years of age.

Second-hand smoke is what smokers exhale and the smoke that rises from a burning cigarette.

Silicosis and Anthracosilicosis – ICD 9 500, 502; ICD 10 J60, J62 – Pneumoconiosis caused by carbon dust or silica dust.

Silicotuberculosis – ICD 9 011.4; ICD 10 J65 – Pneumoconiosis associated with tuberculosis.

Sleep apnea (ICD 10 code G47.3) - A disorder in which a person stops breathing during sleep, at least five times per hour, usually for periods of 10 seconds or longer.

Spirometry – A test of the air capacity of the lungs; lung function testing.

Surfactant – Substance secreted naturally in the lungs to reduce the surface tension of fluids coating the lungs, preventing the lungs from collapsing; the lack of surfactant causes respiratory difficulties in preterm infants.

Tuberculosis (TB) (ICD 9 code 010-018, 137; ICD 10 code A15-A19, B90) – A disease caused by a bacterium called Mycobacterium tuberculosis. TB usually attacks the lungs, but it can also affect other parts of the body such as the lymph nodes. The disease is spread when an infected individual coughs, sending TB bacteria into the air.

Xenotransplantation - Transfer of organs or tissue from one species to another species, such as from animals to humans.

Data Sources

Canadian Cancer Registry – Statistics Canada

Statistics Canada maintains a National Cancer Registry with information submitted by all provincial and territorial cancer registries. The registry includes demographic information and identifies the type of cancer. A variety of data sources, including laboratory and physician reports, are used to identify individuals to be included in the registry.

Canadian Community Health Survey (CCHS) – Statistics Canada

The CCHS is a cross-sectional survey that collects information related to health status, health care utilization and health determinants for the Canadian population. The survey collects information from persons aged 12 or older living in private dwellings in 122 health regions in all provinces and territories. Approximately 98% of the population age 12 and over are covered. There is no information for individuals living on Reserves, Crown lands, or in institutions, or for full-time members of the Canadian Forces.

Canadian Organ Replacement Register (CORR) – Canadian Institute for Health Information

The mission of CORR is to provide a national database on vital organ replacement therapy in Canada, with the goal of enhancing treatment, research and patient care. CORR is the national information system for renal and extra-renal organ failure and transplantation in Canada, with a mandate to record and analyze the level of activity and outcomes of solid organ transplantation and renal dialysis activities. There has been some form of Canadian register of renal failure statistics since the early 1970s. In 1987, the register was expanded to include data on extra-renal organ transplants.

Canadian Patient Data Registry - Canadian Cystic Fibrosis Foundation (CCFF)

The Canadian Patient Data Registry is a database containing medical information on all individuals with cystic fibrosis who have attended a cystic fibrosis clinic in Canada. Data are submitted annually by the 38 cystic fibrosis clinics in the country, and are maintained by the Foundation. Anonymous, aggregate statistics are available to CCFF-supported clinicians.

Canadian Tobacco Use Monitoring Survey (CTUMS) – Health Canada

CTUMS was initiated in 1999 to provide Health Canada and its partners with reliable data on tobacco use and related issues. It collects information on Canadians 15 years of age and older, except residents of Yukon, Nunavut and the Northwest Territories and full-time residents of institutions.

Canadian Tuberculosis Reporting System (CTBRS) – Public Health Agency of Canada

The CTBRS is maintained by Tuberculosis Prevention and Control, Public Health Agency of Canada. This surveillance system is derived from records of provincial and territorial tuberculosis registries that capture information on every new active and relapsed case of tuberculosis. The system has also been designed to capture information on treatment outcomes for these cases. All provinces and territories voluntarily submit case and outcome data to TBPC, four of them electronically and the remainder on paper.

Economic Burden of Illness in Canada (EBIC) – Public Health Agency of Canada

The EBIC is a series of studies offering a comprehensive overview of how the principal direct and indirect costs of illness are distributed in Canada at a given time. The methods used allow us to approximate the cost to society of illness or injury by translating illness, injury, and premature death into direct and indirect costs.

Health Person-Oriented Information Database (HPOI) – Statistics Canada

This linkable database is created from all the hospital discharge records in Canada compiled by the Canadian Institute for Health Information. Each record contains information abstracted from a patient's hospital chart and pertains to one hospital stay. The records are combined to create person-oriented information on patients. Hospital records are available for fiscal years 1995–95 to 2004–05. Medical data are coded according to the International Classification of Disease, 9th revision (ICD-9), or the 10th revision enhanced for Canada (ICD-10-CA).

Hospital Morbidity Database (HMDB) – Canadian Institute for Health Information

The HMDB is a national database that captures administrative, clinical and demographic information on all inpatients at Canadian health care facilities. It displays national discharge statistics by diagnoses and procedures. Discharge data comes from acute care facilities and select chronic care and rehabilitation facilities across the country. In addition to demographic and administrative information, the database contains up to 16 diagnostic codes and some procedures codes. Not included in the database are discharge data from psychiatric facilities, day procedures (e.g., day surgeries) and emergency department visits.

National Air Pollution Surveillance (NAPS) Network – Environment Canada

The NAPS network was established jointly in 1969 by the federal, provincial and municipal governments. Air quality data from the network give governments and the public essential information about air pollution that allows them to assess whether national air quality objectives are being met. In 2004, the network consisted of 260 stations in 172 communities.

National Ambulatory Care Reporting System (NACRS) – Canadian Institute for Health Information

The NACRS is a data collection tool designed to capture information on client visits to facility and community based ambulatory care. Client visit data are collected at the time of service in participating facilities. The database includes: demographic data, clinical data, administrative data, financial data, and service-specific data elements. Currently, data submission to NACRS has been mandated in Ontario for ER, day surgery, dialysis, cardiac catheterization and oncology (including all regional cancer centres). Some facilities in B.C., the Yukon, P.E.I and Nova Scotia are also submitting data.

National Longitudinal Survey of Children and Youth (NLSCY) – Statistics Canada and Human Resource Development Canada (HRDC)

The primary objective of the NLSCY is to develop a national database on the characteristics and life experiences of Canadian children as they grow from infancy to adulthood. Data collection began in 1994-95, and new data will be collected on these children every two years. While the survey is longitudinal, a cross-sectional sample for children 11 years and under is available across the surveys up to 2000. The NLSCY target population includes children in all provinces and territories, except children living in institutions, on Indian reserves, on Canadian Armed Forces Bases and in some remote areas. The survey collects information on the child from the household member most knowledgeable about the child. Up to four children per household are chosen randomly.

National Population Health Survey (NPHS) – Statistics Canada

The NPHS collects information related to the health of the Canadian population and related socio-demographic information. The NPHS is composed of three components: the Household Survey, the Health Care Institution Survey and the Northern Territories Survey. The NPHS Household Survey included a cross-sectional component until 1998–99. The NPHS household component includes household residents in all provinces, except for residents of Indian Reserves, Canadian Forces Bases and some remote areas in Quebec and Ontario.

Respiratory Virus Detection Surveillance System – Public Health Agency of Canada

The Respiratory Virus Detection Surveillance System reports on respiratory viruses in Canada. Each week, selected laboratories report to the Immunization and Respiratory Infections Division (IRID), Public Health Agency of Canada, on numbers of tests performed and numbers positive for influenza, respiratory syncytial virus, parainfluenza, and adenovirus.

Vital Statistics Death Database – Statistics Canada

This is a comprehensive administrative survey that collects demographic and medical (cause of death) information annually from all provincial and territorial vital statistics registries in Canada. The data are used to calculate basic indicators (such as counts and rates) on deaths. Information from this database is also used in the calculation of statistics, such as cause-specific death rates and life expectancy. The personal information portion of the death registration form is completed by an informant, usually a relative of the deceased. The portion of the form comprising the medical certificate of death is completed by the medical practitioner last in attendance or, in the event of an inquest or enquiry, by a coroner. The database includes demographic information and identifies the underlying cause of death as defined by the physician.

Youth Smoking Survey (YSS) – Health Canada

The YSS provides timely and accurate monitoring of tobacco use in children (grades 5–9) attending either public or private schools in all Canadian provinces. Data were initially collected in 1994; the survey was repeated in 2002 and again in 2004–05.