

The Burden of Asthma in Ontario



ICES Investigative Report

September 2006

The Burden of Asthma in Ontario

ICES Investigative Report

Authors

Teresa To, PhD
Andrea Gershon, MD, MSc, FRCPC
Marjan Tassoudji, MSc
Jun Guan, MSc
Chengning Wang, MD, MSc
Eileen Estrabillo, MHSc
Lisa Cicutto, RN, PhD, ACNP

September 2006

Publication Information

Published by the Institute for Clinical Evaluative Sciences (ICES) © 2006

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the proper written permission of the publisher.

How to cite this publication

To T, Gershon A, Tassoudji M, Guan J, Wang C, Estrabillo E, Cicutto L. The Burden of Asthma in Ontario. ICES Investigative Report. Toronto: Institute for Clinical Evaluative Sciences; 2006.

Institute for Clinical Evaluative Sciences (ICES)
G1 06, 2075 Bayview Avenue
Toronto, ON M4N 3M5
Telephone: 416-480-4055
www.ices.on.ca

Authors' Affiliations

Teresa To, PhD

Senior Scientist and Head, Population Health Sciences, Research Institute, The Hospital for Sick Children

Senior Adjunct Scientist, Institute for Clinical Evaluative Sciences

Associate Professor

Departments of Public Health Sciences, Health Policy, Management and Evaluation, Institute for Medical Science and Pediatrics, University of Toronto

Andrea Gershon, MD, MSc, FRCPC

Research Fellow, Canadian Institutes of Health Research and the Public Health Agency of Canada

Research Associate, Population Health Sciences, Research Institute, The Hospital for Sick Children

Research Fellow, Institute for Clinical Evaluative Sciences

Consultant in Respiriology and Internal Medicine

Marjan Tassoudji, MSc

Biostatistician, Population Health Sciences, Research Institute, The Hospital for Sick Children

Jun Guan, MSc

Senior Analyst, Institute for Clinical Evaluative Sciences

Chengning Wang, MD, MSc

Research Assistant, Population Health Sciences, Research Institute, The Hospital for Sick Children

Eileen Estrabillo, MHSc

Research Assistant, Population Health Sciences, Research Institute, The Hospital for Sick Children

Lisa Cicutto, RN, PhD, ACNP

Associate Professor, Faculty of Nursing, University of Toronto

Acknowledgments

The authors wish to acknowledge the following individuals for their contributions to this report.

Critical Review

Dr. Diane Lougheed

Director, Asthma Clinic, Kingston General Hospital

Associate Professor

Department of Medicine, Division of Respiriology, Queen's University

Dr. Astrid Guttmann

Scientist, Institute for Clinical Evaluative Sciences

Knowledge Transfer

Paula McColgan

Vice-President, Policy and External Relations, Institute for Clinical Evaluative Sciences

Camille Marajh

Manager, Institute for Clinical Evaluative Sciences

Susan Garfinkel

Editor and Publications Coordinator, Institute for Clinical Evaluative Sciences

Laura Benben

Senior Web and Graphic Designer, Institute for Clinical Evaluative Sciences

Cleo Surace

Coordinator, Institute for Clinical Evaluative Sciences

About ICES

Ontario's resource for informed health care decision-making

The Institute for Clinical Evaluative Sciences (ICES) is an independent, non-profit organization that conducts research on a broad range of topical issues to enhance the effectiveness of health care for Ontarians. Internationally recognized for its innovative use of population-based health information, ICES knowledge provides evidence to support health policy development and changes to the organization and delivery of health care services.

Unbiased ICES evidence provides fact-based measures of health system performance; a clearer understanding of the shifting health care needs of Ontarians; and a stimulus for discussion of practical solutions to optimize scarce resources.

Key to ICES' research is our ability to link anonymous population-based health information on an individual patient basis, using unique encrypted identifiers that ensure privacy and confidentiality. This allows scientists to obtain a more comprehensive view of specific health care issues than would otherwise be possible. Linked databases reflecting 12 million of 30 million Canadians allow researchers to follow patient populations through diagnosis and treatment, and to evaluate outcomes.

ICES brings together the best and the brightest talent under one roof. Many of our faculty are not only internationally recognized leaders in their fields, but are also practicing clinicians who understand the grassroots of health care delivery, making ICES knowledge clinically-focused and useful in changing practice. Other team members have statistical training, epidemiological backgrounds, project management or communications expertise. The variety of skill sets and educational backgrounds ensures a multi-disciplinary approach to issues management and creates a real-world mosaic of perspectives that is vital to shaping Ontario's future health care.

ICES collaborates with experts from a diverse network of institutions, government agencies, professional organizations and patient groups to ensure research and policy relevance.

List of Exhibits

Chapter 1: Who has Asthma?

- Exhibit 1.1** Sex- and age-specific asthma prevalence rate (percentage), for the population from birth to age 39 years, in Ontario, 1994/95 to 2001/02
- Exhibit 1.2** Age-specific asthma prevalence rate ratio (female vs. male), for the population from birth to age 39 years, in Ontario, 2001/02
- Exhibit 1.3** Sex- and age-specific asthma incidence rate (per 1,000 population), for the population from birth to age 39 years, in Ontario, 1997/98 to 2001/02
- Exhibit 1.4** Age-specific asthma incidence (number) and incidence rate (per 1,000 population), for the population from birth to age 39 years, in Ontario, 2001/02
- Exhibit 1.5** Age-specific asthma incidence rate ratio (female vs. male), for the population from birth to age 39 years, in Ontario, in 2001/02

Chapter 2: What is the Risk of an Individual Developing Asthma?

- Exhibit 2.1** Risk (percentage) of developing asthma before the age of 40 years, from a given age, in Ontario
- Exhibit 2.2** Cumulative risk (percentage) of a newborn developing asthma by any given age (but before the age of 40 years) in males and females

Chapter 3: What Health Care Resources are Being Used by People with Asthma?

- Exhibit 3.1** Overall and age-specific asthma Ontario Health Insurance Plan (OHIP) claim rate (per individual) in individuals with asthma from birth to age 39 years, in Ontario, 1994/95 to 2001/02
- Exhibit 3.2** Overall and age-specific all-cause Ontario Health Insurance Plan (OHIP) claim rate (per individual), in individuals with asthma from birth to age 39 years, in Ontario, 1994/95 to 2001/02
- Exhibit 3.3** Overall and age-specific all-cause Ontario Health Insurance Plan (OHIP) claim rate (per individual), in individuals without asthma from birth to age 39 years, in Ontario, 1994/95 to 2001/02
- Exhibit 3.4** All-cause Ontario Health Insurance Plan (OHIP) claim rate (per individual), in individuals with and without asthma from birth to age 39 years, in Ontario, 1994/95 to 2001/02
- Exhibit 3.5** Overall and age-specific asthma hospitalization rate per 100 population with asthma, from birth to age 39 years, in Ontario, 1994/95 to 2001/02
- Exhibit 3.6** Overall and age-specific all-cause hospitalization rate per 100 population with asthma, from birth to age 39 years, in Ontario, 1994/95 to 2001/02
- Exhibit 3.7** Overall and age-specific all-cause hospitalization rate in individuals without asthma per 100 population, from birth to age 39 years, in Ontario, 1994/95 to 2001/02

Exhibit 3.8 All-cause hospitalization rate (per 100 population) in individuals with and without asthma, from birth to age 39 years, in Ontario, 1994/95 to 2001/02

Exhibit 3.9 Percentage of asthma Ontario Health Insurance Plan (OHIP) claims, by physician specialty, in the population diagnosed with asthma from birth to age 39 years, in Ontario, 2001/02

Chapter 4: How Much Does Asthma Cost the Health Care System?

Exhibit 4.1 Asthma Ontario Health Insurance Plan (OHIP) expenditure rate (dollars per individual), in individuals with asthma from birth to age 39 years, in Ontario, 1994/95 to 2001/02

Exhibit 4.2 All-cause Ontario Health Insurance Plan (OHIP) expenditure rate (dollars per individual), in individuals with asthma from birth to age 39 years, in Ontario, 1994/95 to 2001/02

Exhibit 4.3 All-cause Ontario Health Insurance Plan (OHIP) expenditure rate (dollars per individual), in individuals without asthma from birth to age 39 years, in Ontario, 1994/95 to 2001/02

Exhibit 4.4 All-cause Ontario Health Insurance Plan (OHIP) expenditure rate (dollars per individual), in individuals with and without asthma from birth to age 39 years, in Ontario, 1994/95 to 2001/02

Exhibit 4.5 Difference in all-cause Ontario Health Insurance Plan (OHIP) expenditure rate (dollars per individual), by age group between individuals with and without asthma, and asthma prevalence rates in individuals from birth to age 39 years, in Ontario, 2001/02

Chapter 5: What is the Geographical Variation of Asthma in Ontario?

Exhibit 5.1 Age- and sex-adjusted asthma prevalence rate (percentage) by Local Health Integration Network (LHIN) region, and for the Province of Ontario, 1999/00 to 2001/02

Exhibit 5.2 Age- and sex-adjusted asthma prevalence rate (percentage) by Local Health Integration Network (LHIN) region, 1999/00 to 2001/02

Exhibit 5.3 Age- and sex-adjusted all Ontario Health Insurance Plan (OHIP) claim rate (per individual), in individuals with asthma, by Local Health Integration Network (LHIN) region, and for the Province of Ontario, 1999/00 to 2001/02

Exhibit 5.4 Age- and sex-adjusted all Ontario Health Insurance Plan (OHIP) claim rate (per individual), in individuals with asthma, by Local Health Integration Network (LHIN) region, 1999/00 to 2001/02

Exhibit 5.5 Age- and sex-adjusted rate for asthma hospitalizations per 100 asthma population, by Local Health Integration Network (LHIN) region, and for the Province of Ontario, 1999/00 to 2001/02

Exhibit 5.6 Age- and sex-adjusted rate for asthma hospitalizations per 100 asthma population, by Local Health Integration Network (LHIN) region, 1999/00 to 2001/02

Contents

Publication Information	i
Authors' Affiliations	ii
Acknowledgments	iii
About ICES	iv
List of Exhibits	v
Executive Summary	1
Background	2
Findings	3
Chapter 1: Who Has Asthma?	3
Prevalence of Asthma	3
Incidence of Asthma	5
Discussion.....	8
Chapter 2: What is the Risk of an Individual Developing Asthma?	9
Discussion.....	11
Chapter 3: What Health Care Resources are Being Used by People with Asthma?	12
Outpatient Services	12
Hospitalization Claims	15
Who Provides Medical Care to People with Asthma?.....	18
Discussion.....	19
Chapter 4: How Much Does Asthma Cost the Health Care System?	20
Discussion.....	24
Chapter 5: What is the Geographical Variation of Asthma in Ontario?	25
Prevalence.....	25
Outpatient Services	27
Hospitalization Claims	29
Discussion.....	31
Summary: What is the Burden of Asthma in Ontario?	32
Challenges and Limitations	33
Future Directions	34

Appendices	35
Appendix A. How the Research was Done	35
Appendix B. Summary of Literature on Asthma Prevalence and Incidence	39
B. 1 Canadian Studies Measuring Asthma Prevalence.....	39
B. 2 Studies Measuring Asthma Incidence.....	40
References	41
Glossary of Key Terms	44

Executive Summary

Asthma accounts for approximately 80% of chronic respiratory disease in Canada and, according to Statistics Canada, affects 8.4% of the population.¹ Of people with active asthma, 56% have had uncontrolled exacerbations of their disease in the preceding 12 months.² Asthma places not only a large burden on the individual, but also a large burden on society, and contributes significantly to health care costs. The total cost of asthma in Canada for all ages in 1990 was estimated to be \$504 million,³ and it was estimated that hospital expenditures for asthma in 1998 were \$101.8 million.⁴

Objectives

The purpose of this report is to reveal the burden of asthma in Ontario by answering the following questions:

1. **Who** has asthma?
2. What is the **risk** of an individual **developing** asthma?
3. What **health care resources** are being **used** by people with asthma?
4. **How much** does asthma cost the health care system?
5. What is the **geographical variation** of asthma in Ontario?

Methods

Using Ontario health care administrative databases, a cohort of individuals from birth to 39 years of age was identified as having asthma from 1994/95 to 2001/02. Individuals were identified as having asthma if they had at least one hospitalization for asthma or two Ontario Health Insurance Plan (OHIP) physician billings for asthma in three years.

Results

- From 1994/95 to 2001/02, the prevalence of asthma in Ontario decreased modestly from 6.3% to 5.8% in people up to 39 years of age. The rate of new asthma cases remained relatively stable (10–12 per 1,000 population). Asthma prevalence and incidence were found to be greater in males in childhood and greater in females after early adolescence.
- An individual in Ontario has more than a two in five (40%) risk of developing asthma before they reach 40 years of age. After age 12, this risk decreases to about one in five (20%). The lifetime risk for developing asthma would be significantly higher since asthma can develop after the age of 40 years.
- There appeared to be a significant, persisting gap in the overall all-cause outpatient claim rates between the asthma population and the non-asthma population. This gap was evident in every age group in every year and was only partially due to the presence of asthma-specific claims in the asthma population. This important finding suggests that a study of asthma-specific claims only covers a fraction of health care utilization by this group, and that the actual burden of asthma is larger than previously expected. Similar statements can be made about all-cause hospitalizations as well.
- Family physicians and paediatricians were clearly the frontline providers of care for people with asthma. Thus, primary care physicians are important targets for continuing education initiatives. At the same time, specialist care—associated with decreased emergency department visits and hospitalizations in asthma patients—appeared to be under-utilized and might thus play a greater role in optimizing asthma care.
- Modest regional variation was observed in asthma prevalence and use of outpatient services. An almost four-fold variation was found in asthma hospitalizations, which was explained mostly by high rates in the northwest part of the Province. Asthma claims for inpatient and outpatient health care utilization were inversely correlated so that regions with a higher outpatient claim rate had lower asthma hospitalizations.

Conclusions

This report describes the burden of asthma in Ontario. In 2001/02, asthma affected approximately 6% of people from birth to 39 years of age in Ontario. Those with asthma used significantly more acute and outpatient health services compared to those without asthma. A large proportion of the general population is at risk of developing asthma at some point in their lives, underlining the importance of developing and implementing effective interventions, education programs, and disease management strategies for people with asthma.

Background

After cardiovascular disease (34%) and cancer (29%), chronic respiratory disease is responsible for the greatest proportion of deaths (4.3%) from chronic disease in Canada.⁵ However, unlike cardiovascular disease and cancer, chronic respiratory disease is also highly prevalent in the population. The prevalence (more than 10%) is comparable to high blood pressure (10.1%), and close to the prevalence of back problems (14.1%) and arthritis (13.8%).⁶ In addition, some chronic respiratory conditions can reduce health-related quality of life similar to arthritis, bowel disorders, back problems, epilepsy, heart disease and cataracts.⁶

Respiratory conditions, including asthma, chronic obstructive pulmonary disease (COPD), lung cancer, tuberculosis and cystic fibrosis, affect over three million people in Canada. Other respiratory diseases such as pneumonia, influenza and respiratory distress syndrome are more difficult to measure on a population level, but affect even more Canadians.¹ Asthma is the most common chronic respiratory disease in Canada, accounting for approximately 80% of chronic respiratory disease and affecting 8.4% of the population.¹ Although its prevalence is higher in children, asthma affects people of all ages. In a 1996 Canadian survey, 7.8% of adults were found to have asthma and 6.2% of adults were considered to have active asthma. Of those with active asthma, 56% had uncontrolled exacerbations of their disease in the 12 preceding months.⁷ Not only is asthma responsible for a large burden of illness on the individual, but it also creates a significant burden to society in the form of health care utilization and costs. The total cost of asthma in Canada for all ages was estimated to be \$504 million in 1990.³ In 1998, hospital expenditures alone for asthma were estimated to be \$101.8 million⁴ and \$162 million dollars were spent annually to treat uncontrolled asthma.⁸

The purpose of this report is to reveal the burden of asthma in Ontario. The study addressed the following questions for Ontarians from birth to 39 years of age, between 1994/95 and 2001/02:

1. **Who** has asthma?
2. What is the **risk** of an individual **developing** asthma?
3. What **health care resources** are being **used** by people with asthma?
4. **How much** does asthma cost the health care system?
5. What is the **geographical variation** of asthma in Ontario?

Findings—Chapter 1: Who Has Asthma?

This chapter provides the rates of people with asthma in the Province of Ontario. It also describes the number of people who develop asthma (new cases) every year. These numbers are displayed according to age, sex and trends over time.

Prevalence of Asthma

Exhibit 1.1 Sex- and age-specific asthma prevalence rate* (percentage), for the population from birth to age 39 years, in Ontario, 1994/95 to 2001/02

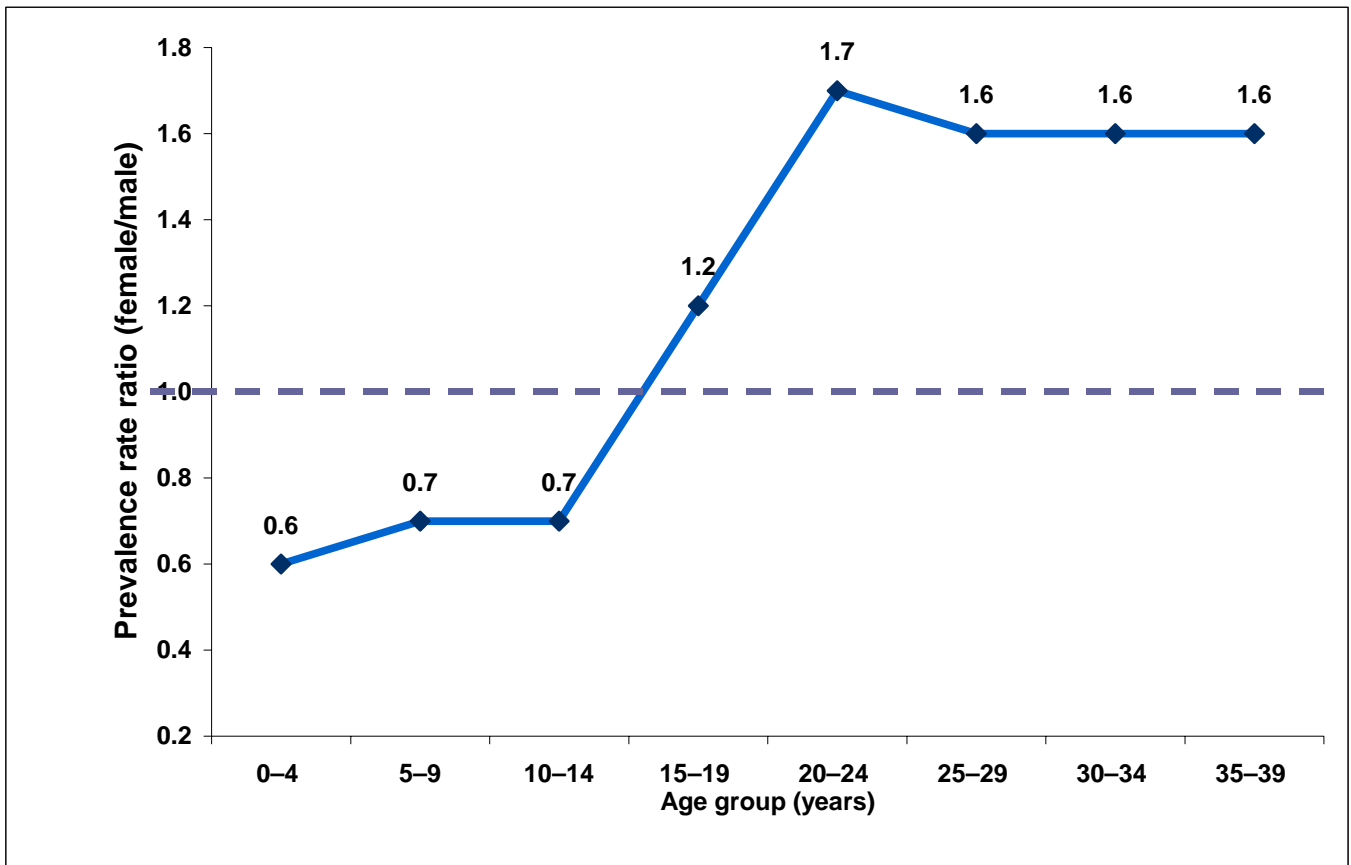
Age group (years)	Sex	Fiscal year							
		1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02
0–4	Female	10.2	10.8	10.8	10.6	10.6	10.2	10.1	9.5
	Male	15.5	16.3	16.4	16.3	16.2	15.9	15.6	15.1
	All	12.9	13.6	13.6	13.5	13.4	13.1	12.9	12.3
5–9	Female	9.3	10.0	9.9	9.3	8.8	8.7	8.5	8.1
	Male	12.9	13.7	13.5	13.0	12.4	12.4	12.3	11.9
	All	11.1	11.9	11.8	11.2	10.6	10.6	10.4	10.0
10–14	Female	6.8	7.0	6.9	6.5	6.2	6.2	6.2	5.9
	Male	8.3	8.7	8.7	8.3	8.0	8.0	8.1	8.0
	All	7.5	7.9	7.8	7.4	7.1	7.1	7.2	7.0
15–19	Female	6.6	6.7	6.5	6.1	5.7	5.4	5.1	4.8
	Male	4.5	4.6	4.6	4.4	4.2	4.2	4.1	4.0
	All	5.5	5.6	5.5	5.3	4.9	4.8	4.6	4.3
20–24	Female	5.2	5.5	5.6	5.5	5.5	5.3	5.1	4.7
	Male	3.1	3.3	3.3	3.3	3.2	3.2	3.1	2.9
	All	4.2	4.4	4.4	4.4	4.3	4.2	4.0	3.8
25–29	Female	4.5	4.7	4.8	4.8	4.8	4.7	4.7	4.5
	Male	2.8	2.9	3.0	2.9	3.0	3.0	3.0	2.9
	All	3.7	3.8	3.9	3.9	3.9	3.9	3.8	3.7
30–34	Female	4.4	4.6	4.7	4.7	4.7	4.7	4.6	4.4
	Male	2.8	2.9	2.9	2.9	2.9	2.9	2.9	2.8
	All	3.6	3.7	3.8	3.8	3.8	3.8	3.7	3.6
35–39	Female	4.4	4.5	4.6	4.6	4.7	4.7	4.7	4.6
	Male	2.7	2.8	2.8	2.8	2.8	2.8	2.9	2.8
	All	3.5	3.7	3.7	3.7	3.8	3.8	3.8	3.7
Overall		6.3	6.6	6.6	6.4	6.3	6.2	6.1	5.8

* Prevalent cases included persons who had at least two OHIP claims or one hospitalization for asthma within a three-year period from 1994/95 to 2001/02. For example, the prevalence of asthma in 1996/97 includes all people who had at least two OHIP claims or one hospitalization for asthma within fiscal years 1994/95, 1995/96, and 1996/97.

For Exhibits 1.1–1.2

- The overall prevalence of asthma decreased by 8% (6.3% to 5.8%) from 1994/95 to 2001/02.
- Prevalence decreased slightly over time in younger age groups, and remained stable or increased slightly in those over 25 years of years.
- The prevalence of asthma was greater in males before early adolescence (prevalence rate ratio less than one) but then greater in females from ages 15 to 39 years.

Exhibit 1.2 Age-specific asthma prevalence rate ratio (female vs. male), for the population from birth to age 39 years, in Ontario, 2001/02



Incidence of Asthma

Exhibit 1.3 Sex- and age-specific asthma incidence rate (per 1,000 population), for the population from birth to age 39 years, in Ontario, 1997/98 to 2001/02

Age group (years)	Sex	Fiscal year							
		1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02
0–4	Female	Data not shown*			34	35	33	34	31
	Male				49	49	48	48	46
	All				42	42	41	41	38
5–9	Female				13	13	12	12	10
	Male				15	16	15	14	12
	All				14	14	13	13	11
10–14	Female				10	10	9	8	7
	Male				9	9	8	8	7
	All				10	9	9	8	7
15–19	Female				10	9	8	8	7
	Male				6	5	5	4	4
	All				8	7	6	6	5
20–24	Female				9	8	8	7	6
	Male				5	5	5	4	3
	All				7	7	6	5	5
25–29	Female				9	8	8	7	6
	Male				5	5	5	5	4
	All				7	7	6	6	5
30–34	Female	9	8	8	7	6			
	Male	5	5	5	5	4			
	All	7	7	6	6	5			
35–39	Female	9	9	8	8	6			
	Male	5	5	5	5	4			
	All	7	7	6	6	5			
Overall				12	12	11	11	10	

* Data not shown due to insufficient lead time to differentiate incidence cases from prior prevalent cases.

For Exhibits 1.3–1.5

- Overall asthma incidence rates varied from 10 to 12 per 1,000 population from birth to 39 years of age.
- Asthma incidence rates decreased across all age groups and for both males and females over time.
- More than half of those people with asthma had an onset age prior to 10 years old; however, significant numbers of people at all ages were affected.
- Asthma incidence was greater in males before early adolescence (10–14 years of age) and greater in females after early adolescence.

Exhibit 1.4 Age-specific asthma incidence (number) and incidence rate (per 1,000 population), for the population from birth to age 39 years, in Ontario, 2001/02

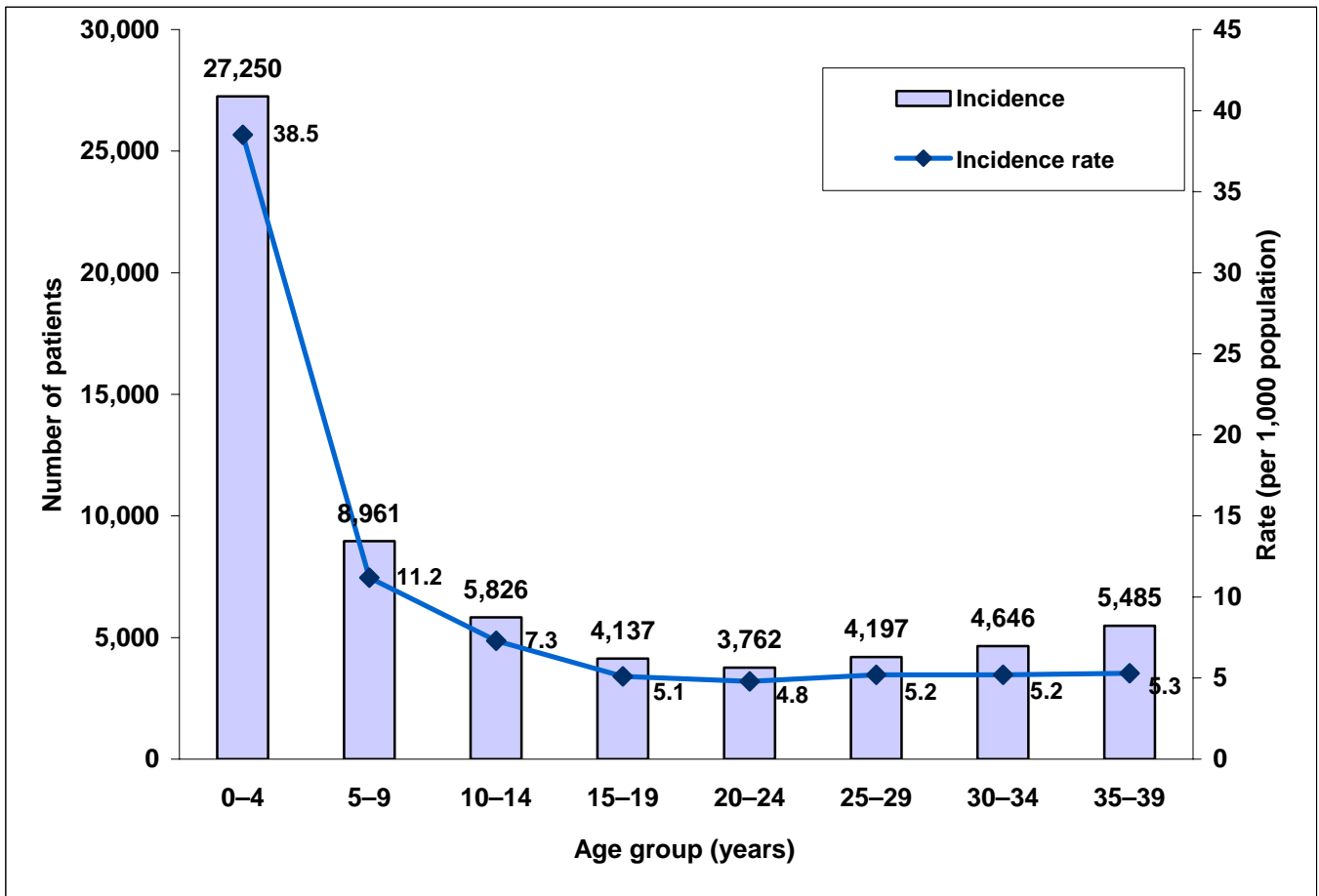
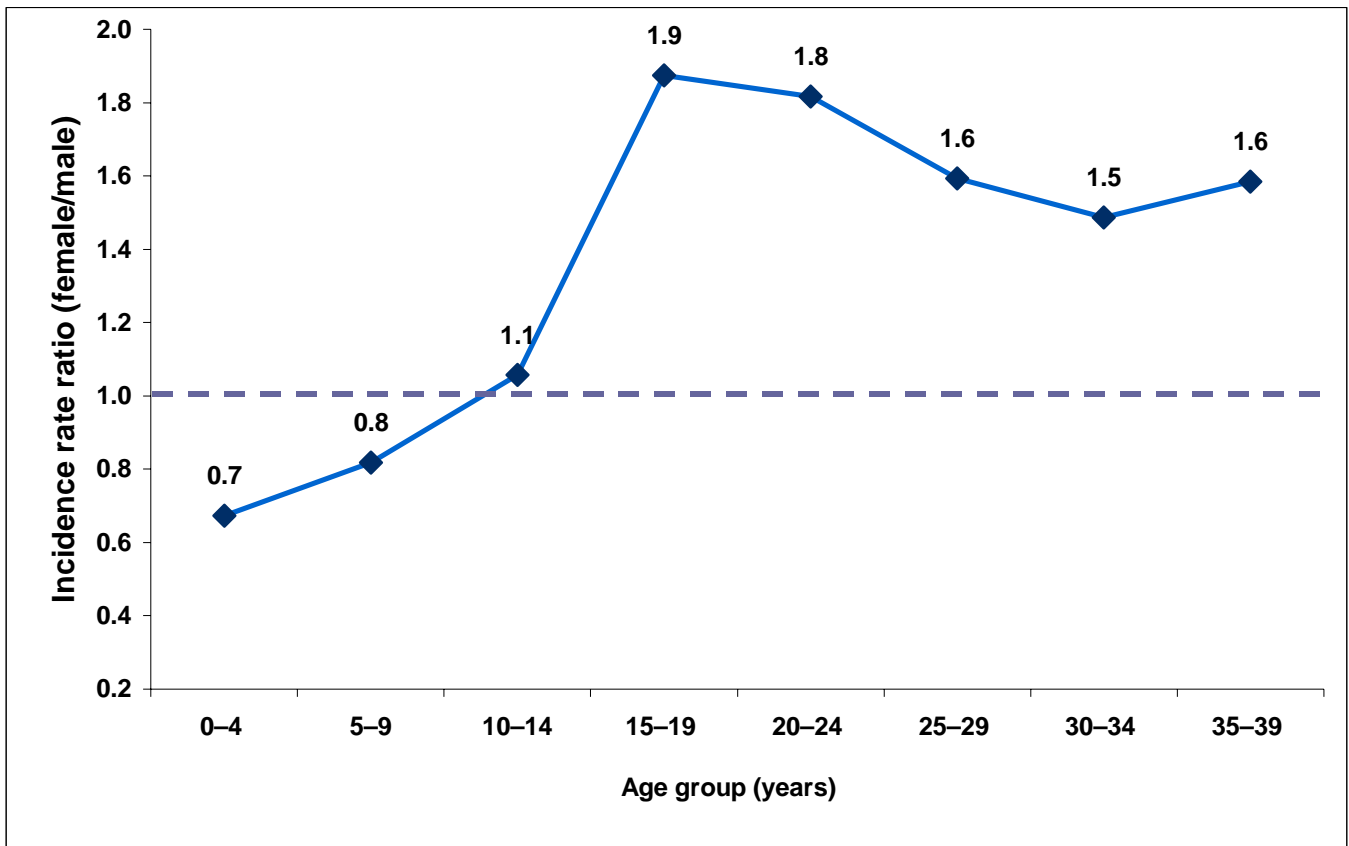


Exhibit 1.5. Age-specific asthma incidence rate ratio (female vs. male), for the population from birth to age 39 years in Ontario in 2001/02



Discussion

The overall asthma prevalence rates in Ontario varied between 5.8% and 6.6%. These rates were comparable to the rates reported in previous Canadian studies (see Appendix B.1).^{1,7,9-12}

The prevalence of asthma decreased over time. The literature suggests that asthma prevalence rates rose during the 1980s and early 1990s,¹³ but stabilized or decreased after that time.^{11,14,15} Several hypotheses have been proposed for this decrease. Some have hypothesized that methodological issues account for some of the change as data is limited by the lack of objective measurements and are thus subject to error. Others have hypothesized that changes are due to trends in cultural perception and how symptoms are named over time. Increased use of inhaled corticosteroids, increased medical professional awareness of the disease, the implementation of asthma prevention and management strategies, changes in disease severity over time, and environmental changes have also been proposed as potential explanations.^{14,15} Still others have suggested that these factors do not account for all of the dramatic rise and then fall in prevalence and that there are still other unknown factors that have contributed to this trend.¹⁴

This study found that the overall incidence of asthma ranged from 10 to 12 per 1,000 population per year between 1997/98 and 2001/02. Among adults, incidence rates ranged from 4 to 9 per 1,000 population. These incidence rates are generally higher than those reported by several European studies, where incidence rates of asthma in adults varied between 2.3 and 15.3 per 1,000 population.¹⁶⁻²⁰ (See Appendix B.2). These differences in rates could be explained by variations in patient population, variation in the measurement and definition of incidence rate, differences in the methods used to ascertain the diagnosis of asthma, and differences in the years over which data were collected.

Among children, data from this study showed that incidence rates varied much more widely, ranging from 5 per 1,000 children aged 15 to 19 years old in 2001, to 42 per 1,000 children from birth to four years old in 1994. Other investigators have reported incidence rates in children ranging from 2.5 to 25.7 per 1,000 population per year.^{18,21-23} Once again, these differences might reflect variations in study design and methodology. The significantly higher rates in young children in this study might have also been due to difficulties in making a diagnosis in this age group which resulted in the over-diagnosis of asthma in children with “pre-school wheeze”. Nonetheless, the criteria used in this report for the diagnosis of asthma have been validated in this age group and is based on physicians’ diagnosis of the disease.

It was also found that incidence rates decreased slightly over time. Trends in prevalence rates over time have been described previously; however, incidence rate trends over time have not been well described.^{14,15} It is likely that incidence rates of asthma have decreased for similar reasons as those previously described for prevalence rates.

The study also showed that, for both prevalence and incidence, the ratio of females to males with asthma was less than one (higher in males) prior to adolescence, and reversed to more than one (higher in females) after adolescence. This finding is consistent with other studies of asthma prevalence and incidence.^{7,11,21,24-26}

Chapter 2: What is the Risk of an Individual Developing Asthma?

Lifetime risks of developing a disease (such as cancer) are widely cited as statistics used to communicate risk estimates to the general population. These risk estimates provide valuable measures to aid investigators and health planners in identifying required research, increasing awareness of effective interventions, predicting future burden of asthma on society, as well as planning and evaluating asthma programs. For clinicians, these risk estimates may assist with the clinical reasoning process by identifying the likelihood of an asthma diagnosis in a given patient.

Exhibit 2.1 Risk (percentage) of developing asthma before the age of 40 years, from a given age, in Ontario

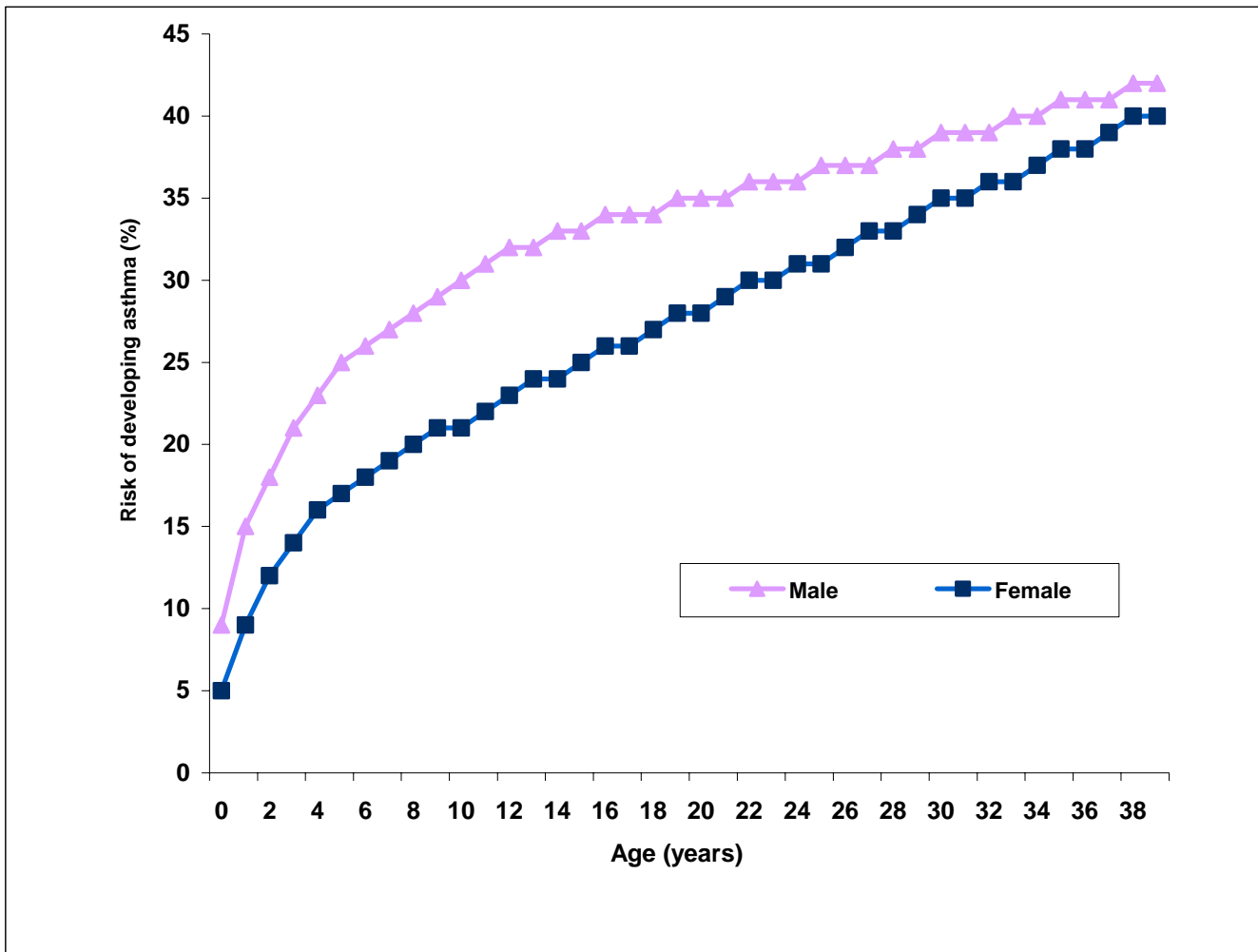
Age (years)	Birth	School age	Early adolescence	Late adolescence	Early adulthood	Adulthood	
	0	6	12	18	24	30	36
Overall risk* (%)	41.2	25.9	20.0	16.0	12.3	8.2	3.5
Male (%)	42.3	23.4	16.4	12.8	10.1	6.7	2.7
Female (%)	40.2	28.1	23.3	19.0	14.5	9.6	4.1

*The risk of developing asthma is calculated based on age- and sex-specific asthma incidence and mortality rates for Ontario in 2001, and on life tables based on 1995–1997 all-cause mortality rates.

For Exhibit 2.1

- The chance of an individual in Ontario being diagnosed with asthma before 40 years of age is very high (41.2%). Even after childhood, the chance of an individual being diagnosed is significant.
- In people who have not been diagnosed with asthma by age 18, the risk of developing asthma before age 40 is 16.0%.

Exhibit 2.2 Cumulative risk (percentage) of a newborn developing asthma by any given age (but before the age of 40 years) in males and females



For Exhibit 2.2

- The risk of a newborn developing asthma by any given age but before the age of 40 years is lower in females than in males, with the largest differences (9%) occurring in late childhood (5–9 years of age) and early adolescence (10–14 years of age).
- Starting from late adolescence (15–20 years of age), the gender-related difference in the risk of developing asthma at any given age narrowed as age increased, dropping to a two percent difference by age 39 years.

Discussion

Asthma will affect a large proportion of the population at some point in their lives. The values presented do not represent the entire lifetime risk of having asthma, as risk estimates were only calculated to 40 years of age. As asthma can develop after the age of 40 years, lifetime risk for developing asthma could be significantly higher. These results agree with other studies in children.^{21,27} Previous studies looking at lifetime cumulative risk of asthma in adults were not available. As mentioned in Chapter 1, some of this high risk might be due to the misdiagnosis of asthma for "preschool wheezing" in very young children. Nonetheless, the risks are still highly significant even when analysis is limited to those aged 6 years and older.

The implications of the finding that two out of every five people develop asthma are enormous. Directly, it means that just less than half of the population is likely to receive medical attention for the management of their disease. This would range from simple education to hospitalization. Indirectly, it suggests significant lost productivity and economic costs due to asthma. Indeed, asthma is a societal problem and not just a disease that affects a few individuals.

Chapter 3: What Health Care Resources are Being Used by People with Asthma?

There is a lack of population-based studies that quantify the magnitude of hospitalizations and other health care resources used by people with asthma. Using administrative data, ICES previously examined the seasonal patterns of asthma hospitalizations in Ontario children from 1988 to 2000.²⁸ A downward trend in the total number of hospitalizations for asthma since the early 1990s—most notably among young males—was found. It is generally agreed that asthma is an “ambulatory care-sensitive condition”. That is to say that good outpatient management should result in decreased hospitalizations.^{29,30} Conversely, inadequate control of asthma can be costly, posing physical consequences and significantly lowering individual quality of life.

This chapter describes the outpatient and inpatient services used by those with asthma. Outpatient services are examined through the number of Ontario Health Insurance Plan (OHIP) claims made by people with asthma, including claims for physician services, pulmonary function testing and allergy testing. Hospitalizations are examined through the analysis of Canadian Institute for Health Information Discharge Abstract Database (CIHI-DAD) hospital discharge records. And finally, the types of physicians who billed for outpatient services are examined to determine who is providing care to people with asthma.

Outpatient Services

Exhibit 3.1 Overall and age-specific asthma Ontario Health Insurance Plan (OHIP) claim rate (per individual) in individuals with asthma from birth to age 39 years, in Ontario, 1994/95 to 2001/02

Age group (years)	Fiscal year							
	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02
0–4	2.1	2.0	1.9	1.8	1.8	1.7	1.7	1.7
5–9	1.9	1.7	1.4	1.4	1.5	1.4	1.4	1.3
10–14	1.6	1.5	1.3	1.3	1.4	1.3	1.3	1.2
15–19	1.5	1.4	1.3	1.3	1.3	1.3	1.2	1.2
20–24	1.6	1.5	1.4	1.4	1.4	1.4	1.3	1.3
25–29	1.5	1.5	1.5	1.4	1.5	1.4	1.4	1.3
30–34	1.7	1.5	1.5	1.4	1.4	1.4	1.4	1.4
35–39	1.7	1.6	1.5	1.5	1.5	1.5	1.4	1.4
Total	1.8	1.6	1.5	1.5	1.5	1.5	1.4	1.4

For Exhibits 3.1–3.4

- The overall rate of Ontario Health Insurance Plan (OHIP) claims for asthma dropped from 1.8 to 1.4 per individual from 1994/95 to 2001/02, representing a decrease of 22%.
- The asthma OHIP claim rate decreased in all age groups, with the largest decrease seen in children aged 5–9 years (29% decrease).
- There was a significant persisting gap in all-cause OHIP claim rates between the asthma population and the non-asthma population. This gap was evident in every age group, in every year, and was only partially explained by the presence of asthma-specific claims in the asthma population.
- From 1994/95 to 2001/02, the overall all-cause OHIP claim rate decreased by 15% (from 13.2 to 11.2 per individual) in the asthma population, and by 7% (from 6.1 to 5.7 per individual) in the non-asthma population. In the asthma population, the all-cause OHIP claim rate decreased in all age groups.

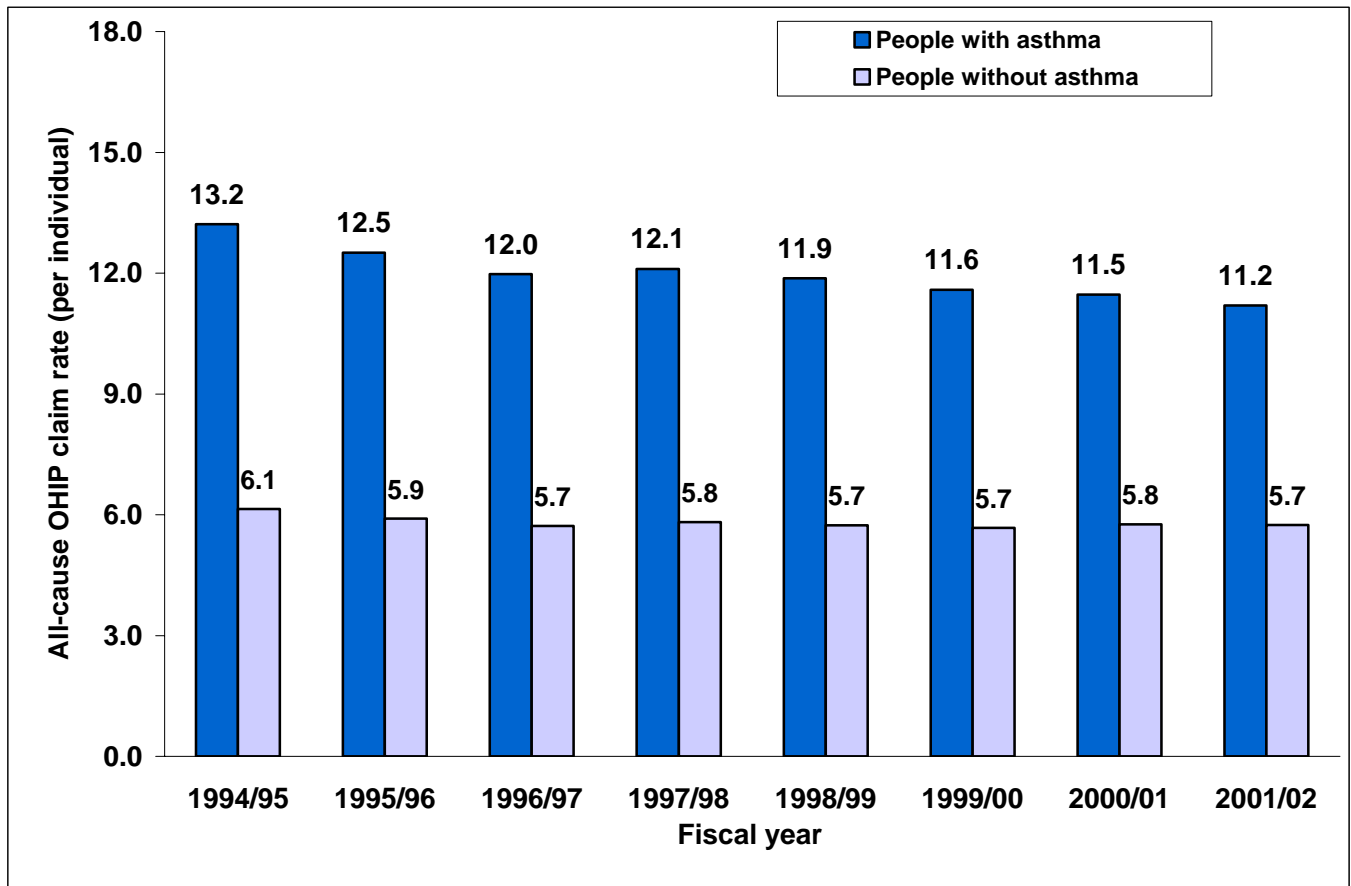
Exhibit 3.2 Overall and age-specific all-cause Ontario Health Insurance Plan (OHIP) claim rate (per individual), in individuals with asthma from birth to age 39 years, in Ontario, 1994/95 to 2001/02

Age group (years)	Fiscal year							
	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02
0–4	11.1	10.6	10.1	10.1	10.1	9.8	9.7	9.6
5–9	10.7	10.0	9.0	9.1	9.1	8.9	8.9	8.5
10–14	10.5	9.7	9.2	9.2	9.1	8.8	8.8	8.6
15–19	13.4	12.5	12.1	12.2	11.8	11.4	11.3	10.9
20–24	14.7	14.0	13.6	13.9	13.3	13.1	12.8	12.6
25–29	16.5	16.0	15.7	15.8	15.3	15.0	14.6	14.4
30–34	18.7	17.7	17.3	17.3	16.7	16.2	16.2	16.0
35–39	19.6	19.0	18.6	18.9	18.1	17.8	17.3	16.8
Total	13.2	12.5	12.0	12.1	11.9	11.6	11.5	11.2

Exhibit 3.3 Overall and age-specific all-cause Ontario Health Insurance Plan (OHIP) claim rate (per individual), in individuals without asthma from birth to age 39 years, in Ontario, 1994/95 to 2001/02

Age group (years)	Fiscal year							
	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02
0–4	6.2	6.1	5.9	6.2	6.4	6.4	6.5	6.5
5–9	4.3	4.0	3.7	3.7	3.7	3.7	3.8	3.7
10–14	4.0	3.7	3.6	3.7	3.6	3.5	3.6	3.6
15–19	4.9	4.8	4.7	4.9	4.8	4.8	4.9	4.8
20–24	5.4	5.2	5.1	5.3	5.2	5.3	5.4	5.5
25–29	6.7	6.4	6.2	6.2	6.0	6.0	6.1	6.2
30–34	7.8	7.4	7.1	7.2	6.9	6.8	6.9	6.9
35–39	8.3	8.0	7.7	7.8	7.6	7.4	7.4	7.3
Total	6.1	5.9	5.7	5.8	5.7	5.7	5.8	5.7

Exhibit 3.4 All-cause Ontario Health Insurance Plan (OHIP) claim rate (per individual), in individuals with and without asthma from birth to age 39 years, in Ontario, 1994/95 to 2001/02



Hospitalization Claims

Exhibit 3.5 Overall and age-specific asthma hospitalization rate per 100 population with asthma, from birth to age 39 years, in Ontario, 1994/95 to 2001/02

Age group (years)	Fiscal year							
	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02
0–4	10.1	9.2	8.3	7.6	7.0	7.4	6.9	6.9
5–9	4.0	4.0	3.0	2.9	2.7	3.3	2.6	2.7
10–14	3.2	3.1	2.7	2.6	2.2	2.7	2.1	1.9
15–19	5.0	5.7	5.2	4.8	4.1	4.5	3.7	3.4
20–24	5.0	5.5	5.7	4.8	4.6	4.5	3.9	3.8
25–29	4.5	5.1	5.2	4.7	4.6	4.7	4.0	3.7
30–34	4.7	5.0	5.2	4.4	4.1	4.4	4.0	3.6
35–39	4.6	4.8	4.9	4.9	4.6	4.8	4.2	3.9
Total	5.7	5.6	5.2	4.8	4.4	4.7	4.1	4.0

For Exhibits 3.5–3.8

- The overall hospitalization rate per 100 population with asthma dropped from 5.7 to 4.0 from 1994/95 to 2001/02, representing a decrease of 31%.
- The hospitalization rate for those with asthma decreased in all age groups, with the largest decrease in children aged 10–14 years (42% decrease).
- The all-cause hospitalization rate decreased in all age groups in the asthma population with the largest decrease occurring in the population aged 15–19 years (32% decrease), and the smallest decrease in the population aged 20–24 years (10% decrease).
- There was also a decrease in all-cause hospitalization rates in those without asthma, but it was less pronounced than in people with asthma.
- There appeared to be a significant persisting gap in the all-cause hospitalization rates between the asthma population and the non-asthma population. This gap was evident in every age group—except from birth to four years of age—and was only partially explained by the presence of asthma hospitalizations in the asthma population.

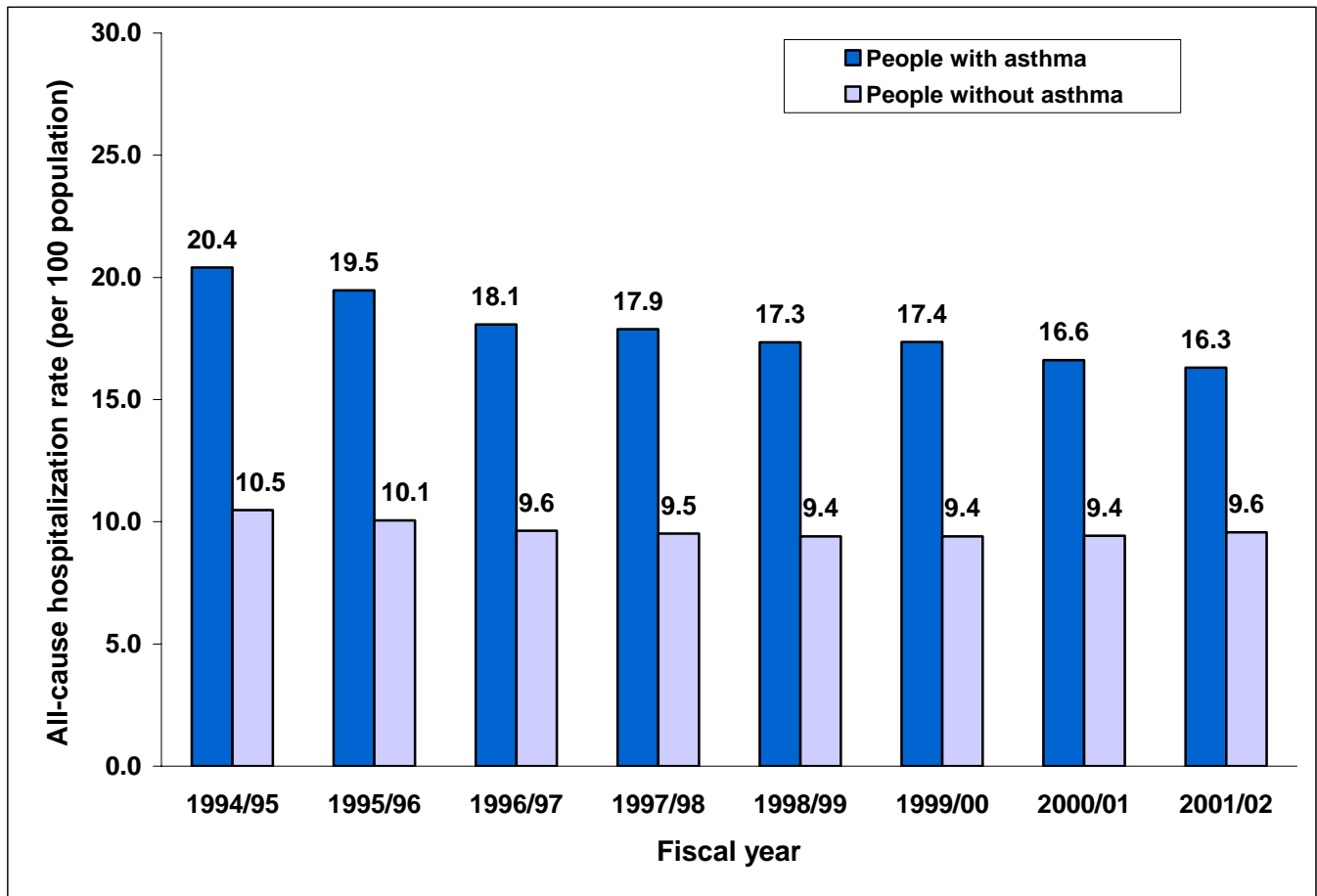
Exhibit 3.6 Overall and age-specific all-cause hospitalization rate per 100 population with asthma, from birth to age 39 years, in Ontario, 1994/95 to 2001/02

Age group (years)	Fiscal year							
	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02
0–4	23.9	22.7	20.7	20.4	19.6	19.4	19.1	19.2
5–9	12.0	11.2	9.5	9.5	9.3	9.8	9.2	9.1
10–14	9.0	8.0	7.6	7.6	6.9	7.4	6.6	6.5
15–19	20.8	19.8	17.8	17.4	16.3	15.6	15.1	14.1
20–24	25.8	25.0	23.7	23.2	21.9	21.2	20.3	20.5
25–29	27.6	27.1	26.5	25.6	25.6	25.7	24.1	24.2
30–34	29.3	28.7	27.9	26.8	26.0	25.7	25.3	24.8
35–39	27.3	27.3	26.2	26.5	26.4	27.2	25.9	24.4
Total	20.4	19.5	18.1	17.9	17.3	17.4	16.6	16.3

Exhibit 3.7 Overall and age-specific all-cause hospitalization rate in individuals without asthma per 100 population, from birth to age 39 years, in Ontario, 1994/95 to 2001/02

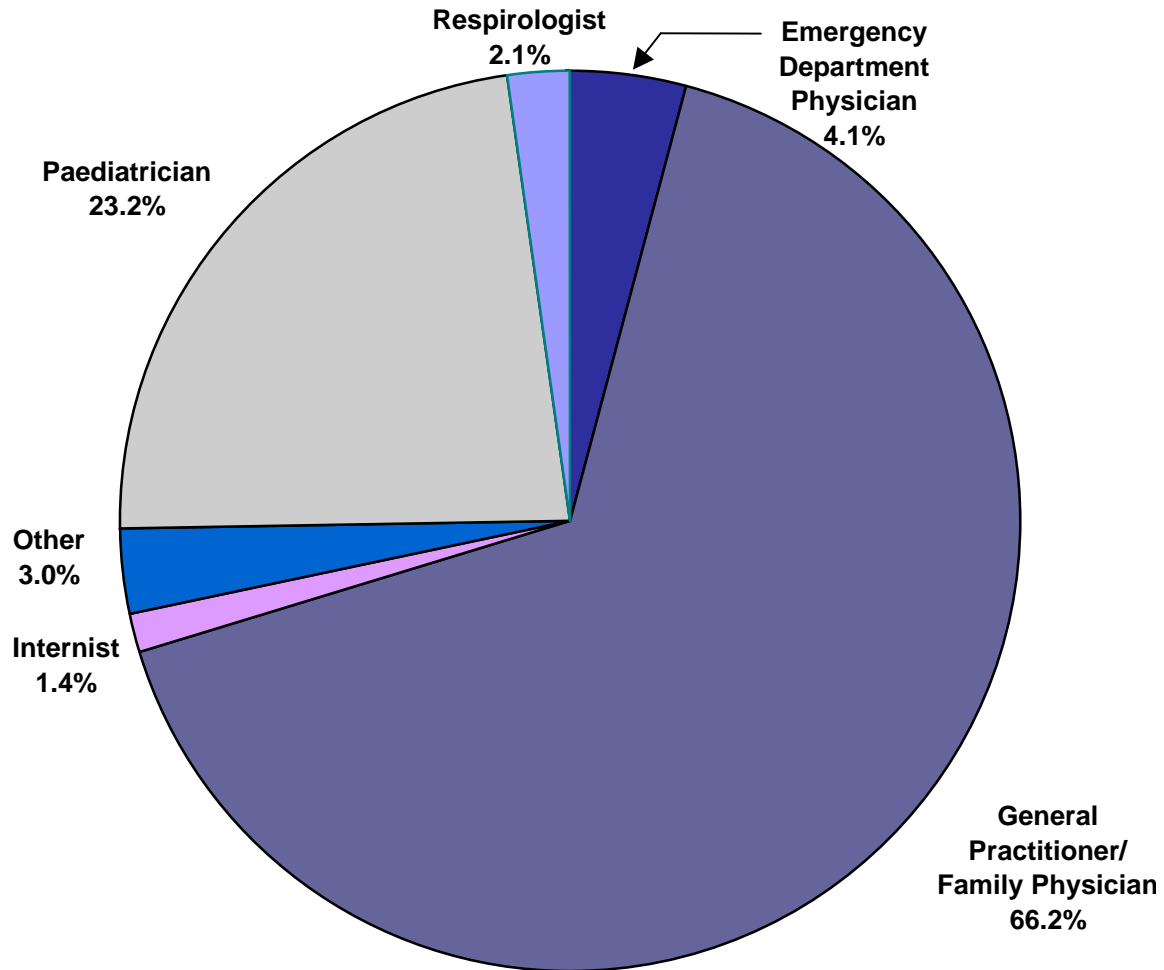
Age group (years)	Fiscal year							
	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02
0–4	19.4	19.4	18.9	19.8	20.4	20.6	21.1	22.3
5–9	4.4	4.1	3.8	3.7	3.6	3.6	3.7	3.6
10–14	3.2	3.0	2.8	2.9	2.7	2.6	2.7	2.7
15–19	6.7	6.3	6.0	6.0	5.8	5.7	5.7	5.6
20–24	9.1	8.5	8.2	8.1	8.0	8.1	8.2	8.2
25–29	12.1	11.5	10.8	10.5	10.2	10.3	10.1	10.3
30–34	13.5	12.8	12.3	11.9	11.5	11.5	11.5	11.6
35–39	12.2	11.8	11.3	11.1	11.0	10.9	10.8	10.7
Total	10.5	10.1	9.6	9.5	9.4	9.4	9.4	9.6

Exhibit 3.8 All-cause hospitalization rate (per 100 population) in individuals with and without asthma, from birth to age 39 years, in Ontario, 1994/95 to 2001/02



Who Provides Medical Care to People with Asthma?

Exhibit 3.9 Percentage of asthma Ontario Health Insurance Plan (OHIP) claims, by physician specialty, in the population diagnosed with asthma from birth to age 39 years, in Ontario, 2001/02



For Exhibit 3.9

- Primary care physicians provided the majority of asthma care to people with asthma.
- Few individuals with asthma received care from specialists.

Discussion

Overall, people with asthma had one to two asthma outpatient Ontario Health Insurance Plan (OHIP) claims per year, for physician visits, emergency department visits, pulmonary function testing (PFT) or allergy testing. Individuals with asthma accounted for about four to six asthma hospitalizations per 100 population per year. Both of these claim rates decreased over time. There are a number of hypotheses that might explain the decrease in asthma claims. The most compelling is that the more widespread use of inhaled corticosteroids during the study period led to better asthma control and less need for health care services.^{31–33} However, this may not account for the entire decrease. Other possible reasons include a decreased trend towards physician coding for asthma, increased barriers in access to care (e.g., limited supply of primary care physicians), increased threshold of physicians to admit asthma patients, and/or decreased resources (e.g., lack of available hospital beds). It is important to keep in mind that, in general, overall health care claims and hospitalization rates in Ontario, not only those due to asthma, have been decreasing.³⁴ Previous research in Ontario has also demonstrated a downward trend in asthma hospitalizations,³⁵ and studies from the United Kingdom, United States, Australia and Sweden have reported similar decreases in asthma hospitalization rates in the last decade.^{36–39}

In this study, individuals with asthma had a significantly higher number of all-cause claims and hospitalizations than individuals without asthma, and the gap in all-cause claims between these groups was only partially explained by the additional asthma-specific claims in the asthma group. This important finding suggests that a study of asthma-specific claims and hospitalizations only covers a small part of health care utilization by this group and that their actual burden on the health care system is larger than previously expected. One hypothesis is that the additional claims and hospitalizations contributing to the gap were due to conditions that might be related to asthma such as pneumonia, upper respiratory tract infections, and bronchiolitis in children. Supporting this hypothesis, it was found that the percentage of claims and hospitalizations attributed to such asthma-related conditions was higher in the asthma population than in the non-asthma population in both adults and children (see Appendix B). In addition, mental health issues in individuals with asthma have been observed to be more common and can result in poorer asthma control and increased health care resource use.^{40,41}

Over time, there was a narrowing of the gap between the asthma and non-asthma populations for all-cause OHIP claims and hospitalization rates. This may be due to the same reasons as the reduction in asthma claims described above.

Consistent with previous reports,^{42–46} this study supports the observation that family physicians and paediatricians are taking care of the majority of patients with asthma, and that relatively few patients see specialists for asthma. This observation suggests that primary care physicians are important targets for continuing education initiatives. At the same time, specialists, who have been shown to improve outcomes (e.g., rates of decreasing emergency department visits and hospitalizations), appear to be under-utilized and might play a greater role in optimizing asthma care in the future.^{44,47–51}

Chapter 4: How Much Does Asthma Cost the Health Care System?

Inadequate control of asthma can be costly both to the individual and to the health care system. In 1990, the total cost of asthma in Canada was estimated to range between \$504 and \$648 million, and the annual direct health care costs for asthma totaled nearly \$306 million.³ In 1995, the total annual direct and indirect costs per Canadian child with asthma were reported to be \$676,³ with hospital admissions accounting for 77% of the total cost—the largest single component. In this chapter, the cost estimates are extended to the adult population and the costs of health care services utilized by individuals with and without asthma are compared. Also, the cost of outpatient health care services used by patients with asthma is described by age, sex and over time.

Exhibit 4.1 Asthma Ontario Health Insurance Plan (OHIP) expenditure rate* (dollars per individual), in individuals with asthma from birth to age 39 years, in Ontario, 1994/95 to 2001/02

Age group (years)	Fiscal year							
	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02
0–4	80.21	77.31	71.46	70.11	64.84	64.57	63.40	63.09
5–9	71.76	66.88	55.84	56.53	55.05	54.85	51.96	48.39
10–14	64.99	59.47	51.81	53.17	51.62	51.32	48.77	45.80
15–19	58.84	56.44	51.15	49.76	46.95	47.33	44.82	43.10
20–24	59.05	57.03	53.72	51.87	49.46	48.12	46.32	44.21
25–29	58.23	58.37	55.05	54.29	51.25	50.49	49.03	46.33
30–34	62.11	59.79	55.71	53.67	50.45	48.99	48.92	46.47
35–39	63.63	61.36	57.87	57.68	53.77	52.74	50.61	47.13
Total	68.11	64.96	58.55	58.02	54.96	54.39	52.43	50.09

*Adjusted to 2001 Canadian dollars.

For Exhibits 4.1-4.5

- Outpatient expenditures specific to asthma care were modest and decreased significantly over the time period studied.
- All-cause outpatient expenditures by individuals with asthma were significantly greater than expenditures by individuals without asthma.
- The gap between overall expenditure rates between people with and without asthma decreased over time but still remained significant. This gap was only partially explained by the additional asthma expenditures in those with asthma.
- As age increased and prevalence decreased, expenditures attributable to asthma continued to increase so that adults between the ages of 35 and 39 years had the highest OHIP expenditures.

Exhibit 4.2 All-cause Ontario Health Insurance Plan (OHIP) expenditure rate* (dollars per individual), in individuals with asthma from birth to age 39 years, in Ontario, 1994/95 to 2001/02

Age group (years)	Fiscal year							
	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02
0–4	399.13	397.05	373.45	379.71	361.69	356.32	354.45	350.48
5–9	389.87	375.64	335.94	343.38	332.32	327.36	321.82	308.79
10–14	376.98	358.54	339.60	349.05	330.60	326.06	324.70	312.69
15–19	540.24	522.95	497.18	507.58	470.37	461.76	463.98	440.63
20–24	618.94	623.12	598.02	606.93	558.36	550.15	539.21	536.67
25–29	704.50	719.16	706.44	711.67	663.07	656.57	634.16	630.02
30–34	810.77	802.51	774.50	796.72	733.32	714.31	710.34	694.12
35–39	846.46	856.05	838.29	854.78	797.61	787.81	761.97	729.88
Total	521.53	513.94	489.16	501.29	472.68	465.66	459.04	446.31

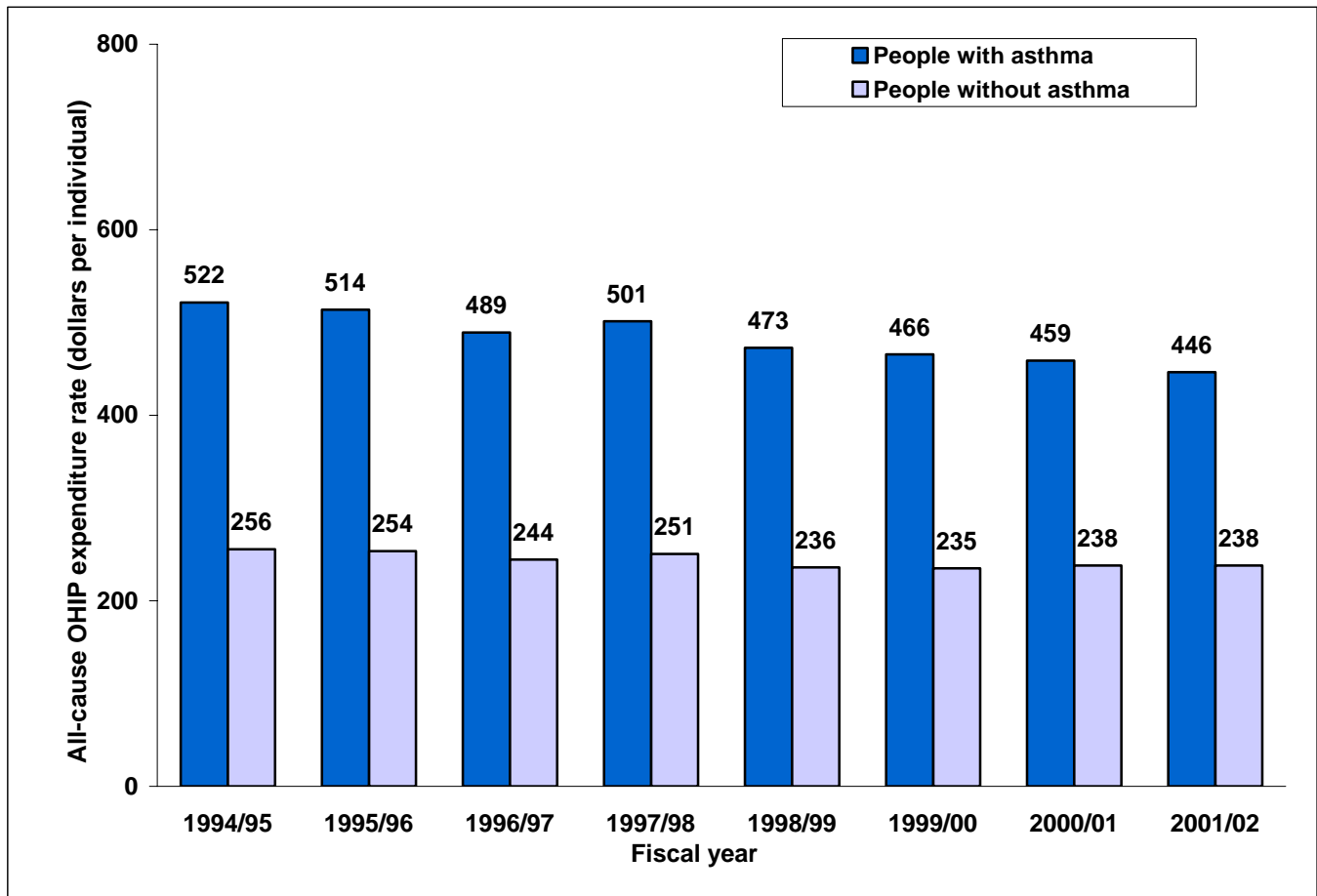
*Adjusted to 2001 Canadian dollars.

Exhibit 4.3 All-cause Ontario Health Insurance Plan (OHIP) expenditure rate* (dollars per individual), in individuals without asthma from birth to age 39 years, in Ontario, 1994/95 to 2001/02

Age group (years)	Fiscal year							
	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02
0–4	220.19	223.35	215.64	228.94	228.26	230.79	234.16	238.41
5–9	155.39	151.02	136.28	137.70	132.45	133.49	135.94	132.61
10–14	144.62	141.19	133.97	139.74	132.56	130.41	133.19	130.12
15–19	197.23	197.62	193.57	200.37	189.52	189.13	192.46	191.82
20–24	231.21	227.18	221.97	231.28	218.39	222.60	228.74	230.09
25–29	295.22	291.60	280.16	282.47	262.20	262.99	266.78	273.09
30–34	345.90	339.91	326.24	330.48	306.13	302.34	306.54	309.18
35–39	363.23	361.98	348.75	356.05	330.45	323.80	321.30	315.71
Total	255.51	253.66	244.30	250.63	235.98	235.18	237.90	237.89

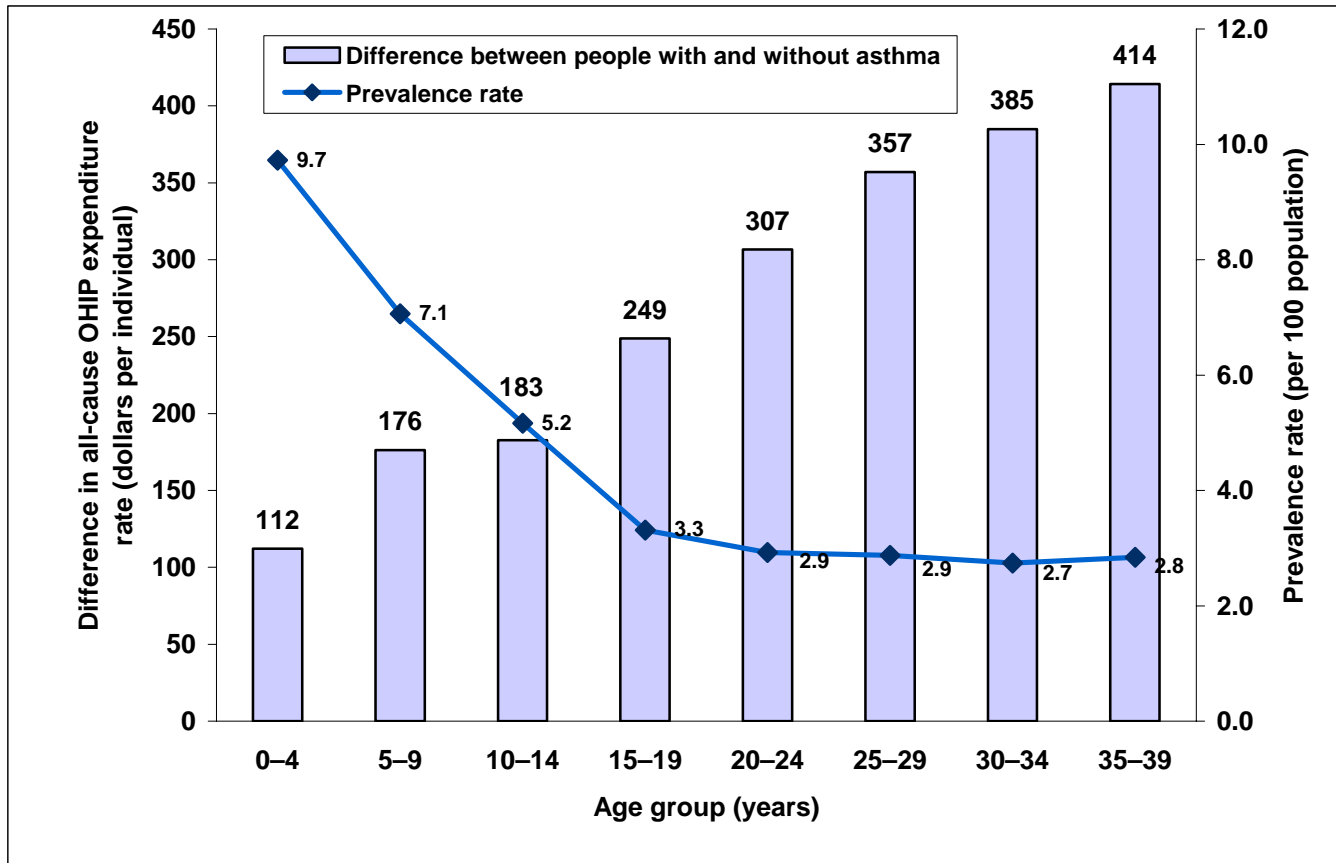
*Adjusted to 2001 Canadian dollars.

Exhibit 4.4 All-cause Ontario Health Insurance Plan (OHIP) expenditure rate* (dollars per individual), in individuals with and without asthma from birth to age 39 years, in Ontario, 1994/95 to 2001/02



*Adjusted to 2001 Canadian dollars.

Exhibit 4.5 Difference in all-cause Ontario Health Insurance Plan (OHIP) expenditure rate (dollars per individual), by age group between individuals with and without asthma, and asthma prevalence rates in individuals from birth to age 39 years, in Ontario, 2001/02



Discussion

Similar to patterns observed for health care utilization in asthma, this study found that outpatient expenditures rates specific to asthma were modest and appeared to decrease over time. Although it is very difficult to compare these results with those of other studies—due to differences in patient population and methodology used to measure expenditures—these results appear to be in line with other Ontario studies.^{46,52} Studies of trends in expenditures related to asthma over the time period examined were not available for comparison.

All-cause Ontario Health Insurance Plan (OHIP) expenditures were significantly greater for patients with asthma than for patients without asthma. This was only partially explained by the additional asthma expenditures in people with asthma and likely reflects the increased health care cost associated with conditions related to asthma (e.g., upper respiratory tract infections, pneumonia, bronchiolitis and allergies).

It was also noted that the gap in expenditures between individuals with and without asthma decreased over time. Again, it was hypothesized that, similar to asthma health care utilization, this is most likely due to better control of asthma over time as a result of the introduction of inhaled corticosteroids and possibly to some extent long-acting bronchodilators. If the authors were able to include the cost of asthma medications—which is known to be a significant expense in asthma care—then the narrowing of this gap may not have been so apparent.^{3,45,46,53,54}

The overall OHIP expenditures decreased from \$32.7 million to \$24.0 million between 1994/95 to 2001/02 (data not shown). However, it is important to note that the study data only include data on direct expenditures due to outpatient OHIP claims, including physician visits and laboratory testing. They do not include emergency department visits, hospitalizations, pharmacy costs or indirect costs—which accounted for the large majority of costs related to asthma in other studies. Expenditures in some of these other areas are likely to have increased during the time period studied and thus this analysis only reveals a small part of the cost of asthma.

Chapter 5: What is the Geographical Variation of Asthma in Ontario?

ICES previously documented distinctive geographical variation in the rate of asthma hospitalizations for Ontario children under 10 years of age.²⁸ The distribution of the asthma hospitalization rates among children with asthma varied across the Local Health Integration Network (LHIN) areas, with the North West LHIN showing the highest rates over time. In this chapter, the authors examined not only the patterns of asthma hospitalization among all people under 40 years of age with asthma in Ontario, but also the geographical variations in asthma prevalence and outpatient health care utilization.

Prevalence

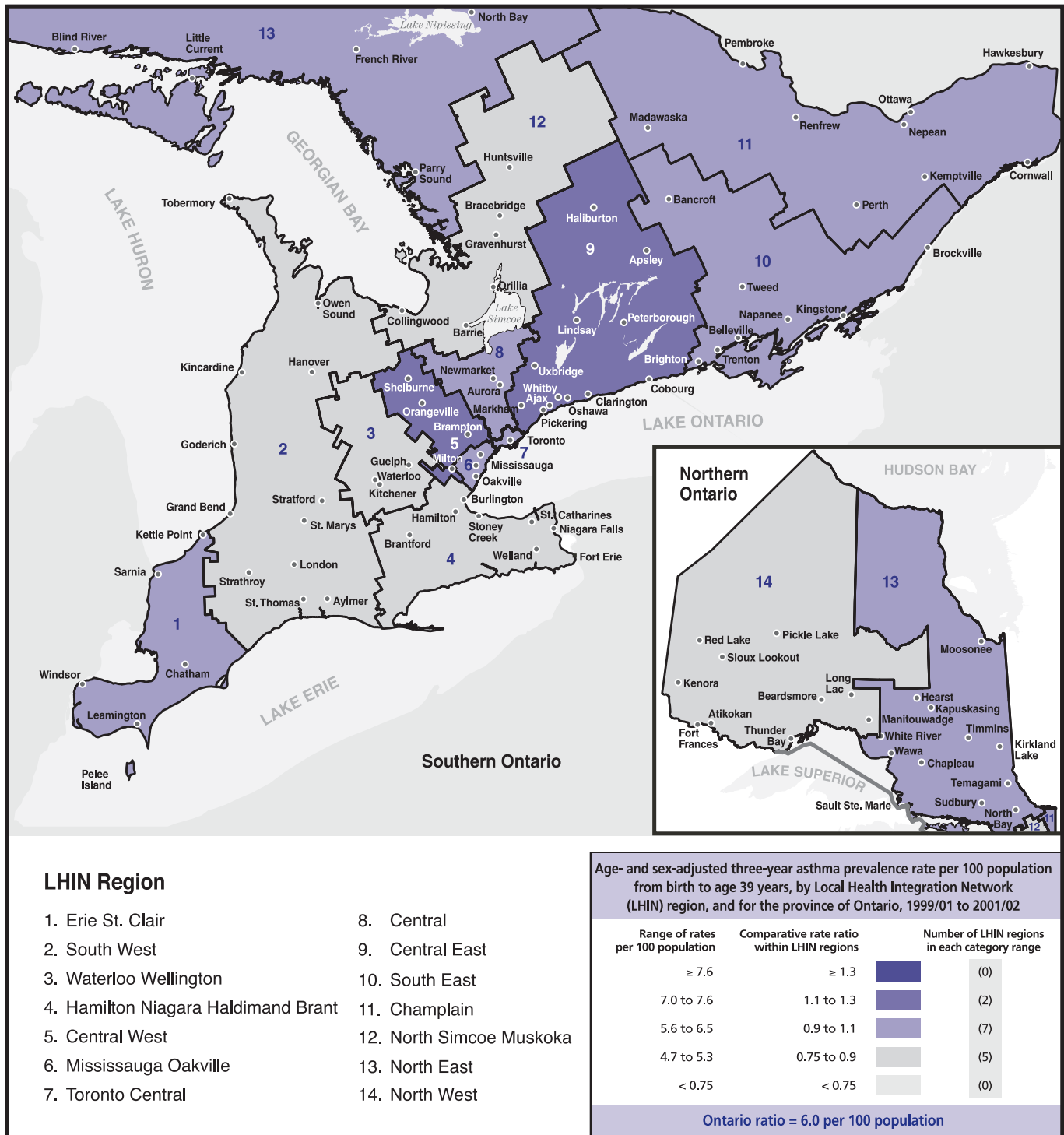
Exhibit 5.1 Age- and sex-adjusted asthma prevalence rate* (percentage) by Local Health Integration Network (LHIN) region, and for the Province of Ontario, 1999/00 to 2001/02

LHIN region	Crude rate*	Age-/sex-adjusted prevalence rate per 100 population	P-value	Rank
1. Erie St. Clair	5.8	5.8	**	7
2. South West	4.9	4.8	**	12
3. Waterloo Wellington	4.7	4.7	**	14
4. Hamilton Niagara Haldimand Brant	5.3	5.2	**	11
5. Central West	7.6	7.6	**	1
6. Mississauga Halton	6.4	6.4	**	5
7. Toronto Central	5.8	6.0	NS	6
8. Central	6.3	6.4	**	4
9. Central East	7.0	7.0	**	2
10. South East	5.6	5.6	**	9
11. Champlain	6.5	6.5	**	3
12. North Simcoe Muskoka	5.4	5.3	**	10
13. North East	5.7	5.7	**	8
14. North West	4.8	4.7	**	13
Ontario	6.0	6.0	Reference	
Coefficient of variation (%) [CV]		13.1		
Extremal quotient [EQ]		1.6		
Systematic component of variation [SCV]		19.9		
Adjusted chi-square (likelihood ratio)		7,728.8 (p<0.0001)		
* Rates averaged over the three-year study period ** Significant at 0.1% level NS=Not significant				

For Exhibits 5.1-5.6

- The age- and sex-adjusted asthma prevalence rates ranged from a low of 4.7 per 100 population in the North West and the Waterloo Wellington Local Health Integration Network (LHIN) regions to a high of 7.6 per 100 population in the Central West LHIN region, representing a 1.6-fold variation.
- The age- and sex-adjusted asthma Ontario Health Insurance Plan (OHIP) claim rate showed a 1.3-fold variation, with the lowest in the North West LHIN region (9.6 OHIP claims per individual) and the highest in the Central LHIN region (12.5 OHIP claims per individual).
- The age- and sex-adjusted asthma hospitalization rates showed a nearly four-fold variation, with the lowest asthma hospitalization rate found in the Central LHIN region (2.7 hospitalization claims per 100 population) compared to the highest rate in the North West LHIN region (10.3 hospitalization claims per 100 population).

Exhibit 5.2 Age- and sex-adjusted asthma prevalence rate* (percentage) by Local Health Integration Network (LHIN) region, 1999/00 to 2001/02

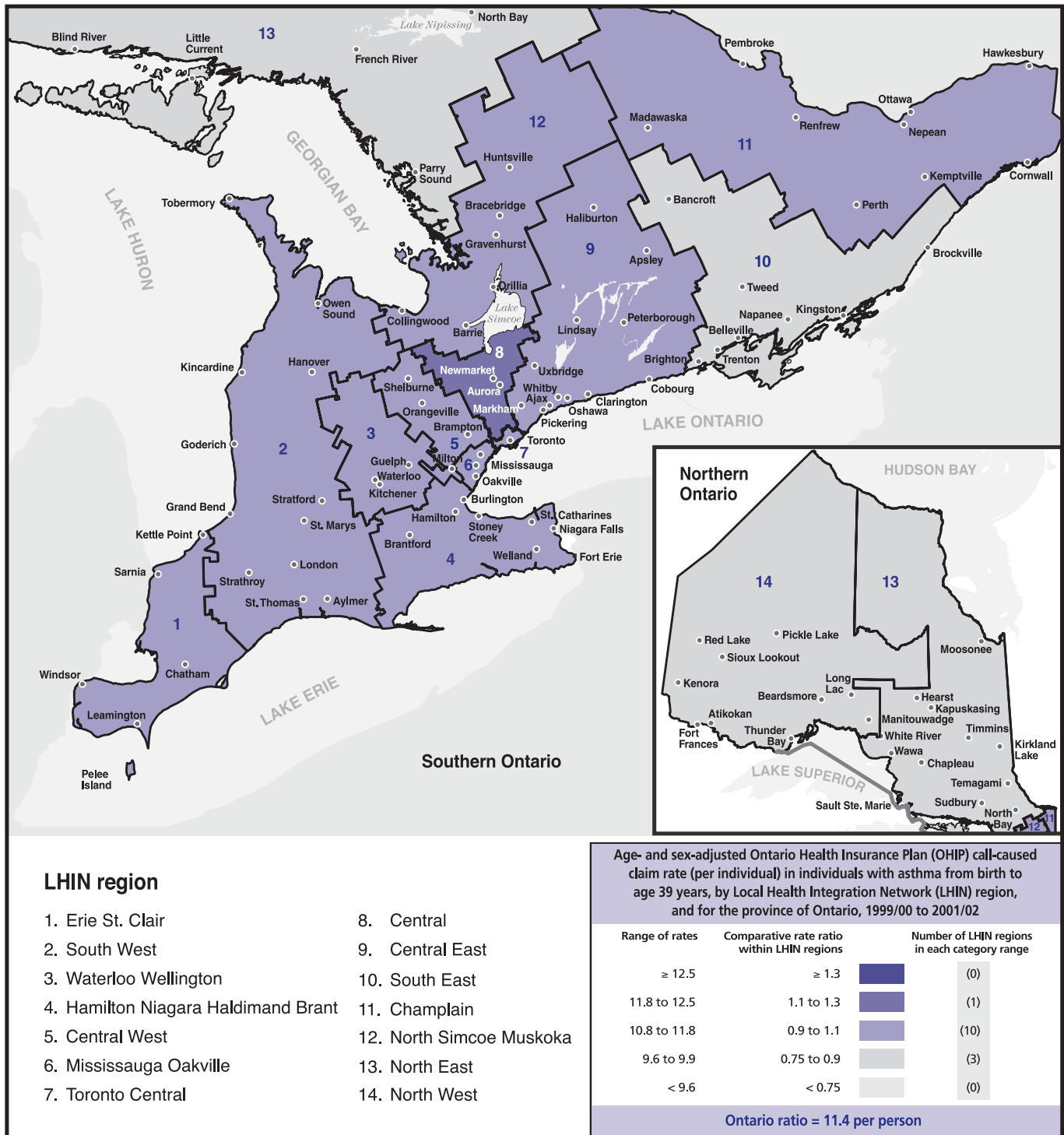


Outpatient Services

Exhibit 5.3 Age- and sex-adjusted all Ontario Health Insurance Plan (OHIP) claim rate* (per individual), in individuals with asthma, by Local Health Integration Network (LHIN) region, and for the Province of Ontario, 1999/00 to 2001/02

LHIN region	Crude rate*	Age-/sex-adjusted OHIP claim rate per individual	P-value	Rank
1. Erie St. Clair	11.5	11.5	NS	7
2. South West	11.2	11.1	***	10
3. Waterloo Wellington	11.0	10.8	***	11
4. Hamilton Niagara Haldimand Brant	11.1	11.1	***	9
5. Central West	11.5	11.8	***	2
6. Mississauga Halton	11.4	11.7	***	4
7. Toronto Central	12.0	11.6	***	5
8. Central	12.3	12.5	***	1
9. Central East	11.7	11.8	***	3
10. South East	10.0	9.8	***	13
11. Champlain	11.4	11.2	***	8
12. North Simcoe Muskoka	11.8	11.5	**	6
13. North East	10.0	9.9	***	12
14. North West	10.0	9.6	***	14
Ontario	11.4	11.4	Reference	
Coefficient of variation (%) [CV]		6.0		
Extremal quotient [EQ]		1.3		
Systematic component of variation [SCV]		5.6		
Adjusted chi-square (likelihood ratio)		4,468.9 (p<0.0001)		
* Rates averaged over the three-year study period ** Significant at 1% level *** Significant at 0.1% level NS=Not significant				

Exhibit 5.4 Age- and sex-adjusted all Ontario Health Insurance Plan (OHIP) claim rate* (per individual), in individuals with asthma, by Local Health Integration Network (LHIN) region, 1999/00 to 2001/02

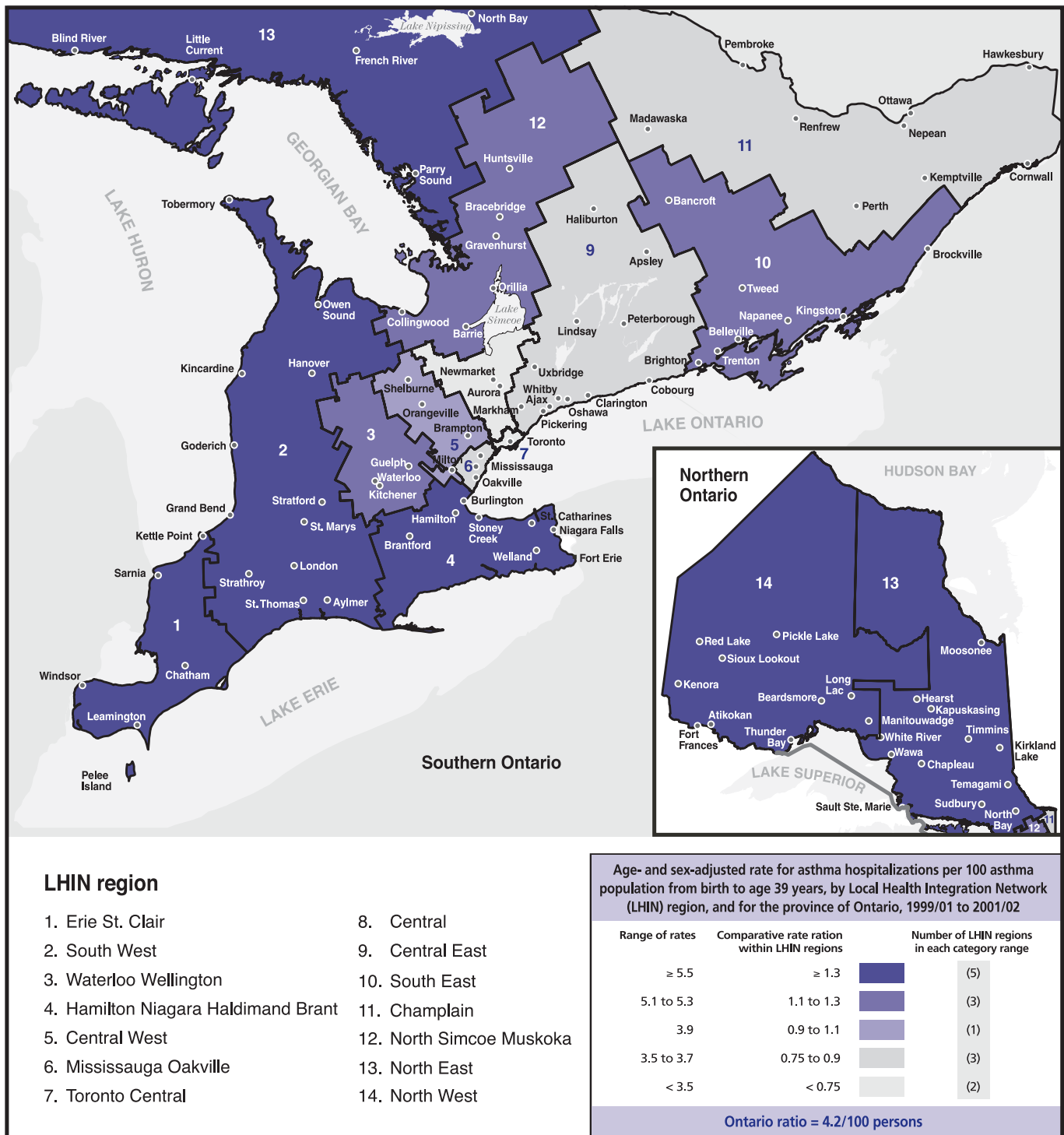


Hospitalization Claims

Exhibit 5.5 Age- and sex-adjusted rate* for asthma hospitalizations per 100 asthma population, by Local Health Integration Network (LHIN) region, and for the Province of Ontario, 1999/00 to 2001/02

LHIN region	Crude rate*	Age-/sex-adjusted hospitalization rate per 100 population	P-value	Rank
1. Erie St. Clair	5.8	5.8	***	4
2. South West	5.8	5.8	***	2
3. Waterloo Wellington	5.3	5.3	***	6
4. Hamilton Niagara Haldimand Brant	5.5	5.5	***	5
5. Central West	4.1	3.9	**	9
6. Mississauga Halton	3.7	3.7	***	10
7. Toronto Central	2.9	2.8	***	13
8. Central	2.8	2.7	***	14
9. Central East	3.7	3.7	***	11
10. South East	4.9	5.1	***	8
11. Champlain	3.4	3.5	***	12
12. North Simcoe Muskoka	5.0	5.2	***	7
13. North East	5.6	5.8	***	3
14. North West	10.2	10.3	***	1
Ontario	4.3	4.2	Reference	
Coefficient variation (%) (CV)		32.2		
Extremal quotient (EQ)		3.8		
Systematic component of variation (SCV)		209.2		
Adjusted chi-square (likelihood ratio)		1,699.8 (p<0.0001)		
* Rates averaged over the three-year study period				
** Significant at 1% level				
*** Significant at 0.1% level				

Exhibit 5.6 Age- and sex-adjusted rate* for asthma hospitalizations per 100 asthma population, by Local Health Integration Network (LHIN) region, 1999/00 to 2001/02



Discussion

In Chapter 1, asthma prevalence rates in Ontario from 1994/95 to 2001/02 among people under 40 years of age were reported to be 6% with a moderate decrease over time. The prevalence of asthma did not show a remarkable variation across the 14 Ontario Local Health Integration Network (LHIN) regions. The Central West LHIN region demonstrated the highest prevalence. Determining whether socioeconomic and environmental factors play a role in the differences observed in asthma prevalence rates across regions in Ontario will require further research.

While the pattern of outpatient asthma health care utilization is relatively consistent across Ontario, the rates of asthma hospitalization showed a four-fold difference across LHIN regions. Ontario Health Insurance Plan (OHIP) claims for inpatient versus outpatient asthma health care utilization were inversely correlated. For example, the Central LHIN region had the highest all-cause asthma OHIP claim rate but the lowest asthma hospitalization rate. Similarly, the North West LHIN region had the lowest all-cause asthma OHIP claim rate but the highest asthma hospitalization rate. The low asthma hospitalization rate in the Central LHIN region may be attributable to higher (or more aggressive) asthma outpatient care, a higher threshold to admit patients and/or a shortage of hospital beds in this region.

Hospitalizations for asthma have been identified as those that are the most commonly preventable ones, especially in children.^{29,30} It is generally agreed that asthma is an “ambulatory care-sensitive condition”, whereby good outpatient management should result in decreased hospitalizations.^{29,30} Inadequate control of asthma poses physical consequences, has significant health care cost implications and lowers a person’s quality of life. A number of important components are known to improve the level of asthma control and these could be considered across Ontario—especially in those LHIN regions with higher rates of asthma hospitalizations—in order to reduce the burden of hospitalization on the health care system as well as on people and their families. These include appropriate medication, medication adherence, use of action plans, recognizing and reducing exposure to asthma triggers (e.g., pets, dust, smoke), appropriate follow-up asthma care appointments, as well as asthma education and self-management programs.

Summary: What is the Burden of Asthma in Ontario?

Who has asthma?

- From 1994/95 until 2001/02, the prevalence of asthma in Ontario decreased modestly from 6.3% to 5.8% in people from birth to 39 years of age. The appearance of new asthma cases appeared stable (10–12 per 1,000 population) from 1997/98 until 2001/02. Asthma prevalence and incidence were found to be greater in males in childhood and greater in females after early adolescence (age 10–14 years).

What is the **risk** of an individual **developing** asthma?

- An individual in Ontario has more than a two in five risk of developing asthma before they turn 40 years of age. After age 12, this decreases to a one in five risk. As asthma can still develop after the age of 40 years, the full lifetime risk of developing asthma would be even higher.

What **health care resources** are being **used** by people with asthma?

- There appeared to be a significant and persisting gap in the overall all-cause outpatient Ontario Health Insurance Plan (OHIP) claim rates between the asthma population and the non-asthma population. Individuals with asthma made, on average, 6 more claims per year than individuals without asthma. This is not explained solely by the additional asthma-specific claims expected in the asthma population. A gap was evident in every age group and in every year. This important finding suggests that a study looking at only asthma-specific claims and hospitalizations only covers a small part of health care utilization by individuals with asthma, and that the actual burden of asthma is larger than previously expected. Similar differences were seen in all-cause hospitalizations as well.
- Family physicians and paediatricians were responsible for approximately 90% of asthma OHIP claims and were clearly the frontline providers. Thus, primary care physicians are important providers to be targeted for continuing education initiatives. At the same time, specialists, who have been shown to improve outcomes in people with asthma (e.g., rates of emergency department visits and hospitalizations), appeared to be under-utilized. They may have a greater role to play in optimizing asthma care in the future.

How much does asthma cost the health care system?

- Outpatient expenditures specific to asthma care were modest and decreased significantly over the time period studied. Costs from all-cause outpatient claims for individuals with asthma were, on average, over \$200 per individual per year higher than for those without asthma.

What is the **geographical variation** of asthma in Ontario?

- Modest variation was observed in prevalence and outpatient services between Local Health Integration Network regions in Ontario. An almost four-fold variation was found in asthma hospitalization rates (adjusted rates of 2.7 to 10.3 hospitalizations per 100 individuals with asthma), which was explained mostly by high rates in the northwest part of the Province. Asthma claims for inpatient and outpatient health care utilization were inversely correlated so that regions with higher outpatient claim rates had lower asthma hospitalization rates.

Challenges and Limitations

The measurement of prevalence of asthma is difficult for a number of reasons. First, asthma is a chronic disease that has a fluctuating course characterized by periods of exacerbations and periods of remission. Secondly, for some individuals (especially children), the disease can go into remission or go away completely.⁵⁵ Finally, the vast majority of individuals do not undergo objective testing for asthma (e.g., spirometry). As a result, accurate epidemiological definitions of asthma do not exist.¹⁵ To avoid these problems, many investigators use self-reported survey data to determine asthma prevalence. This approach has been criticized because, among other things, it is subject to recall bias.^{14,15} Comparing survey data over time and across populations is problematic because various population surveys have asked different questions and focused on non-comparable populations. These limitations have been reported in other studies which have examined the prevalence of asthma both nationally and internationally.⁵⁶

In the current study, a three-year prevalence was used because it was consistent with the time period used to establish a diagnosis of asthma in the study. The three-year prevalence rates were consistent with the one-year prevalence rates on all asthma diagnostic codes, suggesting that it was a stable rate (data not shown). The values presented in this study were likely lower than self-reported, physician-diagnosed, Canadian prevalence rates found in national health surveys because those data reported on lifetime asthma, as opposed to three-year prevalence.^{1,7} Such a lack of fit between health administrative data and survey data has been observed previously in a Canadian context.⁵⁷ Compared to those captured by the national health surveys, people with asthma in the current study would be more likely to have active and/or severe asthma since they all had contact with the health care system for asthma within the last three years. Survey respondents would not necessarily have had such contact.

Regarding the calculations for health care utilization and expenditures, there might have been a slight bias towards more use and cost because the cohort identified was more likely to have active and/or severe disease as described above. Therefore, these values are likely to overestimate the number of claims and costs in individuals with mild and/or very stable asthma. At the same time, because this report does not necessarily capture the many people who have mild asthma and their contribution to the burden of asthma, it might also underestimate the health care burden and expenditures of asthma overall.

With respect to health care expenditures by individuals with asthma, these results were difficult to compare with other studies for two main reasons. First, other studies seemed to have isolated differing types of populations of people with asthma. This made comparison across populations difficult. For example, compared to other studies, the province-wide population in this study appeared to have, on average, fewer hospitalizations, suggesting that they were healthier and therefore less likely to use expensive health care resources.^{45,46} In other studies, comparable statistics on hospitalizations were not available and thus it was difficult to determine if the populations were similar enough to compare.⁵⁴ And second, there were differences in parameters measured compared to other studies. Hospitalizations and pharmacy costs were the first and second major expense in asthma care reported in many studies, but this study was unable to measure these.^{3,52-54} Other studies also considered the indirect costs of asthma—such as lost productivity due to time off work—which this study was unable to measure.^{3,52-54} It is important to note these omissions in the data since they strongly suggest that the economic burden of asthma is much higher than revealed by this report. In summary, the current attributed the discrepancies between the results of this study and those of other studies as most likely being due to differences in the types of patient population and the parameters being measured.

Future Directions

The present report represents a starting point to direct future research. Planned future studies include:

- Expanding the study to people with asthma beyond 39 years of age. This age was chosen because it was unlikely that individuals with chronic obstructive pulmonary disease would be mistaken for having asthma. To study asthma above the age of 39, the diagnosis of asthma must first be validated in this age group. This study is currently ongoing;
- Continuing asthma surveillance in order to determine asthma trends beyond 2001/02;
- Exploring emergency department visits for asthma more closely through the surveillance of Canadian Institute for Health Information (CIHI) National Ambulatory Care Reporting System (NACRS) data;
- Explaining the large gaps found between all-cause claims and all-cause costs when comparing individuals with and without asthma; and,
- Studying various comorbidities in those with asthma.

Appendices—Appendix A. How the Research was Done

Data Sources

This study used three Ontario health care administrative databases:

1. The Ontario Health Insurance Plan (OHIP) database which includes information pertaining to services provided by Ontario physicians who are paid on a fee-for-service basis. These records were used to capture out-of-hospital physician services and laboratory tests, as well as in-hospital services and diagnostic test interpretation performed by fee-for-service physicians. The fee code associated with each billable patient encounter was used to identify visits for asthma.
2. The Canadian Institute for Health Information Discharge Abstract Database (CIHI-DAD) is a national database comprised of information on inpatient hospitalizations, which includes data for same day surgeries, long-term care and rehabilitation. Each abstract in the database is associated with a patient discharge. Beginning in 2002/03, health care facilities used the International Classification of Diseases, Ninth Revision (ICD-9) and Tenth Revision (ICD-10) for DAD submissions to CIHI. Prior to 2002/03, 16 ICD-9 diagnostic codes were used to identify hospitalizations due to asthma.
3. The Registered People Database (RPDB) of the Ontario Ministry of Health and Long-Term Care provides information about individuals who are registered for OHIP. The database collects and maintains information regarding health card number, surname, date of birth, gender, address, and date of death, if applicable.

The ICES Physician Database (IPDB), which comprises information from the Corporate Provider Database (CPDB), the Ontario Physician Human Resource Data Centre (OPHRDC) database and the OHIP database of physician billings, was used to define health care utilization by physician specialty. The CPDB contains information about physician demographics, specialty training and certification, and practice location. This information is validated against the OPHRDC database, which is updated through periodic telephone interviews with all physicians practicing in Ontario.

Cohort Assembly

The index date for the study cohort was defined as the first asthma diagnosis after April 1, 1991. Individuals who were included in the cohort were less than 40 years of age, residents of Ontario at the index date, and contained no missing gender information in the RPDB database. The cut off age of 40 years was used because, below this age, asthma is much less likely to be mistaken for chronic obstructive pulmonary disease. Children under two years of age were not excluded, since asthma diagnosis using health administrative data in this age group has previously been validated.⁵⁸

For the purposes of this study, all OHIP claims that occurred after the index date were extracted, including medical and non-medical physician billings, as well as laboratory and non-laboratory billings. The ICD-9 fee code 493 was used to identify the subset of asthma OHIP claims made between July 1, 1991 and March 31, 2005. Since it is possible for multiple OHIP billings to occur for each patient, only one claim per physician per service day per patient was used to represent a health care visit.

All inpatient acute care hospital admissions and same day surgeries occurring after the index date and prior to March 31, 2005, were extracted from the CIHI database. ICD-9 code 493 and ICD-10 code J45 were used to identify the subset of asthma hospitalizations.

Asthma population

An individual was considered to have asthma if he/she had one asthma hospitalization recorded in the CIHI database, or two asthma OHIP claims over the course of three years between 1991/92 and 2004/05. The diagnosis date was taken as the earlier of either the first asthma hospitalization or the first of two OHIP claims that comprised the asthma algorithm.⁵⁸

Non-asthma population

The non-asthma population consisted of all Ontario residents aged less than 40 years who were not included in the asthma cohort and did not have missing gender information in the RPDB database.

Analyses

Although data were available from 1991/92 to 2004/05, only data from 1994/95 to 2001/02 were exhibited. Three years of prior data (1991/92 through 1993/94) were used to confirm asthma incidence, as well as three years of follow-up data (2002/03 through 2004/05), in order to accurately capture individuals with asthma. Therefore, data from fiscal years 1991/92 to 1993/94 and 2002/03 to 2004/05 were excluded from this report.

Prevalence

The prevalence of asthma was measured in two ways. For one-year period prevalence, prevalent cases included people who had at least one OHIP claim or hospitalization for asthma within any given fiscal year from 1994/95 to 2001/02. To describe the prevalence of cases over three years, prevalent cases included persons who had at least two OHIP claims or one hospitalization for asthma within a three-year period from 1994/95 to 2001/02. For example, the prevalence of asthma in 1996/97 includes all people who had at least two OHIP claims or one hospitalization for asthma within fiscal years 1994/95, 1995/96 and 1996/97.

Efforts were made to identify the definition of prevalence that most accurately reflects the “true” asthma prevalence in Ontario. Sensitivity analyses included comparisons between the one-year period prevalence and the three-year prevalence of asthma in 1996/97, as defined in this report, and the prevalence of asthma according to the 1996/97 National Population Health Survey (NPHS). Table A.1 shows the prevalence values obtained according to these algorithms.

Table A.1 Comparison of asthma prevalence rates reported in the current study versus the National Population Health Survey (NPHS)

Age group (years)	ICES Burden of Asthma in Ontario report (2006) One-year period prevalence (1996/97)	ICES Burden of Asthma in Ontario report (2006) Three-year prevalence (1996/97)	NPHS (1996/97) Prevalence of asthma*	NPHS (1996/97) Prevalence of active asthma**	ICES Burden of Asthma in Ontario report (2006) Prevalence of active asthma*** (1996/97)
0–4	10.7	13.6	8.2†	7.3†	11.9
5–9	7.7	11.8	12.2	9.8	9.3
10–14	5.1	7.8	12.8	10.1	6.5
15–19	3.9	5.5	14.1	11.4	5
20–24	3.2	4.4	8.1	6.1	4.2
25–29	2.9	3.9	8.1	6.1	3.8
30–34	2.8	3.8	8.1	6.1	3.7
35–39	2.8	3.7	NA	NA	3.7

Values reported as %; NA=Not available

* Physician-diagnosed asthma in any time in the past

** Physician-diagnosed asthma in any time in the past and on medication in the last 12 months, or symptoms or exacerbations in the last 12 months

*** At least one CIHI admission or OHIP claim with an asthma diagnosis code in 1996/97

† High sampling variability

The most comparable definition of asthma prevalence between this study and the NPHS survey was the classification of “active asthma”. Given the high sampling variability of the NPHS, the 1996/97 prevalence of active asthma, as identified by the CIHI and OHIP databases, was taken as the gold standard prevalence. Table A.1 shows that the ICES three-year prevalence of asthma matches most closely with the ICES prevalence of active asthma. Therefore, the ICES three-year prevalence was used as the basis for analyses related to health care utilization and expenditures.

Incidence

The incidence of asthma date was defined as the first diagnosis date—that is, the first hospitalization or OHIP claim with a diagnosis of asthma according to the algorithm.

Lifetime risk of developing asthma

To estimate the lifetime risk of developing asthma, this study utilized the life table technique used by previous studies to determine the lifetime risk of nursing home admissions.⁵⁹ This method involved using cross-sectional data to simulate the lifetime experience of a population cohort. Therefore, it did not require extended follow-up periods characteristic of longitudinal designs.

The steps used to compute the lifetime risk of developing asthma included the following:

1. Age- and sex-specific asthma incidence rates were calculated based on cross-sectional data.
2. Cross-sectional incidence rates were applied to a life table stationary population of Ontario to estimate the number of asthma incidence cases between age x and $x+1$ for each sex in the population cohort.⁶⁰
3. The cohort population at risk of developing asthma was defined as those survivors at age x who have never before been diagnosed with asthma.
4. The lifetime probability of being diagnosed with asthma from age x to age y , where $y \geq x$, was estimated for the population at risk who have never before been diagnosed with asthma.

To verify the results of lifetime risk of developing asthma based on lifetable method, the risk of developing asthma from birth until age 11 was calculated using longitudinal follow-up data from the 1994/95 birth cohort and survival analysis (K-M method). The results were found to be very similar.

Health care utilization

To address trends in health care utilization between individuals with and without asthma as measured by the rate of OHIP claims per individual, all office visits to Ontario medical physicians were extracted from the OHIP database. The all-cause OHIP claim rates were compared between the two groups. The rate of hospitalization per 100 population between individuals with and without asthma was also explored. The denominators used to calculate the rates were the number of individuals with asthma (based on the asthma algorithm and the definition of three-year prevalence) and the number of individuals without asthma in Ontario, respectively.

To address the gap in all-cause OHIP/CIHI claim rates between the asthma population and the non-asthma population, the percentage of “asthma-related” OHIP/CIHI claims out of the total OHIP/CIHI claims in 2001/02 were compared between the two groups (See Table A.2). Results showed that the percentage of “asthma-related” OHIP/CIHI claims was higher in the asthma population, which support the theory that the gap in all-cause OHIP/CIHI claim rate between the asthma population and the non-asthma population could be partly attributed to a higher “asthma-related” claim rate in the asthma population.

Table A.2 Comparison of the proportion of the total number of Ontario Health Insurance Plan (OHIP) and Canadian Institute for Health Information (CIHI) claims that are “asthma-related”, in the asthma and non-asthma population, in Ontario, 2001/02

Age group (years)	OHIP		CIHI	
	Asthma (%)	Non-asthma (%)	Asthma (%)	Non-asthma (%)
0–9	8.5	6.2	19.7	8.0
10–39	19.1	15.7	7.5	4.3

Table A.3 International Classification of Diseases, Ninth Revision (ICD-9) diagnosis codes for “asthma-related” conditions in children from birth to age 9 years

ICD-9 diagnosis codes	“Asthma-related” conditions
462	Acute pharyngitis
464	Acute laryngitis, Tracheitis, Croup, Epiglottitis
465	Acute upper respiratory tract Infection
466	Acute bronchitis
480–486	Pneumonia (all types)
490	Bronchitis not otherwise specified
786.09	Wheezing

Table A.4 International Classification of Diseases, Ninth Revision (ICD-9) diagnosis codes for “asthma-related” conditions in individuals aged 9 years and older

ICD-9 diagnosis codes	“Asthma-related” conditions
307	Habit spasms, Tics, Stuttering, Tension headaches
460	Acute nasopharyngitis, Common cold
461	Acute sinusitis
464	Acute laryngitis, Tracheitis, Croup, Epiglottitis
466	Acute bronchitis
473	Chronic sinusitis
477	Allergic rhinitis, Hay fever
486	Pneumonia (all types)
487	Influenza
494	Bronchiectasis
519	Other diseases of the respiratory system
530	Esophagitis, Cardiospasm, Ulcer of esophagus, Stricture
536	Hyperchlorhydria, Hypochlorhydria, Dyspepsia, Indigestion
786	NYD epistaxis, Hemoptysis, Cough, Dyspnea, Masses
787	NYD anorexia, Nausea and vomiting, Heartburn, Dysphagia

Expenditures

Information from the OHIP database was used to determine the amount remunerated to physicians for services and non-hospital laboratory tests. For physicians who receive funding from alternative payment plans such as global or block funding, shadow billed claims were used to determine asthma-related expenditures. Using non-shadow billed OHIP claims, a median cost was calculated for each combination of fee suffix, fee code and service fiscal year. The median cost was then assigned to each shadow billing claim according to the corresponding fee suffix, code and service fiscal year.

To correct for inflation, OHIP expenditures for 1994/95 to 2001/02 were adjusted to the 2001 dollar using the health care Consumer Price Index.

Geographic variations

The patient’s sex, age and postal code were obtained from the RPDB. Postal codes were converted into Dissemination Areas (DA) using Statistics Canada conversion files and the DAs were converted to Local Health Integration Network (LHIN) regions. The analyses were conducted to examine the prevalence, all-cause OHIP claim and asthma hospitalization rates among the asthma cohort, by LHIN regions. The rates were averaged for 1999/00, 2000/01 and 2001/02. Also, the age- and sex-standardized rates were reported using the 2001 Ontario population as the standard population for prevalence rate, and the 2001 asthma three-year prevalence cohort as the standard population for OHIP claim and hospitalization rates. A more detailed description for the methods to analyze geographic variation used in this report can be found elsewhere.⁶¹

Appendices—Appendix B. Summary of Literature on Asthma Prevalence and Incidence

Table B.1 Canadian Studies Measuring Asthma Prevalence

Author	Year	Study design	Study period	Age	Sample size	Method of measurement	Definition of prevalence rate		Findings	
							Population	Asthma diagnosis	Prevalence rate (%)	Overall trend over time of all ages studied
Canada:										
Dale ⁹	1994	Cross-sectional	1988	5–8	14,940	Questionnaire	All children residing in 30 communities in six regions chosen to be free of point source pollutants which could influence respiratory health.	Point prevalence: Currently present, physician-diagnosed asthma	British Columbia: 3.3 Saskatchewan: 6.4 Central Ontario: 4.2 Southwestern Ontario: 5.1 Quebec: 3.4 Maritimes: 7.4 Overall: 4.7	N/A
Manfred ¹⁰	2001	Cross-sectional	1993–1994	22–44	18,616	ECRHS	Random samples of the general population in 6 sites (Vancouver, Winnipeg, Hamilton, Montreal, Halifax, PEI) across Canada selected to represent different environments with respect to climate, air pollution and occupational exposures	One-year period prevalence: Self-reported asthma symptoms, asthma attacks or use of asthma medications in the previous 12 months	Wheezing: 26.5 (men), 28.2 (women) Asthma attack: 5.4 (men), 7.7 (women) Asthma medication use: 5.0 (men), 7.6 (women)	N/A
Statistics Canada ¹	1994–2005	Cross-sectional	1994–2005	12 and over	Number of people in the households surveyed	NPHS/CCHS	Random sample of household residents across Canada	Cumulative prevalence: Physician-diagnosed asthma at anytime in the past	By age group in 2000/01: 12.7 (12–14 years) 12.6 (15–19 years) 10.9 (20–24 years) 9.0 (25–34 years) 7.3 (35–44 years)	Increased in 1990s then decreased slightly
Ontario:										
To	2006	Population-based retrospective cohort	1994–2001	0–39	Population of Ontario	Health administrative databases (physician billings & hospital discharge abstract)	All individuals insured by the universal provincial health insurance plan in the corresponding fiscal year	Three-year period prevalence: Patients who had at least two OHIP claims or one hospitalization for asthma within a three-year period in the three years prior to and including a given fiscal year	By age group in 2001/02: 12.3 (0–4 years) 10.0 (5–9 years) 7.0 (10–14 years) 4.3 (15–19 years) 3.8 (20–24 years)	Small decrease over study period
Saskatchewan:										
Senthilselvan ⁶²	1998	Population-based retrospective cohort	1981–1990	0–64	Population of Saskatchewan	Health administrative databases (physician billings)	All individuals insured by the universal provincial health insurance plan in the corresponding calendar year	One-year period prevalence: At least one physician claim with asthma diagnosis in a given calendar year	By age group in 1990: 5.1 (0–4 years) 4.4 (5–14 years) 2.2 (15–34 years) 1.9 (35–64 years)	Increased over study period
Senthilselvan ¹¹	2003	Population-based retrospective cohort	1991–1998	0–64	Population of Saskatchewan	Health administrative databases (physician billings)	All individuals insured by the universal provincial health insurance plan in the corresponding calendar year	One-year period prevalence: At least one physician claim with asthma diagnosis in a given calendar year	By age group in 1998: 8.1 (0–4 years) 5.9 (5–14 years) 3.5 (15–34 years) 2.7 (35–64 years)	Increased in the early 1990s but then stable during the latter part of 1990s
Manitoba:										
Kozyrskyj ¹²	2001	Population-based retrospective cohort	1996/97, 1998/99	5–19	Population of Manitoba	Health administrative databases (physician billings, hospital discharge abstract & drug prescription data)	All individuals insured by the universal provincial health insurance plan in the corresponding fiscal year	One-year period prevalence: At least one health care contact or prescription drug for asthma in a given fiscal year	By age group in 1996/97: 11.0 (5–9 years) 9.0 (10–14 years) 7.7 (15–19 years) Overall in 1998/99: 10.0	N/A

N/A = Not available

ECRHS = European Community Respiratory Health Survey NPHS = National Population Health Survey

CCHS = Canadian Community Health Survey

Table B.2 Studies Measuring Asthma Incidence

Author	Country	Study design	Year studied (study duration)	Age at baseline	Sample size	Method of measurement	Asthma incidence rate		
							Population at risk	Definition of asthma diagnosis	Incidence rate (per 1,000 per year)
North America:									
Ownby ¹⁶	US	Prospective cohort	1987–1989 1991–1993 (4 years)	Women: 28.7±4.5 Men: 31.0±5.0	1,031	Repeated survey	All pregnant women insured by the Health Alliance Plan health maintenance organization and residing in an area of suburban Detroit due to deliver between 15/04/1980–31/08/1989, and the fathers of their children who did not report asthma at baseline	Positive response to "Has a doctor ever said that you (or your spouse) have or have had asthma?" at follow-up	Average annual incidence rate: 3.4
Dik ²¹	Canada (Manitoba)	Population-based retrospective birth cohort	1980–1996 (6 years)	0	170,960	Health administrative databases (physician billings & hospital discharge abstract)	All children born between 1980–1990 in Manitoba, Canada	One or more claims with a diagnosis of asthma submitted by a physician (time of onset; date of first physician claim for asthma)	Average annual incidence rate: 23.5
To	Canada (Ontario)	Population-based retrospective cohort	1994 – 2001	0–39	950,858	Health administrative databases (physician billings & hospital discharge abstract)	All Ontario residents in a given fiscal year who did not meet diagnosis for asthma at the beginning of a given year	One asthma hospitalization or two asthma OHIP claims in a three-year period (time of onset: first claim date in the three-year period)	By age group in 2001/02: 38 (0–4 years) 11 (5–9 years) 7 (10–14 years) 5 (15–19 years) 5 (20–24 years)
Europe:									
Strachan ¹⁸	England, Scotland and Wales	prospective birth cohort	1958–1991 (33 years)	0–33	5,801	Repeated survey	All people born in England, Scotland and Wales during a given week, March 3-9, 1958, who did not report history of asthma or wheezy bronchitis at baseline and all previous follow-ups	Patient reported asthma or wheezy bronchitis at follow-up surveys at 7, 16 and 33 years of age	Average annual incidence rate from 0–7 years: 25.7 Average annual incidence rate from 8–16 years: 9.8 Average annual incidence rate from 17–33 years: 15.3
Lundback ¹⁹	Sweden	Prospective cohort	1986–1996 (10 years)	36–67	4,754	Repeated questionnaire	All subjects born in 1919–1920, 1934–1935 and 1949–1950, living in eight representative areas of the province of Norrbotten who did not report asthma at baseline	Positive response to "Have you ever had asthma?" or "Have you been diagnosed as having asthma by a doctor?" at follow-up	Average annual incidence rate: 2.3
Ronmark ²²	Sweden	Prospective cohort	1996–1998 (2 years)	7–8	3,247	Repeated ISAAC questionnaire	All children enrolled in the first- and second-grade classes in 1996 in the municipalities of Kiruna, Lulea, and Pitea who did not have asthma at baseline based on questionnaire responses and physician examination	Positive response to "Has your child been diagnosed by a physician as having asthma?" at follow-up	9 (1997) 8 (1998)
Eagan ¹⁷	Norway	Population-based prospective cohort	1985–1997 (11 years)	15–70	2,819	Repeated questionnaire	Random sample of the population living in the city of Bergen or the 11 surrounding municipalities who were at risk of becoming asthmatic (not reporting asthma) at baseline	Positive response to "Have you ever been treated by a doctor or been hospitalized for asthma?" at follow-up	Average annual incidence rate: 3.4
Brogger ²⁰	Norway	Prospective cohort	1985 – 1996/97 (11 years)	15–70	2,427	Repeated questionnaire	Random sample of the population born from 1927–1969 living in the city of Bergen or the 11 surrounding municipalities who were at risk of becoming asthmatic (not reporting asthma) at baseline	Positive response to "Have you ever been treated by a doctor or been admitted to hospital for Asthma?" at follow-up	Average annual incidence rate: 3.3
Asia									
Shima ²³	Japan	Prospective cohort	1989–1997 (6 years)	6	1,910	Repeated annual questionnaire	All children entering 10 elementary schools in 8 different communities in Chiba Prefecture, Japan, during 1989–1992 with no previous history of asthma at baseline	Two or more episodes of wheezing accompanied by dyspnea and the occurrence of asthmatic attacks, or the need for any medication for asthma during the previous two years reported in follow-up questionnaires	Average annual incidence rate: 2.5–16.3

ISAAC: International Study of Asthma and Allergies in Childhood

References

1. Respiratory disease in Canada, Ottawa, Ontario: Canadian Institute for Health Information: Canadian Lung Association, Health Canada, Statistics Canada; 2001.
2. The National Asthma Control Task Force. The Prevention and Management of Asthma in Canada: A Major Challenge Now and in the Future. Ottawa: Health Canada; 2000. ISBN: 0-662-28953-6.
3. Krahn MD, Berka C, Langlois P, Detsky AS. Direct and indirect costs of asthma in Canada, 1990. *Canadian Medical Association Journal* 1996; 154(6):821–831.
4. Economic burden of illness in Canada, 1998. Health Canada;1998.
5. Public Health Agency of Canada. Mortality by major chronic diseases: Both sexes combined, all ages, 2001, Canada. In: Major Chronic Diseases online. 2001. Accessed September 2006 at http://dsol-smed.hc-sc.gc.ca/dsol-smed/mcd-smcm/d_dis_e.html.
6. Schultz SE, Kopec JA. Impact of chronic conditions. *Health Reports*. 2003; 14(4):41–52.
7. The National Asthma Control Task Force. The prevention and management of asthma in Canada: a major challenge now and in the future. Public Health Agency of Canada; 2000. Accessed September 13, 2006 at <http://www.phac-aspc.gc.ca/publicat/pma-pca00/index.html>.
8. Seung SJ, Mittmann N. Urgent care costs of uncontrolled asthma in Canada, 2004. *Canadian Respiratory Journal* 2005; 12(8):435–436.
9. Dales RE, Raizenne M, El-Saadany S, Brook J, Burnett R. Prevalence of childhood asthma across Canada. *International Journal of Epidemiology* 1994; 23(4):776–781.
10. Manfreda J, Margaret R, Becklake MR, Sears MR, Chan-Yeung M, Dimich-Ward H, et al. Prevalence of asthma symptoms among adults aged 20–44 years in Canada. *Canadian Medical Association Journal* 2001; 164(7):995–1001.
11. Senthilselvan A, Lawson J, Rennie DC, Dosman JA. Stabilization of an increasing trend in physician-diagnosed asthma prevalence in Saskatchewan, 1991 to 1998. *Chest* 2003; 124(2):438–448.
12. Brownell M, Kozyrskyj A, Fergusson P, Lerfarld J, Mayer T, Derksen S, Friesen D. Assessing the Health of Children in Manitoba: A Population-Based Study. Manitoba Centre for Health Policy; 2001.
13. Wieringa MH, Vermeire PA, Brunekreef B, Weyler JJ. Increased occurrence of asthma and allergy: critical appraisal of studies using allergic sensitization, bronchial hyper-responsiveness and lung function measurements. *Clinical and Experimental Allergy* 2001; 31(10):1553–1563.
14. Anderson HR. Prevalence of asthma. *British Medical Journal* 2005; 330(7499):1037–1038.
15. Von Hertzen L, Haahtela T. Signs of reversing trends in prevalence of asthma. *Allergy* 2005; 60(3):283–292.
16. Ownby DR, Johnson CC, Peterson EL. Incidence and prevalence of physician-diagnosed asthma in a suburban population of young adults. *Annals of Allergy, Asthma & Immunology* 1996; 77(4):304–308.
17. Eagan TM, Bakke PS, Eide GE, Gulsvik A. Incidence of asthma and respiratory symptoms by sex, age and smoking in a community study. *European Respiratory Journal* 2002; 19(4):599–605.
18. Strachan DP, Butland BK, Anderson HR. Incidence and prognosis of asthma and wheezing illness from early childhood to age 33 in a national British cohort. *British Medical Journal*. 1996; 312:1195–1199.
19. Lundback B, Ronmark E, Jonsson E, Larsson K, Sandstrom T. Incidence of physician-diagnosed asthma in adults: a real incidence or a result of increased awareness? Report from the Obstructive Lung Disease in Northern Sweden Studies. *Respiratory Medicine* 2001; 95(8):685–692.
20. Brogger J, Eagan T, Eide GE, Bakke P, Gulsvik A. Bias in retrospective studies of trends in asthma incidence. *European Respiratory Journal* 2004; 23(2):281–286.
21. Dik N, Tate RB, Manfreda J, Anthonisen NR. Risk of physician-diagnosed asthma in the first 6 years of life. *Chest* 2004; 126(4):1147–1153.
22. Ronmark E, Perzanowski M, Platts-Mills T, Lundback B. Incidence rates and risk factors for asthma among school children: a 2-year follow-up report from the Obstructive Lung Disease in Northern Sweden (OLIN) studies. *Respiratory Medicine* 2002; 96(12):1006–1013.
23. Shima M, Nitta Y, Ando M, Adachi M. Effects of air pollution on the prevalence and incidence of asthma in children. *Archives of Environmental Health* 2002; 57(6):529–535.
24. Basagana X, Sunyer J, Zock J, et al. Incidence of asthma and its determinants among adults in Spain. *American Journal of Respiratory and Critical Care Medicine* 2001; 164(7):1133–1137.
25. Thomsen SF, Ulrik CS, Kyvik KO, et al. The incidence of asthma in young adults. *Chest* 2005; 127(6):1928–1934.

26. Toren K, Gislason T, Omenaas E, Jögi R, Forsberg B, Nyström L et al. A prospective study of asthma incidence and its predictors: the RHINE study. *European Respiratory Journal*. 2004; 24(6):942–946.
27. Lodrup Carlsen KC, Haland G, Devulapalli CS, Munthe-Kaas M, Pettersen M, Granum B, et al. Asthma in every fifth child in Oslo, Norway: a 10-year follow-up of a birth cohort study. *Allergy* 2006; 61(4):454–460.
28. To T, Dell S, Dick P, Cicutto L, Harris J, Tassoudji M, Duong-Hua M. Burden of Childhood Asthma. ICES Investigative Report. Toronto: Institute for Clinical Evaluative Sciences; May 2004.
29. Minkovitz CS, Andrews JS, Serwint JR. Rehospitalization of children with asthma. *Archives of Pediatric and Adolescent Medicine* 1999; 153:727–730.
30. Flores G, Abreu M, Tomany-Korman S, Meure J. Keeping children with asthma out of hospitals: parents' and physicians' perspectives on how pediatric asthma hospitalizations can be prevented. *Pediatrics* 2005; 116:957–965.
31. Adams RJ, Fuhlbrigge A, Finkelstein JA, Lozano P, Livingston JM, Weiss KB, Weiss ST. Impact of inhaled antiinflammatory therapy on hospitalization and emergency department visits for children with asthma. *Pediatrics* 2001; 107(4):706–711.
32. Senthilselvan A, Lawson JA, Rennie DC, Dosman JA. Regular use of corticosteroids and low use of short-acting beta-agonists can reduce asthma hospitalization. *Chest* 2005; 127(4):1242–1250.
33. Suissa S, Ernst P. Inhaled corticosteroids: Impact on asthma morbidity and mortality. *Journal of Allergy and Clinical Immunology* 2001; 107(6):937–944.
34. To T, Guttmann A, Dick P. Inpatient and day surgery use by children in Ontario. ICES Atlas. Toronto: Institute for Clinical Evaluative Sciences; 2001.
35. Crighton EJ, Mamdani MM, Upshur REG. A population-based time series analysis of asthma hospitalizations in Ontario Canada: 1998 to 2000. *BMC Health Services Research*. 2001.
36. Ansari Z, Haby MM, Henderson T, Cicuttini F, Ackland MJ. Trends and geographic variations in hospital admissions for asthma in Victoria: opportunities for targeted interventions. *Australian Family Physician* 2003; 32(4):286–288.
37. Getahun D, Demissie K, Rhoads GG. Recent trends in asthma hospitalization and mortality in the United States. *Journal of Asthma* 2005; 42(5):373–378.
38. MacFaul R. Trends in asthma hospitalization: Is this related to prevention inhaler usage? *Archives of Disease in Childhood* 2004; 89:1158–1160.
39. Wennergren G, Strannegard IL. Asthma hospitalizations continue to decrease in schoolchildren but hospitalization rates for wheezing illnesses remain high in young children. *Acta Paediatrica* 2002; 91:1239–1245.
40. Goodwin RD, Messineo K, Bregante A, Hoven CW, Kairam R. Prevalence of probable mental disorders among pediatric asthma patients in an inner-city clinic. *Journal of Asthma* 2005; 42(8):643–647.
41. Eisner MD, Katz PP, Lactao G, Iribarren C. Impact of depressive symptoms on adult asthma outcomes. *Annals of Allergy, Asthma & Immunology* 2005; 94(5): 566–574.
42. Lozano P, Finkelstein JA, Hecht J, Shulruff R, Weiss KB. Asthma medication use and disease burden in children in a primary care population. *Archives of Pediatrics and Adolescent Medicine* 2003; 157(1):81–88.
43. Ortega AN, Belanger KD, Paltiel AD, Horwitz SM, Bracken MB, Leaderer BP. Use of health services by insurance status among children with asthma. *Medical Care* 2001; 39(10):1065–1074.
44. Schatz M, Zeiger RS, Mosen D, Apter AJ, Vollmer WM, Stibolt TB. Improved asthma outcomes from allergy specialist care: a population-based cross-sectional analysis. *Journal of Allergy and Clinical Immunology* 2005; 116(6):1307–1313.
45. Ungar WJ, Coyte PC, Chapman KR, MacKeigan L. The patient level cost of asthma in adults in south central Ontario. *Canadian Respiratory Journal* 1998; 5(6):463–471.
46. Ungar WJ, Coyte PC, Pharmacy Medication Monitory Program Advisory Board. Prospective study of the patient-level cost of asthma care in children. *Pediatric Pulmonology* 2001; 32:101–108.
47. Wu AW, Young Y, Skinner EA, Diette GB, Huber M, Peres A, Steinwachs D. Quality of care and outcomes of adults with asthma treated by specialists and generalists in managed care. *Archives of Internal Medicine* 2001; 161(21):2554–2560.
48. Fitzgerald JM, Boulet LP, McIvor RA, Zimmerman S, Chapman KR. Asthma control in Canada remains suboptimal: The Reality of Asthma Control (TRAC) study. *Canadian Respiratory Journal* 2006; 13(5):253–259.
49. Jin R, Choi BCK, Chan BTB, McRae L, Li F, Cicutto L, et al. Physician asthma management practices in Canada: Results of the 1996-97 national survey. *Canadian Respiratory Journal* 2000; 7:456–465.
50. Cicutto LC, Llewellyn-Thomas HA, Geerts W. Asthma management: A case scenario based survey of family physicians and pulmonary specialists. *Journal of Asthma* 2000; 37(3):235–246.
51. Cicutto LC, Geerts W, Llewellyn-Thomas HA. Physicians approaches to providing asthma education to their patients and the level of patient involvement in management decisions *Journal of Asthma*. 1999; 36(5):427–439.
52. Ungar WU. Calculating the cost of asthma in Canada [editorial]. *Canadian Medical Association Journal* 1996; 155(7):862–863.

53. Smith DH, Malone DC, Lawson KA, Okamoto LJ, Battista C, Saunders WB, et al. A national estimate of the economic costs of asthma. *American Journal of Respiratory and Critical Care Medicine* 1997; 156:787–793.
54. Szucs TD, Anderhub H, Rutishauser M. The economic burden of asthma: direct and indirect costs in Switzerland. *European Respiratory Journal* 1999; 13:281–286.
55. Sears MR, Greene JM, Willan AR, Taylor DR, Flannery EM, Herbison GP, et al. A longitudinal, population-based, cohort study of childhood asthma followed to adulthood. *The New England Journal of Medicine* 2003; 349(15):1414–1422.
56. Masoli M, Fabian D, Holt S, Beasley R. The global burden of asthma: executive summary of the GINA Dissemination Committee report. *Allergy* 2004; 59(5):469–478.
57. Huzel L, Roos LL, Anthonisen NR, Manfreda J. Diagnosis asthma: The fit between survey and administrative database. *Canadian Respiratory Journal* 2002; 9(6):407–412.
58. To T, Cicutto L, Dell S, Dick PT, MacLusky I. Case verification of children with asthma in Ontario. *Pediatric Allergy and Immunology* 2006; 17:69–76.
59. Mason F, Liu Z, Braun P. The probability of using an aged care home over a lifetime (1999–00). Canberra: Australian Institute of Health and Welfare; 2001.
60. Duchesne D, Tully P, Thomas B, Bourbeau R. Life Tables - Canada, Provinces and Territories 1995–1997. Ottawa: Statistics Canada; 2002.
61. Goel V, Williams JI, Anderson GM, Blackstien-Hirsch P, Fooks C, Naylor CD. Patterns of health care in Ontario: ICES Practice Atlas, 2nd Edition. Ottawa: Canadian Medical Association, 1996.
62. Senthilselvan A. Prevalence of physician-diagnosed asthma prevalence in Saskatchewan, 1981 to 1990. *Chest* 1998; 114(2):388–392.

Glossary of Key Terms

Area rate variations	Rates of asthma can differ across areas and these variations could be random or a function of service availability, patient population characteristics, physician characteristics, etc.
Asthma claim	Either an OHIP claim or a hospitalization that included the diagnosis code for asthma.
Asthma	Individuals were defined as having asthma if they had one asthma hospitalization or two asthma OHIP claims within three years (ICD-9 493).
Asthma-related claim	Either an OHIP claim or a hospitalization that included the diagnosis codes for asthma-related conditions.
Asthma-related conditions	Conditions that are highly correlated with asthma, such as acute bronchitis, pneumonia, acute upper respiratory infections and wheezing [International Classification of Diseases, Ninth Revision (ICD-9) codes for children aged 0 to 9: 462, 464-466, 480-486, 490, 786; for children aged over 9 and adults: 307, 460, 461, 464, 466, 473, 477, 486, 487, 494, 519, 530, 536, 786, 787. See descriptions of these ICD-9 diagnosis codes in Appendix A].
Incidence	The number of new cases of asthma that occurred in one year.
Incident asthma case	The first time the individual, who fulfilled the asthma definition, had a claim with the diagnosis of asthma. There was a minimum look-back window of six years to confirm incidence.
Lifetime risk	The risk or the probability of developing asthma over one's lifetime.
OHIP claim	Ontario Health Insurance Plan (OHIP) claims were included as one claim per physician per day.
Prevalence	The proportion of the population that is affected by asthma in a given time.
Prevalent asthma case	An individual with a diagnosis of asthma having been made in the two years prior to a given fiscal year or the fiscal year for which prevalence is reported (e.g., the prevalence for fiscal 97/98 is based on fiscal years 95/96, 96/97 and 97/98).