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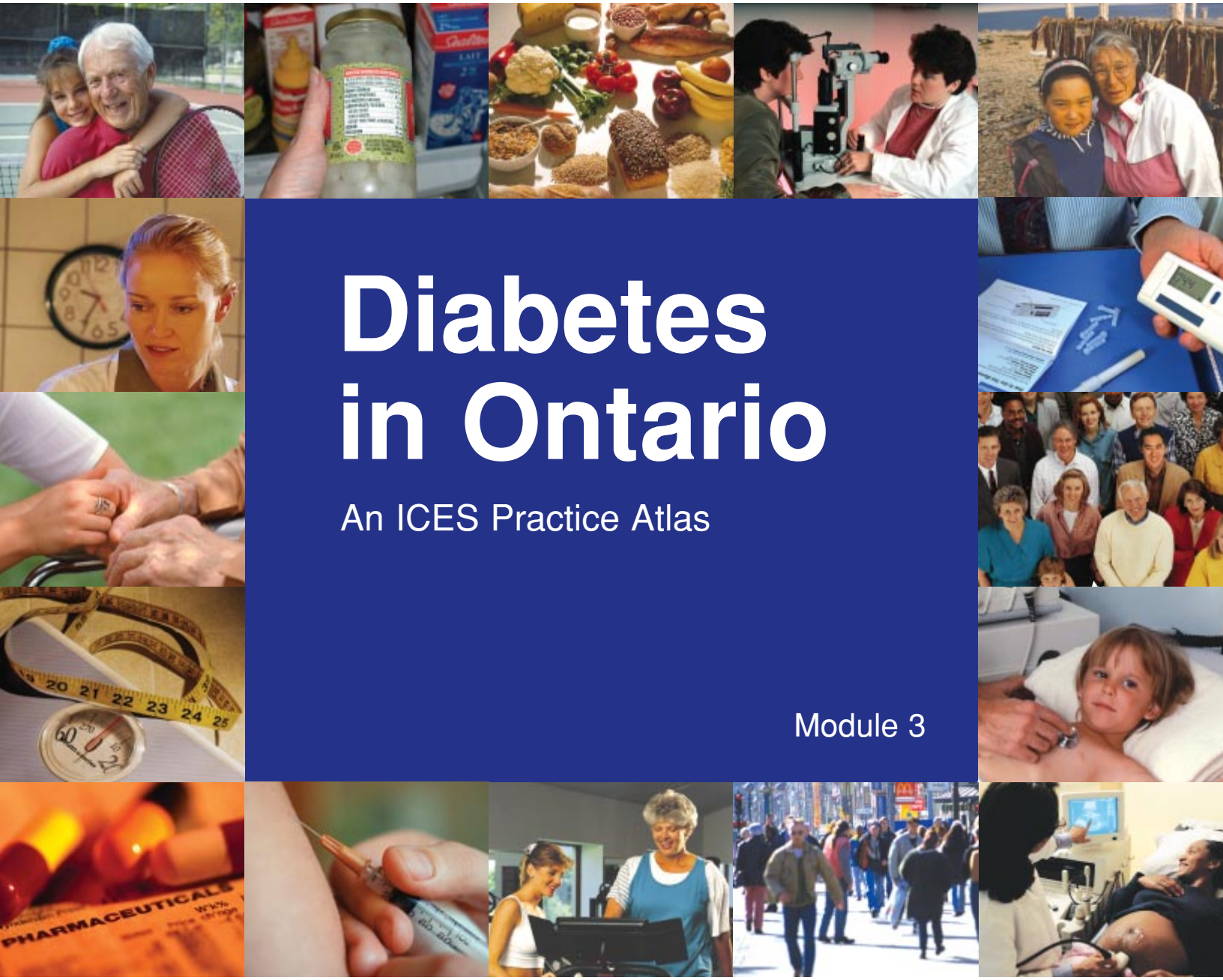


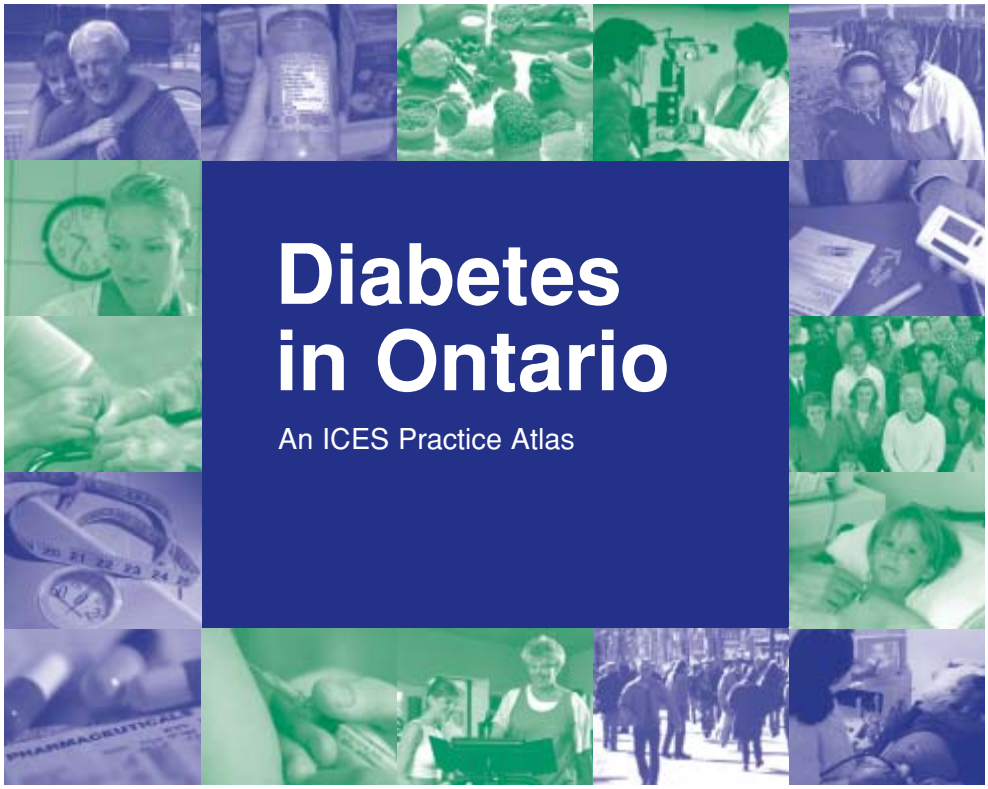
Diabetes in Ontario

An ICES Practice Atlas

Module 3

CANADIAN DIABETES ASSOCIATION | ASSOCIATION CANADIENNE DU DIABÈTE

June 2003



Diabetes in Ontario

An ICES Practice Atlas

Editors

Janet E. Hux, MD, SM, FRCPC

Gillian L. Booth, MD, MSc, FRCPC

Pamela M. Slaughter, RN, MA, MSc

Andreas Laupacis, MD, MSc, FRCPC

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Table of Contents

Exhibits and Appendices

Chapter 1
Patterns of Prevalence and Incidence of Diabetes

Chapter 2
Acute Complications of Diabetes

Chapter 2 (Cont'd)
Acute Complications of Diabetes

Chapter 3
Drug Use in Older People with Diabetes

Chapter 4
Diabetes Health Status and Risk Factors

Chapter 5
Diabetes and Cardiac Disease

Chapter 5 (Cont'd)
Diabetes and Cardiac Disease

Chapter 6
Diabetes and Peripheral Vascular Disease

Chapter 7
Diabetes and Stroke

Chapter 8
Dialysis Therapy for Persons with Diabetes

Chapter 9
Sources of Physician Care for People with Diabetes

Chapter 10
Diabetes and the Eye

Chapter 11
Pregnancy in Women with Diabetes

Chapter 12
Diabetes in Children

Chapter 13
Diabetes and First Nations People

Chapter 14
Supply and Utilization of Health Care Services for Diabetes

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Administrative Support
Eileen Patchett
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Davida Glazer
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J-R Kidston
Catherine Bissett
John Grabowski
Jackson Wong

Knowledge Transfer
Paula McColgan
Julie Argles
Shelley Drennan

Senior Graphic Designer
Laura Benben

Programming & Biostatistics Team
Don DeBoer
Natalie Forde
Kinwah Fung
Alex Kopp
Cindy Li
Ping Li
Minh Le Duang-Hua
Jiming Fang
Deanna Rothwell
Jane Shi
Kathy Sykora
Mei Tang

Project Coordination
Melanie Harju
Susan Garfinkel

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Finally, the Canadian Diabetes Association shared our vision of researching and producing a document that would provide information to help improve the health of people with diabetes. We appreciate their collaboration and generous support.

Commentators on the ICES Diabetes Atlas

The authors and editors have sought to produce work which would be relevant to a wide range of stakeholders, from research to policy, public health to clinical nursing and medicine. Accordingly, we asked a number of leaders in these fields to overview the entire Atlas, with the hope that they would assess the utility of the project from the perspective of their professional expertise. We wish to take this opportunity to thank them for their efforts and their contribution to the success of this project.

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Chief, Epidemiology & Statistics Branch
National Center for Chronic Disease Prevention and
Health Promotion
Division of Diabetes Translation
Centers for Disease Control and Prevention (CDC)

Dr Diane T. Finegood
Scientific Director,
Canadian Insitutes for Health Research—Institute of
Nutrition, Metabolism and Diabetes
Simon Fraser University

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Chair
Diabetes Nursing Interest Group (DNIG),
Registered Nurses Association of Ontario (RNAO)

Dr. Kue Young
Professor,
Department of Public Health Sciences
University of Toronto

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The editors

Janet E Hux • Gillian L Booth • Pamela M Slaughter • Andreas Laupacis

Preface

DIABETES IN ONTARIO: An ICES Practice Atlas was developed by ICES with the support of the Canadian Diabetes Association.

More than two million Canadians have diabetes (more than 600,000 of them in Ontario) and that number is expected to reach three million by 2010. As the diabetes epidemic continues to escalate in Canada and around the world, there has never been a more pressing time to understand the scope and magnitude of the disease. The rich, comprehensive data assembled in *Diabetes in Ontario: An ICES Practice Atlas* provides for—the first time—the kind of detailed population health information about diabetes that will help health care professionals, planners, researchers and policy makers understand how best to effect change to improve health outcomes for Ontarians with diabetes.

The Atlas clearly points to the escalation in the proportion of people living with diabetes (an alarming 31% increase over the five years studied). It highlights findings such as the rise in diabetes complications at a much younger age, and women in lower social economic situations continue to require additional attention. It also reveals a number of trends that need to be addressed, including meeting the needs of those ethnic groups traditionally at higher risk for diabetes.

The Canadian Diabetes Association has long recognized that diabetes has a strong and often devastating link to the complications of heart disease, kidney disease, eye disease and nerve disease. The Atlas is rich in regional and provincial data, from incidence and prevalence rates and hospitalization, complication and mortality rates, to the proportion of people seeing (or not seeing) diabetes specialists. The data amassed by the Atlas is of great assistance to organizations such as the Canadian Diabetes Association as we continue to promote the importance of diabetes prevention, care and management.

Partnerships and collaborations are critical to the ongoing success of making a difference for people with diabetes, ensuring a life free from complications and reducing financial burden to both the individual and the health care system. The opportunity to play a role with ICES in the production of the Atlas was indeed a privilege for the Association and one that has provided us with outstanding data that will enhance our ability to move forward.

Tackling the diabetes epidemic requires multiple strategies aimed at primary, secondary and tertiary prevention. The Canadian Diabetes Association approaches its role in these areas through the development of evidence-based clinical practice guidelines, national standards for diabetes education, extensive awareness programs, as well as consumer resources and support networks for people with diabetes throughout Ontario and across Canada.

The Atlas provides important baseline data from which to measure Ontario's progress on the diabetes front. With the release of the Association's new evidence-based guidelines in the Fall of 2003, dissemination targets and evaluative strategies will be closely aligned with the data in the Atlas.

Michael Howlett
President and Chief Executive Officer
Canadian Diabetes Association

Donna Lillie,
National Director,
Research and Professional Education,
Canadian Diabetes Association

Authors' Affiliations

Sonia Anand, MD, MSc, FRCPC
Vascular Medicine
Hamilton Health Sciences—General Site

Assistant Professor
Faculty of Medicine
McMaster University

Geoffrey M. Anderson, MD, PhD
Liberty Health Management Strategies Chair
Professor
Department of Health Policy, Evaluation and Management
Department of Medicine
University of Toronto

Senior Adjunct Scientist
Institute for Clinical Evaluative Sciences

David Assaad, MD
Ophthalmology Resident
Faculty of Medicine
University of Toronto

Research Student
Institute for Clinical Evaluative Sciences

Gillian L. Booth, MD, MSc, FRCPC
Department of Endocrinology
St. Michael's Hospital

Adjunct Scientist
Institute for Clinical Evaluative Sciences

Ralf Buhrmann, MDCM, PhD, FRCSC
Staff Ophthalmologist
Glaucoma Service and Ophthalmic Epidemiology Unit
University of Ottawa Eye Institute

Assistant Professor
Ophthalmology Department
University of Ottawa

Benjamin T.B. Chan, MD, MPH, MPA
Senior Scientist
Institute for Clinical Evaluative Sciences

Associate Professor
Department of Health Policy, Evaluation and Management
Department of Family and Community Medicine
Department of Public Health Sciences
University of Toronto

Jacqueline R. Curtis, MD, FRCPC
Staff Endocrinologist
Department of Endocrinology and Metabolism
The Hospital for Sick Children

Denis Daneman, MB, BCh, FRCPC
Chief, Division of Endocrinology
The Hospital for Sick Children

Associate Chief of Research
The Hospital for Sick Children Research Institute

Professor
Department of Paediatrics, Faculty of Medicine
University of Toronto

Minh Duong-Hua, BSc
Programmer Analyst
Institute for Clinical Evaluative Sciences

Jiming Fang, PhD
Biostatistician
Registry of Canadian Stoke Network
Institute for Clinical Evaluative Sciences

Denice S. Feig, MD, FRCPC
Staff Endocrinologist
Mount Sinai Hospital

Assistant Professor
Department of Medicine, Faculty of Medicine
University of Toronto

Kinwah Fung, MSc
Biostatistician
Institute for Clinical Evaluative Sciences

Melanie Harju, MSc
Research Coordinator
Institute for Clinical Evaluative Sciences

Janet E. Hux, MD, FRCPC SM
Scientist
Institute for Clinical Evaluative Sciences

Staff General Internist
Sunnybrook & Women's College Health Sciences Centre

Assistant Professor
Department of Health Policy, Evaluation and Management
Faculty of Medicine
University of Toronto

Liisa Jaakkimainen, MD, MSc, CCFP
Family Physician
Sunnybrook & Women's College Health Sciences Centre

Scientist
Institute for Clinical Evaluative Sciences

Assistant Professor
Department of Family and Community Medicine
University of Toronto

Roberta Jacka, MD
Research Coordinator
Institute for Clinical Evaluative Sciences

Moira K. Kapral, MD, MSc, FRCPC
Scientist
Institute for Clinical Evaluative Sciences

Staff Internist
University Health Network

Assistant Professor
Faculty of Medicine
University of Toronto

Alexander Kopp, BA
Programmer Analyst
Clinical Epidemiology Unit
Sunnybrook & Women's College Health Sciences Centre

Andreas Laupacis, MD, MSc, FRCPC
President and Chief Executive Officer
Institute for Clinical Evaluative Sciences

Professor
Department of Medicine, Faculty of Medicine
Department of Health Policy, Management and Evaluation
University of Toronto

Staff General Internist
Sunnybrook & Women's College Health Sciences Centre

Charmaine E. Lok, MD, FRCPC
Staff Nephrologist
University Health Network

Post Doctoral Fellow
Institute for Clinical Evaluative Sciences

Assistant Professor
Department of Medicine
University of Toronto

Muhammad Mamdani, PharmD, MA, MPH
Scientist
Institute for Clinical Evaluative Sciences

Assistant Professor
University of Toronto

Douglas G. Manuel, MD, MSc, FRCPC
Scientist
Institute for Clinical Evaluative Sciences

Assistant Professor
Department of Public Health Sciences
University of Toronto

Matthew J. Oliver, MD, MHS, FRCPC
Director, Haemodialysis
Sunnybrook & Women's College Health Sciences Centre

Assistant Professor
Faculty of Medicine
University of Toronto

Deanna M. Rothwell, MSc
Senior Biostatistician
Institute for Clinical Evaluative Sciences

Susan E. Schultz, MSc, MA
Research Coordinator
Institute for Clinical Evaluative Sciences

Baiju R. Shah, MD, FRCPC
Research Fellow
Institute for Clinical Evaluative Sciences

Clinican Scientist Program
Department of Medicine
University of Toronto

Jane Shi, BSc
Programmer Analyst
Institute for Clinical Evaluative Sciences

Kathy Sykora, MSc
Senior Biostatistician
Institute for Clinical Evaluative Sciences

Mei Tang, MD
Programmer
Institute for Clinical Evaluative Sciences

Teresa To, PhD
Senior Scientist
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;
Clinical Epidemiology and Health Care Research Program
Pediatrics, Institute for Medical Sciences
University of Toronto

Jack V. Tu, MD, PhD, FRCPC
Senior Scientist
Institute for Clinical Evaluative Sciences

Canada Research Chair in Health Services Research

Associate Professor of Medicine,
Department of Public Health Sciences,
Department of Health Policy, Management & Evaluation
University of Toronto

Bernard Zinman, MDCM, FACP, FRCPC
Director, Leadership Sinai Centre for Diabetes
Mount Sinai Hospital

Professor of Medicine
Samuel and Judy Pencer Family Chair in Diabetes
Mount Sinai Hospital/University of Toronto

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Introduction

Diabetes mellitus (DM) is a serious and growing health problem. Studies from Canada and the US have reported the prevalence of diabetes to be between 3 and 8%, although as many as one-third of cases may be yet undiagnosed. In Ontario, about 6% of the adult population have diabetes. However, these rates are considerably higher in those aged 65 years and older, where the prevalence approaches nearly one in five. Because of the aging of the population and growing rates of obesity, the number of individuals with diabetes is expected to rise by a substantial degree. Increasing consumption of the typical 'western' diet, and a greater tendency towards a sedentary lifestyle have added to this phenomenon. Diabetes has also become a global health concern, with rising rates in developing nations contributing to projections of a worldwide epidemic of diabetes.

Diabetes is a leading cause of cardiovascular disease, end-stage renal failure leading to dialysis, amputation, and blindness. Disability caused by diabetic complications can have a major impact on the quality of life of persons affected by this disease. Fortunately, there is now evidence from randomized controlled trials that complications of diabetes can be delayed or prevented by specific interventions; such as those aimed at improving glucose, lipids and blood pressure levels, and reducing other cardiovascular risk factors. With the advent of newer therapies, more options are available for treating each of these components. Based on these innovations more people with DM are living healthy lives than ever before.

Despite great strides made in the treatment of this disease, DM continues to place considerable demands on individuals who have this condition. People with DM play a key role in the successful management of their disease, an effort that requires a long-term investment in time, energy, and resources. This means striking a careful balance between the timing of self-care activities (glucose monitoring and taking medications) with that of meals, exercise and other daily routines. Increased activity and dietary approaches aimed at achieving weight loss can greatly improve glucose control and other metabolic abnormalities. Thus, dealing with diabetes on a day-to-day basis creates a constant challenge for individuals with this disease.

Because of its complexity, diabetes management requires regular access to health care services to prevent long-term complications. A multidisciplinary team is needed to direct the changes in medication, diet, and exercise required for good blood glucose control. Preventing morbidity due to DM relies on regular screening to detect complications and to facilitate treatment at an early stage. Although the Canadian Diabetes Association (CDA) and other organizations have published clinical practice guidelines outlining the optimal therapeutic approach for the management of diabetes, some studies suggest that there is a gap between the level of care recommended by evidence-based guidelines and actual practice. Given the central role that routine clinical care plays in modifying disease outcomes, regular access to high quality outpatient services is essential for all Canadians with diabetes.

Approximately three-quarters of persons with diabetes receive care from their family physician alone. The health care system needs to develop innovative strategies to break down the barriers between specialists, generalists, nurse practitioners, diabetes educators, and other allied health professionals involved in diabetes management. Full access to diabetes services and enhanced coordination of care between providers is essential for ensuring that the best quality of care is delivered to this population.

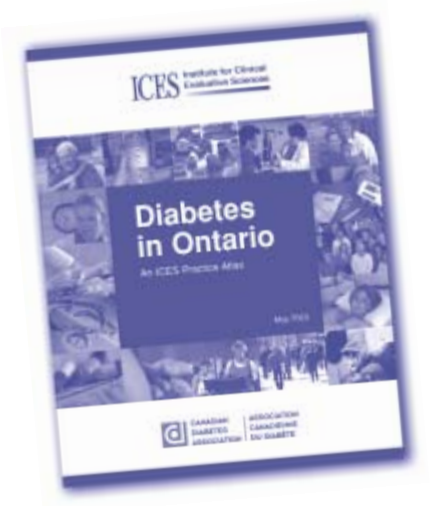
Integration of information technology systems linking patients, pharmacies, and health care providers may ultimately play an important role in achieving these outcomes.

Diabetes will continue to be a significant challenge for patients, providers and policy-makers in the years ahead. In the following series of chapters, we describe the incidence and prevalence of diabetes and its major complications, and patterns of diabetes care in Ontario. We focus on trends in outcomes over time and across regions of the province, and attempt to identify factors that modify these rates. The atlas should be a valuable resource for policy makers, planners, health care providers, advocates, and people with diabetes. We hope that the information provided by the atlas will lead to a better appreciation for the burden of DM in Ontario and will be used to identify ways to improve the care and outcomes of this population.

The editors

Janet E Hux • Gillian L Booth • Pamela M Slaughter • Andreas Laupacis

Introducing the Structure of the Diabetes Atlas



In the first ICES Practice Atlases, we provided information on health care, services and delivery to clinicians, policy-makers, hospital administrators, researchers, health planners and other health system stakeholders. As with the disease-specific ICES Cardiovascular Atlas, we have tried to make the presentation of this Atlas more accessible to a wider audience, more "user-friendly". For that reason, we have included some other pieces to help make this publication useful, including:

- A map which shows county, District Health Council (DHC) and Ministry of Health Planning Region boundaries.
- A tabular format which shows the same information: how the counties and DHCs fold into Ministry of Health Planning Regions.
- A glossary of terms—clinical, statistical and epidemiological

The Atlas is also structured differently. Traditionally, the IMRD format (Introduction, Methods, Results and Discussion, with or without a separate conclusion) is used in scientific publications. We chose another format for this book. Each chapter contains an introduction which lays out the background and importance of the topic area, a summary of the data sources and a brief description of how we did the analyses. These are followed by a particularly important section in each chapter called "Interpretive Cautions". We urge readers to note this section in each chapter because it highlights the limitations of the data used and the limits to the inferences that can be drawn from the results section that follows. It really is important to remember that the data used in the Atlas were originally collected and maintained by other agencies for financial or record-keeping purposes—which can be problematic as some data elements have non-standardized definitions (and some do!). Administrative data also lack depth of detail about relevant clinical characteristics of individual patients and services.

Because of our desire to make the interpretation of results easier for lay persons, we have combined results with discussion, qualifiers and contextual elements. We have also offered two different formats for some exhibits (where possible)—one graphic, the other tabular—because we recognize that some people preferentially choose one or the other. We have also added one-or two-line summaries of what the data show with as many exhibits as possible.

We close each chapter with a short section of conclusions.

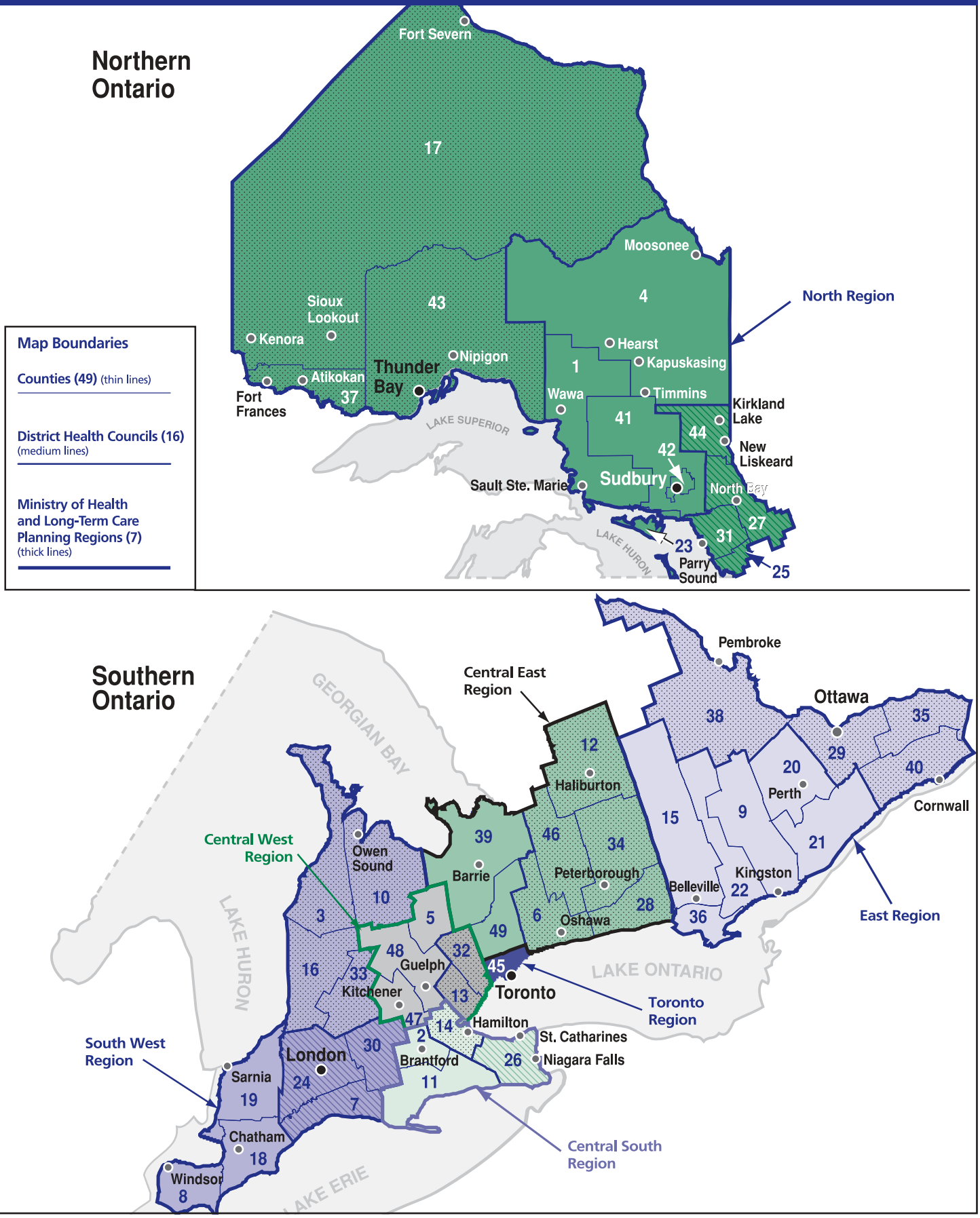
We have encouraged our author colleagues to limit significantly their references and footnotes for each chapter. However, we have used Technical Appendices to augment information that was felt necessary for each chapter—for example, Technical Appendix TA1.A in Chapter 1 provides a flow chart of the development of the Ontario Diabetes Database. Technical Appendix TA2.A in Chapter 2 describes SARV (small area rate variation) statistics, which are used throughout the book to show differences between counties, as another example.

We have included at the back of the book commentaries from learned colleagues about the utility of this book, and a list of policy options for those readers whose focus is policy-making in health care.

As always, we welcome your comments on the Atlas (info@ices.on.ca) and encourage you to help us understand how future Atlases can be made more accessible and informative.

Ontario Health Planning Regions, District Health Councils and Counties

Ministry of Health and Long-Term Care (MOHLTC) Regions	16 District Health Councils (DHCs)	Indicator of Map Shading	49 Counties
1 North	❶ Algoma, Cohrane, Manitoulin, and Sudbury DHC		Algoma District (1), Cochrane District (4), Manitoulin District (23) Sudbury District (41) and Sudbury Regional Municipality (42)
	❷ Muskoka, Nipissing, Parry Sound and Timiskaming DHC		Muskoka District Municipality (25), Nipissing District (27) Parry Sound District (31) and Timiskaming District (44)
	❸ Northwestern Ontario DHC		Kenora District (17), Rainy River District (37) and Thunder Bay District (43)
2 Central East	❹ Durham, Haliburton, Kawartha and Pine Ridge DHC		Durham Regional Municipality (6), Haliburton County (12), Northumberland County (28), Peterborough County (34), and Victoria County (46)
	❺ Simcoe-York DHC		Simcoe County (39), York Regional Municipality (49)
3 Central South	❻ Grand River DHC		Brant County (2), Haldimand-Norfolk Regional Municipality (11)
	❼ Hamilton–Wentworth DHC		Hamilton-Wentworth Regional Municipality (14)
	❽ Niagara Region DHC		Niagara Regional Municipality (26)
4 Central West	❾ Halton–Peel DHC		Halton Regional Municipality (13), Peel Regional Municipality (32)
	❿ Waterloo Region–Wellington–Dufferin DHC		Dufferin County (5), Waterloo Regional Municipality (47) and Wellington County (48)
5 Eastern	⓫ Champlain DHC		Ottawa-Carleton Regional Municipality (29), Prescott-Russel United Counties (35), Renfrew County (38) and Stormont, Dundas and Glengarry United Counties (40)
	⓬ Quinte, Kingston, Rideau Valley DHC		Frontenac County (9), Hastings County (15), Lanark County (20), Leeds and Grenville United Counties (21), Lennox and Addington County (22) and Prince Edward County (36)
6 South West	⓭ Essex, Kent and Lambton DHC		Essex County (8), Kent County (18) and Lambton County (19)
	⓮ Grey, Bruce, Huron, Perth DHC		Bruce County (3), Grey County (10), Huron County (16); Perth County (33)
	⓯ Thames Valley DHC		Elgin County (7), Middlesex County (24) and Oxford County (30)
7 Toronto	⓰ Toronto DHC		Toronto (45)


Northern Ontario
Fort Severn
17
Moosonee
4
North Region
43
Sioux Lookout
Kenora
Atikokan
37
Fort Frances
Thunder Bay
Nipigon
1
Hearst
Kapuskasing
Wawa
Timmins
41
Kirkland Lake
44
New Liskeard
42
Sault Ste. Marie
Sudbury
North Bay
27
31
23
Parry Sound
25
LAKE SUPERIOR
LAKE HURON
Map Boundaries
Counties (49) (thin lines)
District Health Councils (16) (medium lines)
Ministry of Health and Long-Term Care Planning Regions (7) (thick lines)
Southern Ontario
GEORGIAN BAY
Central East Region
Pembroke
Ottawa
38
35
12
29
20
40
Haliburton
Perth
Cornwall
15
9
21
Central West Region
Owen Sound
39
46
34
Barrie
Peterborough
Kingston
Belleville
22
East Region
10
3
5
6
28
36
Oshawa
49
48
32
45
LAKE ONTARIO
16
33
Guelph
Kitchener
13
Toronto
Toronto Region
47
14
Hamilton
St. Catharines
2
Brantford
26
Niagara Falls
South West Region
London
30
Sarnia
24
11
19
7
Chatham
18
Windsor
8
Central South Region
LAKE ERIE

Glossary

A

Aboriginal
an inclusive term which refers to all Canadian aboriginal peoples regardless of residential location as compared to First Nations, which refers to "status Indians" living exclusively on reserves.

Abdominal adiposity (also known as abdominal obesity)
the accumulation of fat within the abdominal region as indicated by a waist circumference ≥ 102 cm (40 inches) in men and > 88cm in women (35 inches). This pattern of obesity is associated with an increased risk of diabetes and cardiovascular disease.

ACE inhibitors
angiotensin converting enzyme inhibitors.

Access
in the context of this publication, the ability to receive health care services without barriers.

Acute
an effect on health that happens rapidly; in the context of acute diabetic complications, consequences of diabetes that occur over a short period of time and are fully reversible.

Acute care hospital
an institution that provides in-hospital medical or surgical treatment

Acute myocardial infarction (AMI)
also called a heart attack. This occurs when a blood clot completely blocks one of the arteries that provide oxygen-rich blood to the heart muscle.

Adjusted rate
a rate that controls for a particular set of characteristics within a study population that may be related to the outcome of interest (eg, age and sex); allows for comparisons across areas or institutions with different population characteristics.

Administrative Data
information that is primarily collected for record keeping, finances or purposes other than research.

Aggregated data
a dataset wherein individual records are combined, usually by age and/or sex. Once data are aggregated, it is not possible to identify the results for an individual person.

Alternate Funding Plan (AFP)
some physicians in Ontario participate in AFPs where they do not submit claims to OHIP for service rendered; rather they are paid a "salary". Most AFPs are requested to submit 'shadow billing' to OHIP (where the claim is sent in for administrative purposes but is not reimbursed) but the reliability of these data is not fully known.

Ambulatory care
medical care, provided in a clinic or office, where the patient is not admitted to hospital.

Angiotensin converting enzyme inhibitors (ACEI)
a class of drugs used to treat high blood pressure and congestive heart failure by interfering with the body's production of angiotensin, a chemical that adds stress to the heart by causing the small arteries to constrict.

Angina
a type of chest pain that occurs when there is not enough blood flow to the heart muscle. This is usually the result of a narrowing of the arteries that supply blood to the heart.

Angiography (see coronary angiography)
the X-ray visualization of the internal anatomy of the heart and blood vessels after a dye is injected into the coronary arteries.

Anti-hyperglycemic medications
medications used to lower blood sugar. These include injectable insulin (used by all individuals with type 1 DM and by many with type 2 DM); all other anti-hyperglycemic drugs are in tablet form: sulfonylureas (including glyburide, gliclazide, and glimepiride), biguanides (metformin), alpha-glucosidase inhibitors (acarbose), meglitinides (repaglinide and nateglinide) and thiazolidinediones (rosiglitazone and pioglitazone).

Area variations (see also small area rate variations)
a comparison of rates of procedures or outcomes across geographic areas (for example counties or district health councils. Events are attributed to the individual's place of residence regardless of where the service was delivered.

Arterial Bypass Surgery (ABS)
a surgical treatment used to relieve obstructions in an artery for patients with peripheral vascular disease (PVD).

Atherosclerosis
the build-up of fat, calcium and other substances under the inner lining of an artery. Atherosclerosis may cause the arteries to the heart to become narrower, leading to angina or a heart attack.

Average length of stay (ALOS)
the average number of days that patients spent in the hospital for a particular procedure or illness (see also length of stay).

B

Bacteremia
the spread of bacterial infections into the blood stream.

Beta-blockers (or beta-adrenergic receptor blocking agents)
a class of drugs used for the treatment of hypertension, heart attacks, angina and heart failure; reduces stress on the heart by slowing down the heart rate, thus reducing the oxygen requirement.

Bias
systematic deviation from the truth.

Body mass index (BMI)
a method of assessing body weight while taking height into account; calculated by dividing weight by height squared (wt [kg] / ht [meters]2). A BMI score between 20 and 25 is considered healthiest on average; over 27 is considered overweight; 30 is the threshold for obesity.

Burden of Illness
the short- and long-term physical, emotional, social, financial, familial and societal effects associated with a particular illness or condition; provides an estimation of the overall scope and impact of a particular disease.

Canadian Classification of Procedures (CCP)
a coding system used in many administrative databases for classifying surgical and medical procedures; developed by Statistics Canada in 1987.

Canadian Institute for Health Information (CIHI)
a federally chartered but independent, non-profit organization that collects and processes health data from a number of sources, particularly from hospitals. All Ontario hospitals are required to submit demographic and clinical information about all hospital admissions and discharges. CIHI assembles these data into a Discharge Abstract Database (DAD), which is the data source for many analyses.

Canadian Organ Replacement Registry (CORR)
a database that contains information on the use and outcomes of vital organ transplantation and renal dialysis activities in Canada.

Carotid arteries
the carotid arteries travel up each side of the neck and branch into smaller vessels that supply blood to the brain.

Carotid endarterectomy
surgery to remove plaque build-up in the carotid arteries. The carotid arteries travel up each side of the neck and branch into smaller vessels that supply blood to the brain.

Cerebral edema
brain swelling due to increased uptake of water by the brain.

Charlson Comorbidity Index (also referred to as Charlson-Deyo score)
a measure of the combination of diseases or risk factors that are present in an individual. The index is used to adjust for differences in patients' risk of having an adverse outcome.

Chi-square test
a statistical test used to test whether a set of properties are equal across subgroups in a population (eg, testing whether stroke rates are the same across counties).

CMA
Canadian Medical Association.

Coefficient of variation
a statistical calculation used to obtain a measure of relative variation of a distribution, that divides the standard deviation by the mean multiplied by 100.

Cohort
a group of subjects who remain together in the same study over a period of time (eg, people with diabetes diagnosed in 1995).

Colinearity
where variables that are being studied are very highly correlated.

Comorbid conditions or illnesses (also called comorbidity)
a set of medical conditions present in an individual, other than the condition of primary interest.

Comparative rate ratio
the ratio of two rates. In epidemiologic terms, it is the comparison of the ratio of the rate in the population with the disease of interest to the rate in the population without the disease of interest.

Confidence interval
an indication of the precision of a population value; wider intervals indicate lesser precision while narrower intervals indicate greater precision.

Congenital anomalies/malformations
physical or mental abnormalities present at birth, which may be hereditary in nature or due to some influence during gestation up to the moment of birth.

Congestive heart failure (CHF)
a condition where the heart fails to pump vigorously enough to meet the needs of the body; may cause fluid to back up into the lungs.

Continuity of family physician care
an index which is the proportion of all family physician visits made with the most-frequently-seen physician. If all visits are to the same physician, the index equals 1.00.

Coronary angiography
the X-ray visualization of the internal anatomy of the heart and blood vessels after a dye is injected into the coronary arteries.

Coronary artery bypass graft (CABG) surgery
an open-heart surgical procedure that helps to improve blood circulation for patients with blockages of the coronary arteries of the heart.

Coronary artery disease (CAD) (also ischemic heart disease)
atherosclerosis involving the arteries to the heart. This causes narrowing of the arteries leading to angina or a heart attack.

Coronary revascularization
a procedure that aims to restore the blood flow through the arteries to the heart with either CABG or coronary angioplasty.

Correlation coefficient
a statistic ranging from –1 to 1 that measures the strength of the linear relationship between two variables made on the same set of individuals; a value of 1 indicates perfect positive association, a value of –1 indicates perfect negative association and a value of 0 indicates no linear association.

Cox proportional hazards model
a statistical method for comparing outcomes between two populations or groups over time while adjusting for other factors that might affect that outcome.

Cross-sectional analyses
analyses that examine the presence of diseases and other variables of interest as they exist in a defined population at a single point in time.

Crude mortality rate
a mortality rate that is not adjusted.

Diabetic ketoacidosis (DKA)
an acute and potentially life-threatening complication of DM resulting in elevated blood sugar levels, dehydration, ketone production, and other metabolic abnormalities; can be the first sign of DM, or may be triggered by another illness or poor adherence with DM medications in persons with pre-existing type 1 DM, or occasionally in the setting of type 2 DM.

Diabetic retinopathy
retinal changes in persons with diabetes marked by hemorrhages or microaneurysms or sharply-defined waxy deposits which can impair vision or cause blindness (most patients with mild DR do not suffer loss of vision).

Diabetes mellitus
a disease characterized by an elevation in blood sugar that can lead to many long-term complications. DM is diagnosed by the presence of one of the following: (1) fasting plasma glucose >7 mmol/L; (2) symptoms of DM (increased thirst and/or urination, fatigue, unexplained weight loss) plus a casual (non-fasting) plasma glucose >11.1 mmol/L; or (3) plasma glucose in the 2-hour sample of an oral glucose tolerance test (OGTT) >11.1 mmol/L.

Diagnostic codes (see International Classification of Diseases, 9th revision (ICD-9)
derived from ICD-9, a set of internationally accepted codes for classification of medical diagnoses, conditions and procedures; medical records staff use these codes when transcribing from medical charts to the hospital database that is submitted to the Canadian Institute for Health Information (CIHI).

Dialysis (also renal or kidney dialysis)
a life-saving treatment that individuals with end stage renal/kidney disease (see below) need on a regular basis in order to clean toxins out of the blood. Two forms of dialysis can be used: hemodialysis, which requires using a dialysis machine to clean the blood directly (usually every 2 to 3 days), and peritoneal dialysis which involves exchanging fluid into and out of the abdomen (usually several times per day).

Direct Standardization (see also adjusted rate)
a statistical method whereby the specific rates in a study population are adjusted for differences in population composition; the rate represents what the crude rate would have been in the study population if the population had the same distribution as the standard population (with respect to the variables for which the standardization is carried out).

Disaggregated data
a dataset where each record represents one individual; in all cases where ICES uses disaggregated data, a scrambled identifier is used to keep track of different individuals.

District Health Council (DHC)
16 councils in Ontario that plan and coordinate health services for the populations they serve.

Early neonatal deaths
deaths of infants 0 to 6 days of age.

End Stage Renal Disease (ESRD)
a condition in which the kidneys are functioning at a very low level. The kidneys are no longer able to remove toxins from the blood and dialysis or transplantation is required.

Epidemiology
the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to prevent or treat health problems.

Ethnoracial status
belonging to a group of people with a similar culture or language, or having a common origin.

Extremal quotient
the ratio of the highest to the lowest rate.

Fee-for-service
the reimbursement scheme by which the Ontario Health Insurance Plan (OHIP) pays physicians for services provided. The claims that physicians submit for payment under this plan are documented in a database, and can be used to track service provision.

Femoropopliteal bypass
a surgical bypass procedure for peripheral vascular disease (narrowing of the arteries in the legs).

Fiscal Year
a financial construct, usually from April 1 to March 31 of the following year for Ontario's public agencies (1994/95 = fiscal 95).

Forward sortation area (FSA)
a geographic area defined by the first three alpha-numeric characters of a Canadian postal code; in the 1996 census the median population of these units was 19,000 persons.

Gestational Diabetes (GD)
diabetes that develops during pregnancy and resolves after the baby is born.

Glaucoma
is caused by impaired absorption of the aqueous humour (gel-like liquid in the eye itself) causing increased intraocular pressure (pressure within the eye) which produces gradual vision loss with reduced nighttime vision.

Glycated (glycosylated) hemoglobin (HbA1c)
a laboratory test that reflects the average glucose level over a two to three month period.

Glycemic control
the level of blood sugar control obtained. Recommended targets in the 1998 CDA Guidelines include a fasting blood sugar of 4.0–7.0 mmol/L, a blood sugar 1–2 hours after meals of 5.0–11.0 mmol/L, and a glycated hemoglobin that is no more than 15% above the upper limit of normal, or about 0.07 in most laboratories.

Health-adjusted life expectancy (HALE)
is a measure that combines both mortality and morbidity by adjusting years of life expectancy according to the amount of time spent in less than perfect health. Life expectancy is weighted or adjusted for the level of health-related quality of life (HRQOL). In this analysis HALE was estimated by the period life table approach (modified Sullivan method).

Health promotion
defined by the World Health Organization as a "process of enabling people to increase control over, and improve, their health".

Health-related Quality of Life (HRQOL)
health-related quality of life measures various components of well-being including physical, mental, emotional, and social functioning.

Heart Failure
see congestive heart failure.

Health Human Resources
professionals involved with the delivery of health care: general practitioners (GPs), family physicians (FPs), specialists and sub-specialists, nurses, nurse practitioners, physio-therapists, etc.

Health Utilities Index 3 (HUI3)
a measure of overall health-related quality of life.

Hemodialysis
treatment done when a patient's own kidneys no longer function; the patient's blood is circulated outside the body along an artificial membrane within a dialysis machine which cleans the blood of toxins and removes excess fluid.

Hyperglycemia
abnormally high blood sugar level.

Hyperosmolar nonketotic coma (HNKS)
an acute and potentially life-threatening complication of DM resulting in severely elevated blood sugar levels, dehydration, and other metabolic abnormalities; can be the first sign of DM, or may be triggered by another illness or poor adherence with DM medications in persons with pre-existing type 2 DM.

Hyperlipidemia
a general term for high concentrations of lipids or fat substances (eg, cholesterol) in the blood.

Hypertension
elevated blood pressure.

Hyperglycemic emergencies
diabetic ketoacidosis or hyperosmolar nonketotic coma.

Hypoglycemia
low blood sugar levels; patients who use insulin or antihyperglycemic medications are at an increased risk for developing hypoglycemia, as a side-effect of the medications.

Impaired fasting glucose (IFG)
is a condition in which fasting blood glucose levels are above normal (between 6.1 and 6.9 mmol/L according to the 1998 CDA guidelines), but not yet within the diabetic range (>7.0 mmol/L).

Impaired glucose tolerance
a condition in which blood glucose levels two hours after an oral glucose tolerance test are above normal (between 7.8 and 11.0 mmol/L), but not yet within the diabetic range (≥11.1mmol/L). Up to five percent of people with IGT develop diabetes each year.

Incidence
a rate that describes the frequency of new cases of a given condition over a specific time period (usually one year).

Incident cases
new cases of a given condition, disease or process in a specified population.

Index admission
the first admission in a specified period of time.

Indirect Standardization
a statistical method whereby the specific rates in a study population are adjusted for differences in population composition. Expected rates in the study population are estimated by calculating how many cases would have been seen in the study population if it had the same pattern of disease as a specific reference (standard) population. The result is expressed as the SMR (standard mortality ratio) which is the ratio of the number of cases that were actually observed (crude rate) to the expected rate.

Intercurrent illness
an acute illness not caused by the disease of interest that may influence the disease state (for example, diarrhea and vomiting caused by a viral illness in a child with DM).

International Classification of Diseases, 9th revision (ICD-9)
a set of internationally accepted codes for classification of medical diagnoses, conditions and procedures; medical records staff use these codes when transcribing from medical charts to the hospital database that is submitted to the Canadian Institute for Health Information (CIHI).

Induction of labour
where labour is artificially induced by using a medication to stimulate the uterus.

Insulin resistance syndrome
a state in which the body's tissues are unable to respond normally to circulating insulin levels. This condition can occur many years before the onset of diabetes and may be associated with other abnormalities, such as high blood pressure, lipid problems and cardiovascular disease. If the pancreas fails to make sufficient insulin to overcome this resistance, blood glucose levels can rise, leading to increased glucose tolerance (IGT) and ultimately to type 2 diabetes.

Intermittent claudication
leg or buttock pain precipitated by walking, which is relieved with rest. Patients with severe disease may progress to having pain even at rest. Reflection of peripheral vascular disease.

Ischemic heart disease (IHD) (see coronary artery disease)
atherosclerosis involving the arteries to the heart. This causes narrowing of the arteries leading to angina or a heart attack.

Laser photocoagulation
retinal photocoagulation; early treatment with this technique decreases the risk of severe vision loss from proliferative diabetic retinopathy and macular edema; the effectiveness of treatment is best before vision loss occurs and falls sharply if applied later (see retinal photocoagulation).

Length of stay (LOS) (see average length of stay)
the number of days spent in hospital for a particular procedure or illness.

Lipid-lowering medications
classes of drugs used to treat hyperlipidemia, including HMG CoA reductase inhibitors (also known as statins), binding resins and fibrates.

Logistic regression
a statistical method for measuring the independent effect of each of a set of factors (predictors, covariates) on an outcome after adjusting for the others (eg, the impact of DM on the risk of AMI after controlling for the effects of age and sex).

Lower extremity amputation
surgical amputation of the leg or foot.

Macrosomic infants
abnormally large size at birth; defined as birth weight >4kg.

Macrovascular disease
damage to large blood vessels associated with diabetes. Macrovascular disease includes coronary heart disease (CHD), stroke and peripheral vascular disease (PVD).

Major amputations
amputation performed between the ankle and the thigh.

Mean
the sum of the values in a sample divided by the number of values; also known as the average.

Median
the middle observation or the one that divides a distribution into two equal halves; also known as the 50th percentile.

Microvascular disease
damage to small blood vessels associated with diabetes. Microvascular disease affects the kidneys, peripheral nerves and eyes in people with DM.

Minor amputations
amputations at the level of the foot or below.

Morbidity
an overall term to describe non-fatal consequences of an illness; often refers to the extent of hospitalization, symptom burden or disability within a population.

Mortality rate
the number of deaths in a given population divided by the number of people alive within that population; may be adjusted for age, sex or other sets of risk factors.

Most responsible diagnosis
for a given hospitalization, the condition that accounts for the majority of the days spent in hospital; used for administrative purposes.

Multivariate analysis or model
statistical technique that predicts the effect of each of a set of independent variables on a dependent or outcome variable; includes multiple linear or logistic regression modeling techniques.

National Diabetes Surveillance System (NDSS)
an initiative involving provinces, territories and Aboriginal groups in diabetes surveillance by using administrative data to conduct analyses using common definitions; allows the data to be meaningfully aggregated to provide a national profile of diabetes.

National Population Health Survey (NPHS)
a household survey conducted by Statistics Canada to obtain information about the health of the Canadian population.

Neighbourhood income profiles
in order to estimate socioeconomic status (SES) in a study population, neighbourhood level median household income from census data is attributed to all persons living in a neighbourhood.

Nephropathy
any disease of the kidney.

Null hypothesis
the hypothesis that there is no difference between groups for the outcome of interest, or that a given factor does not affect the outcome in a statistical model.

Obstructed Labor
where labour fails to progress resulting in the need for a Cesarean section to extract the fetus.

Odds ratio
the ratio of the odds of acquiring a particular disease, given exposure to a risk factor, divided by the odds of acquiring the disease if not exposed.

Oligohydramnios
an insufficient amount of amnionic fluid in the womb.

Ontario Diabetes Database (ODD)
administrative data (CIHI + OHIP) were used to assemble the cohort of persons who had been diagnosed with diabetes mellitus (DM) between fiscal 1992 through fiscal 2000. The complete methodology is described in the Technical Appendix TA1.A in Chapter 1.

Ontario Drug Benefit Plan (ODB)
the drug plan which provides medications to persons 65 years of age and older in Ontario. Only drugs listed in the provincial formulary are paid for; an income-graded co-payment and deductible are applied.

Ontario Health Insurance Plan (OHIP)
the universal health insurance plan for all Ontario residents. Covers costs for physician's services, some allied health professionals and diagnostic testing.

Ontario Ministry of Health Planning Regions
seven regions defined by the Ministry of Health to aid in the coordination and distribution of health services.

Organogenesis
the formation of organs in the developing fetus.

Outcome
the factor that is being studied such as death or hospitalization.

Outpatient care
health care delivered to patients outside the context of hospital admission; in outpatient clinics, walk-in clinics and ambulatory clinics.

p-value (see null hypothesis)
the probability of obtaining a result as extreme or more extreme than the one that is observed, based on chance alone, if the null hypothesis is true. A statistical measure of whether the groups compared are truly different (small p-value), or if it is likely that any apparent difference is due to chance (large p-value).

Percutaneous coronary intervention (PCI) (also called coronary angioplasty or angioplasty)
a catheter-based procedure in which a thin tube (catheter) is inserted through an artery in the arm or groin and threaded up through the artery to the heart. Diagnostic and treatment procedures can be performed through the catheter using special instruments to restore normal blood flow.

Percutaneous Transluminal Angioplasty (PTA)
a catheter-based procedure in which a thin tube (catheter) is inserted through an artery in the groin. Through the catheter, treatments are applied to relieve obstruction in the artery for patients with peripheral vascular disease (PVD).

Perinatal mortality
death of the fetus or newborn, generally defined as occurring between the 28th week of gestation and the first seven days after delivery.

Perinatal mortality rate (PNM)
mortality rate in fetuses and newborns occurring in the period between the 28th week of gestation and the first seven days after delivery.

Perioperative
within the time immediately before, during and immediately after a surgical procedure.

Peripheral vascular disease (PVD)
narrowing of the arteries in the feet, legs, abdomen, pelvis, arms, or neck. PVD can result in a broad spectrum of functional impairment, from a decrease in pain-free walking distance to amputation. In this atlas, we report on PVD affecting the lower extremities.

Peritoneal dialysis
a type of treatment used when a person's kidneys fail; the removal of fluid and toxins by exchanging fluid into and out of the abdomen, using the body's own peritoneal membrane.

Polyhydramnios
excessive amounts of amniotic fluid.

Pharmacotherapy
the treatment of disease using drugs.

Photocoagulation
retinal photocoagulation is performed using laser technology; early treatment with this technique decreases the risk of severe vision loss from proliferative diabetic retinopathy and macular edema; the effectiveness of treatment is best before vision loss occurs and falls sharply if applied later (see laser photocoagulation).

Poisson Model
a statistical modeling technique used for rare events.

Preeclampsia
development of hypertension with proteinuria or edema, or both, due to pregnancy.

Prevalence
the proportion of people in a population who have a particular condition at a given point or period in time.

Prevalent cases
all persons with the condition of interest at a point in time (contrasts with incident cases which includes only those newly-diagnosed.

Primary care
health care that is delivered by family or general "front line" practitioners.

Proliferative retinopathy
a severe form of diabetic retinopathy characterized by the growth of abnormal new blood vessels on the retina, extending into the vitreous humour; may lead to loss of vision.

Public Health Unit
units that plan for and deliver a variety of health programs and services pertinent to local circumstances and needs, according to the Health Protection and Promotion Act; mandatory programs include chronic and infectious disease prevention and detection, injury prevention and family and sexual health education.

Quintiles
a division of a distribution into five equal, ordered subgroups, each containing 20% or one-fifth of the data.

Registered Persons Database (RPDB)
this database includes information on health card number, date of birth, sex, postal code and death date (where applicable) associated with the carrier of each valid Ontario health card number; developed and maintained by the Ministry of Health.

Relative risk
the ratio of the risk of a disease or death among those exposed as compared to those who aren't exposed (eg, persons with DM, persons without DM).

Retinal examinations
microvascular disease in DM can be directly visualized at the back of the eye on clinical examination; screening for diabetic retinopathy should involve a dilated examination of the retina by a trained examiner.

Retinal photocoagulation
retinal photocoagulation is performed using laser technology; early treatment with this technique decreases the risk of severe vision loss from proliferative diabetic retinopathy and macular edema; the effectiveness of treatment is best before vision loss occurs and falls sharply if applied later (see laser photocoagulation).

Retinopathy
non-inflammatory degenerative disease of the retina.

Revascularization
a procedure that aims to restore the blood flow through the arteries by making the diameter of the arteries larger or by bypassing the affected area.

Risk adjusted rate
a rate that is independent of, or controls for the distribution of a particular set of characteristics or risk factors within the study population that are thought to affect the outcome of interest; for example, risk-adjusted acute myocardial infarction rate may control for age, sex, other co-existing medical conditions.

Risk factor
a characteristic that is more prevalent among the people who have a particular disease or outcome than those who do not.

Screening
an initial examination in which identification of unrecognized disease(s) or conditions are attempted by using tests, procedures or examinations (for example, taking blood pressure to determine if an individual has hypertension).

Sensitivity
the probability that a diagnostic test is positive in patients who have the disease/condition; a measure of a test's capacity to detect all cases.

Sepsis
the presence of infectious organisms or their toxins in the blood or tissues causing severe illness.

Shadow Billing
some physicians in Ontario participate in Alternate Funding Plans (AFPs) where they do not submit claims to OHIP for service rendered; AFPs are requested to submit 'shadow bills' to OHIP which describe the diagnosis and the service provided; the reliability of these data is not fully known.

Skin and soft tissue infections
includes foot ulcers and other localized infections.

Small area rate variations (SARV) (see also area rate variation)
statistical tests that compare outcome rates across small geographic areas.

Socioeconomic status
a label that describes a combination of social and economic factors, such as education and income.

Spearman's rank correlation
a measure of association that indicates the degree to which the ordered ranking of two variables have a linear relationship.

Specific rate
rate of an event in a specific sub-population (e.g. sex-specific AMI rates will provide rates of AMI in men and women separately).

Specificity
the probability that a diagnostic test is negative in patients in who do not have the disease/condition; a test with low false-positive rate is specific.

Spontaneous Abortion
abortion that has not been artificially induced; commonly called a 'miscarriage'.

Statins
synthetically-derived cholesterol-lowering agents which act by blocking the enzyme HMG-CoA reductase; also known as HMG-CoA reductase inhibitors.

Statistical significance
generally expressed as a probability value (or p-value), reflecting the likelihood that the observed findings could have occurred on the basis of the play of chance alone; by convention, a p-value <0.05 is regarded as statistically significant, but with a large sample size (which is usually the case when using administrative datasets), more conservative p-values may be prudent.

Stillbirth
the birth of a fetus that has died prior to delivery.

Stroke
a term denoting the sudden development of focal neurological deficits usually related to impaired cerebral blood flow; also called a cerebrovascular accident (CVA). Strokes can be either hemorrhagic (caused by bleeding into the brain) or ischemic (caused by blockages in the blood vessels to the brain).

Temporal trends
trends over time; for purposes of this study, over the six fiscal years of data analyzed.

Therapeutic abortion
abortion that is artificially induced.

Thrombolysis
emergency therapy given during a heart attack which involves the injection of a drug to dissolve the clot in the coronary artery, restoring blood flow to the heart muscle; the sooner the therapy is administered, the better the prognosis. Also used in some types of acute stroke at specialized stroke centres for the same purpose.

Transient ischemic attack (TIA)
is a mini-stroke caused by a temporarily-blocked blood vessel which leaves no permanent brain damage.

Unstable Angina (UA)
a change in the usual pattern of angina (see definition above). Blood flow to the heart has become more inadequate, either because the main artery to the heart has become narrower, or because the demand for oxygen to the heart has increased, leading to more severe or frequent symptoms.

Usual Provider Continuity (UPC) Index
an index which allows measurement of the continuity of care by one family physician (see continuity of family physician care).

Vital Statistics
a registry of Canadian births and deaths that is compiled by the Registrar General of Canada.

Vitrectomy
surgical procedure that uses an instrument that cuts and removes the vitreous liquid of the eye and replaces the liquid with saline or another fluid. Typically used in the setting of vitreous haemorrhage.

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1

Chapter

Patterns of Prevalence and Incidence of Diabetes

Authors: Janet E. Hux and Mei Tang

Key Messages

- Diabetes mellitus (DM) is a large and growing health problem for Ontarians.
- Primary care providers can expect to deal with increased numbers of patients with DM, patients who are living longer and will have more advanced stages of disease.
- The high prevalence of DM in the elderly has important implications for health care resource utilization given the burden of DM and the projected growth of this segment of the population.
- Effective management of DM in older persons is critical, making it important to include individuals in this age group in clinical trials.
- Providers need to be aware of the ethnic, geographic and socioeconomic factors that increase the risk of DM. Strategies to address issues related to access, prevention, and treatment of individuals in these high-risk groups are needed.

Background

Diabetes mellitus (DM) is a common, chronic condition that imposes a heavy burden of morbidity (illness) and early mortality (death) on affected patients.[1-3] DM and its complications drive a substantial portion of medical resource utilization. At the same time, research findings now provide unprecedented levels of evidence regarding the prevention of DM complications.[4-9] In this context, accurate, population-based assessments of the prevalence of DM become important for policy-makers and for those mounting and evaluating strategies for managing this condition.

Evidence from other jurisdictions suggests that the prevalence of DM is rising.[10-13] Prevalence reflects the total number of persons in a population with DM at a given point in time—both those newly diagnosed and those already living with the condition. Prevalence may increase because there are growing numbers of new cases entering the population each year, because those diagnosed with the condition are living longer, or both. An increase in the number of incident cases (persons newly diagnosed with DM) might be expected given the rising rates of obesity[10] and changing demographics. Improvement in survival might be anticipated because of the increasing availability of effective interventions for the prevention and control of DM complications. There is also the possibility that earlier detection of DM, or changes in the threshold for diagnosis, might create the impression that the incidence of DM has increased.

There is a lack of consensus about the most effective way of determining the prevalence of DM in a population. Previous work has based prevalence estimates on surveys,[14-16] registries[17] and cohort studies in highly selected populations.[18] Health interview programs such as the National Population Health Survey (NPHS) have facilitated population-based estimates. However, there is evidence that in health interview surveys (i.e. where no blood samples are obtained) participants under-report DM relative to medical record reviews.[19, 20] Surveys suffer from biases due to low response rates, providing insufficient data to define prevalence at the level of small geographic areas and are inefficient for ongoing surveillance.

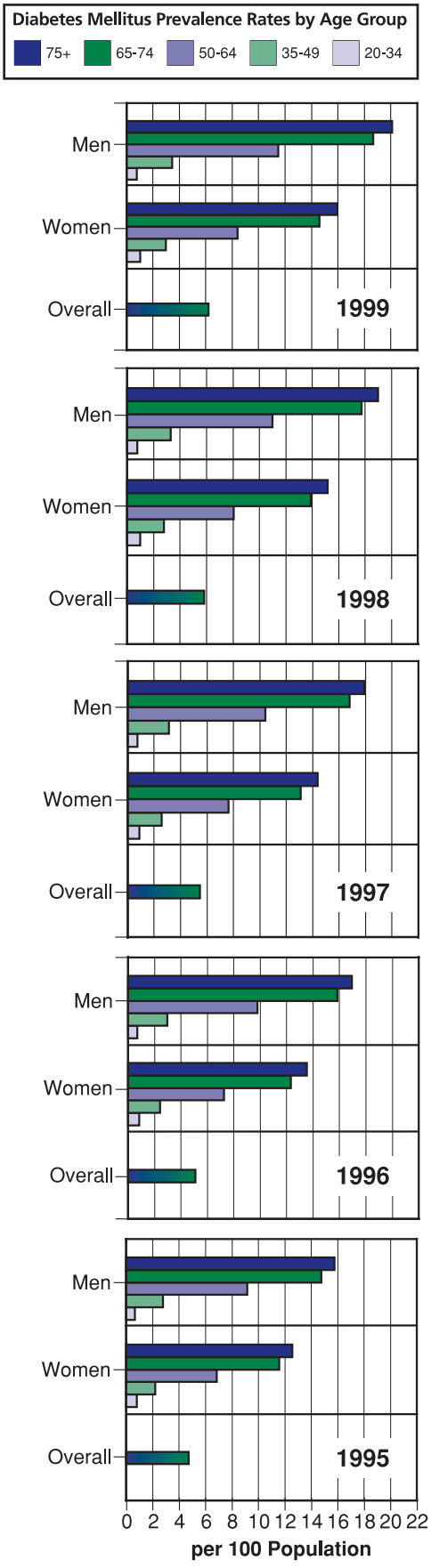
Research by Blanchard and colleagues in Manitoba[21] showed that health care administrative data can be used to identify individuals diagnosed with DM in the province and to estimate rates over time. Their methodology has been adopted by the National Diabetes Surveillance System (NDSS). The NDSS is a Health Canada initiative involving provinces and territories in DM surveillance, using administrative data to conduct analyses based on common guidelines and software. In this way, the data can be meaningfully aggregated to provide a national profile of DM. Prior to the implementation of the NDSS in Ontario, researchers at the Institute for Clinical Evaluative Sciences (ICES) had developed a provincial database, the Ontario Diabetes Database (ODD), using algorithms similar to those developed for the NDSS. The development and validation of the ODD is described in the Technical Appendix TA1.A.

Exhibit 1.1 Overall and Age-/Sex-specific DM Prevalence Rates per 100 Ontarians, 1995–1999

The prevalence of DM rises with age and is generally higher in men than in women. Prevalence rates increased steadily over the years that were studied.

Fiscal Year	Overall Rate	Women by Age Group					Men by Age Group				
		20–34	35–49	50–64	65–74	75+	20–34	35–49	50–64	65–74	75+
1995	4.72	0.79	2.20	6.84	11.58	12.58	0.65	2.78	9.15	14.75	15.75
1996	5.09	0.84	2.41	7.24	12.31	13.51	0.69	2.98	9.79	15.82	16.93
1997	5.45	0.90	2.57	7.64	13.10	14.36	0.72	3.13	10.43	16.80	17.91
1998	5.82	0.96	2.77	8.04	13.89	15.17	0.74	3.28	10.99	17.74	18.98
1999	6.19	1.02	2.97	8.40	14.62	15.97	0.77	3.44	11.50	18.69	20.09

Source: Ontario Diabetes Database (ODD)



This chapter provides an indication of the magnitude of the burden of DM in Ontario. It describes how the patterns of DM are changing. It further explores its distribution across geographic regions, as well as by age, sex, and socioeconomic groupings.

Data Sources

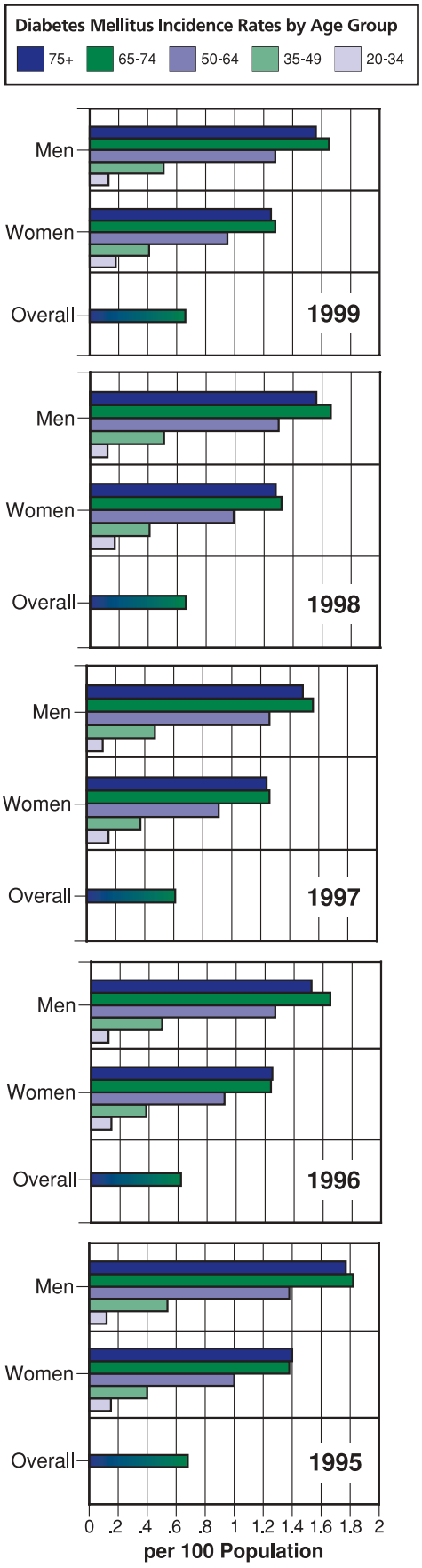
The major source of data for this chapter is the Ontario Diabetes Database (ODD). This database was prepared at ICES using hospital discharge abstracts from the Canadian Institute for Health Information (CIHI), physician service claims from the Ontario Health Insurance Plan (OHIP) database and information regarding the demographics of persons eligible for health care coverage in Ontario from the Registered Persons Database (RPDB). Records from these three sources for all persons in Ontario were linked using an anonymous numeric identifier. Persons were defined as having DM (excluding cases of gestational diabetes) according to criteria described in the Technical Appendix TA1.A. Claims to the Ontario Drug Benefit (ODB) Program were used for validation.

Census data from Statistics Canada were used to establish denominators for calculation of DM rates and to attribute socioeconomic characteristics to the forward sortation area (or local neighbourhood).

How the analysis was done

Prevalence is the proportion of the population affected by a condition at a given point in time. Prevalence of DM was calculated on an annual basis from fiscal 1995 (April 1, 1994 to March 31, 1995) through fiscal 2000 using all persons in the ODD for each year as the numerator and census counts for the population as the denominator (or estimated population measures for those years where there was no census). To adjust for differences in population distribution over time, rates were age- and sex-adjusted to the 1996 Ontario population using direct standardization. Incidence rates were calculated in a similar fashion using only the incident cases for a given year as the numerator. The ODD data are available for fiscal years 1992

Exhibit 1.2 Overall and Age-/Sex-specific DM Incidence Rates per 100 Ontarians, 1995–1999



Incidence rates (persons newly diagnosed with DM) increase with age and are generally higher in men than women. In contrast to prevalence rates, the incidence rates appear to be stable over the years studied.

Fiscal Year	Overall Rate	Women by Age Group					Men by Age Group				
		20–34	35–49	50–64	65–74	75+	20–34	35–49	50–64	65–74	75+
1995	0.68	0.15	0.40	1.00	1.38	1.40	0.12	0.54	1.38	1.82	1.77
1996	0.62	0.14	0.38	0.92	1.24	1.25	0.12	0.49	1.27	1.65	1.52
1997	0.61	0.15	0.37	0.91	1.26	1.24	0.11	0.47	1.26	1.56	1.49
1998	0.66	0.17	0.41	0.99	1.32	1.28	0.12	0.51	1.30	1.66	1.56
1999	0.66	0.18	0.41	0.95	1.28	1.25	0.13	0.51	1.28	1.65	1.56

Source: Ontario Diabetes Database (ODD)

through 2000. In order to identify an incident case (newly diagnosed), a minimum DM-free observation period of three years was set as a requirement. For example, a person meeting the criteria for entering the database in 1995 must have had no OHIP or CIHI records bearing a diagnosis of DM during the previous three years to be labeled as an "incident" case. As a result, the incidence of DM prior to 1995 could not be estimated because a three-year pre-diagnosis observation period was not available.

Socioeconomic status (SES) is known to be an important factor in the epidemiology of DM. However, data on SES are not reported at an individual person level in the available administrative data files. Therefore, in order to estimate the SES of persons with DM, the neighbourhood level median household income from census data was attributed to all persons living in that neighbourhood. Neighbourhood of residence was determined from the postal code in the RPDB and matched to census data at the level of the forward sortation area. The median population of these units in the 1996 census was 19,000 persons. Rates and numbers of cases of DM were also calculated at the county level.

Interpretative Cautions

Administrative data provide imperfect estimates of the rates of DM. At best these data can only be used to measure rates of diagnosed DM and are unable to provide estimates of undiagnosed DM. Studies in other jurisdictions suggest that up to 30% of DM may be undiagnosed.[22] In addition, persons with diagnosed DM may not be detected by the algorithm used here if they receive their care in a setting where services are not billed on a fee-for-service basis. This pattern of service represents only a small proportion of primary care (<5%) in Ontario. Persons receiving care in these settings would still be included in the database if hospitalized or if seen by other fee-for-service providers. Geographic clustering of salaried practitioners—for instance in Algoma and Hamilton-Wentworth—may result in the under-detection of DM in these areas. Conversely, persons may be

Exhibit 1.3 Prevalence of DM per 100 Ontarians by Socioeconomic Status (Median Neighbourhood Income), 1999

There is a marked socioeconomic gradient in the prevalence of DM with higher rates in the lower income quintiles. This effect is most evident in the 35–64 year age groups.

Income Quintile	Overall Prevalence	Women by Age Group					Men by Age Group				
		20–34	35–49	50–64	65–74	75+	20–34	35–49	50–64	65–74	75+
Q1 (lowest)	7.76	1.17	4.13	11.11	16.82	18.89	0.89	4.72	14.23	20.76	23.13
Q2	7.05	1.07	3.42	9.59	14.51	17.13	0.85	3.88	12.54	18.91	22.14
Q3	6.78	1.03	3.21	9.20	14.54	17.40	0.82	3.81	12.90	19.54	22.93
Q4	5.76	0.93	2.64	8.26	13.85	16.54	0.75	3.32	11.86	19.05	21.82
Q5 (highest)	5.12	0.93	2.38	7.62	13.96	17.02	0.68	2.95	12.03	19.70	22.08

Source: Ontario Diabetes Database (ODD)

Denominators for calculation of these rates were taken from 1996 census data rather than the Statistics Canada postcensal estimates used elsewhere in this chapter. As a result, the magnitude of the rates is slightly inflated relative to the overall rates shown in Exhibit 1.1. However, patterns of DM across the age, sex and SES strata are valid.

mislabeled as having DM through errors in coding or in cases where the patient showed symptoms of DM, but the diagnosis was not confirmed in laboratory testing. The requirement for two physician service claims or a hospitalization to establish a diagnosis makes this type of misclassification less likely. The validation of the algorithm by comparison to data abstracted from primary care charts suggested that 86% of cases were detected and of those labeled as having DM, the presence of DM could be confirmed in 90% to 98% of cases.[20]

It is not possible to distinguish between type 1 and type 2 DM from administrative data. Previously, researchers made the distinction using age 30 as a cut point, but the increasing prevalence of early onset type 2 DM makes this assignment less reliable.[23] Although separating the types of DM was thought to be important in the past, recent evidence regarding the benefits of aggressive management of type 2 DM[24] may mean that the distinction is less critical from a planning and policy perspective.

As previously noted, SES is not measured directly but attributed from neighbourhood income profiles reported in census data. The relatively large size of these "neighbourhoods" will lead to some misclassification of individuals' SES. Furthermore, incomplete population data at the level of these geographic units may lead to false elevation of the prevalence rates when measured by income quintile.

Finally, the cohort used in these analyses is based on the RPDB, which is prone to incomplete detection of deaths and out-migration. Since persons who met the criteria for DM are kept in the ODD until death or a move out-of-province is recorded in the RPDB, failures to detect these events would lead to false elevations in disease prevalence. To determine the impact of this type of misclassification, records for fiscal year 2000 were examined from OHIP, CIHI and the ODB Program to determine what proportion of people in the ODD (accumulated over the previous nine years) had

Text Continued...page 1.12

Key Research Findings

- Increases in the number of people with diabetes mellitus (DM)appear to be primarily related to persons living longer with DM, rather than an increase in the number of newly diagnosed cases of DM.
- The burden of disease is disproportionately clustered in older adults and in the lower SES quintiles.
- There is substantial variation in rates of DM between counties in Ontario.
- High rates of DM in some of the geographically remote areas of the province raise concerns about access to appropriate specialty services for persons with DM living in those settings.

Exhibit 1.4 Age-/Sex-adjusted Prevalence of DM per 100 Ontarians Aged 20 Years and Over by County, 1999

The prevalence of DM varies between counties. Elevated rates are observed in counties which have a high proportion of residents with high-risk ethnicity (e.g. Aboriginal, South Asian).

Rate = per 100 persons	Men		Women		Total	
	%	(Cases)	%	(Cases)	%	(Cases)
Algoma District	6.18	(3,255)	5.77	(3,056)	5.97	(6,311)
Brant County	6.97	(3,153)	5.98	(2,936)	6.46	(6,089)
Bruce County	5.34	(1,542)	5.02	(1,439)	5.18	(2,981)
Cochrane District	7.31	(2,420)	7.66	(2,467)	7.49	(4,887)
Dufferin County	5.08	(789)	4.51	(691)	4.79	(1,480)
Durham Regional Municipality	6.03	(9,269)	5.24	(8,232)	5.62	(17,501)
Elgin County	6.80	(2,068)	6.09	(1,962)	6.44	(4,030)
Essex County	7.40	(9,706)	6.57	(9,276)	6.97	(18,982)
Frontenac County	5.66	(3,012)	4.77	(2,712)	5.20	(5,724)
Grey County	5.48	(2,178)	4.80	(1,957)	5.13	(4,135)
Haldimand-Norfolk Regional Municipality	7.34	(3,051)	6.56	(2,776)	6.94	(5,827)
Haliburton County	5.67	(513)	4.84	(407)	5.24	(920)
Halton Regional Municipality	5.08	(6,602)	4.12	(5,526)	4.58	(12,128)
Hamilton-Wentworth Regional Municipality	5.65	(10,364)	5.03	(9,908)	5.33	(20,272)
Hastings County	6.50	(3,207)	5.69	(2,967)	6.08	(6,174)
Huron County	6.27	(1,640)	5.68	(1,516)	5.97	(3,156)
Kenora District	7.66	(1,649)	9.47	(2,006)	8.59	(3,655)
Kent County	6.78	(2,832)	5.82	(2,675)	6.29	(5,507)
Lambton County	6.48	(3,423)	5.58	(3,052)	6.02	(6,475)
Lanark County	5.48	(1,351)	5.02	(1,313)	5.25	(2,664)
Leeds and Grenville United Counties	5.50	(2,303)	4.35	(1,878)	4.91	(4,181)
Lennox and Addington County	6.04	(995)	5.62	(904)	5.82	(1,899)
Manitoulin District	8.96	(461)	10.16	(529)	9.58	(990)
Middlesex County	6.11	(8,602)	5.11	(7,967)	5.60	(16,569)
Muskoka District	5.17	(1,246)	4.53	(1,114)	4.84	(2,360)
Niagara Regional Municipality	6.10	(10,443)	5.09	(9,371)	5.58	(19,814)
Nipissing District	6.87	(2,240)	6.00	(2,076)	6.42	(4,316)
Northumberland County	5.65	(2,089)	4.88	(1,812)	5.26	(3,901)
Ottawa-Carleton Regional Municipality	6.07	(15,594)	4.85	(13,591)	5.44	(29,185)
Oxford County	5.94	(2,246)	5.44	(2,213)	5.68	(4,459)
Parry Sound District	5.63	(1,128)	5.77	(1,091)	5.70	(2,219)
Peel Regional Municipality	7.33	(20,491)	6.46	(17,927)	6.88	(38,418)
Perth County	5.31	(1,462)	4.70	(1,443)	5.00	(2,905)
Peterborough County	5.59	(3,034)	4.27	(2,526)	4.92	(5,560)
Prescott and Russell United Counties	6.55	(1,714)	6.25	(1,656)	6.40	(3,370)
Prince Edward County	5.70	(704)	5.54	(698)	5.62	(1,402)
Rainy River District	7.34	(661)	7.96	(723)	7.66	(1,384)
Renfrew County	5.91	(2,309)	5.29	(2,171)	5.59	(4,480)
Simcoe County	5.50	(7,229)	4.76	(6,420)	5.12	(13,649)
Stormont, Dundas and Glengarry United Counties	7.02	(3,227)	6.24	(2,997)	6.62	(6,224)
Sudbury District	7.76	(843)	8.16	(775)	7.97	(1,618)
Sudbury Regional Municipality	6.76	(4,157)	5.64	(3,540)	6.19	(7,697)
Thunder Bay District	6.85	(4,102)	6.63	(4,020)	6.74	(8,122)
Timiskaming District	6.39	(977)	6.42	(1,014)	6.40	(1,991)
Toronto Metropolitan Municipality	8.03	(71,779)	7.15	(71,102)	7.58	(142,881)
Victoria County	5.92	(1,935)	5.01	(1,633)	5.45	(3,568)
Waterloo Regional Municipality	5.30	(7,434)	4.85	(7,294)	5.07	(14,728)
Wellington County	5.23	(3,330)	4.40	(2,930)	4.80	(6,220)
York Regional Municipality	6.52	(13,937)	5.54	(11,497)	6.02	(25,434)

Source: Ontario Diabetes Database (ODD)

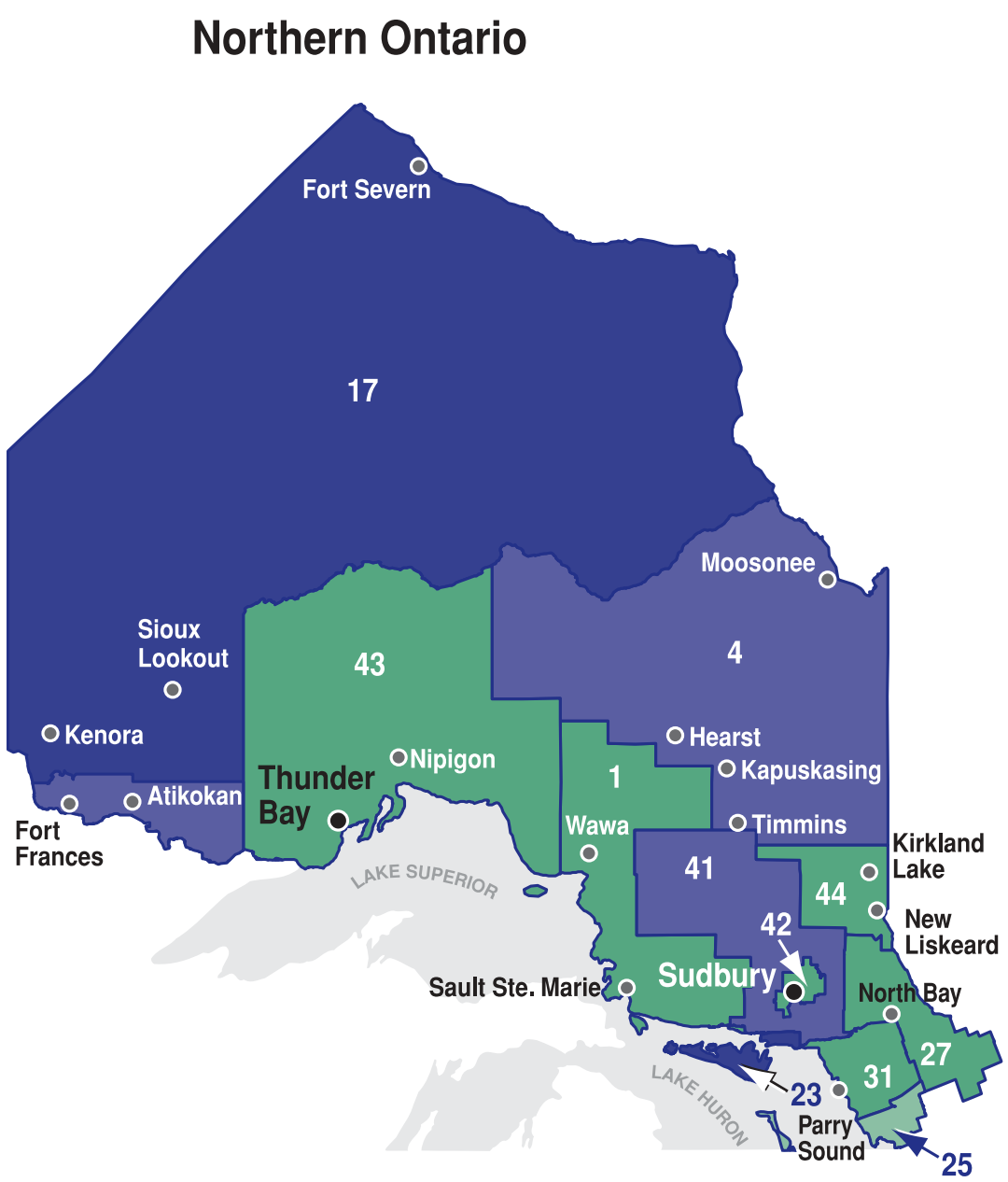
Exhibit 1.5 Age-/Sex-adjusted Prevalence of DM per 100 Ontarians Aged 20 Years and Over by County, 1995–1999

A steady growth in the number of persons with DM was observed across all of the counties independent of their initial prevalence rate.

Rate = per 100 persons	1995		1996		1997		1998		1999	
	%	(Cases)	%	(Cases)	%	(Cases)	%	(Cases)	%	(Cases)
Algoma District	4.70	(4,775)	5.03	(5,195)	5.29	(5,510)	5.61	(5,893)	5.97	(6,311)
Brant County	5.18	(4,763)	5.48	(5,075)	5.81	(5,384)	6.17	(5,763)	6.46	(6,089)
Bruce County	4.15	(2,339)	4.38	(2,476)	4.57	(2,602)	4.93	(2,823)	5.18	(2,981)
Cochrane District	5.58	(3,600)	6.01	(3,898)	6.49	(4,223)	6.99	(4,559)	7.49	(4,887)
Dufferin County	3.76	(1,074)	4.05	(1,184)	4.34	(1,298)	4.54	(1,382)	4.79	(1,480)
Durham Regional Municipality	4.48	(12,373)	4.81	(13,695)	5.07	(14,816)	5.34	(16,123)	5.62	(17,501)
Elgin County	5.19	(3,208)	5.45	(3,394)	5.73	(3,567)	6.11	(3,817)	6.44	(4,030)
Essex County	5.50	(14,407)	5.87	(15,525)	6.18	(16,511)	6.60	(17,812)	6.97	(18,982)
Frontenac County	4.19	(4,429)	4.44	(4,742)	4.65	(5,012)	4.87	(5,313)	5.20	(5,724)
Grey County	4.12	(3,212)	4.36	(3,427)	4.61	(3,656)	4.86	(3,887)	5.13	(4,135)
Haldimand-Norfolk Regional Municipality	5.53	(4,469)	5.90	(4,833)	6.25	(5,157)	6.60	(5,492)	6.94	(5,827)
Haliburton County	3.90	(648)	4.27	(712)	4.57	(778)	4.95	(857)	5.24	(920)
Halton Regional Municipality	3.53	(8,449)	3.82	(9,345)	4.09	(10,239)	4.33	(11,171)	4.58	(12,128)
Hamilton-Wentworth Regional Municipality	4.04	(14,951)	4.34	(16,172)	4.67	(17,486)	5.01	(18,931)	5.33	(20,272)
Hastings County	4.78	(4,783)	5.10	(5,118)	5.40	(5,423)	5.73	(5,777)	6.08	(6,174)
Huron County	4.82	(2,581)	5.11	(2,743)	5.38	(2,879)	5.66	(3,016)	5.97	(3,156)
Kenora District	6.13	(2,535)	6.64	(2,777)	7.27	(3,045)	7.94	(3,363)	8.59	(3,655)
Kent County	4.82	(4,262)	5.17	(4,587)	5.51	(4,863)	5.86	(5,156)	6.29	(5,507)
Lambton County	4.82	(5,040)	5.12	(5,403)	5.40	(5,737)	5.69	(6,092)	6.02	(6,475)
Lanark County	4.00	(1,954)	4.31	(2,134)	4.58	(2,283)	4.90	(2,470)	5.25	(2,664)
Leeds and Grenville United Counties	3.94	(3,263)	4.11	(3,431)	4.36	(3,663)	4.60	(3,897)	4.91	(4,181)
Lennox and Addington County	4.66	(1,445)	4.88	(1540)	5.18	(1,648)	5.53	(1,781)	5.82	(1,899)
Manitoulin District	7.37	(746)	7.62	(783)	8.29	(844)	8.83	(907)	9.58	(990)
Middlesex County	4.40	(12,476)	4.68	(13,400)	4.97	(14,349)	5.29	(15,446)	5.60	(16,569)
Muskoka District	3.96	(1,846)	4.15	(1,962)	4.27	(2,044)	4.53	(2,187)	4.84	(2,360)
Niagara Regional Municipality	4.36	(15,022)	4.69	(16,226)	4.98	(17,392)	5.28	(18,604)	5.58	(19,814)
Nipissing District	4.60	(3,081)	5.03	(3,378)	5.49	(3,677)	5.97	(3,994)	6.42	(4,316)
Northumberland County	4.06	(2,853)	4.33	(3,073)	4.59	(3,291)	4.94	(3,593)	5.26	(3,901)
Ottawa-Carleton Regional Municipality	3.94	(19,837)	4.27	(21,775)	4.65	(24,065)	5.06	(26,643)	5.44	(29,185)
Oxford County	4.57	(3,541)	4.82	(3,735)	5.07	(3,936)	5.36	(41,88)	5.68	(4,459)
Parry Sound District	4.45	(1,693)	4.76	(1,824)	5.05	(1,932)	5.42	(2,095)	5.70	(2,219)
Peel Regional Municipality	5.24	(24,873)	5.68	(28,107)	6.14	(31,518)	6.52	(34,976)	6.88	(38,418)
Perth County	4.06	(2,361)	4.25	(2,467)	4.48	(2,604)	4.70	(2,728)	5.00	(2,905)
Peterborough County	3.96	(4,313)	4.16	(4,566)	4.39	(4,865)	4.62	(5,182)	4.92	(5,560)
Prescott and Russell United Counties	5.00	(2,479)	5.33	(2,666)	5.65	(2,869)	6.06	(3,137)	6.40	(3,370)
Prince Edward County	4.50	(1,081)	4.74	(1,149)	5.16	(1,262)	5.31	(1,312)	5.62	(1,402)
Rainy River District	5.59	(1,019)	6.11	(1,115)	6.56	(1,196)	7.04	(1,279)	7.66	(1,384)
Renfrew County	4.41	(3,479)	4.71	(3,737)	5.03	(3,992)	5.32	(4,245)	5.59	(4,480)
Simcoe County	4.07	(9,734)	4.31	(10,552)	4.58	(11,516)	4.86	(12,563)	5.12	(13,649)
Stormont, Dundas and Glengarry United Counties	5.02	(4,641)	5.29	(4,918)	5.70	(5,312)	6.10	(5,724)	6.62	(6,224)
Sudbury District	6.09	(1,215)	6.61	(1,317)	7.14	(1,411)	7.53	(1,507)	7.97	(1,618)
Sudbury Regional Municipality	4.54	(5,516)	4.91	(5,990)	5.27	(6,461)	5.73	(7,088)	6.19	(7,697)
Thunder Bay District	5.05	(6,054)	5.42	(6,495)	5.92	(7,087)	6.34	(7,618)	6.74	(8,122)
Timiskaming District	4.90	(1,557)	5.25	(1,670)	5.59	(1,769)	5.98	(1,873)	6.40	(1,991)
Toronto Metropolitan Municipality	5.52	(101,675)	6.06	(112,522)	6.55	(122,292)	7.06	(132,691)	7.58	(142,881)
Victoria County	4.54	(2,801)	4.79	(2,999)	5.04	(3,175)	5.26	(3,378)	5.45	(3,568)
Waterloo Regional Municipality	3.77	(10,206)	4.06	(11,134)	4.36	(12,160)	4.74	(13,504)	5.07	(14,728)
Wellington County	3.82	(4,604)	4.08	(4,999)	4.31	(5,368)	4.57	(5,826)	4.80	(6,260)
York Regional Municipality	4.67	(16,174)	5.06	(18,393)	5.40	(20,542)	5.70	(22,863)	6.02	(25,434)

Source: Ontario Diabetes Database (ODD)

Exhibit 1.6a Age-/Sex-adjusted Prevalence of DM per 100 Ontarians Aged 20 Years and Over by County, Northern Ontario, 1995–1999



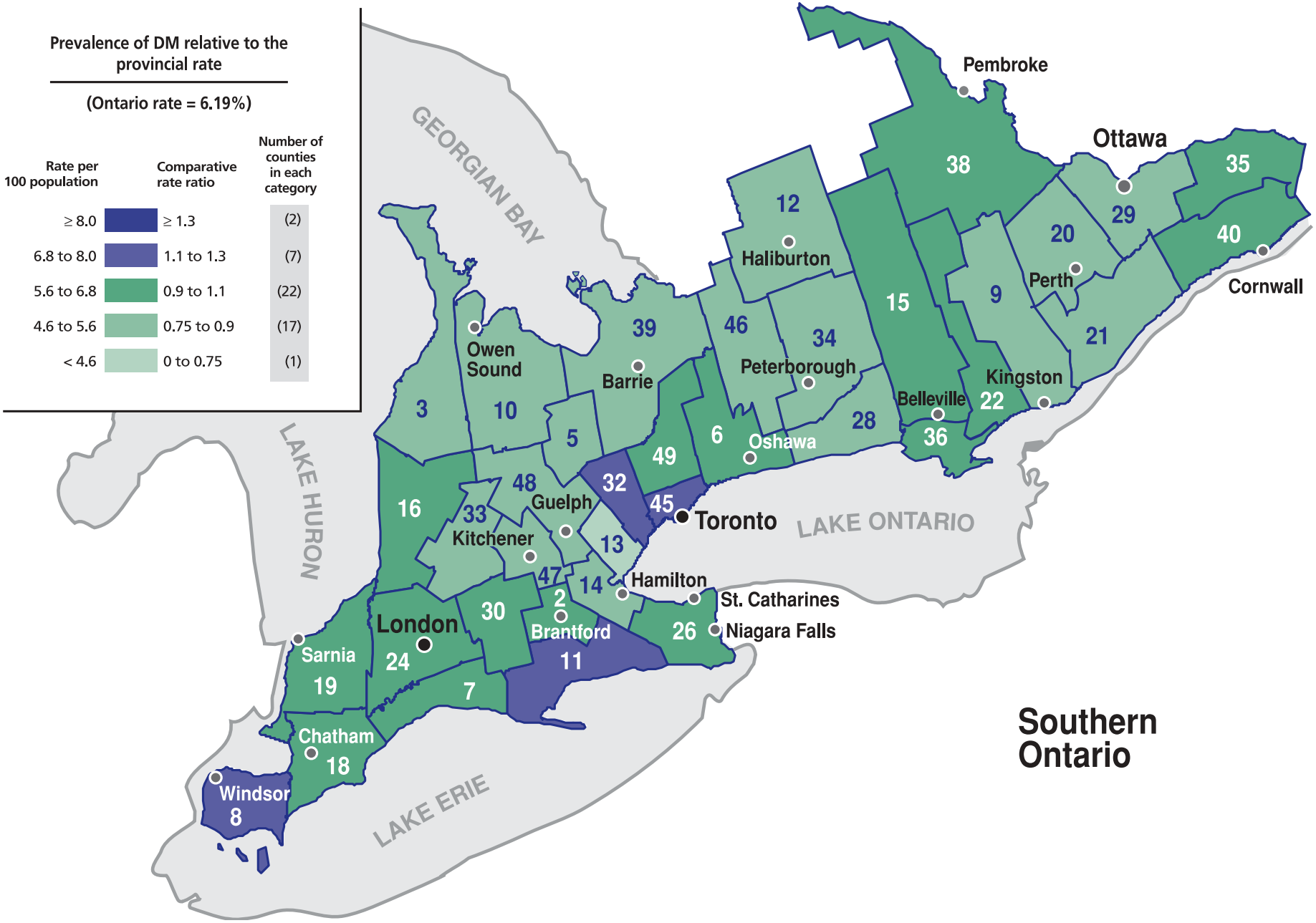
Ontario Counties

1 Algoma District
2 Brant County
3 Bruce County
4 Cochrane District
5 Dufferin County
6 Durham Regional Municipality
7 Elgin County
8 Essex County
9 Frontenac County
10 Grey County
11 Haldimand-Norfolk Regional Municipality
12 Haliburton County
13 Halton Regional Municipality
14 Hamilton-Wentworth Regional Municipality
15 Hastings County
16 Huron County
17 Kenora District
18 Kent County
19 Lambton County
20 Lanark County
21 Leeds and Grenville United Counties
22 Lennox and Addington County
23 Manitoulin District
24 Middlesex County
25 Muskoka District
26 Niagara Regional Municipality
27 Nipissing District
28 Northumberland County
29 Ottawa-Carleton Regional Municipality
30 Oxford County
31 Parry Sound District
32 Peel Regional Municipality
33 Perth County
34 Peterborough County
35 Prescott and Russell United Counties
36 Prince Edward County
37 Rainy River District
38 Renfrew County
39 Simcoe County
40 Stormont, Dundas and Glengarry United Counties
41 Sudbury District
42 Sudbury Regional Municipality
43 Thunder Bay District
44 Timiskaming District
45 Toronto Metropolitan Municipality
46 Victoria County
47 Waterloo Regional Municipality
48 Wellington County
49 York Regional Municipality

Note: See Exhibit 1.6b for Legend.

Source: Ontario Diabetes Database (ODD)

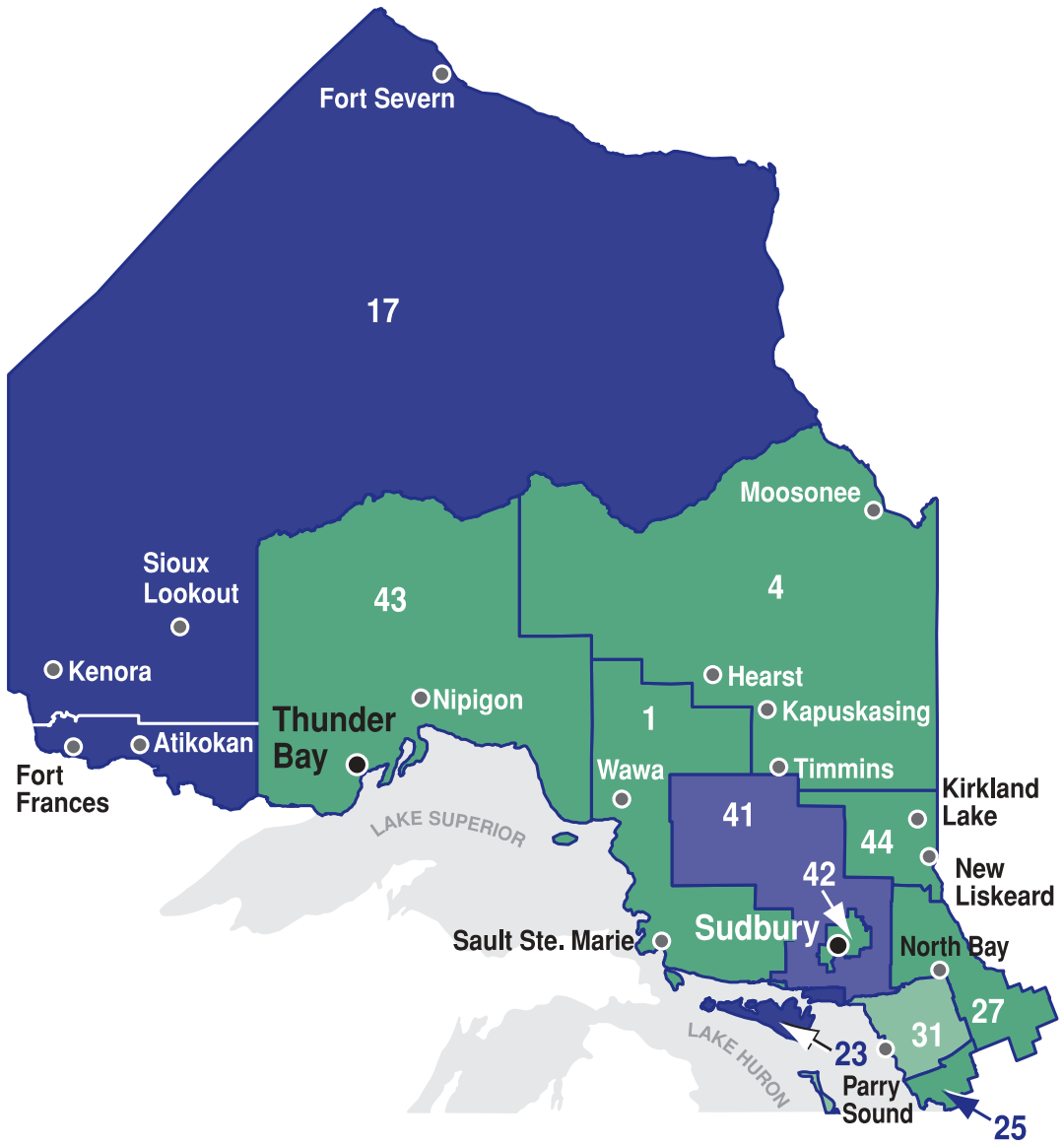
Exhibit 1.6b Age-/Sex-adjusted Prevalence of DM per 100 Ontarians Aged 20 Years and Over by County, Southern Ontario, 1995–1999



Note: See Exhibit 1.6a for County definitions.

Source: Ontario Diabetes Database (ODD)

Exhibit 1.7a Age-/Sex-adjusted Incidence of DM per 100 Ontarians Aged 20 Years and Over by County, Northern Ontario, 1995–1999



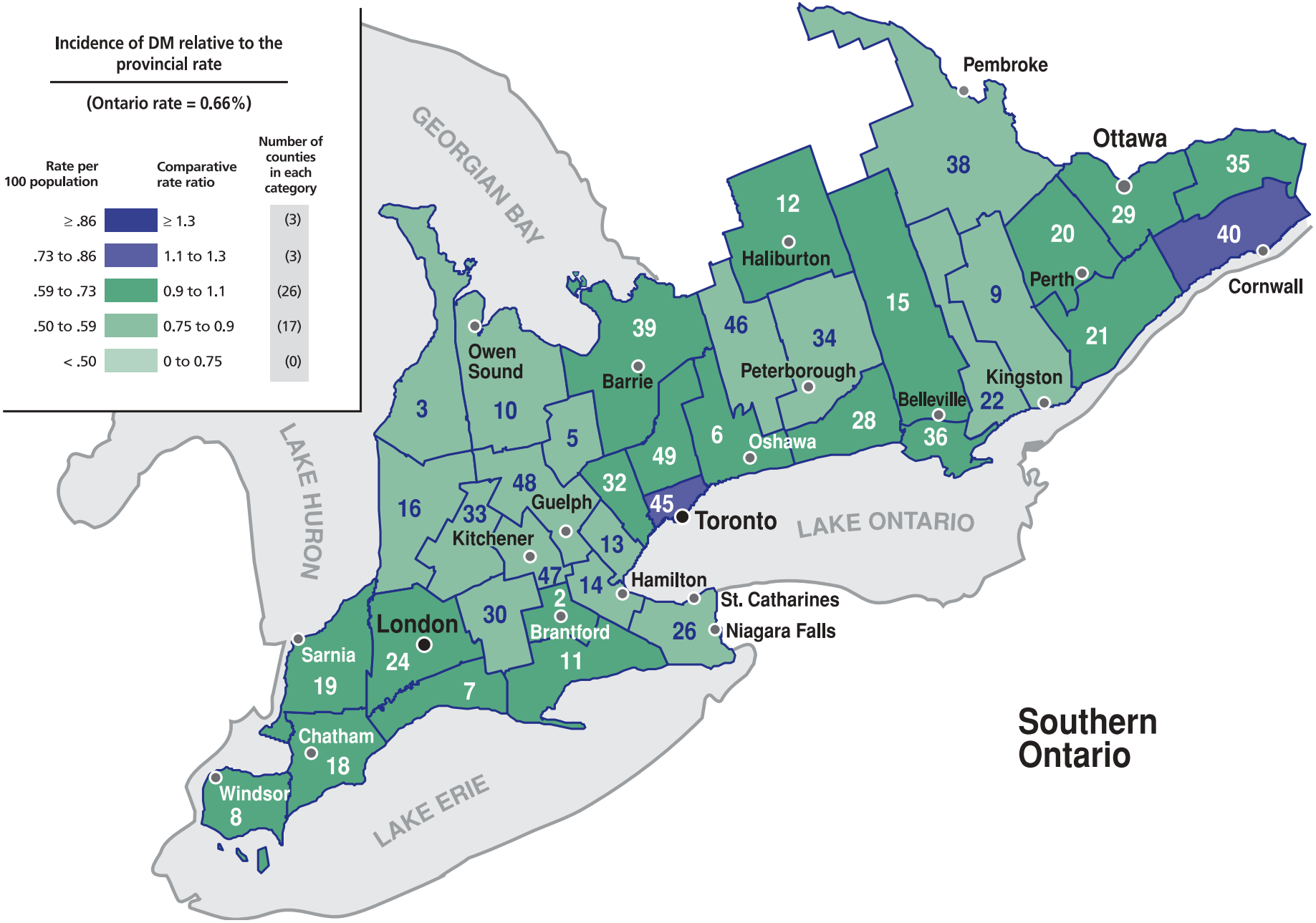
Ontario Counties

1 Algoma District
2 Brant County
3 Bruce County
4 Cochrane District
5 Dufferin County
6 Durham Regional Municipality
7 Elgin County
8 Essex County
9 Frontenac County
10 Grey County
11 Haldimand-Norfolk Regional Municipality
12 Haliburton County
13 Halton Regional Municipality
14 Hamilton-Wentworth Regional Municipality
15 Hastings County
16 Huron County
17 Kenora District
18 Kent County
19 Lambton County
20 Lanark County
21 Leeds and Grenville United Counties
22 Lennox and Addington County
23 Manitoulin District
24 Middlesex County
25 Muskoka District
26 Niagara Regional Municipality
27 Nipissing District
28 Northumberland County
29 Ottawa-Carleton Regional Municipality
30 Oxford County
31 Parry Sound District
32 Peel Regional Municipality
33 Perth County
34 Peterborough County
35 Prescott and Russell United Counties
36 Prince Edward County
37 Rainy River District
38 Renfrew County
39 Simcoe County
40 Stormont, Dundas and Glengarry United Counties
41 Sudbury District
42 Sudbury Regional Municipality
43 Thunder Bay District
44 Timiskaming District
45 Toronto Metropolitan Municipality
46 Victoria County
47 Waterloo Regional Municipality
48 Wellington County
49 York Regional Municipality

Note: See Exhibit 1.7b for Legend.

Source: Ontario Diabetes Database (ODD)

Exhibit 1.7b Age-/Sex-adjusted Incidence of DM per 100 Ontarians Aged 20 Years and Over by County, Southern Ontario, 1995–1999

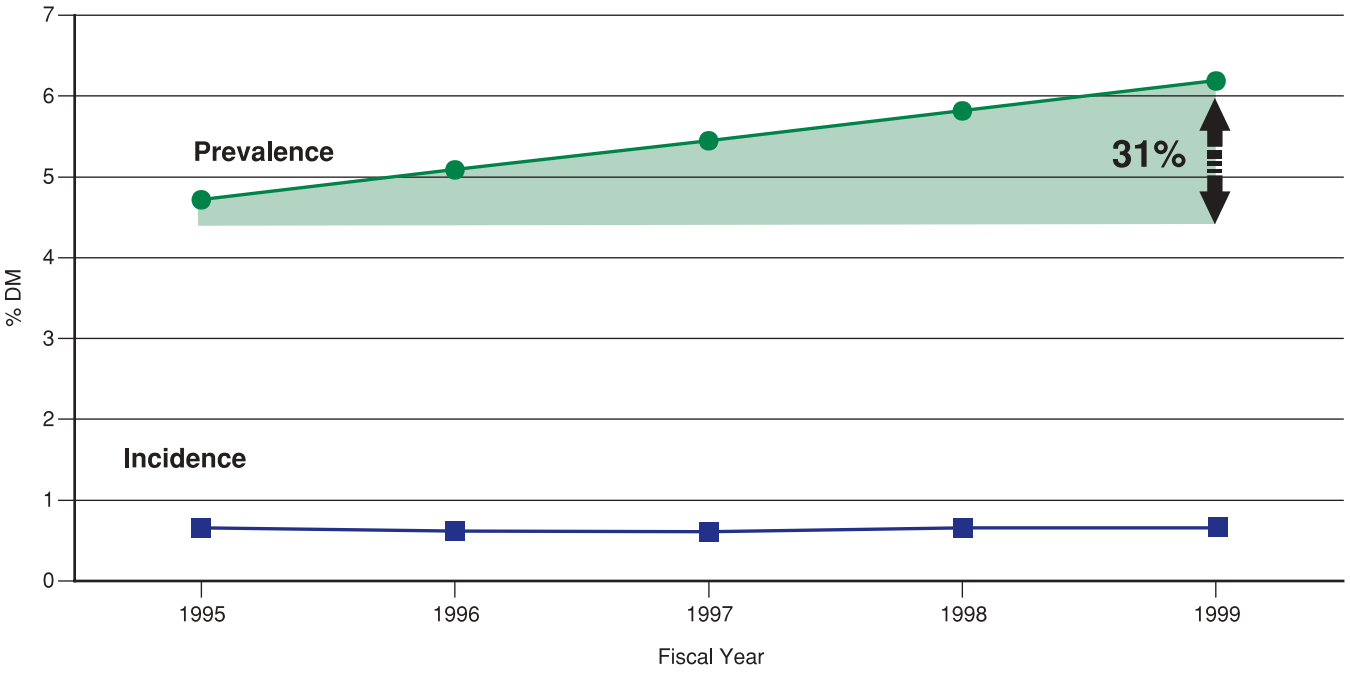


Note: See Exhibit 1.7a for County definitions.

Source: Ontario Diabetes Database (ODD)

Exhibit 1.8 Prevalence and Incidence of Ontarians with DM, 1995–1999

Prevalence of DM is increasing over time while incidence remains relatively stable. This indicates that the growth in DM is primarily due to persons living longer with DM, rather than an increase in the number of newly diagnosed cases of DM.



Source: *Diabetes Care* 2002; 25(3):512–516 with permission.

evidence of service utilization in that year. Over 98% of people in the ODD were still receiving services during that period. Accordingly, any over-estimate of DM rates related to inaccuracy in the RPDB is likely to be small in magnitude.

Findings and Discussion

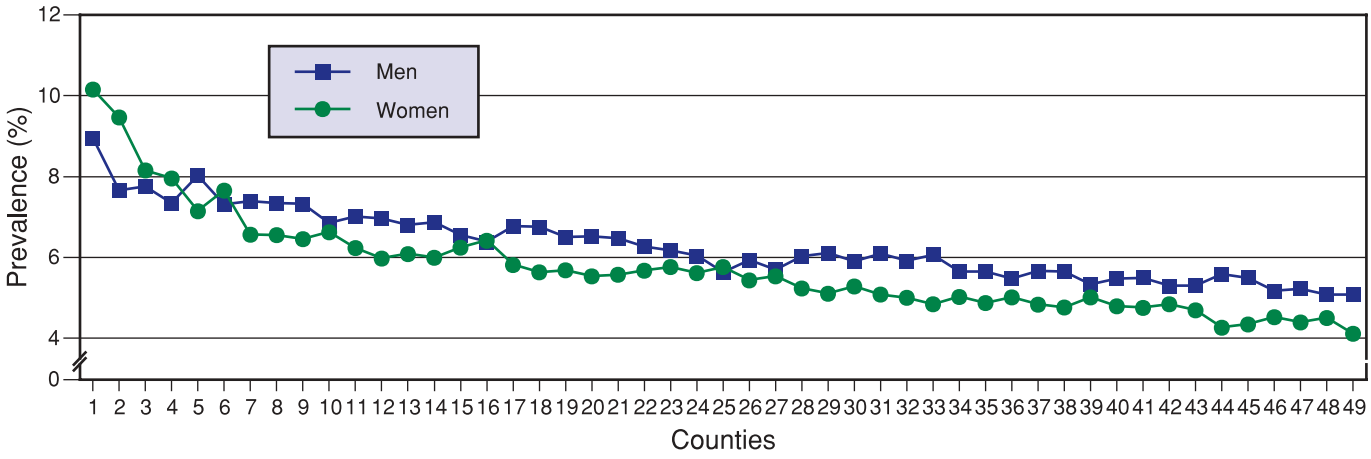
Prevalence and incidence rates are shown in Exhibits 1.1 and 1.2, respectively. Incidence remains essentially unchanged over the five years of observation, but prevalence increases steadily from 4.72% in 1995 to 6.19% in 1999, a 31% relative increase (Exhibit 1.8). These findings together suggest that while there is a marked growth in the number of DM cases, the increase is not primarily due to increasing numbers of persons developing the condition, but rather to persons living longer with DM. Consistent with findings in other jurisdictions,[25, 26] prevalence rates are higher in men than in women and increase sharply over the middle adult years. An exception to this sex-distribution is seen in counties with high proportions of First Nations residents[27] (e.g. Manitoulin, Kenora, Sudbury District, Rainy River and Cochrane) (Exhibits 1.4 and 1.9). A further exception is among younger individuals between ages 20 and 34, possibly because of the earlier onset of type 2 DM associated with gestational diabetes and a higher ratio of type 1 to type 2 DM in this age group.

The relationship between SES and the prevalence of DM is shown in Exhibit 1.3. As demonstrated in other jurisdictions,[28, 29] rates of DM are much higher among people living in low SES neighbourhoods. This effect is particularly evident in persons between ages 35 and 49 where the rate for women, for instance, is 4.13% in the lowest SES quintile and only 2.38% in the highest quintile. By age 75, the difference is much more modest (18.9% vs. 17.0%). This observation suggests that people living in lower SES neighbourhoods are at particular risk for the early development of what is presumably type 2 DM.

County level prevalence and incidence rates of DM are presented in Exhibits 1.4–1.7 and Exhibit 1.9. There is marked variation across small geographic areas with a more than two-fold increase from the lowest to the highest rate counties. Rates are high in counties with a clustering of ethnic groups at high risk for DM. For instance, as previously noted, the counties of Manitoulin, Kenora, Sudbury and Rainy River have high proportions of First Nations residents. Metropolitan Toronto and Peel region, which follow these counties at 5th and 9th rank in prevalence, respectively, have high proportions of South Asian immigrants.[30] It is possible that in some counties an apparently elevated prevalence merely reflects higher rates of detection.

Exhibit 1.9 Prevalence of DM in Ontarians by County, 1995–1999

County rates of DM for men and women are shown, ranked by county prevalence. This figure illustrates the significant variation in rates between counties. Many of the high rate counties contain Aboriginal communities in which rates for women are higher than rates for men.



1. Manitoulin District
2. Kenora District
3. Sudbury District
4. Rainy River District
5. Toronto Metropolitan Municipality
6. Cochrane District
7. Essex County
8. Haldimand-Norfolk Regional Municipality
9. Peel Regional Municipality
10. Thunder Bay District
11. Stormont, Dundas and Glengarry United Counties
12. Brant County
13. Elgin County
14. Nipissing District
15. Prescott and Russell United Counties
16. Timiskaming District
17. Kent County
18. Sudbury Regional Municipality
19. Hastings County
20. York Regional Municipality
21. Lambton County
22. Huron County
23. Algoma District
24. Lennox and Addington County
25. Parry Sound District
26. Oxford County
27. Prince Edward County
28. Durham Regional Municipality
29. Middlesex County
30. Renfrew County
31. Niagara Regional Municipality
32. Victoria County
33. Ottawa-Carleton Regional Municipality
34. Hamilton-Wentworth Regional Municipality
35. Northumberland County
36. Lanark County
37. Haliburton County
38. Frontenac County
39. Bruce County
40. Grey County
41. Simcoe County
42. Waterloo Regional Municipality
43. Perth County
44. Peterborough County
45. Leeds and Grenville United Counties
46. Muskoka District
47. Wellington County
48. Dufferin County
49. Halton Regional Municipality

Adapted From: *Diabetes Care* 2002; 25(3):512–516.

Conclusions

Diabetes is a large and growing health problem for Ontarians. Increases in the prevalence of the disease appear to be primarily related to persons living longer with DM, rather than an increase in the incidence of DM. A number of interventions have been shown in clinical trials to delay or avert DM complications (e.g. aggressive lipid lowering, anti-hypertensive, ACEI medications), which would be expected to both improve survival and contribute to the increase in prevalence.

DM is disproportionately clustered in older adults, a finding that has important implications in view of the projected growth of this segment of the population over the next decade.[31] An increase in the burden of DM is also anticipated in view of the increasing prevalence of obesity in the western world.[10] DM cases were found to be clustered in the lower SES quintiles, particularly in the middle adult years. Effective delivery of services for DM prevention and management to this vulnerable population will be an important issue for providers and planners.

A substantial variation in rates of DM between counties in Ontario has been observed. While further studies using primary data collection will be required to fully explain the causes of the variation, the distribution patterns observed here point to the vulnerability of high risk ethnic groups and the need for culturally appropriate and effective interventions for the prevention and treatment of DM in these populations. High rates in some of the more geographically remote areas of the province raise concern about access to appropriate specialty services for persons with DM residing in these settings. Distribution of provider services will be addressed in a later chapter.

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Technical Appendices (Exhibits TA1.A, TA1.B and TA1.C)
Development and Validation of the Ontario Diabetes Database (ODD)

Exhibit TA1.A Development/Validation of the ODD

Data Sources

Ontario health care administrative data were used to assemble the cohort of persons who had been diagnosed with diabetes mellitus (DM). Discharge abstracts prepared by the Canadian Institute for Health Information (CIHI) describe each hospitalization in the province and are available on an individual basis from fiscal 1992 (April 1, 1991 to March 31, 1992). These were used to identify patients who had been admitted to hospital with a diagnosis of DM, whether or not it was the primary reason for admission (any of 16 reported diagnostic fields showing a diagnosis of DM: ICD9 code 250.x). For outpatient services, Ontario Health Insurance Plan (OHIP) records were used to identify physicians' service claims for which DM was the recorded diagnosis (ICD8 250.x). Note that OHIP claims contain only a single diagnostic code independent of the number of conditions with which the patient had been diagnosed or which the physician addressed in the encounter.

All of the relevant records from these two data sources from fiscal 1992 through fiscal 2000 were extracted. The CIHI and OHIP records bear a reproducibly scrambled unique health care identifier. This permits the linkage of all records pertaining to an individual patient across time and between settings yet preserves patient confidentiality.

Definition of DM using the Data Sources

Not all of the individuals identified with a diagnostic code for DM would truly have been diagnosed with DM. Coding errors may occur and, in the case of outpatient visits, the code may have been applied because the individual was being tested for DM (and could not be revised when those tests were subsequently negative). This study followed an algorithm for detection of DM developed by Blanchard et al,[1] using administrative data in Manitoba. The algorithm specified that any patient with two physician service claims bearing a diagnosis of DM within a two-year period, or one hospitalization with a diagnostic code for DM would be identified as having DM. A similar algorithm requiring only a single physician service claim was also examined reasoning that, while vulnerable to over-counting, it would also be more sensitive to detect disease in persons who used health services infrequently. In order to exclude women who had gestational diabetes only from the DM database, any record bearing a DM diagnostic code but followed within 5 months by a physician service claim or hospital discharge record indicating an obstetrical event were eliminated. While those specific records were eliminated, the women were still eligible to enter the database either before or after the pregnancy. The resultant administrative data cohort was titled the Ontario Diabetes Database (ODD).[2]

Individuals who were identified as having DM were linked by their unique identifier to the Registered Persons Database (RPDB), the annual registry of all persons eligible for provincial health coverage. The RPDB provided patients' sex, year of birth, date of death where applicable and postal codes. Persons for whom no death record was identified remained in the DM database whether or not they had claims with a diagnosis of DM in subsequent years.

Validation of the Ontario Diabetes Database

a) Primary Data Collection

The ODD was validated by primary data collection from physicians' office charts. To simplify data collection, the individuals selected for review were nested within the practices of randomly selected primary care physicians who practised within 50 km of Toronto and who consented to participate. A trained abstractor collected information regarding the diagnosis, duration and type of DM. A diagnosis of DM determined based on clinic notes and/or consult letters and/or prescriptions for antidiabetic medications. In the absence of such evidence for disease, the patient was labeled as not having DM.

b) Analysis

The appropriate algorithm for identifying cases of DM from administrative data was determined by comparing the patients within the ODD to the information derived from the primary chart review. Two algorithms were tested: one which required only one physician service claim or one hospitalization with a diagnosis of DM, and the previously reported algorithm which required either two physician service claims within a two-year period or one hospitalization bearing a diagnosis of DM. An algorithm that maximized sensitivity while providing at least 80% positive predictive value was sought. Positive predictive value is the proportion of individuals labeled as having DM by the algorithm that were confirmed to have DM in the gold standard—in this case, chart review.

Results

Validation of the Administrative Data Algorithm

Representative results for application of the ODD algorithm are shown in Exhibit TA1.A (see next page). The majority of cases are defined on the basis of OHIP claims with an average of over 10 claims per individual over the two-year observation period. Note that there may be some overlap between the cells in Exhibit TA1.A (Algorithm); for instance those with CIHI hospital records may also have OHIP physician service claims.

For the chart abstraction, 520 randomly selected physicians were invited to participate through an initial letter with follow-up to non-responders. Chart abstraction was performed in the offices of 57 physicians (11%) who agreed to participate. Where provided, the most common reasons for declining participation were disruption of office routine and concerns about patient confidentiality. A standard data collection instrument was used to abstract 3,337 charts, of which 3,317 could be linked to the DM databases defined from administrative data. The comparison of the two sources is shown in Exhibit TA1.B.

Even when two OHIP claims or a CIHI record were required to establish the diagnosis there appeared to be about 20% "false positives" (i.e. persons for whom the administrative data diagnosis of DM could not be confirmed through their chart). These cases were examined in more detail.

Persons who were labeled as having DM on the basis of administrative data (2-claim rule) but not confirmed in chart review (85 apparent false positives) are described in Exhibit TA1.C. Since there are no barriers to patients seeing multiple primary care providers, it is possible that some of these persons had DM diagnosed by a different physician than the one whose charts were abstracted and, accordingly, may be true rather than false positives. Such a circumstance would be more likely where the patient sees multiple providers. This is the situation for the apparent false positive cases who had seen a median of five (range 1–36) different physicians in the last five years and had a median of five claims (range 0–67) with a diagnosis of DM. Consent was not obtained from participating physicians to link provider data; therefore, it was not confirmed whether the DM claims for these persons were submitted by a study physician or by one or more of their other physicians.

Persons labeled as having DM by administrative data but not confirmed by chart review are also more likely to truly have DM if they are receiving antidiabetic drugs, if they have multiple office visits for DM or if their DM was diagnosed in hospital, where accuracy of diagnostic information in administrative data is greater. If persons meeting one or more of these criteria (Exhibit TA1.A) are considered true positives, the positive predictive value of the 2-claim algorithm increases to 98%.

Summary

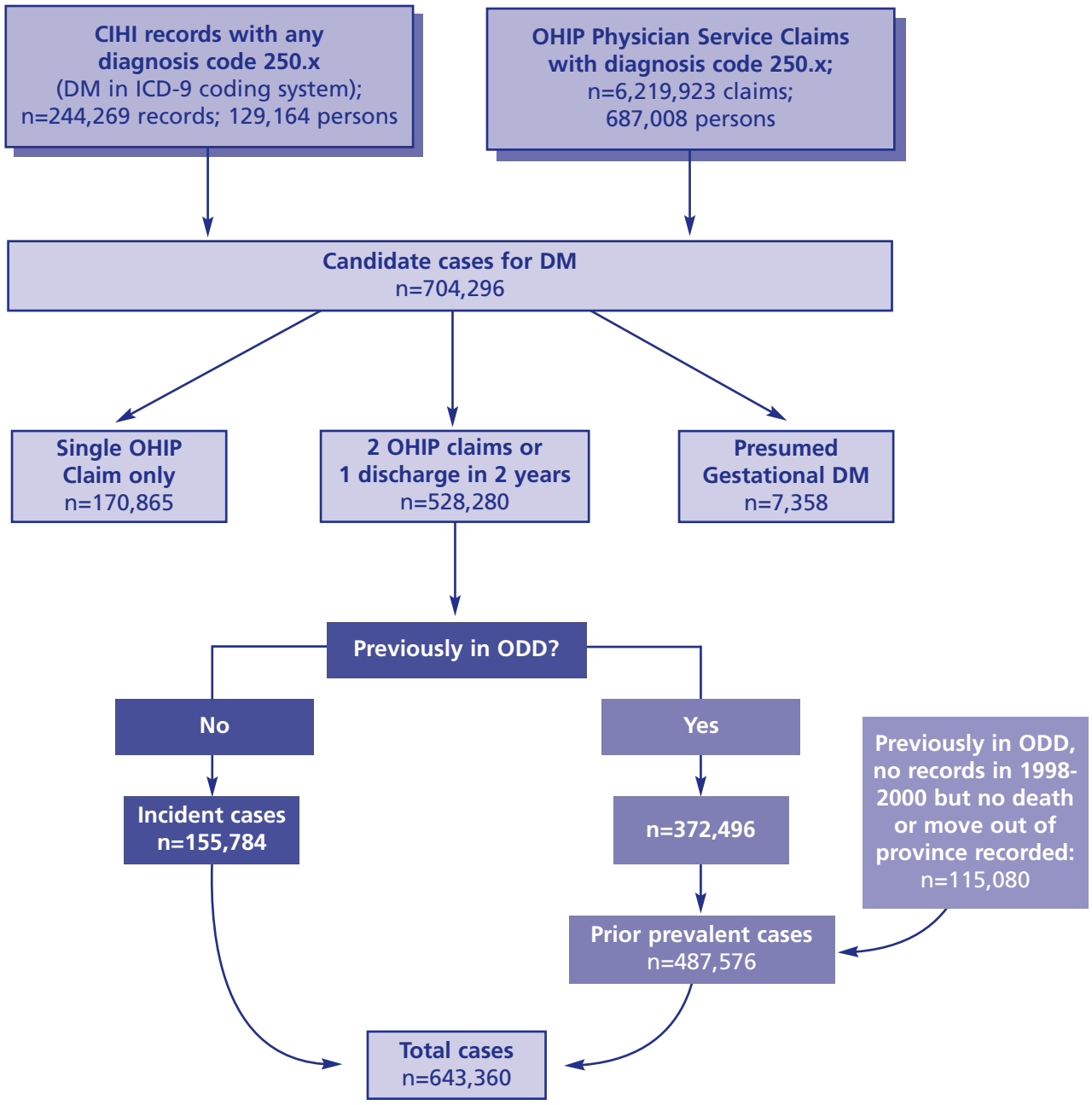
This work supports the feasibility of using administrative data for chronic disease surveillance. Data from various sources can be linked to facilitate identification of persons with DM.

Validation of the database by comparison to data abstracted from primary care charts showed that the ODD has an acceptable level of accuracy. However, the accuracy of the ODD cannot be fully defined because of limitations of the chart review methodology employed. Migration between providers and lack of efficient vertical integration of care may contribute to under-detection of DM in the chart review if data are abstracted at the office of a single practitioner, since that physician may not represent the patient's regular source of care. The fact that persons were identified who had no evidence of DM in the chart review, yet were using insulin or oral hypoglycemics (medications which are only used for DM) provides strong evidence for the fallibility of such chart reviews.

The purpose of this study was to determine an optimal administrative data algorithm for detecting DM—a task predictably hampered by the trade-off between sensitivity (ensuring that no cases are missed) and specificity (ensuring that no disease-free persons are labeled with DM). Requiring only a single physician service claim significantly improves sensitivity but at the cost of unacceptable false positives. These false positives may simply be coding errors or cases where DM was clinically suspected but subsequent laboratory tests did not confirm the diagnosis.

One of the principal advantages of the method employed here is that it not only quantifies the burden of disease, it defines a population in which process and outcome of disease management may be explored. A population-based cohort of persons diagnosed with DM represents a valuable resource to those seeking to evaluate the delivery and outcomes of care for DM.

Exhibit TA1.A (Cont'd) Algorithm for the Development of ODD, 1998–2000



Sources: Canadian Institute for Health Information (CIHI), Ontario Health Insurance Plan (OHIP), Registered Persons Database (RPDB)

Exhibit TA1.B Validation of Administrative Data Algorithms Against Primary Care Chart Data

1 Physician Service Claim *or* 1 Hospitalization with Diagnosis of DM

Administrative Data \ Office Charts	DM	No DM	
DM	353	223	576
No DM	36	2,705	2,741
	389	2,928	3,317

Sensitivity: 0.91; PPV: 0.61

2 Physician Service Claims *or* 1 Hospitalization with Diagnosis of DM

Administrative Data \ Office Charts	DM	No DM	
DM	335	85	420
No DM	54	2,843	2,897
	389	2,928	3,317

Sensitivity: 0.86; PPV: 0.80

Sensitivity: proportion of persons with DM according to the office charts who were detected by the administrative data algorithm.

PPV: positive predictive value—proportion of positive cases from the administrative data that were confirmed to be true positives by the chart data

Data Sources: Canadian Institute for Health Information (CIHI), Ontario Health Insurance Plan (OHIP). Adapted From: *Diabetes Care* 2002; 25(3):512–516.

Exhibit TA1.C Description of Apparent False-positives Using 2-claim Rule: Persons Labeled as Having DM on the Basis of Administrative Data but not Confirmed in Chart Reviews (n=85)

Criteria:	Number (%)
Persons using hypoglycemic drugs (of those ≥ 65 yrs, n=18)	**3** (16.7)
Persons with > 3 office visits coded with diagnosis of DM	**55** (64.7)
Persons with at least 1 hospitalization with a diagnosis of DM	**11** (12.9)
Persons having seen more than 3 different physicians in last 5 years*	**63** (74.1)
Persons with one or more of the above 4 criteria	**78** (91.8)

* Where a patient routinely sees multiple physicians, it is less likely that a given physician (i.e. the one whose charts were abstracted) would have the patient's full medical history including the diagnosis of DM.

Sources: Canadian Institute for Health Information (CIHI), Ontario Drug Benefit Plan (ODB), Ontario Health Insurance Plan (OHIP)

References:

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2

Chapter

Acute Complications of Diabetes

Authors: Gillian L. Booth and Jiming Fang

Key Messages

- Outpatient care for diabetes mellitus (DM) has improved, contributing to lower rates of admission and fewer emergency department visits for acute complications (high or low glucose) of DM.
- Availability of hospital and community resources, as well as differences in physician practices, are likely to contribute to the variation in rates of admission and emergency department visits for DM across the province.
- Access to a regular care provider, more frequent primary care visits, and an annual visit to a diabetes specialist were associated with fewer admissions for acute complications of DM.

Background

Diabetes mellitus (DM) is associated with a number of short-term consequences that can lead to hospital admission. Diabetic ketoacidosis (DKA) and hyperosmolar nonketotic coma (HNKS) are acute and potentially life-threatening emergencies that require immediate medical attention. Both syndromes are characterized by severe elevations in blood glucose levels (hyperglycemia) and a variety of other metabolic disturbances that can develop over days to weeks. Hyperglycemic emergencies can be the first sign of DM. However, in persons with pre-existing DM, these episodes may be triggered by another illness or poor adherence with DM medications.[1-3] People who have poorly controlled DM are at a greater risk for developing these complications, as are those from low-income groups who may have problems paying for DM medications and monitoring supplies.[3-5] In many cases, hospitalization for acute hyperglycemic episodes can be averted through early recognition and by avoiding errors in management. Patient education is extremely important and education programs have been shown to reduce rates of these admissions.[6]

Patients who use insulin or medications that increase insulin levels in the blood are also at a greater risk for developing low blood sugar levels (hypoglycemia). People suffering severe episodes of hypoglycemia may require assistance from another person and can lead to loss of consciousness. While tight control of blood glucose levels can improve the long-term outcome for people with DM, running levels close to the normal range increases the risk of developing severe hypoglycemia.[7,8] Again, DM education and regular follow- up visits to a physician can reduce this risk.[9]

People with DM are also more susceptible to common infections, including those of the skin and soft tissue, urinary tract infections, pneumonia and the spread of bacterial infections into the blood stream (bacteremia).[10] Acute infections due to tuberculosis (TB) occur at low rates in the general population, but are known to be increased in some subgroups of the DM population.[11] High blood glucose levels are believed to be directly responsible for the increased risk of infections among people with DM.[12]

Many hospital admissions for acute complications of DM can be prevented by good outpatient care. Access to medical care appears to be a key factor influencing admission rates for these complications. For example, studies done in the U.S. show that people who lack adequate health insurance have markedly higher rates of admission for hyperglycemic emergencies.[4,13] Although the Canadian health care system provides insurance coverage for most physician and hospital services, other barriers to accessing care, such as socioeconomic status and region of residence, may have an impact on the development of acute complications of DM.

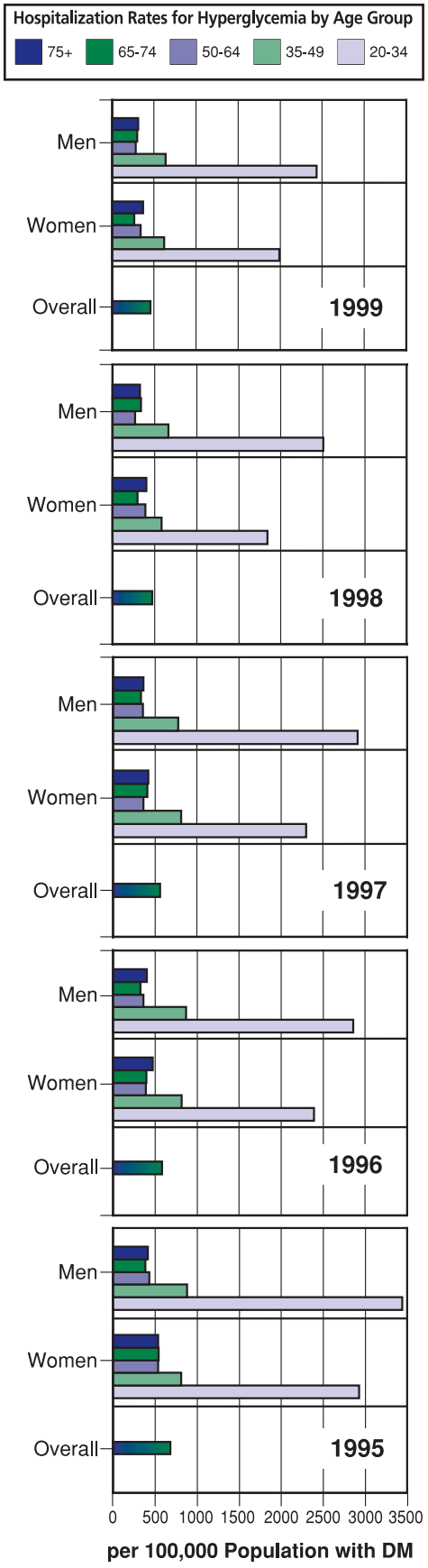
Exhibit 2.1 Overall and Age-/Sex-specific Rates of Hospitalization for Hyperglycemia per 100,000 Ontarians with DM Aged 20 Years and Over, 1995–1999

Hospital admissions for hyperglycemia fell by 30% over the study period. The observed decline occurred in all age groups, but to a greater extent in women than in men.

Fiscal Year	Overall Rate	Women by Age Group					Men by Age Group				
		20–34	35–49	50–64	65–74	75+	20–34	35–49	50–64	65–74	75+
1995	679	2,925	806	537	541	533	3,442	876	428	381	412
1996	583	2,390	819	388	398	472	2,860	871	363	325	404
1997	560	2,298	814	361	408	421	2,911	778	355	335	364
1998	473	1,839	580	388	293	400	2,506	661	266	336	325
1999	458	1,990	618	342	262	368	2,432	640	282	301	311
P value*	.005	.03	.09	.1	.01	.003	.02	.009	.02	.09	.003

*P value is for trend over time

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)



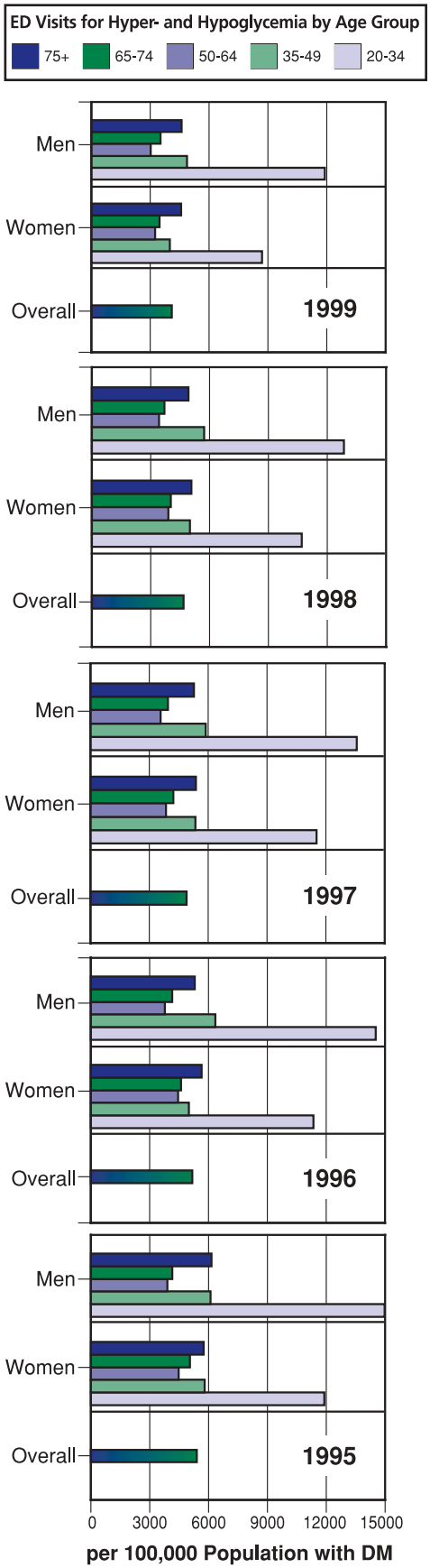
Data Sources

Persons with DM (excluding cases of gestational diabetes) were identified using the Ontario Diabetes Database (ODD). Creation of the ODD is described in the Chapter 1 Technical Appendix TA1.A. Records of hospitalizations for hyper- or hypoglycemia were obtained from the Canadian Institute for Health Information (CIHI) database. Emergency department (ED) visits were identified from Ontario Health Insurance Program (OHIP) records. Each database was linked together using a unique anonymous identifier for each individual. Census data from Statistics Canada were used to assign socioeconomic status to individuals in the ODD on the basis of their neighbourhood of residence. The two databases were linked using postal codes as a common variable.

How the analysis was done

The annual rate of hospitalizations or ED visits for hyper- or hypoglycemia was calculated from fiscal 1995 (April 1, 1994 to March 31, 1995) through fiscal 1999. The numerator was the total number of episodes in a given year, while the denominator was the total number of persons with DM who were in the ODD during the same time period. Hospitalizations were identified from CIHI records in which an acute hyperglycemic (9th International Classification of Disease (ICD-9) codes 250.1 to 250.3) or hypoglycemic episode (ICD-9 code 251.0) was documented as a primary or most responsible diagnosis. Information on ED visits came from physician services' claims in which the visit was for DM (ICD-9 codes 250 or 251) and the visit occurred in an ED. Diagnostic codes from physician billing claims are less specific than those from CIHI records and are likely to be less reliable. For instance, physicians may be inclined to code all acute episodes simply as 'diabetes mellitus' (ICD-9 code 250). Therefore, any visit to an ED for a diagnosis of 250 or 251 was categorized as DM-related rather than separating them into hyper- or hypoglycemic episodes. Similar methods were used to identify admissions to hospital for the following infections:

Exhibit 2.2 Overall and Age-/Sex-specific Rates of Emergency Department Visits for Hyper- and Hypoglycemia per 100,000 Ontarians with DM Aged 20 Years and Over, 1995–1999



ED visits for DM fell by 24% over the study period.

Fiscal Year	Overall Rate	Women by Age Group					Men by Age Group				
		20–34	35–49	50–64	65–74	75+	20–34	35–49	50–64	65–74	75+
1995	5,388	11,887	5,800	4,466	5,042	5,730	14,964	6,090	3,891	4,137	6140
1996	5,170	11,355	5,008	4,436	4,594	5,647	14,522	6,343	3,772	4,154	5,295
1997	4,907	11,516	5,345	3,852	4,223	5,378	13,579	5,882	3,574	3,945	5,270
1998	4,666	10,695	4,978	3,902	4,023	5,056	12,846	5,724	3,412	3,692	4,909
1999	4,101	8,701	4,000	3,247	3,473	4,588	11,917	4,874	3,040	3,532	4,613
P value*	0.004	0.05	0.06	0.02	0.0009	0.006	0.0005	0.06	0.004	0.008	0.01

*P value is for trend over time

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP)

skin and soft tissue, urinary tract infections, pneumonia, bacteremia/sepsis, and tuberculosis. Diagnostic codes are listed in Technical Appendix TA2.B.

Annual rates of hospitalizations or ED visits for hyperglycemia are presented for each age and sex category. Furthermore, annual age- and sex-adjusted rates of hospitalization and ED visits for hyperglycemia are presented at the regional (Ministry of Health and Long-term Care [MOHLTC] planning regions), district health council (DHC) region, and/or county level, depending upon the analysis. In some instances, the number of individuals who had an acute complication within a given jurisdiction was too small to report. Rates that were based on only a few events were suppressed to retain confidentiality and to avoid inaccuracies that arise when the number of events is too small. Therefore, for regional analyses, annual admission rates were averaged over the five-year period, using county level data for hyperglycemic episodes, and DHC region data for hypoglycemic episodes. Similarly, annual admission rates for hypoglycemia could only be presented at the DHC level.

In Ontario, personal income is not available in administrative data sources. Therefore, income level for individuals in the ODD was estimated from the median household income level in their neighbourhood of residence, collected in the 1996 Canadian Census.

Multivariate techniques (logistic regression) were used to identify risk factors for developing any acute metabolic complication (either hyper- or hypoglycemia) during the five-year period. Factors that were tested include age, sex, presence of other medical conditions (comorbidity), type of residential area (urban versus rural), geographic region of the province, and use of outpatient services. Individuals were categorized as having a regular provider if at least 50% of their primary care visits were to a single provider. Adjustment for the presence of other medical conditions that might affect outcomes was performed using the Johns Hopkins Ambulatory Care Groups (ACG) assignment

software.[14,15] Region of residence was based on the MOHLTC planning regions (Technical Appendix TA2.Ca and TA2.Cb). Small area rate variation (SARV) analysis was conducted to compare hospitalization and ED visit rates across DHC regions and counties (a full discussion of SARV statistics appears in Technical Appendix TA2.A).

Interpretative Cautions

The use of administrative data to identify hyper- or hypoglycemic episodes has not been fully validated. Although diagnoses obtained in the hospital setting are based on specific ICD-9 codes, the exact coding depends on details recorded in the hospital chart. Further, administrative data do not include information on case severity or other clinical details. Therefore, some of these episodes might have been milder forms of hyperglycemia that would not have fulfilled the criteria for DKA or HNKS.

Diagnoses obtained in the outpatient and ED setting (containing only the first three digits of the ICD-9 code) are derived from physicians' billing claims and may be imprecise. This imprecision has been partially addressed by pooling ED visits for diagnostic codes pertaining to both hyper- and hypoglycemia, thus creating a category that reflects DM control. There may be a tendency to under-report some severe episodes of hyper- or hypoglycemia presenting to the ED if these are coded according to another condition present at the time of diagnosis (e.g. a fracture from falling or an acute myocardial infarction). However, these visits would likely lead to hospital admission and would therefore be captured in one of the 16 diagnostic fields contained in CIHI records. Therefore, these episodes would have been detected in the analysis of hospitalization rates.

Some EDs participate in an alternative funding plan (AFP) whereby physicians are paid out of a special budget allocated directly to the hospital or a group of physicians, rather than on a fee-for-service basis.[16] During the study period, some but not all EDs participating in an AFP submitted 'shadow billing' to OHIP (where the claim is sent in for administrative purposes but is not reimbursed). For those that did not, visits can only be detected using OHIP claims if another, non-AFP, physician billed for a service during the same visit. For most EDs, the funding arrangement remained the same during the five-year study period. Consequently, the annual trends should not have been affected by these payment practices.

Lastly, because this analysis is based on cross-sectional data, we can observe associations between outcomes but cannot fully establish causation. The purpose of this analysis is to identify trends in admissions and ED visits over time and across regions, to identify health care patterns that warrant further examination, and to support planning and policy development.

Key Research Findings

- Between 1994 and 1999, hospital admissions for elevated blood sugar levels decreased by 30%, while admissions for low blood sugar levels fell by 75% across all regions in Ontario.
- ED visits for diabetes mellitus (DM) fell by 24%, greater than the decline in ED use observed in the general population over the same time period.
- There was a significant degree of regional variation in rates of hospitalization and ED visits for acute diabetic complications across the province.
- Northern communities had markedly higher rates of ED visits for hyper- and hypoglycemia than areas in southern Ontario, but similar overall rates of hospital admissions.
- Young people living in the north had a three-fold greater likelihood of being seen in an ED for an acute complication of DM than those living in southern regions.
- Persons in lower income groups had greater numbers of hospitalizations and ED visits for DM.
- Over the five-year period, hospital admissions for skin and soft tissue infections declined by 25% among persons with DM. In contrast, rates of hospitalization for most other common infections remained constant.

Findings and Discussion

a) Hyper- and Hypoglycemia

Between fiscal years 1995 and 1999, hospital admissions for hyperglycemic emergencies in Ontario decreased by 30% from an overall rate of 525 admissions per 100,000 people with DM in 1995 to 364 admissions per 100,000 in 1999. The decline in admissions was observed in all age and sex subgroups, but occurred to a greater extent in women (Exhibit 2.1 and 2.3). There was also a tendency toward shorter lengths of stay (LOS) over the period of observation (median LOS 6 vs. 5 days, p=0.06). In-hospital mortality was directly related to age and was stable over the five-year period (4.8% vs. 6.0%, p=0.2) (Exhibit 2.4).

Although bed closures and reduced hospital staffing could lead to a higher threshold for admission to hospital, ED visits for DM also fell by 24% over the same time period, suggesting that reduced availability of inpatient services was not the only factor leading to the observed decline (Exhibit 2.2 and 2.3). Furthermore, the proportion of ED visits that led to hospital admission in 1999 was only marginally less than the proportion in 1995. Overall, the use of EDs per capita in the general population declined by 10.3% between 1993 and 2000, while ED use rose in the elderly by a similar degree.[16] In contrast, the fall in ED visits for DM occurred in all age groups (Exhibit 2.2).

Northern communities had markedly higher rates of ED visits for hyperglycemia than areas in southern Ontario, but similar rates of hospital admissions (Exhibit 2.5 and 2.6). The need for hospitalization to manage hyperglycemia depends on the severity of each case. Patients who are in moderate to severe DKA or HNKS need specialized care that can only be delivered in a hospital setting. However, barriers to accessing regular outpatient care may lead patients in remote communities to use emergency services for less severe episodes of hyperglycemia that would not otherwise warrant admission to hospital. On average, people with DM living in different regions of the province have similar numbers of visits to a primary care physician in a given year (median six visits per year), and an equal likelihood of having a regular care provider (72% of all patients). However, one might be more inclined to delay seeking attention for an acute episode if the distance to medical care is greater. Unfortunately, the severity of cases admitted to northern and southern regions cannot be adequately compared based on administrative data alone, but the mean in-hospital mortality rate (age- and sex-adjusted) was lower in the northern (3.0% to 6.2%) than in the southern regions (2.6% to 9.1%) of the province (p=0.002 for the comparison across DHC regions) (Exhibit 2.7).

There was a significant degree of regional variation in rates of both hospitalizations and ED visits for hyperglycemia at both a DHC region and county level (Exhibits 2.8 to 2.12). All regions experienced a decline in rates over the five-year period. However, differences across regions remained significant (Exhibit 2.8 and 2.9). The proportion of ED visits leading to hospitalization also varied depending on the location of the hospital. Regions containing institutions that participate in an AFP appear to have lower ED visit rates and a higher proportion of ED visits leading to hospitalization, likely because of under-reporting (Exhibit 2.12). In counties where all ED claims are billed directly to OHIP, the proportion of ED visits leading to hospital admission ranged from about 6% in some northern (Thunder Bay, Timiskaming) and eastern (Haliburton, Hastings, Prince Edward) counties, to close to 20% in Sudbury and Waterloo regional municipalities. Sites that admitted a larger proportion of patients visiting their EDs tended to have a lower volume of ED visits. This may be due to more efficient use of outpatient services to treat less severe cases in the community. However, this explanation cannot be confirmed without more detailed clinical data. The tendency for physicians to admit a patient to hospital may also vary from site to site. For example, Waterloo regional municipality had a higher number of admissions for hyperglycemia in 1999 than Lennox and Addington County despite having comparable ED volumes. The availability of hospital resources, teaching hospital status, and community alternatives to deal with these episodes in an outpatient setting likely also contributed to the observed variation in rates, although further examination is warranted.

The fall in admission rates for hyperglycemia occurred at a time when large scale studies promoting tighter control of blood glucose levels were published.[7,17] Thus, local practice patterns may have been influenced by this information, leading to better glycemic control for patients with DM throughout Ontario. Although tight glycemic control increases the risk of developing severe hypoglycemia, hospital admissions for hypoglycemia fell by 75% during the five-year period (Exhibit 2.13), while mortality rates and LOS remained the same (mortality 2.4% vs. 1.6%, p=0.9; median LOS 3 vs. 3, p=0.6).

Declining hospitalizations for hypoglycemia might reflect a shift in practice toward treating patients primarily in the ED with a lower proportion being admitted to hospital. The fact that overall rates of ED visits for DM also declined between 1995 and 1999 does not support this view. One possible explanation is that outpatient management has improved, leading to fewer severe episodes. However, it is not possible to comment on the number of episodes that were treated by emergency personnel in the field and not taken to hospital, as the use of emergency medical services is not captured by administrative data.

Similar declines in hospitalization for hypoglycemia were observed in different jurisdictions (Exhibit 2.14 and 2.15), but the exact rates varied across DHC regions (Exhibit 2.16). In 1995, admission rates were highest in the north and southwest regions; however, by 1999 these rates were similar to other regions of the province (Exhibit 2.14).

The risk of having at least one hyper- or hypoglycemic event (either a hospitalization or ED visit) was greatest among people living in northern communities, but the magnitude of this risk depends largely on age (Exhibit 2.17). For example, young people living in the north had a three-fold greater likelihood of being seen in an ED for any acute metabolic complication than their southern counterparts. Older persons (over 65 years of age) were also at a somewhat higher risk if they lived in northern communities. However, the odds ratio was much lower in this age group (OR 1.43 [1.33–1.53]). Subsidization of medication costs under the ODB Program for those 65 and over may help to offset some of the excess risk associated with living in northern communities. Other independent factors shown to increase the risk of developing an acute complication included failure to see a primary care physician in the previous year (2-fold risk) as well as younger age, lower socioeconomic status and rural residence. Factors that protected against developing an acute complication included more frequent primary care visits, having a regular primary care provider, and having seen a DM specialist in the previous year.

b) Infections

Rates of hospitalization for most common infections remained constant between 1995 and 1999 (Exhibit 2.18 and 2.19). In contrast, admissions for skin and soft tissue infections declined by 25% over the five-year period for all ages and subgroups. The risk of hospitalization for acute bacterial infections rose with increasing age over 65, with the highest rates occurring in the very elderly (over 75). Hospitalization rates were quite variable across DHC regions (Exhibit 2.20). Admissions for tuberculosis were highest in middle-aged people with DM and appeared to be even more sensitive to geographical location, as rates in Toronto far exceeded those in other regions (Exhibit 2.21).

It is not clear whether the observed fall in admission rates for skin and soft tissue infections is due to a reduction in the frequency or in the severity of infective episodes among people with DM. Diabetic foot infections probably make up a significant proportion of this category of infections. The importance of regular foot care has received considerable attention over the past five years and may have led to greater vigilance among primary care and other providers to recognize and treat infections earlier in their course. In addition, there may be a higher threshold for admitting these patients to hospital and greater community resources to provide proper wound care and treatment with oral or intravenous antibiotic therapy in the outpatient setting.

Conclusions

Between 1995 and 1999, hospital admissions for acute complications of DM decreased by 25% to 30% across Ontario. Similar trends in acute care hospitalizations have been noted for other chronic conditions.[18] However, during the same time period, there was also a fall in ED visits for DM. Thus, reduced bed availability and staffing of acute care hospitals cannot fully account for the observed changes in hospitalization patterns.

The findings, in part, reflect a general improvement in care delivered to people with DM in the province between 1995 and 1999. Although there is mounting evidence that tight control of blood glucose levels can reduce or prevent long-term complications of DM, health care professionals are sometimes slow to adopt even the best evidence for care of their patients and blood glucose control is likely more difficult to achieve in the overall diabetic population compared to those seen in clinical trials. However, even small changes in the intensity of therapy can lead to fewer cases with extremely poor glycemic control, and thus can have a large impact on admissions for hyperglycemia. A shift toward treating severe episodes of hypoglycemia in an outpatient setting may have limited the rise in admissions for low blood glucose levels expected to occur with more aggressive DM management.

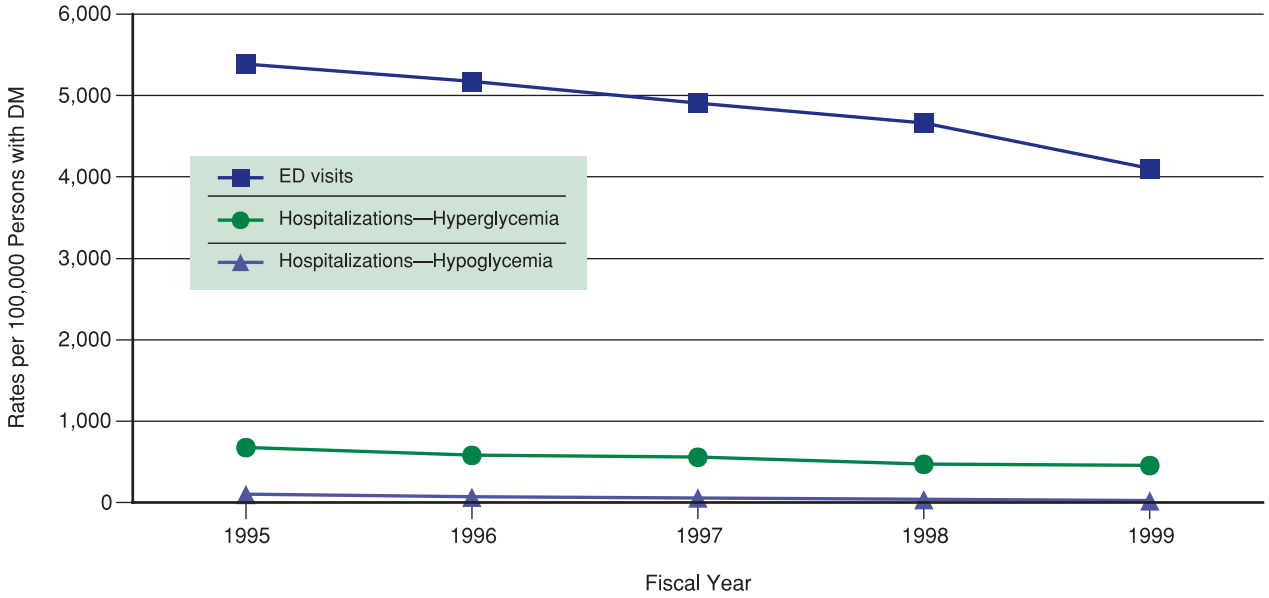
A number of patient factors, including socioeconomic status, geographic region and outpatient care use, predicted the development of acute complications of DM. Northern regions had the highest rates of ED visits for DM, suggesting a possible lack of access to outpatient services in these communities. By 1999, there was less regional variation in hospitalizations for hyper- and hypoglycemia across the province. However, rates of ED visits for DM occurring in the north still exceeded those seen in other jurisdictions. Future research should focus on understanding patterns of health care delivery and utilization across regions. Greater access to outpatient services, including DM education programs, may further reduce the frequency of acute care visits for hyper- and hypoglycemia through earlier treatment and prevention.

Lastly, there was a fall in hospitalizations for skin and soft tissue infections over the five-year time period, while admission rates for other infections that commonly occur in people with DM remained constant. This finding may be due to a greater degree of attention devoted to foot care and both earlier and more aggressive management of diabetic foot infections in the outpatient setting.

Overall, these results represent an improvement in outcomes for persons with DM and potential cost savings to the health care system. The number of acute complications in each DHC region and county are small and detailed clinical information that could explain the observed differences between jurisdictions is not available in administrative data. Thus, the variations across regions are of interest but should be interpreted with caution. Each DHC region and county should examine its own area in more detail to gain a better understanding of the local rates of acute complications of DM and the health care factors that influence them.

Exhibit 2.3 Rates of Hospitalizations and ED Visits† for Hyper- and Hypoglycemia per 100,000 Ontarians with DM Aged 20 Years and Over, 1995–1999

Between fiscal years 1995 and 1999, hospital admissions for hyperglycemia fell by 30%, whereas admissions for hypoglycemia decreased by 75%. ED visits for DM also fell by 24% over the same period of study.

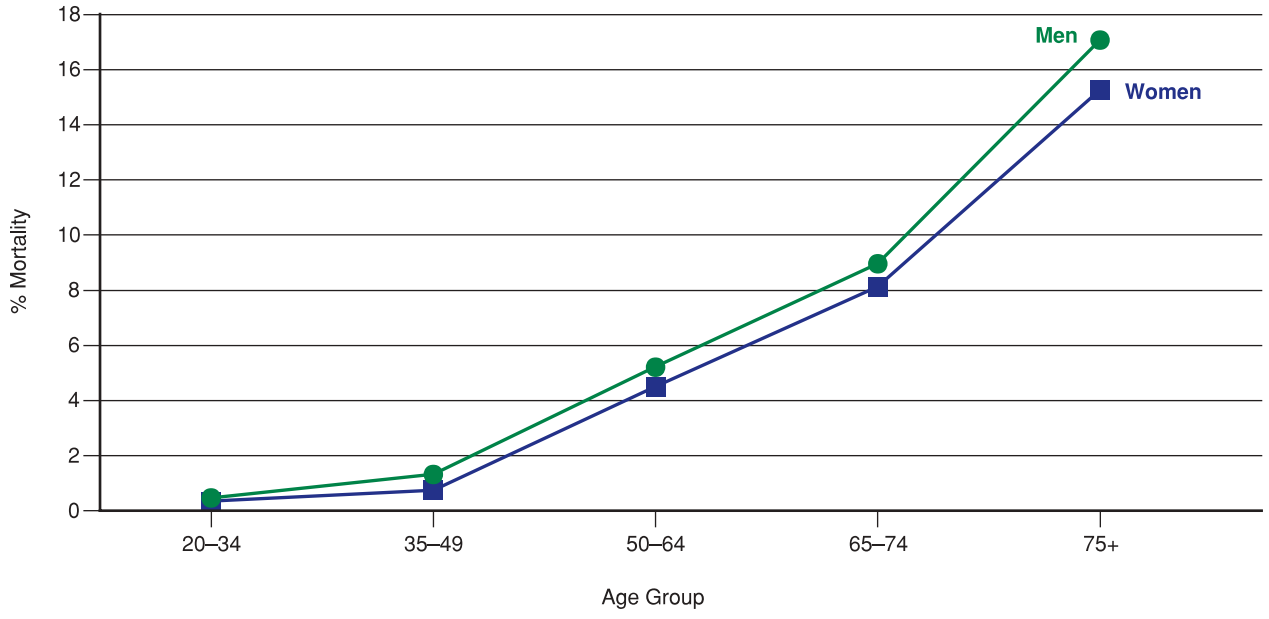


† Hyper- and hypoglycemia combined.

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP)

Exhibit 2.4 In-Hospital Mortality following Admission for Acute Hyperglycemia Among Ontarians with DM Aged 20 Years and Over, 1995–1999

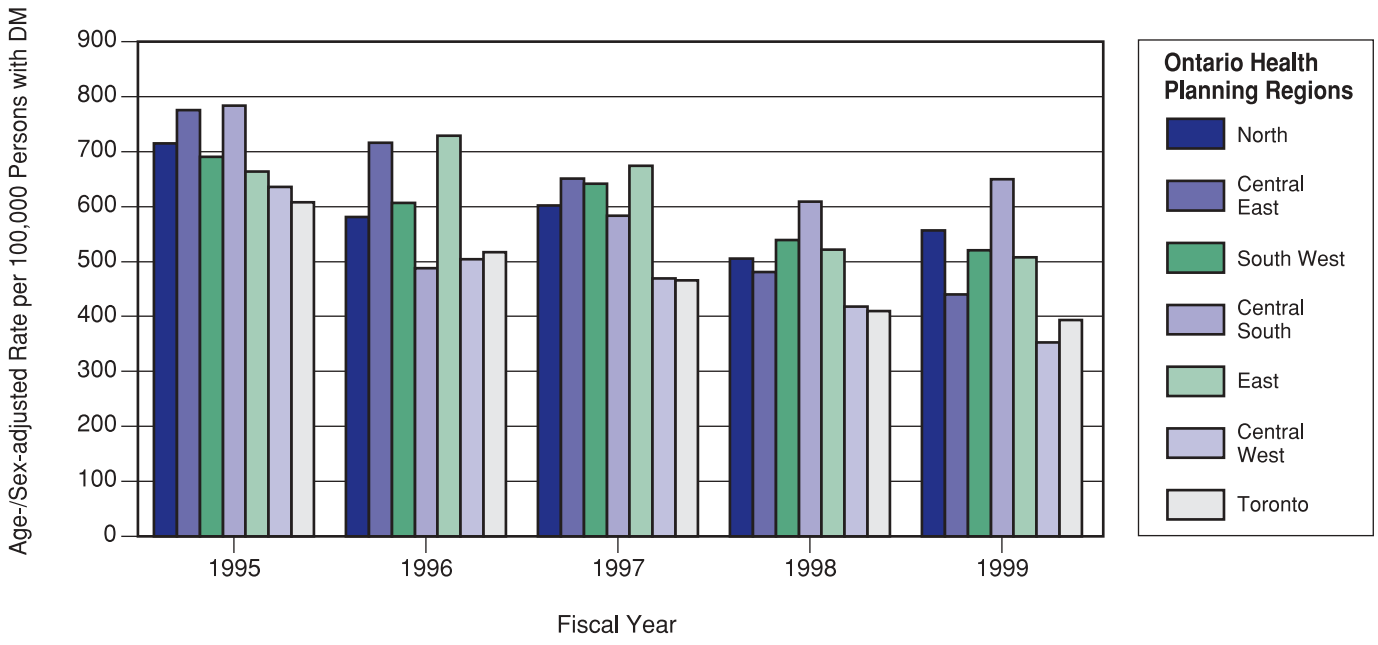
In-hospital mortality was directly related to age.



Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

Exhibit 2.5 Regional Rates of Hospitalizations for Hyperglycemia per 100,000 Ontarians with DM Aged 20 Years and Over, 1995–1999

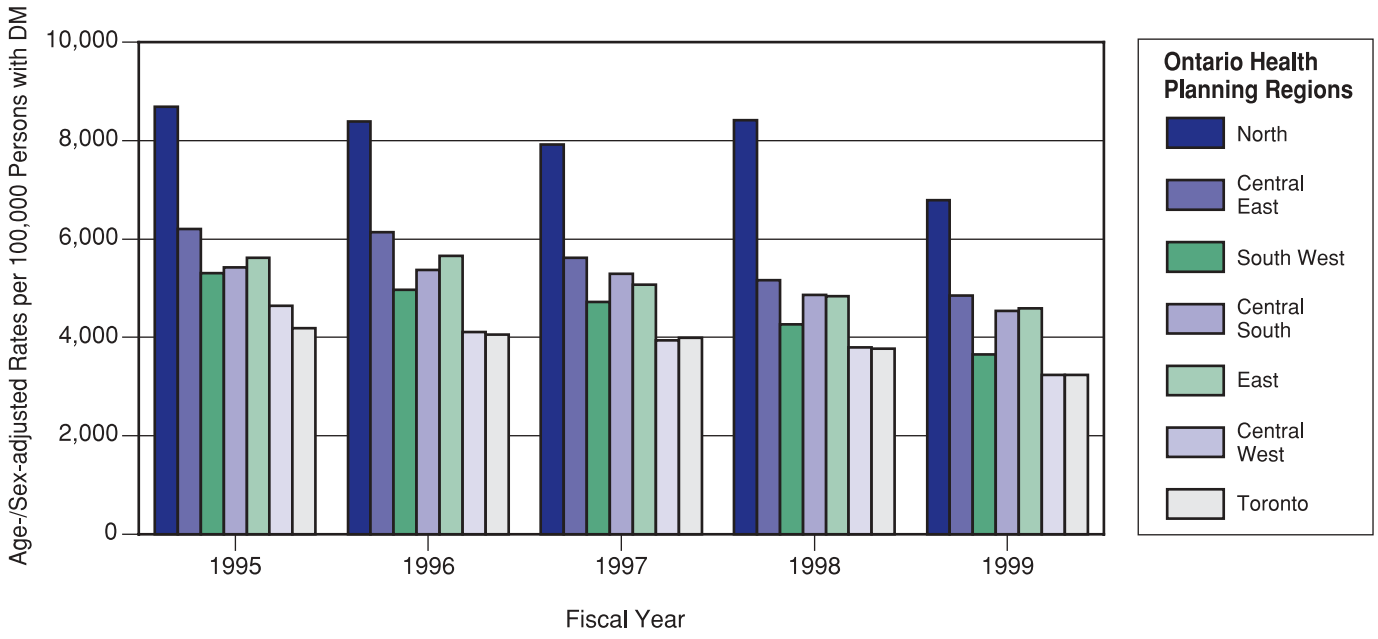
Northern communities had similiar rates of hospitalizations for hyperglycemia to Southern Ontario.



Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

Exhibit 2.6 Regional Rates of ED visits for DM per 100,000 Ontarians with DM Aged 20 Years and Over, 1995–1999

Northern communities had markedly higher rates of ED visits than in Southern Ontario.



Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP)

Exhibit 2.7 Average In-Hospital Mortality for Ontarians with DM Admitted for Hyperglycemia by DHC 1995–1999

The mean in-hospital mortality rate varied across DHC regions.

District Health Councils	Number of Cases	Crude Mortality Rate (%)	Age-/Sex-adjusted Mortality Rate (%)
Algoma, Cochrane, Manitoulin & Sudbury	439	4.5	4.7
Champlain	952	4.9	5.0
Durham, Haliburton, Kawartha & Pine Ridge	711	4.4	4.7
Essex, Kent, and Lambton	741	5.1	5.4
Grand River	276	5.8	6.9
Grey, Bruce, Huron, Perth	347	2.9	3.1
Halton-Peel	715	3.3	3.7
Hamilton-Wentworth	551	8.8	9.1
Metropolitan Toronto	2,382	6.7	6.9
Muskoka, Nipissing, Parry Sound & Timiskaming	204	5.7	6.2
Niagara Region	361	3.6	3.8
Northwestern Ontario	249	3.0	3.0
Quinte, Kingston, Rideau	410	5.3	6.7
Simcoe-York	735	4.0	4.3
Thames Valley	643	6.5	7.0
Waterloo Region-Wellington-Dufferin	423	2.3	2.6

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

Exhibit 2.8 Age-/Sex-adjusted Annual Rates of Hospitalizations for Hyperglycemia per 100,000 Ontarians with DM Aged 20 Years and Over by DHC, 1995–1999

All regions experienced a decline in hospitalizations, but the differences across regions remained significant.

District Health Councils (Rate = per 100,000 persons)	1995	1996	1997	1998	1999
Algoma, Cochrane, Manitoulin & Sudbury	732	540	673	613	651
Champlain	734	799	744	574	532
Durham, Haliburton, Kawartha & Pine Ridge	927	804	673	434	415
Essex, Kent, and Lambton	587	541	725	530	470
Grand River	631	543	573	526	533
Grey, Bruce, Huron, Perth	909	704	686	618	452
Halton-Peel	583	476	414	375	296
Hamilton-Wentworth	895	431	666	800	865
Metropolitan Toronto	607	517	466	410	394
Muskoka, Nipissing, Parry Sound & Timiskaming	725	718	544	378	613
Niagara Region	778	530	504	464	494
Northwestern Ontario	680	559	550	434	400
Quinte, Kingston, Rideau	533	593	545	436	466
Simcoe-York	634	637	638	522	458
Thames Valley	712	632	518	519	614
Waterloo Region-Wellington-Dufferin	788	586	602	516	481
P value for chi square	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
CV (Coefficient of variation)	16.3	18.3	19.1	20.1	25.6
EQ (Extremal quotient)	1.7	1.9	1.8	2.1	2.9
SCV (Systematic component of variation)	23.0	22.6	19.2	43.9	74.1

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

Exhibit 2.9 Age-/Sex-adjusted Annual Rates of ED Visits for Hyperglycemia per 100,000 Ontarians with DM Aged 20 Years and Over by DHC, 1995–1999

All regions experienced a decline in ED visits, but the differences across regions remained significant.

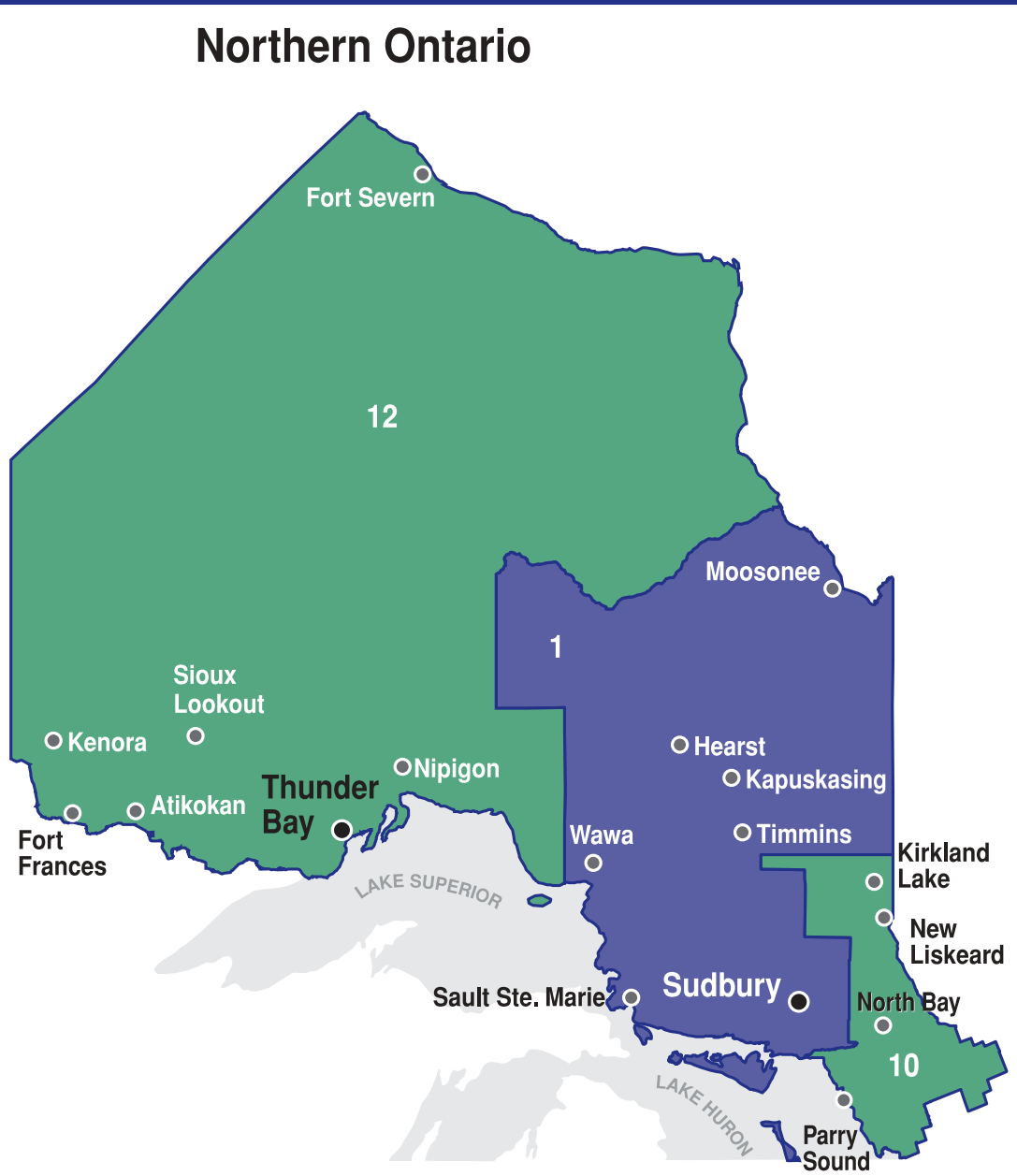
District Health Councils (Rate = per 100,000 persons)	1995	1996	1997	1998	1999
Algoma, Cochrane, Manitoulin & Sudbury	7,667	7,376	6,769	6,688	6,615
Champlain	5,110	5,474	4,593	4,462	4,142
Durham, Haliburton, Kawartha & Pine Ridge	6,506	6,665	5,784	5,248	5,090
Essex, Kent, and Lambton	6,350	5,780	5,065	4,551	3,486
Grand River	5,717	4,615	4,779	4,511	4,083
Grey, Bruce, Huron, Perth	8,476	7,627	8,098	7,476	7,116
Halton-Peel	4,698	4,214	4,029	3,812	3,190
Hamilton-Wentworth	2,685	3,700	3,534	2,956	2,778
Metropolitan Toronto	4,180	4,055	3,989	3,773	3,236
Muskoka, Nipissing, Parry Sound & Timiskaming	9,806	9,830	8,169	7,822	7,963
Niagara Region	8,051	7,604	7,415	7,084	6,636
Northwestern Ontario	9,336	8,805	9,508	11,367	6,225
Quinte, Kingston, Rideau	6,573	6,026	5,986	5,594	5,532
Simcoe-York	5,948	5,704	5,510	5,128	4,659
Thames Valley	2,425	2,659	2,593	2,297	2,123
Waterloo Region-Wellington-Dufferin	4,815	4,124	3,908	3,934	3,414
P value for chi square	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
CV (Coefficient of variation)	32.2	30.4	30.4	35.3	33.5
EQ (Extremal quotient)	4.1	3.7	3.7	5.0	3.8
SCV (Systematic component of variation)	168.4	152.3	166.0	252.7	186.0

=1–3 EDs* = 4 or more EDs = Largely teaching hospitals

*DHCs containing one or more EDs with Alternate Funding Plans.

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP)

Exhibit 2.10a Average Age-/Sex-adjusted Rates of Hospitalization for Hyperglycemia per 100,000 Ontarians with DM Aged 20 Years and Over by DHC in Northern Ontario, 1995–1999



Ontario District Health Councils

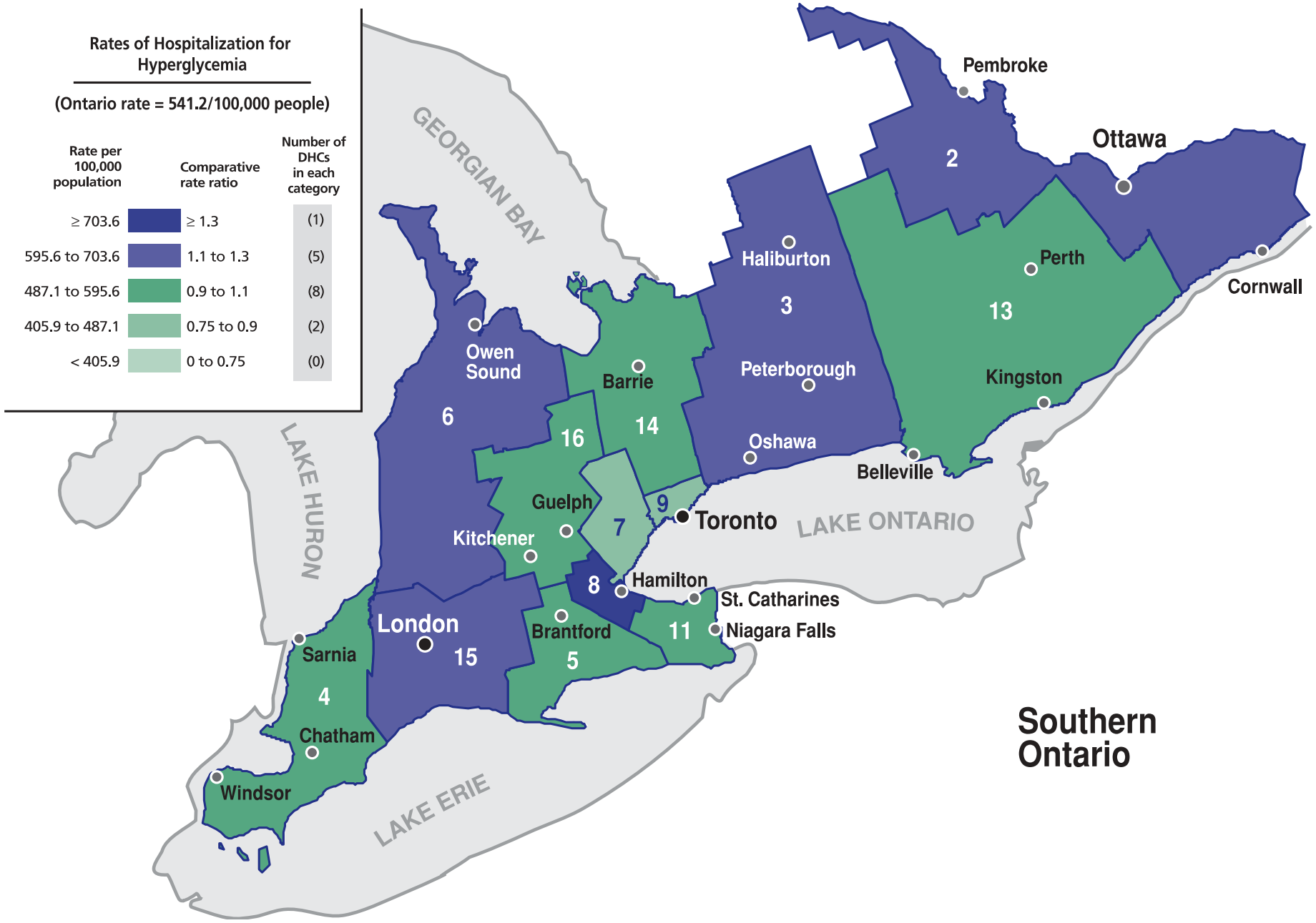
1 Algoma, Cochrane, Manitoulin & Sudbury
2 Champlain
3 Durham, Haliburton, Kawartha & Pine Ridge
4 Essex, Kent and Lambton
5 Grand River
6 Grey, Bruce, Huron, Perth
7 Halton-Peel
8 Hamilton-Wentworth
9 Metropolitan Toronto
10 Muskoka, Nipissing, Parry Sound & Timiskaming
11 Niagara Region
12 Northwestern Ontario
13 Quinte, Kingston, Rideau
14 Simcoe-York
15 Thames Valley
16 Waterloo Region-Wellington-Dufferin

Rates of Hospitalization for Hyperglycemia
(Ontario rate = 541.2/100,000 people)

Rate per 100,000 population	Comparative rate ratio	Number of DHCs in each category
≥ 703.6	≥ 1.3	(1)
595.6 to 703.6	1.1 to 1.3	(5)
487.1 to 595.6	0.9 to 1.1	(8)
405.9 to 487.1	0.75 to 0.9	(2)
< 405.9	0 to 0.75	(0)

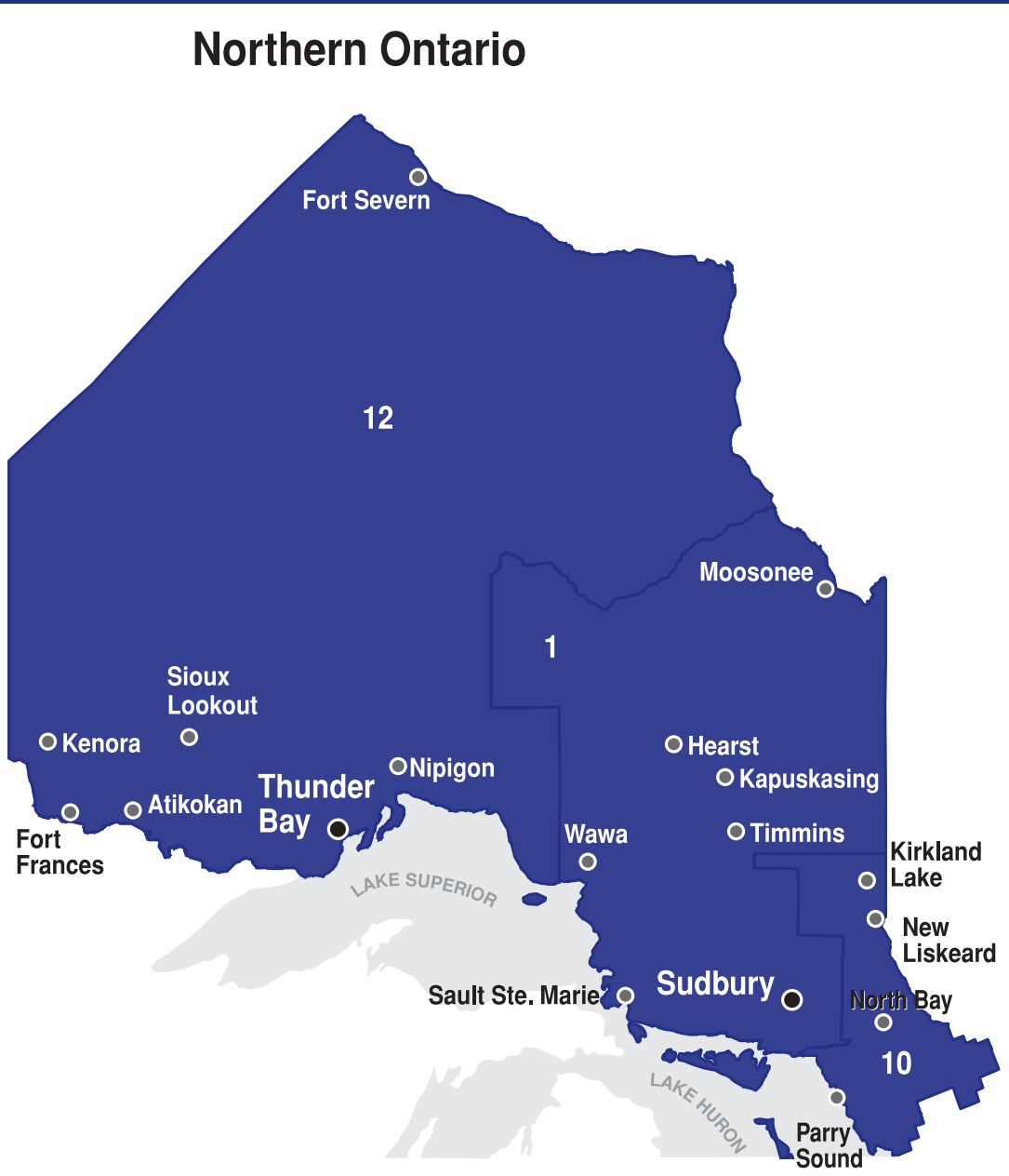
Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

Exhibit 2.10b Average Age-/Sex-adjusted Rates of Hospitalization for Hyperglycemia per 100,000 Ontarians with DM Aged 20 Years and Over by DHC in Southern Ontario, 1995–1999



Note: See Exhibit 2.10a for DHC definitions. Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

Exhibit 2.11a Average Age-/Sex-adjusted Rates of ED Visits per 100,000 Ontarians with DM Aged 20 Years and Over by DHC in Northern Ontario, 1995–1999



Ontario District Health Councils

1 Algoma, Cochrane, Manitoulin & Sudbury
2 Champlain
3 Durham, Haliburton, Kawartha & Pine Ridge
4 Essex, Kent and Lambton
5 Grand River
6 Grey, Bruce, Huron, Perth
7 Halton-Peel
8 Hamilton-Wentworth
9 Metropolitan Toronto
10 Muskoka, Nipissing, Parry Sound & Timiskaming
11 Niagara Region
12 Northwestern Ontario
13 Quinte, Kingston, Rideau
14 Simcoe-York
15 Thames Valley
16 Waterloo Region-Wellington-Dufferin

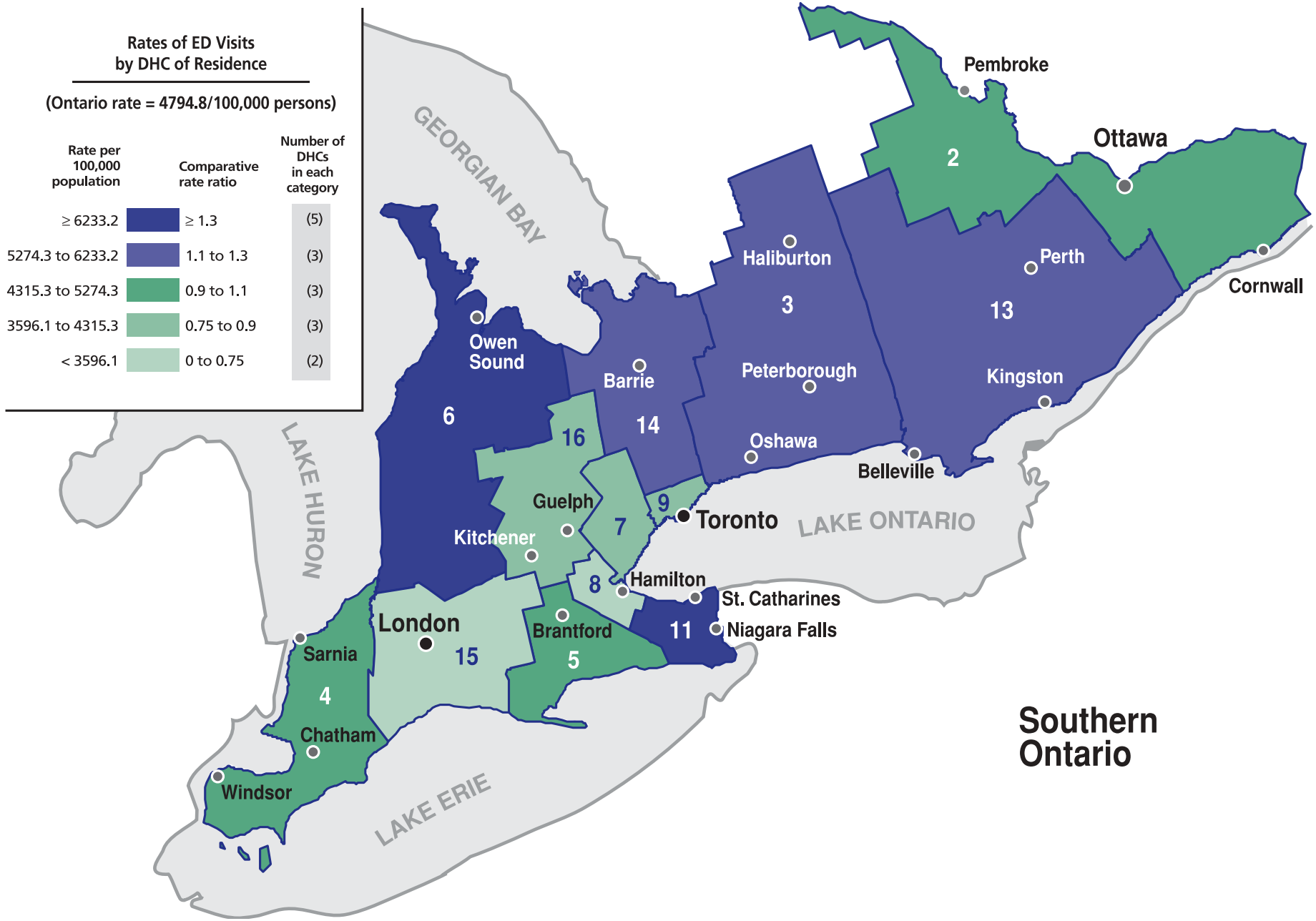
Rates of ED Visits by DHC of Residence

(Ontario rate = 4794.8/100,000 persons)

Rate per 100,000 population	Comparative rate ratio	Number of DHCs in each category
≥ 6233.2	≥ 1.3	(5)
5274.3 to 6233.2	1.1 to 1.3	(3)
4315.3 to 5274.3	0.9 to 1.1	(3)
3596.1 to 4315.3	0.75 to 0.9	(3)
< 3596.1	0 to 0.75	(2)

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP)

Exhibit 2.11b Average Age-/Sex-adjusted Rates of ED Visits per 100,000 Ontarians with DM Aged 20 Years and Over by DHC in Southern Ontario, 1995–1999



Note: See Exhibit 2.11a for DHC definitions.

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP)

Exhibit 2.12 Average Age-/Sex-adjusted Rates of Hospitalizations for Hyperglycemia and ED Visits for DM per 100,000 Ontarians with DM Aged 20 Years and Over by County, 1995–1999

	Hospitalization	ED Visits	% ED Visits Admitted
Algoma District	1,052	8,766	12.0
Brant County	490	3,916	12.5
Bruce County	675	10,810	6.2
Cochrane District	544	10,945	5.0
Dufferin County	742	7,735	9.6
Durham Regional Municipality	498	5,266	9.5
Elgin County	463	4,263	10.9
Essex County	514	5,072	10.1
Frontenac County	414	808	51.2
Grey County	792	7,313	10.8
Haldimand-Norfolk Regional Municipality	630	5,503	11.4
Haliburton County	575	8,582	6.7
Halton Regional Municipality	542	4,770	11.4
Hamilton-Wentworth Regional Municipality	737	3,123	23.6
Hastings County	525	8,668	6.1
Huron County	616	6,420	9.6
Kenora District	633	12,128	5.2
Kent County	570	4,673	12.2
Lambton County	729	4,835	15.1
Lanark County	719	9,714	7.4
Leeds and Grenville United Counties	589	5,682	10.4
Lennox and Addington County	295	3,259	9.1
Manitoulin District	816	10,696	7.6
Middlesex County	653	1,215	53.7
Muskoka District	475	6,912	6.9
Niagara Regional Municipality	547	7,314	7.5
Nipissing District	721	10,170	7.1
Northumberland County	965	7,785	12.4
Ottawa-Carleton Regional Municipality	642	2,953	21.7
Oxford County	463	5,217	8.9
Parry Sound District	380	5,702	6.7
Peel Regional Municipality	380	3,666	10.4
Perth County	510	6,639	7.7
Peterborough County	723	5,212	13.9
Prescott and Russell United Counties	557	6,799	8.2
Prince Edward County	643	12,456	5.2
Rainy River District	439	3,984	11.0
Renfrew County	1,272	12,239	10.4
Simcoe County	813	7,579	10.7
Stormont, Dundas and Glengarry United Counties	382	5,998	6.4
Sudbury District	385	5,736	6.7
Sudbury Regional Municipality	423	2,702	15.7
Thunder Bay District	483	8,294	5.8
Timiskaming District	610	10,749	5.7
Toronto Metropolitan Municipality	470	3,808	12.3
Victoria County	931	6,932	13.4
Waterloo Regional Municipality	553	3,130	17.7
Wellington County	619	5,106	12.1
York Regional Municipality	451	4,202	10.7

= Counties containing one or more EDs with Alternate Funding Plans. Small area rate variation analysis was not performed for rates that were pooled across years.
Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP)

Exhibit 2.13 Overall and Age-/Sex-specific Rates of Hospitalizations for Hypoglycemia per 100,000 Ontarians with DM Aged 20 Years and Over, 1995–1999

Hypoglycemia-related hospital admissions fell by 75% during the study period.

Fiscal Year	Overall Rate	Women by Age Group				Men by Age Group			
		20–49	50–65	65–74	75+	20–49	50–65	65–74	75+
1995	103	110	53	80	150	128	66	93	216
1996	68	62	40	61	121	86	33	71	110
1997	59	61	34	41	119	85	23	52	106
1998	39	36	32	45	73	28	23	29	68
1999	24	9	11	27	44	24	9	34	45
P value*	0.003	0.008	0.01	0.01	0.005	0.01	0.03	0.01	0.02

*P value is for trend over time

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

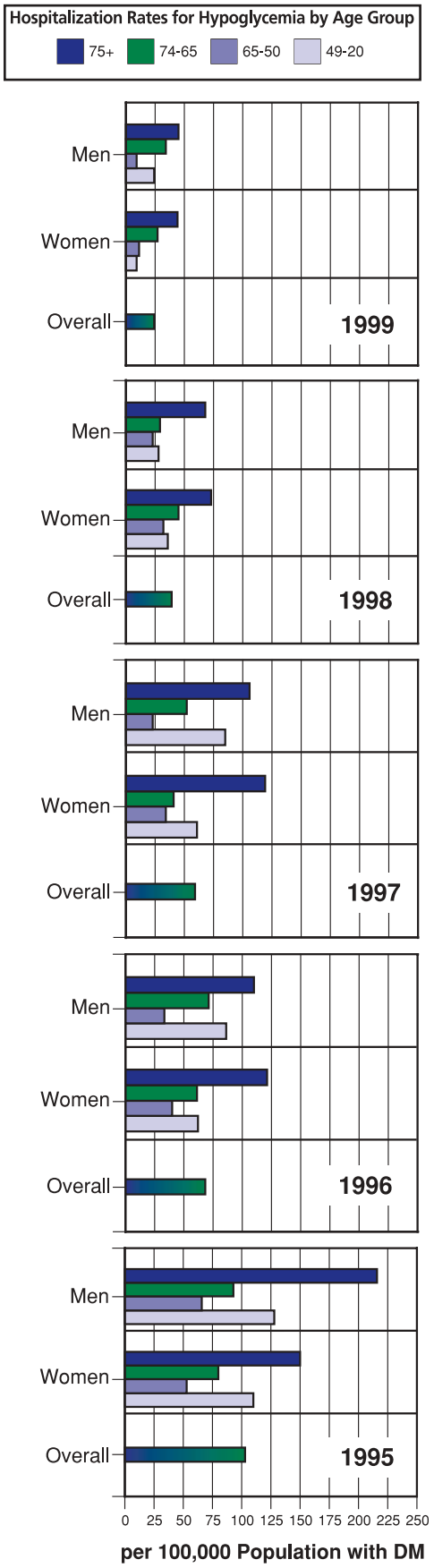
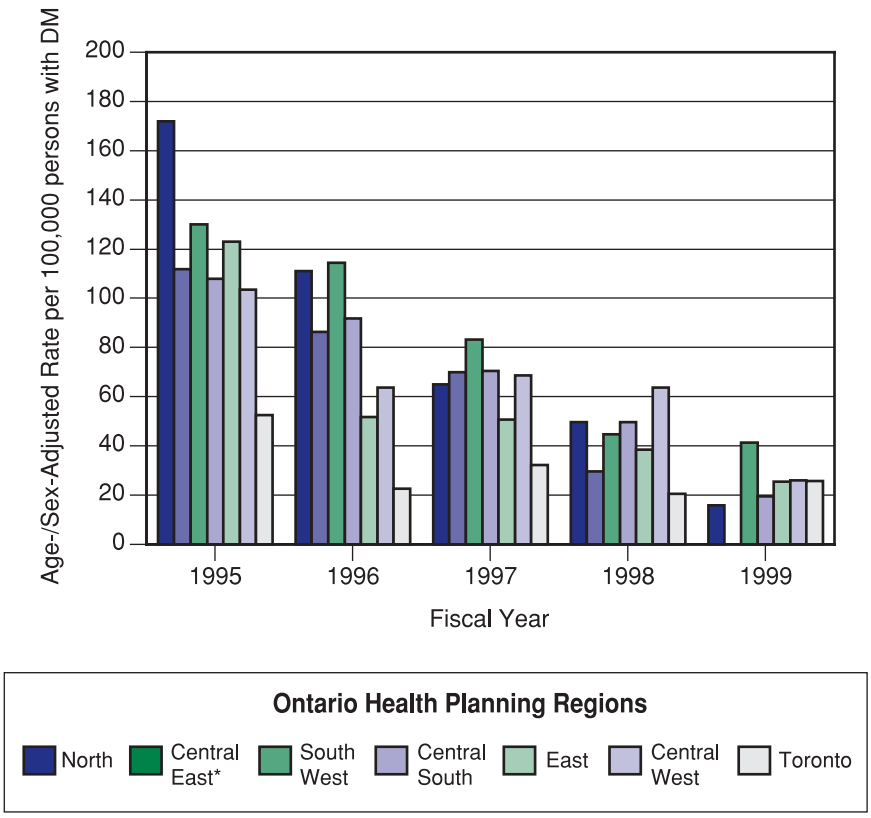


Exhibit 2.14 Regional Rates of Hospitalizations for Hypoglycemia per 100,000 Ontarians with DM Aged 20 Years and Over, 1995–1999

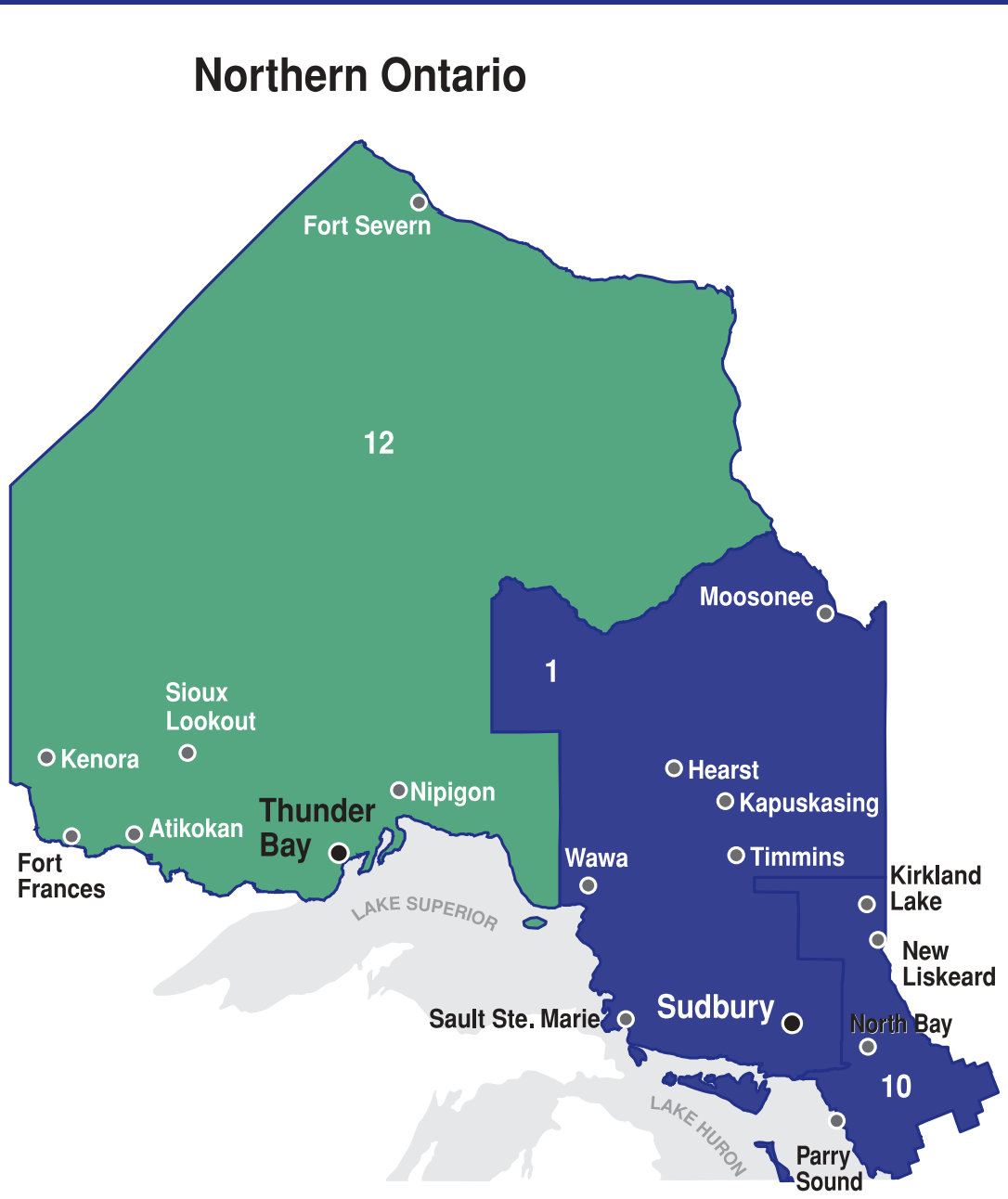
Similar declines in hypoglycemia-related hospitalizations were noted in different jurisdictions but the exact rates varied across regions.



* Hospitalization rate for Central East: <20 per 100,000 in 1999.

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

Exhibit 2.15a Average Age-/Sex-adjusted Rates of Hospitalizations for Hypoglycemia per 100,000 Ontarians with DM Aged 20 Years and Over by DHC in Northern Ontario, 1995–1999



Ontario District Health Councils

1 Algoma, Cochrane, Manitoulin & Sudbury
2 Champlain
3 Durham, Haliburton, Kawartha & Pine Ridge
4 Essex, Kent and Lambton
5 Grand River
6 Grey, Bruce, Huron, Perth
7 Halton-Peel
8 Hamilton-Wentworth
9 Metropolitan Toronto
10 Muskoka, Nipissing, Parry Sound & Timiskaming
11 Niagara Region
12 Northwestern Ontario
13 Quinte, Kingston, Rideau
14 Simcoe-York
15 Thames Valley
16 Waterloo Region-Wellington-Dufferin

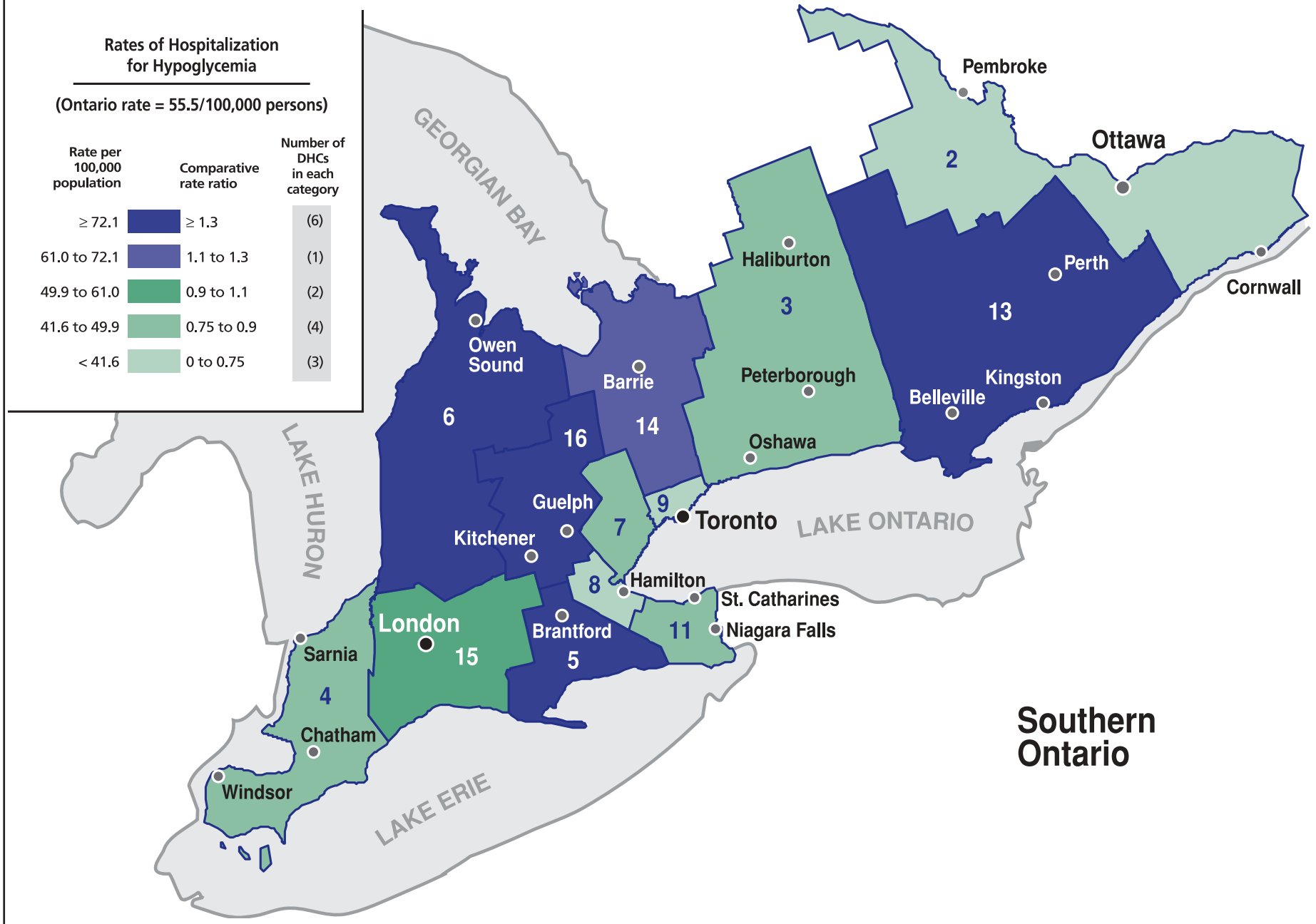
Rates of Hospitalization for Hypoglycemia

(Ontario rate = 55.5/100,000 persons)

Rate per 100,000 population	Comparative rate ratio	Number of DHCs in each category
≥ 72.1	≥ 1.3	(6)
61.0 to 72.1	1.1 to 1.3	(1)
49.9 to 61.0	0.9 to 1.1	(2)
41.6 to 49.9	0.75 to 0.9	(4)
< 41.6	0 to 0.75	(3)

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

Exhibit 2.15b Average Age-/Sex-adjusted Rates of Hospitalizations for Hypoglycemia per 100,000 Ontarians with DM Aged 20 Years and Over by DHC in Southern Ontario, 1995–1999



Note: See Exhibit 2.15a for DHC definitions.

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

Exhibit 2.16 Average Age-/Sex-adjusted Annual Rates of Hospitalizations for Hypoglycemia per 100,000 Ontarians with DM Aged 20 Years and Over by DHC, 1995–1999

District Health Councils	Average Hospitalization Rate per Year
Algoma, Cochrane, Manitoulin & Sudbury	73
Champlain	35
Durham, Haliburton, Kawartha & Pine Ridge	49
Essex, Kent, and Lambton	50
Grand River	153
Grey, Bruce, Huron, Perth	199
Halton-Peel	43
Hamilton-Wentworth	33
Metropolitan Toronto	30
Muskoka, Nipissing, Parry Sound & Timiskaming	98
Niagara Region	44
Northwestern Ontario	58
Quinte, Kingston, Rideau	91
Simcoe-York	63
Thames Valley	55
Waterloo Region-Wellington-Dufferin	104

Small area rate variation analysis was not performed for rates that were pooled across years

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

Exhibit 2.17 Risk of Hospitalization or ED visit in Ontario for Hyper- or Hypoglycemia by Age and Region of Residence

The risk of at least one hyper- or hypoglycemic event occurring was greater among young people in northern communities.

	Age Group					
	18–44		45–64		65–100	
Region	Odds Ratio	Confidence Interval	Odds Ratio	Confidence Interval	Odds Ratio	Confidence Interval
North West	**3.12**	2.89–3.38	**2.40**	2.25–2.56	**1.43**	1.33–1.53
North East	**2.28**	2.14–2.43	**1.95**	1.87–2.03	**1.36**	1.30–1.42
South West	**1.45**	1.38–1.53	**1.31**	1.26–1.36	**1.00**	0.97–1.03
Central West	**1.26**	1.12–1.41	**1.16**	1.12–1.20	**0.95**	0.92–0.98
East	**0.88**	0.77–1.00	**1.11**	1.07–1.15	**0.99**	0.95–1.02
Central South	**1.00**	1.00	**1.00**	1.00	**1.00**	1.00

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP)

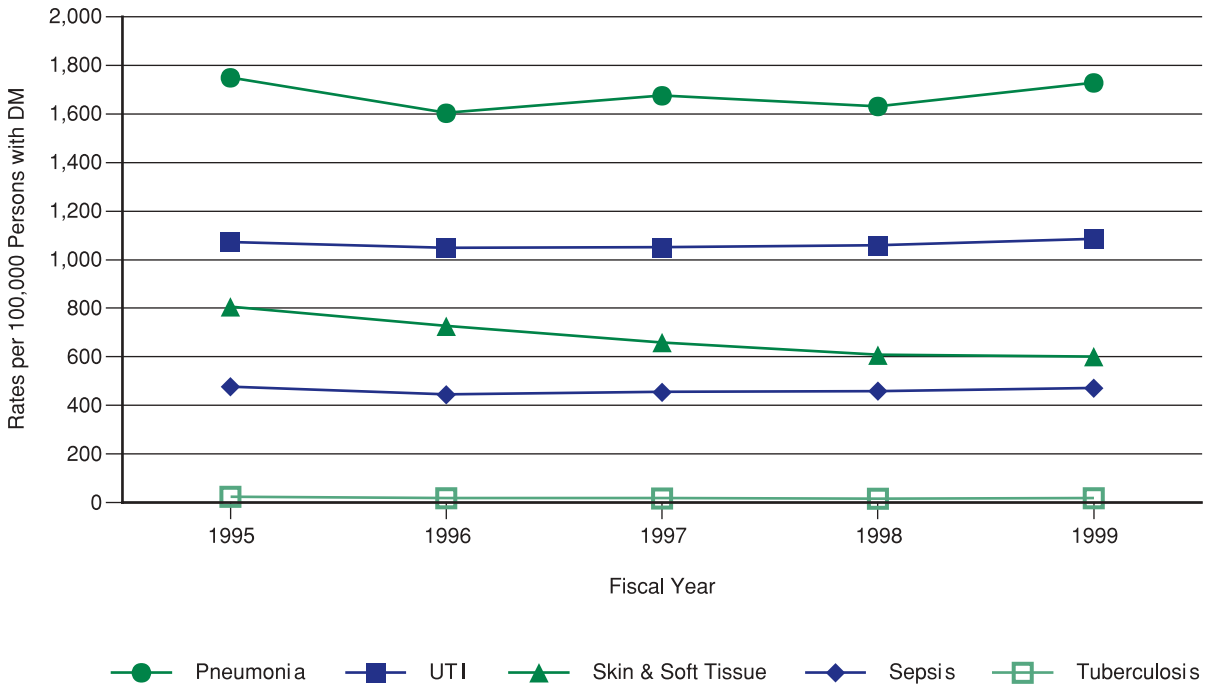
Exhibit 2.18 Overall and Age-/Sex-specific Rates of Hospitalizations for Common Infections per 100,000 Ontarians with DM Aged 20 Years and Over, 1995–1999

Hospitalization rates for skin and soft tissue infections declined by 25% while rates for most common infections remained constant.

Fiscal Year	Overall Rate	Women by Age Group					Men by Age Group				
		20-34	35-49	50-64	65-74	75+	20-34	35-49	50-64	65-74	75+
Urinary Tract Infections											
1995	1,074	706	614	853	1,445	3,045	109	173	377	897	1,912
1996	1,050	898	627	769	1,393	2,935	251	185	317	926	1,918
1997	1,051	714	587	806	1,436	2,942	190	145	323	873	2,000
1998	1,059	576	569	781	1,440	3,052	180	181	335	856	1,959
1999	1,085	707	560	798	1,389	3,118	156	195	350	812	2,186
Pneumonia											
1995	1,750	418	516	873	1,634	3,684	523	441	836	2,136	5,704
1996	1,604	415	441	823	1,454	3,277	432	417	749	2,101	5,121
1997	1,676	479	485	814	1,484	3,536	360	416	827	2,129	5,284
1998	1,632	306	439	835	1,429	3,396	406	447	803	1,943	5,314
1999	1,729	350	491	908	1,649	3,674	408	461	805	2,059	5,282
Bacteremia/Sepsis											
1995	478	176	203	289	613	826	152	213	286	552	1,177
1996	445	169	199	330	453	837	120	182	286	550	988
1997	455	133	218	287	518	830	152	192	283	553	1,054
1998	460	131	215	320	503	852	153	200	327	595	863
1999	472	124	218	312	515	846	174	186	303	604	1,048
Skin & Soft Tissue											
1995	807	539	674	651	742	1,037	566	794	809	891	1,030
1996	727	347	537	636	712	859	482	806	702	816	921
1997	660	408	476	557	605	773	484	711	610	747	982
1998	608	387	384	502	508	772	487	595	586	741	868
1999	602	274	446	476	588	737	539	579	619	627	864

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

Exhibit 2.19 Rates of Hospitalizations for Common Infections per 100,000 Ontarians with DM Aged 20 Years and Over, 1995–1999



Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

Exhibit 2.20 Average Age-/Sex-adjusted Rates of Hospitalizations for Common Infections per 100,000 Ontarians with DM Aged 20 Years and Over by DHC, 1995–1999

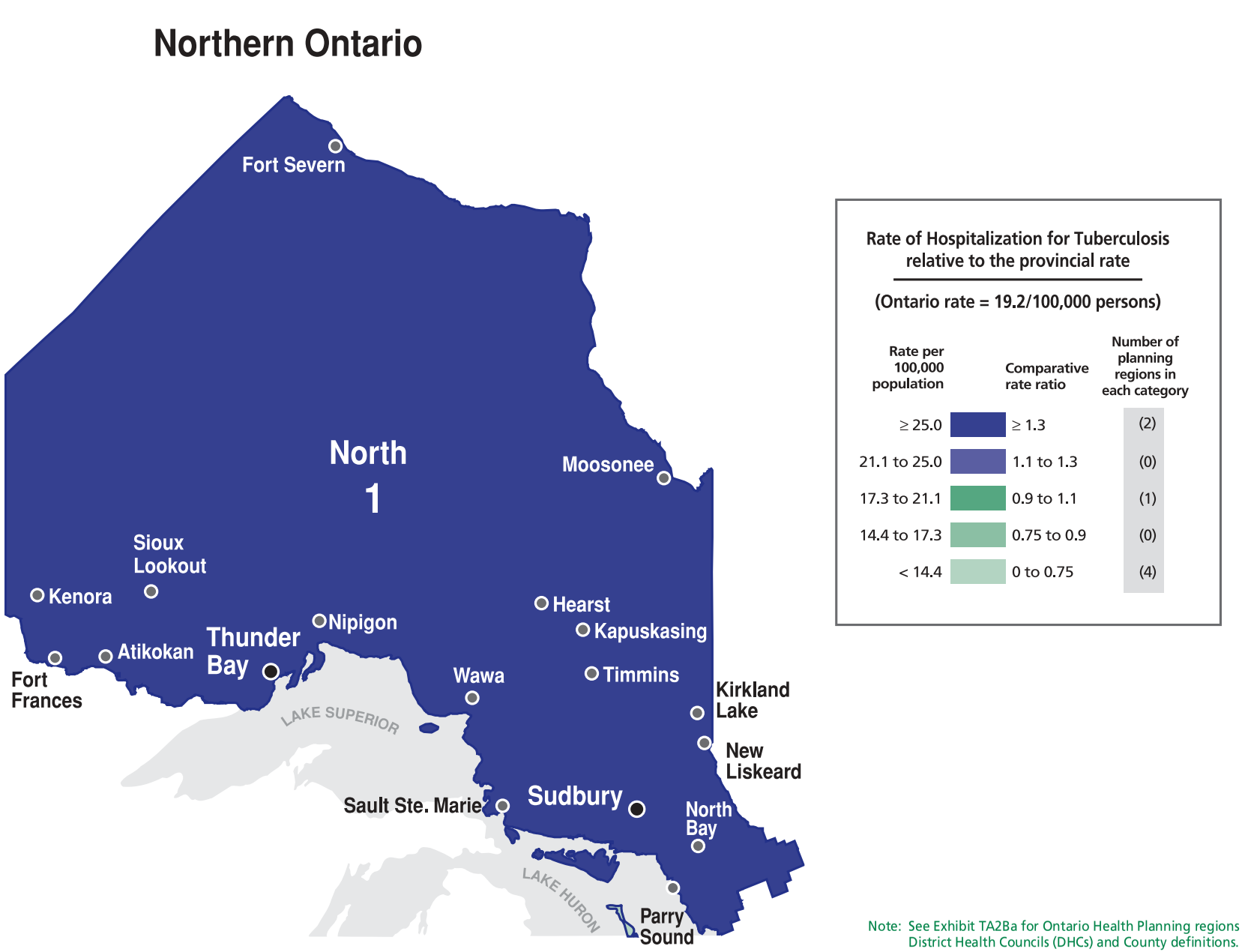
Hospitalization rates for common infections varied across DHC regions.

District Health Councils (Rate = per 100,000 persons)	Urinary Tract	Skin & Soft Tissue	Pneumonia	Sepsis
Algoma, Cochrane, Manitoulin & Sudbury	1,304	782	2,062	465
Champlain	874	681	1,725	382
Durham, Haliburton, Kawartha & Pine Ridge	841	587	2,121	340
Essex, Kent, and Lambton	1,366	852	1,516	459
Grand River	1,189	846	2,171	528
Grey, Bruce, Huron, Perth	1,160	966	1,846	445
Halton-Peel	782	436	1,394	451
Hamilton-Wentworth	1,423	755	1,848	538
Metropolitan Toronto	960	570	1,492	464
Muskoka, Nipissing, Parry Sound & Timiskaming	1,046	800	2,021	402
Niagara Region	1,080	752	1,336	476
Northwestern Ontario	1,754	1,123	2,029	531
Quinte, Kingston, Rideau	1,056	779	2,167	461
Simcoe-York	1,012	571	1,632	481
Thames Valley	1,265	802	1,423	481
Waterloo Region-Wellington-Dufferin	1,213	753	1,602	559

Small area rate variation analysis was not performed for rates that were pooled across years

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

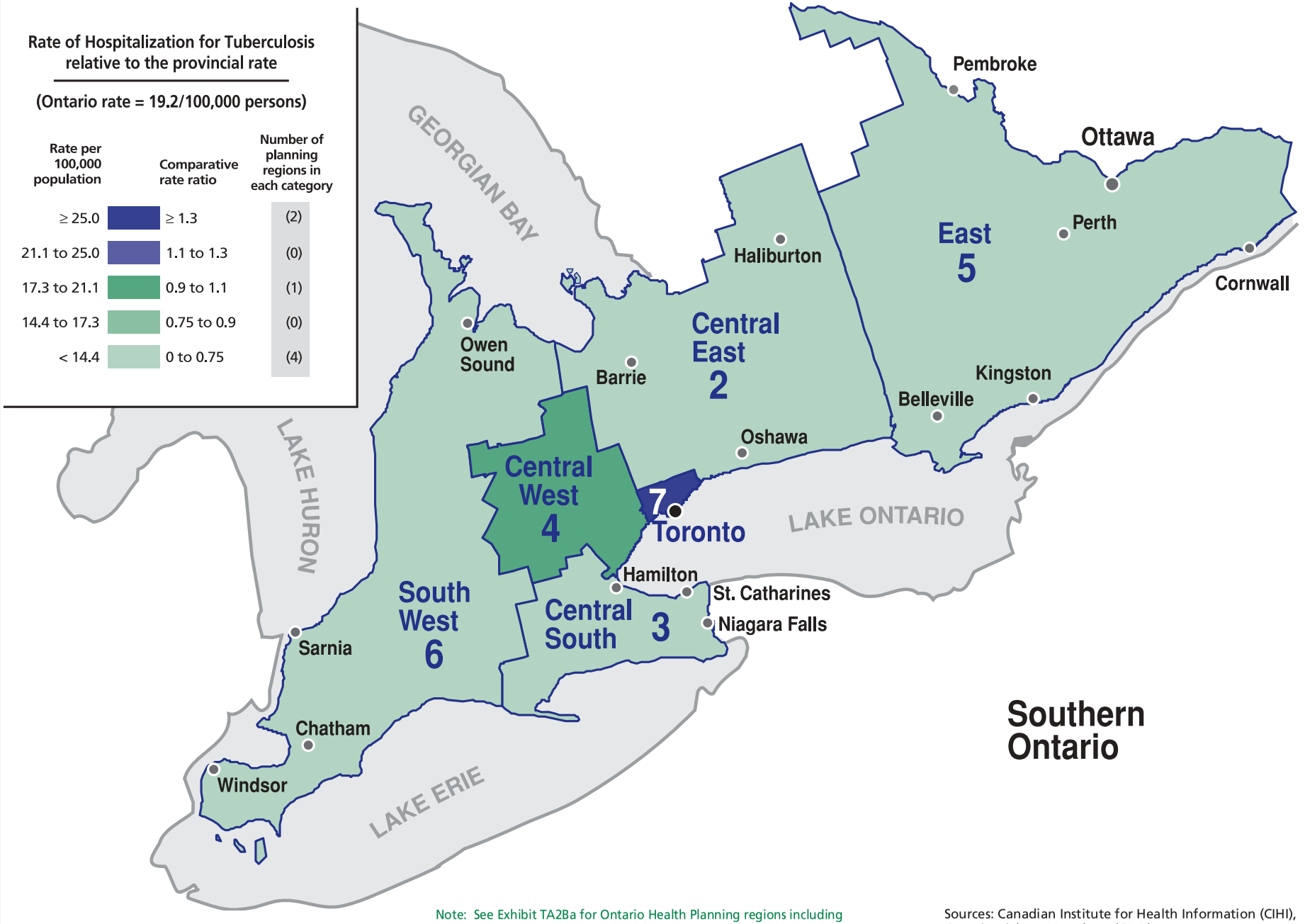
Exhibit 2.21a Age-/Sex-adjusted Rates of Hospitalization for Tuberculosis per 100,000 Ontarians with DM Aged 20 Years and Over by Planning Regions in Northern Ontario, 1995–1999



Note: See Exhibit TA2Ba for Ontario Health Planning regions including District Health Councils (DHCs) and County definitions.

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

Exhibit 2.21b Age-/Sex-adjusted Rates of Hospitalization for Tuberculosis per 100,000 Ontarians with DM Aged 20 Years and Over by Planning Regions in Southern Ontario, 1995–1999



Note: See Exhibit TA2Ba for Ontario Health Planning regions including District Health Councils (DHCs) and County definitions.

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

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Technical Appendices (Exhibits TA2.A TA2.B, TA2.Ca and TA2.Cb)

SARV Analysis, ICD-9 Coding and Health Planning Regions

Exhibit TA2.A Small Area Rate Variation (SARV) Analysis

Small area rate variation (SARV) analysis techniques have been developed in order to quantify the amount of variation across regions and, for some measures, to determine whether the observed variation is statistically greater than would be expected by chance alone.[1] The advantages and disadvantages of methods used in this and other chapters are discussed below.

The extremal quotient (EQ) is simply the ratio of the highest to the lowest observed rates in the population; thus a ten-fold difference is associated with an EQ of 10. This measure is easy to understand but may over-estimate the true variation because it only uses information from the most extreme rates, and thus may be influenced by the presence of outliers.[2,3] For instance, if the analysis contains one region with an observed rate of zero then the EQ will be equal to infinity. Another limitation is that there are no published tables that list what a normal EQ should be.[3,4] Studies suggest that EQs are more meaningful when used to compare large, similarly sized counties, where only one episode per person had occurred.[5] Many factors (such as variations in population size, low event rates, and high rates of recurrence) can lead to falsely inflated values.

$$EQ = \frac{\text{highest rate}}{\text{lowest rate}}$$

The coefficient of variation (CV) represents the amount of variation between regions relative to the mean rate in the entire population (expressed as a percentage of the mean). In the analysis for this chapter, the purpose of the CV was to help determine whether observed regional rates were significantly above or below the mean provincial rate. Although CV makes use of all available data, it is strongly influenced by the event rate and the overall size of the population.[5] The CV behaves similarly to the EQ, such that it rises when the size of the population or the number of events is lower.[3] However variations in population size may have a lesser impact on the CV than they have on the EQ, and the impact can be further reduced by weighting each regional rate by its population size. Again, there are no published tables to judge whether the observed CV is larger than would be expected from random fluctuations alone.[3]

$$CV = \frac{\text{standard deviation (SD) of regional rates}}{\text{mean population rate}} \times 100\%$$

The systematic component of variation (SCV) divides the amount of variation into two components: (1) variation due to chance and (2) variation due to systematic differences between regions.[4] In theory, the SCV estimates the variation among counties after the variation within counties has been removed. To do so, the nonrandom component of variation is estimated by subtracting the random component from the total estimated variance using the following formula:

$$SCV = \frac{(1/k)[\Sigma ((O_i - E_i)^2)]}{[E_i^2 - \Sigma(1/E_i)]} \times 1000$$

where **k** is the number of counties, O_i is the observed number of admissions and E_i is the expected number of admissions in county '**i**'.

The SCV was designed as a measure for comparing rates across geographic units of different sizes, and for comparing the utilization of different services.[3] However, the SCV is still sensitive to many of the characteristics that can influence EQ and CV (low event rates, variable population sizes and recurrent events).[3,4]

Lastly, a **chi square test of significance** can be used to assess whether the variation in rates is significantly different across regions. If age/sex adjustment is required then two variations of the chi square test—the Mantel-Haenszel test or logistic regression can be used.[3] In this chapter, the latter was used to test the null hypothesis that utilization rates were the same in each region after controlling for age and sex differences among regions.

The chi square statistic appears to be the most useful measure in SARV analysis.[5] However, when using large administrative databases, comparisons may be highly significant statistically even if the rates are not meaningfully different.[2] Another problem concerns multiple comparisons.[2] If a chi square test is used repeatedly to compare each regional rate with the provincial rate (df=1), then if the p value is 0.05, it would be expected that 5% of comparisons would be statistically significant on the basis of chance alone. Therefore, when comparing rates in 48 counties to the overall rate, a p value of less than 0.001 (based on a Bonferroni correction of 0.05/48) may be a more reasonable threshold. The chi square test that was used in this chapter evaluated whether county rates were significantly different statistically from each other (df=47) and

therefore would not be subject to the problem of multiple comparisons. In this case, a p value of less than 0.05 indicates that overall there is significant variation in rates, but does not tell the observer which rates are contributing to this variation.

Interpretative Cautions

From SARV analysis alone, it is not possible to tell whether observed rates are appropriate for a given population. The extremal quotient, coefficient of variation and systematic component of variation serve largely as descriptive measures since the exact value that constitutes an abnormally high level of variation is not known.[3] Furthermore, these three measures are extremely sensitive to population characteristics and therefore should be interpreted with caution.[3-5] In contrast, the chi square test can be used to test the hypothesis that regional rates are statistically different from each other. Chi square analysis is relatively insensitive to many of the factors that can influence the other, more descriptive statistics.[3-5] However all four measures will become artificially increased by recurrent events.[3,5]

Conclusions

There are many reasons why hospitalization rates may vary from one region to the next. Important factors include the availability of services (e.g. the distance to medical care, and access to diabetes education centres or other specialized services), physician factors (e.g. specialty, prescribing patterns and practice characteristics), and inherent differences in the population (e.g. age, sex, socioeconomic and health status, disease prevalence/ severity, and the propensity to seek care).[4-7] SARV analysis is a well-accepted methodology to study differences in procedure or admission rates across regions. However there are some caveats associated with its use. Although these data may identify potentially meaningful differences across regions, further studies are often needed to understand the reasons for the differences and how best to address them.

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Exhibit TA2.B International Classification of Diseases, 9th Revision (ICD-9) Codes

Acute Complication	Diagnosis	ICD-9 Code
Metabolic:		
Hyperglycemia	Diabetes with acidosis, acetonemia/ ketosis, or ketoacidosis	250.1
	Diabetes with hyperosmolar (nonketotic) coma	250.2
	Diabetes with ketoacidosis and coma or hyperglycemic coma	250.3
Hypoglycemia	Hypoglycemic/insulin coma	251.0
Infections:		
Urinary Tract Infections	Pyelonephritis	590.01–590.9
	Acute cystitis	595.0
	Urinary tract infection not otherwise specified	599.0
Pneumonia	Pneumococcal pneumonia	481
	Klebsiella pneumoniae pneumonia	482.0
	Pseudomonal pneumonia	482.1
	Haemophilus influenzae pneumonia	482.2
	Streptococcal pneumonia	482.3
	Staphylococcal pneumonia	482.4
	Bacterial pneumonia not otherwise specified	482.8–482.9
	Bronchopneumonia/Pneumonia, organism not otherwise specified	483–486
Skin & Soft Tissue Infections	Carbuncle	680.0–680.9
	Cellulitis, digit	681.01–681.9
	Cellulitis, other sites	682.1–682.9
	Acute lymphadenitis	683
	Impetigo	684
	Pilonidal cyst	685.0–685.1
	Pyoderma/local skin infection	686.0–686.9
	Fasciitis not otherwise specified	729.4
	Gas gangrene	785.4
	Gangrene	040.0
Bacteremia/Sepsis	Salmonella septicemia	003.1
	Meningococcemia	036.2
	Streptococcal septicemia	038.0
	Staphylococcal septicemia	038.1
	Pneumococcal septicemia	038.2
	Anaerobic septicemia	038.3
	Gram negative septicemia	038.40–038.49
	Septicemia not otherwise specified	038.8–038.9

Exhibit TA2.C.a Ministry of Health Planning Regions, Northern Ontario

Ontario Health Planning Regions

1 North

District Health Councils: Algoma, Cochrane, Manitoulin, and Sudbury; Muskoka, Nipissing, Parry Sound and Timiskaming; Northwestern Ontario

Counties: Algoma District, Cochrane District, Manitoulin District, Sudbury District and Sudbury Regional Municipality; Muskoka District Municipality, Nipissing District, Parry Sound District and Timiskaming District; Kenora District, Rainy River District and Thunder Bay District

2 Central East

District Health Councils: Durham, Halibuton, Kawartha & Pine Ridge; Simcoe-York

Counties: Durham Regional Municipality, Haliburton County, Northumberland County, Peterborough County and Victoria County; Simcoe County, York Regional Municipality

3 Central South

District Health Councils: Grand River; Hamilton-Wentworth; Niagara Region

Counties: Brant County, Haldimand-Norfolk Regional Municipality; Hamilton-Wentworth Regional Municipality; Niagara Regional Municipality

4 Central West

District Health Councils: Halton-Peel; Waterloo Region-Wellington-Dufferin

Counties: Halton Regional Municipality, Peel Regional Municipality; Dufferin County, Waterloo Regional Municipality and Wellington County

5 Eastern

District Health Councils: Champlain; Quinte, Kingson, Rideau Valley

Counties: Ottawa-Carleton Regional Municipality, Prescott-Russell United Counties, Renfrew County and Stormont, Dundas and Glengarry United Counties; Frontenac County, Hastings County, Lanark County, Leeds and Grenville United Counties, Lennox and Addington County and Prince Edward County

6 South West

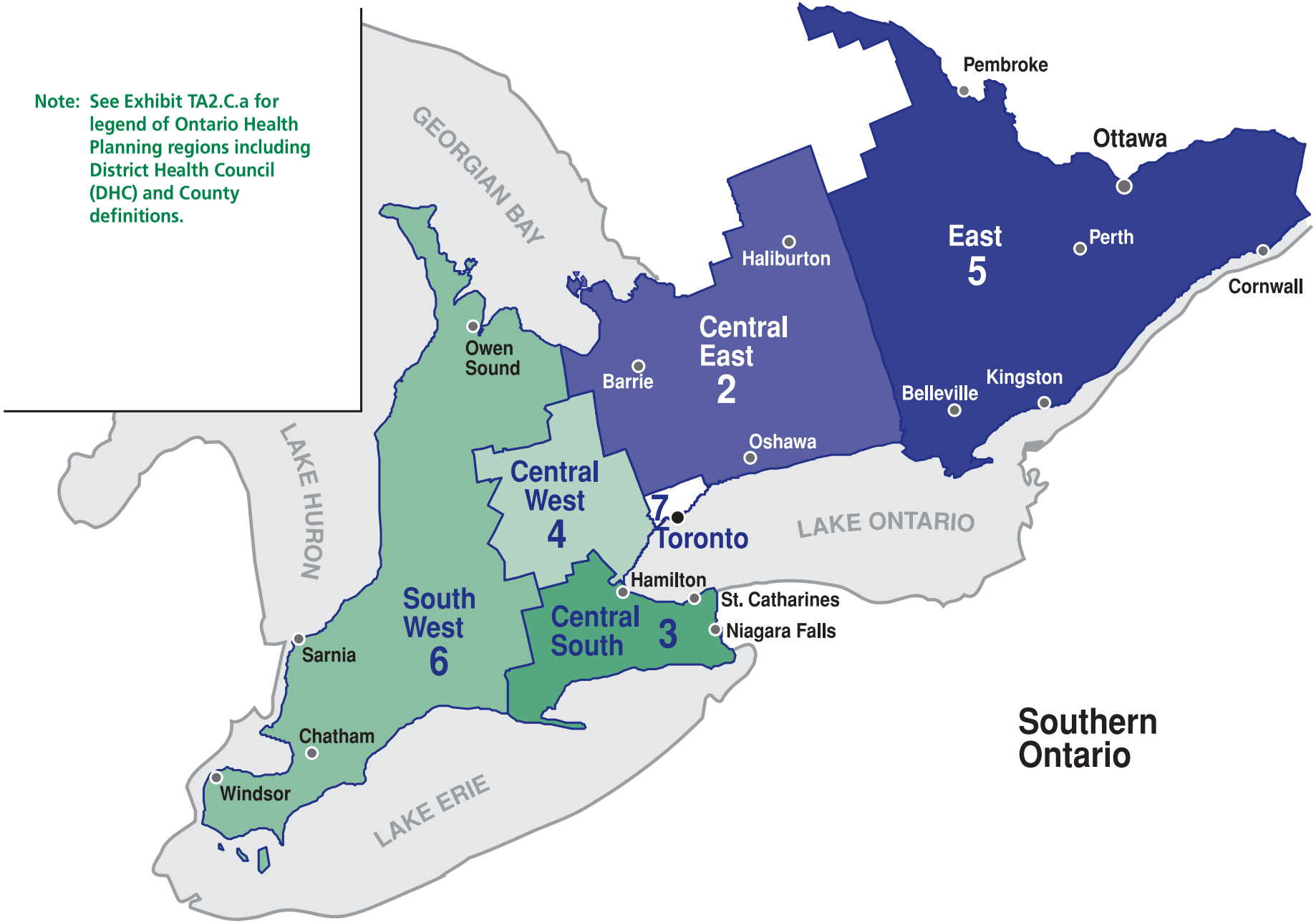
District Health Councils: Essex, Kent and Lambton; Grey, Bruce, Huron, Perth; Thames Valley

Counties: Essex County, Kent County and Lambton County; Bruce County, Grey County, Huron County and Perth County; Elgin County, Middlesex County and Oxford County

7 Toronto

Source: Ministry of Health and Long-Term Care

Exhibit TA2.C.b Ministry of Health Planning Regions, Southern Ontario



Source: Ministry of Health and Long-Term Care

3

Chapter

Drug Use in Older People with Diabetes

Authors: Baiju R. Shah, Muhammad Mamdani and Alexander Kopp

Key Messages

- Medications are an important part of managing diabetes mellitus (DM). In combination with weight control, nutrition and exercise, medications assist in controlling blood sugar levels to reduce the risk of developing complications.
- Studies show that the majority of persons with DM are unable to maintain glucose control with lifestyle measures alone. However, many people with DM in Ontario are still not using anti-hyperglycemic drugs.
- Cardiovascular disease is the main cause of death in persons with DM. Aggressive management of risk factors for cardiovascular disease, including high blood pressure and abnormal lipids, is important.
- Biguanides, such as metformin, are recommended as the first-choice agent for most people with type 2 DM. Currently, most people are first treated with sulfonylureas.
- Antihypertensive drugs, angiotensin-converting enzyme inhibitors (ACEIs) and lipid lowering drugs are also being under-utilized in people with DM. These medications have been shown to modify risk factors and improve outcomes in persons with DM.

Background

Medications are an important part of managing diabetes mellitus (DM). In combination with lifestyle measures of weight control, proper nutrition and adequate exercise, medications can assist in controlling blood sugar levels to reduce the risk of developing long-term diabetic complications.[1,2]

There are six classes of anti-hyperglycemic drugs. Insulin, given by injection, is used by all individuals diagnosed with type 1 DM and by many with type 2 DM. All other anti-hyperglycemic drugs are in tablet form. Sulfonylureas (including glyburide and gliclazide) and the biguanides (metformin) have been available the longest. Alpha-glucosidase inhibitors (acarbose), meglitinides (repaglinide and nateglinide) and thiazolidinediones (rosiglitazone and pioglitazone) have been approved for use in Canada in the last six years. Canadian guidelines suggest that either sulfonylureas or biguanides can be used as first-line drug therapy for type 2 DM; however, biguanides may have fewer adverse effects (including hypoglycemia and weight gain) and are the agents of choice for treatment of overweight individuals.[3] Furthermore, a recent study suggests that these medications can reduce mortality (death) in overweight patients when compared to other anti-hyperglycemic drugs.[4]

The most recent Canadian guidelines suggest that anti-hyperglycemic treatment should be escalated every two to four months until patients achieve the targets of a fasting blood sugar of 4.0–7.0 mmol/L, a blood sugar 1–2 hours after meals of 5.0–11.0 mmol/L, and a glycated hemoglobin that is no more than 15% above the upper limit of normal, or about 0.07 in most laboratories.[3] Studies show that DM progresses over time and that drug treatment needs to be intensified to maintain these targets. At three years after diagnosis, only one-quarter of people not taking anti-hyperglycemic medications and only one-half of those started on a single medication are able to maintain a glycated hemoglobin of 0.07.[5]

In addition to controlling blood sugars, drugs are used to prevent and slow the progression of complications of the disease. Early intervention to manage risk factors for complications is extremely important, since 7.5% of people newly diagnosed already have cardiovascular disease (CVD)[6] and 37% have retinal disease.[7]

Cardiovascular disease is the main cause of death in persons with DM. Aggressive management of risk factors for CVD is recommended. Modifiable risk factors include high blood pressure, abnormal lipids and cigarette smoking. The blood pressure target for those with DM is 130/80, a lower target than for the general population.[8] About 80% of people with DM aged 55–74 have blood pressures above 140/90.[9] The proportion of seniors with DM whose blood pressure is above the current target is even higher. Most people with both DM and hypertension will require more than one antihypertensive drug to meet the target of 130/80.[10] Fortunately, several classes of medications are available.

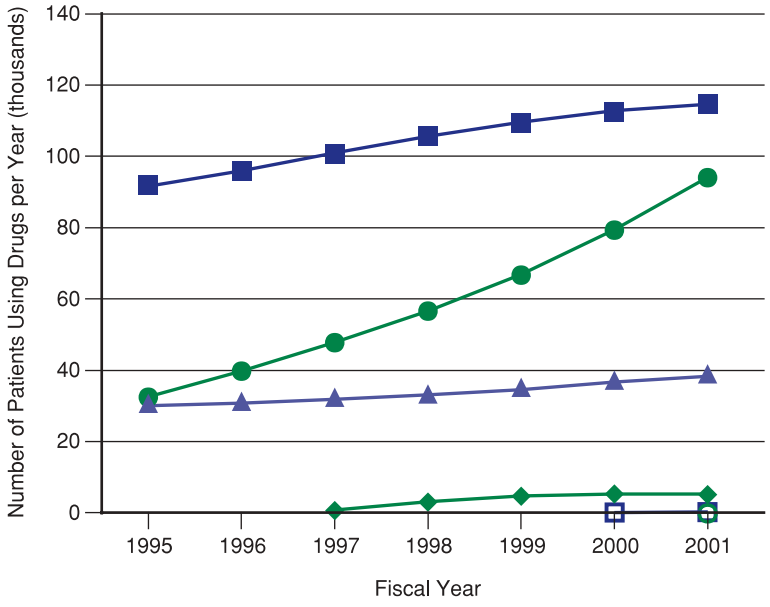
Angiotensin-converting enzyme inhibitors (ACEIs) are antihypertensive medications, but they also provide other benefits to people with DM. Kidney disease is a major complication of DM, occurring in 30% of those who have had type 2 DM for less than four years, and in 60% of those who have had DM for 17 to 20 years.[11] Several large clinical trials have shown that taking ACEIs when only subtle changes in kidney function have occurred can slow the progression to advanced kidney disease, kidney failure and dialysis.[12–14] More recently, a large study has shown that taking ACEIs can also reduce the risk of developing coronary artery disease (CAD) in those at risk, independent of their effect on blood pressure.[15]

Just as for blood pressure, goals for blood lipid levels (cholesterol and triglycerides) are stricter for individuals with DM than for most of the general population. Targets are: LDL cholesterol less than 2.5 mmol/L, triglycerides less than 2.0 mmol/L and the ratio of total cholesterol to HDL cholesterol less than 4.0.[16] While the most beneficial lipid-lowering medications are the HMGCoA reductase inhibitors (also known as statins), several other drug classes can lower blood lipids, including binding resins and fibrates. Canadian health surveys have found that among adults 65 and older, including those with DM, the average LDL cholesterol is 3.6 mmol/L, and only 10% have levels below 2.5 mmol/L.[17] Similarly, a recent US study found that 58% of people in all age groups with DM had LDL-cholesterol levels above 3.3 mmol/L, and 89% had levels above 2.5 mmol/L.[18]

This chapter examines prescription patterns in Ontario for therapies proven to be beneficial for people with DM: anti-hyperglycemic drugs, anti-hypertensive drugs, ACEIs and lipid-lowering drugs. Some of the trials evaluating the clinical benefits of these drugs are summarized in Technical Appendix TA3.A.

Exhibit 3.1 Anti-hyperglycemic Drug Use by Ontarians Aged 65 and Over, 1995–2001

Nearly three times as many people were taking biguanides in 2001 compared to 1995. The number of Ontarians taking sulfonylureas increased by 25% and the number taking insulin increased by 27%.



	1995	1996	1997	1998	1999	2000	2001
Sulfonylureas	91,634	95,923	101,026	105,673	109,529	112,770	114,549
Biguanides	32,525	39,840	47,829	56,681	66,773	79,395	94,110
Insulins	30,104	30,814	31,794	33,059	34,598	36,664	38,258
Glucosidase inhibitors			729	3,100	4,744	5,374	5,204
Meglitinides						7	229
Thiazolidinediones							334

Source: Ontario Drug Benefit Plan (ODB)

Data Sources

For the analysis of drug use in persons with DM, data were drawn from the Ontario Drug Benefit (ODB) Program database, containing drug prescription information for Ontario residents aged 65 and over. People with DM (excluding cases of gestational diabetes) were identified using the Ontario Diabetes Database (ODD), which is described in detail in the Chapter 1 Technical Appendix TA1.A. The Registered Persons Database (RPDB) provided information on birth dates, gender and place of residence. A list of all the drugs examined in this chapter is shown in Technical Appendix TA3.B.

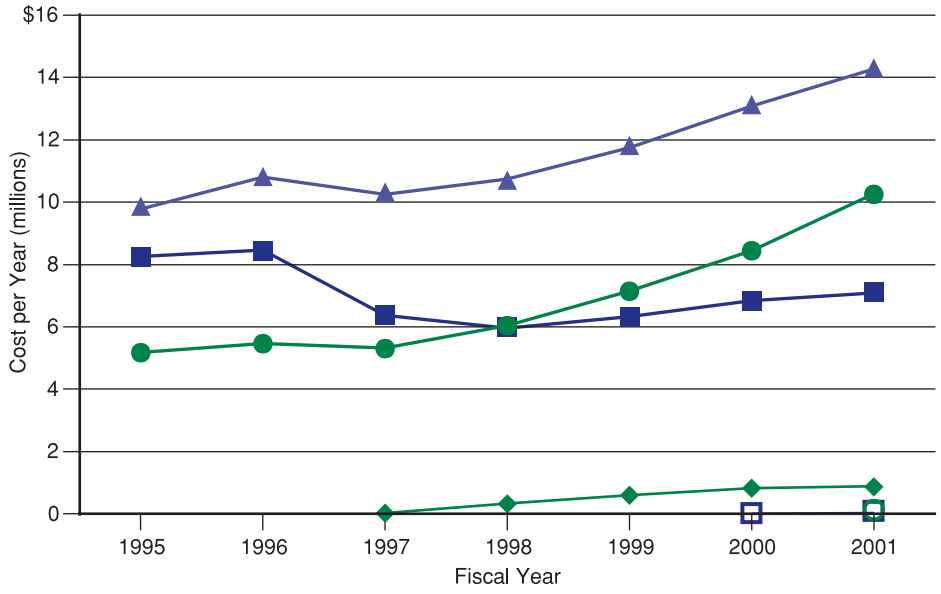
How the analysis was done

A cross-sectional yearly time series analysis of prescriptions dispensed from fiscal year 1995 (April 1, 1994 to March 31, 1995) to fiscal year 2001 was conducted to estimate changes in the number of people receiving prescriptions of anti-hyperglycemic drugs over time. Unique drug identification numbers were used to identify individual drugs. The anti-hyperglycemic drug treatment regimens of people diagnosed with DM on or before April 1, 1999 was determined by examining which prescription(s) they had filled in the subsequent six months. The proportion of people who had a prescription for antihypertensive agents, ACEIs or lipid-lowering drugs within one year after being diagnosed with DM was also examined. The analysis of antihypertensive drugs included ACEIs, as well as all other anti-hypertensive agents (see Technical Appendix TA3.B). Drug costs were defined as the amount paid by the ODB Program. In 1996, the ODB Program introduced a co-payment plan that decreased total costs to the program for all prescriptions.

Variations, by county, were examined using small area variation analysis (SARV) (see Chapter 2 Technical Appendix TA2.C). Analyses of the following were undertaken: 1) the time from new diagnosis of DM to the first prescription of an anti-hyperglycemic drug; 2) the choice of initial anti-hyperglycemic drug class within three years for people newly diagnosed with DM; and 3) the age- and sex-adjusted usage rates of anti-hyperglycemic drugs, antihypertensive drugs, more than one concurrent antihypertensive drug (including combination tablets), ACEIs and lipid-lowering drugs among people with DM. To assess changes in use over time, drug prescription rates were examined for 180 days following April 1, 1994 for everyone living with a diagnosis of DM on or before this date. These estimates were compared to estimates for everyone diagnosed with DM on or before April 1, 1999 using identical methods.

Exhibit 3.2 Anti-hyperglycemic Drug Costs to the Ontario Drug Benefit Program for Ontarians Aged 65 and Over, 1995–2001

Insulin accounted for the highest cost to the ODB Program, over $14 million in 2001. The total cost of anti-hyperglycemic drugs increased from $23 million in 1995 to $33 million in 2001. Costs to the program for all medications declined in 1997 with the introduction of a co-payment plan.

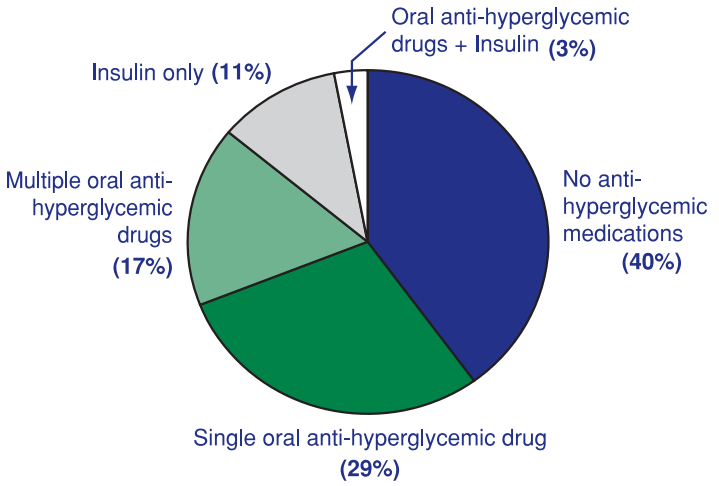


	1995	1996	1997	1998	1999	2000	2001
Sulfonylureas	8,249,632	8,466,566	6,371,306	5,952,273	6,331,249	6,850,412	7,088,296
Biguanides	5,181,690	5,470,139	5,313,228	6,047,918	7,150,227	8,449,457	10,257,200
Insulins	9,777,445	10,796,362	10,248,801	10,734,338	11,734,988	13,074,347	14,273,490
Glucosidase inhibitors			35,695	335,828	611,032	837,673	881,764
Meglitinides						585	39,093
Thiazolidinediones							98,584

Sources: Ontario Diabetes Database (ODD), Ontario Drug Benefit Plan (ODB)

Exhibit 3.3 Distribution of Treatment Regimens for Ontarians with DM Aged 65 and Over, 1999

Forty percent of Ontarians with DM were not taking any anti-hyperglycemic medications. Only 14% took insulin.



Sources: Ontario Diabetes Database (ODD), Ontario Drug Benefit Plan (ODB)

Interpretative Cautions

All of the data related to drug prescriptions came from the ODB Program. Since this program provides universal coverage of approved medications for all Ontario residents 65 years of age or older, only people in this age group were examined. This group represents about one-half of all people with DM in the province. The vast majority of this population has type 2 DM, but it was not possible to separate type 2 from type 1. Prescriptions written but not filled and prescriptions purchased outside the ODB Program were not included in the data. All dispensed medications were included whether or not the recipient took them. When examining the rate of simultaneous use of more than one medication (such as the use of two or more antihypertensive drugs, or the use of insulin plus an oral anti-hyperglycemic drug), it was only possible to determine when individuals had filled prescriptions for different medications within a 180-day time period. It was impossible to determine whether people actually took the medications concurrently, or if one medication replaced another.

Although the ODB Program covers many anti-hyperglycemic medications, there are some that are not covered (see Technical Appendix TA3.B). Certain types of insulin are available with "limited use" to individuals meeting specific clinical criteria. People that do not meet the "limited use" criteria are required to pay for these forms of insulin, independent of the ODB Program. However, these forms of insulin are usually prescribed in conjunction with other types of insulin that are covered by the ODB Program, so it is likely that most insulin users were identified. The newer anti-hyperglycemic medications (alpha-glucosidase inhibitors, meglitinides

Key Research Findings

- Increasing numbers of older people are taking anti-hyperglycemic medications to treat diabetes mellitus (DM). The rising cost of these medications will have implications given the projected growth in this sector of the population.
- More elderly people are now taking biguanides for treatment of DM. However, while biguanides are considered a better choice for many patients, nearly 75% of individuals diagnosed with DM start treatment with a sulfonylurea.
- Only 53% of people with DM are taking anti-hyperglycemic drugs within three years of their diagnosis. Studies have shown that 75% will need medication to achieve adequate blood sugar control.
- The use of antihypertensives and angiotensin-converting enzyme inhibitors among people with DM is increasing, but is still below the level recommended by treatment guidelines.
- Although there has been an increase in the proportion of people receiving lipid-lowering drugs (from 7.8% in 1994 to 24.7% in 1999) these medications are still being underused given that an estimated 90% of individuals have LDL cholesterol levels above the recommended target. Guidelines have provided targets for LDL cholesterol less than 2.5 mmol/L, triglycerides less than 2.0 mmol/L and the ratio of total cholesterol to HDL cholesterol less than 4.0.

and thiazolidinediones) also have restricted availability. Many people using these medications may have purchased them independently. Therefore, the data presented may underestimate the actual use of these medications among people aged 65 or older.

The analysis of antihypertensive drugs included the many classes of drugs that can be used to lower blood pressure. However, most of these drugs have other benefits and can also be prescribed to people with normal blood pressure for other reasons (e.g. beta blockers are used to treat angina). Therefore, the proportion of people with DM actually being treated for high blood pressure may be over-estimated.

Aspirin is recommended for many people with DM to reduce the risk of myocardial infarction and stroke. However, because it is often purchased "over the counter", the ODB Program data on aspirin prescriptions do not reflect actual drug use. Therefore, it was not possible to examine the usage of this important medication.

Optimal glucose management requires people to check their blood sugar levels on a regular basis. The ODB Program pays for glucose testing strips, the data for which were not analyzed. Therefore, the total costs of glucose management are higher than the data presented.

Finally, although it was possible to quantify prescriptions for drugs that treat blood sugar, blood pressure and lipids, the data do not provide information on whether target levels for these measures were actually reached. Furthermore, although observed rates of medication use were compared to expected rates of use, based on the population prevalence of various risk factors, many of the studies and the guidelines that have determined current targets were only recently published (see Technical Appendix TA3.A) and therefore, could not have influenced practice during the time period evaluated.

Findings and Discussion

a) Trends in anti-hyperglycemic drug use

The use of anti-hyperglycemic medications in Ontario from 1995 to 2001 is shown in Exhibit 3.1. Sulfonylureas were the most commonly prescribed anti-hyperglycemic drug class, used by about 115,000 people in Ontario in 2001. There was a 25% increase in the number of people using these drugs between 1995 and 2001. However, the most striking trend was the almost three-fold increase in the use of biguanides, from 32,525 people in 1995 to 94,110 in 2001. Over the same period, 27% more people used insulin. Alpha-glucosidase inhibitors were prescribed with increasing frequency since they were introduced in 1996, while fewer than 350 people per year received either meglitinides or thiazolidinediones through the ODB Program.

The cost of these medications to the ODB Program is shown in Exhibit 3.2. Costs associated with each drug class declined between 1996 and 1997, at which time the ODB Program introduced a co-payment and deductible plan, resulting in a global reduction in expenditures for the program. Insulin accounted for the highest portion of drug costs, showing a 46% increase over the time period studied. Reasons for this increase are likely multi-factorial, although there are more people taking insulin, as shown in Exhibit 3.1. In addition, higher doses of insulin are being used. The average number of units of insulin prescribed per person per month has increased from 1,662 units in early 1997 to 1,907 units in late 2001. Finally, the cost of insulin being prescribed increased, as newer, more expensive preparations became available. In 2001, over $14 million was spent on insulin, not including the additional cost of insulin syringes.

The average annual cost to the ODB Program for sulfonylureas was $61.88/person in 2001. The cost of biguanides was $108.99/person; alpha-glucosidase inhibitors was $169.44/person; meglitinides was $170.71/person; and, thiazolidinediones was $295.16/person. The cost of insulin was $373.09/person. The daily cost of usual doses for each anti-hyperglycemic medication is shown in Technical Appendix TA3.B.

Exhibit 3.3 shows the distribution of anti-hyperglycemic treatment regimens among all those with DM on April 1, 1999. About 40% of people did not use anti-hyperglycemic medications. About 29% took a single oral anti-hyperglycemic drug, while 17% took more than one type of medication. Insulin was used alone by 11% of people with DM and in combination with oral medications by another 3%. There was little variation (range: 51.4% to 71.5%) between counties in the use of these medications in 1999.

b) Initiation of anti-hyperglycemic drug therapy after diagnosis of DM

The time that patients began taking anti-hyperglycemic medications after diagnosis with DM was estimated. Exhibit 3.4 shows these findings from 1995 to 1998 by county. Approximately three out of eight people began taking these medications within 60 days of diagnosis. The proportion of people newly diagnosed who had started on medications by the end of the first year was 44.0%, and was 53.0% by the end of three years. Therefore, 47.0% of people were not prescribed anti-hyperglycemic drugs within three years of diagnosis, although studies show that only 25% will have adequate blood glucose control without medications.[5]

Of those receiving anti-hyperglycemic drugs within three years of diagnosis, the class of drugs that was first used to control blood sugar was determined (Exhibit 3.5). The sum of the values is greater than 100% because individuals who filled prescriptions

for more than one anti-hyperglycemic drug on the same day were double-counted. Overall, sulfonylureas were found to be the most common choice, used by 76.4% of people. Biguanides were the next most popular, used by 21.8%. Insulin was the first drug used in 7.1% of the population. Alpha-glucosidase inhibitors were used first by only 0.3%, as these drugs are "limited use" products and are only reimbursed for use as a first-line agent in rare circumstances. There were striking regional variations in the choice of first-line anti-hyperglycemic drugs. Biguanides were used first for fewer than one in eight patients in Dufferin County and in the Muskoka District, whereas they were used first for almost half of the patients in Essex County. There was a nearly five-fold difference in the proportion of patients receiving insulin as their first anti-hyperglycemic drug between the Waterloo and Haldimand-Norfolk Regional Municipalities.

c) Regional variations in antihypertensive drug, angiotensin-converting enzyme inhibitor and lipid-lowering drug use

The age-/sex-adjusted rates of use of antihypertensive drugs (including ACEIs), ACEIs and lipid-lowering drugs, by county, among people with DM in 1999 and the overall rates for Ontario in 1994 are shown in Exhibit 3.6. Antihypertensive drug use increased from 57.7% to 64.7%, ACEI use from 25.2% to 36.5% and lipid-lowering drug use from 7.8% to 24.7%. As with anti-hyperglycemic medications, there were regional variations in the use of these drugs. The overall proportion of people receiving any antihypertensive medication in 1999 was close to, but still somewhat lower than, the 80% estimated to have hypertension based on previous studies.[9] Exhibit 3.7 maps antihypertensive drug use rates for 1999.

The rates of prescription of two or more antihypertensive drugs were also examined, since at least 60% of people with DM and hypertension will need two or more antihypertensive drugs to achieve even moderate blood pressure control.[10] Exhibits 3.6 and 3.8 show the proportion of people with DM having prescriptions for two or more antihypertensive drugs by county in 1999 and the overall rate for Ontario in 1994. The proportion has increased from 23.5% in 1994 to 33.1% in 1999. Estimates would suggest that at least half of all people over 65 years of age with DM should be taking more than one anti-hypertensive drug.[9,10]

The highest rate of ACEI use was in predominantly rural and northern counties in 1999. Of the counties with an academic medical centre, only the Hamilton-Wentworth Regional Municipality was in the top half of ACEI-prescribing counties. The use of ACEIs was somewhat lower than expected given the population at risk for cardiovascular and renal disease. The MICRO-HOPE study[15] demonstrated a survival benefit with an ACEI for patients with DM and one other cardiac risk factor, a combination expected to be present in the majority of older persons with DM studied here. Evidence of diabetic kidney disease is another indication for the use of an ACEI and is found in 30 to 60% of patients with DM. Exhibit 3.9 maps ACEI use rates for 1999.

Lipid-lowering drugs showed the largest increase in prescription between 1994 (7.8%) and 1999 (24.7%). Despite the increase, the proportion of people receiving lipid-lowering drugs remains markedly lower than the estimated 90% of individuals whose LDL cholesterol levels are above the recommended target.[17] Exhibit 3.10 maps lipid-lowering drug use rates for 1999.

d) Initiation of antihypertensive drug, angiotensin-converting enzyme inhibitor and lipid-lowering drug therapy after diagnosis of DM

Exhibit 3.11 reveals the proportion of people newly diagnosed with DM that filled prescriptions for antihypertensive drugs, ACEIs and lipid-lowering drugs within one year after diagnosis. Early intervention is important because many complications of DM are already present when people are diagnosed with the disease.[6,7] In fact, many people may have been taking these medications prior to diagnosis. Of those diagnosed with DM in 1999, 64.4% were prescribed antihypertensives. In the year following diagnosis, 34.0% were prescribed ACEIs and 24.0% were prescribed lipid-lowering drugs, all of which had increased from 1995.

Conclusions

As the number of individuals with DM increases in Ontario, so will the number of people using anti-hyperglycemic medications and the associated cost of therapy. Expenditures for people aged 65 and older were $23.2 million in 1995, and over $32.6 million in 2001. Of that, nearly 44% went toward the cost of insulin. However, improved DM care should lead to a decrease in the rate of cardiovascular and renal complications.

The majority of people with DM aged 65 and over in Ontario are using anti-hyperglycemic medications to control their blood sugar. However, a significant proportion manage their DM through lifestyle measures, without medications. The data likely represent under-use of anti-hyperglycemic medications, since management of DM through lifestyle factors alone fail to achieve optimal glycemic control in the majority of cases.[3,5]

Most individuals who start anti-hyperglycemic drugs within three years of the diagnosis of DM do so within the first 60 days. In 1999, after the results of the United Kingdom Prospective Diabetes Study Group[19] were published, the Canadian Diabetes Association (CDA) revised its guidelines to recommend that metformin be considered as initial therapy for obese patients with type 2 DM. However, in Ontario, during the years

Summary of Canadian Diabetes Treatment Guidelines

Anti-hyperglycemic medications

- For most people with type 1 and type 2 DM, optimal glycemic control is that level of glucose control which achieves a glycated hemoglobin no more than 15% above the upper limit of the normal range (i.e. 0.07 if the upper limit of normal is 0.06), a fasting glucose between 4 and 7 mmol/L and a glucose 1–2 hours after a meal between 5 and 11 mmol/L. Higher targets should be considered for individuals who are having frequent or severe episodes of hypoglycemia.
- If optimal glucose levels in type 2 DM are not attained within 2 to 4 months of non-drug therapy, drug therapy should be started. Metformin is the drug of first choice for obese patients with type 2 DM, but it should not be used in patients with significant kidney or liver dysfunction.
- If optimal glucose levels in type 2 DM are not attainable with a single oral anti-hyperglycemic medication, medications from other classes should be added until targets are met or until the maximum dose of a medication from each class is reached. Therapy should be escalated every 2 to 4 months.
- Insulin therapy should be initiated for people with type 2 DM to improve glycemic control when target glucose levels are not achieved with oral medications, or in patients with symptomatic hyperglycemia (e.g., frequent nocturia). The concomitant use of oral medications and insulin may result in better glucose control with a smaller insulin dose and less weight gain than with insulin alone.
- To achieve target glucose levels, people with type 1 DM usually require an intensified DM management regimen with multiple daily insulin injections (at least three per day) or the use of continuous subcutaneous insulin infusion.

Meltzer S, Leiter L, Daneman D, Gerstein HC, Lau D, Ludwig S, et al. 1998 clinical practice guidelines for the management of diabetes in Canada. *CMAJ* 1998; 159(Suppl 8):S1–S29.

Gerstein HC, Hanna A, Rowe R, Leiter L, MacGregor A. CDA position statement regarding the UKPDS and revision of diabetes clinical practice guidelines accounting for the UKPDS results. *Can J Diabetes Care* 1999; 23:15–17.

Antihypertensive medications and angiotensin-converting enzyme inhibitors

- Hypertension in people with DM should be treated to attain a target blood pressure ≤ 130/80 mmHg. Multiple medications are usually needed.
- Angiotensin-converting enzyme inhibitors (ACEIs) are recommended as first-line antihypertensive drug therapy for people with DM. One large trial found that people over 55 with DM and risk factors for cardiovascular events (abnormal lipids, hypertension, microalbuminuria or current smoking) should also take ACEIs to reduce their risk.
- In type 1 and type 2 DM, the presence of micro-albuminuria or overt nephropathy is an indication for treatment with an ACEI, even in the absence of hypertension, in order to reduce the progression of renal disease. Recent studies have shown that angiotensin receptor blockers are also effective for this indication.

Feldman RD, Campbell N, Larochelle P, Bolli P, Burgess ED, Carruthers SG, et al. 1999 Canadian recommendations for the management of hypertension. *CMAJ* 1999; 161(Suppl 12): S1–S22.

The Canadian Hypertension Recommendations Working Group. 2001 Canadian Hypertension Recommendations. http://www.chs.md

studied, more than three-quarters of people with DM were started on sulfonylureas, whereas only about one in five was started on a biguanide. Nonetheless, the number of people receiving biguanides nearly tripled between 1995 and 2001.

Management of DM involves not only the control of blood glucose levels, but also the control of blood pressure, blood lipids and other risk factors for cardiovascular disease. Current evidence suggests that antihypertensive drugs, ACEIs, and lipid-lowering drugs contribute to improved outcomes in people with DM. Although the prescription rates for these medications are increasing, some are still below that recommended by treatment guidelines. Subsequent analyses to examine the impact of the 1998 CDA clinical practice guidelines on prescription rates, as well as educational efforts to improve provider adherence, are required in the future.

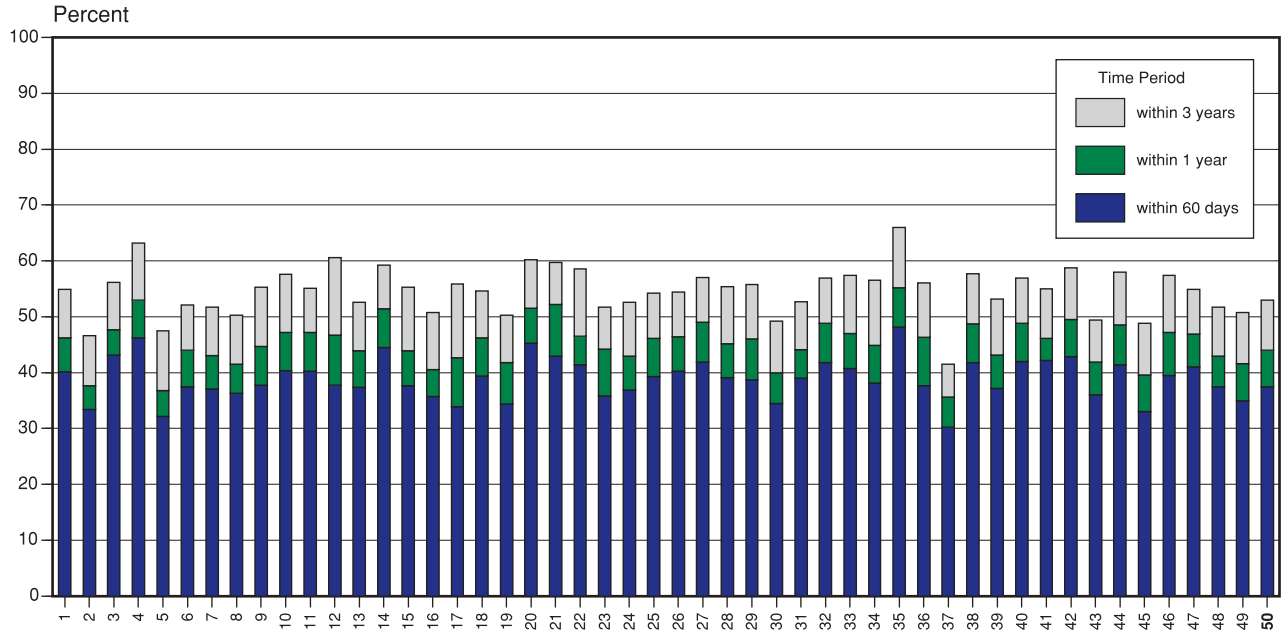
Lipid-lowering medications

- People with DM are considered to be at "very high" risk for developing CAD. Therefore, treatment of elevated levels should be instituted to achieve target levels: LDL-cholesterol ≤ 2.5 mmol/L, triglycerides ≤ 2.0 mmol/L and total cholesterol: HDL-cholesterol ratio ≤ 4.

Fodor JG, Frohlich JJ, Genest JJG, McPherson PR, for the Working Group on Hypercholesterolemia and Other Dyslipidemias. Recommendations for the management and treatment of dyslipidemia. *CMAJ* 2000; 162: 1441–1447.

Exhibit 3.4 Distribution by County of Ontarians Aged 65 and Over with DM by Time from Diagnosis of DM to Initiation of Anti-hyperglycemic Drug Therapy, 1995–1998

Over one-third of Ontarians with DM started taking anti-hyperglycemic medications within 60 days of being diagnosed. However, 47% still did not take any medications after 3 years.



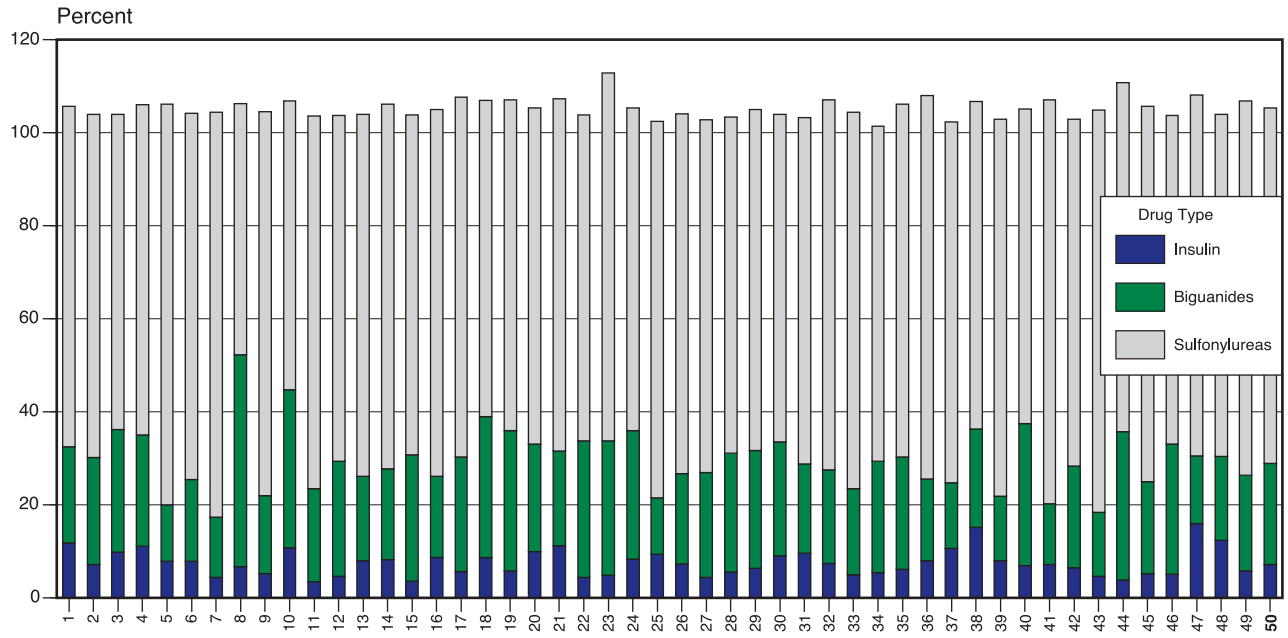
	within 60 days	within 1 year	within 3 years
1. Algoma District	40.2%	46.2%	54.9%
2. Brant County	33.4%	37.7%	46.6%
3. Bruce County	43.2%	47.7%	56.2%
4. Cochrane District	46.2%	53.0%	63.2%
5. Dufferin County	32.2%	36.8%	47.5%
6. Durham Regional Municipality	37.5%	44.0%	52.1%
7. Elgin County	37.1%	43.1%	51.7%
8. Essex County	36.3%	41.5%	50.3%
9. Frontenac County	37.8%	44.7%	55.3%
10. Grey County	40.4%	47.2%	57.6%
11. Haldimand-Norfolk Regional Municipality	40.3%	47.2%	55.1%
12. Haliburton County	37.8%	46.7%	60.6%
13. Halton Regional Municipality	37.4%	43.9%	52.6%
14. Hamilton-Wentworth Regional Municipality	44.5%	51.4%	59.3%
15. Hastings County	37.7%	43.9%	55.3%
16. Huron County	35.7%	40.6%	50.8%
17. Kenora District	33.9%	42.7%	55.9%
18. Kent County	39.4%	46.2%	54.6%
19. Lambton County	34.4%	41.8%	50.3%
20. Lanark County	45.3%	51.5%	60.2%
21. Leeds and Grenville United Counties	43.0%	52.2%	59.7%
22. Lennox and Addington County	41.4%	46.5%	58.6%
23. Manitoulin District	35.8%	44.2%	51.7%
24. Middlesex County	36.9%	43.0%	52.6%

	within 60 days	within 1 year	within 3 years
25. Muskoka District	39.3%	46.8%	57.9%
26. Niagara Regional Municipality	40.3%	46.4%	54.4%
27. Nipissing District	41.9%	49.0%	57.0%
28. Northumberland County	39.1%	45.2%	55.4%
29. Ottawa-Carleton Regional Municipality	38.7%	46.0%	55.8%
30. Oxford County	34.5%	40.0%	49.2%
31. Parry Sound District	39.0%	44.1%	52.7%
32. Peel Regional Municipality	41.8%	48.8%	56.9%
33. Perth County	40.7%	47.0%	57.4%
34. Peterborough County	38.1%	44.9%	56.6%
35. Prescott and Russell United Counties	48.2%	55.2%	66.0%
36. Prince Edward County	37.7%	46.3%	56.1%
37. Rainy River District	30.2%	35.6%	41.5%
38. Renfrew County	41.8%	48.7%	57.7%
39. Simcoe County	37.2%	43.2%	53.2%
40. Stormont, Dundas and Glengarry United Counties	42.0%	48.8%	56.9%
41. Sudbury District	42.2%	46.1%	55.0%
42. Sudbury Regional Municipality	42.9%	49.5%	58.8%
43. Thunder Bay District	36.0%	41.9%	49.4%
44. Timiskaming District	41.4%	48.6%	58.0%
45. Toronto Metropolitan Municipality	33.3%	39.6%	48.8%
46. Victoria County	39.5%	47.2%	57.4%
47. Waterloo Regional Municipality	41.0%	46.9%	54.9%
48. Wellington County	37.5%	43.0%	51.7%
49. York Regional Municipality	35.0%	41.6%	50.8%
50. Ontario	37.5%	44.0%	53.0%

Sources: Ontario Diabetes Database (ODD), Ontario Drug Benefit Plan (ODB)

Exhibit 3.5 Initial Choice of Anti-hyperglycemic Drug Class for Newly-Diagnosed Ontarians with DM Aged 65 and Over by County, 1995–1998

Sulfonylureas were the first choice of anti-hyperglycemic drugs used for most Ontarians with DM in all regions. However, in certain counties, many more Ontarians were started on biguanides than in other counties.



	Biguanides	Insulin	Sulfonylureas
1. Algoma District	20.7%	11.8%	73.2%
2. Brant County	23.1%	7.1%	73.7%
3. Bruce County	26.4%	9.8%	67.8%
4. Cochrane District	23.9%	11.1%	71.0%
5. Dufferin County	12.2%	7.8%	86.1%
6. Durham Regional Municipality	17.6%	7.8%	78.8%
7. Elgin County	12.9%	4.4%	87.1%
8. Essex County	45.6%	6.7%	54.0%
9. Frontenac County	16.7%	5.2%	82.6%
10. Grey County	34.0%	10.7%	62.1%
11. Haldimand-Norfolk Regional Municipality	20.1%	3.4%	80.1%
12. Haliburton County	24.8%	4.6%	74.3%
13. Halton Regional Municipality	18.1%	8.0%	77.8%
14. Hamilton-Wentworth Regional Municipality	19.5%	8.2%	78.4%
15. Hastings County	27.1%	3.6%	73.1%
16. Huron County	17.5%	8.6%	78.9%
17. Kenora District	24.7%	5.6%	77.3%
18. Kent County	30.3%	8.6%	68.1%
19. Lambton County	30.1%	5.8%	71.2%
20. Lanark County	23.2%	9.9%	72.2%
21. Leeds and Grenville United Counties	20.4%	11.2%	75.7%
22. Lennox and Addington County	29.4%	4.4%	70.0%
23. Manitoulin District	29.0%	4.8%	79.0%
24. Middlesex County	27.6%	8.3%	69.4%

	Biguanides	Insulin	Sulfonylureas
25. Muskoka District	12.2%	9.3%	80.9%
26. Niagara Regional Municipality	19.4%	7.3%	77.4%
27. Nipissing District	22.5%	4.4%	75.9%
28. Northumberland County	25.6%	5.5%	72.3%
29. Ottawa-Carleton Regional Municipality	25.4%	6.3%	73.3%
30. Oxford County	24.5%	9.0%	70.5%
31. Parry Sound District	19.2%	9.6%	74.5%
32. Peel Regional Municipality	20.1%	7.4%	79.6%
33. Perth County	18.5%	5.0%	80.9%
34. Peterborough County	24.0%	5.4%	72.0%
35. Prescott and Russell United Counties	24.2%	6.1%	75.8%
36. Prince Edward County	17.5%	8.0%	82.5%
37. Rainy River District	14.1%	10.6%	77.6%
38. Renfrew County	21.2%	15.1%	70.4%
39. Simcoe County	13.8%	8.0%	81.1%
40. Stormont, Dundas and Glengarry United Counties	30.6%	6.9%	67.6%
41. Sudbury District	13.1%	7.1%	86.9%
42. Sudbury Regional Municipality	21.8%	6.5%	74.6%
43. Thunder Bay District	13.8%	4.6%	86.5%
44. Timiskaming District	31.9%	3.8%	75.1%
45. Toronto Metropolitan Municipality	19.8%	5.2%	80.7%
46. Victoria County	27.9%	5.1%	70.7%
47. Waterloo Regional Municipality	14.6%	15.9%	77.6%
48. Wellington County	18.0%	12.4%	73.5%
49. York Regional Municipality	20.6%	5.7%	80.5%
50. Ontario	21.8%	7.1%	76.4%

The sum of the values is > 100% because persons who filled prescriptions for more than one drug on the same day were double-counted.

Sources: Ontario Diabetes Database (ODD), Ontario Drug Benefit Plan (ODB)

Exhibit 3.6 Age-/Sex-adjusted Prevalence of Use of Antihypertensive Drugs, Angiotensin-converting Enzyme Inhibitors and Lipid-lowering Drugs per 100 Ontarians with DM Aged 65 and Over by County, 1999

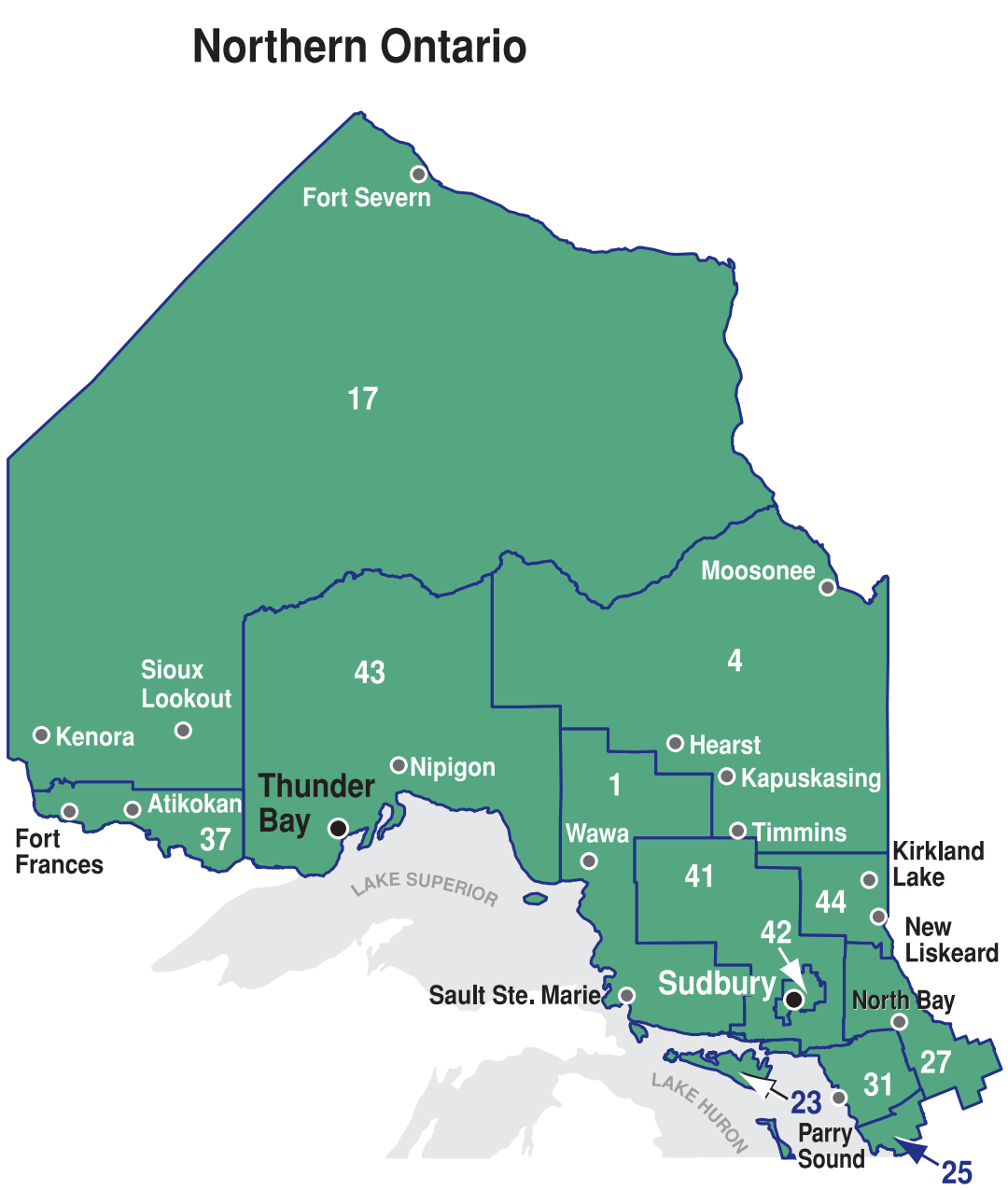
Prescription rates of antihypertensive drugs, angiotensin-converting enzyme inhibitors (ACEIs) and lipid-lowering drugs are lower than expected, given the prevalence of heart disease risk factors and complications of DM.

Rate = per 100 persons	At least one anti-hypertensive drug+	Rank	2 or more anti-hypertensive drugs+	Rank	ACEIs	Rank	Lipid-lowing drugs	Rank
Algoma District	68.2	13	33.8	23	38.3	20	18.8 **	43
Brant County	64.2	40	31.2	42	36.0	37	20.2 **	33
Bruce County	67.7	16	32.7	30	36.8	30	20.7 *	31
Cochrane District	69.2	2	37.3 *	2	38.8	15	21.1 **	30
Dufferin County	61.7	47	32.4	33	35.2	43	17.1 **	47
Durham Regional Municipality	67.2	23	36.3 **	3	39.6 **	12	24.7	13
Elgin County	66.6	29	34.2	16	34.9	44	21.8	27
Essex County	65.8	32	33.5	25	37.8	25	32.4 **	2
Frontenac County	67.2	22	31.4	41	36.8	29	17.4 **	45
Grey County	68.9	6	33.1	29	40.2 *	11	22.0	25
Haldimand-Norfolk Regional Municipality	68.8	7	34.1	21	38.9	14	23.7	20
Haliburton County	68.9	5	34.4	14	41.1	7	32.7 **	1
Halton Regional Municipality	64.5	37	34.1	18	39.1 **	13	26.3 *	8
Hamilton-Wentworth Regional Municipality	67.5 *	19	35.9 **	5	41.1 **	5	27.5 **	4
Hastings County	67.5	20	34.6	12	36.4	33	22.5	23
Huron County	71.9 **	1	37.4 *	1	40.3	10	26.1	9
Kenora District	61.0	49	27.7 *	48	41.0 *	8	9.7 **	49
Kent County	67.0	26	35.9	6	36.8	28	19.2 **	40
Lambton County	65.8	33	34.1	20	33.9	48	21.7 **	28
Lanark County	68.6	10	35.8	7	38.4	19	24.2	15
Leeds and Grenville United Counties	67.0	25	31.1	43	34.0	47	19.8 **	35
Lennox and Addington County	69.1	3	35.2	9	41.1	6	20.2 *	34
Manitoulin District	68.5	11	30.2	46	42.9	2	19.0	41
Middlesex County	65.4	35	32.5	31	35.7	39	24.5	14
Muskoka District	66.8	28	32.3	36	37.8	24	23.1	21
Niagara Regional Municipality	66.9 *	27	35.2 **	8	40.4 **	9	24.9	12
Nipissing District	66.3	30	34.3	15	36.1	35	18.9 **	42
Northumberland County	64.6	36	31.6	40	38.1	22	25.7	11
Ottawa-Carleton Regional Municipality	61.4 **	48	29.7 **	47	34.0 **	46	24.1	16
Oxford County	65.6	34	34.1	19	35.5	42	18.0 **	44
Parry Sound District	68.6	9	33.1	28	38.0	23	22.0	26
Peel Regional Municipality	63.1	43	33.2	27	35.6	40	26.0 *	10
Perth County	68.8	8	34.2	17	42.7 **	3	19.3 **	39
Peterborough County	64.3	39	30.5	45	35.9	38	29.1 **	3
Prescott and Russell United Counties	66.2	31	34.8	10	38.7	16	26.3	7
Prince Edward County	68.1	15	33.5	24	35.5	41	23.0	22
Rainy River District	61.9	45	26.6 *	49	36.2	34	12.2 **	48
Renfrew County	67.6	18	32.4	34	36.8	31	22.3 *	24
Simcoe County	67.0	24	33.5	26	38.4	18	21.3 **	29
Stormont, Dundas and Glengarry United Counties	68.1	14	34.4	13	38.2	21	24.1	17
Sudbury District	67.6	17	30.7	44	36.5	32	19.6 *	37
Sudbury Regional Municipality	69.0 *	4	36.0 *	4	42.2 **	4	23.9	19
Thunder Bay District	64.0	41	32.3	35	38.6	17	20.5 **	32
Timiskaming District	68.4	12	34.8	11	43.8 **	1	19.5 *	38
Toronto Metropolitan Municipality	62.6 **	44	32.5	32	34.2 **	45	27.1 **	5
Victoria County	67.2	21	33.8	22	37.4	27	26.8	6
Waterloo Regional Municipality	63.7	42	31.7	39	36.0	36	19.7 **	36
Wellington County	64.4	38	31.9	38	37.7	26	17.3 **	46
York Regional Municipality	61.7 **	46	32.0	37	33.2 **	49	24.1	18
Ontario (1999)	**64.7**		**33.1**		**36.5**		**24.7**	
Ontario (1994)	57.7		23.5		25.2		7.8	

* $p \leq 0.01$ vs. the provincial mean ** $p \leq 0.001$ vs. the provincial mean +Anti-hypertensive drugs include angiotensin-converting enzyme inhibitors.

Sources: Ontario Diabetes Database (ODD), Ontario Drug Benefit Plan (ODB)

Exhibit 3.7a Age-/Sex-adjusted Prevalence of Use of at Least one Antihypertensive Drug per 100 Ontarians with DM Aged 65 Years and Over by County, Northern Ontario, 1999



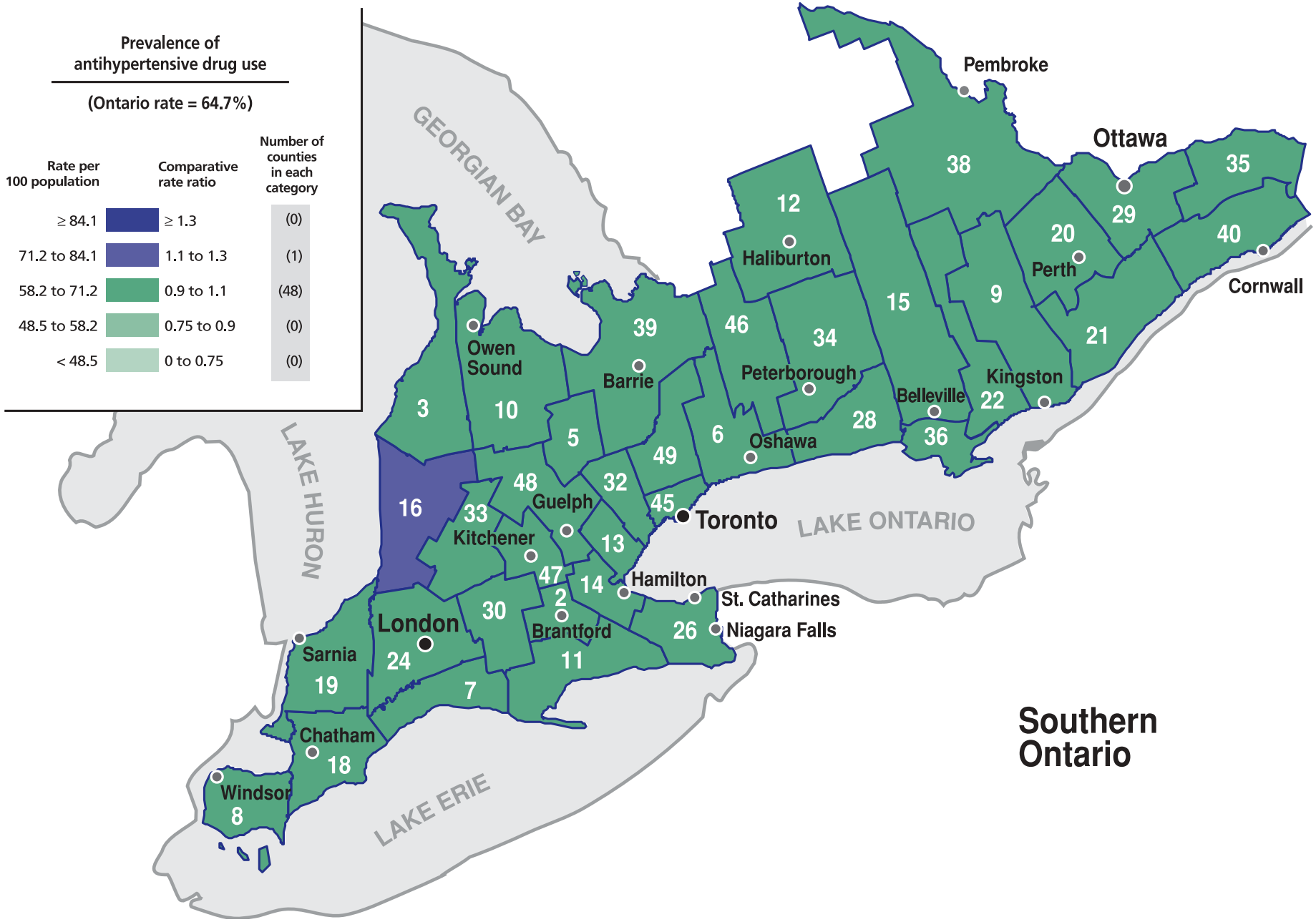
Ontario Counties

1 Algoma District
2 Brant County
3 Bruce County
4 Cochrane District
5 Dufferin County
6 Durham Regional Municipality
7 Elgin County
8 Essex County
9 Frontenac County
10 Grey County
11 Haldimand-Norfolk Regional Municipality
12 Haliburton County
13 Halton Regional Municipality
14 Hamilton-Wentworth Regional Municipality
15 Hastings County
16 Huron County
17 Kenora District
18 Kent County
19 Lambton County
20 Lanark County
21 Leeds and Grenville United Counties
22 Lennox and Addington County
23 Manitoulin District
24 Middlesex County
25 Muskoka District
26 Niagara Regional Municipality
27 Nipissing District
28 Northumberland County
29 Ottawa-Carleton Regional Municipality
30 Oxford County
31 Parry Sound District
32 Peel Regional Municipality
33 Perth County
34 Peterborough County
35 Prescott and Russell United Counties
36 Prince Edward County
37 Rainy River District
38 Renfrew County
39 Simcoe County
40 Stormont, Dundas and Glengarry United Counties
41 Sudbury District
42 Sudbury Regional Municipality
43 Thunder Bay District
44 Timiskaming District
45 Toronto Metropolitan Municipality
46 Victoria County
47 Waterloo Regional Municipality
48 Wellington County
49 York Regional Municipality

Note: See Exhibit 3.7b for Legend.

Sources: Ontario Diabetes Database (ODD), Ontario Drug Benefit Plan (ODB)

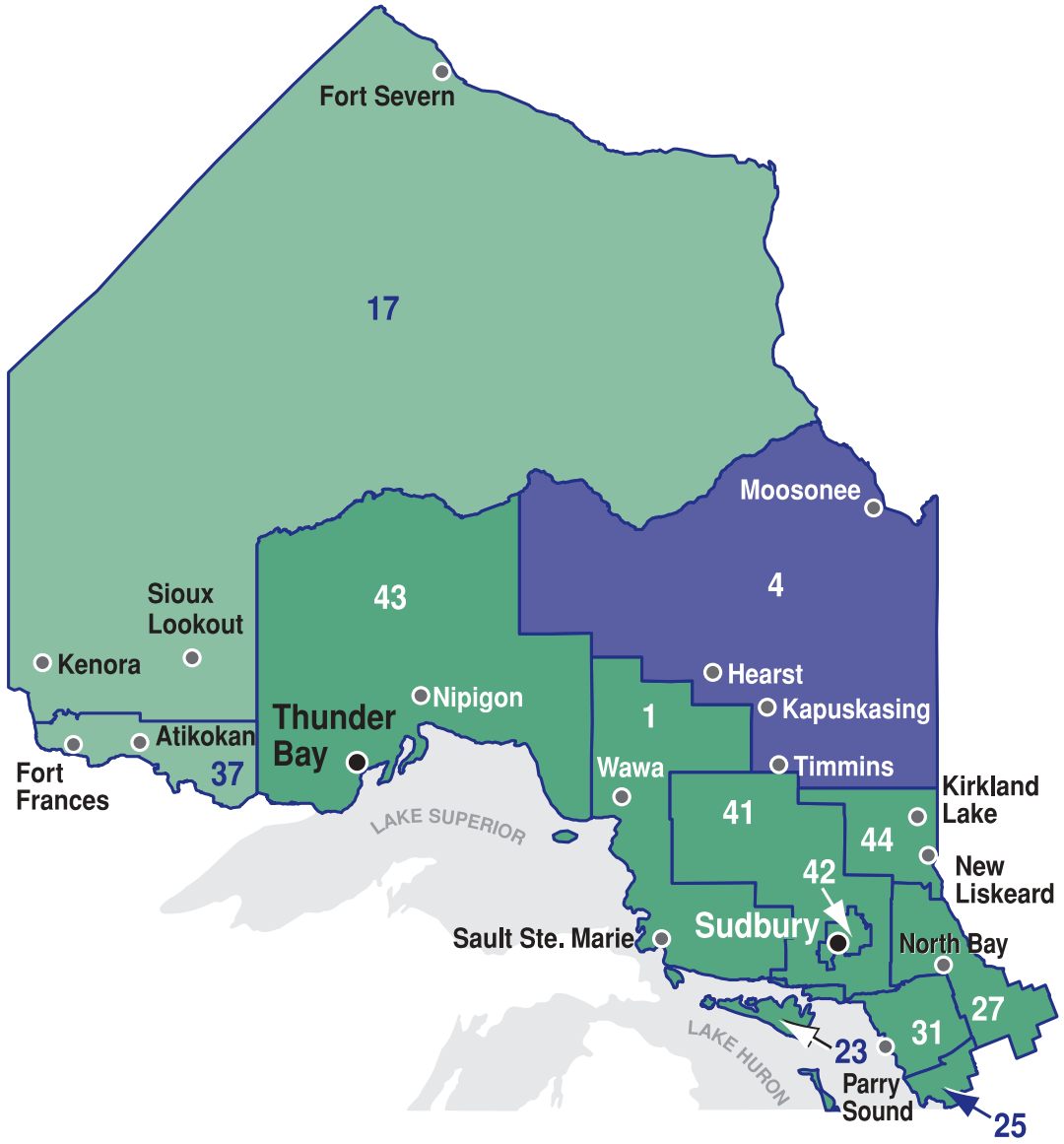
Exhibit 3.7b Age-/Sex-adjusted Prevalence of Use of at Least one Antihypertensive Drug per Ontarians with DM Aged 65 Years and Over by County, Southern Ontario, 1999



Note: See Exhibit 3.7a for County definitions.

Sources: Ontario Diabetes Database (ODD), Ontario Drug Benefit Plan (ODB)

Exhibit 3.8a Age-/Sex-adjusted Prevalence of Use of Two or More Antihypertensive Drugs Including ACEIs per 100 Ontarians with DM Aged 65 Years and Over by County, Northern Ontario, 1999



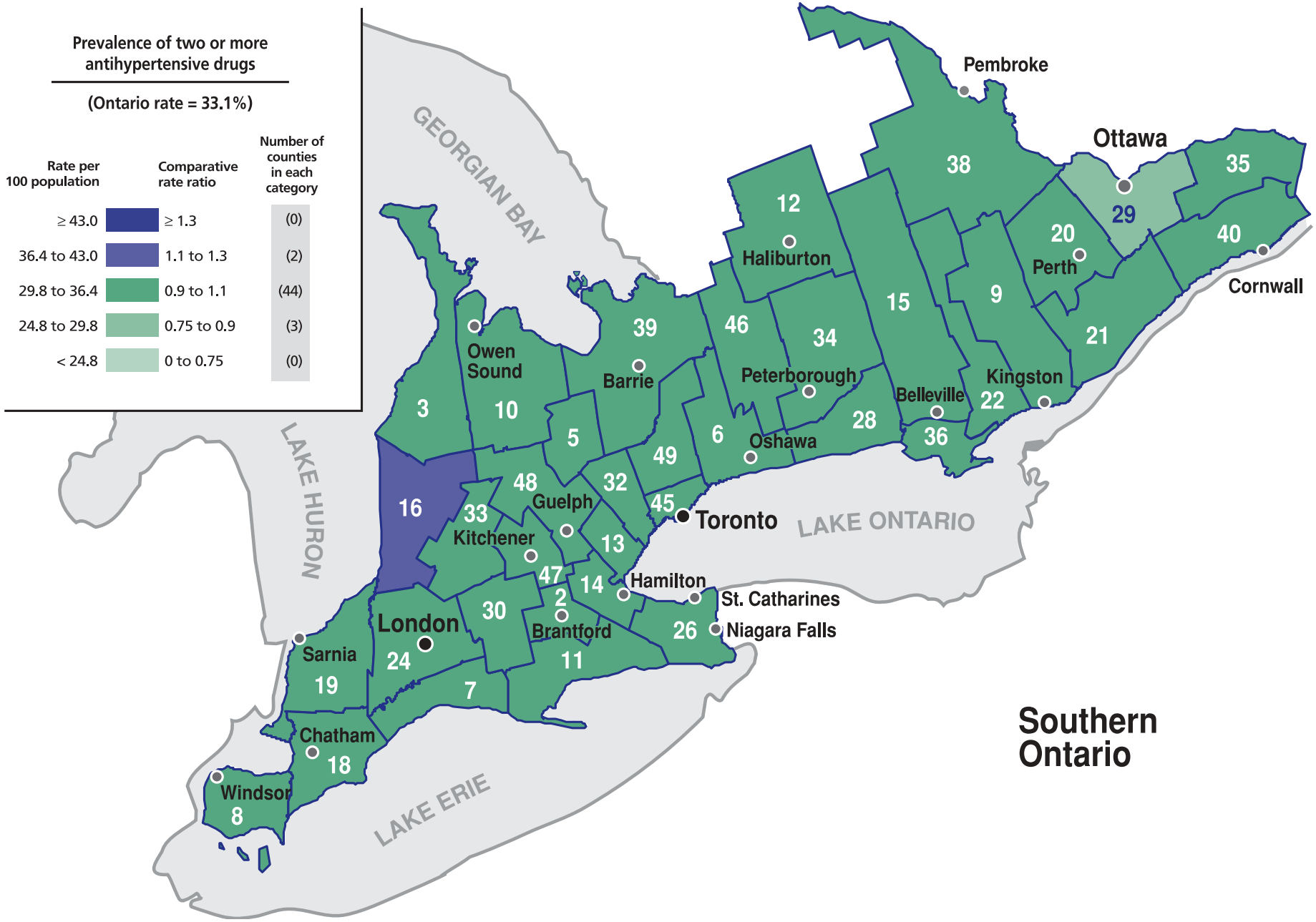
Note: See Exhibit 3.8b for Legend.

Ontario Counties

1 Algoma District
2 Brant County
3 Bruce County
4 Cochrane District
5 Dufferin County
6 Durham Regional Municipality
7 Elgin County
8 Essex County
9 Frontenac County
10 Grey County
11 Haldimand-Norfolk Regional Municipality
12 Haliburton County
13 Halton Regional Municipality
14 Hamilton-Wentworth Regional Municipality
15 Hastings County
16 Huron County
17 Kenora District
18 Kent County
19 Lambton County
20 Lanark County
21 Leeds and Grenville United Counties
22 Lennox and Addington County
23 Manitoulin District
24 Middlesex County
25 Muskoka District
26 Niagara Regional Municipality
27 Nipissing District
28 Northumberland County
29 Ottawa-Carleton Regional Municipality
30 Oxford County
31 Parry Sound District
32 Peel Regional Municipality
33 Perth County
34 Peterborough County
35 Prescott and Russell United Counties
36 Prince Edward County
37 Rainy River District
38 Renfrew County
39 Simcoe County
40 Stormont, Dundas and Glengarry United Counties
41 Sudbury District
42 Sudbury Regional Municipality
43 Thunder Bay District
44 Timiskaming District
45 Toronto Metropolitan Municipality
46 Victoria County
47 Waterloo Regional Municipality
48 Wellington County
49 York Regional Municipality

Sources: Ontario Diabetes Database (ODD), Ontario Drug Benefit Plan (ODB)

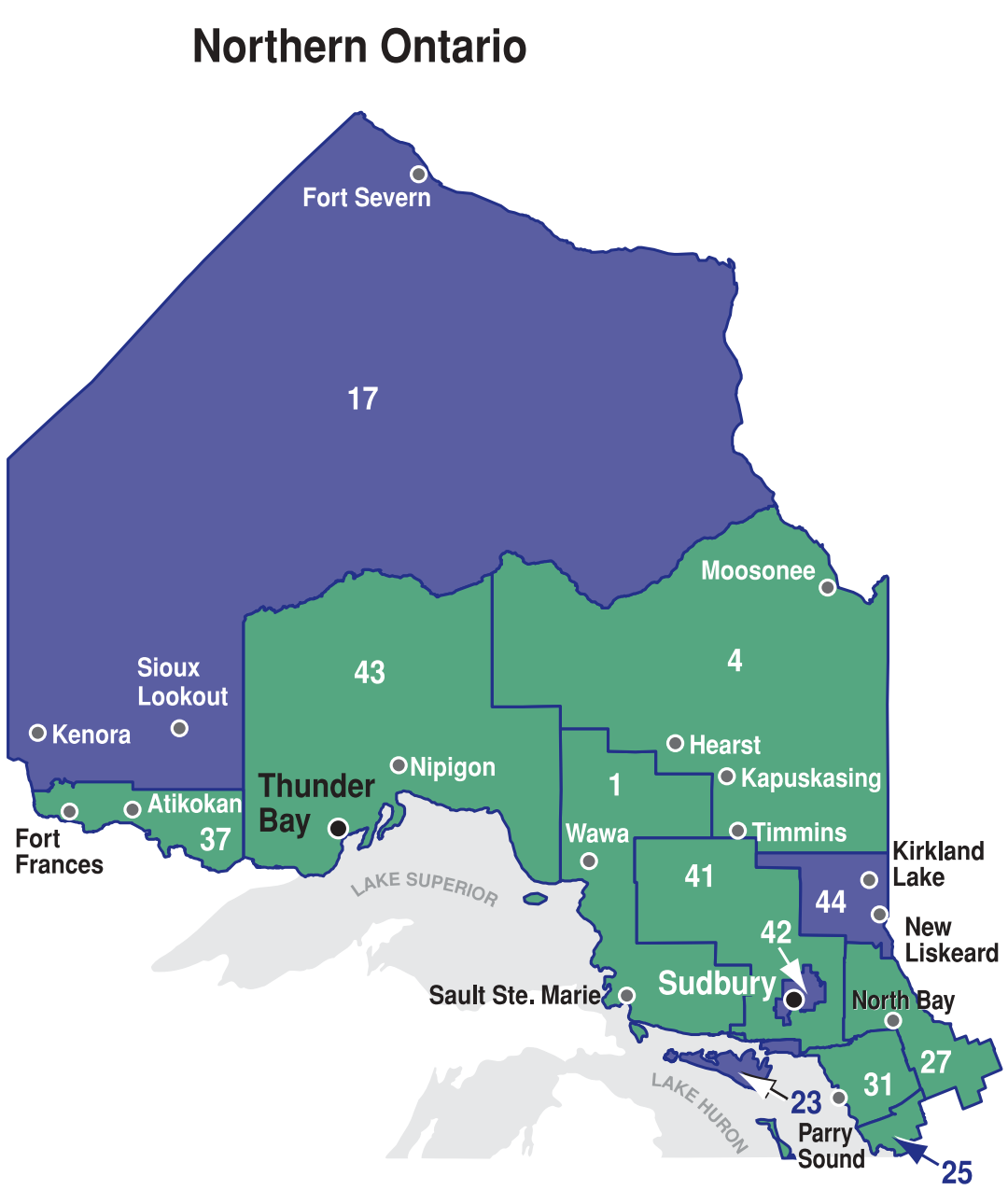
Exhibit 3.8b Age-/Sex-adjusted Prevalence of Use of Two or More Antihypertensive Drugs Including ACEIs per 100 Ontarians with DM Aged 65 Years and Over by County, Southern Ontario, 1999



Note: See Exhibit 3.8a for County definitions.

Sources: Ontario Diabetes Database (ODD), Ontario Drug Benefit Plan (ODB)

Exhibit 3.9a Age-/Sex-adjusted Prevalence of Use of Angiotensin-Converting Enzyme Inhibitors per 100 Ontarians with DM Aged 65 Years and Over by County, Northern Ontario, 1999



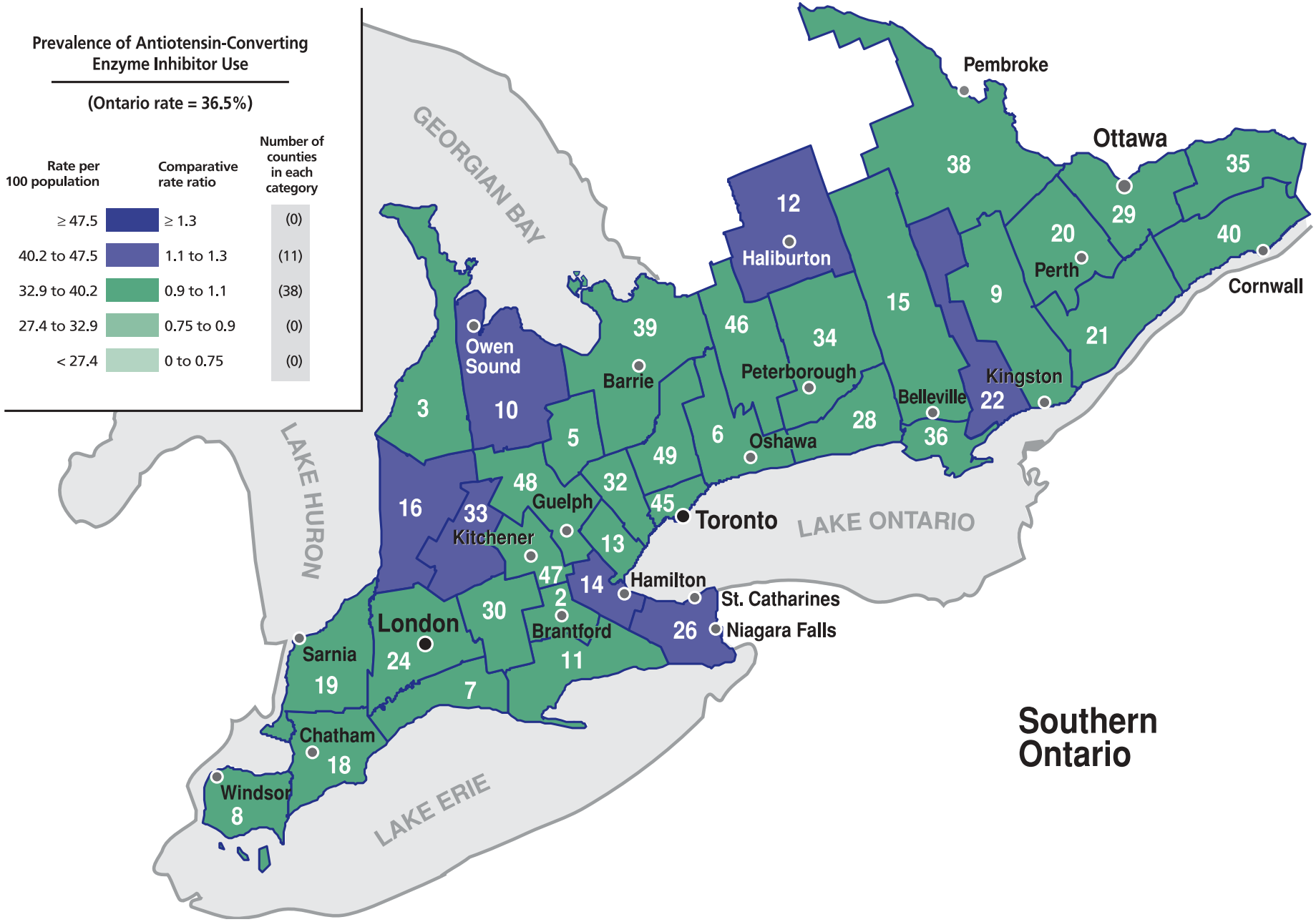
Ontario Counties

1 Algoma District
2 Brant County
3 Bruce County
4 Cochrane District
5 Dufferin County
6 Durham Regional Municipality
7 Elgin County
8 Essex County
9 Frontenac County
10 Grey County
11 Haldimand-Norfolk Regional Municipality
12 Haliburton County
13 Halton Regional Municipality
14 Hamilton-Wentworth Regional Municipality
15 Hastings County
16 Huron County
17 Kenora District
18 Kent County
19 Lambton County
20 Lanark County
21 Leeds and Grenville United Counties
22 Lennox and Addington County
23 Manitoulin District
24 Middlesex County
25 Muskoka District
26 Niagara Regional Municipality
27 Nipissing District
28 Northumberland County
29 Ottawa-Carleton Regional Municipality
30 Oxford County
31 Parry Sound District
32 Peel Regional Municipality
33 Perth County
34 Peterborough County
35 Prescott and Russell United Counties
36 Prince Edward County
37 Rainy River District
38 Renfrew County
39 Simcoe County
40 Stormont, Dundas and Glengarry United Counties
41 Sudbury District
42 Sudbury Regional Municipality
43 Thunder Bay District
44 Timiskaming District
45 Toronto Metropolitan Municipality
46 Victoria County
47 Waterloo Regional Municipality
48 Wellington County
49 York Regional Municipality

Note: See Exhibit 3.9b for Legend.

Sources: Ontario Diabetes Database (ODD), Ontario Drug Benefit Plan (ODB)

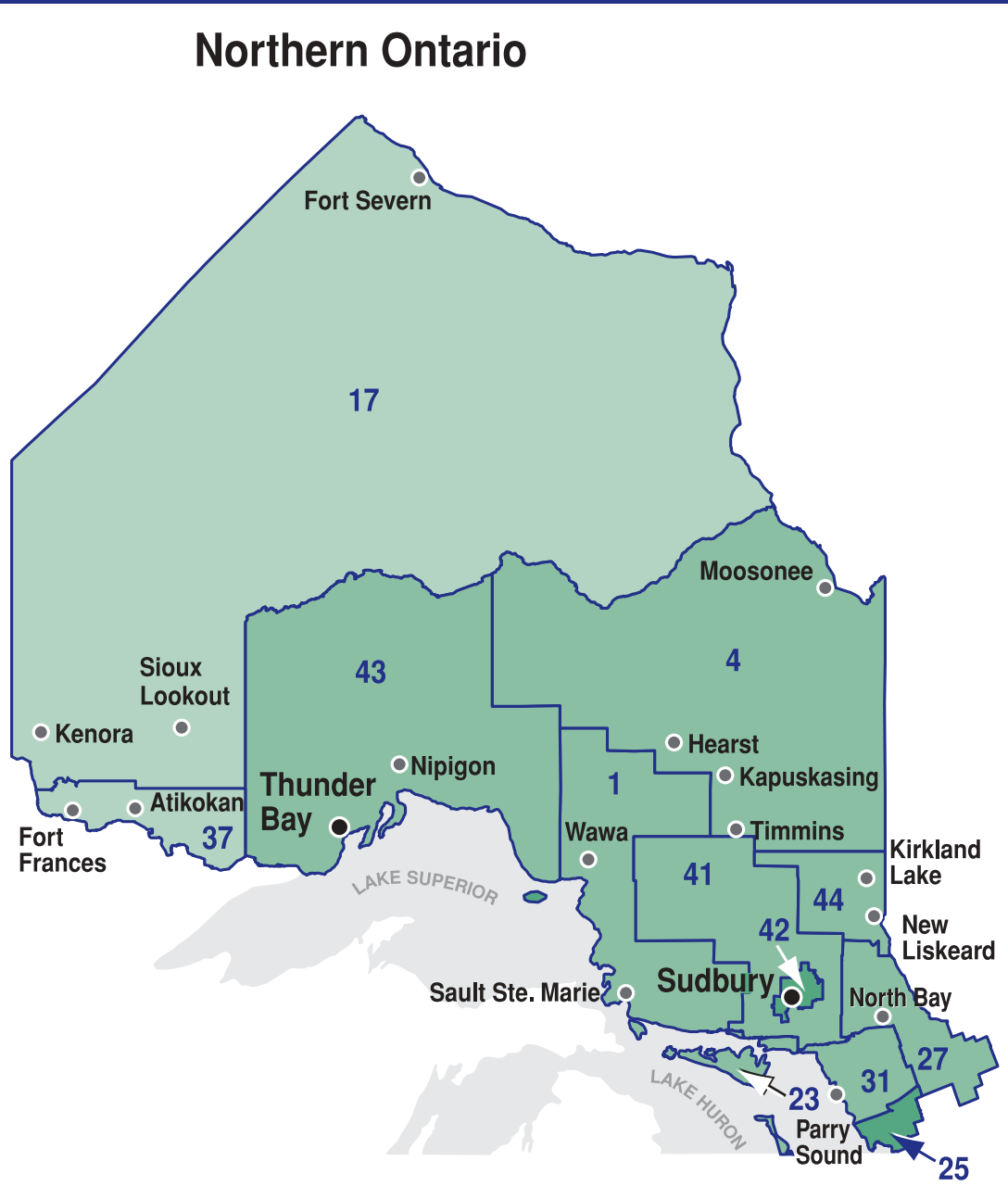
Exhibit 3.9b Age-/Sex-adjusted Prevalence of Use of Angiotensin-Converting Enzyme Inhibitors per 100 Ontarians with DM Aged 65 Years and Over by County, Southern Ontario, 1999



Note: See Exhibit 3.9a for County definitions.

Sources: Ontario Diabetes Database (ODD), Ontario Drug Benefit Plan (ODB)

Exhibit 3.10a Age-/Sex-adjusted Prevalence of Use of Lipid-Lowering Drugs per 100 Ontarians with DM Aged 65 Years and Over by County, Northern Ontario, 1999



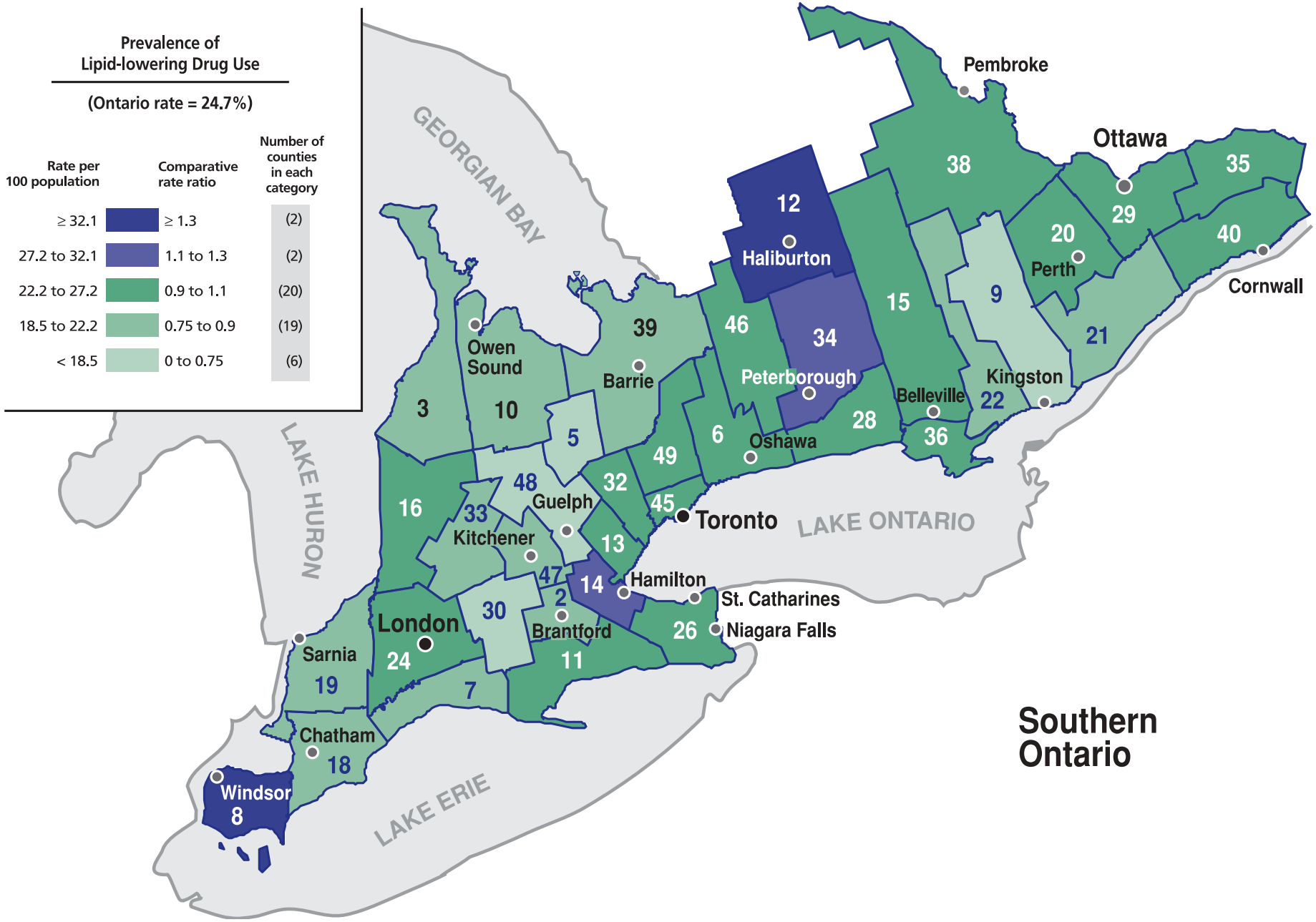
Ontario Counties

1 Algoma District
2 Brant County
3 Bruce County
4 Cochrane District
5 Dufferin County
6 Durham Regional Municipality
7 Elgin County
8 Essex County
9 Frontenac County
10 Grey County
11 Haldimand-Norfolk Regional Municipality
12 Haliburton County
13 Halton Regional Municipality
14 Hamilton-Wentworth Regional Municipality
15 Hastings County
16 Huron County
17 Kenora District
18 Kent County
19 Lambton County
20 Lanark County
21 Leeds and Grenville United Counties
22 Lennox and Addington County
23 Manitoulin District
24 Middlesex County
25 Muskoka District
26 Niagara Regional Municipality
27 Nipissing District
28 Northumberland County
29 Ottawa-Carleton Regional Municipality
30 Oxford County
31 Parry Sound District
32 Peel Regional Municipality
33 Perth County
34 Peterborough County
35 Prescott and Russell United Counties
36 Prince Edward County
37 Rainy River District
38 Renfrew County
39 Simcoe County
40 Stormont, Dundas and Glengarry United Counties
41 Sudbury District
42 Sudbury Regional Municipality
43 Thunder Bay District
44 Timiskaming District
45 Toronto Metropolitan Municipality
46 Victoria County
47 Waterloo Regional Municipality
48 Wellington County
49 York Regional Municipality

Note: See Exhibit 3.10b for Legend.

Sources: Ontario Diabetes Database (ODD), Ontario Drug Benefit Plan (ODB)

Exhibit 3.10b Age-/Sex-adjusted Prevalence of Use of Lipid-Lowering Drugs per 100 Ontarians with DM Aged 65 Years and Over by County, Southern Ontario, 1999

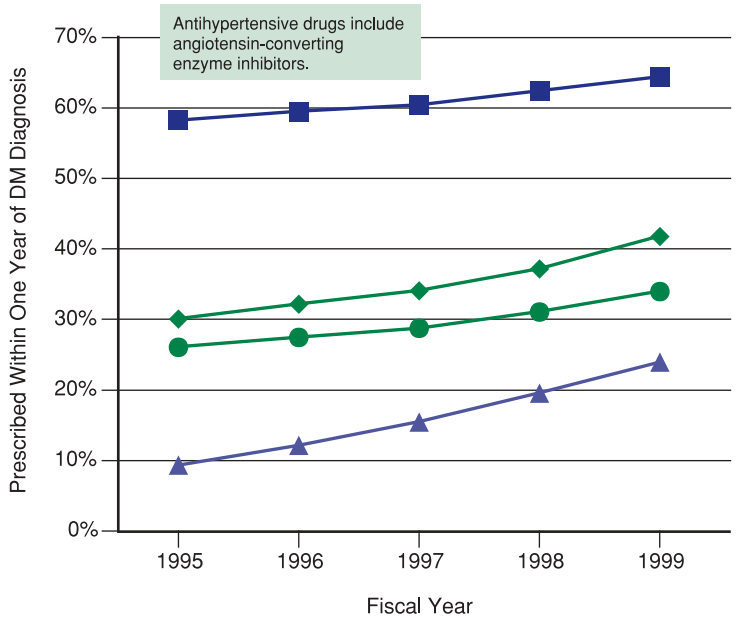


Note: See Exhibit 3.10a for County definitions.

Sources: Ontario Diabetes Database (ODD), Ontario Drug Benefit Plan (ODB)

Exhibit 3.11 Percentage of Ontarians Aged 65 and Over Diagnosed with DM who Received Antihypertensive Medications, Angiotensin-converting Enzyme Inhibitors and Lipid-lowering Medications Within the Following Years, 1995–1999

Early initiation of antihypertensive drugs, angiotensin-converting enzyme inhibitors (ACEIs) and lipid-lowering drugs increased over the 5-year period of the study.



	Percentage				
	1995	1996	1997	1998	1999
At least one anti-hypertensive	58.3	59.5	60.4	62.4	64.4
2 or more anti-hypertensives	30.1	32.2	34.1	37.2	41.8
ACEI	26.1	27.5	28.8	31.1	34.0
Lipid-Lowering	9.4	12.2	15.5	19.6	24.0

Sources: Ontario Diabetes Database (ODD), Ontario Drug Benefit Plan (ODB)

Technical Appendices (TA3.A and TA3.B)

Drugs in DM; Clinical Trial Summary; Costs, Coverage and Dosing

See following pages **3**.71–**3**.73.

Exhibit TA3.A Summary of Important Clinical Trials of Anti-hyperglycemic Drugs, Anti-hypertensive Drugs, Angiotensin-converting Enzyme Inhibitors and Lipid-lowering Drugs in People with DM

Study	Year	Population studied	Intervention examined	NNT*	Outcome prevented
Anti-hyperglycemic drugs					
DCCT[1]	1993	1,441 people with type 1 DM	Intensive vs conventional therapy for 6.5 years	6 5	New diabetic retinopathy Progression of diabetic retinopathy
Okhubo et al[20]	1995	110 people with type 2 DM	Intensive vs conventional therapy for 6.5 years	4 5	Development or progression of diabetic retinopathy Development or progression of diabetic nephropathy
UKPDS[2]	1998	3,867 people newly diagnosed with DM	Intensive glucose control vs conventional control for 10 years	31 46 (NS)†	Composite DM-related endpoint** AMI
UKPDS[4]	1998	1,704 overweight people newly diagnosed with DM	Metformin vs sulfonylureas or insulin for 10.7 years	12 19	Composite DM-related endpoint All cause mortality
DIGAMI[21,22]	1996 1997	620 people with type 2 DM admitted with AMI	Intensive insulin therapy in hospital and ≥3 months after vs standard care	14	All cause mortality at 1 year All cause mortality at 3.4 years
Angiotensin-converting enzyme inhibitors/Angiotensin receptor blockers					
Collaborative Study[12]	1993	409 people with type 1 DM for 7 years; overt proteinuria	Captopril vs placebo for 3 years	11 10	Doubling of serum creatinine Death or dialysis or transplantation
North American Micro-albuminuria Study[23]	1995	143 people with type 1 DM and microalbuminuria	Captopril vs placebo for 2 years	8	Progression to nephropathy
Microalbuminuria Captopril Study[24]	1996	225 people with type 1 DM and microalbuminuria	Captopril vs placebo for 2 years	7	Progression to nephropathy❖
Ravid et al[25]	1993	94 people with type 2 DM and microalbuminuria	Enalapril vs placebo for 5 years	3	Progression to nephropathy❖
Ahmad et al[26]	1997	103 people with type 2 DM and microalbuminuria	Enalapril vs placebo for 5 years	6	Progression to nephropathy❖
Micro-HOPE[15]	2000	3,577 people with DM + ≥ 1 cardiac risk factor (32% had microalbuminuria)	Rampiril vs placebo for 4.5 years	51 22	Progression to nephropathy❖ AMI or stroke or cardiovascular death
Collaborative Study[27]	2001	1,715 people with type 2 DM, hypertension and overt proteinuria	Irbesartan vs placebo for 2.6 years	16	Doubling of creatinine, end-stage renal disease or death
RENAAL[28]	2001	1,513 people with type 2 DM with proteinuria ≥ 500 mg/day	Losartan vs placebo for 3.4 years	28	Doubling of creatinine, end-stage renal disease or death
Parving et al[29]	2001	590 people with type 2 DM and microalbuminuria	Irbesartan vs placebo for 2 years	13	Progression to nephropathy❖
Anti-hypertensive drugs					
SHEP[30]	1996	583 people with type 2 DM and systolic hypertension	Chlorthalidone ± atenolol vs placebo for 4.5 years	13 20	CVD events CHD death + nonfatal AMI
UKPDS[10]	1998	1,148 people with type 2 DM and hypertension	Target BP < 150/85 vs < 180/105 for 8.4 years	6 20 14	Composite DM-related endpoint** Stroke Microvascular disease
HOT[31]	1998	1,505 people with type 2 DM and diastolic hypertension	Target diastolic blood pressure ≤80 vs ≤90 for 3.8 years	22	CHD death or AMI or stroke
ABCD[32]	1998	470 people with type 2 DM and diastolic hypertension	Enalapril vs nisoldipine for 5 years	12	AMI
Syst-Eur[33]	1999	492 elderly people with type 2 DM and systolic hypertension	Medications to lower systolic BP vs placebo changes to medications for 2 years	21 13 23	CHD death CVD events Stroke
Lipid-lowering drugs					
4S[34]	1997	202 men with DM; high cholesterol; previous MI or angina	Simvastatin vs placebo for 5.3 years	4	CHD death or nonfatal AMI
CARE[35]	1998	586 people with DM; moderate cholesterol; recent MI	Pravastatin vs placebo for 4.9 years	12 38 (NS)‡	CHD death or nonfatal AMI or revascularization CHD death or nonfatal AMI
LIPID[36]	1998	782 people with DM; moderate cholesterol; recent MI or angina	Pravastatin vs placebo for 6.1 years	28 (NS)‡	CHD death or nonfatal AMI
AFCAPS/ TexCAPS[37]	1998	155 people with DM; moderate cholesterol; no coronary disease	Lovastatin vs placebo for 5.2 years	78 (NS)‡	CHD death or nonfatal AMI or angina
Post-CABG[38]	1999	116 people with DM after CABG	Aggressive vs moderate LDL lowering with lovastatin for 4 years	8.8 (NS)‡	CHD death or AMI or stroke or revascularization
Helsinki[39]	1992	135 people with type 2 DM; elevated cholesterol	Gemfibrozil vs placebo for 5 years	14 (NS)‡	CHD death or nonfatal AMI
VA-HIT[40]	1999	627 people with DM; low HDL cholesterol; CAD	Gemfibrozil vs placebo for 5.1 years	13 (NS)‡	CHD death or nonfatal AMI

* NNT = number of people needed to treat with the intervention to prevent one person from experiencing the outcome (the reciprocal of the absolute risk reduction)

† NS = Not statistically significant.

‡ NS = Not statistically significant. However, these NNTs are for sub-group analyses of people with DM from larger trials. The larger trials did have statistically significant overall NNTs for all participants.

** Composite DM-Related Endpoint = sudden death, death from hyperglycemia or hypoglycemia, fatal or non-fatal AMI, angina, heart failure, stroke, renal failure, amputation (of at least one digit), vitreous hemorrhage, retinal photocoagulation, blindness in one eye, or cataract extraction.

❖ Nephropathy = progression from elevated microalbuminuria (30–299 mg albumin in urine in 24 h) to overt nephropathy (greater than 300 mg albumin in 24 h).

Exhibit TA3.B Drug Costs, Ontario Drug Benefit Program Coverage, and Usual Daily Dose of Medications included in Analysis *(as of December 2001)*

Available Drugs	Usual Daily Cost	ODB Coverage	Usual Daily Dose
Anti-hyperglycemic drugs			
Insulins			
Aspart—cartridges	❖	Not Covered*	Varies
Human—cartridges	$2.14/mL	Covered†	Varies
Human—vial	$1.55–1.60/mL	Covered	Varies
Lispro—cartridges	$3.07/mL	Limited Use‡	Varies
Lispro—vial	$2.30/mL	Limited Use	Varies
Pork	$1.88/mL	Covered	Varies
Sulfonylureas			
Acetohexamide	Not available	Not Covered	250–1500 mg/d divided
Chlorpropamide	$0.04–0.08	Covered	250–500 mg od
Gliclazide	$0.38–1.51	Not Covered	80–320 mg/d divided
Glimepiride	❖	Not Covered	1–8 mg od
Glyburide	$0.04–0.27	Covered	2.5 mg od – 10 mg bid
Tolbutamide	$0.02–0.09	Covered	500–2000 mg od
Biguanides			
Metformin	$0.36–0.73	Covered	1500–3000 mg/d divided
Alpha-glucosidase inhibitors			
Acarbose	$0.68–0.94	Limited Use	50–100 mg tid
Miglitol	Not available	Not Covered	25–100 mg tid
Meglitinides			
Nateglinide	❖	Not Covered	120–180 mg tid
Repaglinide	$0.75–1.62	Not Covered	0.5–4 mg tid
Thiazolidinediones			
Pioglitazone	$2.46–4.15	Not Covered	15–45 mg od
Rosiglitazone	$1.93–3.86	Not Covered	4–8 mg od
Troglitazone	Not available	Not Covered	200–600 mg od
Anti-hypertensive drugs			
Angiotensin-converting enzyme inhibitors			
Benazepril	$0.68–1.56	Covered	10–40 mg od
Captopril	$0.90–1.68	Covered	25–50 mg tid
Cilazapril	$0.59–1.58	Covered	2.5–10 mg od
Enalapril	$0.83–2.00	Covered	10–40 mg od
Fosinopril	$0.79–1.90	Covered	10–40 mg od
Lisinopril	$0.51–1.36	Covered	5–40 mg od
Perindopril	$0.60–1.50	Covered	4–8 mg od
Quinapril	$0.82	Covered	10–40 mg od
Ramipril	$0.75–0.95	Covered	2.5–10 mg od
Trandolapril	$0.77–1.54	Covered	2–4 mg od
Angiotensin receptor blockers			
Candesartan	$1.08	Limited Use	8–16 mg od
Eprosartan	$1.02–2.04	Not Covered	400–800 mg od
Irbesartan	$1.08	Limited Use	150–300 mg od
Losartan	$1.10	Limited Use	25–100 mg od
Telmisartan	$1.07	Limited Use	40–80 mg od
Valsartan	$1.05	Limited Use	80–160 mg od
Beta adrenergic blockers			
Acebutolol	$0.49–0.97	Covered	200–400 mg bid
Atenolol	$0.36–0.59	Covered	50–100 mg od
Bisoprolol	$0.35–1.16	Covered	5–20 mg od
Carvedilol	$2.54	Limited Use	3.125–25 mg bid
Labetalol	$0.58–1.17	Covered	200–400 mg bid
Metoprolol	$0.25–0.45	Covered	50–100 mg bid
Nadolol	$0.35–1.01	Covered	80–240 mg od
Oxprenolol	$0.80–1.57	Covered	60–160 mg bid
Pindolol	$0.68–1.75	Covered	15–45 mg/d divided
Propranolol	$0.12–0.24	Covered	80–160 mg bid

Exhibit TA3.B (Cont'd) Drug Costs, Ontario Drug Benefit Program Coverage, and Usual Daily Dose of Medications included in Analysis *(as of December 2001)*

Available Drugs	Usual Daily Cost	ODB Coverage	Usual Daily Dose
Anti-hypertensive drugs			
Beta adrenergic blockers (Cont'd)			
Timolol	$0.51–1.00	Covered	10–20 mg bid
Calcium channel blockers			
Amlodipine	$1.28–1.90	Covered	5–10 mg od
Diltiazem	$0.80–2.28	Covered	120–360 mg/d divided
Felodipine	$0.66–0.99	Covered	5–10 mg od
Isradipine	Not available	Not Covered	2.5–5 mg bid
Nicardipine	Not available	Not Covered	20–40 mg tid
Nifedipine	$0.75–2.39	Covered	20–90 mg/d divided
Verapamil	$0.82–1.70	Covered	240–480 mg/d divided
Diuretics			
Amiloride	$0.29–0.57	Covered	5–10 mg od
Bendroflumethiazide	Not available	Not Covered	2.5–20 mg od
Chlorothiazide	Not available	Not Covered	250–1000 mg od
Chlorthalidone	$0.01–0.02	Covered	25–50 mg od
Hydrochlorothiazide	$0.01	Covered	25–50 mg od
Indapamide	$0.30	Covered	1.25–2.5 mg od
Methyclothiazide	Not available	Not Covered	2.5–5 mg od
Spironolactone	$0.14–0.21	Covered	50–100 mg od
Triamterene	$0.47	Covered	100 mg bid
Other anti-hypertensive drugs			
Clonidine	$0.35–0.95	Covered	0.2–0.6 mg/d divided
Doxazosin	$0.35–1.08	Covered	1–8 mg od
Guanethidine	$0.39	Covered	25 mg od
Hydralazine	$0.37–1.01	Covered	40–200 mg/d divided
Methyldopa	$0.12–0.46	Covered	500–2000 mg/d divided
Minoxidil	$1.26–2.79	Covered	10–40 mg/d divided
Prazosin	$0.42–0.61	Covered	2–5 mg bid
Reserpine	$0.06–0.11	Covered	0.125–0.25 mg od
Terazosin	$0.35–0.60	Covered	1–5 mg od
Lipid-lowering drugs			
Atorvastatin	$1.60–2.15	Covered	10–40 mg od
Bezafibrate	$2.65	Covered	200 mg tid
Cerivastatin	Not available	Not Covered	0.2–0.4 mg od
Cholestyramine resin	$0.64–2.85	Covered	1–6 packs/day
Clofibrate	Not available	Not Covered	500 mg qid
Colestipol	$0.82–4.91	Covered	1–6 packs/day
Fenofibrate	$1.21	Covered	200 mg od
Fluvastatin	$0.75–1.05	Covered	20–40 mg od
Gemfibrozil	$1.19	Covered	600 mg bid
Lovastatin	$1.09–4.02	Covered	20–80 mg od
Niacin	$0.44–1.77	Covered	1.5–6 g/d divided
Pravastatin	$0.95–1.35	Covered	10–40 mg od
Probucol	Not available	Not Covered	500 mg bid
Simvastatin	$1.78–2.20	Covered	10–80 mg od

Not covered = the cost of the drug is not routinely reimbursed for patients.

Covered† = the cost of the drug is reimbursed for all patients with no restrictions.

Limited Use‡ = the cost of the drug is reimbursed only for patients who meet certain clinical criteria.[41]

❖ = These drugs have become available in Ontario since December 2001, but were not included in the analyses.

Source: Drug Programs Branch, Ministry of Health and Long-Term Care, December 2001.

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4

Chapter

Diabetes Health Status and Risk Factors

Authors: Douglas G. Manuel and Susan E. Schultz

Key Messages

- Diabetes mellitus (DM) is the cause of significant burden of illness in Ontario.
- As the prevalence of DM grows, providers need to be prepared to deal with the substantive impact that DM may have on a person's life expectancy and health-related quality of life (HRQOL).
- Providers should be prepared to address the restrictions in activities of daily living and limitations to social participation in the management of DM.
- The increasing evidence of effective DM preventive measures and the large number of people at risk of developing DM suggest that prevention can play an important role in reducing the burden of disease from DM.

Background

Diabetes mellitus (DM) affects a person's health in many different ways. From the simplest disease perspective, DM results in high blood sugar levels that can lead to vital organ damage. However, current definitions of health consider a broader context—beyond just the absence of disease, health comprises physical, emotional and mental well-being that acts as a resource for everyday living.[1,2]

In this context, high blood sugar levels can influence health in a variety of ways. For many people with DM, sustained high blood sugar levels may affect the function of many organs including the circulatory, nervous and immune systems, eyes, and kidneys. Changes in physical functioning may result in restrictions in the ability to perform activities of daily living, such as housekeeping, shopping, eating or getting dressed. In turn, complications may impair one's ability to participate in social functions and society. For some, the condition may become so severe that they require hospital treatment; for others DM may result in premature death.

This chapter examines the health of people in Ontario with DM from these different perspectives of functional health, restrictions in activities of daily living, and mortality (death). Summary measures are estimated that combine mortality with morbidity (illness) to examine the overall health of people with DM and the proportion of life lived in a healthy state. This chapter also examines lifestyle and sociodemographic factors related to DM and associated chronic diseases.

Data Sources

The health status information used in this chapter comes from the 1996/97 Ontario Health Survey (OHS II), which comprises the Ontario portion of the National Population Health Survey (NPHS).[3] There were 37,247 respondents in the OHS II; 36,892 of them were 12 years old and over. The response rate at the selected respondent level was 94%. While the OHS II contains a question which asks whether the respondent has DM, this question was not relied upon due to concern that self-reports of DM tend to underestimate the number of people with the disease.[4] Instead, the Ontario Diabetes Database (ODD) (see Chapter 1 Technical Appendix TA1.A) was directly and individually linked to the OHS II. Although 96% of respondents agreed to allow their survey responses to be linked to administrative data, only 23,403 (65.6%) were actually linkable due to technical difficulties. Population estimates for Ontario were generated from this linked sample using special analytic weights provided by Statistics Canada.

Mortality measures were calculated using mortality data from the ODD and Statistics Canada. The Office of the Registrar General is responsible for collecting and maintaining Vital Statistics including death certificates. Records of deaths are transferred to Statistics Canada and the Ministry of Health and Long-term Care (MOHL-TC) in Ontario. Deaths for people with DM in the ODD were estimated by linking vital statistics data to the MOHL-TC's Registered Persons

Database (RPDB). The linking process resulted in approximately 7% under-counting, and the death rates calculated using these data were adjusted to compensate for this (see Technical Appendix TA4.A for details).

How the analysis was done

In this chapter, the associations between DM and a number of different factors were examined in two different ways. In the first type of analysis, the distribution of socio-demographic characteristics, health status indicators and risk factors among the populations with and without DM were compared. In the second type of analysis, changes in the prevalence of DM across different levels or categories of a risk factor were examined. To illustrate the difference, the table below lists the number of people with and without DM by income level (fictional data).

Income Level	Diabetes	No Diabetes	Total
Low	250	750	1,000
High	150	850	1,000
Total	400	1,600	2,000

The first analysis looks at these fictional data vertically, so the comparison would be: 250/400 or 62.5% of people with DM have low income compared with 750/1600 or 46.9% of those without DM. In the second analysis, the comparisons are done by rows horizontally. In this analysis, 250/1000 or 25% of people with low income have DM compared with 150/1000 or 15% of high-income people.

The risk factors and socio-demographic characteristics examined included age, self-defined ethnic origin, highest level of education attained, adjusted household income, body mass index (BMI) and level of physical activity. With respect to ethnic origin, respondents were assigned to one of five ethnic origin groups based on three survey questions dealing with country of birth, ethnic origin and race, using the algorithm described in the Technical Appendix TA4.A at the end of this chapter. Education was grouped into three categories and income into four categories, adjusted for household size.

BMI is a measure commonly used to determine if an individual is in a healthy weight range. It is calculated by dividing a person's weight in kilograms by the square of their height in metres. A BMI of 20.0 to 24.9 is generally considered to be within the healthy weight range. A person with a BMI of 25.0 to 26.9 has some excess weight, 27.0 to 29.9 is considered overweight and 30.0 is the threshold for obesity. BMI was calculated for everyone over the age of 12, recognizing that BMI scores in the teenage years may not be a good predictor of adult BMI, and that the loss of height among seniors may also result in some loss of validity of BMI for this group.

Key Research Findings

- The life expectancy of people with diabetes mellitus (DM) in Ontario is about 13 years less than people without DM.
- Twelve per cent of men with DM and 18 per cent of women with DM need assistance with activities such as shopping, cooking and cleaning. This is over twice the likelihood of those without DM.
- Men with DM are three times more likely than men without the condition to report disability as their reason for not working.
- Sixty-nine per cent of people without DM in Ontario have at least one of the following risk factors for type 2 DM: BMI>27, physical inactivity, and low income.
- Although complications such as blindness and amputation are important, most people with DM have a fairly high level of physical functioning.

The analysis of health status included examinations of both mortality and morbidity, beginning with a comparison of the numbers and rates of deaths among people with and without DM. Using life table analyses, the life and health-adjusted life expectancies of people with and without DM were then examined. Finally, the Health-Related Quality of Life (HRQOL) of those with and without DM were compared using a number of indicators, including measures of physical function such as vision and mobility; measures of activity such as activity restriction and impairment (see Technical Appendix TA4.C for a definition of impairment) and measures of social participation such as employment status. For more information on the different health status measures used in this chapter, see Technical Appendix TA4.D.

There is a strong positive association between DM prevalence and age. To examine the associations between DM and other factors independent of age, all analyses were age standardized to the total 1991 Canadian population using the direct method. As well, all analyses, with the exception of those by ethnic origin, were run separately for men and women. The analyses by ethnic origin were not stratified by sex due to small cell sizes and high sampling variability.

Life and health expectancy measures used age- and sex-specific mortality rates from both the ODD and Statistics Canada. An adapted version of Chaing's method was used for life table calculations.[5] The life table template that was used for the analysis is available at: http://www.cehip.org. Health-adjusted life expectancy was calculated using a modified Sullivan method and the Health Utilities Index 3 (see Technical Appendix TA4.D).[6,7]

Interpretative Cautions

The OHS II excludes people living in long-term care facilities, remote communities and on reserves; therefore, estimates from these surveys should not be interpreted to represent the entire population. This is especially important in the case of DM, since DM prevalence is higher among the Aboriginal population and the elderly. The OHS II was a self-report survey and therefore the questions may be subject to differing interpretation by individual respondents. In addition, linkage was only possible for 66.5% of those who gave permission for their data to be linked. However, while there are some differences between the linkable and total samples, these do not appear to be systematic.[8]

Data from cross-sectional studies such as the OHS II generally do not yield accurate estimates of risk because they measure a person's current health practices, which may have changed as a result of being diagnosed with the condition. Ideally, people with DM make lifestyle changes to reduce complications from the disease; therefore current prevalence estimates may not reflect the lifestyle risks present before they developed the disease.

Findings and Discussion

Sociodemographic Characteristics

Exhibit 4.1 shows the sociodemographic characteristics of people with and without DM in Ontario. About 60 per cent of Ontarians with DM are over the age of 55 years compared to less than 25 per cent for the rest of the population. The older age of people with DM and increasing prevalence with age (see also Exhibit 4.6) is typical of many chronic diseases. A greater proportion of people with DM have less than a high school diploma, even after controlling for age, and they are more likely to be in the low-income category. The latter is particularly true for women, with 21 per cent of females with DM classified as low income compared to only 10 per cent for those without DM. The exact reasons for this association between DM and low socio-economic status (SES) are not known but may be related to a higher prevalence of risk factors such as obesity and sedentary lifestyle (see section on Diabetes Risk Factors) among people in lower SES groups.

Mortality, Life and Health Expectancy

Death from DM can be measured in two ways. First, physicians complete death certificates that identify the main underlying cause of death. Thus, DM will only be identified in cause of death statistics when a physician believes DM is the most important disease related to an individual's death.[9,10] Since people with DM often die from other related conditions such as heart disease, death certificates likely under-represent the burden of mortality from DM. For this reason, deaths were also examined from all causes in people who were diagnosed with DM (people identified with DM in the ODD). This number may also under-represent the burden of DM since many people die without ever being diagnosed with or treated for DM. In Ontario in 1997, 18,320 people, or almost one quarter of all people who died, had DM (see Exhibit 4.2). However, only 12.5 per cent of people dying with DM were identified as dying from DM on their death certificates.

The age-standardized mortality rate for people with DM is more than twice that of people without the disease (see Exhibit 4.2). This increased death rate translates into a life expectancy of 64.7 years for men with DM compared with 77.5 years for those without the disease (Exhibit 4.3). For women, life expectancy is only 70.6 years for those with DM, compared with 82.9 years for those without the disease. The difference in life expectancy is about 13 years for both men and women. Put another way, the chances of men and women with DM surviving to age 65 years of age are 60 and 71 per cent respectively, compared to 83 and 90 per cent for men and women without DM.

Exhibit 4.1 Distribution of Socio-demographic Characteristics Among Ontarians with/without DM, 1996–1997

Sixty-one per cent of people with DM are 55 years or older. Twenty-one per cent of women with DM have a low income.

	MEN						WOMEN					
	With DM			Without DM			With DM			Without DM		
Age	N[2] (unwtd)	N[3] (wtd)	% (wtd)	N[2] (unwtd)	N[3] (wtd)	% (wtd)	N[2] (unwtd)	N[3] (wtd)	% (wtd)	N[2] (unwtd)	N[3] (wtd)	% (wtd)
12–39	78	40,920	12.8	4,916	2,331,855	54.9	100	46,277	16.9	5,300	2,299,996	51.4
40–54	196	85,218	26.6	2,444	1,062,570	25.0	148	64,826	23.7	2,557	1,095,743	24.5
55–69	338	119,093	37.2	1,636	574,374	13.5	266	81,905	29.9	2,033	665,569	14.9
70+	251	74,738	23.4	916	282,488	6.6	293	80,608	29.5	1,591	418,159	9.3
Highest Level of Education[1]												
College/University Graduation	223	91,588	33.6	3,043	1,428,049	33.5	162	61,980	28.5	3,735	1,439,909	31.9
High School Graduation+	254	97,707	32.3	3,441	1,480,259	35.2	261	92,177	37.6	4,316	1,676,009	37.5
< High School Graduation	366	122,739	34.2	3,343	1,296,068	31.4	377	117,903	33.9	3,364	1,332,369	30.6
Adjusted Household Income[1]												
High	94	26,193	13.1[a]	316,757	684	15.6	188	53,909	8.2[a]	1,686	457,582	14.2
Upper-middle	248	84,716	26.6	804,118	1,736	30.0	232	66,200	23.3	2,761	931,365	27.3
Low-middle	262	88,888	29.5	1,279,966	2,764	19.1	188	64,312	23.7	3,450	1,233,493	21.1
Low	105	37,192	5.4[a]	673,007	1,453	7.5	48	17,684	21.0	1,500	647,182	10.4
Unknown	154	82,980	25.9	1,177,439	2,542	27.7	151	71,511	26.1[a]	2,084	1,209,844	27.0

	TOTAL POPULATION					
	With DM			Without DM		
Ethnic Origin[1]	N[2] (unwtd)	N[3] (wtd)	% (wtd)	N[2] (unwtd)	N[3] (wtd)	% (wtd)
Canadian/US	370	119,853	24.6	6,523	2,585,886	30.1
European	1,048	329,172	44.4	12,055	4,515,142	52.2
Aboriginal/Black/ Latin American	46	17,735	3.8[a]	406	222,980	2.6
South or West Asian	55	47,473	12.1	401	338,007	3.9
Other	139	73,169	15.1	1,786	972,028	11.2

[1]Standardized to the 1991 Canadian population.

[2]The unweighted (unwtd) N refers to the number of survey respondents (actual observations).

[3]The weighted (wtd) N is the survey sample weighted up to the community dwelling Ontario population (does not include people in institutions, living in remote communities, on reserves, or in the Armed Forces). All analyses in this chapter have been carried out on the weighted data.

[a]Estimates should be treated with caution due to high sampling variability (coefficient of variation between 16.5–33.0).

Sources: 1996/97 Ontario Health Survey (OHS II), Ontario Diabetes Database (ODD)

Exhibit 4.2 Mortality Rates in Ontarians with/without DM, 1996–1997

The death rate (age-adjusted) for people with DM is more than twice as high as that for people without DM.

	Male			Female			Total		
	Without DM	With DM	Rate Ratio	Without DM	With DM	Rate Ratio	Without DM	With DM	Rate Ratio
Population 1997	5,365,841	232,553	--	5,515,006	216,658	***	10,880,847	449,211	--
Deaths, All-cause	31,022	9,646	--	29,900	8,750	***	60,922	18,396	--
Crude Death Rate (per 100,000)[1]	578	4,148	7.2	542	4,039	7.4	560	4,095	7.3
Age-adjusted Death Rate (per 100,000)[1,2]	588	1,369	2.3	533	1,315	2.5	559	1,358	2.4

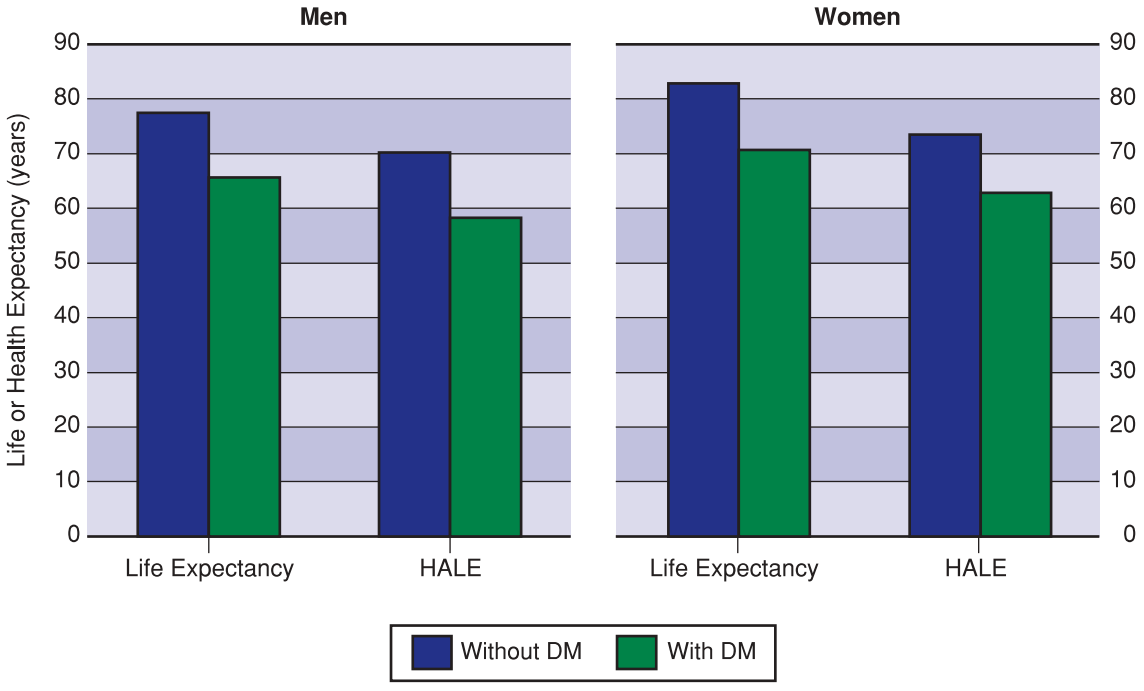
[1] Crude and age-adjusted rates calculated for all-cause mortality.

[2] Rates age-adjusted to 1991 Canadian population.

Sources: Ontario Diabetes Database (ODD), Registered Persons Database (RPDB), Statistics Canada

Exhibit 4.3 Differences in Life and Health-adjusted Life Expectancy (HALE) in Ontarians with/without DM by Sex, 1996–1997

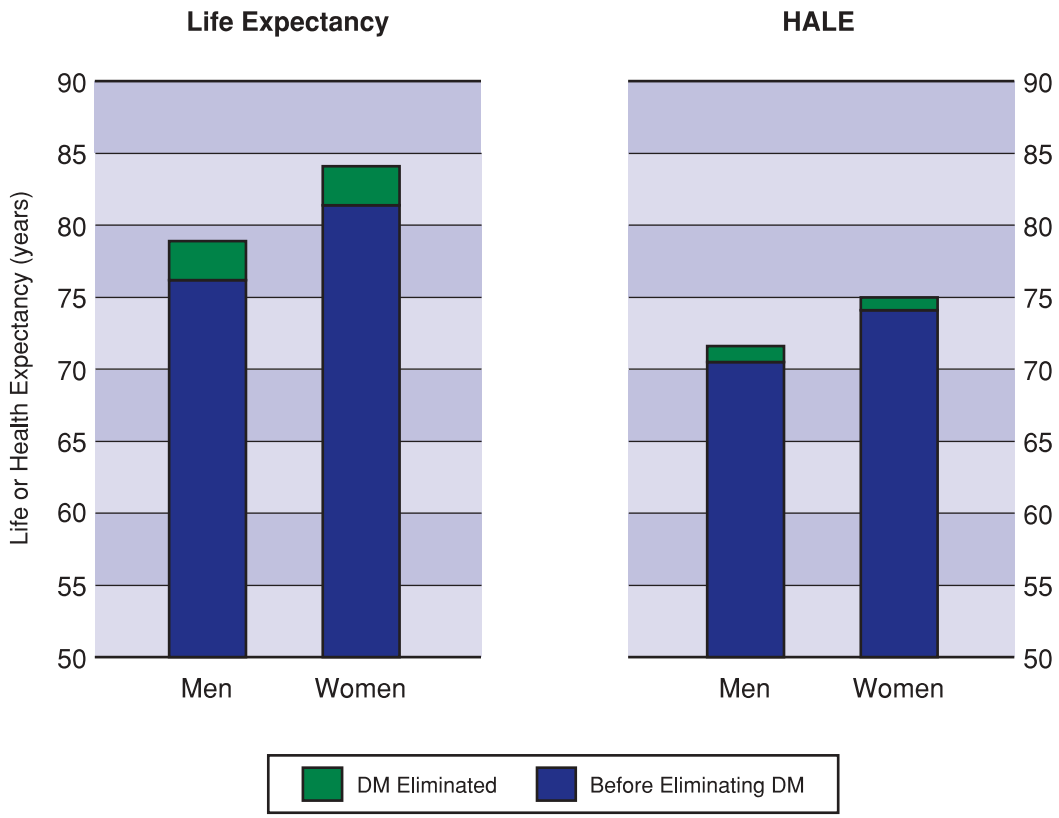
Life expectancy for people with DM is 13 years less than those without DM. Health-adjusted life expectancy, the amount of life lived in good health, for people with DM is 12 years less those people without DM.



Sources: Ontario Diabetes Database (ODD), 1996/97 Ontario Health Survey (OHS II), Registered Persons Database (RPDB), Statistics Canada

Exhibit 4.4 Impact of Eliminating DM on Life and Health-adjusted Life Expectancy (HALE) in Ontarians by Sex, 1996–1997

If DM were eliminated, life expectancy would rise 2.7 years and HALE would rise 1.0 years.



Sources: Ontario Diabetes Database (ODD), 1996/97 Ontario Health Survey (OHS II), Registered Persons Database (RPDB), Statistics Canada

Exhibit 4.4 shows that overall life expectancy in Ontario would be 2.7 years longer for both men and women if excess deaths among people with DM were eliminated. This estimate assumes that once these excess deaths were eliminated, the death rates of people who would have died from DM-related causes would become equivalent to that of other Ontarians of the same age and sex. Gains in life expectancy from eliminating DM-related deaths might be even larger if the deaths were prevented through a reduction in the prevalence of such risk factors as poor diet, obesity and lack of physical activity designed to prevent DM, because such a change could also reduce deaths from chronic conditions such as heart disease among people without DM. Conversely, if the DM-related deaths were reduced or eliminated primarily through improvements in medical or hospital care that target diabetic complications, the gains in life expectancy might actually be smaller, since people would continue to suffer from other chronic conditions related to DM lifestyle risks.

Health-adjusted life expectancy (HALE) is a measure that combines both mortality and morbidity by adjusting years of life expectancy according to the amount of time spent in less than perfect health. HALE was 58.3 years for men with DM, compared to 70 years for those without; and 63.8 years for women with DM compared to 73.5 years for those without (Exhibit 4.3).

The ratio of HALE to life expectancy is the proportion of life spent in good health. For men and women with DM, these proportions were 90 and 89 per cent, respectively. Men and women without DM can expect to spend similar proportions of their lives in good health. The fact that the proportion of life spent in good health is very similar for people with and without DM suggests that the impact of DM on length of life is similar to or slightly larger than its impact on years of healthy life. The proportion of life spent in good health for people with DM is similar to that of people with heart disease and cancer, although there is a larger burden of mortality and morbidity from these diseases. Disease such as arthritis and depression result in a lower proportion of life spent in good health, but the impact on life expectancy from these diseases is much lower than that of DM.

It is important to not only add "years to life", but also add "life to years", meaning improvements in life expectancy should ideally be accompanied by improvements in health-related quality of life (HRQOL).[10] Efforts to reduce diseases that are fatal will add "years to life"; reducing diseases that affect HRQOL will add "life to years". Because diseases such as arthritis and mental health largely affect HRQOL, more so than mortality, reducing or eliminating them will mostly add "life to years". Since diseases such as DM, cancer and heart disease impact life expectancy more than HRQOL, reducing these diseases has the potential of adding more "years to life" than "life to years". Given the present burden of disease, eliminating DM will extend Ontario life expectancy by 2.7 years, but less than half of this time would be in a healthy state (1.0 years). The potential for extending life expectancy without correspondingly large increases in HALE results in a greater number of years lived in poor health and is referred to as an "expansion of morbidity".[11] In Ontario, there has been an overall contraction of morbidity.[10] Although we do not know why HALE has been increasing faster than life expectancy, it is likely from a combination of overall reduction in the age-standardized prevalence of chronic diseases, in particular heart disease in both men and women and cancer in men, and an increasing availability of health care interventions that either delay the progression of disease or focus on improving HRQOL. Because many preventative and health care interventions for DM target HRQOL, it is possible that addressing the health needs of persons with DM will result in greater improvements in HALE than life expectancy.

Health-related Quality of Life (HRQOL)

Life expectancy and health-adjusted life expectancy paint a broad picture of the health of people with DM. It is also important to understand the impact of DM on day-to-day living. A new framework developed by the World Health Organization divides HRQOL into overlapping domains that begin at the level of the body's physiological or psychological function and extend to an individual's participation in real life situations.[10]

Exhibit 4.5 shows that people with DM generally reported moderately higher levels of major functional limitation compared to those without DM. For example, people with DM have a much higher risk of being disabled and impaired. Twenty per cent of men with DM and 15 per cent of women with DM reported having a long-term disability. Impairment takes into account both the need to restrict one's activities due to a long-term health problem and need for assistance with various activities of daily living. Twenty-five per cent of men with DM and 19 per cent of women with DM reported that they restrict their activities either at home, school, work or leisure. While the age-adjusted proportion of the population 20–64 years of age currently working was 74 per cent for men without DM, it was only 67 per cent for those with the disease. The proportions for women were 62 per cent and 43 per cent, respectively. Women with DM were more than three times more likely than men without DM to report disability or illness as the reason they were not currently working.

People with DM were about twice as likely to rate their health as fair or poor compared to non-diabetic individuals. Self-rated health is a useful measure because it allows people to gauge their health from their own perspective. Studies have shown that functional status is one of the main criteria used by individuals to rate their health, but that self-rated health is also influenced by a person's judgment about the severity of current illness, personal resource to maintain well-being, health behaviour, and family health history.[9] Self-rated health is strongly predictive of future health, including the likelihood of dying.[12]

Commonly, medical tests and other examinations evaluate organ and body function. The broader measures of HRQOL such as impairment, self-rated health, and social participation often indicate a larger burden of disease than the measures of body function. Thus, medical examinations and tests may underestimate the impact of DM on health. These findings suggest that having DM results not only in increased medical needs, but also in increased need for non-medical resources such as assistive devices and home care to ensure that people with DM are able to maximize their participation in society. It is not known to what degree people with DM are receiving the help they need; however, in Canada it is estimated that half the people with limitations in activities of daily living have unmet needs for health-related personal assistance.[13]

Diabetes Risk Factors

A number of important risk factors for DM have been identified, some of which can be modified while others cannot. Among the non-modifiable risk factors is ethnic origin (Exhibit 4.6). It is believed that some ethnic groups are more likely to have a "thrifty" gene that helps store body energy reserves for times of famine.[14] This predisposition may have had a historical evolutionary advantage in societies that were affected by wide seasonal variations in food availability. However, in recent years there has been an increase in obesity in most developed and many developing countries which, in turn, has contributed to a particularly high DM prevalence in some ethnic groups.[15] For example, people of South or West Asian origin make up only 3.9 per cent of the non-diabetic Ontario population, but 12 per cent of the population with DM (Exhibit 4.1). A similarly high prevalence of DM is seen in North American aboriginal communities;[16] however, it was not possible to examine this particular link due to the small number of aboriginal respondents in the OHS II survey (see section on Interpretive Cautions).

Exhibit 4.5 Health-related Quality of Life of Ontarians with/without DM, 1996–1997[1]

DM has a larger impact on social participation and the ability to live an active life—especially for men—than it does on physical function.

	MEN			WOMEN		
	Prevalence among those with DM (%)	Prevalence among those without DM (%)	Prevalence Ratio[2,3]	Prevalence among those with DM (%)	Prevalence among those without DM (%)	Prevalence Ratio[2,3]
Measures of Physical Functioning						
Vision (% with vision problems not corrected by lenses)	1.9[a]	1.7	1.1	4.4[a]	2.4	1.8
Mobility (% with mobility problems)	4.1	2.5	1.6*	4.9	3.1	1.6*
Dexterity (% with dexterity problems)	1.0[a]	0.6	1.6	1.3[a]	1.0	1.4
Pain (% reporting chronic pain)	13.6[a]	9.8	1.4	17.3	12.7	1.4
Measures of Mental/ Psychological Functioning						
Emotion (% reporting less than perfect emotional state)	17.5	14.4	1.2	20.3	14.1	1.4*
Cognition (% reporting less than perfect cognition)	17.5[a]	17.9	1.0	21.3	20.9	1.0
Distress Level						
None	39.3	41.3	1.0	25.3	34.8	0.7**
Low	21.8	27.3	0.8	24.7	27.2	0.9
Medium	24.4[a]	21.1	1.2	22.8	23.3	1.0
High	14.5[a]	10.3	1.4	27.3	14.7	1.9**
Measures of Activity						
Has Long-term Disability (lasting six months or more)	20.3	8.5	2.4**	15.1	9.6	1.6**
Needs Assistance with Basic Activities of Daily Living	2.3[a]	1.4	1.6	2.9[a]	1.9	1.6
Needs Assistance with Instrumental Activities of Daily Living	12.3	5.6	2.2**	17.9	10.0	1.8**
Level of Impairment						
None	72.4	87.3	0.8**	74.7	83.5	0.9**
Mild	16.9	7.8	2.2**	13.0	8.4	1.6*
Moderate	9.0[a]	3.6	2.5**	9.5	6.3	1.5*
Severe	1.7[a]	1.3	1.3	2.8[a]	1.8	1.6
Measures of Social Participation						
Restriction of Normal Activities	25.4	11.7	2.2**	19.4	14.3	1.4**
Current Working Status (those less than 70 years of age only)						
Currently working	66.5	74.1	0.9	43.3	61.5	0.7**
Not working—illness/disability	10.5[a]	3.0	3.5**	7.9	3.7	2.1*
Not working—family responsibilities	---	---	---	25.9	11.7	2.2**
Not working—other reasons	23.0[a]	22.6	1.0	22.9	23.1	1.0
Global Measures of Health Status						
Self-Rated Health of "Good" or more	84.8	92.1	0.9**	80.7	90.9	0.9**
Mean Health Utilities Index Score	0.896	0.924		0.886	0.909	

[1]All estimates age standardized to the 1991 Canadian population. [2]Prevalence ratio is the ratio of the prevalence of each characteristic among those with DM to the prevalence among those without. [3] * = p<.05; ** = p<.005. [a]Estimate should be treated with caution due to high sampling variability (coefficient of variation between 16.5–33.0).

Sources: Ontario Diabetes Database (ODD), 1996/97 Ontario Health Survey (OHS II)

Exhibit 4.6 Risk Factors Associated with DM in Ontario, 1996–1997[1]

Obesity and increasing age are the two most important risk factors associated with DM. Obesity is the most important modifiable risk factor associated with DM.

	MEN		WOMEN	
	DM Prevalence Rate (%)	Prevalence Ratio[2,3]	DM Prevalence Rate (%)	Prevalence Ratio[2,3]
Age (years)				
12–39[2]	1.7	1.0	2.0	1.0
40–54	7.4	4.3**	5.6	2.8**
55–69	17.2	10.0**	11.0	5.6**
70+	20.9	12.2**	16.2	8.2**
Highest Level of Education				
College/University Graduation[2]	5.7	1.0	4.4	1.0
High School Graduation +	6.3	1.1	5.3	1.2
< High School Graduation	7.6	1.3*	7.2	1.6**
Adjusted Household Income				
High[2]	5.5	1.0	2.6[a]	1.0
Upper-middle	6.4	1.2	5.1	2.0*
Low-middle	8.0	1.5*	6.0	2.3*
Low	7.9	1.4	9.9	3.8**
Body Mass Index (ratio of height to weight; kg/m^2)				
<20	2.4[a]	0.6*	---[a]	---
20–24.9[2]	4.4	1.0	3.3	1.0
25–26.9	5.2	1.2	4.8	1.5*
27–29.9	7.5	1.7**	8.3	2.5**
30+	12.3	2.8**	13.0	4.0**
Physical Activity				
Active[2]	5.2	1.0	4.1	1.0
Moderately Active	5.5	1.0	4.5	1.1
Inactive	7.4	1.4*	6.2	1.5
Alcohol Consumption (Type of Drinker)				
Regular Drinker[2]	5.2	1.0	2.7	1.0
Occasional Drinker	7.3	1.4*	6.1	2.3
Former Drinker	9.4	1.8**	8.4	3.1
Abstainer	10.6	2.0**	8.7	3.2

	TOTAL POPULATION	
	DM Prevalence Rate (%)	Prevalence Ratio[2,3]
Ethnic Origin		
Canadian/US[2]	5.2	1.0
European	5.5	1.1
South or West Asian	14.1	2.7**
Aboriginal, Black or Latin American	8.9[a]	1.7*
Other	7.2	1.4*

[1]Standardized to the 1991 Canadian population. [2]Reference category. Prevalence ratio is the ratio of all other categories to the reference category. [3] * = p<.05; ** = p<.005. [a]Estimate should be treated with caution due to high sampling variability (coefficient of variation between 16.5–33.0). [b] Estimate not reportable due to coefficient of variation > 33.0

Sources: Ontario Diabetes Database, 1996/97 Ontario Health Survey (OHS II)

Exhibit 4.7 Selected Conditions and Risk Factors Among Ontarians with/without DM, 1996–1997[1]

People with DM commonly have other related health conditions and risks.

	MEN			WOMEN		
	Prevalence among those with DM (%)	Prevalence among those without DM (%)	Prevalence Ratio[2,3]	Prevalence among those with DM (%)	Prevalence among those without DM (%)	Prevalence Ratio[2,3]
Hypertension	18.8	8.0	2.3**	22.8	10.0	2.3**
Heart Disease	9.3	3.8	2.5**	6.5	3.5	1.8**
Depression	3.6[a]	2.5	1.5	8.3[a]	5.3	1.6
Obesity						
BMI 27.0–29.9	20.2	19.3	1.0	18.2	10.1	1.8*
BMI >30	26.7	11.4	2.3**	30.5	9.8	3.1**
Smoking						
Current Smoker	26.5	28.2	0.9	22.1	23.1	1.0
Former Smoker	32.5	30.4	1.1	20.8	25.6	0.8*
Never Smoker	41.0	41.3	1.0	57.1	51.3	1.1
Multiple Risk Factors (BMI>27, Physical Inactivity, Low Income)						
At Least One Risk Factor	80.2	66.6	1.2**	87.0	67.4	1.3**
One Risk Factor	47.7	46.3	1.0	49.6	49.5	1.0
Two Risk Factors	30.5	19.2	1.6**	30.3	16.5	1.8**
All Three Risk Factors	2.1[a]	1.1	1.8	7.1[a]	1.4	5.2**

[1]Standardized to the 1991 Canadian population. [2]Prevalence ratio is the ratio of the prevalence in those with DM to the prevalence in those without DM.
[3] * = p<.05; ** = p<.005. [a]Estimate should be treated with caution due to high sampling variability (coefficient of variation between 16.5–33.0).

Sources: Ontario Diabetes Database (ODD), 1996/97 Ontario Health Survey (OHS II)

Important modifiable risk factors for the development of type 2 DM include obesity, lack of physical exercise and diet. Results from the Nurses Health Study, a prospective study of 120,000 female nurses that began in 1976, found the group defined as low risk on all three risk factors (BMI<25, 30 min/day of vigorous exercise and a diet high in fibre and low in saturated fat and sugar) had an incidence of type 2 DM that was approximately 90 per cent lower than the rest of the study population.[17] Recent randomized clinical trials in Finland,[18] China[19] and the United States[20] have found that modification of some or all of these risk factors, and modest weight loss in particular, can be effective in preventing type 2 DM, at least among individuals with impaired glucose tolerance.

Associations between DM and obesity and lack of physical activity were also found in these data. The prevalence of DM increased with BMI and decreasing exercise (Exhibit 4.6). Of perhaps even more concern, approximately 67 per cent of the Ontario population without DM has one or more modifiable risk factors for the disease (Exhibit 4.7).

These results also suggest an association between DM and income, particularly for women. The prevalence of DM in the lowest income category was nearly four times higher than in the highest category. In addition, this analysis suggested that moderate alcohol consumption might offer some protective benefit, a finding also noted in the Nurses Study and elsewhere.[21,22]

Other Conditions and Risk Factors

Diabetes is best thought of not as a single disease but as a collection of metabolic and lifestyle conditions that in combination result in damage to many vital organs.[23–25] Exhibit 4.7 shows that 19 per cent of men and 23 per cent of women with DM report that a doctor diagnosed them with high blood pressure, compared with 10 per cent or less of non-diabetic individuals (prevalence ratio = 2.3 for both sexes). Furthermore, 9.3 per cent of men with DM and 6.5 per cent of women with DM reported that they had heart disease (Prevalence Ratio = 2.5 and 1.8 respectively compared to people without DM).

Living with a chronic condition such as DM can also contribute to increased psychological difficulties. Men and women with DM were at 50–60 per cent greater risk of having had a depressive episode (Exhibit 4.7) and were also more likely than those without DM to be experiencing high levels of distress.

Smoking is one of the most important risk factors for heart disease, peripheral vascular disease and lower extremity amputations. Exhibit 4.7 shows that people with DM frequently smoke and that there is no difference in rates of smoking between people with and without DM.

Differences Between Men and Women

This analysis shows that there are a number of differences in both health outcomes and risk factors between men and women. Compared to men, women who have DM are older and live longer, but are much more likely to have lower income and generally have a lower HRQOL. The combined effect of mortality and morbidity is a narrowing of the gender difference in HALE. However, the gender difference in HRQOL varies depending on which measure is used. In the general population, women tend to score lower on measures of activity limitation and social participation; however, this difference is narrowed or reversed in people with DM. For example, more men with DM report having a long-term disability or activity restriction compared to women with DM. With respect to risk factors, the most notable difference is a higher prevalence of obesity among women with DM compared to men with DM.

Conclusions

DM has a major impact on the health of people with the disease. Life expectancy is much lower, reflecting not only the deaths from DM, but also from related diseases and complications such as heart disease. However, DM not only affects length of life, but also HRQOL. In particular, people with DM have a higher need for assistance with activities of daily living.

A high BMI, physical inactivity and low income are strong, modifiable risk factors for type 2 DM. Low income, obese women are particularly at risk. Trends in the prevalence of such risk factors over time will undoubtedly affect the future incidence and prevalence of DM in Ontario. For example, studies of obesity report that its prevalence has been increasing over time, suggesting that the prevalence of DM will also continue to increase.[26] Even more worrisome are the changes in risk factors among children and youth.[27] Some people worry that the increase in childhood obesity and low levels of physical activity will be the public health epidemic of the 21st century.[28,29] Already there is an increase in type 2 DM in young people, especially in native children.[30,31]

Through an examination of the health status and modifiable risk factors of people with DM, this chapter also provides some insight into different ways to reduce the burden of disease from type 2 DM. Broadly speaking, this involves a three-pronged approach: primary (disease) prevention, which targets risk factors so as to delay or prevent the onset of disease; secondary prevention, which aims to slow the progression of disease and lessen complications; and supportive care, the purpose of which is to improve the ability of people with diabetic complications to live a rewarding life. For instance, as the results from clinical trials have demonstrated, relatively small improvements in risk factors have the potential to delay or even prevent the onset of type 2 DM and subsequent related chronic conditions such as heart disease.[18,20,26] In Ontario, the province's Chief Medical Officer of Health recently published a report outlining a public health strategy for the prevention of DM.[32] In addition to reducing the incidence of DM, another benefit of a preventive approach that targets lifestyle risks is a reduction in other related conditions such as heart disease.

For those who develop DM, medical and health care services first focus on maintaining healthy blood sugar levels in order to reduce the severity and progression of disease and to prevent or minimize complications. For those with complications, the goal is to prevent premature mortality and to minimize limitations in activities and social participation. In this way, health interventions for DM are designed to both reduce mortality and improve HRQOL. The final component necessary for reducing the impact of DM is adequate supportive care for those with complications. As the prevalence of DM grows, so too will the need for personal assistance from programs such as home care. This is already an area of urgent need.[13]

This chapter demonstrated that DM is the cause of significant burden of illness in Ontario. However, a balanced approach as outlined above has the potential to reduce this burden by reducing the number of new cases, reducing mortality among those with the disease and enabling those living with DM to participate fully in their communities.

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Technical Appendices (Exhibits TA4.A, TA4.B, TA4.C and TA4.D)

Diabetes Health Status and Risk Factors

Exhibit TA4.A Methods, Definitions and Algorithm

Methods

Adjustment for Undercounting of Deaths in the Registered Persons Database (RPDB)

When the number of deaths in Ontario in Fiscal 1997 according to the RPDB was compared with the numbers reported by Statistics Canada, the RPDB total was lower by approximately 7 per cent. Taking the Statistics Canada numbers as the 'gold standard', an adjustment factor consisting of the ratio of StatsCan deaths to RPDB deaths was calculated for each 5-year age-sex group in the total population. These adjustment factors were then applied to the RPDB subpopulations with and without DM.

Definitions

Depression

Based on the work of Kessler and Mroczek (from the University of Michigan), the 1997 Ontario Health Survey II contains a subset of questions from the Composite International Diagnostic Interview (CIDI) that measure the probability of having had a major depressive episode.[1] For this analysis, respondents are considered to have had a depressive episode if the probability is 0.9 or greater.

Distress

The OHS II also includes a subset of questions from the CIDI designed to identify psychological distress. The questions yield a score between 0 and 24, with a higher score indicating more distress. For this analysis, the scores were then grouped into four categories: none (0), low (1–2), medium (3–5), high (6–24).

Health-Adjusted Life Expectancy

Health-adjusted life expectancy (HALE) is life expectancy weighted or adjusted for the level of health-related quality of life (HRQOL). In this analysis HALE was estimated by the period life table approach[2] using a modified Sullivan method.[3] Age-specific life-years lived were weighted by the age-specific mean Health Utilities Index 3 (HUI 3) 4 scores, which were obtained from the OHS II. As there were few respondents under 10 years of age and the OHS II only contains HUI 3 scores for those over four years of age, the Canadian HUI 3 estimates for ages four to nine years were used for all ages under 10.

Ethnic Origin

There is no "gold standard" for assigning an individual to an ethnic group or for determining someone's ethnicity as part of a population-based survey. Canadian population-based surveys and the census tend to take an open-ended approach, allowing individuals to 'self-define' their ethnic origins and then developing categories based on the range of responses. In the OHS II, information on ethnicity is available from five questions in which respondents were asked to give their country of birth, their "ethnic origins" (multiple responses accepted), the languages in which they are able to conduct a conversation, their first language learned and still understood, and their "race or colour." All questions were asked in an open-ended manner, but the responses were slotted into predetermined categories. In this study, the classification algorithms outlined in Exhibits TA4.A and TA4.B were used to assign each individual to an ethnic group primarily on the basis of the "ethnic origin" question, but in some cases also on the "country of birth" and the "race or colour" questions. The initial classification had 10 categories, but small numbers of diabetic individuals in some groups forced a final re-aggregation into five categories: Canadian/US, European, South or West Asian, Aboriginal/Black/Latin American and Other. Of the 23,063 in the linked sample, 234 (1.1%) did not respond to the questions and a further 558 (2.5%) could not be classified.

Level of Impairment

Level of impairment is determined based on two variables: the presence of long-term activity restriction and the need for assistance with activities of daily living. Four levels of impairment were defined using the algorithm presented in Exhibit TA4.C.

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Exhibit TA4.A (Cont'd) Algorithm Used to Assign OHS II Respondents to a Single Ethnic Group

Possible Ethnic Groups (sdc6_4a-s)+ (may select more than 1)	Country of Birth* (sdc6_1)	Race* (sdc6drac)	Ethnic Group 1 (10 categories)	Final Aggregations (5 categories)
Canadian			Canadian/US	Canadian/US
North American Indian Métis Inuit/Eskimo			Aboriginal	Aboriginal/Black/Latin American
French English German Scottish Irish Dutch (Netherlands)			Northern/Western European	European
Italian Ukrainian Polish Portuguese			Southern/Eastern European	European
Chinese			East Asian	Other
South Asian			South/West Asian	South or West Asian
Jewish			Jewish	Other
Black			Black	Aboriginal/Black/Latin American
Other:	Country of Birth* (sdc6_1)			
	Canada		Canadian/US	Canadian/US
	China		East Asian	Other
	France		Northern/Western European	European
	Germany		Northern/Western European	European
	Greece		Southern/Eastern European	European
	Guyana		Caribbean/South Am/ Central Am/ Latin Am.	Aboriginal/Black/Latin American
	Hong Kong		East Asian	Other
	Hungary		Southern/Eastern European	European
	India		South/West Asian	South or West Asian
	Italy		Southern/Eastern European	European
	Jamaica		Caribbean/South Am/ Central Am/ Latin Am.	Aboriginal/Black/Latin American
	Netherlands/Holland		Northern/Western European	European
	Philippines		East Asian	Other
	Poland		Southern/Eastern European	European
	Portugal		Southern/Eastern European	European
	United Kingdom		Northern/Western Europe	Europe
	United States		Canadian/US	Canadian/US
	Vietnam		East Asian	Other
	Other:	Race* (sdc6drac)		
		White	Undefined	Unknown
		Black	Black	Aboriginal/Black/Latin American
		Korean	East Asian	Other
		Filipino	East Asian	Other
		Japanese	East Asian	Other
		Chinese	East Asian	Other
		Aboriginal	Aboriginal	Aboriginal/Black/Latin American
		South Asian	South/West Asian	South or West Asian
		South East Asian	East Asian	Other
		Arab and West Asian	South/West Asian	South or West Asian
		Latin American	Caribb./South Am/ Cent. Am. /Latin American	Aboriginal/Black/Latin American
		Multiple Race	Multi	Other
		Not Stated	Undefined	Unknown
	Don't Know			Unknown
	Refusal			Unknown

* Variable name. Additional information from sdc6_1 and sdc6drac were used only in cases where a respondent gave only one ethnic group and that group was coded as "Other." When more than one ethnic group was identified, one of which was "Other," the latter was ignored.

Exhibit TA4.B Classification by Ethnic Group when Single and Multiple Ethnicity Reported

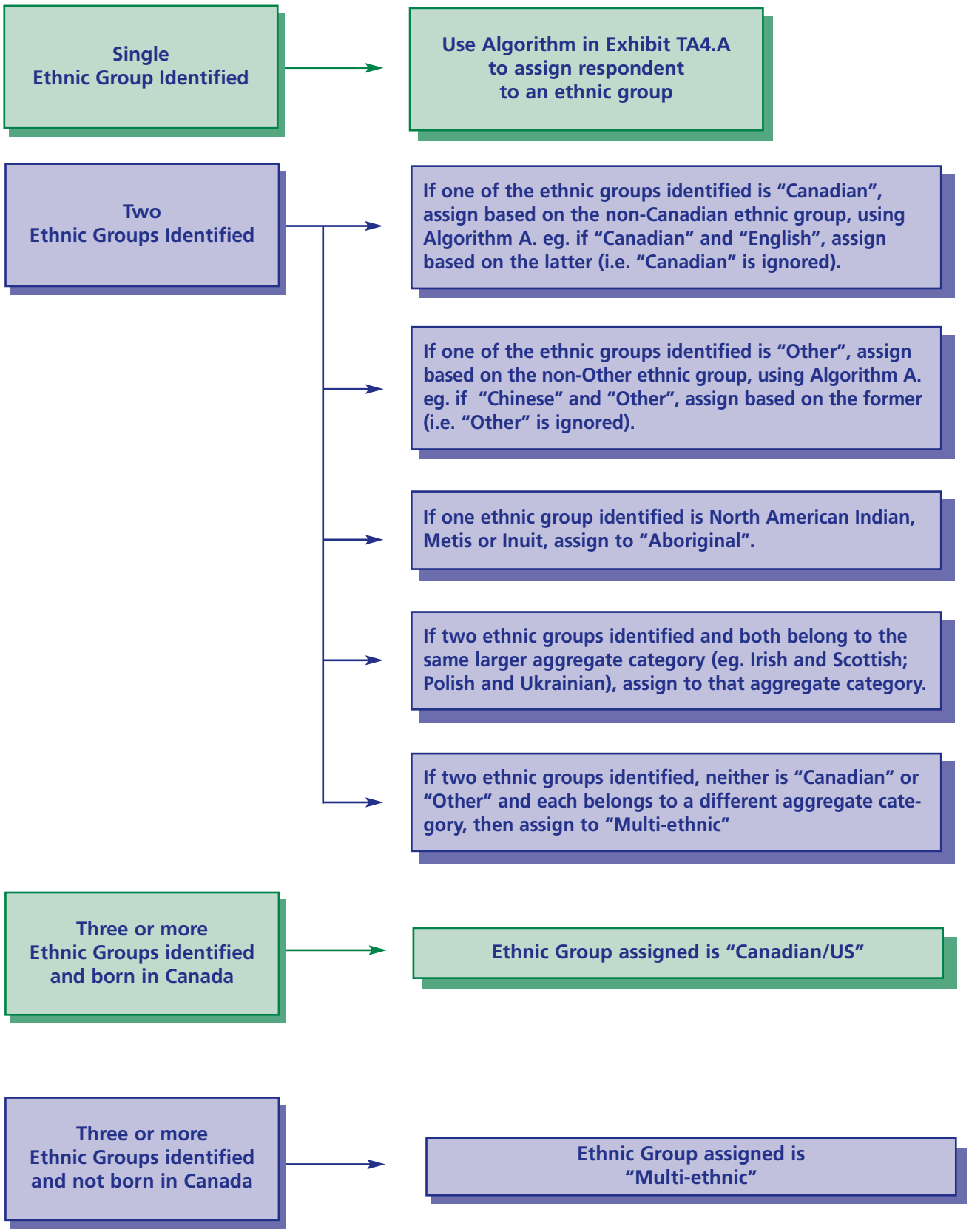
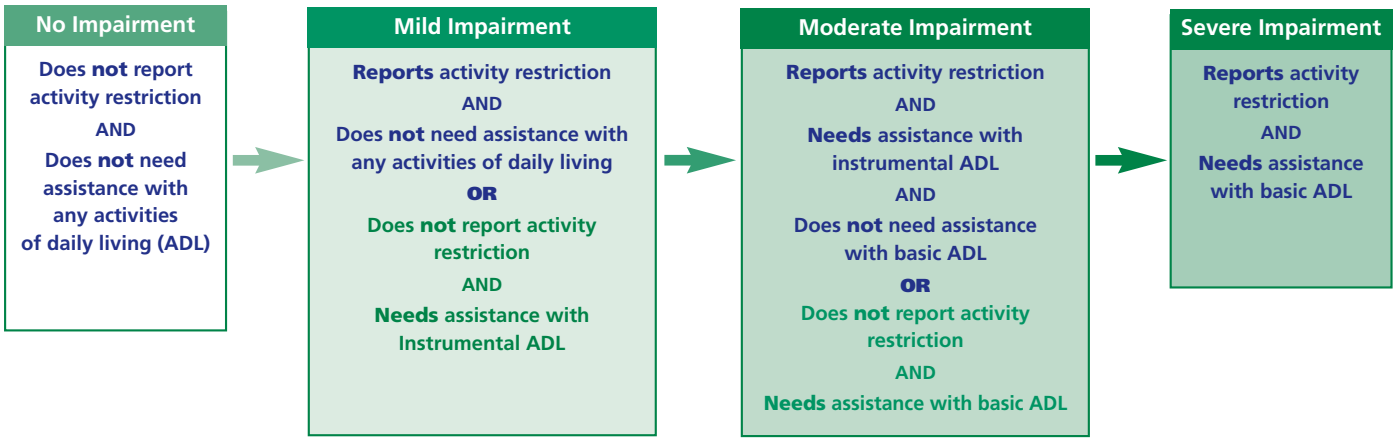


Exhibit TA4.C Levels of Impairment



Basic ADL = eating, washing, dressing, personal care

Instrumental ADL = shopping, cooking, cleaning

Source: Manuel D, Schultz S. *Atlas Report: The Health of Ontarians—Adding Life to Years and Years to Life: Life and Health Expectancy in Ontario.* Institute for Clinical Evaluative Sciences. Toronto, 2001.

Exhibit TA4.D Measures of Health Status

Mortality

Mortality indicators are derived from vital statistics from the Office of the Registrar General. Since 1991 these data exclude deaths for residents outside Ontario.

Measure	What it Captures	Limitations
Total Deaths	A summary measure of "negative" health. Total deaths are associated with absolute health care demand.	Poor reflection of population health status since there is no adjustment for population size or age distribution.
Crude Death Rate	Similar to total deaths with adjustment for population size.	Poor reflection of population health status since there is no adjustment for age distribution.
Age-standardized Death Rate	Similar to total deaths with adjustment for population size and age-distribution. Useful for comparing health status to a standard population when size and age distribution varies.	Requires an arbitrary standard population.
Life Expectancy	Intuitive summary measure of mortality expressed in terms of years. Useful for comparing mortality between different populations without need for a standard, comparison population.	Generally should not be used to predict the future or potential life expectancy.
% Survival to 65 Years	A summary measure of premature mortality.	Same as for life expectancy.

Health-related Quality of Life (HRQOL)

HRQOL indicators are derived from the OHS and NPHS. These surveys exclude certain populations including people living in long-term care institutions.

Measure	What it Captures	Limitations
Health Utilities Index (HUI)	Functional health status or health.	1/3 of respondents have perfect scores, implying perfect health. Does not capture functional health that is not represented within the eight attributes.
Activities of Daily Living (ADL)	Restrictions in activities of daily living including eating, bathing, dressing, or moving about a residence.	Does not capture whether or not needs are being met.
Instrumental Activities of Daily Living (IADL)	Need for assistance with activities of daily living including shopping for groceries, meal preparation, light or heavy work.	Same as for ADL.
Activity Restrictions	Need for assistance with instrumental activities of daily living or limitations in activities in the home, school, work, or other leisure time activities.	Same as for ADL.
Long-term Disability and Handicap	Long-term disability and handicap as defined by the respondent.	Respondents may interpret disability and handicap differently, including concepts of abnormal body function or disease status.
Self-rated Health Status	Respondents' own evaluations of their health.	Respondents may use different criteria for evaluating their health, such as future expectations, health behaviour, etc.

Combined Measures of Morbidity and Mortality

Measure	What it Captures	Limitations
Health-adjusted Life Expectancy	Life expectancy in good health. Health status is measured using utility-based measures such as the Health Utilities Index.	Calculation requires several different data sources each with their own limitations. Currently, difficult to compare results to other countries.

Disease-specific Measures

Measure	What it Captures	Limitations
Cause-deleted Life Expectancy	Potential life expectancy if individual diseases are eliminated. Provides an intuitive and realistic measure of the impact on a population's health if a disease is reduced. Deaths at younger ages will have a larger impact on life expectancy than older deaths.	Overestimates the impact of reducing disease for chronic conditions since a person may more likely have other potential fatal diseases.
Cause-deleted Health Expectancy	Potential health expectancy if individual diseases are eliminated. Useful for comparing diseases with varying measures of mortality and morbidity.	This report relies on self-report of chronic conditions, and likely under represents acute conditions. Comorbidity is considered for only those respondents with no leading cause of disability.

Source: Manuel D, Schultz S. *Atlas Report: The Health of Ontarians—Adding Life to Years and Years to Life: Life and Health Expectancy in Ontario.* Institute for Clinical Evaluative Sciences. Toronto, 2001.

5

Chapter

Diabetes and Cardiac Disease

Authors: Gillan L. Booth, Deanna M. Rothwell, Kinwah Fung and Jack V. Tu

Key Messages

- Diabetes mellitus (DM) is a major risk factor for cardiac disease. Care providers need to focus more attention on reducing and treating the risk factors that contribute to the high burden of cardiovascular disease in this population.
- DM shifts the age at which acute myocardial infarction (AMI) is seen 15 to 20 years earlier.
- Higher AMI rates among individuals in low-income groups and those living in rural or remote areas of the province may be due to problems in accessing health care, or to a greater prevalence of cardiac risk factors in these populations.

Background

Cardiovascular disease (CVD) accounts for approximately 70% of all deaths among people with diabetes mellitus (DM), contributing to the excess mortality associated with this condition.[1,2] Data from other countries suggest that mortality from cardiovascular causes is two- to three-fold higher in men with DM, and as much as five-fold higher in women with DM compared to the rest of the population.[3,4] Even in the absence of previous cardiovascular problems, middle-aged persons with DM may be just as likely to suffer from acute myocardial infarction (AMI) as individuals who do not have DM but who have already had cardiovascular events.[5,6]

There are several reasons why this excess risk occurs. People with DM are more likely to have other concomitant risk factors that contribute to the development of cardiovascular disease. Hypertension and lipid abnormalities are common problems in people with DM, and randomized controlled trials have shown that treating these disorders can significantly reduce the risk of cardiovascular complications in this population.[7–9] Further, DM is associated with other abnormalities that can lead to premature atherosclerosis, including defects involving the endothelial lining of blood vessels and the coagulation system. These changes can occur years before the onset of DM, explaining in part the elevated risk of CVD associated with individuals who have impaired glucose tolerance or other aspects of the insulin resistance syndrome.[10]

Several large epidemiological studies have also found a strong relationship between glucose levels and subsequent coronary events, with levels that are only modestly elevated placing patients at risk.[11,12] The United Kingdom Prospective Diabetes Study (UKPDS) demonstrated a direct relationship between the average glucose level achieved during the study and the development of AMI. For every 1% reduction in glycated hemoglobin (HbA1c)—for instance, from 8% to 7%—the authors observed a 14% drop in the incidence of AMI and a 16% drop in heart failure rates.[13] Moreover, the updated mean HbA1c remained an independent predictor of cardiovascular complications after adjustment for other important risk factors.

Studies in other jurisdictions have found that mortality after an AMI is 1.5 to 2-fold higher for persons with DM compared to the non-diabetic population.[14,15] A number of theories have been raised to explain these differences. Patients with DM may present to hospital later when important therapies, such as thrombolysis, are less effective.[16–18] The amount of damage sustained during an AMI appears to be similar, yet cardiac function is more compromised in patients with DM compared to those without. In keeping with this observation, persons with DM are more likely to develop heart failure, shock, and other complications in the early stages of AMI.[18]

The purpose of this chapter was to compare the frequency of hospitalization for cardiac problems—AMI, unstable angina (UA) and congestive heart failure (CHF)—and for coronary procedures

Exhibit 5.1 Overall and Age-/Sex-specific Hospitalization Rates for AMI per 100,000 Ontarians with/without DM, 1995–1999

Of 104,471 hospitalizations for AMI in Ontario over the study period, nearly one-third occurred in individuals with DM. Admission rates were over seven-fold higher among persons with DM than in those without DM and three-fold higher after accounting for age and sex differences between the populations.

Fiscal Year	DM Status	Overall Men & Women	Women by Age Group						Men by Age Group					
		Rate	20–34	35–49	50–64	65–74	75+	Overall	20–34	35–49	50–64	65–74	75+	Overall
1995	DM	1,477	88.0	286.8	873.2	1,662.3	2,538.8	1,306	92.6	680.0	1,489.1	2,106.5	2,862.0	1,636
	No DM	186	1.4	21.9	131.3	391.2	838.1	126	8.2	120.3	449.7	842.0	1,364.8	250
1996	DM	1,421	40.5	341.4	773.4	1,708.6	2,432.4	1,269	76.7	757.7	1,358.7	1,946.2	2,872.8	1,563
	No DM	187	1.6	22.5	129.4	382.4	870.8	128	9.0	117.8	445.5	836.1	1,350.7	249
1997	DM	1,464	75.2	310.1	741.2	1,767.6	2,633.5	1,317	82.1	654.0	1,413.6	2,138.7	2,753.7	1,601
	No DM	191	1.5	20.4	121.5	407.0	880.7	130	8.0	118.8	440.5	869.3	1,436.0	257
1998	DM	1,389	41.9	270.0	780.8	1,609.3	2,385.4	1,221	130.0	665.2	1,254.0	2,028.6	2,899.9	1,546
	No DM	186	1.4	24.0	118.4	370.6	870.9	128	6.6	109.6	417.0	848.8	1,413.1	249
1999	DM	1,340	45.8	196.5	701.2	1,477.2	2,294.4	1,129	67.0	631.9	1,259.2	2,017.4	2,867.1	1,536
	No DM	180	1.4	17.8	98.3	338.7	875.4	120	7.3	106.9	406.9	800.8	1,401.2	243
Odds Ratio Crude*		7.26 (7.04–7.48)	32.73 (13.67–78.38)	10.90 (8.44–14.07)	6.81 (6.07–7.65)	4.20 (3.84–4.59)	2.57 (2.40–2.76)	9.16 (8.72–9.61)	9.32 (4.53–19.20)	5.81 (5.11–6.59)	3.03 (2.83–3.25)	2.45 (2.29–2.63)	1.99 (1.85–2.14)	6.16 (5.92–6.40)
Odds Ratio Adjusted*		3.00 (2.91–3.09)						3.65 (3.47–3.83)						2.68 (2.57–2.78)

Source: Ontario Diabetes Database (ODD). *Odds Ratios (95% CI) are only for 1999. Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

among individuals with and without DM in Ontario, and to identify risk factors for AMI among the diabetic population using administrative data sources. Temporal and geographic trends were examined for each cardiac outcome among persons with DM, in order to support planning and policy development at the regional level. Lastly, the impact of DM on mortality following admission for AMI, UA, and CHF was evaluated both before and after adjustment for other important risk factors.

Data Sources

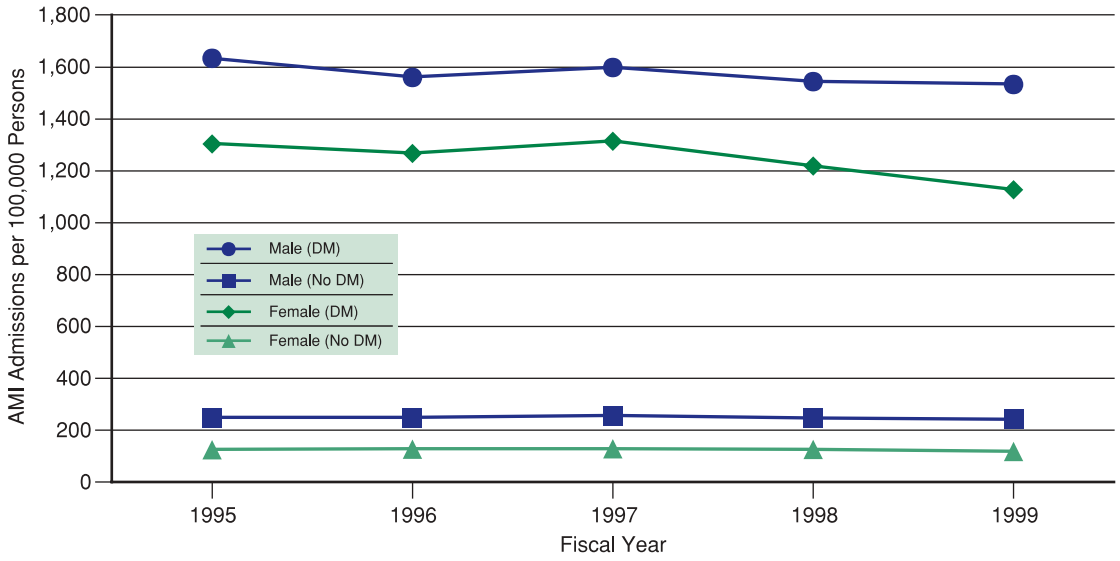
The Registered Persons Database (RPDB) was used to identify all individuals between the ages of 20 and 105, who were eligible for coverage under the Ontario Health Insurance Plan (OHIP) during the fiscal years 1995 to 1999. Persons with DM were identified using the Ontario Diabetes Database (ODD), which is described in detail in Chapter 1 Technical Appendix TA1.A. Individuals in the RPDB who were not present in the ODD served as a non-diabetic comparison group. Creation of this cohort is described in Technical Appendix TA5.A. Records of hospitalizations for cardiac admissions (AMI, UA, and CHF) and in-patient coronary procedures (coronary angiography, percutaneous coronary interventions [PCI], coronary artery bypass graft [CABG] surgery) were obtained from the Canadian Institute for Health Information (CIHI) discharge abstract database (DAD). Day-surgery files were used to identify records of procedures (angiography and PCI) that were performed as a same-day admission. The OHIP database was used to identify additional coronary angiography procedures that did not appear in CIHI or same-day surgery files. Records from each of these sources were linked together using a unique anonymous identifier for each person. Census data from Statistics Canada were used to obtain information on the socioeconomic status (SES) of residential neighbourhoods. These data were linked to other sources using postal code of residence as a common variable.

How the analysis was done

The annual rates of hospitalization were calculated from fiscal 1995 (April 1, 1994 to March 31, 1995) through fiscal 1999. The total number of admissions for each outcome defined the numerator, while the denominator was the total number of persons with DM in the cohort during the same time period. Cardiac admissions were identified from CIHI records that listed AMI, UA, or CHF as the most responsible diagnosis.[19] Admissions for coronary procedures were determined using similar methods. All hospitalizations that occurred during the fiscal year were included in the analysis, with the following exception: AMI admissions that lasted less than three days or involved transfer from another acute care hospital were excluded. The crude and age-/sex-adjusted odds ratios (OR) associated with DM

Exhibit 5.2 Acute Myocardial Infarction Rates by Gender and DM Status in Ontario, 1995–1999

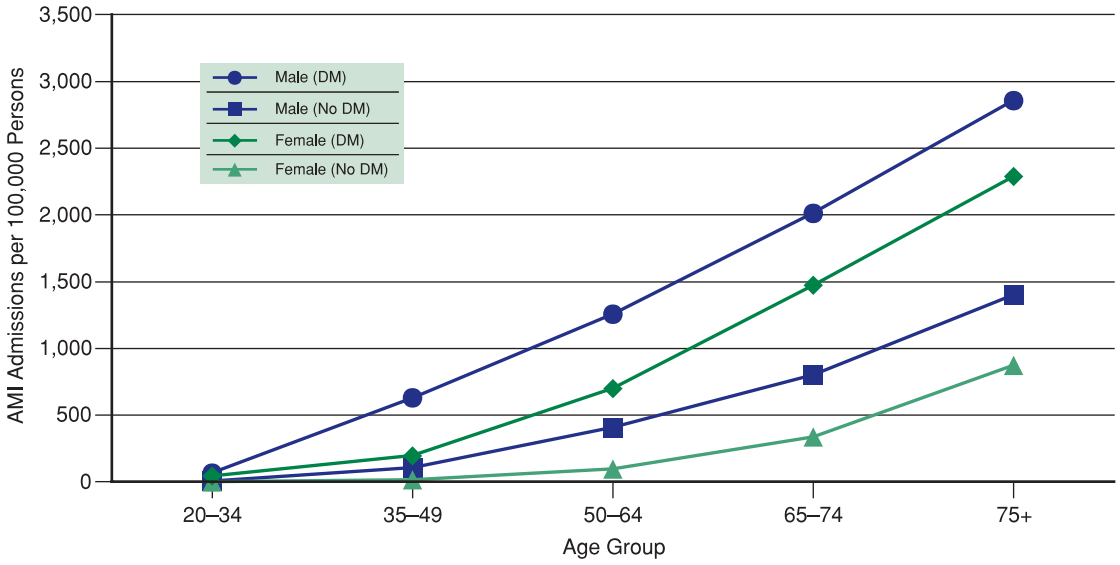
Over the five-year study period, AMI admissions fell by more than 9% among those with DM and by a lesser extent (<4%) in those without DM. AMI rates in women with DM far exceeded those in men without DM.



Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 5.3 Acute Myocardial Infarction Admission Rates by Age Group and DM Status in Ontario, 1995–1999

DM shifts the risk of AMI earlier by 15 to 20 years.



Source: Ontario Diabetes Database (ODD)

were determined for each outcome by comparing the rates of individuals with DM who had a cardiac admission or procedure versus the rates of non-diabetic individuals who had the same outcome. Diagnostic codes for each outcome are listed in Technical Appendix TA5.B.

Annual hospitalization rates for each cardiac diagnosis and for major coronary procedures were calculated for the diabetic and non-diabetic population as a whole, and by age and sex categories. Furthermore, annual age- and sex-adjusted hospitalization rates were calculated at the county level for each cardiac diagnosis. In contrast, average coronary procedure rates were presented at the District Health Council (DHC) regional level because the number of individuals who had a particular procedure within a given county was too small to report. Results that were based on only a few events were suppressed to preserve confidentiality and to avoid imprecise rates that may be obtained when the number of events is small. Small area rate variation (SARV) analysis was performed to compare hospitalization and procedure rates across regions of the province (a full discussion of SARV statistics appears in Chapter 2 Technical Appendix TA2.A).

Socioeconomic status (SES) has previously been shown to be an important predictor of mortality following myocardial infarction;[20] therefore, the relationship between SES and rates and outcomes of AMI was explored for both individuals with and without DM. In Ontario, personal income is not available in administrative data sources. Therefore, neighbourhood level median household income was attributed to the individuals studied. Neighbourhood level income quintiles were obtained from 1996 census data at the level of the enumeration area.[21] This method defines quintiles separately for census metropolitan areas (CMA) or census agglomerations (CA) and areas not in any CMA or CA, so that the measure is relative to the larger area in which a person resides. Annual age- and sex-adjusted hospitalization rates for AMI were reported by quintile of household income.

Mortality rates following hospitalization for each cardiac outcome were calculated at 30 days and one year after the index admission. Deaths were ascertained from the RPDB and CIHI discharge abstracts. Mortality rates after AMI and UA were adjusted for age, sex, and the presence of any of the following comorbidities: shock, pulmonary edema/CHF, cardiac dysrhythmias, acute/chronic renal disease, cancer, and cerebrovascular disease. Mortality after admission for CHF was adjusted for age, sex, and comorbidity, based on the Charlson-Deyo score, a commonly used method that uses indicators of major disease groups within hospital diagnostic codes to assign a level of comorbidity.[22] We also evaluated the effect of DM on rates of re-admission for AMI, UA, or CHF within one year of surviving an AMI.

Multivariate techniques (Cox proportional hazards models) were used to identify risk factors for myocardial infarction among persons with

Key Research Findings

- Admission rates for acute myocardial infarction (AMI), unstable angina (UA) and congestive heart failure (CHF) were between seven and ten-fold higher among persons with diabetes mellitus (DM) than in those without DM. After accounting for age and sex differences between the two populations, persons with DM remained three to four times more likely to have a cardiac admission.
- Over the five-year study period, AMI admissions fell by more than 9% and CHF admissions decreased by 23% among those with DM. This may be due, in part, to a concomitant increase in the use of cardioprotective agents in persons with DM.
- Other independent predictors of AMI in the diabetic population included: male gender, previous MI, the presence of other chronic diseases, lower socioeconomic status, rural residence, and region of residence outside of Toronto and the East planning region.
- Cardiac disease occurs earlier in persons with DM, with rates in young adults mirroring those of individuals without DM who are at least 15 years older.
- Mortality at 30 days and one year after admission for AMI or UA was significantly increased in the DM population compared to persons without DM.

Exhibit 5.4 Average Age-/Sex-adjusted Rates of Hospitalization for AMI per 100,000 Ontarians with DM Aged 20 Years and Over by County, 1995–1999

Rate = per 100,000 persons	Crude Rate*	Adjusted Rate*
Algoma District	1,637	950
Brant County	1,587	933
Bruce County	1,733	1,001
Cochrane District	1,403	923
Dufferin County	1,882	1,349
Durham Regional Municipality	1,338	855
Elgin County	1,586	875
Essex County	1,213	757
Frontenac County	1,637	899
Grey County	1,840	1,108
Haldimand-Norfolk Regional Municipality	2,025	1,190
Haliburton County	1,827	1,103
Halton Regional Municipality	1,337	786
Hamilton-Wentworth Regional Municipality	1,623	996
Hastings County	1,708	1,088
Huron County	1,646	813
Kenora District	783	529
Kent County	1,955	1,169
Lambton County	1,606	981
Lanark County	1,793	1,077
Leeds and Grenville United Counties	1,421	966
Lennox and Addington County	1,696	940
Manitoulin District	2,200	1,199
Middlesex County	1,598	927
Muskoka District	1,536	831
Niagara Regional Municipality	1,622	919
Nipissing District	1,534	944
Northumberland County	1,677	980
Ottawa-Carleton Regional Municipality	1,212	727
Oxford County	1,813	1,027
Parry Sound District	1,415	889
Peel Regional Municipality	1,150	762
Perth County	1,537	918
Peterborough County	1,753	1,093
Prescott and Russell United Counties	1,516	898
Prince Edward County	1,850	1,136
Rainy River District	1,656	1,122
Renfrew County	1,366	710
Simcoe County	1,648	980
Stormont, Dundas and Glengarry United Counties	1,561	1,075
Sudbury District	1,482	941
Sudbury Regional Municipality	1,401	913
Thunder Bay District	1,599	945
Timiskaming District	2,025	1,203
Toronto Metropolitan Municipality	1,264	708
Victoria County	1,814	982
Waterloo Regional Municipality	1,561	907
Wellington County	1,384	814
York Regional Municipality	1,085	675
Provincial-wide Age-/Sex-adjusted Rate		832.8
Extremal Quotient [EQ]		2.6
Coefficient of Variation (%) [CV]		16.9
Systematic Component of Variation [SCV]		11.2
Adjusted Chi-square (likelihood ratio), DF=48		106.2 P-value <0.001

* rates averaged over the 5-year study period, rounded to whole numbers

Source: Ontario Diabetes Database (ODD)

DM. All prevalent cases of DM in the ODD as of April 1,1994 were included in the analysis. The primary outcome was time to first myocardial infarction between April 1,1994 and March 31, 2000. Factors that were tested included age, sex, socioeconomic status, presence of other medical conditions (comorbidity), previous AMI (occurring between fiscal 1991 and 1993 inclusive), type of residential area (urban versus rural), geographic region of the province, and use of outpatient services. Individuals were categorized as having a regular provider of care if at least 50% of their primary care visits were to a single provider. Adjustment for the presence of other medical conditions that might affect outcomes was performed using the John Hopkins Ambulatory Care Groups (ACG) assignment software.[23,24] Region of residence was based on the MOHLTC planning regions. There was no significant colinearity between any of the variables included in the model.

Interpretive Cautions

There are several limitations to this analysis. First, administrative records contain no clinical information on some cardiac risk factors (e.g. history of smoking, blood pressure or serum lipids) so that we are unable to establish the reasons for observed differences in outcomes between groups. Furthermore, this analysis was cross-sectional; therefore, any associations observed may or may not be causally linked.

While the coding of hospitalization records for AMI has been found to be accurate, it was not possible to estimate the overall prevalence of AMI, since up to 30% of episodes result in death before admission to hospital, and were thus not identified through in-hospital records. The ability to identify admissions for UA and CHF was not fully validated. Furthermore, administrative datasets do not contain specific details on the severity of each condition on presentation to hospital. Therefore, while differential thresholds for admitting patients with or without DM may exist, this could not be determined from administrative data sources alone.

Coronary angiography procedures were identified through either hospitalization records or physicians' service claims, as a significant number of these procedures might have been missed through CIHI records alone. This approach may have resulted in a small overestimation of angiography rates if the same procedure was counted twice; however, it is unlikely that this would have selectively affected the rates among individuals with DM versus those without. The use of in-patient services in the northwestern regions of Ontario, where patients are sometimes referred to Manitoba for specialized care may have been underestimated.

Findings and Discussion

Acute Myocardial Infarction (AMI)

Temporal Trends in AMI Rates

Over the five-year period, there were 104,471 hospitalizations for AMI in Ontario. Nearly one-third occurred in individuals with DM. Rates were substantially higher among persons with DM than those without (1,477 vs. 186/100,000 in 1999) (Exhibit 5.1). However, there was a 9.3% decline in AMI admission rates in persons with DM over the five-year period compared to only a 3.5% fall in rates in those without DM (Exhibit 5.2). This decline was somewhat higher in women than men with DM (13.5% vs. 6.1% over the period of observation).

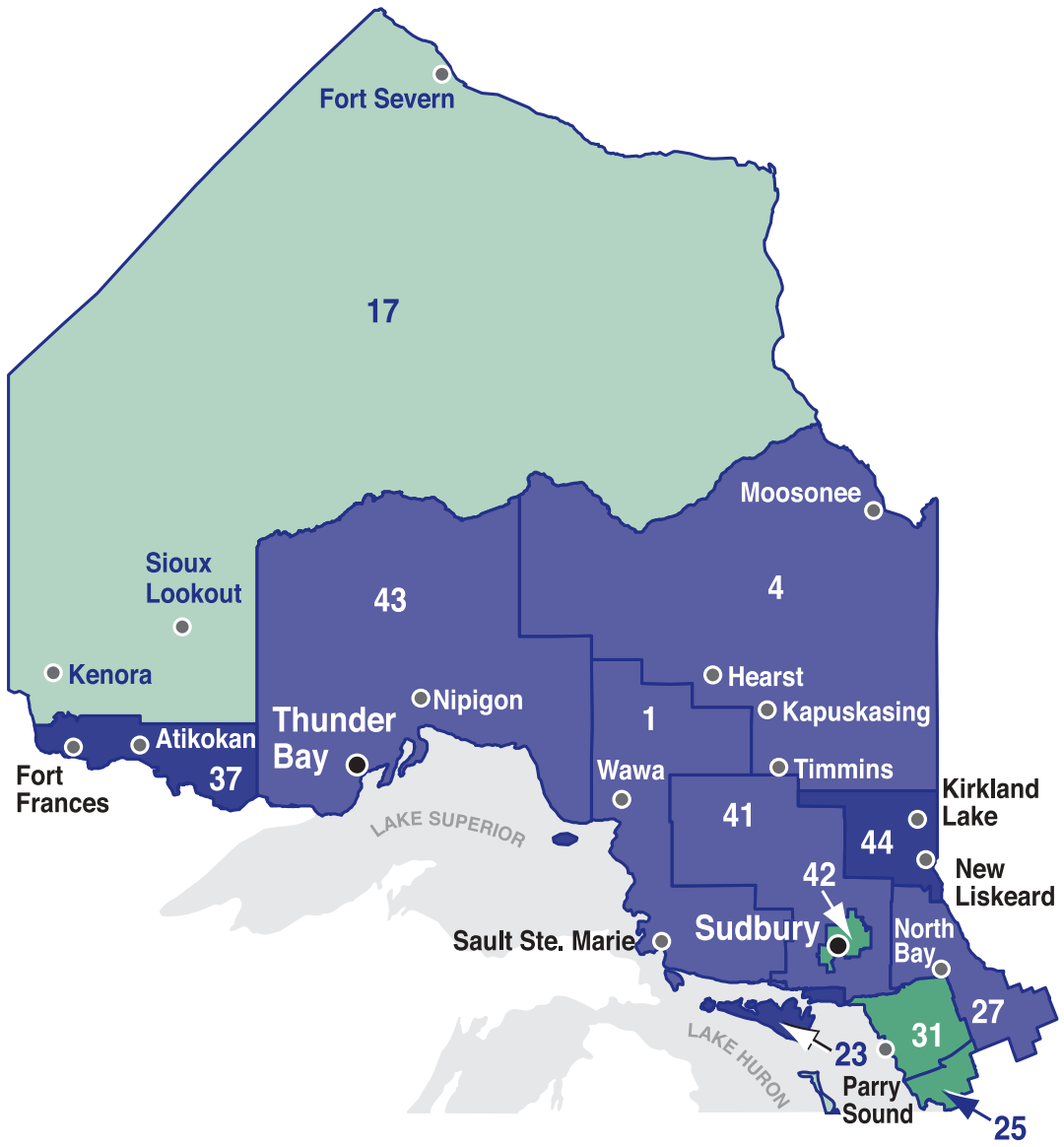
Risk Factors for AMI

Age and sex differences between the DM and non–DM populations partially accounted for the large discrepancy in rates. While admission rates for AMI were over seven–fold greater in persons with DM compared to those without DM, adjustment for age and gender yielded odds ratios (OR) closer to three–fold (Exhibit 5.1). The disparity in rates between the diabetic and non-diabetic populations was more pronounced among women, in whom the odds of having an AMI were nine–fold greater (adjusted OR 3.7) in those with DM (Exhibit 5.1). Moreover, AMI rates in women with DM exceeded those in men without DM (Exhibits 5.1 and 5.2).

An important finding is that young adults with DM had dramatically higher rates of AMI than their non-diabetic counterparts. For instance, young women with DM in the 20 to 34 year age group had over 30-fold higher rates of AMI (45.9 /100,000 in 1998) than similarly aged women without DM (1.4/100,000) in the same year (Exhibit 5.1). In both men and women with DM, AMI rates are comparable to those of non-diabetic individuals who are at least 15 years older. As Exhibit 5.3 demonstrates, DM shifts the risk of AMI earlier by 15 to 20 years. Although less than 1% of myocardial infarctions occur in those under 35 years of age, people with DM make up one-quarter to one-third of all events occurring in this age group. In fact, the disparity in rates between diabetic and non-diabetic individuals was greatest in younger age groups.

There was a significant degree of variation in AMI rates among persons with DM across Ontario (Exhibits 5.4 and 5.5). Age-/sex-adjusted rates varied over two and a half fold between areas with the highest—Dufferin County (1,349/100,000)– and the lowest rates—Kenora District (529/100,000). However, Kenora District may represent an outlier since patients in that jurisdiction tend to be transferred to Winnipeg for acute care. A number of urban communities were among the areas with the lowest AMI rates: Toronto, Essex County, Ottawa-Carleton, Peel, Halton, and York Regional Municipalities. In contrast,

Exhibit 5.5a Acute Myocardial Infarction Admission Rates per 100,000 Ontarians with DM by County in Northern Ontario, 1995–1999



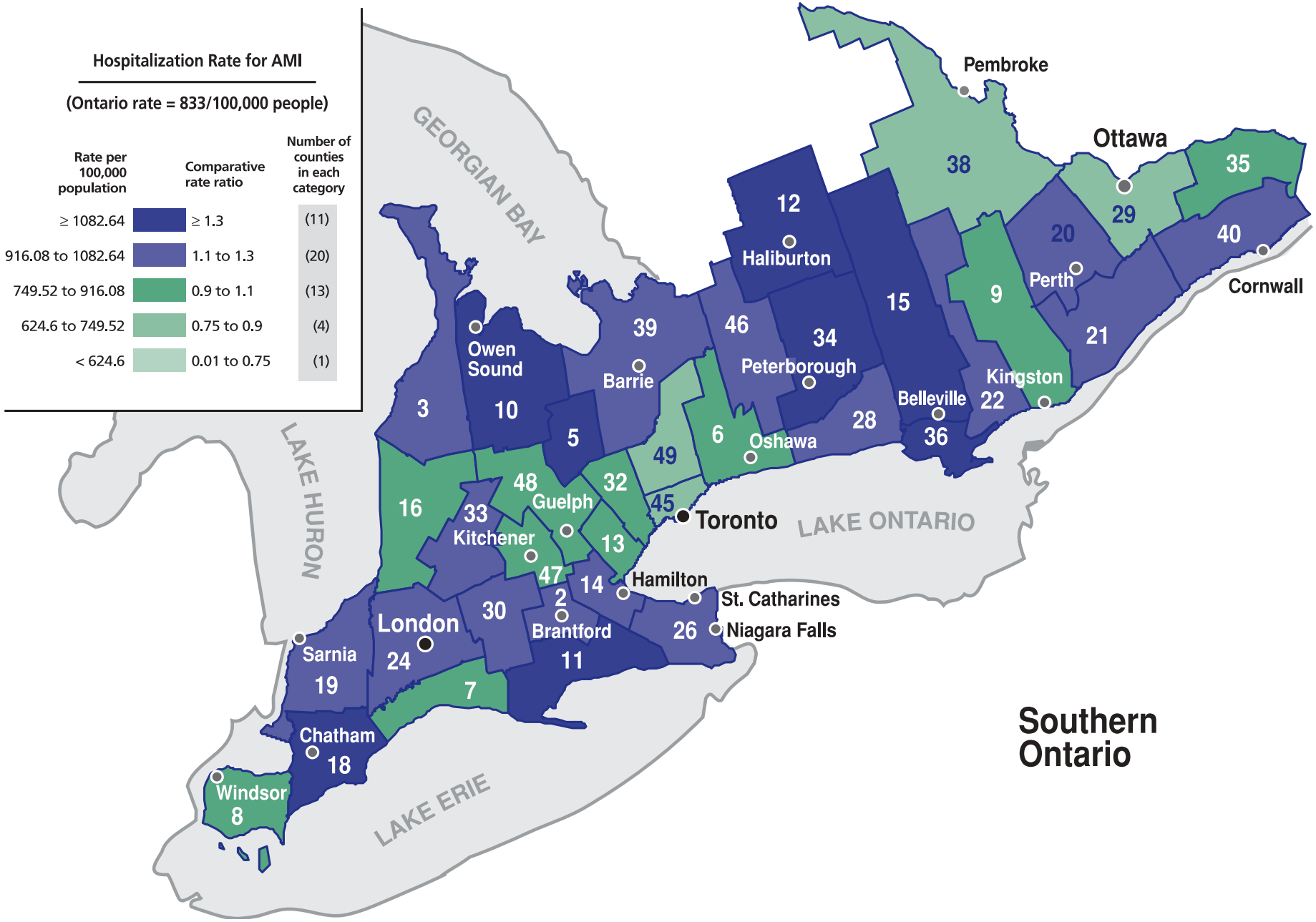
Ontario Counties

1 Algoma District
2 Brant County
3 Bruce County
4 Cochrane District
5 Dufferin County
6 Durham Regional Municipality
7 Elgin County
8 Essex County
9 Frontenac County
10 Grey County
11 Haldimand-Norfolk Regional Municipality
12 Haliburton County
13 Halton Regional Municipality
14 Hamilton-Wentworth Regional Municipality
15 Hastings County
16 Huron County
17 Kenora District
18 Kent County
19 Lambton County
20 Lanark County
21 Leeds and Grenville United Counties
22 Lennox and Addington County
23 Manitoulin District
24 Middlesex County
25 Muskoka District
26 Niagara Regional Municipality
27 Nipissing District
28 Northumberland County
29 Ottawa-Carleton Regional Municipality
30 Oxford County
31 Parry Sound District
32 Peel Regional Municipality
33 Perth County
34 Peterborough County
35 Prescott and Russell United Counties
36 Prince Edward County
37 Rainy River District
38 Renfrew County
39 Simcoe County
40 Stormont, Dundas and Glengarry United Counties
41 Sudbury District
42 Sudbury Regional Municipality
43 Thunder Bay District
44 Timiskaming District
45 Toronto Metropolitan Municipality
46 Victoria County
47 Waterloo Regional Municipality
48 Wellington County
49 York Regional Municipality

Note: See Exhibit 5.5b for Legend.

Source: Ontario Diabetes Database (ODD)

Exhibit 5.5b Acute Myocardial Infarction Admission Rates per 100,000 Ontarians with DM by County in Southern Ontario, 1995–1999



Note: See Exhibit 5.5a for County definitions.

Source: Ontario Diabetes Database (ODD)

rural areas in northern (Rainy River, Manitoulin, Timiskaming), eastern (Haliburton, Hastings, Peterborough, Prince Edward County), and southwestern Ontario (Grey, Haldimand-Norfolk, Kent counties) had very high rates of AMI.

Other high-risk groups include those living in low-income neighbourhoods. There was an inverse relationship between AMI rates and socioeconomic status among women of all ages (Exhibit 5.6). However, this gradient was more pronounced among middle–aged women (aged 50 to 64 years), in whom the lowest income quintile had nearly two–fold higher rates of AMI than those in the highest quintile. In contrast, the relationship between socioeconomic status and AMI was less clear among men.

On multivariate analysis, age remained an important predictor of developing an AMI among individuals with DM, with the risk rising sharply over age 35 years. In comparison to those under 35 years, the relative risk of AMI was four-fold higher among individuals in the 35 to 49 year age group, almost seven-fold higher in those aged 50 to 64, and almost nine-fold higher among the elderly, after adjusting for other factors. Other independent predictors of AMI in the diabetic population included: male gender, previous MI, other chronic diseases, SES, rural residence, and region of residence outside of Toronto and the East planning region.

Outcomes Following Acute Myocardial Infarction

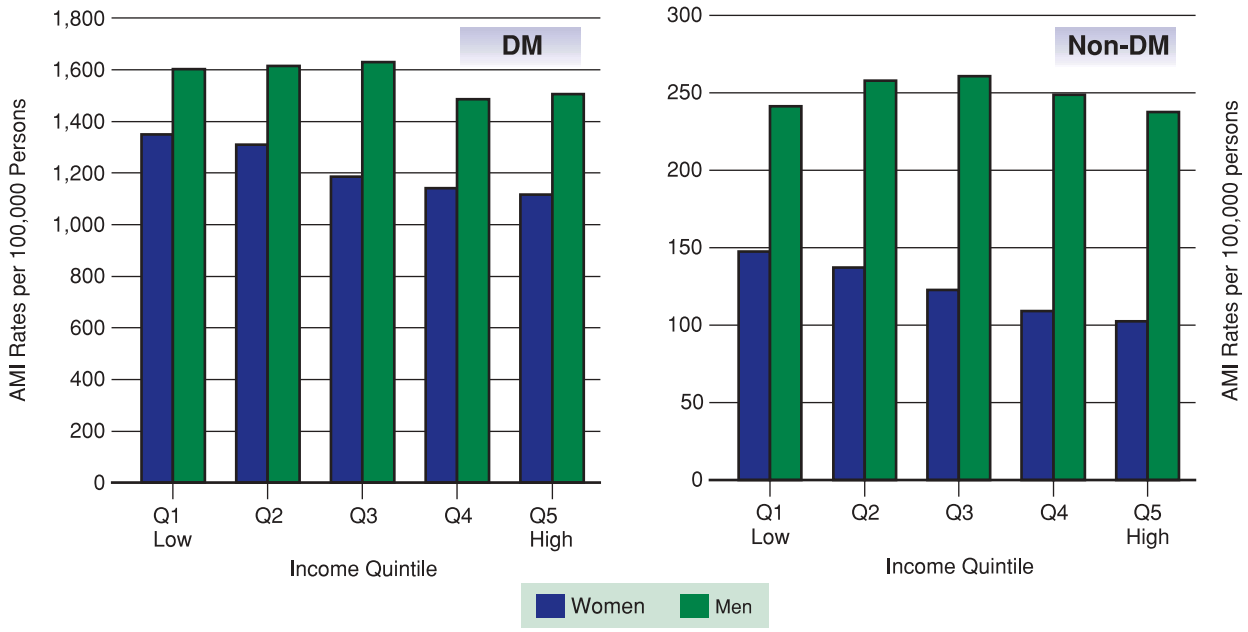
Among those admitted to hospital with an AMI, persons with DM had a slightly longer length of stay (LOS) than those without DM (median 7.3 vs. 6.9 days, $p<0.0001$). The 30-day mortality rate was greater among persons with DM (16.0% vs. 11.3% among men and 21.1% vs. 18.7% among women) (Exhibit 5.7). Furthermore, the relative odds of dying from an AMI within the first month remained higher for individuals with DM after adjustment for other important predictors . One-year cumulative mortality rates after AMI were also higher among individuals with DM than those who did not have DM (30.4% vs. 20.8%), both before and after adjustment for other factors (Exhibit 5.7). Among AMI survivors, persons with DM were much more likely to be re-admitted to hospital with another AMI, unstable angina, and CHF in the same year (Exhibit 5.8).

Unstable Angina (UA)

A similar pattern was observed with respect to admissions for UA (Exhibit 5.7). Persons with DM had nearly seven-fold higher admission rates for UA compared to the non-DM population (1,543 vs. 216/100,000 in fiscal 1999). Odds ratios were greater in the youngest compared to older age categories (women aged 20 to 34: crude OR 47.35, 95% CI: 20.92–107.17; women over 75 years: crude OR 2.02, 95% CI: 1.88–2.12). Furthermore, the odds of having an admission for UA remained significantly elevated after adjustment for age

Exhibit 5.6 Age-adjusted Hospitalization Rates for AMI by Income Quintile and DM Status, 1995–1999

There was an inverse relationship between AMI rates and socioeconomic status among women of all ages.



Source: Ontario Diabetes Database (ODD). Based on total admissions in fiscal 1999 for each income group.

Exhibit 5.7 Thirty-day and One-year Mortality Rate per 100 Ontarians Following AMI, UA, or CHF by DM Status and Gender, 1995–1999

Mortality within the first month and at one-year following hospitalization for an acute coronary syndrome (myocardial infarction and unstable angina) was significantly greater among persons with DM than in those without DM.

AMI		30-day Mortality		One-year Mortality	
Gender	DM Status	Crude Rate*	Adjusted Odds Ratio/ 95% Confidence Interval	Crude Rate*	Adjusted Odds Ratio/ 95% Confidence Interval
Men	DM No DM	16.0 11.3	1.21 (1.14–1.29)	27.0 17.3	1.42 (1.35–1.50)
Women	DM No DM	21.1 18.7	1.13 (1.06–1.21)	35.2 27.4	1.42 (1.34–1.50)
Total	DM No DM	18.1 13.9	1.17 (1.12–1.23)	30.4 20.8	1.42 (1.37–1.48)
UA Diagnosis					
Men	DM No DM	2.4 1.4	1.30 (1.11–1.52)	11.4 6.5	1.59 (1.47–1.72)
Women	DM No DM	2.2 1.4	1.13 (1.13–1.13)	11.6 6.4	1.78 (1.77–1.78)
Total	DM No DM	2.3 1.4	1.38 (1.23–1.55)	11.5 6.4	1.67 (1.67–1.67)
CHF Diagnosis					
Men	DM No DM	11.4 12.5	0.80 (0.75–0.86)	36.5 35.8	0.92 (0.88–0.97)
Women	DM No DM	11.9 13.2	0.78 (0.72–0.84)	35.7 34.4	0.95 (0.90–0.99)
Total	DM No DM	11.6 12.9	0.79 (0.75–0.83)	36.1 35.1	0.93 (0.90–0.97)

Source: Ontario Diabetes Database (ODD). * rounding performed.

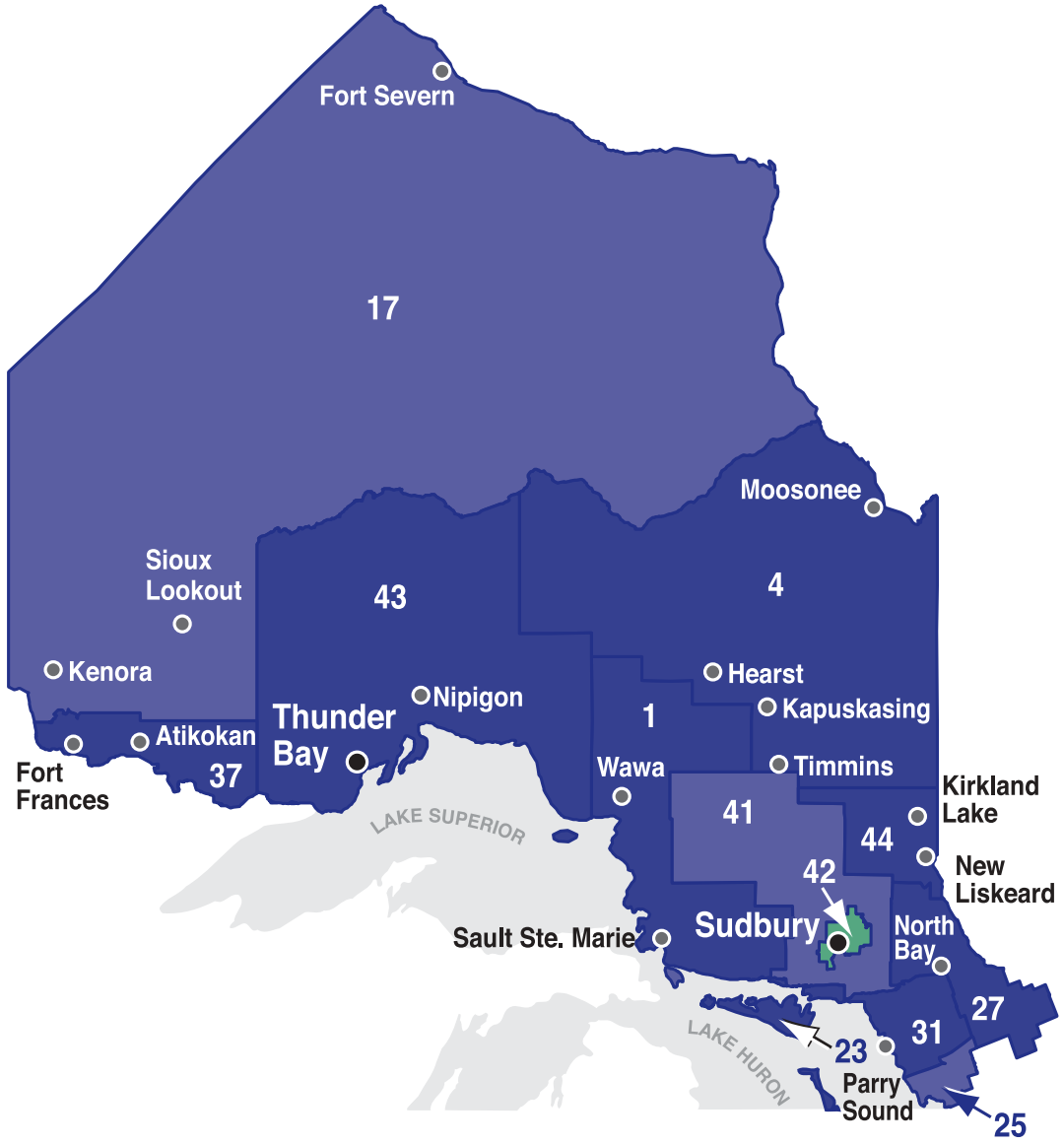
Exhibit 5.8 Age-adjusted One-year Readmission Rates per 100 AMI Survivors Aged 20 Years and Over by DM Status, 1995–1999

Among AMI survivors, persons with DM were much more likely to be re-admitted to hospital with another myocardial infarction, unstable angina, or CHF in the same year.

Gender	DM Status	AMI Rate	Adjusted Odds Ratio/ 95% Confidence Interval	UA Rate	Adjusted Odds Ratio/ 95% Confidence Interval	CHF Rate	Adjusted Odds Ratio/ 95% Confidence Interval
Men	DM No DM	11.1 7.5	1.45 (1.36–1.55)	13.6 12.6	1.11 (1.05–1.18)	11.5 5.2	2.09 (1.94–2.24)
Women	DM No DM	13.9 8.4	1.76 (1.63–1.91)	16.7 14.2	1.21 (1.13–1.30)	17.4 9.1	2.19 (2.03–2.36)
Total	DM No DM	12.2 7.8	1.58 (1.50–1.66)	14.9 13.1	1.17 (1.12–1.22)	13.9 6.5	2.16 (2.05–2.28)

Source: Ontario Diabetes Database (ODD)

Exhibit 5.9a Unstable Angina Admission Rates per 100,000 Ontarians with DM by County, Northern Ontario, 1995–1999



Ontario Counties

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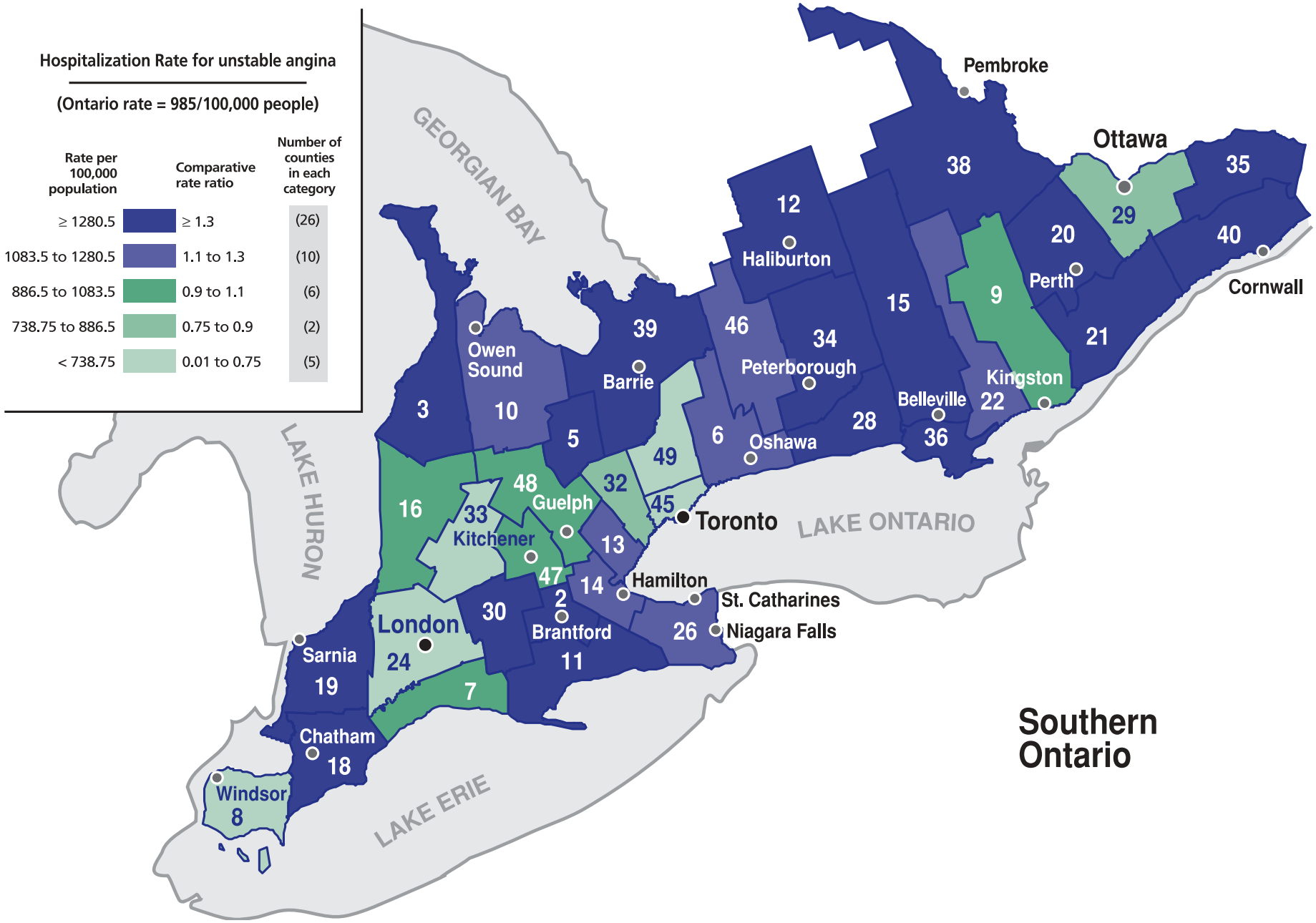
43 Thunder Bay District
44 Timiskaming District
45 Toronto Metropolitan Municipality
46 Victoria County
47 Waterloo Regional Municipality
48 Wellington County
49 York Regional Municipality

Note: See Exhibit 5.9b for Legend.

Source: Ontario Diabetes Database (ODD)

Exhibit 5.9b Unstable Angina Admission Rates per 100,000 Ontarians with DM by County, Southern Ontario, 1995–1999



Note: See Exhibit 5.9a for County definitions.

Source: Ontario Diabetes Database (ODD)

Exhibit 5.10 Age-/Sex-specific Hospitalization Rates for CHF per 100,000 Ontarians with/without DM Aged 20 Years and Over, 1995–1999

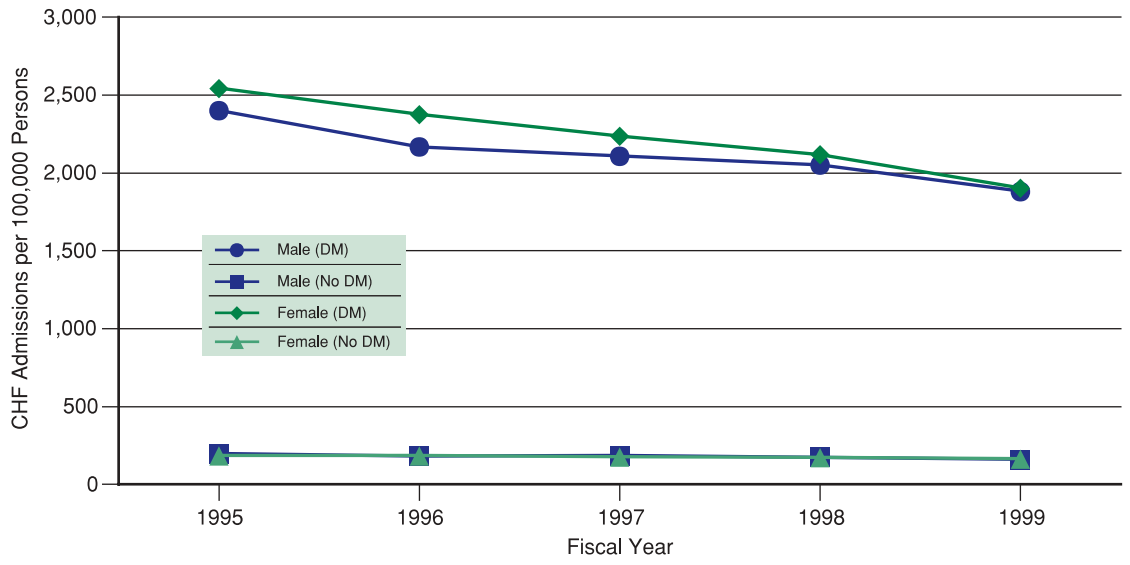
Hospital admissions for CHF were 11 times more common among persons with DM than in those without DM. Rates remained four-fold higher in the diabetic population after adjustment for age and gender.

Fiscal Year	DM Status	Overall Men & Women	Women by Age Group					Men by Age Group				
		Rate	20–49	50–64	65–74	75+	Overall	20–49	50–64	65–74	75+	Overall
1995	DM	2,488	170.7	1,301.3	2,981.5	6,182.7	2,562	239.9	1,411.0	3,521.2	6,260.1	2,418
	No DM	191	4.4	73.6	389.9	1,900.1	185	9.8	164.4	762.9	2,382.8	197
1996	DM	2,283	153.4	1,220.6	2,778.2	5,791.1	2,392	230.2	1,268.1	3,205.7	5,654.7	2,182
	No DM	184	4.7	70.1	363.7	1,908.7	184	8.9	150.5	668.1	2,271.0	183
1997	DM	2,184	189.1	1,093.8	2,682.5	5,376.4	2,251	264.8	1,192.6	3,116.3	5,466.0	2,121
	No DM	181	5.1	60.0	353.3	1,822.3	178	9.2	135.7	677.4	2,294.7	185
1998	DM	2,096	183.0	1,039.0	2,473.2	5,169.1	2,131	256.7	1,111.6	2,913.2	5,580.3	2,064
	No DM	175	5.3	59.3	360.8	1,741.5	174	9.7	119.2	633.4	2,198.2	176
1999	DM	1,902	138.6	926.6	2,353.4	4,531.0	1,913	229.2	1,010.7	2,694.7	5,049.9	1,891
	No DM	163	4.9	57.9	334.1	1,640.8	164	9.7	112.9	559.8	2,004.5	161
Odds Ratio Crude*		10.82 (10.50–11.15)	25.62 (18.56–35.38)	14.48 (12.70–16.51)	6.03 (5.53–6.57)	2.64 (2.50–2.79)	10.67 (10.23–11.12)	23.39 (18.49–29.59)	8.40 (7.56–9.33)	4.43 (4.10–4.78)	2.41 (2.26–2.57)	11.02 (10.56–11.50)
Odds Ratio Adjusted*		3.85 (3.73–3.97)					3.92 (3.76–4.10)					3.77 (3.61–3.94)

Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 5.11 CHF Admissions per 100,000 Ontarians by DM Status, 1995–1999

Over the five-year time period, admission rates for CHF declined significantly, more so among the diabetic than the nondiabetic population (24% vs. 15%).



Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

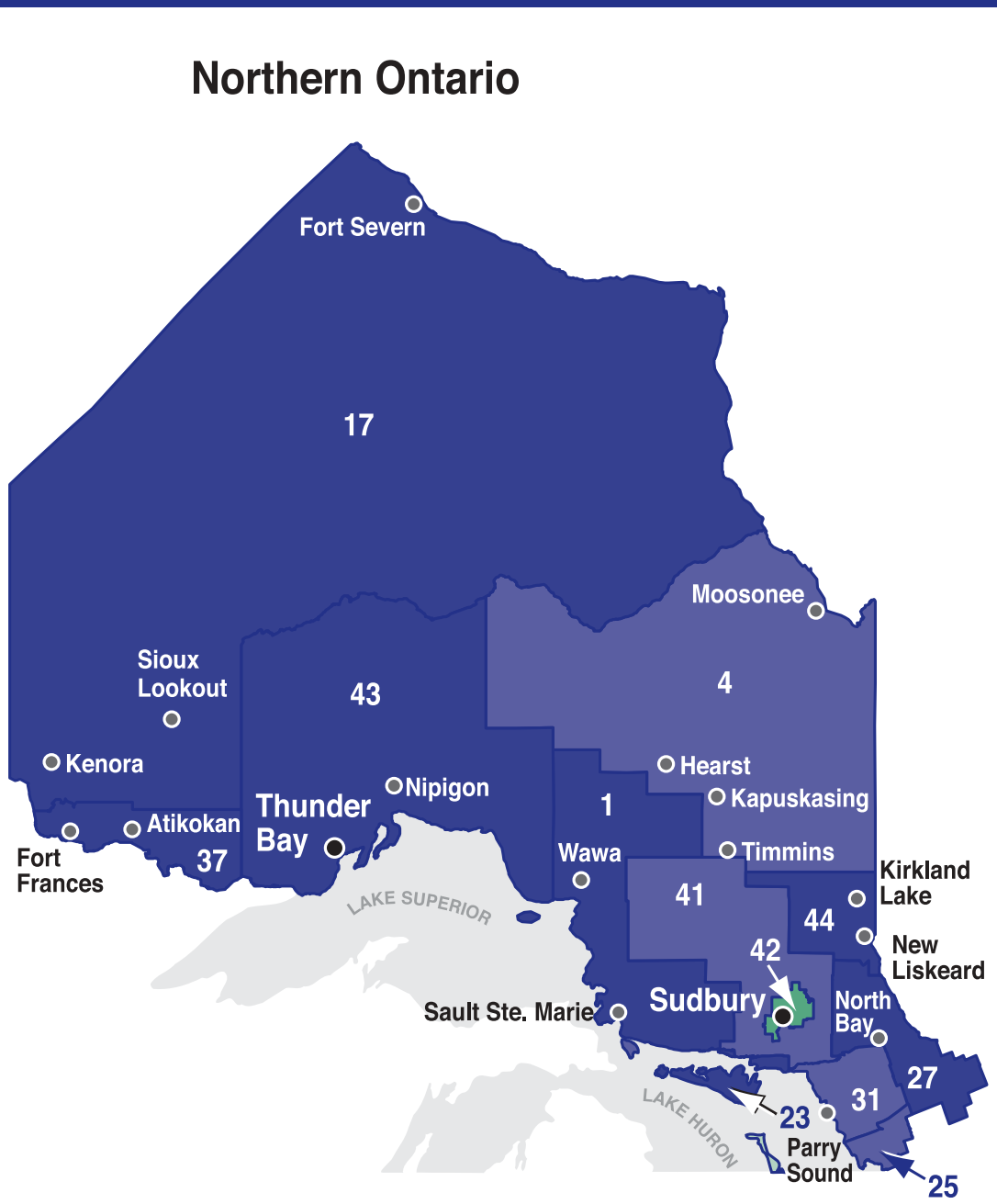
Exhibit 5.12 Average Age-/Sex-adjusted Rates of Hospitalization for CHF per 100,000 Ontarians with DM Aged 20 Years and Over by County, 1995–1999

Rate = per 100,000 persons	Crude Rate*	Adjusted Rate*
Algoma District	3,235	1,633
Brant County	2,796	1,341
Bruce County	3,092	1,349
Cochrane District	2,083	1,192
Dufferin County	2,748	1,452
Durham Regional Municipality	1,927	1,031
Elgin County	2,594	1,226
Essex County	2,454	1,163
Frontenac County	1,909	940
Grey County	3,489	1,722
Haldimand-Norfolk Regional Municipality	2,853	1,362
Haliburton County	2,040	796
Halton Regional Municipality	1,989	951
Hamilton-Wentworth Regional Municipality	2,217	1,021
Hastings County	2,472	1,225
Huron County	2,842	1,143
Kenora District	2,079	1,416
Kent County	2,698	1,218
Lambton County	2,491	1,200
Lanark County	2,591	1,154
Leeds and Grenville United Counties	3,204	1,581
Lennox and Addington County	2,007	963
Manitoulin District	4,093	1,943
Middlesex County	1,784	889
Muskoka District	3,010	1,268
Niagara Regional Municipality	2,592	1,269
Nipissing District	2,963	1,556
Northumberland County	2,707	1,430
Ottawa-Carleton Regional Municipality	1,852	908
Oxford County	2,968	1,302
Parry Sound District	2,935	1,361
Peel Regional Municipality	1,399	846
Perth County	2,360	865
Peterborough County	2,741	1,270
Prescott and Russell United Counties	2,242	1,143
Prince Edward County	3,189	1,429
Rainy River District	3,158	1,647
Renfrew County	2,830	1,400
Simcoe County	2,648	1,254
Stormont, Dundas and Glengarry United Counties	2,260	1,102
Sudbury District	2,416	1,281
Sudbury Regional Municipality	2,105	1,082
Thunder Bay District	2,895	1,496
Timiskaming District	2,946	1,383
Toronto Metropolitan Municipality	1,915	911
Victoria County	2,496	1,061
Waterloo Regional Municipality	2,340	1,158
Wellington County	2,151	1,001
York Regional Municipality	1,352	743
Provincial-wide Age-/Sex-adjusted Rate		1,055
Extremal Quotient [EQ]		2.6
Coefficient of Variation (%) [CV]		20.7
Systematic Component of Variation [SCV]		47.9
Adjusted Chi-square (likelihood ratio), DF=48		293.0 P-value <0.001

* rates averaged over the 5-year study period, rounded to whole numbers

Source: Ontario Diabetes Database (ODD)

Exhibit 5.13a CHF Admission Rates per 100,000 Ontarians with DM by County in Northern Ontario, 1995–1999



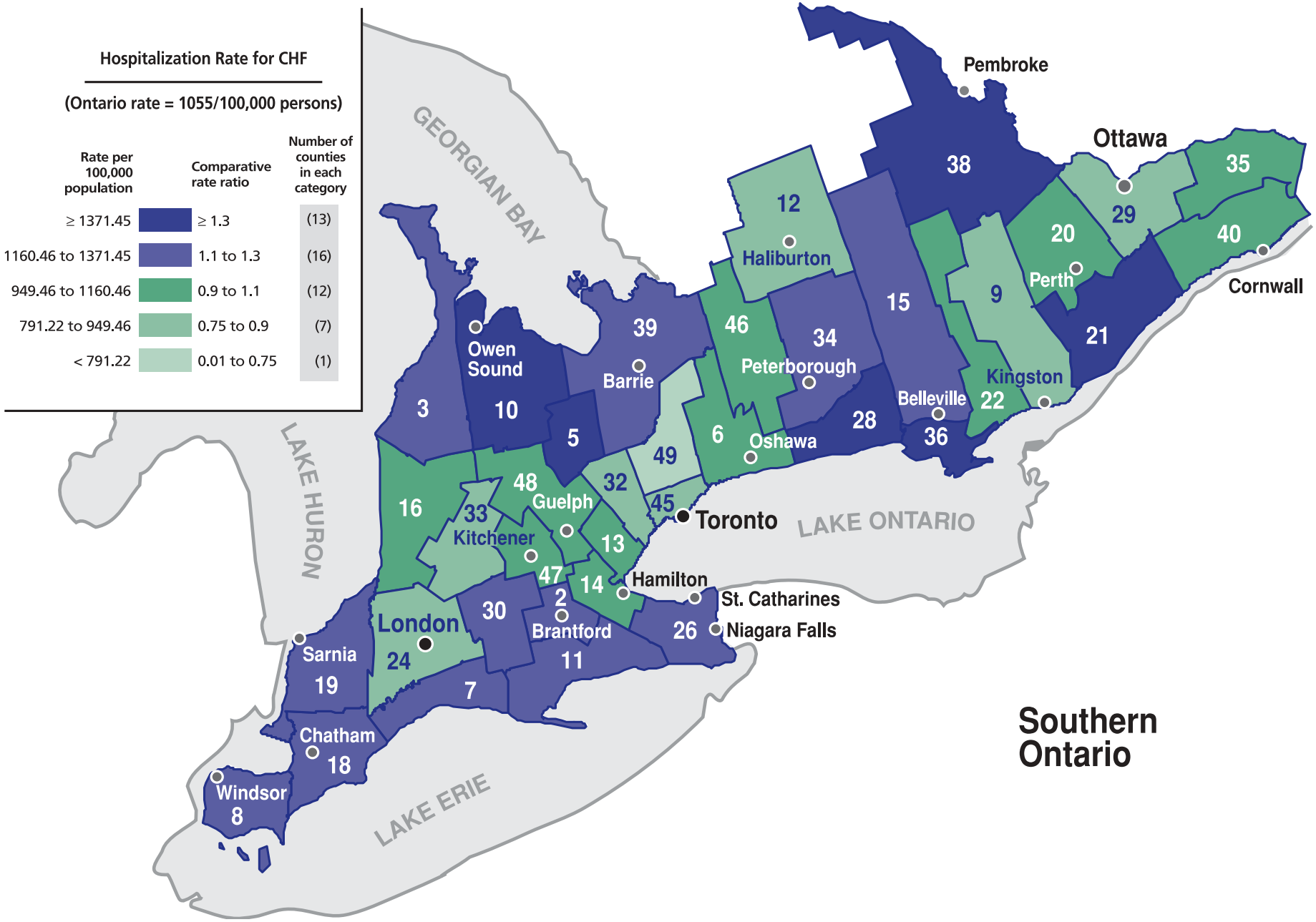
Ontario Counties

1 Algoma District
2 Brant County
3 Bruce County
4 Cochrane District
5 Dufferin County
6 Durham Regional Municipality
7 Elgin County
8 Essex County
9 Frontenac County
10 Grey County
11 Haldimand-Norfolk Regional Municipality
12 Haliburton County
13 Halton Regional Municipality
14 Hamilton-Wentworth Regional Municipality
15 Hastings County
16 Huron County
17 Kenora District
18 Kent County
19 Lambton County
20 Lanark County
21 Leeds and Grenville United Counties
22 Lennox and Addington County
23 Manitoulin District
24 Middlesex County
25 Muskoka District
26 Niagara Regional Municipality
27 Nipissing District
28 Northumberland County
29 Ottawa-Carleton Regional Municipality
30 Oxford County
31 Parry Sound District
32 Peel Regional Municipality
33 Perth County
34 Peterborough County
35 Prescott and Russell United Counties
36 Prince Edward County
37 Rainy River District
38 Renfrew County
39 Simcoe County
40 Stormont, Dundas and Glengarry United Counties
41 Sudbury District
42 Sudbury Regional Municipality
43 Thunder Bay District
44 Timiskaming District
45 Toronto Metropolitan Municipality
46 Victoria County
47 Waterloo Regional Municipality
48 Wellington County
49 York Regional Municipality

Note: See Exhibit 5.13b for Legend.

Source: Ontario Diabetes Database (ODD)

Exhibit 5.13b CHF Admission Rates per 100,000 Ontarians with DM by County in Southern Ontario, 1995–1999



Note: See Exhibit 5.13a for County definitions.

Source: Ontario Diabetes Database (ODD)

Exhibit 5.14 Age-/Sex-specific Coronary Angiography Rates per 100,000 Ontarians with/without DM Aged 20 Years and Over, 1995–1999

Persons with DM were nearly six times more likely to undergo coronary angiography.

Fiscal Year	DM Status	Overall Men & Women	Women by Age Group						Men by Age Group					
		Rate	20–34	35–49	50–64	65–74	75+	Overall	20–34	35–49	50–64	65–74	75+	Overall
1995	DM	1,293	70.4	663.3	1,265.3	1,282.5	364.9	908	216.1	1,196.5	2,240.2	1,939.4	732.5	1,651
	No DM	236	10.1	66.8	302.5	486.1	174.2	137	18.4	212.3	833.1	1,136.3	491.9	341
1996	DM	1,384	129.6	746.6	1,332.8	1,410.9	412.5	985	230.1	1,334.4	2,320.5	2,077.9	824.5	1,754
	No DM	243	8.1	68.2	313.9	508.8	217.7	145	15.6	214.8	824.4	1,185.0	513.8	347
1997	DM	1,477	82.8	712.2	1,474.2	1,499.4	508.3	1,057	237.1	1,267.4	2,423.4	2,280.7	1,073.7	1,868
	No DM	56	8.3	68.7	311.3	557.1	275.1	153	17.4	213.2	846.0	1,269.7	643.4	365
1998	DM	1,557	160.7	715.6	1,503.3	1,674.4	643.4	1,144	312.1	1,286.0	2,448.2	2,445.4	1,159.4	1,941
	No DM	275	8.6	74.3	336.1	619.3	313.7	169	7.6	207.6	882.8	1,376.0	767.5	388
1999	DM	1,636	117.8	728.6	1,563.1	1,717.6	727.5	1,187	167.5	1,423.2	2,521.6	2,599.2	1,329.7	2,054
	No DM	288	7.9	71.6	351.4	666.5	373.9	180	18.2	205.0	897.0	1,457.0	838.1	403
Odds Ratio Crude*		5.74 (5.59–5.89)	14.61 (8.73–24.46)	9.90 (8.64–11.33)	4.46 (4.14–4.79)	2.60 (2.41–2.80)	1.96 (1.75–2.21)	6.60 (6.31–6.90)	9.73 (6.16–15.38)	6.73 (6.15–7.36)	2.87 (2.74–3.02)	1.82 (1.72–1.92)	1.59 (1.43–1.76)	5.19 (5.03–5.36)
Odds Ratio Adjusted*		2.76 (2.69–2.84)						3.39 (3.24–3.55)						2.50 (2.42–2.58)

Source: Ontario Diabetes Database (ODD). *Odds Ratios (95% CI) are only for 1999. Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 5.15 Age-/Sex-specific Percutaneous Coronary Intervention (PCI) Rates per 100,000 Ontarians with/without DM Aged 20 Years and Over, 1995–1999

Persons with DM were five times more likely to undergo percutaneous coronary interventions.

Fiscal Year	DM Status	Overall Men & Women	Women by Age Group					Men by Age Group				
		Rate	20–49	50–64	65–74	75+	Overall	20–49	50–64	65–74	75+	Overall
1995	DM	231	107.0	223.5	267.5	72.5	178	188.5	389.3	305.1	110.8	280
	No DM	461	4.9	50.9	88.9	41.4	24	26.8	175.2	209.2	72.9	71
1996	DM	239	93.9	254.3	256.0	66.0	178	250.5	409.0	270.4	129.8	295
	No DM	47	5.0	52.6	100.4	40.7	25	25.9	177.9	198.5	80.3	70
1997	DM	266	106.0	311.8	268.3	75.1	202	244.0	456.8	323.7	147.9	326
	No DM	52	5.2	53.2	100.6	58.8	27	28.6	195.9	237.6	101.9	80
1998	DM	300	114.4	350.8	300.8	141.2	238	256.7	494.2	381.3	155.3	359
	No DM	59	5.5	64.2	116.4	64.6	31	30.3	212.2	261.9	148.3	88
1999	DM	343	124.6	316.2	340.0	157.1	243	290.7	542.8	497.8	293.3	436
	No DM	67	7.3	69.6	132.9	86.9	36	33.3	234.0	311.1	176.2	100
Odds Ratio Crude*		5.03 (4.76–5.32)	16.27 (12.16–21.77)	4.49 (3.82–5.28)	2.65 (2.25–3.12)	1.77 (1.38–2.28)	6.71 (6.08–7.40)	8.27 (6.97–9.80)	2.29 (2.07–2.53)	1.60 (1.41–1.82)	1.57 (1.26–1.96)	4.27 (3.99–4.57)
Odds Ratio Adjusted*		2.54 (2.40–2.69)					3.41 (3.08–3.77)					2.24 (2.09–2.41)

Source: Ontario Diabetes Database (ODD). *Odds Ratios (95% CI) are only for 1999. Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 5.16 Age/Sex-specific Coronary Artery Bypass Graft Surgery (CABG) Rates per 100,000 Ontarians with/without DM Aged 20 Years and Over, 1995–1999

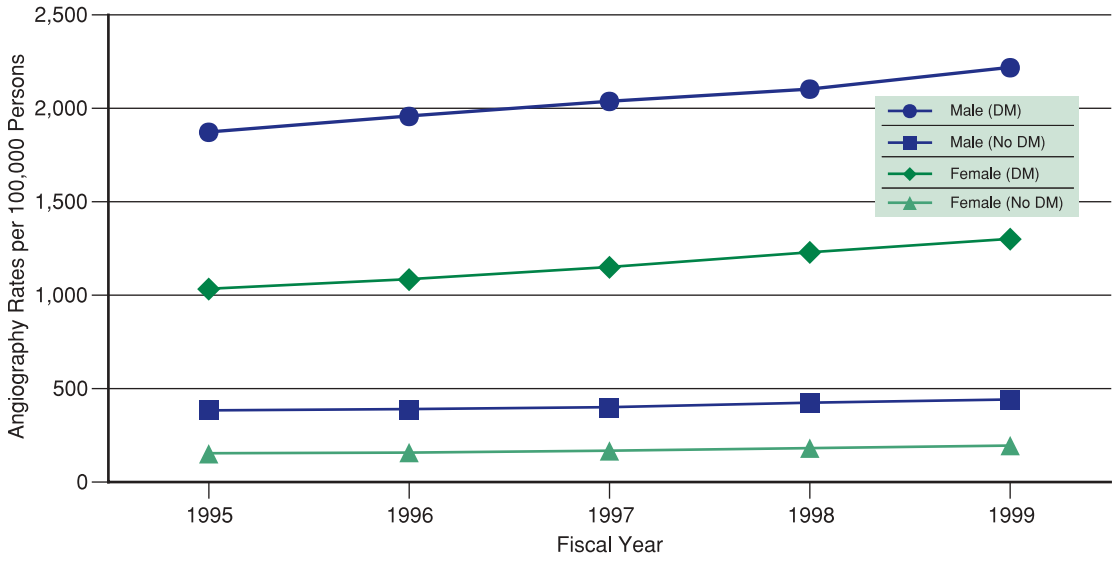
Persons with DM were over seven times more likely to under coronary artery bypass surgery.

Fiscal Year	DM Status	Overall Men & Women	Women by Age Group					Men by Age Group				
		Rate	20–49	50–64	65–74	75+	Overall	20–49	50–64	65–74	75+	Overall
1995	DM	450	81.5	359.9	443.2	119.1	270	235.6	871.2	808.4	246.4	617
	No DM	62	2.6	45.9	119.6	43.9	24	19.4	245.3	454.8	187.0	103
1996	DM	448	80.1	335.0	477.9	101.4	266	283.1	791.3	843.2	311.6	617
	No DM	63	2.6	45.3	121.6	54.9	25	19.8	246.1	439.6	189.5	102
1997	DM	501	110.2	359.2	499.2	160.8	296	266.7	903.7	941.3	399.3	691
	No DM	66	3.1	48.6	148.7	61.2	29	20.3	241.4	462.0	220.7	105
1998	DM	542	91.5	371.7	553.1	180.5	313	302.8	937.4	1,074.5	452.5	755
	No DM	72	3.2	46.9	146.8	80.9	30	20.7	264.0	518.2	268.4	117
1999	DM	521	70.2	386.3	578.9	167.9	314	285.7	865.1	1,055.0	415.5	714
	No DM	72	3.4	44.8	142.2	81.3	29	20.2	255.8	516.4	293.3	116
Odds Ratio Crude*		7.32 (6.99–7.66)	20.97 (14.45–30.44)	8.65 (7.40–10.11)	4.08 (3.57–4.66)	2.05 (1.61–2.60)	10.74 (9.81–11.75)	14.21 (11.97–16.88)	3.40 (3.14–3.69)	2.05 (1.88–2.24)	1.42 (1.19–1.69)	6.18 (5.86–6.52)
Odds Ratio Adjusted*		3.18 (3.03–3.33)					4.95 (4.51–5.42)					2.76 (2.61–2.91)

Source: Ontario Diabetes Database (ODD). *Odds Ratios (95% CI) are only for 1999. Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 5.17 Coronary Angiography Rates by Gender and DM Status in Ontario, 1995–1999

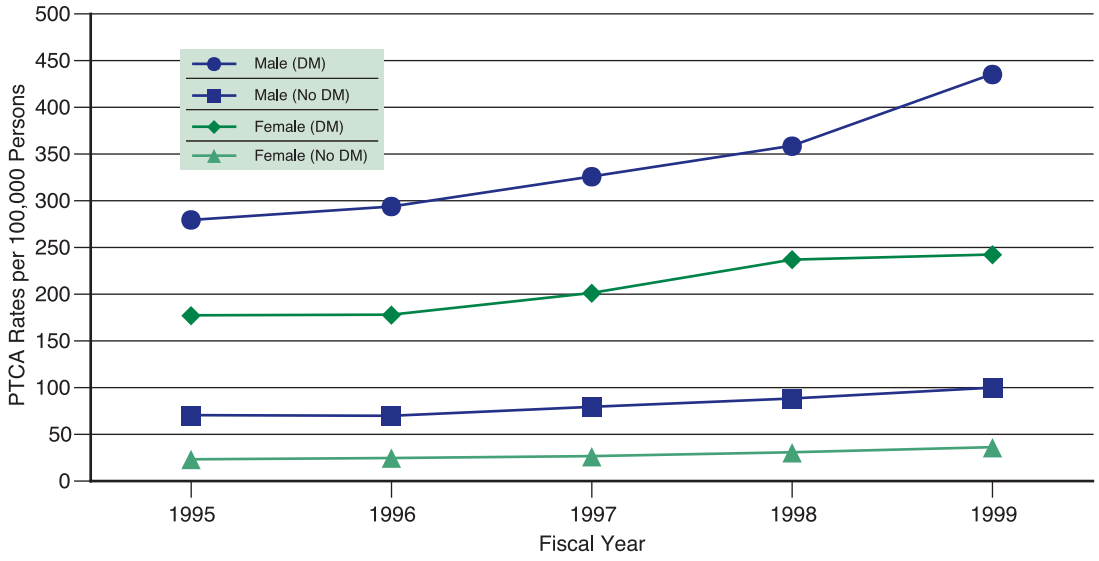
Rates of angiography increased 10–20% in persons with DM over the study period.



Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 5.18 Percutaneous Coronary Intervention (PCI) Rates by Age Group and DM Status in Ontario, 1995–1999

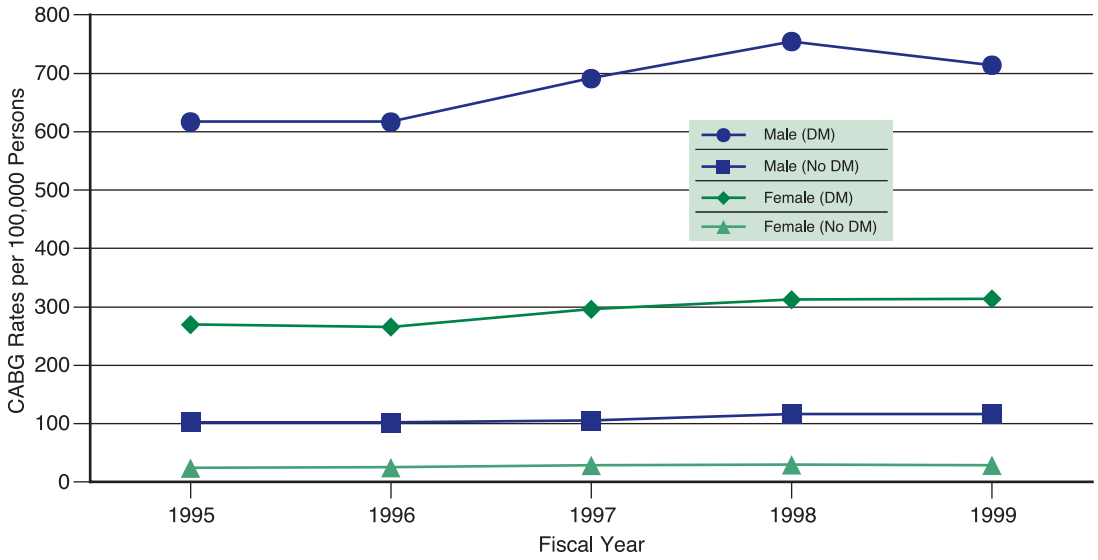
Over the study period, PCI rates increased by 50%.



Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 5.19 Coronary Artery Bypass Graft Surgery (CABG) Rates by Gender and DM Status in Ontario, 1995–1999

Rates of CABG in persons with DM increased 10–20% over the study period.



Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

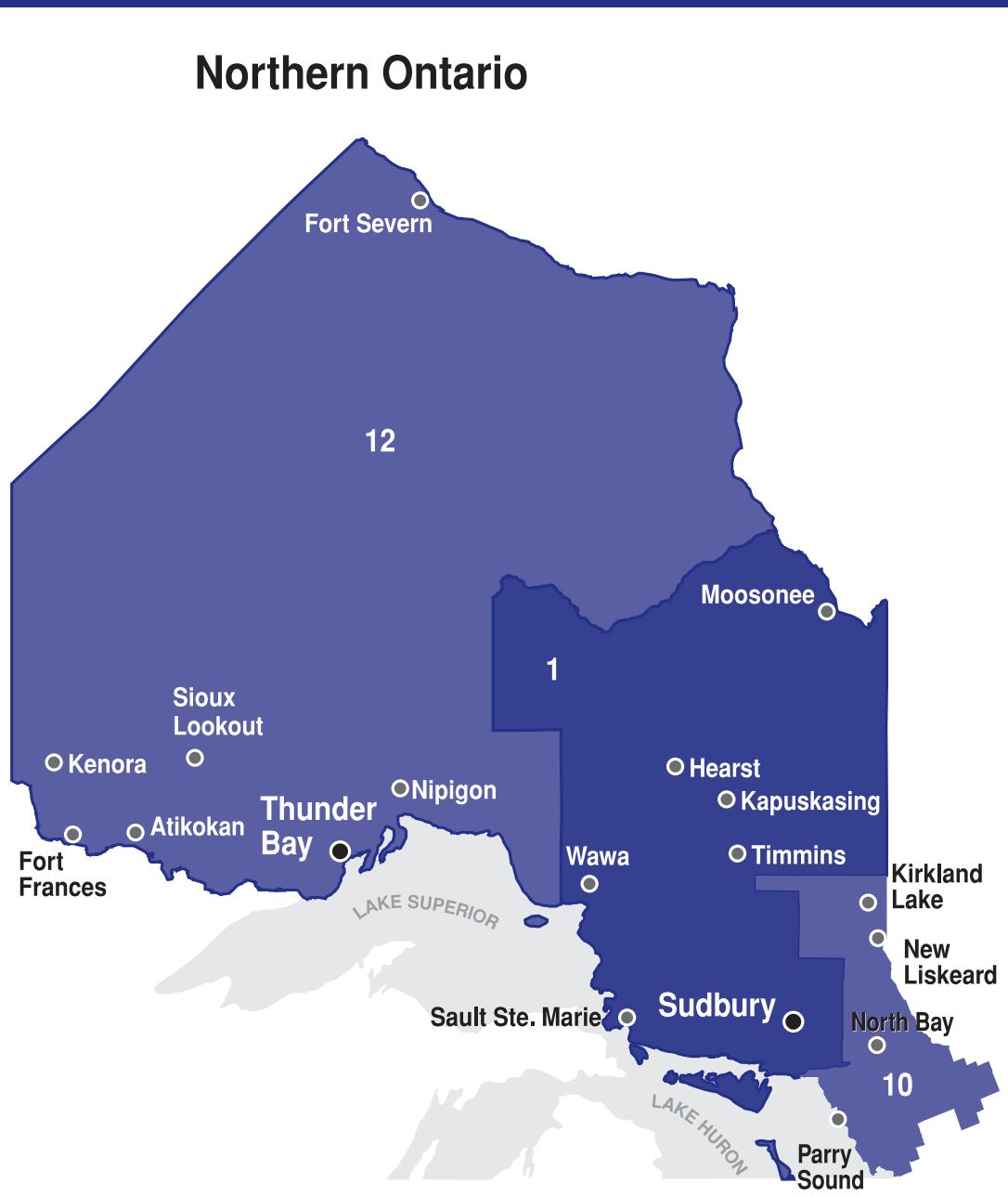
Exhibit 5.20 Average Age-/Sex-adjusted Rates of Coronary Angiography per 100,000 Ontarians with DM Aged 20 Years and Over by DHC in Ontario, 1995–1999

The rates of coronary angiography varied across regions of the province.

District Health Councils	Crude Rate*	Adjusted Rate*
Algoma, Cochrane, Manitoulin & Sudbury	2,710	2,054
Champlain	1,904	1,471
Durham, Haliburton, Kawartha & Pine Ridge	1,751	1,344
Essex, Kent and Lambton	1,557	1,195
Grand River	1,236	1,042
Grey, Bruce, Huron, Perth	1,140	968
Halton-Peel	1,702	1,252
Hamilton-Wentworth	1,765	1,418
Metropolitan Toronto	1,468	1,074
Muskoka, Nipissing, Parry Sound & Timiskaming	1,862	1,482
Niagara Region	1,507	1,139
Northwestern Ontario	1,745	1,359
Quinte, Kingston, Rideau	1,999	1,636
Simcoe-York	1,580	1,162
Thames Valley	1,426	1,096
Waterloo Region-Wellington-Dufferin	1,201	924
Provincial-wide Age-/Sex-adjusted Rate		1,240
Extremal Quotient [EQ]		2.2
Coefficient of Variation (%) [CV]		19.6
Systematic Component of Variation [SCV]		43.6
Adjusted Chi-square (likelihood ratio, DF=15)		221.5 P-value <0.001
*averaged over the 5-year study period, rounded to whole numbers		

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP)

Exhibit 5.21a Average Age-/Sex-adjusted Coronary Angiography Rates per 100,000 Ontarians with DM by DHC in Northern Ontario, 1995–1999



Ontario District Health Councils

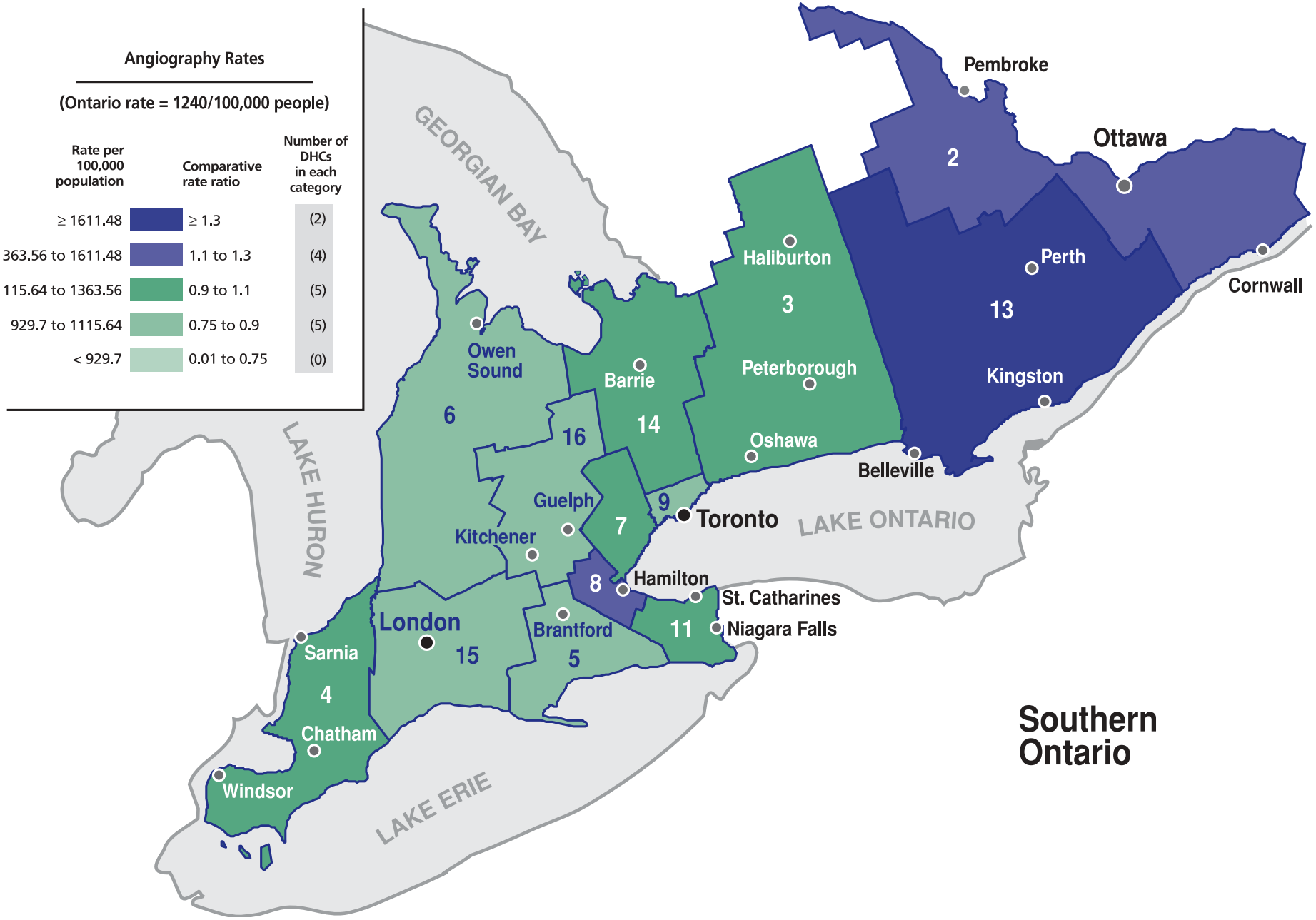
1 Algoma, Cochrane, Manitoulin & Sudbury
2 Champlain
3 Durham, Haliburton, Kawartha & Pine Ridge
4 Essex, Kent and Lambton
5 Grand River
6 Grey, Bruce, Huron, Perth
7 Halton-Peel
8 Hamilton-Wentworth
9 Metropolitan Toronto
10 Muskoka, Nipissing, Parry Sound & Timiskaming
11 Niagara Region
12 Northwestern Ontario
13 Quinte, Kingston, Rideau
14 Simcoe-York
15 Thames Valley
16 Waterloo Region-Wellington-Dufferin

Angiography Rates
(Ontario rate = 1240/100,000 people)

Rate per 100,000 population	Comparative rate ratio	Number of DHCs in each category
≥ 1611.48	≥ 1.3	(2)
1363.56 to 1611.48	1.1 to 1.3	(4)
1115.64 to 1363.56	0.9 to 1.1	(5)
929.7 to 1115.64	0.75 to 0.9	(5)
< 929.7	0.01 to 0.75	(0)

Source: Ontario Diabetes Database (ODD)

Exhibit 5.21b Average Age-/Sex-adjusted Coronary Angiography Rates per 100,000 Ontarians with DM by DHC in Southern Ontario, 1995–1999



Note: See Exhibit 5.21a for District Health Councils (DHCs) definitions.

Source: Ontario Diabetes Database (ODD)

Exhibit 5.22 Average Age-/Sex-adjusted Rates of Percutaneous Coronary Interventions (PCI) per 100,000 Ontarians with DM Aged 20 Years and Over by DHC, 1995–1999

The rates of PCI varied across regions of the province.

District Health Councils	Crude Rate*	Adjusted Rate*
Algoma, Cochrane, Manitoulin & Sudbury	429	356
Champlain	462	361
Durham, Haliburton, Kawartha & Pine Ridge	296	248
Essex, Kent, and Lambton	268	234
Grand River	198	168
Grey, Bruce, Huron, Perth	224	225
Halton-Peel	262	209
Hamilton-Wentworth	305	282
Metropolitan Toronto	236	175
Muskoka, Nipissing, Parry Sound & Timiskaming	258	211
Niagara Region	232	194
Northwestern Ontario	194	183
Quinte, Kingston, Rideau	378	331
Simcoe-York	267	217
Thames Valley	308	261
Waterloo Region-Wellington-Dufferin	186	149
Provincial-wide Age-/Sex-adjusted Rate		227.8
Extremal Quotient [EQ]		2.4
Coefficient of Variation (%) [CV]		27.7
Systematic Component of Variation [SCV]		55.2
Adjusted Chi-square (likelihood ratio, DF=15)		78.3 P-value <0.001
*averaged over the 5-year study period, rounded to whole numbers		

Source: Ontario Diabetes Database (ODD)

and sex (men: age-adjusted OR 2.69, 95% CI: 2.58–2.80; women: age-adjusted OR 3.29, 95% CI: 3.14–3.34). Persons with DM had somewhat longer LOS than those without DM (median LOS 4.0 vs. 3.6 days, p<0.0001), and significantly higher mortality following hospitalization for UA both at 30 days (2.3% vs. 1.4%), and at one year (11.5% vs. 6.4%).

A similar geographical distribution was observed for admissions relating to UA as was seen for AMI, with the exception that rates were consistently high throughout northern Ontario. Rates were also high in rural areas of southern Ontario—particularly in the Eastern counties, as well as south central (Dufferin, Simcoe, Haldimand, Brant and Oxford counties), and southwestern Ontario (Kent and Lambton counties) (Exhibit 5.9). Rates were lowest in communities near Toronto (Metropolitan Toronto, York and Peel Regions), Ottawa, London, Windsor and Perth County.

Admissions for Congestive Heart Failure (CHF)

Hospital admissions for CHF were also much more common among persons with DM than those without DM (1,902 vs. 163/100,000 in fiscal year 1999) (Exhibit 5.10). Similar to other cardiovascular complications, persons with DM had dramatically higher admission rates for CHF regardless of age and gender; however, women and men with DM had comparable admission rates (1,913 vs. 1,891/100,000 in 1999) (Exhibit 5.10). Trends in rates showed a significant decline over the five-year time period (Exhibit 5.11). Rates of admission dropped substantially during the study period, more so among those with DM compared to those without DM (23.6% vs. 14.9%).

There was a substantial degree of variation in hospitalization rates for CHF across regions of Ontario (Exhibits 5.12 and 5.13). Adjusted rates of admission were high throughout the north, particularly in Manitoulin District (1,943/100,000), as well as in the following areas of southern Ontario: Renfrew, Leeds, Northumberland, Prince Edward, Dufferin and Grey Counties. The lowest rates occurred in regions near Toronto (Metropolitan Toronto, Peel and York Regional Municipalities), Kingston, Ottawa, and London, as well as in Perth and Haliburton counties.

Persons with DM tended to have longer length of stays for CHF than those without DM (6.0 vs. 5.8 days, p<0.0001). However, mortality following admission for CHF was somewhat lower among persons with DM compared to those without DM at

Exhibit 5.23 Average Age-/Sex- Adjusted Rates of Coronary Artery Bypass Graft Surgery (CABG) per 100,000 Ontarians with DM Aged 20 Years and Over by DHC, 1995–1999

The rates of CABG procedures varied across regions of the province.

District Health Councils	Crude Rate*	Adjusted Rate*
Algoma, Cochrane, Manitoulin & Sudbury	736	474
Champlain	502	344
Durham, Haliburton, Kawartha & Pine Ridge	560	360
Essex, Kent, and Lambton	461	304
Grand River	408	293
Grey, Bruce, Huron, Perth	353	257
Halton-Peel	569	372
Hamilton-Wentworth	516	332
Metropolitan Toronto	443	285
Muskoka, Nipissing, Parry Sound & Timiskaming	618	375
Niagara Region	486	300
Northwestern Ontario	361	237
Quinte, Kingston, Rideau	594	420
Simcoe-York	512	330
Thames Valley	468	303
Waterloo Region-Wellington-Dufferin	457	320
Provincial-wide Age-/Sex-adjusted Rate		326.1
Extremal Quotient [EQ]		2.0
Coefficient of Variation (%) [CV]		15.5
Systematic Component of Variation [SCV]		20.5
Adjusted Chi-square (likelihood ratio, DF=15)		44.4 P-value <0.001
*averaged over the 5-year study period, rounded to whole numbers		

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

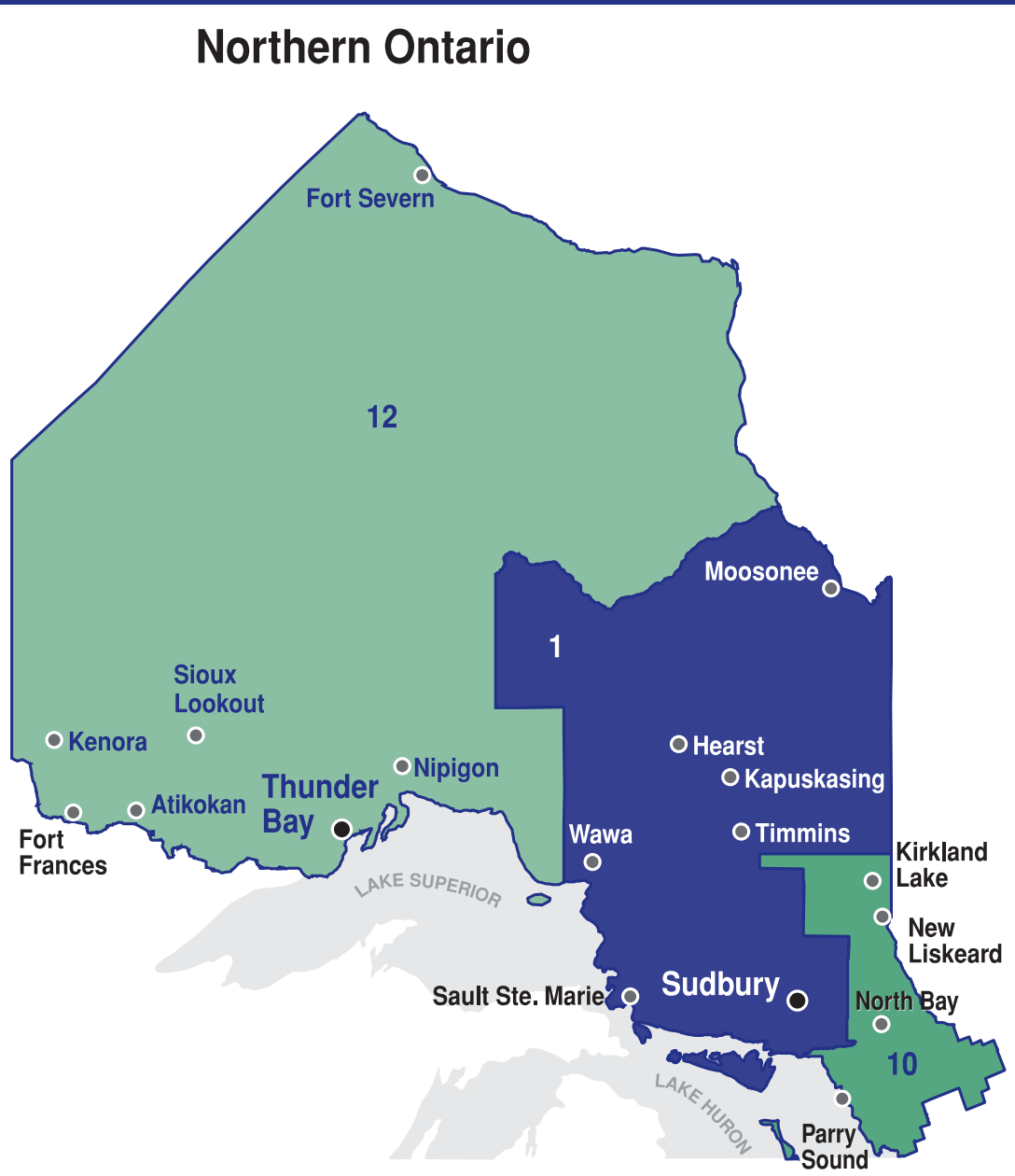
both 30 days and one year (Exhibit 5.7). Reasons for this observation are not clear; however, one possibility is that the threshold for admission to hospital is lower for persons with DM, thus lessening the average severity of CHF episodes. Administrative data sources do not include clinical details such as case severity, so this hypothesis could not be tested; however, this finding merits further study.

Cardiac procedures

Rates of all cardiac procedures were significantly higher among the diabetic compared to the non-diabetic population (Exhibits 5.14 to 5.16). Persons with DM were almost three times more likely to undergo coronary angiography and coronary artery bypass surgery (CABG), and more than twice as likely to undergo percutaneous coronary interventions (PCI). Among persons with DM, use of angiography and CABG increased by 10–20% over the study period; however, PCI rates increased by 50% (Exhibits 5.17 to 5.19). While men with DM were only a third more likely to have an admission for AMI than women with DM, they received over two-thirds more PCI procedures and twice as many CABG procedures. Of individuals undergoing coronary angiography, those with DM were somewhat more likely to undergo CABG and less likely to undergo PCI than individuals without DM.

The rates of all three procedures varied across regions of the province. Some regions with high rates of admissions for AMI and UA also had higher rates of cardiac procedures (Algoma, Cochrane, Manitoulin and Sudbury; Quinte, Kingston, Rideau) (Exhibits 5.20 to 5.25). However, there were some disparities noted. For instance, some regions had procedure rates that were significantly lower than the provincial average despite containing counties that have high rates of admissions for AMI and UA (eg. Grand River; Grey, Bruce, Huron, Perth). Measured procedure rates were also lower than expected among individuals living in the northwest, who may be transferred to Winnipeg, Manitoba for specialized services. The optimal rate of use of these procedures is unclear; however, regional variation in procedure rates probably reflects differences in their availability. Other factors that could contribute to rate variation, such as physician preferences and patient populations, could not be measured in this analysis.

Exhibit 5.24a Average Age-/Sex-adjusted Percutaneous Coronary Intervention (PCI) Rates per 100,000 Ontarians with DM by DHC in Northern Ontario, 1995–1999



Ontario District Health Councils

1 Algoma, Cochrane, Manitoulin & Sudbury
2 Champlain
3 Durham, Haliburton, Kawartha & Pine Ridge
4 Essex, Kent and Lambton
5 Grand River
6 Grey, Bruce, Huron, Perth
7 Halton-Peel
8 Hamilton-Wentworth
9 Metropolitan Toronto
10 Muskoka, Nipissing, Parry Sound & Timiskaming
11 Niagara Region
12 Northwestern Ontario
13 Quinte, Kingston, Rideau
14 Simcoe-York
15 Thames Valley
16 Waterloo Region-Wellington-Dufferin

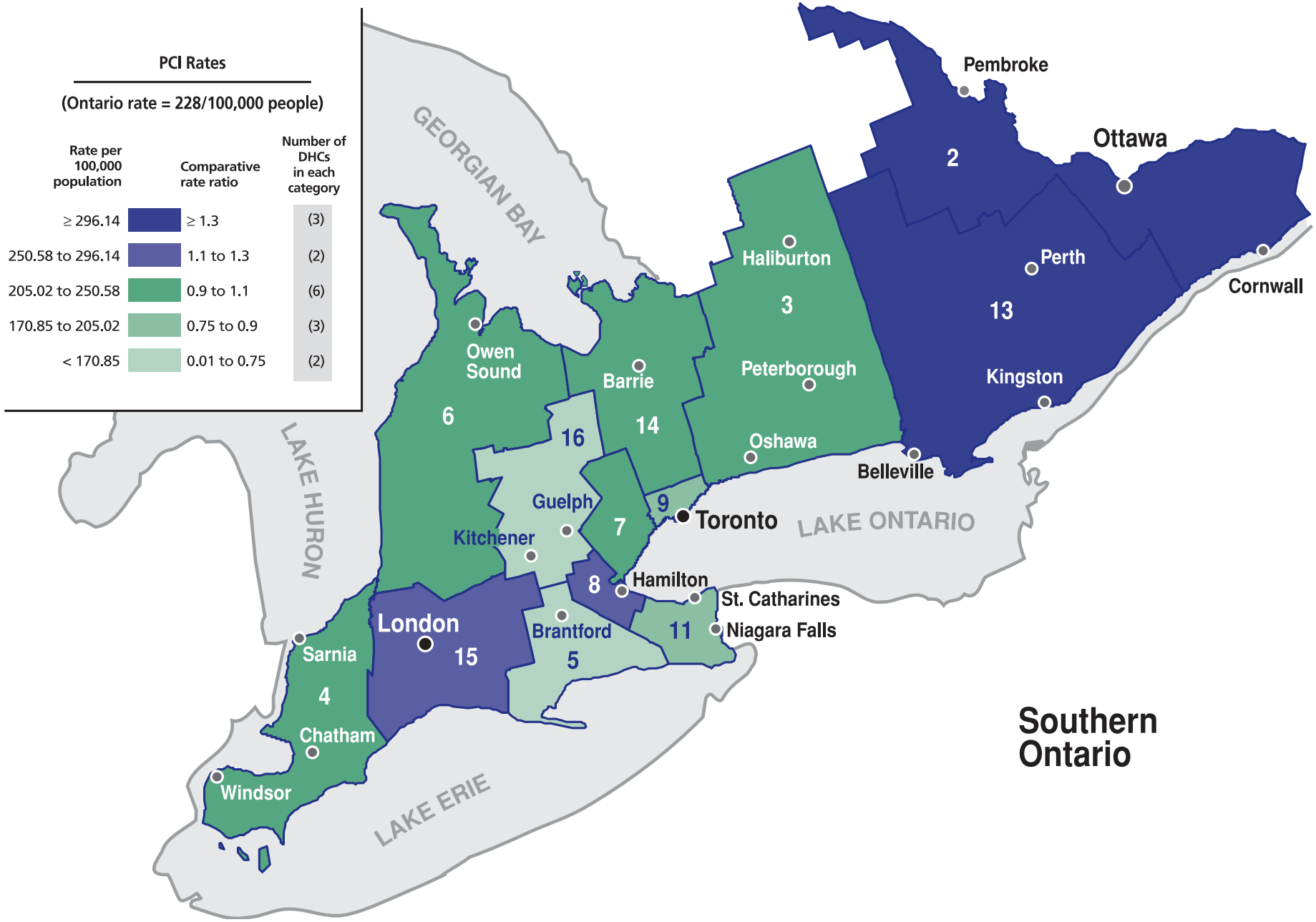
PCI Rates
(Ontario rate = 228/100,000 people)

Rate per 100,000 population	Comparative rate ratio	Number of DHCs in each category
≥ 296.14	≥ 1.3	(3)
250.58 to 296.14	1.1 to 1.3	(2)
205.02 to 250.58	0.9 to 1.1	(6)
170.85 to 205.02	0.75 to 0.9	(3)
< 170.85	0.01 to 0.75	(2)

Note: See Exhibit 5.24b for Legend.

Source: Ontario Diabetes Database (ODD)

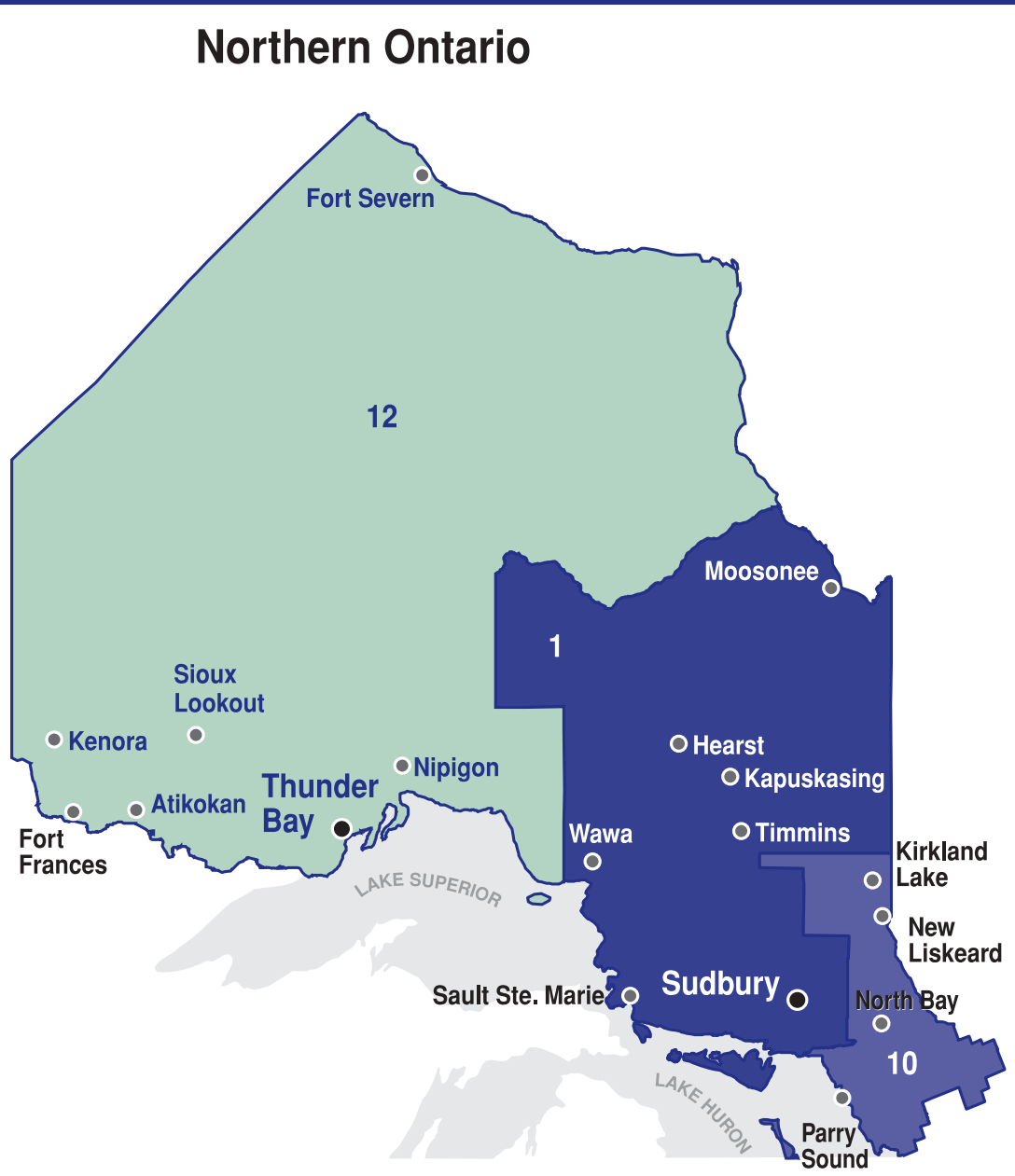
Exhibit 5.24b Average Age-/Sex-adjusted Percutaneous Coronary Intervention (PCI) Rates per 100,000 Ontarians with DM by DHC in Southern Ontario, 1995–1999



Note: See Exhibit 5.24a for District Health Councils (DHCs) definitions.

Source: Ontario Diabetes Database (ODD)

Exhibit 5.25a Average Age-/Sex-adjusted Coronary Artery Bypass Graft Surgery (CABG) Rates per 100,000 Ontarians with DM by DHC in Northern Ontario, 1995–1999



Ontario District Health Councils

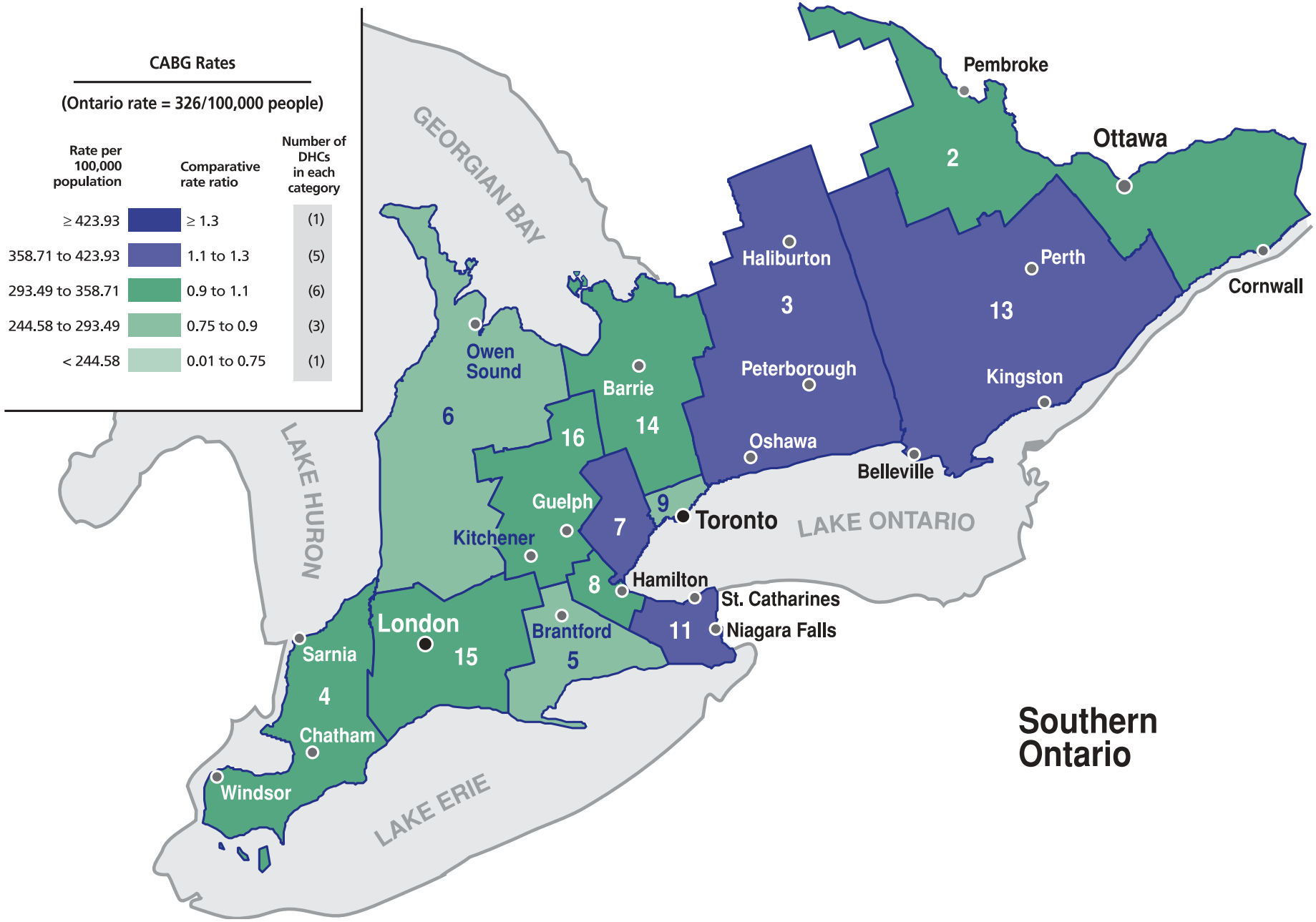
1 Algoma, Cochrane, Manitoulin & Sudbury
2 Champlain
3 Durham, Haliburton, Kawartha & Pine Ridge
4 Essex, Kent and Lambton
5 Grand River
6 Grey, Bruce, Huron, Perth
7 Halton-Peel
8 Hamilton-Wentworth
9 Metropolitan Toronto
10 Muskoka, Nipissing, Parry Sound & Timiskaming
11 Niagara Region
12 Northwestern Ontario
13 Quinte, Kingston, Rideau
14 Simcoe-York
15 Thames Valley
16 Waterloo Region-Wellington-Dufferin

CABG Rates
(Ontario rate = 326/100,000 people)

Rate per 100,000 population	Comparative rate ratio	Number of DHCs in each category
≥ 423.93	≥ 1.3	(1)
358.71 to 423.93	1.1 to 1.3	(5)
293.49 to 358.71	0.9 to 1.1	(6)
244.58 to 293.49	0.75 to 0.9	(3)
< 244.58	0.01 to 0.75	(1)

Source: Ontario Diabetes Database (ODD)

Exhibit 5.25b Average Age-/Sex-adjusted Coronary Artery Bypass Graft Surgery (CABG) Rates per 100,000 Ontarians with DM by DHC in Southern Ontario, 1995–1999



Note: See Exhibit 5.25a for District Health Councils (DHCs) definitions.

Source: Ontario Diabetes Database (ODD)

Conclusions

Our findings demonstrate an extremely high rate of cardiovascular complications among persons with DM. This excessive risk is partially accounted for by age and sex differences; however, after adjustment, cardiac admission rates continue to be two- to three-fold greater among those with DM. The risk of CVD appears to occur earlier in persons with DM, with rates in young adults mirroring those of non-DM individuals who are at least 15 years older. In fact, the odds of suffering a cardiovascular event are dramatically higher among younger persons with DM compared to older individuals, although the total number of events is lower in the younger age group.

Other risk factors for AMI include residence in lower socioeconomic neighbourhood and previous myocardial infarction or other chronic diseases. Moreover, there was a significant degree of variation in admission rates throughout the province, with areas further from larger centres having the highest rates. This finding was further supported on multivariate analysis, were living in a rural area and region of residence outside of Toronto or the East planning region were independent predictors of having an AMI. Geographic variations may be due to differences in management across regions of the province, but may reflect inherent differences in the underlying population, such as the prevalence of cardiac risk factors (e.g. smoking, obesity, genetic effects).

Importantly, the rates of admission for AMI and CHF fell considerably over the five-year time period. This may be due, in part, to a concomitant increase in the use of cardioprotective agents in persons with DM, as demonstrated in Chapter 3. Over the same time frame, the use of revascularization procedures, particularly PCI, increased substantially among persons with DM. Although there is some evidence favouring the use of CABG over PCI in patients with DM,[25] greater access to the latter has likely driven its use.

Cardiovascular disease is the leading cause of death among persons with DM. Our findings highlight the relative burden of cardiac complications among persons with DM compared to the general population. There is now compelling evidence from randomized trials that specific interventions such as the use of ACE inhibitors, antihypertensive medications and lipid lowering agents can sharply reduce the risk of cardiovascular complications in this population. While overall increases in use have been observed, the proportion of individuals with DM who are receiving these agents is far lower than expected.[26] Thus, it is extremely important for care providers to focus more attention on reducing and treating the risk factors that contribute to the high burden of cardiovascular disease in this population. Further improvements in DM management may lead to additional reductions in cardiovascular events in the coming years.

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Technical Appendices (Exhibit TA5.A and TA5.B)
Cardiovascular Analyses and Diagnostic Codes

Exhibit TA5.A Creation of the Cohort Used for Cardiovascular Analyses

Of All Individuals in the Registered Persons Database (RPDB)

Inclusion Criteria

[a]At start of study period:
- Alive
- Eligible for OHIP
- Age 20–105 years

Exclusion Criteria

[b]If ≥ 65 years and last contact date is more than 90 days before the start of study period

n=10,453,815

At Start of Study Period:

Present in ODD*	Not Present in ODD*

Year	Diabetes n	No Diabetes n	Total n
1995	372,771	7,684,746	**8,057.517**
1996	407,053	7,773,474	**8.180,527**
1997	440,514	7,867,498	**8,308,012**
1998	477,301	7,960,742	**8,438,043**
1999	514,755	8,081,557	**8,596,312**

[a] The start of each study period is April 1st of the fiscal year (i.e. for fiscal 1995, start date = April 1, 1994)

[b] The last contact date is the most recent date of contact with the health care system—identified as the last record from the Canadian Institute for Health Information (CIHI) or the Ontario Health Insurance Plan (OHIP) databases during the period of April 1994 to March 2000 or the last record from the Ontario Drug Benefits (ODB) database during the period of April 1994 to March 2001.

Source: *Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit TA5.B Diagnostic Codes and Procedures Codes for Each Outcome

Diagnosis/Procedure	ICD-9 Code[a]	Procedure Code[b]	Description
Acute Myocardial Infarction	410.00–410.92		Acute Myocardial Infarction
Unstable Angina	411.0–411.89 413.0–413.9		Other Acute and Subacute Forms of Ischemic Heart Disease Angina Pectoris
Congestive Heart Failure	428.0 428.1 428.9		Congestive Heart Failure Left Heart Failure Unspecified Heart Failure
Coronary Angiography		48.92–48.98 49.96 49.97	
Percutaneous Coronary Interventions		48.02 48.03 48.09	
Coronary Artery Bypass Graft Surgery		48.10–48.19	

Procedure	Fee Code[c]	Description
Coronary Angiography	Z442 G297	

ICD-9 = International Classification of Diseases, 9th Revision

[a] As listed in the Canadian Institute for Health Information (CIHI) Database

[b] Canadian Classification of Procedure codes as listed in CIHI Database

[c] As listed in the Ontario Health Insurance Plan (OHIP) Database

6

Chapter

Diabetes and Peripheral Vascular Disease

Authors: Janet E. Hux, Robert Jacka, Kinwah Fung and Deanna M. Rothwell

Key Messages

- Diabetes mellitus (DM) increases the risk of amputation by 20-fold.
- The declining rate of foot amputations parallels the decrease in hospitalizations for skin and soft tissue infections seen earlier (Chapter 2). These trends likely reflect more effective outpatient care for diabetic foot ulcers and infections.
- Rates of major amputations remained stable between 1995–1999. Interventions to reduce of risk of peripheral vascular disease (e.g. smoking cessation) and neuropathy (e.g. improved blood sugar control) coupled with regular foot care may help to lower rates of amputation in this population.
- Among people with DM, those living in the north or in low income neighbourhoods and those with poor access to physician services are at particular risk for amputation.
- Rates of revascularization are almost five-fold higher in persons with DM than in those without DM. Given the very high burden of peripheral vascular disease among persons with DM, these rates may still not reflect adequate access to revascularization.

Background

Diabetes mellitus (DM) is a multi-system disease. In addition to the problems resulting directly from abnormal blood sugar levels, DM is associated with an increased risk of damage to large and small blood vessels, so-called macrovascular and microvascular disease. Macrovascular disease includes coronary heart disease (CHD), stroke and peripheral vascular disease (PVD), each of which is a significant source of morbidity and mortality in the diabetic population. Major risk factors for PVD include increased age, male sex, smoking, DM, hyperlipidemia, and hypertension.[1] In the general population, prevalence ranges from 3% to 10%, with a marked increase in those over the age of 60.[2, 3] Persons with DM have been estimated to have a two-to-four-fold increase in the rates of PVD.[4] With respect to the anatomic distribution of PVD, the lower leg is more frequently and severely affected than the upper leg in persons with DM.[5, 6]

As PVD progresses, several characteristic symptoms and signs may develop. The most common of these symptoms, intermittent claudication, is described as leg pain precipitated by walking which is relieved with rest. Patients with severe disease may progress to having pain even at rest. Intermittent claudication is associated with a ten year mortality risk of at least 50%, with most of those deaths due to cardiovascular causes.[7, 8] However, individuals with asymptomatic PVD also have a significantly increased mortality risk.[9] PVD can result in a broad spectrum of functional impairment, from a decrease in pain-free walking distance to amputation and a requirement for support in a long-term care facility.

Despite the morbidity and mortality due to PVD, this condition is frequently unrecognized and undertreated.[3, 10] When the disease is diagnosed, there are a range of therapies that can be offered. Medical therapy typically involves addressing the identified risk factors, such as smoking, diet and exercise level, and intensively controlling glucose levels. Various specific medications have been proposed, although few have been shown to be of clear benefit.[11–14] Initial surgical or procedural treatment options include revascularization (relieving the obstruction in the artery)—by PTA (Percutaneous Transluminal Angioplasty) or ABS (Arterial Bypass Surgery). However, when it is not possible to restore adequate arterial blood supply and the patient has intractable pain or uncontrolled infection, amputation may be required. Approximately 50% of all amputations of the lower extremity are reported to be performed in patients with DM.[15]

This chapter examines procedures used to treat PVD in people with and without DM as a marker of rates of PVD and as a measure of the resultant service utilization.

Exhibit 6.1 Overall and Age-/Sex-specific Minor Amputation Rates per 100,000 Ontarians with/without DM, 1995–1999

Rates of minor amputations increased with age in both persons with/ without DM, and were much higher in men than women, an effect that was more marked in the diabetic population.

Fiscal Year	DM Status	Overall Men & Women		Women by Age Group					Men by Age Group				
		Rate	n	20–49	50–64	65–74	75+	Overall	20–49	50–64	65–74	75+	Overall
1995	DM	158	590	38.2	104.2	93.9	160.5	99	92.0	208.4	297.3	264.4	213
	No DM	4	278	0.5	3.6	10.5	25.0	4	1.0	4.5	12.1	24.5	4
1996	DM	140	568	45.8	84.2	87.2	94.3	77	71.3	177.2	290.0	269.4	196
	No DM	3	224	0.6	1.8	7.5	13.1	2	1.3	2.9	13.0	23.2	4
1997	DM	144	634	49.9	66.9	117.3	109.4	86	87.0	186.4	284.1	245.5	198
	No DM	2	191	0.4	2.7	6.2	17.2	3	0.5	2.0	9.3	20.0	2
1998	DM	141	672	30.5	92.6	102.3	129.5	94	93.8	152.7	268.6	251.7	185
	No DM	2	171	0.3	1.4	5.2	13.0	2	0.9	2.9	8.6	13.5	2
1999	DM	112	576	42.1	57.7	75.9	90.3	66	59.8	131.0	221.4	237.1	155
	No DM	2	187	0.4	1.9	6.0	12.4	2	0.5	2.1	10.4	23.5	3
Odds Ratio Crude*		48.42 (41.06–57.11)		102.92 (50.42–210.12)	30.93 (17.15–55.78)	12.60 (7.61–20.87)	7.28 (4.77–11.10)	31.98 (24.63–41.51)	123.30 (65.39–232.49)	62.82 (37.34–105.70)	21.44 (14.58–31.55)	10.09 (7.01–14.54)	60.11 (48.35–74.72)
Odds Ratio Adjusted*		24.14 (20.24–28.79)						17.54 (13.27–23.17)					29.40 (23.32–37.08)

Source: Ontario Diabetes Database (ODD). *Odds Ratios (95% CI) are only for 1999. Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995. Minor amputation defined as at the level of the foot or below.

Data Sources

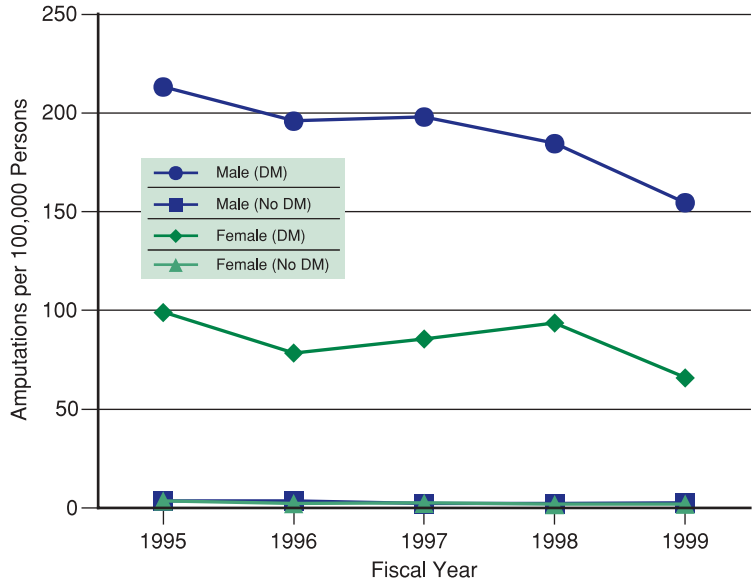
Persons with DM were identified using the Ontario Diabetes Database (ODD). Creation of the ODD is described in the Chapter 1 Technical Appendix TA1.A . Records of hospitalizations for minor and major amputations and ABS were obtained from the Canadian Institute for Health Information (CIHI) and procedure records for PTA from the Ontario Health Insurance Plan (OHIP) databases. The databases were linked using a unique anonymous identifier for each individual. Census data from Statistics Canada were used to establish denominators for calculation of DM rates and to attribute socioeconomic characteristics to the forward sortation area (or local neighbourhood).

How the analysis was done

The annual rate of procedures was calculated from fiscal year 1995 (April 1, 1994 to March 31, 1995) through fiscal year 1999. The total number of persons in the ODD receiving a particular procedure in a given year defined the numerator, while the denominator was the total number of persons with DM who were in the ODD during the same time period. Hospitalizations for these procedures were identified from CIHI records in which one of the Canadian Classification of Diagnostic Procedures (CCP) codes representing lower extremity

Exhibit 6.2 Age-/Sex-specific Minor Amputation Rates per 100,000 Ontarians with/without DM Aged 20 Years and Over, 1995–1999

Although rates for minor amputations were 24-fold higher in the diabetic population versus the non-diabetic population, between 1995 and 1999 minor amputation rates for persons with DM decreased by about 29%.



Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 6.3 Overall and Age-/Sex-specific Major Amputation Rates per 100,000 Ontarians with/without DM, 1995–1999

Major amputation rates were relatively stable over the five-year study period.

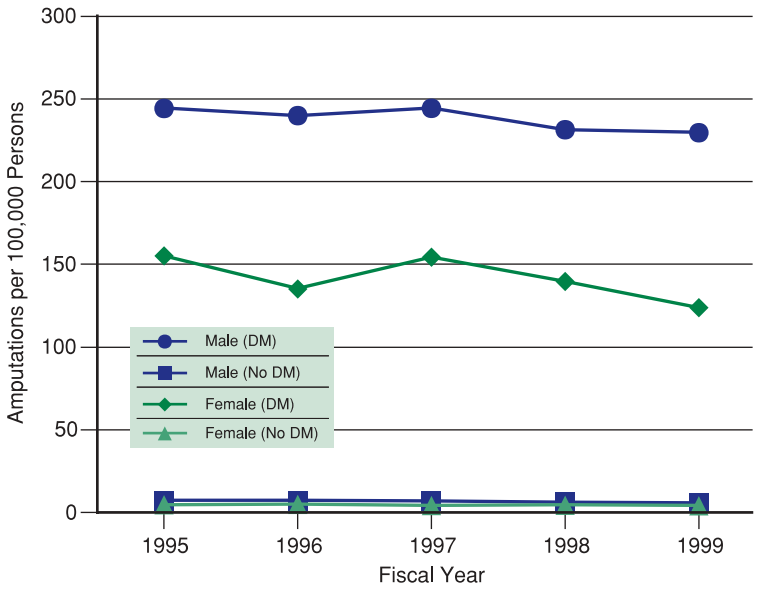
Fiscal Year	DM Status	Overall Men & Women		Women by Age Group					Men by Age Group				
		Rate	n	20–49	50–64	65–74	75+	Overall	20–49	50–64	65–74	75+	Overall
1995	DM	202	751	43.3	100.4	163.4	333.9	155	62.8	170.8	369.2	485.9	244
	No DM	6	467	0.2	2.5	12.9	45.0	5	0.7	7.6	35.0	63.2	7
1996	DM	190	772	27.5	101.7	176.4	240.4	135	44.8	187.8	361.1	457.7	240
	No DM	6	487	0.5	3.3	13.2	42.8	5	0.8	9.3	31.4	63.4	7
1997	DM	201	886	49.9	101.2	186.5	293.8	155	70.0	155.6	374.9	496.9	245
	No DM	6	457	0.2	3.0	10.0	40.2	5	0.6	6.1	33.8	69.1	7
1998	DM	187	894	34.3	101.5	180.5	251.1	140	81.4	167.4	328.8	441.8	232
	No DM	5	433	0.3	3.4	11.4	38.1	5	0.9	7.9	22.6	55.3	6
1999	DM	179	920	24.6	78.4	155.0	250.9	124	56.5	167.4	315.5	486.4	230
	No DM	5	410	0.3	2.5	10.7	36.6	4	0.6	6.1	27.0	50.5	6
Odds Ratio Crude*		35.29 (31.41–39.65)		82.54 (34.63–196.76)	31.49 (18.92–52.41)	14.52 (10.02–21.05)	6.88 (5.36–8.82)	28.87 (24.01–34.71)	100.92 (54.97–185.29)	27.34 (19.75–37.83)	11.70 (9.06–15.10)	9.67 (7.52–12.43)	39.07 (33.58–45.45)
Odds Ratio Adjusted*		14.18 (12.56–16.00)						11.92 (9.87–14.41)					15.87 (13.55–18.58)

Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995. *Odds Ratios (95% CI) are only for 1999.

amputations or ABS were documented. Since lower extremity PTA is not clearly associated with a specific CCP code, OHIP billing codes were used instead. Although the selected OHIP code is not exclusively used to indicate lower extremity PTA—it has been used for renal angioplasty in the past, and currently is also used for upper extremity and carotid PTA—it is estimated that over 85% of these codes refer to PVD. (See Technical Appendix TA6.A for a list of relevant CCP and OHIP codes.)

Exhibit 6.4 Age-/Sex-specific Major Amputation Rates per 100,000 Ontarians with/without DM Aged 20 Years and Over, 1995–1999

Rates of major amputation were higher (14-fold) in persons with DM and were higher in men of all ages.



Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Minor amputations included those at the level of the foot or below, and major amputations, from the ankle to the thigh. In order to limit the procedures to those performed only for PVD, other causes, such as trauma or malignancy, were excluded in the event these diseases were documented as a primary or most responsible diagnosis (see Technical Appendix TA6.A for the list of excluded ICD-9 codes.)

Annual rates of procedures for PVD are presented for each age and sex category. Each of these tables compares rates in persons with and without DM. Furthermore, annual age- and sex-adjusted rates of these procedures are presented at the regional (Ministry of Health and Long-term Care [MOHLTC] planning regions), district health council (DHC), and/or county level, depending upon the analysis. In some instances, the number of individuals who had a particular procedure within a given

Exhibit 6.5 Age-/Sex-adjusted Rates for Minor, Major and Total Amputations per 100,000 Ontarians with/without DM Aged 20 Years and Over, 1995–1999

Combined amputation rates declined by about 20% in the diabetic population, essentially due to the significant decrease in minor amputation.

Fiscal Year	Minor Amputation				Major Amputation				Total Amputation			
	Crude		Adjusted		Crude		Adjusted		Crude		Adjusted	
	DM	No DM	DM	No DM	DM	No DM	DM	No DM	DM	No DM	DM	No DM
1995	158.3	3.6	103.8	4.1	201.5	6.1	112.1	7.1	326.2	9.3	194.9	10.7
1996	139.5	2.9	91.2	3.2	189.7	6.3	98.7	7.2	292.6	8.8	170.0	9.9
1997	143.9	2.4	98.2	2.7	201.1	5.8	115.2	6.7	312.6	7.9	191.7	9.1
1998	140.8	2.2	93.9	2.4	187.3	5.4	109.4	6.1	294.4	7.3	179.9	8.1
1999	111.9	2.3	74.7	2.6	178.7	5.1	95.2	5.7	265.6	7.2	156.0	8.1

Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

jurisdiction was too small to report. Results that were based on only a few events were suppressed to preserve confidentiality and to avoid imprecise rates that are obtained when the number of events is small. Therefore, in some of the regional analyses, annual procedure rates were averaged over the five-year period.

In Ontario, personal income is not available in administrative data sources. Therefore, neighbourhood median household income was attributed to the individuals studied. Neighbourhood income quintiles were obtained from 1996 census data at the level of the enumeration area.[16] This method defines quintiles separately for census metropolitan areas (CMA) or census agglomerations (CA) and areas not in any CMA or CA, so that the measure is relative to the larger area in which a person resides. Annual age- and sex-adjusted procedure rates are reported by income quintile.

Mortality rates for persons undergoing amputation and revascularization were calculated at 30 days and one year after the index procedure. Deaths were ascertained from the Registered Persons Data Base (RPDB) and CIHI discharge abstracts. Rates were adjusted for age, sex and for the presence of other medical conditions which might affect the risk of death using the Charlson-Deyo comorbidity index, a commonly applied method that uses indicators of major disease groups within hospital diagnostic codes to assign a level of comorbidity.[17]

Multivariate techniques (Cox proportional hazards models) were used to identify risk factors for undergoing any amputation during the five-year observation period. Factors that were tested included age, sex, socioeconomic status (SES), presence of other medical conditions (comorbidity), type of residential area (urban versus rural), geographic region of the province, and use of outpatient services. Individuals were categorized as having a regular provider of care if at least 50% of their primary care visits were to a single provider. Adjustment for the presence of other medical conditions that might affect outcomes was performed

Key Research Findings

- Adjusted rates of lower extremity amputation are about 20 times higher in persons with diabetes mellitus (DM) than persons without DM.
- Rates of minor amputation (below the ankle) fell by almost 30% between 1995 and 1999.
- Amputations were more frequent in men, in persons from low-income neighbourhoods, from northern Ontario and in those with low use of physician services.
- The need for amputation reflects generally poor health—30% of those undergoing amputation die within the following year.
- Rates of procedures to improve blood flow in the setting of peripheral vascular disease are almost five times higher in persons with DM compared to those without DM.

Guideline Excerpts:

- Foot examination in adults should be an integrated component of DM management and decreases risk of foot ulcers and amputation [Grade A, Level 1].
- Screening for peripheral neuropathy should be carried out annually to identify those at high risk of developing foot ulcers [Grade A, Level 1].

Exhibit 6.6 Five-year Averaged Age-/Sex-adjusted Total Amputation Rates per 100,000 Ontarians with DM Aged 20 Years and Over by County, 1995–1999

Marked regional variation in rates of amputation was observed across Ontario counties with a more than three-fold range between lowest and highest rate counties. Rates in the north were generally high.

Rate = per 100,000 persons	Crude Rate*	Adjusted Rate*
Algoma District	470	264
Brant County	359	220
Bruce County	358	367
Cochrane District	383	249
Dufferin County	283	163
Durham Regional Municipality	250	169
Elgin County	392	223
Essex County	254	160
Frontenac County	401	230
Grey County	408	252
Haldimand-Norfolk Regional Municipality	466	268
Haliburton County	285	235
Halton Regional Municipality	231	155
Hamilton-Wentworth Regional Municipality	324	182
Hastings County	355	213
Huron County	360	262
Kenora District	408	303
Kent County	367	228
Lambton County	420	273
Lanark County	266	119
Leeds and Grenville United Counties	459	242
Lennox and Addington County	215	117
Manitoulin District	521	248
Middlesex County	389	294
Muskoka District	348	201
Niagara Regional Municipality	360	231
Nipissing District	485	361
Northumberland County	293	217
Ottawa-Carleton Regional Municipality	264	168
Oxford County	359	262
Parry Sound District	554	312
Peel Regional Municipality	153	96
Perth County	546	287
Peterborough County	326	208
Prescott and Russell United Counties	239	157
Prince Edward County	423	473
Rainy River District	410	326
Renfrew County	362	204
Simcoe County	345	190
Stormont, Dundas and Glengarry United Counties	389	276
Sudbury District	400	277
Sudbury Regional Municipality	364	257
Thunder Bay District	456	278
Timiskaming District	398	270
Toronto Metropolitan Municipality	238	136
Victoria County	310	206
Waterloo Regional Municipality	360	218
Wellington County	389	250
York Regional Municipality	168	112

* rates averaged over the 5-year study period, rounded to whole numbers

Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

using the John Hopkins Ambulatory Care Groups (ACG) assignment software.[18, 19] Region of residence was based on the MOHLTC planning regions. There was no significant colinearity between any of the variables included in the model.

Small area rate variation (SARV) analysis was performed to compare hospitalization and procedure rates across regions of the province (a full discussion of SARV statistics appears in Chapter 2 Technical Appendix TA2.1).

Interpretative Cautions

The use of administrative data to identify PVD procedure rates has not been fully validated. Although attempts were made to exclude procedures that were performed for reasons other than as a consequence of PVD, the exact indication for the procedure cannot confidently be determined from these data. Administrative data may give an incomplete picture of the provision of these procedures in some parts of the province. Specifically, OHIP claims data for PTA are incomplete in the Kingston area where many specialists are reimbursed through an alternative funding program (AFP) rather than on a fee-for-service basis. CIHI records of surgical procedures will undercount the use of these services for areas in the northwest of the province, where specialty services may be referred to Winnipeg.

Another caveat is that the procedure rates presented here offer only a crude measure of the incidence and prevalence of symptomatic PVD in both the diabetic and non-diabetic populations. Persons who have only mild disease or whose symptoms are controlled by medication will not be accounted for by this method. Differences in procedure rates may be affected by many unmeasured non-patient factors including resource allocation, changing practice patterns and coding behaviours, as well as by patient factors which are not captured in administrative data.

In the case of PTA, a single OHIP billing code was used to identify all lower extremity PTAs due to PVD. OHIP claims data are not subject to the same quality controls as CIHI records and they contain much less diagnostic information.

Comparisons of outcomes, particularly between persons with and without DM, may be influenced by many other important clinical factors besides the presence of DM and accordingly these analyses do not measure the isolated impact of DM.

It may be of interest to examine what proportion of patients undergoing revascularization go on to require an amputation, particularly early amputation. Unfortunately neither the CIHI or OHIP data record which side (left or right) has been operated on so it would not be possible in most cases to attribute an amputation as an outcome of the revascularization procedure. Moreover, it is not possible to construct a cohort of persons with a similar degree of PVD treated medically who might serve as a comparator population.

Lastly, because this analysis is based on cross-sectional data, we can observe associations between outcomes but cannot fully establish causation. The lack of clinical data in the administrative claims prevents us from commenting on other important risk factors such as smoking, which may be significant contributors to the development of PVD.

Findings and Discussion

Amputations

Minor Amputations *(Exhibits 6.1 and 6.2)*

Between fiscal years 1995 and 1999, minor amputation rates for persons with DM decreased by about 29% from 158/100,000 people with DM in 1995 to 112/100,000 in 1999. Rates for minor amputations were much higher in the diabetic population compared to the non-diabetic population: after adjusting for differences in age and sex, in 1999 the odds of having a minor amputation were 24-fold greater in the persons with DM. Comparing rates in persons with and without DM for the individual age-sex categories confirms the pattern of early disease in the diabetic population with an odds ratio of 103 for women in the youngest group in 1999.

Rates of minor amputations increased with age both in persons with and without DM. Rates of minor amputation were much higher in men than women, an effect that was more marked in the diabetic population (155/100,000 vs 66/100,000 in 1999).

Minor amputations in persons with DM may relate primarily to the presence of soft tissue and bone infections not responsive to medical therapy rather than peripheral arterial disease. A decline in these rates, therefore, may reflect the adoption of effective preventive and management strategies for diabetic foot ulcers.

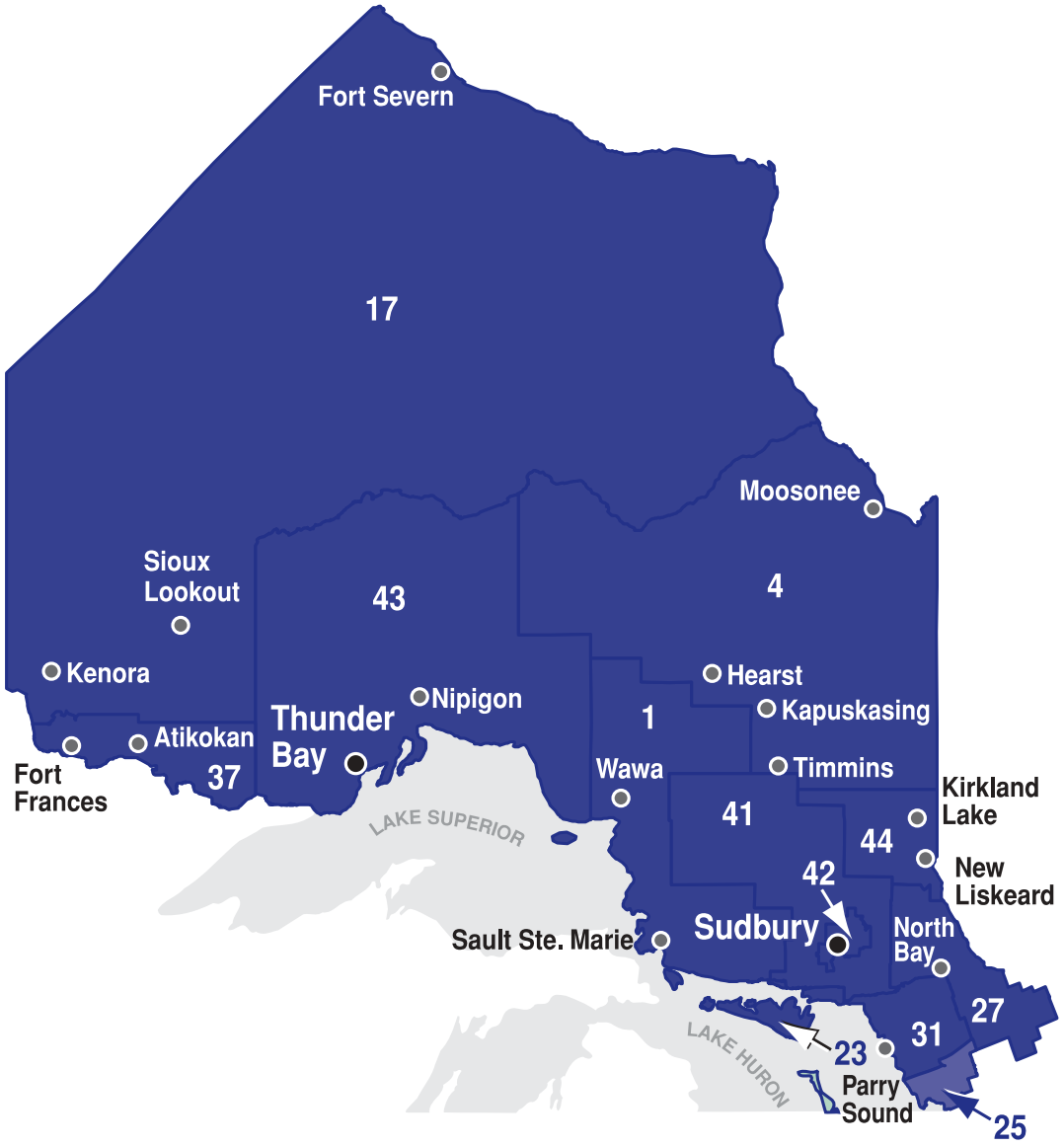
Major Amputations *(Exhibits 6.3 and 6.4)*

Major amputation rates remained relatively stable over the five-year interval. Rates increased with age and were significantly higher in men across all ages. As with minor amputation rates, major amputation rates were significantly higher in persons with DM: in 1999, the odds of amputation were 14-fold higher for persons with DM even after adjusting for differences in age and sex.

Combined Amputation Rates *(Exhibits 6.5–6.7)*

During the five-year period, combined amputation rates declined by about 20% in the diabetic population, essentially due to the significant decrease in minor amputations. Marked regional variation in rates of amputation was observed across

Exhibit 6.7a Age-/Sex-adjusted Amputation Rates per 100,000 Ontarians with DM Aged 20 Years and Over by County, Northern Ontario, 1995–1999



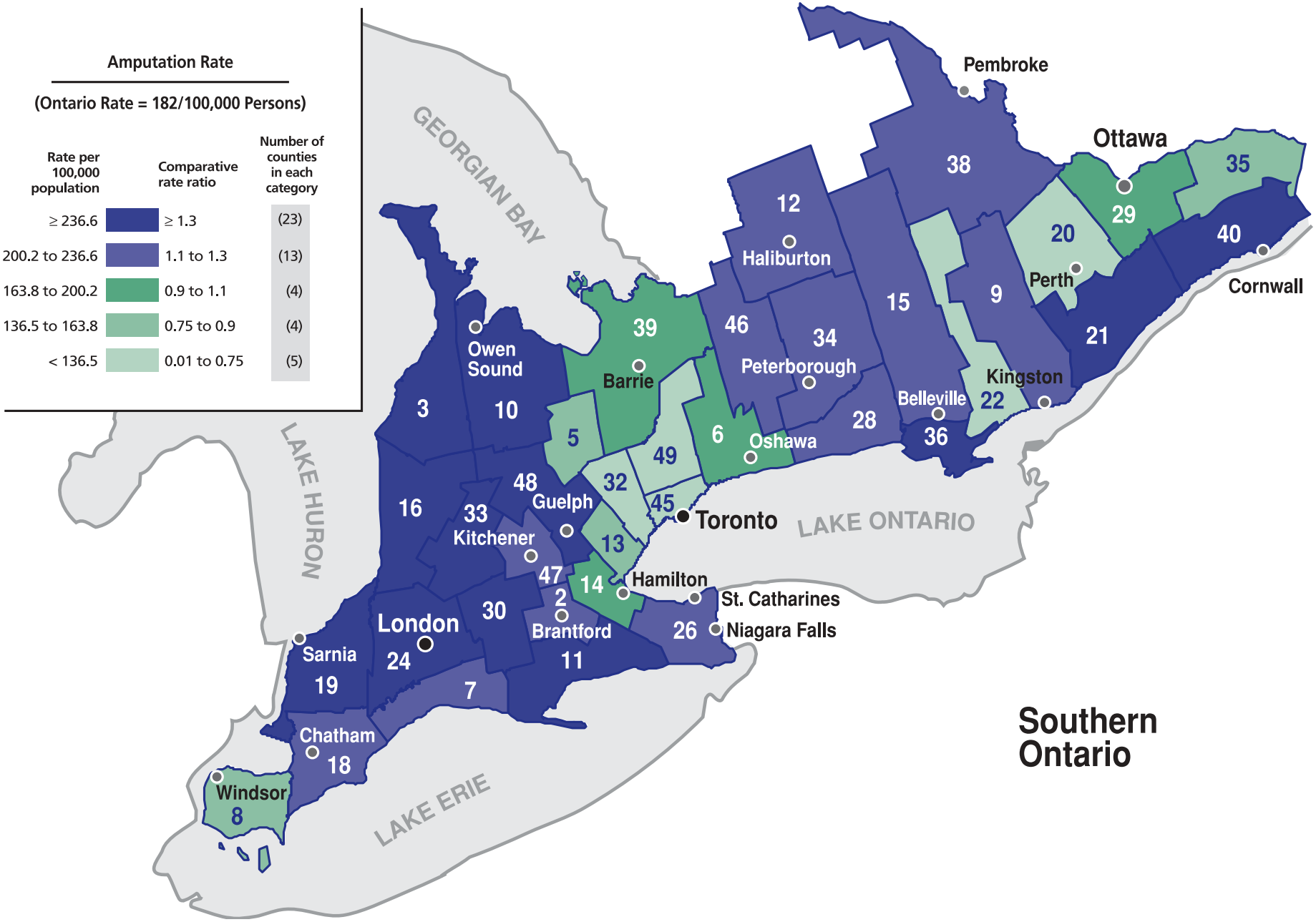
Ontario Counties

1 Algoma District
2 Brant County
3 Bruce County
4 Cochrane District
5 Dufferin County
6 Durham Regional Municipality
7 Elgin County
8 Essex County
9 Frontenac County
10 Grey County
11 Haldimand-Norfolk Regional Municipality
12 Haliburton County
13 Halton Regional Municipality
14 Hamilton-Wentworth Regional Municipality
15 Hastings County
16 Huron County
17 Kenora District
18 Kent County
19 Lambton County
20 Lanark County
21 Leeds and Grenville United Counties
22 Lennox and Addington County
23 Manitoulin District
24 Middlesex County
25 Muskoka District
26 Niagara Regional Municipality
27 Nipissing District
28 Northumberland County
29 Ottawa-Carleton Regional Municipality
30 Oxford County
31 Parry Sound District
32 Peel Regional Municipality
33 Perth County
34 Peterborough County
35 Prescott and Russell United Counties
36 Prince Edward County
37 Rainy River District
38 Renfrew County
39 Simcoe County
40 Stormont, Dundas and Glengarry United Counties
41 Sudbury District
42 Sudbury Regional Municipality
43 Thunder Bay District
44 Timiskaming District
45 Toronto Metropolitan Municipality
46 Victoria County
47 Waterloo Regional Municipality
48 Wellington County
49 York Regional Municipality

Note: See Exhibit 6.7b for Legend.

Source: Ontario Diabetes Database (ODD)

Exhibit 6.7b Age-/Sex-adjusted Amputation Rates per 100,000 Ontarians with DM Aged 20 Years and Over by County, Southern Ontario, 1995–1999



Note: See Exhibit 6.7a for County definitions.

Source: Ontario Diabetes Database (ODD)

Ontario counties with greater than three-fold range between lowest and highest rate counties. Rates in the north were generally high. The lowest observed rate was 153/100,000 in Peel. This county was previously noted to have very high prevalence of DM (Chapter 1), a finding which was attributed to South Asian immigration. While immigrants from this region are at higher risk of DM, those with DM have been reported to be at a lower risk for peripheral vascular disease and amputation.[20, 21]

Amputation Associated Factors (Exhibits 6.8–6.11)

Characteristics of the patients undergoing amputation are shown in Exhibit 6.8. Amputation rates are highest in the lowest socioeconomic (SES) quintile and disproportionately high rates are again seen in men with DM.

The independent effects of these various factors on amputation rates were examined using a Cox regression model. The relative risks (RR) for each risk factor, when all the other factors are controlled for, are shown in Exhibit 6.11. As described earlier, age was an important predictor, with the risk for persons aged 65–74 about 3.6 times that of those under 35. Males have nearly twice the risk of amputation of females. Living in Northern Ontario increased the likelihood of having an amputation to about 1.5 times that of counterparts residing in Toronto. This finding may be related to reduced access to primary and specialist care, higher proportions of early onset DM among Aboriginal peoples and differential rates of other unmeasured risk factors such as smoking. Amputation rates were inversely related to SES. In other studies, lower SES has been shown to be associated with decreased access to primary care, decreased educational level and a decreased ability to advocate effectively for better care.[22]

Access to regular care was an important predictor of amputation. Persons with DM having more than two ambulatory care visits reduced their risk for amputation by over 30%. In addition, those having a regular source of primary care were found to be less likely to undergo amputation. This may reflect access to care, but also may be a marker for individuals and their supports who are more motivated to seek treatment and regular follow up, and be more committed to their care plans.

Mortality rates (Exhibit 6.12)

Lower extremity amputation is associated with a markedly increased risk of death. While some of the risk is temporally related to the surgery (30-day risk-adjusted mortality between 6% and 11%), the risk continues to rise, reaching about 30% at one year. This suggests that the need for an amputation is a marker for poor health status rather than the amputation itself directly precipitating death.

The observation that mortality rates are lower in persons with DM may appear surprising. However, it should not be taken to mean that the presence of DM is protective in this setting. Rather, it suggests that factors contributing to case-selection (the decision regarding who receives a particular procedure) may differ between the two populations. As noted above, minor amputations in persons with DM may reflect local infections in patients who do not have a significant degree of arterial disease. Since individuals without arterial disease are less likely to also have heart disease and other comorbidities, their survival profile may be different. At the other end of the disease spectrum, in a person with severe arterial disease and DM, the chance of wound healing and recovery may be rated to be so low that palliative care rather than surgery is offered. The exclusion of these very ill persons from the DM amputation group will tend to improve survival in that group relative to those free of DM. The impact of these various factors cannot be determined without more detailed clinical data.

Revascularization

Procedure Type (Exhibit 6.13)

For all procedure types, revascularization was more common in persons with DM than in those without. This effect was greatest in peripheral bypass procedures (femoropopliteal bypass) where adjusted rates were six to seven times greater in those with DM. Overall revascularization rates were relatively stable over the period of study however there was a slight shift away from aorto-femoral bypass surgery and toward PTA.

Revascularization Rates (Exhibits 6.14– 6.17a&b)

Rates of revascularization are higher in men than in women. Given that an even larger gender gradient was seen in amputation rates, the effect is attributed to differences in burden of disease rather than bias in access to surgical services. The overall odds of revascularization in 1999 were four to five times higher for persons with DM after adjusting for age and sex. However, in 1999, in the youngest group the odds ratio was much higher at 20. This finding is consistent with the premature onset of PVD known to be associated with DM. There was little change in revascularization rates over time.

Substantial regional variation was observed in revascularization rates. It should be noted that the low rates for the extreme northwest part of the province (Kenora and Rainy River Districts) represent incomplete data since persons living in those regions are routinely referred to Winnipeg for vascular surgery procedures. For the remainder of the province, up to three-fold variation in rates was observed. In the absence of more detailed clinical information, these data are somewhat difficult to interpret. For instance, lower rates of revascularization may indicate reduced access to vascular surgery services, may

Exhibit 6.8 Characteristics of Persons Undergoing Amputation by DM Status in Ontario, 1995–1999

	DM (n=5,640)	No DM (n=3,179)	P-value
Male—n (%)	3,736 (66%)	1,780 (56%)	<0.001
Mean age—years	68.01	71.36	<0.001
Income quintile n (%)			
Q1 (low)	1,399 (27%)	773 (27%)	0.192
Q2	1,196 (23%)	621 (22%)	
Q3	969 (19%)	561 (20%)	
Q4	912 (18%)	469 (16%)	
Q5 (high)	732 (14%)	442 (15%)	

Amputation rates are highest in the lowest socioeconomic (SES) quintile and disproportionately high rates are seen in men with DM.

Source: Ontario Diabetes Database (ODD)

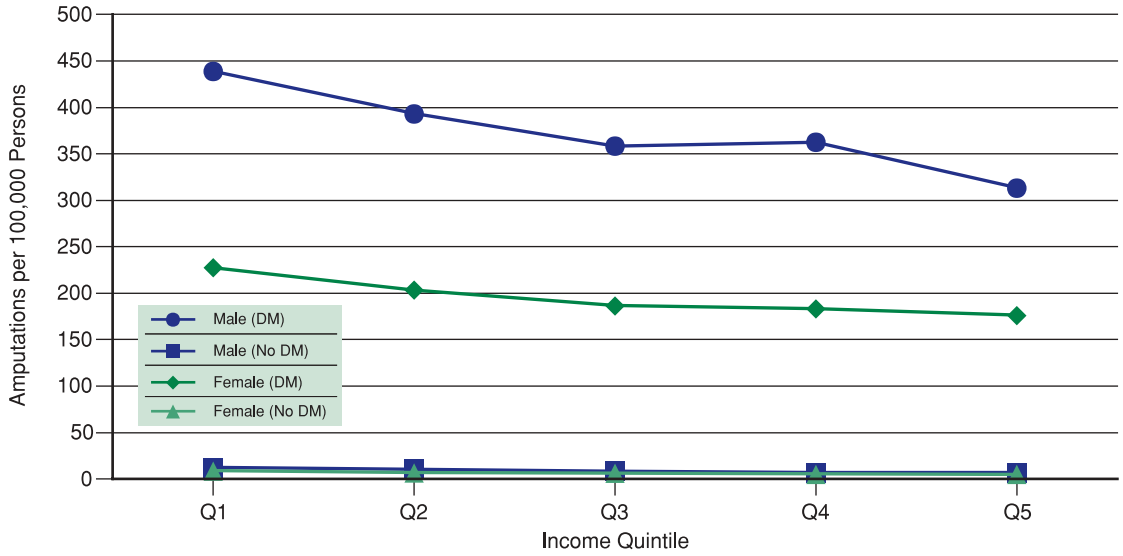
Exhibit 6.9 Five-year Averaged Age-/sex-specific Total Amputation Rates per 100,000 Ontarians with DM Aged 20 Years and Over by Residence Area Income Quintile, 1995–1999

Amputation rates are highest in the lowest income quintile and in men with DM.

Income Quintile	DM Status	Overall Men & Women		Women by Age Group					Men by Age Group				
		Rate	n	20–49	50–64	65–74	75+	Overall	20–49	50–64	65–74	75+	Overall
Q1 (low)	DM	328.8	342	87.5	181.4	282.6	376.4	227.7	141.3	403.6	699.1	616.1	439.1
	No DM	10.5	165	0.9	8.9	19.4	62.1	8.7	1.9	19.4	57.4	93.2	12.4
Q2	DM	300.5	284	72.3	156.3	249.7	346.9	203.6	144.5	322.1	538.3	688.3	393.3
	No DM	8.6	134	0.8	4.7	17.7	50.6	6.8	1.5	11.4	46.3	84.9	10.5
Q3	DM	277.6	240	54.2	162.9	213.2	328.7	186.5	113.0	267.1	494.4	705.2	358.7
	No DM	7.5	115	0.8	5.8	17.0	48.8	6.5	1.6	9.0	32.6	73.2	8.5
Q4	DM	281.6	212	57.8	149.4	212.7	346.3	183.4	135.0	274.5	536.6	649.2	362.8
	No DM	6.0	91	0.6	3.7	17.2	46.8	5.3	1.5	6.8	28.2	58.8	6.8
Q5 (high)	DM	253.9	170	62.5	120.3	204.8	332.1	176.2	88.2	233.4	445.4	574.2	313.4
	No DM	5.9	92	0.6	2.7	14.1	47.5	5.3	1.0	4.3	25.7	66.4	6.7

Source: Ontario Diabetes Database (ODD). *Odds Ratios are only for 1998/99. Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 6.10 Age-/sex-specific Total Amputation Rates per 100,000 Ontarians with DM Aged 20 Years and Over by Residence Area Income Quintile, 1995–1999



Source: Ontario Diabetes Database (ODD)

Exhibit 6.11 Factors Associated with Amputation Among Ontarians with DM*

Older age, male sex, lack of access to regular care, and living in Northern Ontario increased the likelihood of having an amputation .

Variable (n=313,575)	%	Relative Risk	95% Confidence Interval	P-value
Age at April 1st, 1994, years				
<35	5.4	1.00		
35–49	16.1	2.45	(1.89–3.17)	<.001
50–64	32.7	3.27	(2.54–4.20)	<.001
65-74	27.8	3.63	(2.83–4.67)	<.001
75+	18.0	2.82	(2.18–3.63)	<.001
Male	51.9	1.71	(1.62–1.82)	<.001
Rural Residence	15.9	1.06	(0.98–1.14)	0.14
Region				
Toronto	27.3	1.00		
South West	14.5	1.26	(1.51–1.38)	<.001
Central West	13.1	1.07	(0.96–1.18)	0.22
Central South	10.5	1.22	(1.11–1.35)	<.001
Central East	13.1	1.09	(0.99–1.20)	0.10
East	12.9	1.22	(1.11–1.34)	<.001
North	8.7	1.48	(1.34–1.64)	<.001
Neighbourhood Income Quintile				
Q1	24.9	1.32	(1.21–1.45)	<.001
Q2	22.3	1.23	(1.12–1.35)	<.001
Q3	20.1	1.17	(1.06–1.29)	<.001
Q4	17.2	1.15	(1.04–1.27)	0.01
Q5	15.5	1.00		
Previous MI (Fiscal 1991–1993	2.7	0.91	(0.80–1.04)	0.17
Number of Ambulatory Care Visits				
0–2	18.1	1.00		
3–5	21.6	0.70	(0.63–0.77)	<.001
6–8	19.7	0.68	(0.61–0.75)	<.001
9–11	14.7	0.65	(0.58–0.72)	<.001
12+	26.0	0.73	(0.67–0.8)	<.001
Regular Source of Care	90.2	0.87	(0.79–0.96)	0.01

* Cox proportional hazards model; Cohort of Ontarians with DM alive on April 1st, 1994 and followed up to March 31, 2000.

Of the 313,575 prevalent cases of DM

5,235 (1.67%) had an amputation in the followup window
67,518 (21.53%) died before having an amputation in the followup window
240,822 (76.80%) neither died nor had an amputation in the followup window

Source: Ontario Diabetes Database (ODD). Note: Comorbidity adjusted for using ACG Classification.

Exhibit 6.12 Thirty-day and One-year Mortality Rates for Persons Undergoing Amputation by DM Status and Gender in Ontario, 1995–1999

Lower extremity amputation is associated with a markedly increased risk of death (both at 30 days and one year), suggesting that the need for amputation is a marker for poor health status.

Gender/DM Status	30-day Mortality		1-year Mortality	
	Number of Cases	Risk-adjusted Rate*	Number of Cases	Risk-adjusted Rate
Men				
Overall	430		1,513	
DM	248	6.93 (6.04–7.82)	994	27.52 (26.11–28.94)
No DM	182	11.21 (9.88–12.53)	519	33.26 (31.08–35.44)
Women				
Overall	299		1,067	
DM	145	6.87 (5.72–8.01)	600	27.60 (25.84–29.35)
No DM	154	10.23 (8.86–11.60)	467	31.70 (29.51–33.89)
All Patients				
Overall	729		2,580	
DM	393	6.91 (6.20–7.61)	1594	27.55 (26.45–28.65)
No DM	336	10.74 (9.79–11.69)	986	32.50 (30.96–34.05)

Source: Ontario Diabetes Database (ODD). * Adjusted for age, sex and Charlson comorbidity score.

Exhibit 6.13 Age-/Sex-adjusted Revascularization Rates per 100,000 Ontarians with/without DM Aged 20 Years and Over, 1995–1999

Revascularization was more common in persons with DM, particularly peripheral bypass procedures (femoropopliteal bypass) where adjusted rates were six to seven times greater in those with DM.

Fiscal Year	Aorto-femoral bypass				Peripheral bypass				PTA				Revascularization			
	Crude		Adjusted		Crude		Adjusted		Crude		Adjusted		Crude		Adjusted	
	DM	No DM	DM	No DM	DM	No DM	DM	No DM	DM	No DM	DM	No DM	DM	No DM	DM	No DM
1995	30.9	5.5	20.8	5.9	200.1	14.1	105.8	15.9	158.3	17.2	104.8	18.9	363.2	34.9	216.5	38.6
1996	32.7	4.9	22.8	5.4	185.2	13.0	103.6	14.5	169.0	18.5	120.8	20.2	359.2	34.5	229.1	37.9
1997	33.6	5.2	24.9	5.6	193.2	13.5	106.1	15.1	162.3	18.1	105.5	19.7	361.4	34.4	216.9	37.9
1998	25.4	4.7	18.8	5.0	178.7	12.5	98.1	14.0	172.0	18.9	117.8	20.6	352.4	34.0	221.0	37.3
1999	24.1	4.5	17.8	4.9	169.8	11.7	92.6	13.1	182.6	19.5	134.4	21.2	351.4	33.7	228.6	37.0

Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 6.14 Overall and Age-/Sex-specific Revascularization Rates (Arterial Bypass Surgery and PTA) per 100,000 Ontarians with/without DM Aged 20 Years and Over, 1995–1999

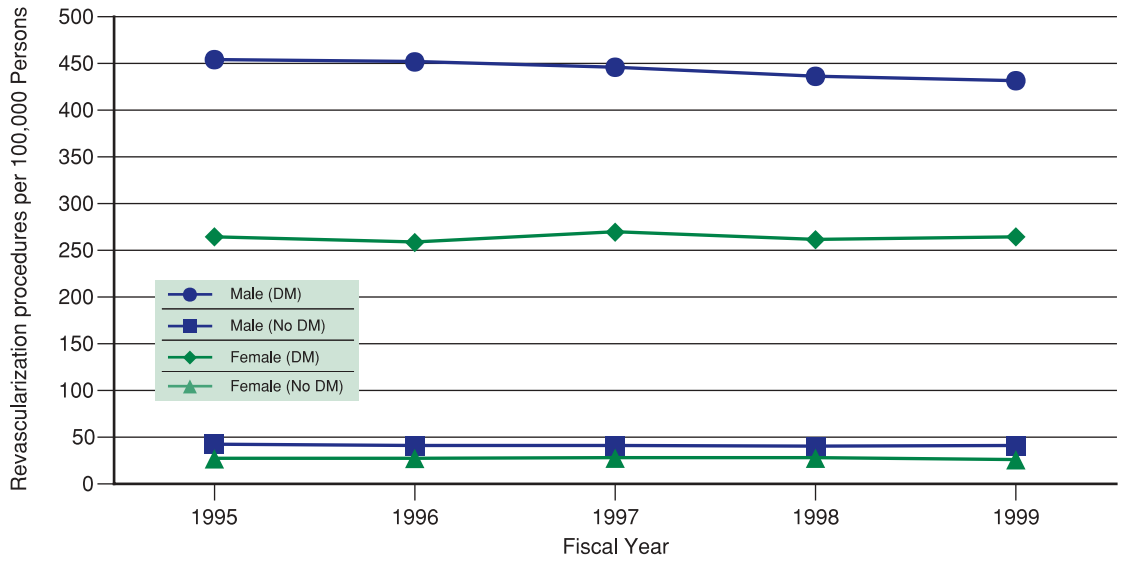
Rates of revascularization were higher in men than in women, an effect attributed to differences in burden of disease rather than bias in access to surgical services.

Fiscal Year	DM Status	Overall Men & Women		Women by Age Group					Men by Age Group				
		Rate	n	20–49	50–64	65–74	75+	Overall	20–49	50–64	65–74	75+	Overall
1995	DM	363.2	1,354	89.2	284.1	357.4	300.2	265.0	127.9	421.1	676.3	650.3	454.6
	No DM	34.9	2,684	5.0	46.6	96.7	93.6	27.3	8.6	89.5	172.9	161.8	43.0
1996	DM	359.2	1,462	130.5	231.5	364.1	297.0	258.9	140.5	454.2	692.0	506.4	452.2
	No DM	34.5	2,679	6.3	42.6	96.1	98.1	27.8	8.4	84.7	180.4	134.3	41.6
1997	DM	361.4	1,592	74.8	254.7	408.6	323.8	269.9	147.6	421.0	708.5	505.8	446.5
	No DM	34.4	2,708	6.1	37.1	108.6	100.8	28.0	9.0	77.0	170.7	166.2	41.3
1998	DM	352.4	1,682	112.5	232.9	384.4	310.0	261.9	143.4	391.3	691.6	546.2	436.8
	No DM	34.0	2,710	6.2	37.4	100.7	108.4	28.0	7.9	74.6	169.3	173.0	40.5
1999	DM	351.4	1,809	115.8	239.2	389.1	310.5	264.9	167.8	385.8	629.5	596.4	432.1
	No DM	33.7	2,725	5.7	37.5	98.4	92.4	26.3	8.3	72.8	174.9	187.1	41.6
Odds Ratio Crude*		10.46 (9.85–11.10)		20.34 (15.26–27.18)	6.40 (5.31–7.71)	3.97 (3.37–4.67)	3.37 (2.79–4.07)	10.09 (9.16–11.11)	20.37 (16.10–25.78)	5.31 (4.66–6.06)	3.62 (3.18–4.11)	3.20 (2.71–3.78)	10.44 (9.68–11.26)
Odds Ratio Adjusted*		4.69 (4.41–4.99)						4.91 (4.44–5.43)					4.56 (4.21–4.93)

Source: Ontario Diabetes Database (ODD). *Odds Ratios (95%CI) are only for 1999. Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 6.15 Age-/Sex-specific Revascularization Rates (Arterial Bypass Surgery and PTA) per 100,000 Ontarians with/without DM Aged 20 Years and Over, 1995–1999

There was little change in revascularization rates over the study period.



Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 6.16 Five-year Averaged Age-/Sex-adjusted Revascularization Rates per 100,000 Ontarians with/without DM Aged 20 Years and Over by County, 1995–1999

Substantial regional variation was observed in revascularization rates.

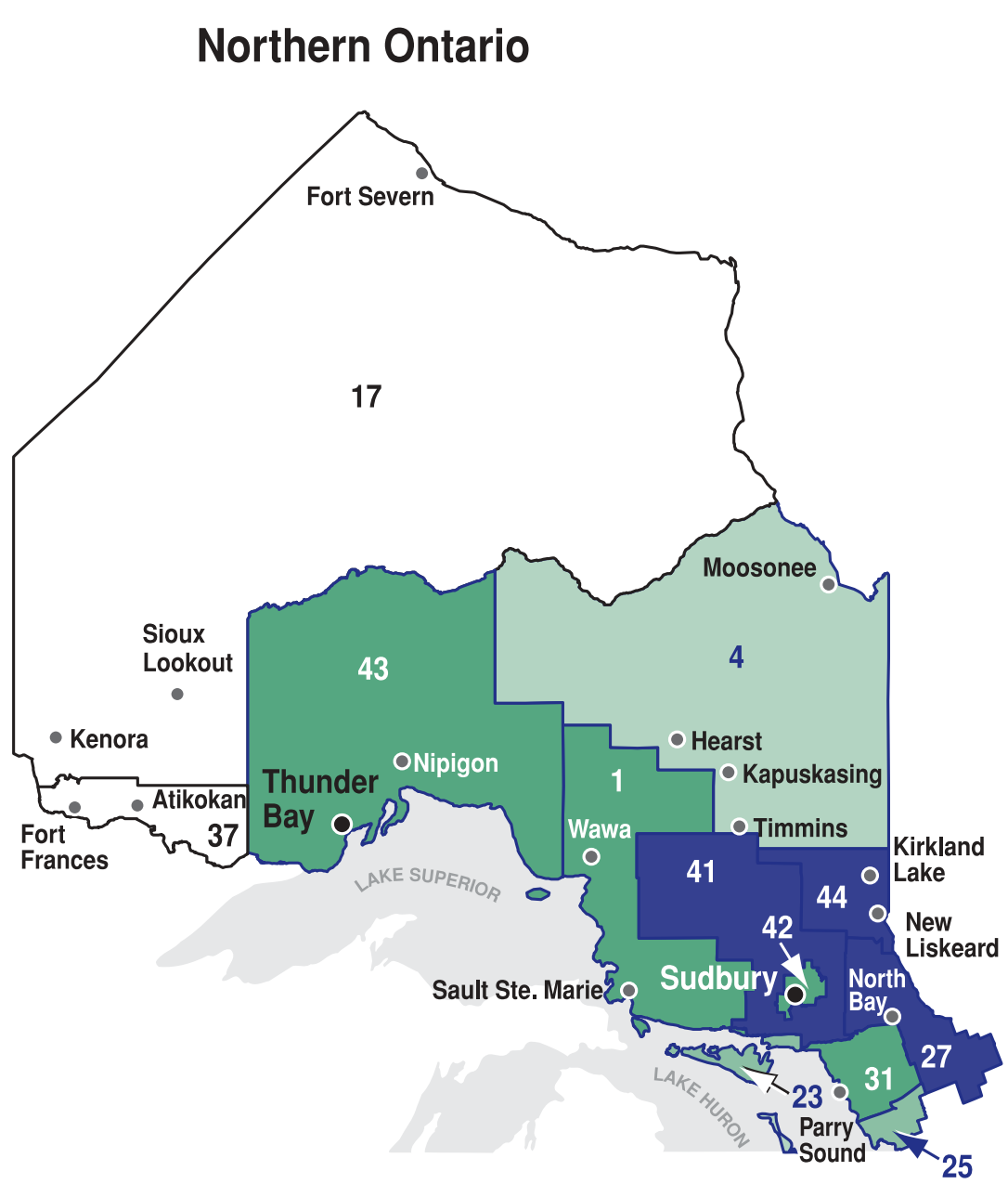
Rate = per 100,000 persons	Crude Rate*	Adjusted Rate*
Algoma District	356	231
Brant County	534	331
Bruce County	318	159
Cochrane District	293	171
Dufferin County	516	266
Durham Regional Municipality	303	204
Elgin County	332	251
Essex County	283	169
Frontenac County	434	322
Grey County	414	198
Haldimand-Norfolk Regional Municipality	435	237
Haliburton County	475	315
Halton Regional Municipality	340	201
Hamilton-Wentworth Regional Municipality	470	310
Hastings County	439	329
Huron County	290	217
Kenora District ▲	72	41
Kent County	460	270
Lambton County	395	241
Lanark County	302	156
Leeds and Grenville United Counties	310	189
Lennox and Addington County	287	250
Manitoulin District	379	183
Middlesex County	372	236
Muskoka District	440	189
Niagara Regional Municipality	380	240
Nipissing District	474	331
Northumberland County	388	243
Ottawa-Carleton Regional Municipality	359	250
Oxford County	304	282
Parry Sound District	468	234
Peel Regional Municipality	277	189
Perth County	261	140
Peterborough County	661	452
Prescott and Russell United Counties	385	239
Prince Edward County	300	308
Rainy River District ▲	171	81
Renfrew County	373	221
Simcoe County	583	389
Stormont, Dundas and Glengarry United Counties	329	224
Sudbury District	652	347
Sudbury Regional Municipality	419	238
Thunder Bay District	398	239
Timiskaming District	501	350
Toronto Metropolitan Municipality	342	220
Victoria County	403	219
Waterloo Regional Municipality	266	153
Wellington County	318	229
York Regional Municipality	253	181

* rates averaged over the 5-year study period, rounded to whole numbers

▲ = measured rates do not include procedures referred to Winnipeg

Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 6.17a Age-/Sex-adjusted Revascularization Rates per 100,000 Ontarians with DM Aged 20 Years and Over by County, Northern Ontario, 1995–1999



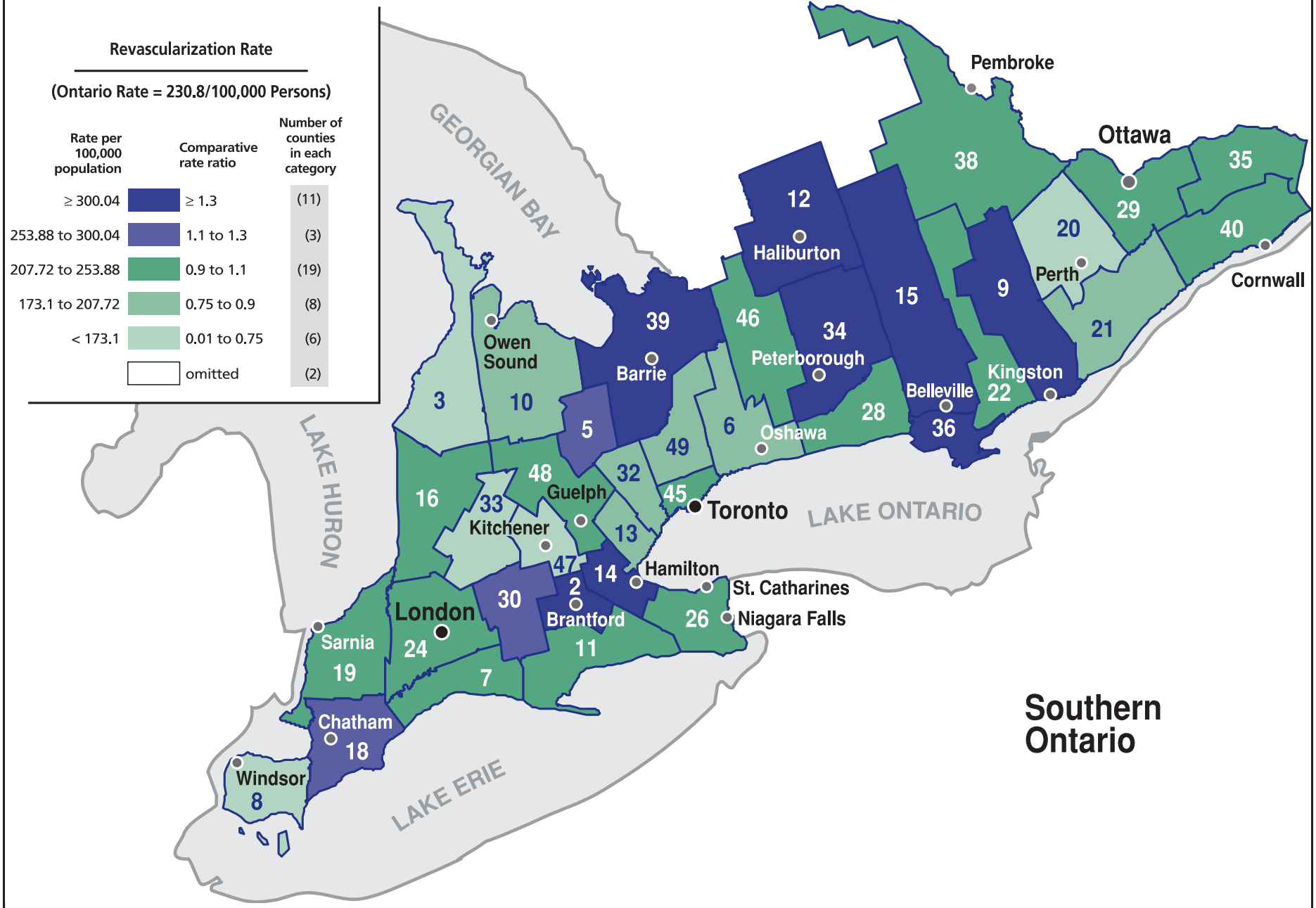
Ontario Counties

1 Algoma District
2 Brant County
3 Bruce County
4 Cochrane District
5 Dufferin County
6 Durham Regional Municipality
7 Elgin County
8 Essex County
9 Frontenac County
10 Grey County
11 Haldimand-Norfolk Regional Municipality
12 Haliburton County
13 Halton Regional Municipality
14 Hamilton-Wentworth Regional Municipality
15 Hastings County
16 Huron County
17 Kenora District
18 Kent County
19 Lambton County
20 Lanark County
21 Leeds and Grenville United Counties
22 Lennox and Addington County
23 Manitoulin District
24 Middlesex County
25 Muskoka District
26 Niagara Regional Municipality
27 Nipissing District
28 Northumberland County
29 Ottawa-Carleton Regional Municipality
30 Oxford County
31 Parry Sound District
32 Peel Regional Municipality
33 Perth County
34 Peterborough County
35 Prescott and Russell United Counties
36 Prince Edward County
37 Rainy River District
38 Renfrew County
39 Simcoe County
40 Stormont, Dundas and Glengarry United Counties
41 Sudbury District
42 Sudbury Regional Municipality
43 Thunder Bay District
44 Timiskaming District
45 Toronto Metropolitan Municipality
46 Victoria County
47 Waterloo Regional Municipality
48 Wellington County
49 York Regional Municipality

Note: See Exhibit 6.17b for Legend.

Source: Ontario Diabetes Database (ODD)

Exhibit 6.17b Age-/Sex-adjusted Revascularization Rates per 100,000 Ontarians with DM Aged 20 Years and Over by County, Southern Ontario, 1995–1999



Note: See Exhibit 6.17a for County definitions.

Source: Ontario Diabetes Database (ODD)

Exhibit 6.18 Characteristics of Patients Undergoing Revascularization by DM Status in Ontario, 1995–1999

	DM (n=6,534)	No DM (n=12,125)	P-value
Male—n (%)	4,188 (64%)	7,167 (59%)	<0.001
Mean age—years	66.67	64.23	<0.001
Income quintile n (%)			
Q1 (low)	1,674 (26%)	2,858 (24%)	0.001
Q2	1,428 (23%)	2,575 (22%)	
Q3	1,256 (20%)	2,382 (20%)	
Q4	1,039 (16%)	2,073 (17%)	
Q5 (high)	965 (15%)	1,998 (17%)	

There is a disproportionately high rate of revascularization in men with DM.

Source: Ontario Diabetes Database (ODD)

Exhibit 6.19 Five-year Averaged Age-/Sex-specific Revascularization Rates per 100,000 Ontarians with/without DM Aged 20 Years and Over by Residence Area Income Quintile, 1995–1999

Persons in low income neighbourhoods were more likely to require revascularization procedures, particularly at younger ages.

Income Quintile	DM Status	Overall Men & Women		Women by Age Group					Men by Age Group				
		Rate	n	20–49	50–64	65–74	75+	Overall	20–49	50–64	65–74	75+	Overall
Q1 (low)	DM	390.4	409	133.6	293.0	414.8	300.5	287.8	157.6	519.3	808.0	562.0	502.2
	No DM	41.3	650	7.7	57.8	121.7	106.0	33.5	10.7	116.8	224.8	186.2	49.6
Q2	DM	358.2	339	94.8	263.4	384.3	327.9	272.3	146.7	432.8	673.3	503.8	440.4
	No DM	37.3	580	5.9	45.4	109.1	103.9	29.8	8.9	95.4	179.2	177.6	45.2
Q3	DM	354.9	306	100.9	243.9	374.9	306.6	260.2	138.6	391.5	623.7	672.0	439.0
	No DM	33.8	520	6.0	38.9	91.4	95.1	26.1	8.8	77.9	180.7	152.5	41.9
Q4	DM	339.9	258	103.3	218.0	356.7	285.1	241.0	135.9	367.5	630.1	643.4	421.7
	No DM	30.9	467	5.6	37.4	90.5	103.6	24.7	7.0	69.7	158.8	165.8	37.4
Q5 (high)	DM	337.1	228	70.2	178.1	354.6	385.2	246.2	142.8	334.7	661.3	475.1	406.5
	No DM	27.9	431	4.1	27.2	83.7	99.3	22.2	6.7	51.7	131.8	155.7	33.9

Source: Ontario Diabetes Database (ODD)

reflect a local practice pattern which favours conservative medical management of PVD rather than revascularization, or may represent local use of effective interventions to reduce arterial disease.

Revascularization Associated Factors (Exhibits 6.18–6.20)

The characteristics of persons undergoing revascularization procedures are shown in Exhibits 6.18 to 6.20. As with amputations, for persons with DM there is a disproportionately high rate of revascularization in men. Persons in low income neighbourhoods were also more likely to require revascularization procedures, particularly at younger ages.

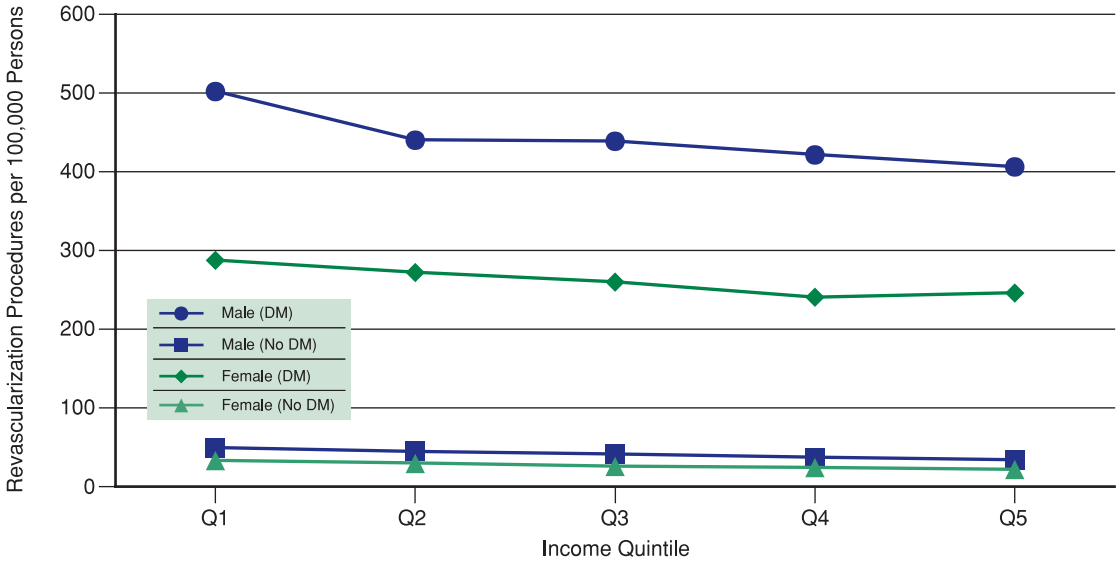
Mortality Rates (Exhibit 6.21)

Thirty-day mortality rates, which reflect the acute impact of the procedure, are similar in persons with and without DM at about 4%. At one year, mortality rates have increased to 13–14%, reflecting the magnitude of risk faced by persons who have extensive vascular disease. As seen above in the case of amputations, the failure to find higher rates of early mortality in persons with DM does not suggest that DM is protective in some way. Rather, it reflects case selection—for persons with DM to be considered for revascularization, they must have somewhat better general health status than persons from a corresponding non-diabetic population. Even for these more highly selected individuals, by the end of one year, the risk of death has exceeded that of persons free of DM undergoing the same procedures.

Conclusions

The heavy burden of PVD experienced by persons with DM has been confirmed in these data. Those with DM received surgical treatment for their vascular disease on average about 20 years earlier than those without DM. Similarly, procedure rates at any given age were found to be as much as 50–70 times higher in persons with DM than in those without the condition. Procedure rates for PVD in diabetic and non-diabetic persons were found to increase with age across all

Exhibit 6.20 Five-year Average Age-/Sex-specific Revascularization Rates per 100,000 Ontarians with/without DM Aged 20 Years and Over by Residence Area Income Quintile, 1995–1999



Source: Ontario Diabetes Database (ODD)

Exhibit 6.21 Thirty-day and One-year Mortality Rates for Ontarians with/without DM Undergoing Revascularization (excluding PTA) by Gender, 1995–1999

Thirty-day mortality rates, which reflect the acute impact of the procedure, are similar in persons with and without DM at about 4%. At one year, mortality rates have increased to 13–14%, reflecting the magnitude of risk faced by persons who have extensive vascular disease.

Gender/DM Status	30-day Mortality		1-year Mortality	
	Number of Cases	Risk-adjusted Rate	Number of Cases	Risk-adjusted Rate
Men				
Overall	255		922	
DM	128	3.85 (3.20–4.50)	483	14.09 (13.02–15.17)
No DM	127	3.94 (3.28–4.61)	439	13.39 (12.24–14.54)
Women				
Overall	157		532	
DM	63	3.44 (2.57–4.31)	250	14.07 (12.58–15.57)
No DM	94	4.27 (3.47–5.08)	282	13.47 (12.03–14.92)
All Patients				
Overall	412		1,454	
DM	191	3.71 (3.19–4.23)	733	14.09 (13.22–14.96)
No DM	221	4.08 (3.56–4.59)	721	13.42 (12.52–14.32)

Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

years and both sexes. As the population ages, the disease burden from PVD is likely to increase.

Males with and without DM typically underwent these procedures about twice as frequently as their female counterparts. An increased likelihood of amputation was also associated with northern residence and lower SES, suggesting that access to medical services may be a signficant contributor. Decreased rates of amputation in those persons with DM who had received regular medical care (at least three ambulatory care visits annually) and in those who saw the same provider regularly highlight the importance of access to care in preventing this serious complication.

Earlier findings in the Atlas demonstrated a 25% decrease in the rates of hospitalization for skin and soft tissue infections in persons with DM between 1995-1999.[23] This observation, together with the finding of decreased rates of minor amputations in persons with DM, suggests that recent evidence regarding the benefits of good foot care and regular foot exams is being translated into practice.[24]

The impact of PVD on the lives of those with DM is profound. This combination of diseases has an unfortunate synergy which results in a significant burden to individual and society alike. The importance of early detection, lifestyle risk factor modification and aggressive medical treatment will be the cornerstone of future efforts to prevent the vascular and other complications of DM and their subsequent resource and human costs.

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Technical Appendix (Exhibit TA6.A)

Relevant CCP and Excluded ICD-9 Codes.

Exhibit TA6.A Relevant CCP and Excluded ICD-9 Codes

Amputation (4/94–3/99)	
Minor	
96.11	**Amputation and disarticulation of toes:** partial or complete toe amputation
96.12	**Amputation and disarticulation of foot:** amputation below ankle, transmetatarsal amputation
Major	
96.13	**Amputation and disarticulation of ankle:** amputation of ankle through malleoli of tibia and fibula
96.14	**Amputation of lower leg:** below-knee amputation
96.15	**Amputation of thigh:** above-knee amputation
Exclusion ICD-9 Codes	• to limit amputations to those for PVD
170	**Malignant bone tumor**
171	**Malignant connective tissue tumor**
213	**Benign neoplasm of bone**
730	**Osteomyelitis**
740–759	**Congenital abnormalities**
800–900	**Trauma**
901–904	**Arterial injury**
940–950	**Burns**

Arterial Bypass Surgery	
CIHI	
51.25	**Aorto-iliac-femoral bypass:** aortofemoral, aortoiliac, aortopopliteal, iliofemoral
51.29	**Other (peripheral) shunt or bypass:** femoropopliteal, femoroperoneal, femorotibial, femoral-femoral, axillary-femoral
Exclusion ICD-9 Codes	• to limit to ABS for PVD
441.3–441.7	**Abdominal aortic aneurysm**
442.0, 442.2	**Iliac artery aneurysm**
442.3	**Lower extremity artery aneurysm**

Percutaneous Transluminal Angioplasty	
OHIP	• not specific—also used for renal angioplasty to 1994; currently also used for upper extremity and carotid PTA; estimated >85% used for PVD
J025	**Percutaneous transluminal angioplasty**
Exclusion OHIP Codes	• to limit PTAs to those for PVD, by removing renal/carotid angioplasties
593.8	**Renal vascular anomalies**
403	**Hypertensive renal disease**
584, 585, 586	**Renal failure (acute and chronic, uremia NOS)**
435	**Transient ischemic attack**
437	**Chronic arteriosclerotic cerebrovascular disease**

7

Chapter

Diabetes and Stroke

Authors: Moira K. Kapral, Deanna M. Rothwell, Kinwah Fung, Mei Tang, Gillian L. Booth and Andreas Laupacis

Key Messages

- Stroke risk is markedly increased in the presence of diabetes mellitus (DM), even in younger individuals. Health care professionals and patients should be aware of these risks, and should be attentive to the appropriate management of associated stroke risk factors.
- Stroke hospitalization rates in those with DM are declining over time. Further research is needed to determine whether this is due to changes in stroke incidence or stroke admission thresholds.

Background

Stroke is a leading cause of death and disability in Canada.[1] Diabetes mellitus (DM) increases the risk of stroke, and is a particularly potent stroke risk factor in younger individuals, with previous studies suggesting an increase in stroke risk of as much as 10-fold in some younger subgroups.[2,3,4] DM is associated with a higher prevalence of other stroke risk factors, including high blood pressure and high cholesterol,[5] and may increase the risk of stroke recurrence and mortality.[6,7] Despite the association between DM and stroke, the available data from clinical trials do not support the hypothesis that better blood sugar control decreases stroke risk.[6,8]

Carotid endarterectomy is a surgical procedure to remove atherosclerotic plaque from the carotid artery. Clinical trials have found that in appropriately selected individuals with previous stroke or transient ischemic attack (TIA), carotid endarterectomy substantially lowers the risk of future stroke or death compared to medical therapy.[9-11] It is not known whether carotid endarterectomy rates are different in those with and without DM. Perioperative complications may be more frequent in those with DM.[12]

This chapter will present analyses of stroke-related hospitalizations, outcomes (death, length of stay and discharge to complex continuing care institutions) and procedures (carotid endarterectomy) in Ontario, in people with and without DM, with stratification by age, sex, socioeconomic status and geographic region.

Data Sources

The Registered Persons Database (RPDB) was used to identify all individuals between the ages of 20 and 105 who were eligible for coverage under the Ontario Health Insurance Plan (OHIP) during the fiscal years 1995 to 1999. Persons with DM were identified using the Ontario Diabetes Database (ODD), which is described in detail in the Chapter 1 Technical Appendix TA1.A. Individuals in the RPDB who were not present in the ODD served as a non-diabetic comparison group. Creation of this cohort is described in Chapter 5 Technical Appendix TA5.A. Records of hospitalizations for stroke and carotid endarterectomy procedures were obtained from the Canadian Institute for Health Information (CIHI) discharge abstract database. Census data from Statistics Canada were used to obtain information on the socioeconomic status of residential neighbourhoods. These data were linked to other sources using postal code of residence as a common variable.

How the analysis was done

Annual stroke hospitalization rates were calculated from fiscal 1995 (April 1, 1994 to March 31, 1995) through fiscal 1999. The total number of persons with DM who were admitted with a stroke in a given year defined the numerator, while the denominator was the total number of persons with DM during the same time period.

Exhibit 7.1 Overall and Age-/Sex-specific Stroke Hospitalization Rates per 100,000 Ontarians with/without DM, 1995–1999

Stroke hospitalization rates are almost three-fold higher in individuals with DM compared to those without DM, and the relative increase in stroke risk is particularly marked in the younger age groups.

Fiscal Year	Diabetic Status	Overall Men & Women		Women by Age Group					Men by Age Group				
		Rate	n	20–49	50–64	65–74	75+	Overall	20–49	50–64	65–74	75+	Overall
1995	DM	1,214	4,526	147.8	575.8	1,427.5	2,846.8	1,203	177.3	738.0	1,661.5	3,290.8	1,225
	No DM	158	12,131	11.1	88.8	395.6	1,374.7	156	14.1	154.5	639.1	1,691.7	160
1996	DM	1,177	4,792	109.9	541.9	1,323.7	2,800.1	1,145	177.2	743.3	1,700.7	3,077.3	1,207
	No DM	154	11,972	11.6	94.6	373.9	1,344.5	155	14.4	147.0	590.0	1,639.9	154
1997	DM	1,151	5,071	116.4	579.6	1,303.9	2,706.4	1,134	136.2	691.4	1,639.9	3,073.2	1,167
	No DM	154	12,078	12.6	86.9	372.1	1,334.3	154	14.4	156.0	574.0	1,585.8	153
1998	DM	1,074	5,125	135.3	513.6	1,243.3	2,509.0	1,059	152.3	605.0	1,526.9	2,883.8	1,088
	No DM	150	11,906	11.9	80.6	347.2	1,334.5	151	15.2	142.2	548.7	1,527.3	148
1999	DM	1,015	5,222	82.5	467.4	1,130.9	2,487.5	999	164.4	594.8	1,405.3	2,688.7	1,029
	No DM	141	11,356	10.5	79.3	349.1	1,218.6	142	14.0	132.2	514.4	1,435.6	139
Odds Ratio Crude*		7.28 (7.05–7.53)		7.87 (5.78–10.72)	5.92 (5.19–6.75)	3.27 (2.98–3.5)	2.07 (1.94–2.20)	7.08 (6.75–7.42)	11.74 (9.40–14.65)	4.52 (4.08–5.01)	2.76 (2.54–2.99)	1.90 (1.77–2.04)	7.50 (7.16–7.85)
Odds Ratio Adjusted*†		2.67 (2.58–2.76)						2.67 (2.55–2.81)					2.66 (2.54–2.79)

Source: Ontario Diabetes Database (ODD). *Odds Ratios (95% CI) are only for 1999. Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995. †Adjusted for age and sex.

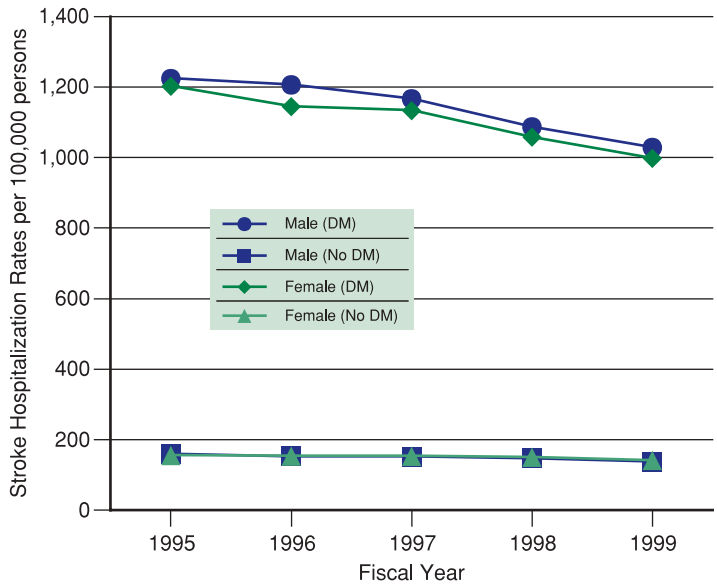
Records of admissions to acute care hospitals with a diagnosis of stroke were obtained from the CIHI discharge abstract database using ICD-9 codes 431, 434 and 436. Previous studies using these codes have established an accuracy rate of over 90% for the diagnosis of stroke.[13] Persons transferred from other facilities and those with stroke as an in-hospital complication were excluded from the analyses. For those persons with more than one stroke admission during the study time frame, only the first stroke admission was included in the analyses.

Annual stroke hospitalization rates were calculated for persons with and without DM, and were categorized by age, sex, socioeconomic status, and geographic region (county). In Ontario, personal income is not available in administrative data sources. Therefore, neighbourhood median household income was attributed to the individuals studied. Neighbourhoood level income quintiles were obtained from 1996 census data at the level of the enumeration area.[14] This method defines quintiles separately for census metropolitan areas (CMA) or census agglomerations (CA) and areas not in any CMA or CA, so that the measure is relative to the larger area in which a person resides.

Among stroke patients, median length of stay and rates of discharge to complex continuing care institutions were compared in persons with and

Exhibit 7.2 Age-/Sex-specific Hospitalization Rates for Stroke per 100,000 Ontarians with/without DM Aged 20 Years and Over, 1995–1999

There was a decline in stroke hospitalization rates over the study period in persons with and without DM.



Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 7.3 Overall and Five-year Average Age-/Sex-specific Stroke Hospitalization Rates per 100,000 Ontarians with/without DM by DM Status and Residence Area Income Quintile, 1995–1999

Stroke hospitalization rates in both those with and without DM were inversely related to socioeconomic status, with modestly increased stroke hospitalization rates seen in the lowest income quintiles.

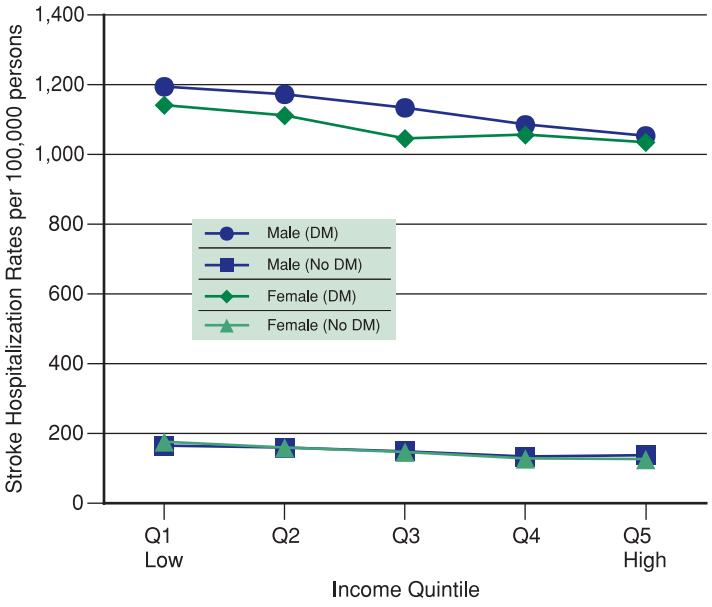
Income Quintile	Diabetic Status	Overall Men & Women		Women by Age Group					Men by Age Group				
		Rate	n	20–49	50–64	65–74	75+	Overall	20–49	50–64	65–74	75+	Overall
Q1 (low)	DM	1,166	1,215	145.9	636.4	1,405.8	2,586.8	1,141	164.9	779.1	1,736.7	3,131.8	1,194
	No DM	170	2,678	13.0	118.3	431.5	1,384.3	176	16.3	196.3	679.6	1,753.7	164
Q2	DM	1,143	1,078	124.9	521.4	1,304.0	2,703.5	1,111	150.7	706.9	1,638.4	3,018.0	1,172
	No DM	159	2,472	12.5	85.7	380.2	1,355.0	159	14.7	168.6	606.0	1,588.4	159
Q3	DM	1,092	938	91.8	501.9	1,179.4	2,679.3	1,045	155.2	682.0	1,487.9	3,078.9	1,134
	No DM	148	2,275	11.7	92.9	360.9	1,304.9	147	15.8	145.1	566.2	1,517.6	149
Q4	DM	1,072	804	101.6	489.4	1,198.6	2,860.0	1,056	179.1	609.3	1,572.2	2,965.0	1,085
	No DM	130	1,967	11.1	77.1	343.0	1,309.7	127	13.5	124.9	528.3	1,509.2	133
Q5 (high)	DM	1,045	707	98.5	426.8	1,198.4	2,611.0	1,035	153.8	564.3	1,419.1	2,807.8	1,053
	No DM	131	2,029	9.2	62.1	303.5	1,241.1	126	11.4	110.6	478.5	1,503.4	138

Source: Ontario Diabetes Database (ODD)

without DM, with stratification by stroke type (hemorrhagic and ischemic). Mortality rates following hospitalization for stroke were calculated at 30 days and one year after the index admission. Deaths were ascertained from the Registered Persons Data Base (RPDB) and CIHI discharge abstracts. Mortality rates after stroke were adjusted for age, sex, stroke type and comorbidity based on the Charlson-Deyo score, a commonly used method that uses indicators of major disease groups within hospital diagnostic codes to assign a level of comorbidity.[15]

Exhibit 7.4 Five-year Average Stroke Hospitalization Rates per 100,000 Ontarians with DM Aged 20 Years and Over by Residence Area Income Quintile, 1995–1999

Stroke hospitalization rates in both persons with/without DM were inversely related to socioeconomic status.



Source: Ontario Diabetes Database (ODD)

Admissions for carotid endarterectomy procedures within a year after the index admission were identified from CIHI records in which the Canadian Classification of Procedures (CCP) code was 50.12. Carotid endarterectomy rates per 100 patients with stroke were calculated for persons with and without DM, categorized by age and sex. Waiting times for carotid surgery were calculated using the time from stroke admission to the date of surgery.

Multivariate techniques (Cox proportional hazards models) were used to identify risk factors for suffering a stroke during the five-year observation period. Factors that were tested included age, sex, socioeconomic status (SES), presence of other medical conditions (comorbidity), type of residential area (urban versus rural), geographic region of the province, and use of outpatient services. Individuals were categorized as having a regular provider of care

if at least 50% of their primary care visits were to a single provider. Adjustment for the presence of other medical conditions that might affect outcomes was performed using the John Hopkins Ambulatory Care Groups (ACG) assignment software.[16,17] Region of residence was based on the Ontario Ministry of Health and Long-Term Care (MOHLTC) planning regions. There was no significant colinearity between any of the variables included in the model.

Small area rate variation (SARV) analysis compared hospitalization and procedure rates across regions of the province (a review of SARV statistics appears in Chapter 2 Technical Appendix TA2.1).

Interpretive Cautions

The analyses rely on administrative data, which lack information on important prognostic factors such as stroke subtype and severity. In addition, comorbid conditions may be miscoded. The analyses use neighbourhood income quintile as a marker of socioeconomic status, rather than individual level data, which may lead to misclassification of individual socioeconomic status. The CIHI database only captures hospital admissions, which would lead to under-reporting of stroke rates since it does not include patients with stroke or transient ischemic attack who were never admitted to hospital. It is not known whether any of these factors would lead to systematic bias in comparisons between individuals with and without DM. However, it is conceivable that a person with DM and minor stroke or TIA is more likely to be admitted to hospital than a person without DM with a similar stroke presentation. This could lead to higher stroke admission rates (and decreased stroke severity among admitted patients) in persons with DM relative to those without.

Trends in the control of risk factors, especially hypertension, are likely to be important determinants of stroke rates over time, and these were not evaluated in the current analyses. For the analyses of carotid endarterectomy rates, administrative data do not have information on the prevalence or degree of carotid stenosis or the indications for surgery, so one cannot comment on the appropriateness of the observed rates of surgery in this study population. In addition, waiting times for carotid endarterectomy are estimated based on the time between the index stroke admission and the date of surgery, and may not be an accurate reflection of the time interval from diagnosis or referral to surgery.

Findings and Discussion

Even after adjustment for age and sex, stroke risk was greatly increased in those with DM, with stroke hospitalization rates almost three-fold higher in individuals with DM than in those without (Exhibit 7.1). The diabetes-related stroke risk was particularly marked in the younger age groups, such that their stroke risk was similar to what would be expected in an older non-diabetic population. For example, the risk of stroke in a 20 to 49-year-old person with DM was greater than that of a 50 to 64-year-old

Key Research Findings

- Stroke hospitalization rates are approximately three-fold higher in those with diabetes mellitus (DM) compared to those without, and are even more markedly increased in younger age groups.
- Stroke hospitalization rates are decreasing over time.
- There are only minor regional variations in stroke hospitalization rates across Ontario.
- Older age, male sex, lower neighbourhood income quintile, previous myocardial infarction and comorbid illness are all associated with increased stroke admission rates; conversely, the presence of a regular source of care and the number of ambulatory care visits do not appear to affect stroke admission rates.
- After stroke admission, those with DM are at increased risk of death within 30 days or discharge to chronic care compared to those without DM.
- Men are more likely than women to undergo carotid endarterectomy after stroke.

Exhibit 7.5a Five-year Averaged Crude and Age-/Sex-adjusted Stroke Hospitalization Rates per 100,000 Ontarians *with DM* Aged 20 Years and Over by County, 1995–1999

Regional differences in hospitalization rates for stroke were not statistically significant in individuals with DM.

Rate = per 100,000 persons	Crude Rate*	Adjusted Rate*
Algoma District	1,364	679
Brant County	1,106	518
Bruce County	1,383	683
Cochrane District	973	521
Dufferin County	1,616	803
Durham Regional Municipality	944	524
Elgin County	1,568	726
Essex County	1,201	602
Frontenac County	1,066	546
Grey County	1,627	732
Haldimand-Norfolk Regional Municipality	1,146	584
Haliburton County	1,139	558
Halton Regional Municipality	1,032	536
Hamilton-Wentworth Regional Municipality	1,044	505
Hastings County	1,295	612
Huron County	1,369	507
Kenora District	822	539
Kent County	1,469	661
Lambton County	1,337	608
Lanark County	1,207	611
Leeds and Grenville United Counties	1,319	727
Lennox and Addington County	1,147	546
Manitoulin District	946	408
Middlesex County	881	409
Muskoka District	1,351	615
Niagara Regional Municipality	1,174	545
Nipissing District	1,484	780
Northumberland County	1,525	686
Ottawa-Carleton Regional Municipality	985	505
Oxford County	1,111	544
Parry Sound District	1,367	714
Peel Regional Municipality	860	515
Perth County	1,399	717
Peterborough County	1,289	606
Prescott and Russell United Counties	1,088	542
Prince Edward County	1,304	644
Rainy River District	1,451	732
Renfrew County	1,511	726
Simcoe County	1,255	648
Stormont, Dundas and Glengarry United Counties	1,119	546
Sudbury District	1,201	742
Sudbury Regional Municipality	844	458
Thunder Bay District	1,157	597
Timiskaming District	1,593	764
Toronto Metropolitan Municipality	1,102	551
Victoria County	1,183	487
Waterloo Regional Municipality	1,186	608
Wellington County	1,231	591
York Regional Municipality	912	510

* rates averaged over the 5-year study period, rounded to whole numbers

Source: Ontario Diabetes Database (ODD)

Exhibit 7.5b Five-year Averaged Age-/Sex-adjusted Stroke Hospitalization Rates per 100,000 Ontarians *without DM* Aged 20 Years and Over by County, 1995–1999

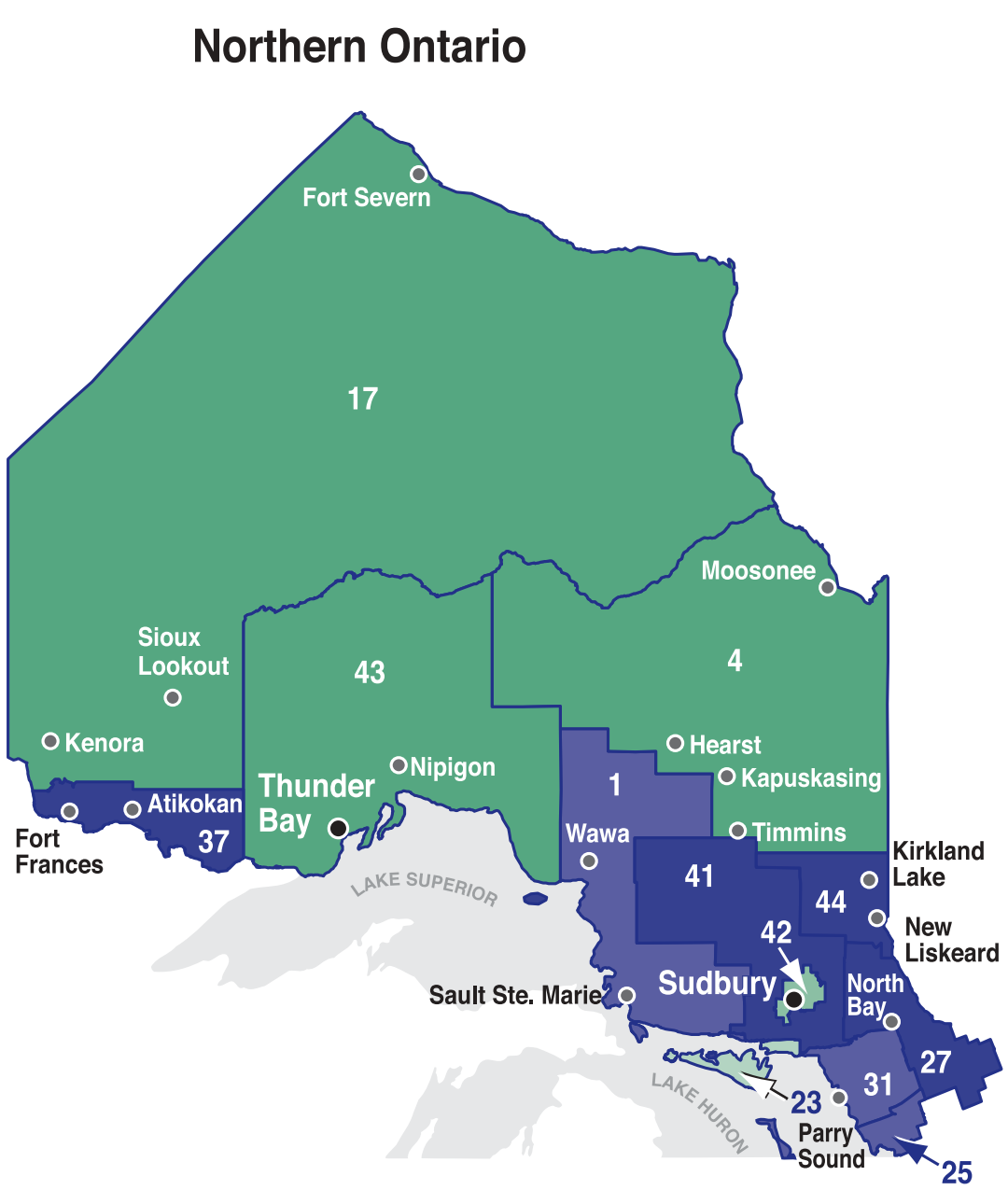
There were significant regional variations in stroke hospitalization rates in individuals without diabetes.

Rate = per 100,000 persons	Crude Rate*	Adjusted Rate*
Algoma District	179	195
Brant County	174	173
Bruce County	232	207
Cochrane District	157	195
Dufferin County	195	243
Durham Regional Municipality	120	168
Elgin County	213	205
Essex County	170	186
Frontenac County	140	143
Grey County	235	198
Haldimand-Norfolk Regional Municipality	190	192
Haliburton County	236	173
Halton Regional Municipality	133	159
Hamilton-Wentworth Regional Municipality	135	138
Hastings County	190	176
Huron County	239	197
Kenora District	142	178
Kent County	199	195
Lambton County	221	218
Lanark County	216	201
Leeds and Grenville United Counties	208	184
Lennox and Addington County	169	167
Manitoulin District	224	199
Middlesex County	118	131
Muskoka District	207	176
Niagara Regional Municipality	188	176
Nipissing District	188	198
Northumberland County	250	219
Ottawa-Carleton Regional Municipality	123	149
Oxford County	187	180
Parry Sound District	230	192
Peel Regional Municipality	88	149
Perth County	189	170
Peterborough County	199	170
Prescott and Russell United Counties	127	152
Prince Edward County	228	178
Rainy River District	195	187
Renfrew County	253	233
Simcoe County	164	172
Stormont, Dundas and Glengarry United Counties	188	179
Sudbury District	185	210
Sudbury Regional Municipality	132	156
Thunder Bay District	173	191
Timiskaming District	230	212
Toronto Metropolitan Municipality	149	171
Victoria County	204	172
Waterloo Regional Municipality	136	165
Wellington County	147	165
York Regional Municipality	105	158

* rates averaged over the 5-year study period, rounded to whole numbers

Source: Ontario Diabetes Database (ODD)

Exhibit 7.6a Age-/Sex-adjusted Stroke Hospitalization Rates per 100,000 Ontarians with DM, Aged 20 Years and Over, by County, Northern Ontario, 1995–1999



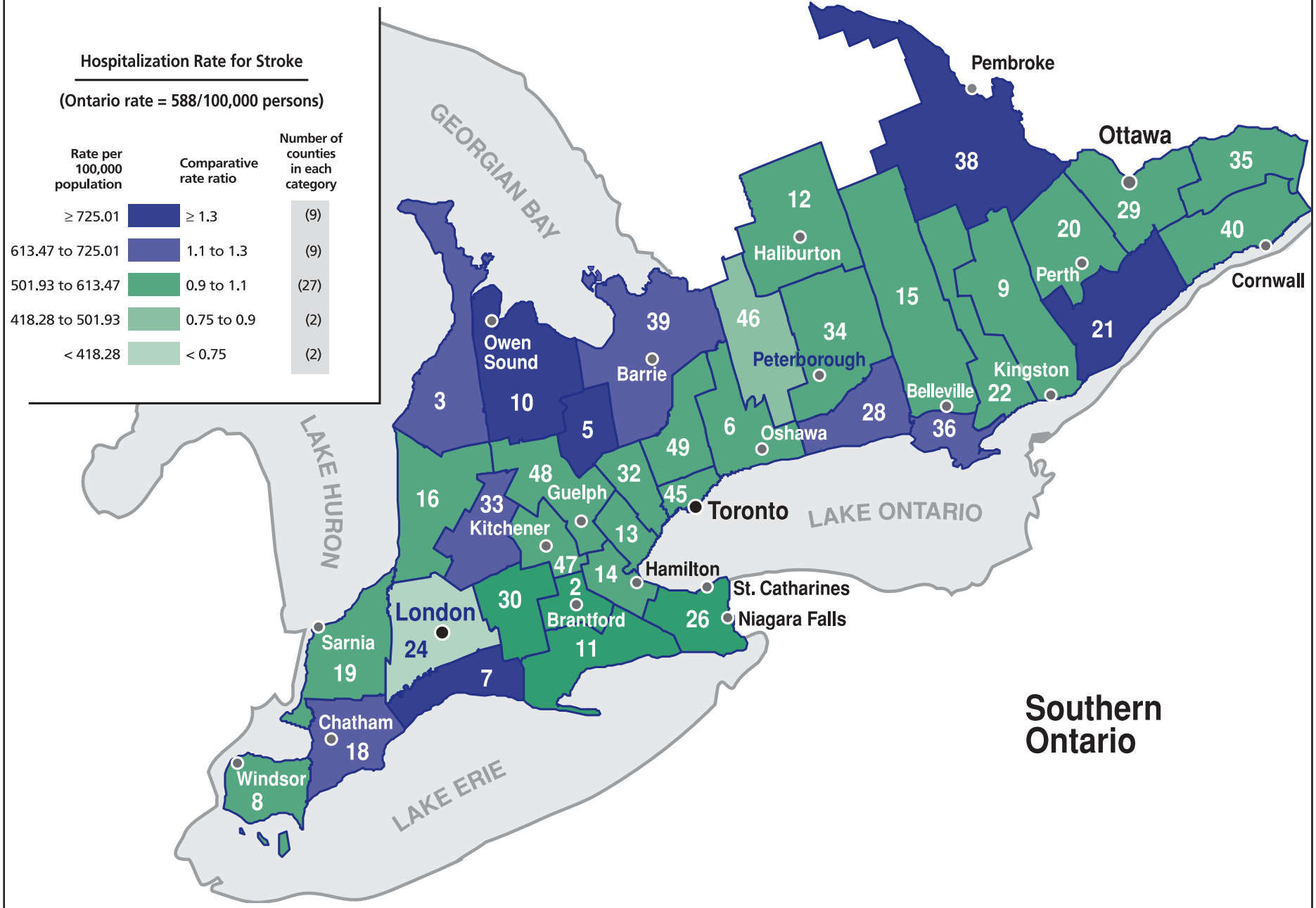
Ontario Counties

1 Algoma District
2 Brant County
3 Bruce County
4 Cochrane District
5 Dufferin County
6 Durham Regional Municipality
7 Elgin County
8 Essex County
9 Frontenac County
10 Grey County
11 Haldimand-Norfolk Regional Municipality
12 Haliburton County
13 Halton Regional Municipality
14 Hamilton-Wentworth Regional Municipality
15 Hastings County
16 Huron County
17 Kenora District
18 Kent County
19 Lambton County
20 Lanark County
21 Leeds and Grenville United Counties
22 Lennox and Addington County
23 Manitoulin District
24 Middlesex County
25 Muskoka District
26 Niagara Regional Municipality
27 Nipissing District
28 Northumberland County
29 Ottawa-Carleton Regional Municipality
30 Oxford County
31 Parry Sound District
32 Peel Regional Municipality
33 Perth County
34 Peterborough County
35 Prescott and Russell United Counties
36 Prince Edward County
37 Rainy River District
38 Renfrew County
39 Simcoe County
40 Stormont, Dundas and Glengarry United Counties
41 Sudbury District
42 Sudbury Regional Municipality
43 Thunder Bay District
44 Timiskaming District
45 Toronto Metropolitan Municipality
46 Victoria County
47 Waterloo Regional Municipality
48 Wellington County
49 York Regional Municipality

Note: See Exhibit 7.6b for Legend.

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

Exhibit 7.6b Age-/Sex-adjusted Stroke Hospitalization Rates per 100,000 Ontarians with DM, Aged 20 Years and Over, by County, Southern Ontario, 1995–1999



Note: See Exhibit 7.6a for County definitions.

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD)

Exhibit 7.7 Characteristics of Stroke Patients by DM Status in Ontario, 1995–1999

	DM	No DM	P-value
N	21,774	56,759	
Male—n (%)	11,450 (53%)	27,335 (48%)	<0.001
Mean age—years	72.92	73.81	<0.001
Income quintile n (%)			
Q1 (low)	4,952 (24%)	12,243 (23%)	<0.001
Q2	4,583 (23%)	11,308 (21%)	
Q3	4,093 (20%)	10,571 (20%)	
Q4	3,575 (18%)	9,337 (18%)	
Q5 (high)	3,065 (15%)	9,517 (18%)	
Stroke type n (%)			<0.001
Ischemic	20,395 (94%)	50,366 (89%)	
Hemorrhagic	1,331 (6%)	6,453 (11%)	

There were significant differences in stroke type in persons with/without DM, with a higher proportion of ischemic stroke among those with diabetes.

Source: Ontario Diabetes Database (ODD)

Exhibit 7.8 Age-adjusted Rates of Discharge to Complex Continuing Care Institution or Death within 30 Days after Stroke per 100 Ontarians with Stroke by DM Status, Stroke Type, and Gender, 1995–1999

After admission to hospital for either ischemic or hemorrhagic stroke, mortality within 30 days or discharge to chronic care was higher in those with DM.

Hemorrhagic Stroke

Gender/DM Status	Discharge to Complex Continuing Care Institution or Death within 30 Days of Stroke	
Men	Number of Cases	Rate/100 Persons
Overall	**2,078**	**35.1**
DM	433	43.9
No DM	1,645	34.3
Women		
Overall	**2,210**	**40.9**
DM	390	50.4
No DM	1,820	39.9
All Patients (age-/sex-adjusted)		
Overall	**4,288**	**38.0**
DM	823	47.2
No DM	3,465	37.1

Ischemic Stroke

Gender/DM Status	Discharge to Complex Continuing Care Institution or Death within 30 Days of Stroke	
Men	Number of Cases	Rate/100 Persons
Overall	**8,673**	**14.1**
DM	2,788	15.3
No DM	5,885	13.7
Women		
Overall	**10,241**	**13.9**
DM	2,787	13.4
No DM	7,454	13.9
All Patients (age-/sex-adjusted)		
Overall	**18,914**	**14.0**
DM	5,575	14.4
No DM	13,339	13.8

NOTE: If both ischemic and hemorrhagic stroke coded on the same visit, stroke type was labelled ***hemorrhagic***.
Source: Ontario Diabetes Database (ODD)

Exhibit 7.9 Thirty-day and One-year Mortality Rates per 100 Persons with Stroke by DM Status and Gender in Ontario, 1995–1999

After adjusting for age, sex, comorbid conditions and stroke type, there were no large differences in all-cause mortality at 30 days or one year in those with or without DM.

Gender/DM Status	30-day Mortality		1-year Mortality	
	Number of Cases	Risk-adjusted Rate*	Number of Cases	Risk-adjusted Rate*
Men				
Overall	7,728		13,131	
DM	2,295	20.63 (95%CI;19.90-21.36)	4,024	34.40 (95%CI; 33.59-35.21)
No DM	5,433	20.82 (95%CI;20.35-21.30)	9,107	35.37 (95%CI; 34.82-35.93)
Women				
Overall	8,580		14,411	
DM	2,170	20.36 (95%CI;19.61-21.10)	3,725	33.58 (95%CI; 32.76-34.41)
No DM	6,410	21.91 (95%CI;20.47-21.34)	10,686	35.62 (95%CI; 35.11-36.13)
All Patients				
Overall	16,308		27,542	
DM	4,465	20.50 (95%CI;19.98-21.02)	7,749	34.00 (95%CI; 34.42-34.58)
No DM	11,843	20.87 (95%CI;20.55-21.19)	19,793	35.51 (95%CI; 35.13-35.88)

Source: Ontario Diabetes Database (ODD). *Adjusted for age, sex, Charlson comorbidity and stroke type.

Exhibit 7.10 Sex-specific Post-stroke Carotid Endarterectomy Rates per 100 Ontarians with Stroke and Waiting Times by DM Status, 1995–1999

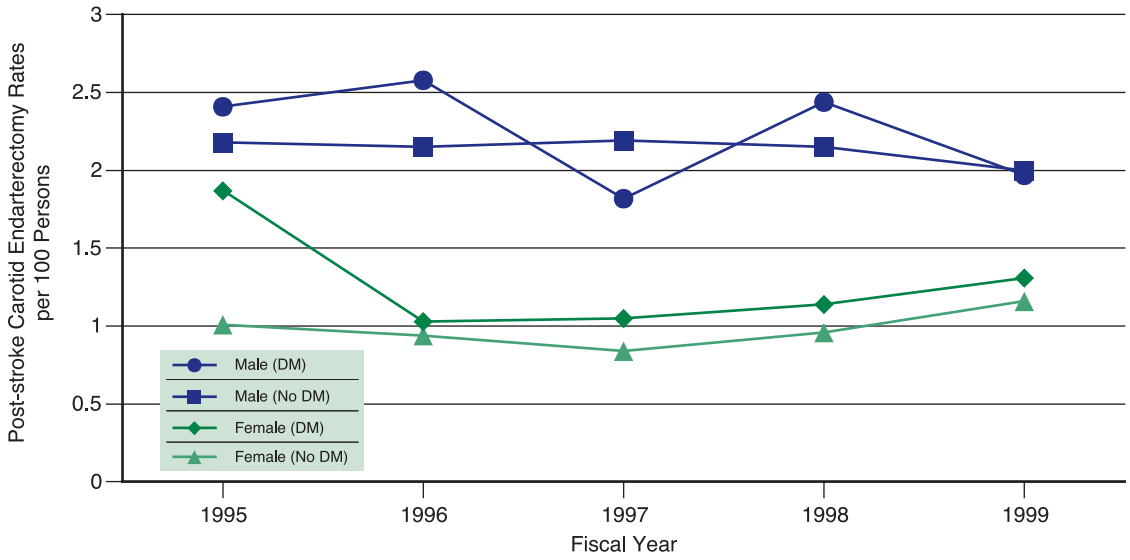
Overall rates of carotid endarterectomy after stroke were similar in those with and without DM.

Fiscal Year	DM Status	Overall Men & Women		Median Waiting Time (days)	Women Overall	Men Overall
		Rate	n		Rate	Rate
1995	DM	2.2	77	51	1.9	2.4
	No DM	1.6	150	41	1.0	2.2
1996	DM	1.9	71	74	1.0	2.6
	No DM	1.5	144	63	0.9	2.2
1997	DM	1.5	59	82	1.1	1.8
	No DM	1.5	143	55	0.8	2.2
1998	DM	1.8	75	62	1.1	2.4
	No DM	1.5	144	70	1.0	2.2
1999	DM	1.7	70	74	1.3	2.0
	No DM	1.6	141	55	1.2	2.0
Odds Ratio Crude* (95% CI)		1.07 (0.80–1.42)			1.14 (0.71–1.82)	0.99 (0.69–1.43)
Odds Ratio Adjusted* (95% CI)		0.95 (0.71–1.27)			1.00 (0.62–1.60)	0.99 (0.69–1.43)

Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 7.11 Sex-specific Post-stroke Carotid Endarterectomy Rates per 100 Ontarians with Stroke by DM Status, 1995–1999

Rates of surgery were about twice as high for men than for women regardless of diabetes status.



Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

person without DM. Stroke hospitalization rates increased with age for both men and women, and were only slightly higher in men than in women.

In persons with DM, there was a decline in stroke hospitalization rates over time (Exhibit 7.2). Consistent with results from other jurisdictions, stroke hospitalization rates in both those with and without DM were inversely related to socioeconomic status, with modestly increased stroke hospitalization rates seen in the lowest income quintiles (Exhibits 7.3 and 7.4). There were regional variations in stroke hospitalization rates in individuals with DM across the province during the overall study time frame (1995 to 1999), although these were not statistically significant (P=0.16 for comparison across counties), and were smaller than those seen for many other disorders (Exhibits 7.5a and 7.5b).

Variations in stroke admission rates could be due to either variations in stroke incidence or variations in stroke admission thresholds across the province and over time. The fact that only minor regional variations in stroke admission rates were observed across the province is consistent with relatively equitable access to hospital care for persons with DM and stroke (Exhibits 7.6a and 7.6b).

In the Cox proportional hazards model, independent predictors of stroke in persons with DM included older age, male sex, lower neighbourhood income quintile, previous myocardial infarction and comorbid illness. Rural residence, region of residence, number of ambulatory care visits and having a regular source of care were not significant predictors of subsequent stroke admission.

Among hospitalized stroke patients, the characteristics of those with and without DM were similar. Those with DM were slightly younger and were more likely to be male, but the differences were small (Exhibit 7.7). There were significant differences in stroke type in those with and without DM, with a higher proportion of ischemic stroke among those with DM (94% vs. 89%, P<0.0001). This is consistent with other studies which have found that DM increases the risk of ischemic rather than hemorrhagic stroke.[18] The median length of stay for stroke was slightly longer for patients with DM compared to those without (9.8 vs. 9.2 days, P<0.001). Since administrative data do not capture information on stroke severity, discharge to a chronic care institution after a stroke admission was used as a marker for severe stroke. Analyses were stratified by stroke type, as those with hemorrhagic stroke would be expected to have greater stroke severity than those with ischemic stroke. Rates of death within 30 days or discharge to complex continuing care facilities after stroke admission were higher in those with DM compared to those without DM, both for ischemic stroke (14.4% vs. 13.8%, P<0.001) and for hemorrhagic stroke (47.2% vs. 37.1%, P=0.002) (Exhibit 7.8). After adjustment for age, sex, comorbid conditions, and stroke type, there was

very little difference in 30-day and one-year all-cause mortality in those with and without DM (Exhibit 7.9).

Overall rates of carotid endarterectomy after stroke were low, but similar in those with and without DM (Exhibits 7.10 and 7.11). The most significant finding was that rates of surgery were about twice as high for men than for women regardless of DM status.

Conclusions

Diabetes is an extremely powerful risk factor for stroke (it increases the risk of stroke almost three-fold), in both men and women and in every age group. Between 1995 and 1999, there was a gradual decline in the risk of stroke hospitalization in those with and without DM. This could be related to a decrease in the incidence of stroke due to improved blood glucose control, use of antithrombotic agents, or modification of other stroke risk factors such as hypertension and hyperlipidemia. Of note, there was an increase in the use of antihypertensive and lipid lowering medications during the study time frame (See Chapter 3: Drug Use in Older People with Diabetes). However, it is difficult to draw firm conclusions given the multifactorial etiology of stroke and the relatively short time interval studied. Other potential explanations for the observed decline in stroke hospitalization rates include changes in admission thresholds for those with less severe strokes.

These analyses do not provide direct information on the influence of diabetes on stroke severity. Persons with DM had a slightly longer length of stay, and were more likely to be either discharged to complex continuing care facility or die within 30 days of stroke, regardless of stroke type. While this could indicate greater stroke severity in those with DM, other explanations include a greater frequency of post-stroke complications or other comorbid illness. The finding that adjusted 30-day and 1-year all cause mortality after stroke were not increased in those with DM argues against major differences in stroke severity based on DM status.

Post-stroke carotid endarterectomy rates were similar in those with and without DM. It is surprising that women were only half as likely as men to undergo carotid endarterectomy, even in the presence of DM where stroke risks are similar in women and men. Data sources with more detailed clinical information are needed to determine the prevalence of moderate to severe carotid stenosis in men and women with and without DM and the appropriate rates of carotid endarterectomy in these populations.

Overall, these analyses confirm that stroke is a common and serious complication of DM. Further study is needed to determine whether local initiatives to improve DM care will result in significant reductions in stroke risks or improved stroke outcomes.

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8

Chapter

Dialysis Therapy for Persons with Diabetes

Authors: Matthew J Oliver, Charmaine E Lok, Jane Shi and Deanna M. Rothwell

Key Messages

- Based on current use patterns, the growing diabetes mellitus (DM) population on dialysis will increase the demand for hospital-based dialysis facilities.
- The number of people with DM starting dialysis rose by 84% over the six year study period, even though rates remained steady. This suggests that the growing number of persons with DM requiring dialysis reflects demographic shifts and broader clinical indications rather than sub-optimal DM care.
- The age and comorbidity of people with DM starting dialysis in Ontario is high and increasing. Care of these patients is complex.
- There is good evidence that the growth of end stage renal disease (ESRD) may be reduced by effective preventive interventions including blood pressure reduction and tight glucose control.

Background

Kidney disease remains one of the most serious complications of diabetes mellitus (DM) and can lead to chronic kidney failure, known as end stage renal disease (ESRD). The risk of developing ESRD has been reported to be up to 13-fold higher in persons with DM than in those without.[1,2] DM has been reported to be the cause of nearly a third of new cases of ESRD in Canada and to be present in nearly 41% of people starting dialysis.[3] In 2001, the USRDS (US Renal Data System) registry reported that 45% of American incident dialysis patients had DM.[4]

Among persons with DM, the main risk factors for developing kidney disease are poor blood pressure control, poor control of blood sugar, and high cholesterol. People with abnormal levels of protein in their urine are likely in the early stages of kidney disease and are at even higher risk of developing ESRD. Fortunately, aggressively treating high blood pressure, high blood sugar, and high cholesterol can stop or slow the progression of kidney disease.[5,6] Medications known as ACE inhibitors and angiotensin receptor blockers are particularly beneficial in controlling blood pressure and slowing the progression of kidney disease.[7] Recommendations for prevention and management of nephropathy in persons with DM have been described in clinical practice guidelines.

Once a person develops ESRD, survival depends on replacing kidney function by either dialysis or transplantation. Transplantation is preferred because it offers increased survival and improved quality of life; however, donor kidneys are limited and often the waiting time for transplantation in Ontario is long. Furthermore, comorbid conditions such as cardiovascular disease (CVD) or peripheral vascular disease (PVD) are more common in people with DM[4,5] and may make them ineligible for transplantation, leaving dialysis as the only treatment option.

The two types of dialysis are hemodialysis and peritoneal dialysis (PD). In hemodialysis, the patient's blood is circulated outside the body along an artificial membrane within a dialysis machine which cleans the blood of toxins and removes excess fluid. Peritoneal dialysis is the removal of fluid and toxins by exchanging fluid into and out of the abdomen, using the body's own peritoneal membrane. Both modalities are considered to be similarly effective when used chronically; however, PD is substantially less costly and has the advantage of allowing patients to stay in their homes, avoiding frequent hospital trips. Canadian registry data (Canadian Organ Replacement Registry [CORR]) has reported that 78% of new persons with ESRD are started on hemodialysis, while 22% are started on peritoneal dialysis.[3] The majority of persons with ESRD are also treated with hemodialysis in the United States and Europe.[4, 8, 9]

Hemodialysis is primarily available in Ontario at hospital-based dialysis centres, although the role of satellite centres affiliated with these centres is increasing. Peritoneal dialysis can be performed in the home, but to be successful it often requires significant assistance

Exhibit 8.1 Crude and Age-/Sex-adjusted Incidence of Chronic Dialysis per 100,000 Ontarians with/without DM Aged 20 Years and Over, 1995–2000

The population with DM starting chronic dialysis is growing at an average annual rate of approximately 13.2%, more than eight times the 1.6% annual increase in people without DM starting dialysis.

	DM			No DM			Total		
		Incidence Rate			Incidence Rate			Incidence Rate	
Fiscal Year	N	Crude	Adjusted	N	Crude	Adjusted	N	Crude	Adjusted
1995	448	125.8	134.4	741	10.1	10.8	1,189	15.4	15.9
1996	509	130.7	135.0	721	9.7	10.5	1,230	15.7	16.1
1997	523	124.0	117.4	736	9.8	10.5	1,259	15.8	16.2
1998	664	145.2	123.0	811	10.6	11.5	1,475	18.2	18.5
1999	738	149.7	135.2	833	10.8	11.7	1,571	19.1	19.3
2000	823	155.6	132.9	797	10.1	11.0	1,620	19.3	19.5
Average Annual Growth, %	13.2			1.6			6.5		

1) Rates are age-/sex-adjusted to the Ontario 1996 population aged 20 and over
2) Incidence rate refers to the number of people starting chronic dialysis per 100,000 people at risk either with/without DM
3) Average annual growth refers to growth from previous year in that group, not growth rate of people with DM relative to those without DM

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP).
Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

by the regional dialysis centres, community-based support, or family members, particularly in patients who are frail or elderly. Canadian registries report that the ESRD population is growing at 8.4% per year,[3] and much of the growth is occurring in people with DM.

Among the dialysis population, persons with DM have significantly lower rates of survival than those without DM. In Canada, CORR reported that the three-year survival was 52% for those with DM (between December 1, 1991 and December 1, 1999) compared to 65% for those without; five-year survival was substantially lower (34% vs. 53%).[3] American USRDS data report unadjusted survival rates in those with DM as being approximately 60% at two years and 25% at five years.[4] Compared to non-diabetic individuals on dialysis, persons with DM are much more likely to have other comorbid conditions which may reduce their survival, particularly cardiovascular disease, peripheral vascular disease, and stroke.[10]

The purpose of this chapter is to describe the characteristics of persons in Ontario with DM and ESRD and how dialysis therapy is provided to them.

Data Sources

The Registered Persons Database (RPDB) was used to identify all individuals between the ages of 20 and 105, their gender, and region of residence who were eligible for coverage under the Ontario Health Insurance Plan (OHIP) during the fiscal years 1995 to 2000. People from the Quinte/Kingston/ Rideau District Health Council (DHC) were excluded from the analysis because it was not possible to accurately identify dialysis patients in that DHC region. Dialysis providers in that region are paid using an alternative funding plan that differs from the rest of the provincial fee-for-service billing plan (OHIP).

Persons with DM were identified using the Ontario Diabetes Database (ODD), which is described in detail in the Chapter 1 Technical Appendix TA1.A. Individuals in the RPDB who were not present in the ODD served as a non-diabetic comparison group. Creation of this cohort is described in Chapter 5 Technical Appendix TA5.A. Persons in Ontario with ESRD requiring dialysis were identified by extracting records containing dialysis billing claims from the Ontario Health Insurance Plan (OHIP) Database. The Canadian Institute for Health Information (CIHI) Hospital Discharge Abstract Database was used to identify comorbidities based on hospital discharge diagnoses. RPDB was used to determine the vital status of people in the study.

The names, addresses and opening dates of dialysis units were obtained from the Kidney Foundation of Canada, CIHI, the Toronto Region Dialysis Registry, and CORR. Dialysis units were defined as free-standing, physically distinct sites found in different postal code areas (using forward sortation area [FSA]). Information was verified where possible by telephone survey by two independent research assistants.

Data on the pediatric dialysis population were not included in our analyses for several reasons: this patient population is

Exhibit 8.2 Crude and Age-/Sex-adjusted Prevalence of Chronic Dialysis per 100,000 Ontarians with/without DM Aged 20 Years and Over, 1995–2000

The average annual growth in the number of prevalent dialysis cases was 15% in persons with DM and 5% in persons without DM.

	DM			No DM			Total		
		Prevalence Rate			Prevalence Rate			Prevalence Rate	
Fiscal Year	N	Crude	Adjusted	N	Crude	Adjusted	N	Crude	Adjusted
1995	1,480	415.6	437.9	2,859	38.9	41.8	4,339	56.2	58.1
1996	1,708	438.6	439.4	3,024	40.6	43.7	4,732	60.4	62.0
1997	1,931	458.0	435.2	3,169	42.0	45.1	5,100	64.1	65.4
1998	2,265	495.5	450.6	3,347	43.9	47.0	5,612	69.4	70.4
1999	2,614	530.1	454.1	3,539	45.7	49.0	6,153	74.6	75.3
2000	2,983	564.0	474.4	3,677	46.7	50.2	6,660	79.2	79.8
Average Annual Growth, %	15.1		1.7	5.2		4.0	8.9		

1) Rates are age-/sex-adjusted to the Ontario 1996 population aged 20 and over
2) Prevalence rate refers to the number of people receiving chronic dialysis per 100,000 people at risk either with/without DM
3) Average annual growth refers to growth from previous year in that group, not growth rate of people with DM relative to those without DM
4) Total prevalent patients cannot be calculated from adding yearly prevalences; the same patient can be prevalent in more than one year

Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 8.3 Age and Sex Profile of the Incident Chronic Dialysis Population Aged 20 and Over in Ontario by DM Status, 1995–2000

The mean annual increase in the number of persons over the age of 75 receiving dialysis is very high in both women and men regardless of DM status.

	Women by Age Group											
	20–34		35–49		50–64		65–74		75–105		Median Age	
Fiscal Year	DM	No DM	DM	No DM	DM	No DM	DM	No DM	DM	No DM	DM	No DM
1995	10	46	33	50	76	70	64	84	15	37	62	61
1996	8	43	29	53	75	65	77	90	22	40	63	62
1997	8	43	39	55	79	68	69	80	27	49	62	61
1998	9	37	29	61	100	91	84	73	34	69	64	61
1999	9	26	41	65	90	73	90	81	63	84	65	65
2000	12	30	49	46	100	72	120	74	86	89	66	66

	Men by Age Group											
	20–34		35–49		50–64		65–74		75–105		Median Age	
Fiscal Year	DM	No DM	DM	No DM	DM	No DM	DM	No DM	DM	No DM	DM	No DM
1995	18	67	51	94	82	123	68	111	31	59	61	58
1996	16	45	52	92	105	117	76	101	39	75	60	59
1997	15	43	50	92	110	108	102	112	24	86	62	62
1998	16	47	55	103	150	90	133	135	54	105	63	65
1999	21	47	72	84	158	121	127	144	67	108	63	65
2000	20	50	54	90	153	104	152	116	77	126	65	64

Source: Ontario Diabetes Database (ODD). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 8.4 Age-/Sex-adjusted Incidence and Prevalence Rates of Chronic Dialysis per 100,000 Ontarians with/without DM Aged 20 and Over by District Health Councils (DHCs), 2000

In general, DHCs with high incidence rates tended to have high prevalence rates.

	Adjusted Incidence		Adjusted Prevalence	
District Health Councils	**DM**	**No DM**	**DM**	**No DM**
Algoma, Cochrane, Manitoulin & Sudbury	214	14	652	62
Champlain	166	14	437	66
Durham, Haliburton, Kawartha & Pine Ridge	136	11	381	41
Essex, Kent, and Lambton	86	10	388	41
Grand River	184	12	552	45
Grey, Bruce, Huron, Perth	92	11	503	43
Halton-Peel	86	9	408	47
Hamilton-Wentworth	187	11	646	57
Metropolitan Toronto	104	11	454	55
Muskoka, Nipissing, Parry Sound & Timiskaming	241	12	599	43
Niagara Region	183	11	618	52
Northwestern Ontario	106	12	663	45
Simcoe-York	133	9	458	38
Thames Valley	162	10	555	51
Waterloo Region - Wellington-Dufferin	180	14	460	52
Province	133	11	474	50

1) Rates are age-/sex-adjusted to the Ontario 1996 population aged 20 and over
2) Incidence rate refers to the number of people starting chronic dialysis per 100,000 people at risk either with/without DM
3) Prevalence rate refers to the number of people receiving chronic dialysis per 100,000 people at risk either with/without DM

Source: Ontario Diabetes Database (ODD)

substantially different from the adult population with highly specialized needs; the numbers of children on dialysis are relatively small; and importantly, privacy concerns precluded the description of such small numbers of individuals.

How the analysis was done

The study period was from April 1, 1994 to March 31, 2000. OHIP claims records were examined to define people with ESRD whose period of dialysis treatment received was at least 90 days. Any person with a dialysis billing claim was identified in the OHIP database; these records are submitted regularly by fee-for-service physicians for all forms of dialysis, regardless of type and location. For each individual, the dialysis billing claims were sorted by date, and the duration of dialysis was calculated as the time between the first and last dialysis records. To account for significant gaps in dialysis treatments between the first and last billing claims, gaps in time between consecutive claims were calculated. Each single gap longer than 21 days was subtracted from the total dialysis duration. After accounting for gaps, if an individual's dialysis treatment

Key Research Findings

- The number of persons with diabetes mellitus (DM) receiving dialysis is growing rapidly—nearly doubling over the past five years.
- People with DM in Ontario are 12 times more likely to require dialysis than people without DM.
- The majority of dialysis provided to persons with DM is hospital-based hemodialysis.

Exhibit 8.5 Average Age-/Sex-adjusted Incidence/Prevalence of Chronic Dialysis per 100,000 Ontarians *with DM* Aged 20 Years and Over by County, 1995–2000

Prevalence rates are notably higher in the north and in the Counties Halton and Hamilton-Wentworth.

Rate = per 100,000 persons	Incidence Rate*	Prevalence Rate*
Algoma District	151	396
Brant County	75	238
Bruce County	92	327
Cochrane District	111	331
Dufferin County	104	401
Durham Regional Municipality	84	258
Elgin County	74	280
Essex County	71	254
Grey County	63	186
Haldimand-Norfolk Regional Municipality	117	345
Haliburton County	62	368
Halton Regional Municipality	115	422
Hamilton-Wentworth Regional Municipality	123	468
Huron County	66	334
Kenora District	206	615
Kent County	69	238
Lambton County	78	252
Manitoulin District	239	1,003
Middlesex County	91	317
Muskoka District	59	148
Niagara Regional Municipality	93	317
Nipissing District	105	304
Northumberland County	58	152
Ottawa-Carleton Regional Municipality	102	316
Oxford County	85	321
Parry Sound District	84	275
Peel Regional Municipality	93	364
Perth County	65	194
Peterborough County	76	263
Prescott and Russell United Counties	92	247
Rainy River District	166	500
Renfrew County	72	244
Simcoe County	120	383
Stormont, Dundas and Glengarry United Counties	83	243
Sudbury District	72	330
Sudbury Regional Municipality	109	386
Thunder Bay District	108	429
Timiskaming District	70	337
Toronto Metropolitan Municipality	83	320
Victoria County	65	191
Waterloo Regional Municipality	98	318
Wellington County	95	293
York Regional Municipality	101	339
Province	91	319

* rates were adjusted to take into account differences in the age/sex distributions between counties

Source: Ontario Diabetes Database (ODD)

period was at least 90 total days, they were considered to have received chronic dialysis. Consecutive dialysis days were not required, so that people would not be excluded if gaps existed in their dialysis billing claims. The start date of dialysis was defined as the earliest dialysis billing record. The type of dialysis code (acute or chronic) was not used as an indicator when defining the start date of the dialysis period.

The type and location for each week of dialysis treatment was determined by analyzing billing claims after July 1, 1998. Billing claims after that date use new OHIP billing codes which better describe the modality (type of dialysis) and location. The billing codes represent the "predominant location and modality of dialysis". The categories are: a) G860–hospital hemodialysis; b) G861–hospital peritoneal dialysis; c) G862–hospital self care or satellite unit hemodialysis; d) G863–independent health facility hemodialysis; e) G864–home peritoneal dialysis; or f) G865–home hemodialysis.

People starting chronic dialysis (incident cases) in a fiscal year were defined as any person who met the aforementioned definition of chronic dialysis and whose start date of dialysis occurred in that year. Persons receiving chronic dialysis (period prevalent cases) in a fiscal year were defined as those individuals who met the definition of chronic dialysis and who had at least one dialysis billing claim in that year. Point prevalence (the number of persons on dialysis at the beginning of the year) can be calculated as the period prevalence for that year minus the incidence in that year. To identify all people who received chronic dialysis in the study period, dialysis billing records were included one year before and one year after the study period, even if some of the 90-day total occurred outside the study period. These methods identified prevalent people at the very beginning of the study, and incident people near the very end of the study period, who might otherwise have been missed.

Incidence and prevalence rates of chronic dialysis were calculated for persons with and without DM for each year of the study, using the ODD or RPDB minus people in the ODD, respectively, as the denominator of the rates. For example, to determine the incident rate of people with DM going on to dialysis, the numerator consisted of those with DM starting dialysis; those in the ODD comprised the denominator. Rates were also categorized by patient age, sex and geographic region of residence after adjusting for differences in the age/sex distribution of the population over time.

For the survival analysis, individuals were followed to March 31, 2001. Survival time was calculated from the start of dialysis treatment to the date of death in the RPDB. Those who received a kidney transplant based on OHIP billing claims were censored on the date of their first transplant. People who were alive according to the RPDB were censored at the end of the study. A small number of people receiving chronic dialysis stopped having billing records but did not have a death recorded in the RPDB. Neither including those individuals as deceased, nor censoring them substantively affected the estimate of survival. Survival, both unadjusted and adjusted for age, sex, presence of DM and Charlson score (Charlson-Deyo Comorbidity Index)[11] was determined as well.

Comorbidities in people at the start of chronic dialysis were estimated from hospital discharge records using the Charlson score, a commonly used method assigns a numeric level of comorbidity to the patient for major disease groups identified within hospital diagnostic codes. CIHI discharge records were reviewed during the five years before the start of dialysis and up to three months afterwards. Individual components of the Index (e.g., myocardial infarction) were used to estimate the percentage of persons with different comorbidities at the start of their chronic dialysis.

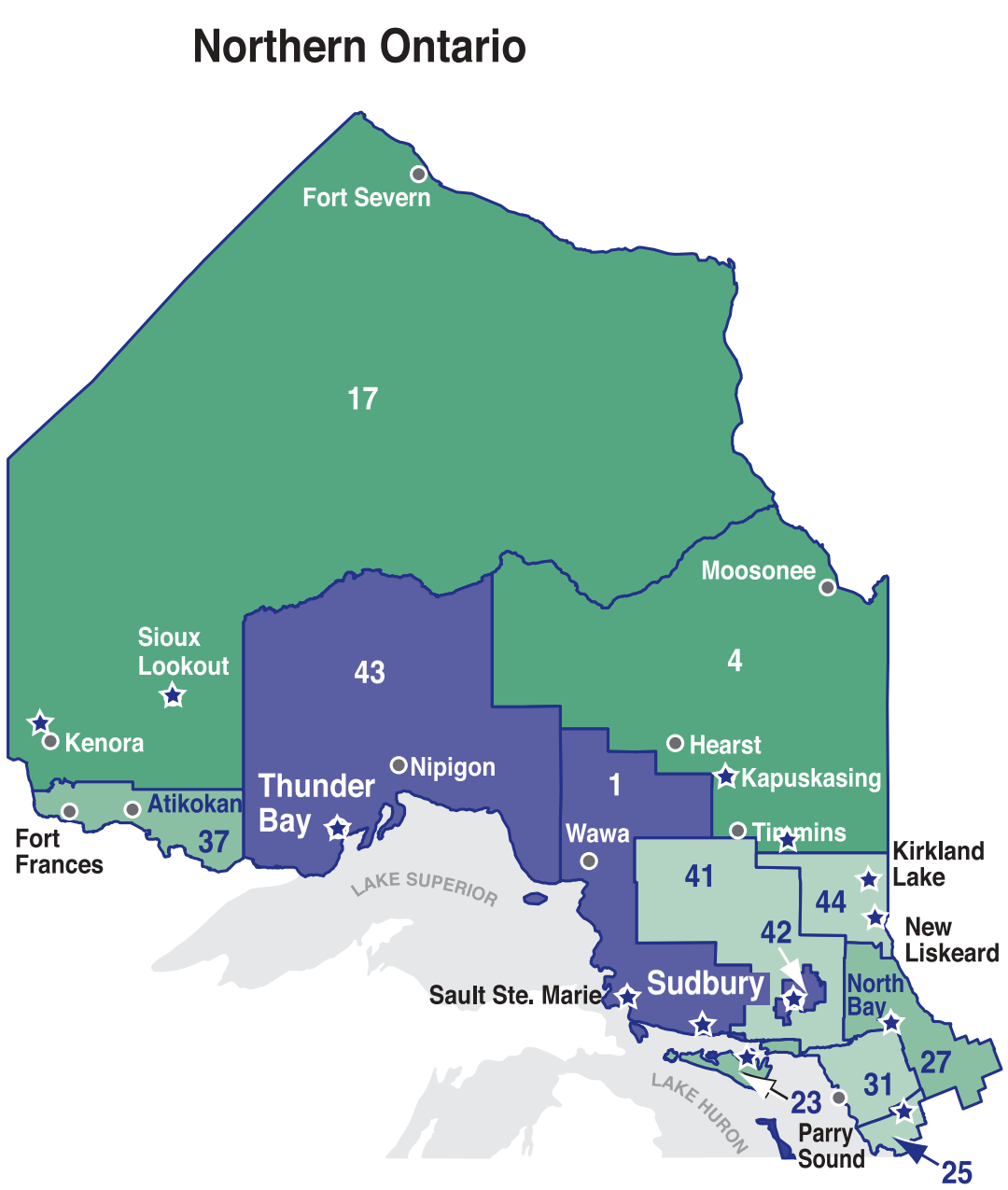
Interpretive Cautions

People with kidney failure in Ontario who did not have at least a 90 day period of dialysis based on OHIP billing claims were not included in the analysis. Thus, the study excluded people with kidney failure who did not require 90 days of dialysis (e.g., acute renal failure), those who received transplants or died within 90 days of starting dialysis therapy, and people who were not eligible for OHIP. Chronic dialysis was defined as at least 90 total days of dialysis, not consecutive dialysis days, a definition that may differ from other studies.

Despite the fact that a large number of people with ESRD are served in the Quinte/Kingston/Rideau District Health Council (DHC), this region was not included in this analysis, since we could not accurately identify patients on chronic dialysis using OHIP billing claims. Rates in some of the bordering counties may also be falsely low. Therefore, this chapter underestimates the number of patients with and without DM with ESRD in Ontario. Provincial rates of chronic dialysis per 100,000 population are unaffected because people from this DHC were removed from both the numerator and denominator of the reported rates.

In past studies, the type and location of dialysis were usually described by the percentage of people starting on either hemodialysis or peritoneal dialysis. This description relates the type of dialysis (modality) to the person. In 1999, 78% and 22% of people starting dialysis in Canada received hemodialysis and peritoneal dialysis, respectively. In the current analysis, dialysis type is related to each week of treatment, not the person. The total amount of hemodialysis and peritoneal dialysis treatments billed per week in Ontario is reported, not the number of people receiving these treatments. If a patient switches between hemodialysis and peritoneal dialysis, which is not uncommon, their treatments contribute to both the total number of

Exhibit 8.6a Number of Dialysis Patients with DM Aged 20 Years and Over by County in Northern Ontario between 1995–2000 in Relation to Location of Dialysis Units



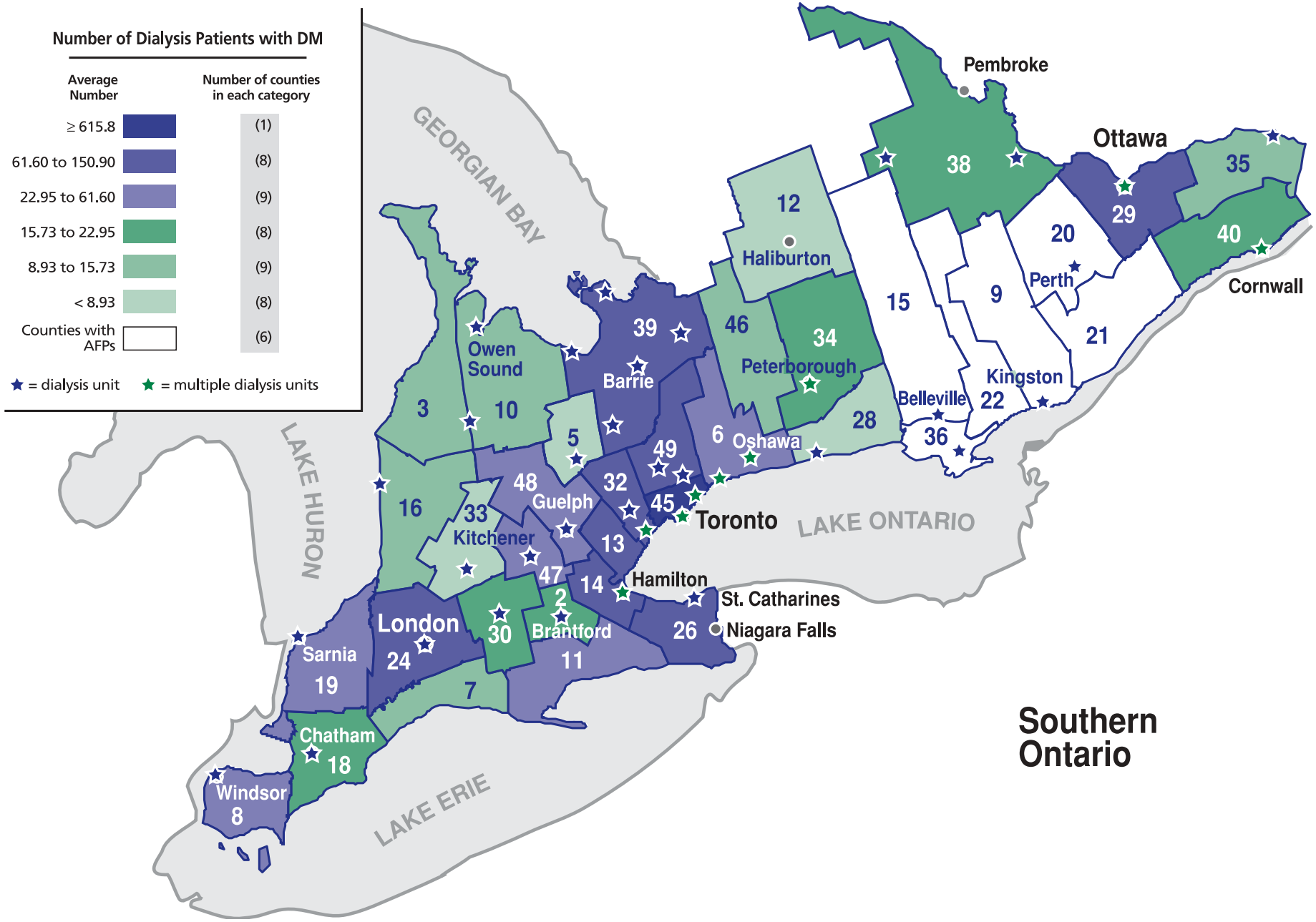
Ontario Counties

1 Algoma District
2 Brant County
3 Bruce County
4 Cochrane District
5 Dufferin County
6 Durham Regional Municipality
7 Elgin County
8 Essex County
9 Frontenac County
10 Grey County
11 Haldimand-Norfolk Regional Municipality
12 Haliburton County
13 Halton Regional Municipality
14 Hamilton-Wentworth Regional Municipality
15 Hastings County
16 Huron County
17 Kenora District
18 Kent County
19 Lambton County
20 Lanark County
21 Leeds and Grenville United Counties
22 Lennox and Addington County
23 Manitoulin District
24 Middlesex County
25 Muskoka District
26 Niagara Regional Municipality
27 Nipissing District
28 Northumberland County
29 Ottawa-Carleton Regional Municipality
30 Oxford County
31 Parry Sound District
32 Peel Regional Municipality
33 Perth County
34 Peterborough County
35 Prescott and Russell United Counties
36 Prince Edward County
37 Rainy River District
38 Renfrew County
39 Simcoe County
40 Stormont, Dundas and Glengarry United Counties
41 Sudbury District
42 Sudbury Regional Municipality
43 Thunder Bay District
44 Timiskaming District
45 Toronto Metropolitan Municipality
46 Victoria County
47 Waterloo Regional Municipality
48 Wellington County
49 York Regional Municipality

Note: See Exhibit 8.6b for Legend.

Source: Ontario Diabetes Database (ODD)

Exhibit 8.6b Number of Dialysis Patients with DM Aged 20 Years and Over by County in Southern Ontario between 1995–2000 in Relation to Location of Dialysis Units



Note: See Exhibit 8.6a for County definitions.

Source: Ontario Diabetes Database (ODD)

dialysis-weeks for hemodialysis and for peritoneal dialysis.

People with DM receiving chronic dialysis as described in this chapter may or may not have diabetic nephropathy as the cause of their kidney failure.

Renal transplantation is an important therapy for people with ESRD, but is not described in this chapter. To provide context for this treatment modality, CORR data reported that 23% of persons with DM and ESRD had functioning kidney transplants in Ontario in 1999.[3]

Finally, administrative data do not fully capture disease severity and comorbidity. Other important factors that describe or may affect an individual on dialysis such as ethnicity, nutritional status or variables requiring laboratory data (biochemistry, hematology) are not included.

Findings

Incidence and prevalence of chronic dialysis in people with and without DM

A total of 8,344 people started chronic dialysis (incident) in Ontario during the study period (Exhibit 8.1). The average incident rate of chronic dialysis was 130/100,000 in people with DM compared to 11/100,000 in people without DM over the study period. After adjusting for population changes, the rates of dialysis remained stable from fiscal year 1995 to 2000. However, since the general population with DM is increasing in size, the absolute number of persons on dialysis is increasing annually. In fact, the population with DM starting chronic dialysis is growing at an average annual rate of approximately 13.2%, which is more than eight times the 1.6% annual increase in people starting dialysis without DM. With this expansion, the proportion of the total dialysis population who have DM starting dialysis has grown from 37.7% in 1995 to 50.8% in 2000. That is, by the end of the study period, half the persons starting chronic dialysis in Ontario had DM.

The average rate of prevalent chronic dialysis during the study period was also substantially higher among people with DM than among those without (449 vs. 46/100,000). The prevalent rate of dialysis increased slightly during the study period for those with DM (438 to 474/100,000) (Exhibit 8.2). The average annual growth in the number of prevalent dialysis cases was 15% in the DM and 5% in the non-diabetic population. Persons with DM represent a slightly lower proportion of the prevalent population than the incident population (45% vs. 51% in 2000).

The demographics of persons with DM starting chronic dialysis by age, sex and fiscal year are presented in Exhibit 8.3. Persons with DM comprised 59% of the incident dialysis population between the ages of 50–74 years in 2000, and the proportion of persons with DM in this group increased over the study period. The number of persons over the age of 75 receiving dialysis increased sharply among both women and men with and without DM.

Regional variation in dialysis rates

The incidence and prevalence rates of chronic dialysis varied across DHCs (Exhibit 8.4). There were increases in all regions over the period of the study (data not shown). In 2000, the lowest incidence rate was 36% of the highest (range 86–241/100,000 population), while the lowest prevalence rate in persons with DM was 57% of the highest (range 381–663/100,000 population). In general, DHCs with high incidence rates tended to have high prevalence rates, as new patients starting dialysis were added to the prevalent population.

Age- and sex-adjusted incidence and prevalence rates of dialysis among persons with DM by county of residence are shown in Exhibit 8.5. Variation in the rate of dialysis was greater when smaller geographic units were considered. Adjusted incidence rates, averaged over 1995 to 2000, ranged between 58 and 239/100,000 persons (Northumberland and Manitoulin District, respectively). Adjusted prevalence rates varied more than six-fold, with the highest rates again seen in Manitoulin District (1,003/100,000 vs. 148/100,000 persons with DM in Muskoka District).

Exhibits 8.6A (Northern Ontario) and 8.6B (Southern Ontario) map, by quintiles, the total number of persons with DM on chronic dialysis by county and the locations of hemodialysis units. The Toronto Region is excluded from the quintile classification and is plotted separately due to the large number of people receiving dialysis in the Toronto region. See Technical Appendix TA8.A for a list of dialysis units, geographic location by postal code, start-up date and affiliation.

Comorbidity and Survival

Persons with DM have significantly greater comorbidity compared to people without DM. The mean Charlson index at the start of chronic dialysis for people with and without DM was 4.2 and 2.4 respectively. In particular, people with DM were more likely to start dialysis with a past history of myocardial infarction, congestive heart failure, peripheral vascular disease and cerebro-vascular disease (Exhibit 8.7). Even before starting dialysis, a significant number of patients had suffered chronic complications requiring hospitalization due to their DM. Of note, the Charlson index may underestimate patient comorbidity, since not all patients were hospitalized and not all comorbidities are recorded at hospitalization.

After starting chronic dialysis, the three-year survival was 54.9% and 67.9% in persons with and without DM (Exhibit 8.8). The unadjusted relative risk of death for those with DM starting dialysis was 1.52 (95% CI, 1.42–1.63). The relative risk of death

Exhibit 8.7 Proportion of Ontarians with Selected Comorbidities Among Incident Chronic Patients with/without DM Aged 20 Years and Over, 1995–2000

People with DM are more likely to start dialysis with a past history of myocardial infarction, congestive heart failure, peripheral vascular disease and cerebrovascular disease.

Comorbidity	DM %	No DM %
Myocardial Infarction	24.4	12.6
Congestive Heart Failure	42.6	20.7
Peripheral Vascular Disease	14.6	9.4
Cerebrovascular Disease	14.9	8.3
Dementia	0.9	0.8
Chronic Lung Disease	14.8	11.9
Rheumatological Disease	1.7	4.7
Digestive Ulcer	5.1	4.4
Mild Liver Disease	1.5	1.1
Diabetes	83.5	N/A
Diabetes with Chronic Complications	42.5	N/A
Hemi or Paraplegia	2.0	1.1
Renal Disease	73.4	67.1
Primary Cancer	6.1	9.5
Moderate/Severe Liver Disease	0.7	0.7
Metastatic Cancer	1.1	1.6
HIV Infection	N/A	0.2

1) Comorbidities reflect diagnoses coded on hospital admissions five years before and three months after starting dialysis
2) Only 73% of people on dialysis with DM and 67% of people without DM had renal disease recorded as a discharge diagnosis. Not all patients who are started on dialysis are admitted to hospital, and therefore they won't have a discharge record to scan for comorbid conditions. Only 83.5% of persons with DM have DM listed as a comorbidity for the same reason.

Source: Ontario Diabetes Database (ODD)

Exhibit 8.8 Yearly Survival Estimates Based on Incident Chronic Dialysis Patients with/without DM in Ontario Aged 20 Years and Over, 1995–2000

The three-year survival is 55% and 68% in persons with and without DM respectively. The unadjusted relative risk of death for those with DM starting dialysis was 1.52.

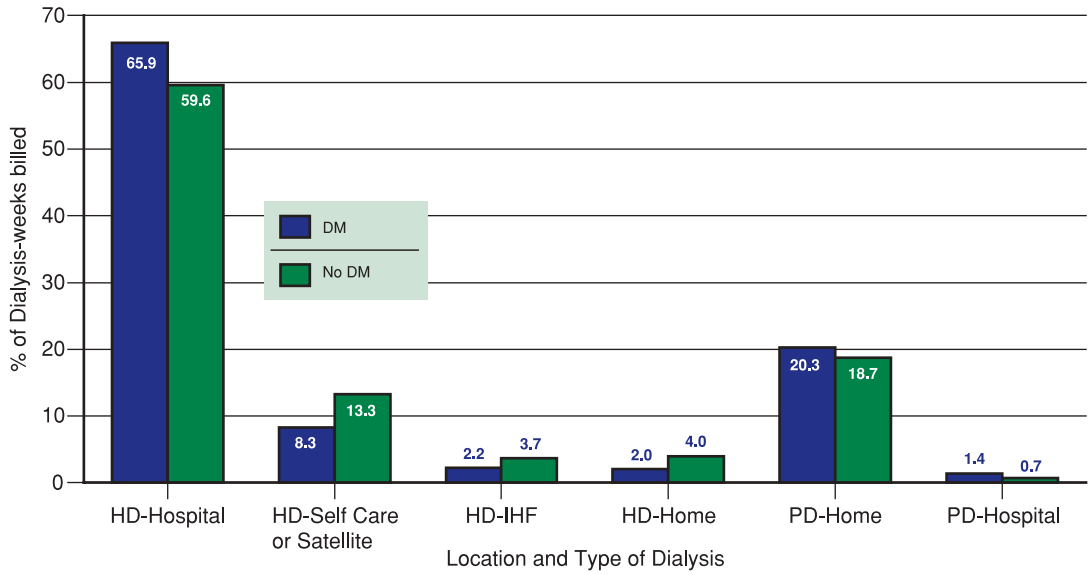
	Unadjusted Survival %		Adjusted Survival %	
Year	DM	No DM	DM	No DM
1	85.9	89.0	89.8	90.7
2	70.0	78.0	78.2	79.9
3	54.9	67.9	66.2	68.7
4	44.5	59.4	56.6	59.5
5	35.0	53.1	48.2	51.4
Relative Risk of DM (95% confidence interval)	1.52 (1.42, 1.63)		1.10 (1.02, 1.18)	

1) Survival is from start of dialysis to death, censoring for transplants, with follow-up of 84 months possible (April 1/1994 to March 31/2001)
2) Unadjusted survival is calculated using the Kaplan-Meier method
3) Adjusted survival is calculated using the Cox proportional hazard model, adjusting for DM, age, sex, and Charlson comorbidity score
4) Adjusted survival for a particular time point is estimated using the mean age, sex, and Charlson comorbidity score for DM and non-DM together

Source: Ontario Diabetes Database (ODD)

Exhibit 8.9 Types of Dialysis Billed Through Ontario Health Insurance Plan (OHIP) by Physicians: Proportion of Total Dialysis Claims for Ontarians with/without DM, 1999 and 2000

The majority of chronic dialysis treatments provided are hospital-based hemodialysis.



Source: Ontario Diabetes Database (ODD). HD= Hemodialysis; PD= Peritoneal Dialysis.

for those with DM after adjusting for age, sex, and increased comorbidity was 1.10 (95% CI, 1.02–1.18) (Exhibit 8.8). The reduction in relative risk with adjustment suggests that the decreased survival of people with DM receiving dialysis compared to those without DM is largely explained by differences in comorbid conditions when they start dialysis. Because the Charlson Index is based on hospital discharge coding, we cannot fully adjust for all baseline differences due to other unmeasured comorbidities.

Type and location of chronic dialysis

The majority of chronic dialysis treatments provided were hospital-based hemodialysis (Figure 8.9) in both people with and without DM. Hospital hemodialysis comprised 66% and 60% of treatments for people with and without DM, respectively. For people with DM, modalities of treatment outside hospital totalled 12.5%: hemodialysis in self care or satellites (8.3%), at independent health facilities (2.2%), or at home (2%), compared to 19% of treatments for people without DM (13.3%, 3.7%, and 4.0% of each modality respectively). Home peritoneal dialysis represented approximately 20% of treatments for persons both with and without DM. Hospital peritoneal dialysis provided less than 2% of dialysis-treatment weeks in Ontario.

Discussion

There has been a striking increase in the number of persons with DM on dialysis. Almost 3,000 people with DM in Ontario were treated with chronic dialysis in 2000, and more than 800 new individuals with DM started on dialysis that year compared with numbers of 1,500 and 450, respectively, five years earlier. This growth is explained by increasing numbers of persons with DM and increasing use of dialysis in older persons with DM. In contrast, rates of dialysis remained relatively steady, suggesting that the growth is not due to poorer DM outcomes and a higher proportion of patients progressing to ESRD.

The proportion of people on dialysis who have DM is increasing, and by the end of this study, more than half of people in Ontario starting dialysis had DM. The number of people with ESRD was especially high in the 50–74 year age group; however, the greatest growth in incident cases was in people over the age of 75. For example, the number of women with DM over 75 years of age starting dialysis doubled every two years during the study period. While these findings are from Ontario, similar trends have been observed in Canadian and American registry data.[3–5] This aging population of dialysis patients, combined with the complications of DM, results in persons starting dialysis with substantial comorbidity.

Because the mortality rate of people with DM was higher than those without DM, the growth of DM in the prevalent chronic dialysis population was slightly less than the incident chronic dialysis population.

This chapter also describes the absolute and age-/sex-adjusted rate of chronic dialysis in people with DM across Ontario. The incidence and prevalence of chronic dialysis in individuals with DM demonstrates a 12-fold greater risk of starting dialysis, and a ten-fold higher risk of being on dialysis compared to the population without DM. Knowledge of these diabetes-specific and regional rates should allow providers to better understand the dialysis needs of people with DM in their region. Regional variations in chronic dialysis rates in people with DM, although relatively small, may be partly explained by differing numbers of people at risk for kidney disease in the regions, the ethnic composition of a region, differences in practice patterns, or resource availability issues. The reasons why these rates vary across regions in Ontario require further study.

The detailed nature of OHIP billings claims for dialysis allowed a description of the type and location of dialysis on a per treatment-week basis, rather than a per-person basis. In these analyses, PD was the mode of dialysis for 20% of treatments delivered to individuals with ESRD, both with and without DM. PD is thought to be as effective a treatment as hemodialysis, but substantially less costly. There may be persons with and without DM whose multiple comorbidities limit or preclude dialysis being performed outside the hospital. Reasons for the relatively low rate of PD and the potential to expand its use in persons with DM requires further study.

Conclusions

This chapter provides a description of people with DM receiving chronic dialysis and how dialysis is provided to them. The rate of dialysis for individuals with DM is many times the rate of those without DM. The number of people with DM receiving dialysis is increasing rapidly, particularly in people in older age groups. During the study period, the majority of dialysis was provided by hospital hemodialysis units. People with DM often start dialysis with functional impairment or significant comorbidities besides ESRD, and have a relatively high rate of mortality on dialysis.

For Ontario, the primary challenges are: 1) to provide optimal health care for the growing number of people with DM receiving dialysis and to increase their survival on dialysis; 2) to provide the necessary capacity to accommodate current growth; and 3) to slow the progression of ESRD, limiting the growth of dialysis in people with DM. Preventive therapies are available. Persons with DM should be screened for early kidney disease and treated to slow or stop the loss of kidney function. In the meantime, hospital dialysis capacity will need to increase to keep pace with high growth of ESRD in Ontario as described in this chapter. Cost-effective, home-based therapies such as PD and home hemodialysis should also be explored as methods to increase capacity to meet the needs of residents of Ontario. To optimize care of complex patients with DM on dialysis, a multidisciplinary approach to kidney disease, combining expertise in DM care, geriatrics, rehabilitation, palliative care and other fields should be encouraged.

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Technical Appendix (Exhibit TA8.A)

List of Dialysis Units

Exhibit TA.8.A Ontario Dialysis Units: Geographic Location by Postal Code, Year Opened, Type and Affiliation

Dialysis Centre	Postal Code	Year Opened	Type	Affiliated Hospital*
Ajax–Pickering, Dialysis Management Clinic	L1V 1C3	1996	Satellite	Independent Health Facility
Alexander Marine and General Hospital–Goderich Satellite Dialysis Unit	N7A 1W5	2001	Satellite	London Health Sciences Centre
Bayshore Centres–Brockville Clinic	K6V 5V5	1998	Satellite	Independent Health Facility
Bayshore Centres–Stoney Creek	L8G 1B5	1995	Satellite	Independent Health Facility
Brantford General Hospital	N3R 1G9	1998	Satellite	St. Joseph's Hospital, Hamilton
Chatham Satellite Dialysis Unit	N7M 1G8	1996	Satellite	London Health Sciences Centre
Children's Hospital of Eastern Ontario	K1H 8L1	Pre-1981	In hospital	
Collingwood General & Marine	L9Y 2W9	1996	Satellite	Orillia Soldiers' Memorial Hospital
Cornwall Dialysis Clinic	K6J 5C6	1998	Satellite	Independent Health Facility
Cornwall General Hospital	K6H 1Z6	Jun-02	Satellite	The Ottawa Hospital
Credit Valley Hospital	L5M 2N1	1995	In hospital	
Credit Valley Hospital–Renal Care Centre	L4Z 3E5	2001	Satellite	Credit Valley Hospital
Dufferin–Caledon Health Care Corporation	L9W 4X9	1996	Satellite	Credit Valley Hospital
Grand River Hospital	N2G 1G3	Pre-1981	In hospital	
Grey Bruce Satellite Dialysis Unit	N4K 6M9	1997	Satellite	London Health Sciences Centre
Guelph General Hospital	N1E 6L9	1999	Satellite	Grand River Hospital
Halton Healthcare/Oakville Trafalgar Hospital	L6J 3L7	1997	In hospital	
Hamilton Health Sciences Corporation–McMaster Division	L8S 4J9	1984	In hospital	
Hanover Self-Care Dialysis Unit	N4N 1N1	1976	Satellite	London Health Sciences Centre
Hawkesbury General Hospital (hemo)	K6A 3G5	2002	Satellite	The Ottawa Hospital
Hospital for Sick Children	M5G 1X8	Pre-1981	In hospital	
Hotel Dieu Grace Hospital, Windsor	N9A 1E1	1966	In hospital	Hotel Dieu Grace Hospital
Hotel Dieu Grace Hospital–Self-Care, Windsor	N9A 5C6	1997	Satellite	Hotel Dieu Grace Hospital
Hotel Dieu–St. Catharines	L2R 5K2	Pre-1981	In hospital	
Humber River Hospital–Church St. Site	M9N 1N8	1997	In hospital	
Huntsville District Memorial Hospital	P1H 1H7	1996	Satellite	Orillia Soldiers' Memorial Hospital
Kingston General Hospital–Self-Care	K7L 2V7	1998	Satellite	Kingston General Hospital
Kirkland Lake & District Hospital	P2N 1R2	1991	Satellite	Sudbury Regional Hospital–Laurentian Site
Lake of the Woods District Hospital	P9N 3W7	1991	Satellite	Manitoba Health Sciences Centre
Lakeridge Health Corporation	L1N 5T2	1991	In hospital	
Lakeridge Health Corporation, RDU, Oshawa	L1G 4T1	2001	Satellite	Lakeridge Health Corporation
La Verendrye Hospital, Fort Frances	P9A 2B7	Oct 01	Satellite	Thunder Bay Regional Hospital, McKellar site
London Health Sciences Centre–University	N6A 5A5	Pre-1981	In hospital	
London Health Sciences Centre–Victoria	N6A 4G5	Pre-1981	In hospital	
London HSC–Westminster Campus	N6A 4G5	Pre-1981	In hospital	
Manitoulin Health Centre, Little Current	P0P 1K0	1992	Satellite	Sudbury Regional Hospital–Laurentian Site
Markham, Dialysis Management Clinic	L3R 1A8	1993	Satellite	Independent Health Facility
North Bay General Hospital	P1B 5A4	Pre-1981	In hospital	
North York General Hospital, Branson Site	M2R 1N5	Pending	Satellite	Sunnybrook WCHSC
Northumberland Health Care Centre	K9A 4K9	Pending	Satellite	Peterborough Regional Health Centre
Orillia Soldiers' Memorial Hospital	L3V 2Z3	1992	In hospital	
Ottawa Carleton Dialysis Clinic	K2C 3V8	1998	Satellite	Independent Health Facility
Ottawa Hospital–Civic Campus	K19 4E9	Pre-1981	In hospital	
Ottawa Hospital–General Campus	K1H 8L6	Pre-1981	In hospital	

Exhibit TA.8.A (Cont'd) Ontario Dialysis Units: Geographic Location by Postal Code, Year Opened, Type and Affiliation

Dialysis Centre	Postal Code	Year Opened	Type	Affiliated Hospital*
Ottawa Hospital–Riverside Campus	K1H 7W9	Pre-1981	In hospital	
Penetanguishene General Hospital	L5M 1K6	2000	Satellite	Orilllia Soldiers' Memorial Hospital
Perth and Smith Falls District Hospital, Smith Falls	K7A 2H9	1999	Satellite	Kingston General Hospital
Peterborough Regional Health Centre	K9J 7C6	2001	In hospital	
Peterborough RHC–Port Hope Satellite	L1A 3Y9	2002	Satellite	Peterborough Regional Health Centre
Peterborough, Dialysis Management Clinic	K9H 5R1	1996	Satellite	Independent Health Facility
Quinte Healthcare Dialysis Clinic, Belleville	K8N 5A9	Sep-93	Satellite	Kingston General Hospital
Quinte Healthcare Dialysis Clinic, North Hastings, Bancroft	K0L 1C0	Pending	Satellite	Kingston General Hospital
Quinte Healthcare Dialysis Clinic, Picton	K0K 2T0	2002	Satellite	Kingston General Hospital
Renfrew Victoria Hospital	K7V 1P6	1995	In hospital	
Royal Victoria Hospital	L4N 1K4	1999	Satellite	Orillia Soldiers' Memorial Hospital
Sarnia General Hospital (Lambton Hospital Group)	KN7T 6H6	Pre-1981	Satellite	London Health Sciences Centre
Sault Area Hospital–Plummer Memorial	P6A 2C4	Pre-1981	In hospital	
Scarborough RDC–Hemo. Satellite Unit	M1H 3G4	2000	Satellite	Scarborough Hospital–General Division
Scarborough Regional Dialysis Centre	M1P 2V5	1996	In hospital	
Senenbrenner Hospital, Kapuskasing	P5N 3H5	1997	Satellite	Sudbury Regional Hospital–Laurentian Site
Sheppard Centre Self Care Dialysis Unit	M2N 5X3	1988	Satellite	University Health Network–Toronto General
Sioux Lookout District Health Centre	P8T 1B4	1991	Satellite	Thunder Bay Regional Hospital, McKellar Site
Southwest Regional Self-Care, London	N6A 4G5	Pre-1981	Satellite	London Health Sciences Centre
St. Francis Memorial Hospital–Barry's Bay	K0J 1B0	Jun-01	Satellite	Renfrew Victoria Hospital
St. Joseph's Health Centre–Toronto	M6R 1B5	Pre-1981	In hospital	
St. Joseph's Health Centre–Toronto	M6R 1B5	Pending	Satellite	St. Joseph's Health Centre–Toronto
St. Joseph's Hospital–Hamilton	L8N 1Y4	Pending	Satellite	St. Joseph's Hospital–Hamilton
St. Joseph's Hospital–Elliot Lake	P5A 1X2	1991	Satellite	Sudbury Regional Hospital–Laurentian Site
St. Joseph's Hospital–Hamilton	L8N 1Y4	Pre-1981	In hospital	
St. Michael's Hospital	M5B 1W8	Pre-1981	In hospital	
St. Vincent's Hospital	K1R 7A5	2002	Satellite	The Ottawa Hospital
Stevenson Memorial Hospital (Alliston)	L9R 1W7	1996	Satellite	Orillia Soldier's Memorial hospital
Stratford General Hospital (Huron Perth Hospitals Partnership)	N5A 2Y6	1997	Satellite	London Health Sciences Centre
Sudbury Hospital Corporation, Laurentian Site	P3E 5J1	Pre-1981	In hospital	
Sunnybrook WCHSC	M4N 3M5	Pre-1981	In hospital	
Sussex Centre Self-Care Dialysis Unit	L5B 3C3	1994	Satellite	University Health Network–Toronto General
Temiskaming Hospital–New Liskeard	P0J 1P0	1991	Satellite	Sudbury Regional Hospital–Laurentian Site
The Riverdale Hospital (now Bridgepoint Health)	M4M 2B5	1990	Satellite	Scarborough Hospital–General Division
Thunder Bay Regional Hospital, McKellar Site	P7E 1G6	1997	In hospital	
Timmins District Hospital	P4N 8P2	1998	In hospital	
Toronto East General Hospital	M4C 3E7	Pending	Satellite	Scarborough Hospital–General Division
University Health Network–Toronto General	M5G 2C4	Pre-1981	In hospital	
University Health Network–Toronto Rehab.	M6K 2R7	2002	Satellite	University Health Network–Toronto General
University Health Network–Toronto Western	M5T 2S8	Pre-1981	In hospital	
West Parry Sound Health Centre	P2A 1Z8	1992	Satellite	Sudbury Regional Hospital–Laurentian Site
William Osler Health Centre–Brampton	L6W 2Z8	1997	In hospital	
Winchester District Memorial Hospital	K0C 2K0	Pending	Satellite	The Ottawa Hospital
Woodstock General Hospital	N4S 6N6	1997	Satellite	London Health Sciences Centre
York Central Hospital	L4C 4Z3	1996	In hospital	

Data Sources: Kidney Foundation of Canada, Canadian Institute for Health Information (CIHI), Toronto Region Dialysis Registry, Canadian Organ Replacement Registry (2002), telephone survey. *satellite centre managed by the affiliated hospital.

9

Chapter

Sources of Physician Care for People with Diabetes

Authors: Liisa Jaakkimainen, Baiju R. Shah and Alexander Kopp

Key Messages

- Family physicians are the main providers of physician care for people with diabetes mellitus (DM) in Ontario. Fewer than one in five people with DM had contact with a DM specialist, and this proportion is decreasing.
- Practical, evidence-based guidelines should be targeted to family physicians.
- Regional variations in the sources of DM physician care may be due to the distribution of DM specialists in Ontario.
- People who were older, male, or poor were less likely to see a DM specialist.
- People with DM in Ontario, in general, have good continuity of care with their family physicians.
- More information is needed to determine the contribution of non-physician specialists to the care of persons with DM.

Background

The goal of medical monitoring of blood sugars and providing other preventative services for people with diabetes mellitus (DM) is to reduce their risk of developing complications of the disease. The Canadian Diabetes Association (CDA) recommends that care be delivered by a DM health care team, which is "interdisciplinary and provides comprehensive, shared care."[1] Each team is based around the person with DM, his or her family, a primary care physician, and DM educators (who may be nutritionists or nurses). Other team members could include a DM specialist (who may be an endocrinologist or internist), and other medical specialists or non-physician health professionals.

Having a regular source of medical care is important to ensure appropriate long-term follow-up of people with DM. The CDA guidelines state that "those with DM require regular medical assessment and laboratory testing to ensure optimal health."[1] The guidelines recommend clinical assessments every two to four months, or more often as indicated, and blood or urine laboratory assessments at least every six months. People with DM are more likely to meet these guidelines if they see the same physicians on a regular basis.[2]

Certain types of people would be expected to be more likely to receive care from DM specialists: those with more DM complications, those whose blood sugars are more difficult to control, and those with other significant medical problems. However, given the rapid growth in the number of people with DM in Ontario (see Chapter 1, *Patterns of Prevalence and Incidence of Diabetes*) and the relatively small number of DM specialists in Ontario, most people will receive their DM care from family physicians.

In this chapter, the types of physicians who provide medical care for people with DM in Ontario are described. In addition, variability in these physician sources and continuity of family physician care were examined in terms of geography, age, sex and socioeconomic status.

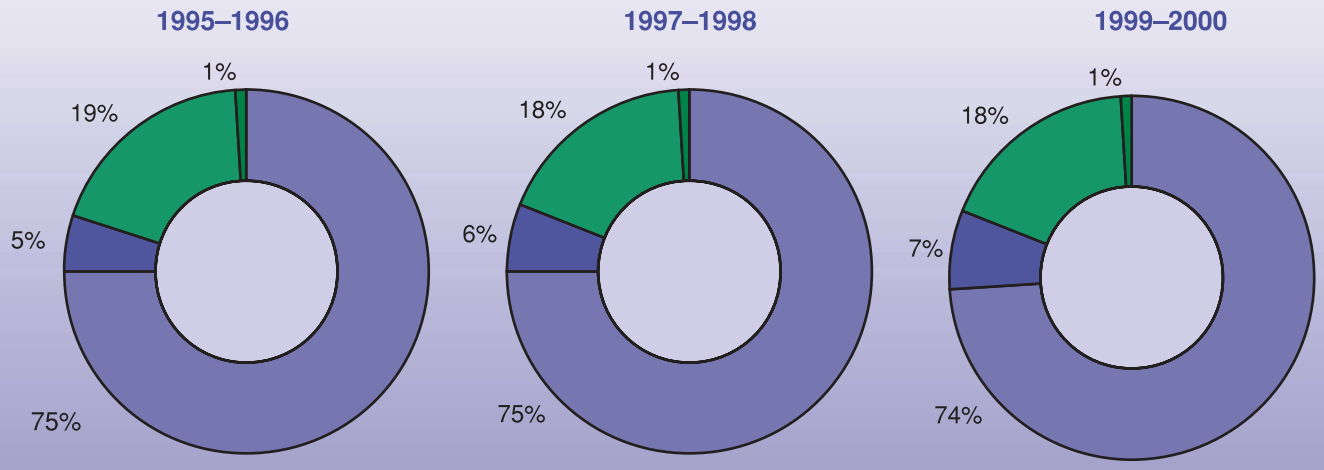
How the analysis was done

For this chapter, source of provider care refers to the type of physicians who monitor individuals with DM. Four categories of provider care were examined: 1) care from both DM specialists and family physicians; 2) care from DM specialists only; 3) care from family physicians only; and 4) no DM-related physician care, which was defined as individuals who had no family physician nor DM specialist visits, but who may have had visits to other specialists. Diabetes specialist visits were defined as visits to an endocrinologist or to a general internist where the submitted claim had the diagnosis code for DM. Office-based visits to all physicians in Ontario were extracted for each individual over the age of 20 years identified in the Ontario Diabetes Database (ODD) from

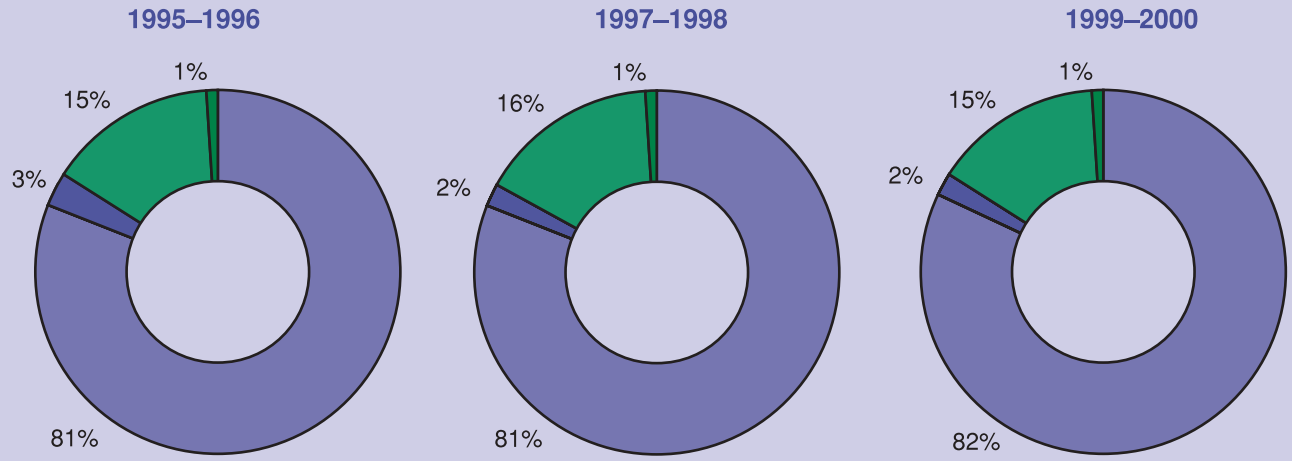
Exhibit 9.1 Distribution of Sources of Care for Adults with DM: Fiscal Years 1995–2000

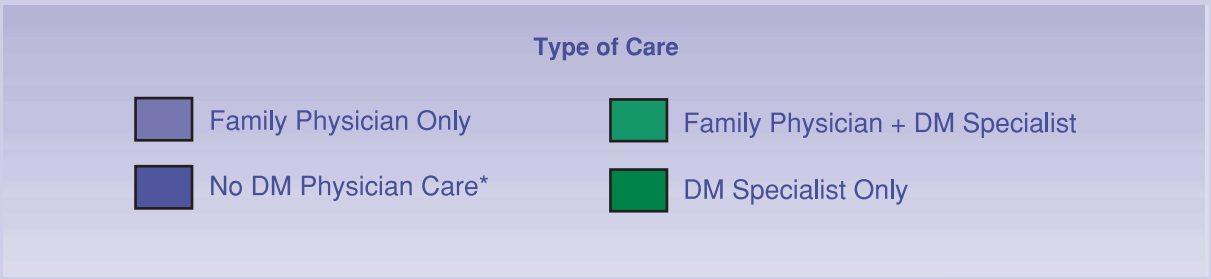
About three-quarters of people with DM in Ontario receive their DM care from family physicians only. Among those recently diagnosed, even fewer see DM specialists. An increasing proportion is not receiving any DM care from a physician.

All People Diagnosed with DM



People with Newly-diagnosed DM





Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). *No DM or Family Physician Visits but Visits to Other Specialits.
Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 9.2 Distribution of Sources of Care for Adults with DM by County in Ontario, 1995–2000

	1995–1996				1997–1998				1999–2000			
	Family Physician + DM Specialist	DM Specialist Only	Family Physician Only	No DM Physician Care	Family Physician + DM Specialist	DM Specialist Only	Family Physician Only	No DM Physician Care	Family Physician + DM Specialist	DM Specialist Only	Family Physician Only	No DM Physician Care
	%	%	%	%	%	%	%	%	%	%	%	%
Algoma District*	8.8	1.6	73.4	16.2	9.5	1.6	71.5	17.4	9.6	2.3	67.1	21.0
Brant County	12.5	0.6	84.6	2.4	10.6	0.4	85.4	3.5	11.9	0.5	83.5	4.1
Bruce County	10.2	0.3	86.0	3.4	14.0	0.2	81.6	4.2	13.6	0.4	81.9	4.1
Cochrane District	6.0	0.1	85.1	8.9	9.3	0.4	82.1	8.2	7.6	0.1	83.4	8.9
Dufferin County	19.1	0.3	77.3	3.3	18.9	0.4	76.7	4.0	19.8	0.3	76.0	3.9
Durham Regional Municipality	22.6	0.6	73.5	3.2	20.1	0.6	75.1	4.2	18.1	0.4	76.9	4.6
Elgin County	13.3	0.1	83.8	2.7	12.6	0.2	83.2	4.0	12.7	0.2	82.4	4.6
Essex County	30.4	1.3	64.3	4.0	27.1	1.5	67.3	4.2	25.8	0.8	68.7	4.7
Frontenac County*	9.2	0.6	85.9	4.3	3.2	0.3	90.5	5.9	5.7	0.3	88.7	5.2
Grey County	9.4	0.6	84.8	5.3	13.1	0.5	80.6	5.8	14.3	1.1	78.8	5.9
Haldimand-Norfolk Regional Municipality	11.2	0.3	85.9	2.5	11.4	0.3	84.7	3.6	10.5	0.5	84.3	4.7
Haliburton County	7.1	0.0	91.9	1.0	6.8	0.0	91.4	1.9	7.2	0.2	88.5	4.1
Halton Regional Municipality	21.0	1.5	73.2	4.3	22.2	1.3	70.9	5.6	20.6	0.9	72.5	6.1
Hamilton-Wentworth Regional Municipality*	19 .5	6.1	59.9	14.6	17.8	5.9	60.8	15.5	17.4	3.8	65.8	12.9
Hastings County	15.0	0.6	81.6	2.9	14.0	0.4	81.9	3.8	13.1	0.4	82.3	4.2
Huron County	14.1	0.9	81.3	3.7	13.9	0.7	80.4	4.9	12.1	0.6	82.7	4.6
Kenora District	3.5	0.9	86.8	8.8	3.3	0.8	82.3	13.6	3.4	0.7	81.7	14.3
Kent County	16.3	0.8	80.7	2.2	19.2	1.2	76.7	2.9	17.8	0.3	78.6	3.3
Lambton County	15.4	2.0	77.9	4.8	15.1	2.0	76.1	6.8	16.2	2.0	74.9	6.9
Lanark County*	8.5	0.4	88.2	2.9	9.6	0.3	85.8	4.3	9.8	0.3	85.0	5.0
Leeds and Grenville United Counties*	7.7	1.8	79.2	11.3	7.3	1.2	80.0	11.5	8.1	0.8	79.9	11.2
Lennox and Addington County	6.5	0.8	88.2	4.5	3.7	0.9	91.3	4.1	4.7	0.9	90.0	4.4
Manitoulin District*	2.3	0.2	91.7	5.9	2.4	0.1	90.9	6.5	1.9	0.1	92.8	5.1
Middlesex County	22.8	1.0	71.4	4.8	22.7	1.2	70.9	5.2	22.3	1.1	71.0	5.6
Muskoka Disrict Municipality	8.8	0.2	88.0	3.1	10.4	0.2	85.8	3.7	11.4	0.2	84.0	4.4
Niagara Regional Municipality	13.6	1.1	81.3	3.9	13.0	0.7	81.1	5.2	13.3	0.8	79.7	6.2
Nipissing District	17.8	0.9	78.3	3.0	17.3	0.6	78.5	3.6	15.2	0.3	79.8	4.6
Northumberland County	12.6	0.5	84.7	2.2	14.6	0.3	82.3	2.9	14.1	0.3	82.9	2.8
Ottawa-Carleton Regional Municipality	25.2	2.4	66.1	6.3	27.0	2.0	63.8	7.2	27.0	1.5	63.0	8.4
Oxford County	14.4	0.6	81.3	3.7	13.0	0.5	82.3	4.2	12.9	0.8	81.9	4.4
Parry Sound District	11.1	0.3	86.1	2.6	10.3	0.2	84.7	4.9	11.2	0.2	85.4	3.3
Peel Regional Municipality	23.7	0.6	71.6	4.1	22.6	0.6	71.0	5.8	22.1	0.4	71.0	6.5
Perth County	10.4	0.2	86.8	2.6	10.6	0.2	86.5	2.7	10.2	0.2	86.3	3.3
Peterborough County	14.6	0.9	81.4	3.1	15.5	0.8	80.1	3.6	15.8	0.7	79.4	4.1
Prescott and Russell United Counties	13.3	0.6	82.8	3.4	12.7	0.8	81.9	4.6	14.3	0.8	79.0	5.9
Prince Edward County	9.1	0.2	88.6	2.1	7.9	0.0	89.6	2.5	6.7	0.2	90.5	2.7
Rainy River District	0.5	0.0	95.5	4.0	1.5	0.1	92.4	6.1	1.1	0.2	90.4	8.3
Renfrew County	14.4	0.7	81.6	3.3	14.8	1.8	74.5	8.9	16.4	0.9	77.3	5.4
Simcoe County	15.3	0.3	81.7	2.7	14.1	0.3	82.2	3.4	14.4	0.3	81.5	3.9
Stormont, Dundas and Glengarry United Counties	22.4	1.1	72.3	4.3	23.8	1.3	69.7	5.3	25.3	1.1	68.2	5.4
Sudbury District	4.8	0.0	92.1	3.1	5.0	0.3	90.6	4.0	6.2	0.1	89.5	4.2
Sudbury Regional Municipality	4.2	0.0	93.2	2.5	5.2	0.1	91.6	3.1	5.6	0.2	90.6	3.6
Thunder Bay District	11.1	1.0	81.7	6.1	11.6	0.8	81.0	6.6	9.5	0.4	83.4	6.7
Timiskaming District	6.0	0.2	90.1	3.7	5.3	0.1	90.0	4.6	4.6	0.3	87.7	7.4
Toronto Metropolitan Municipality	22.4	1.1	71.7	4.7	21.1	0.9	72.1	5.9	20.3	0.8	71.9	6.9
Victoria County	11.4	0.3	86.3	2.0	12.1	0.3	85.0	2.6	11.8	0.3	84.3	3.5
Waterloo Regional Municipality*	12.5	3.0	72.3	12.1	12.6	2.9	70.5	14.0	13.0	2.7	70.0	14.2
Wellington County	17.7	3.0	73.4	6.0	17.3	1.9	74.1	6.6	17.4	1.4	75.2	6.1
York Regional Municipality	23.2	0.6	72.4	3.7	21.6	0.6	73.2	4.6	20.1	0.6	73.9	5.4

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995. *These counties have high proportions of physicians participating in alternative payment mechanisms, and the physician visit data are not complete. Caution is required with the interpretation of these results.

fiscal years 1995–2000. Office and clinic visits, nursing home visits and house call visits were included, while emergency room visits and inpatient visits were excluded.

For all individuals identified in the ODD, their sources of DM care were determined from office-based visits made over two-year intervals for three consecutive time frames (fiscal years 1995–1996, 1997–1998 and 1999–2000). Each time frame was analyzed using all individuals already diagnosed with DM as of the start of the time frame. In addition, sources of care were determined for individuals who were newly-diagnosed with DM during the first year of each time frame. Care was considered shared when individuals had visits to both DM specialists and family physicians during each time period, and when at least one of those family physicians was listed as the referring physician in at least one of the DM specialists' claims.

The age, sex and county of residence for each individual were retrieved from the ODD. The first year of each time frame was used to assign income quintiles based on that neighbourhood of residence from census data. Sources of care were compared based on these variables.

In addition, a family physician continuity of care index was calculated for each person by determining the proportion of all the family physician visits that person made with the most frequently seen family physician, regardless of the reason for the visit. This Usual Provider Continuity (UPC) index is an established measure of physician continuity of care.[3] For comparison, an age- and sex-matched group of people without DM was randomly selected, and their family physician UPC index was determined.

Interpretive Cautions

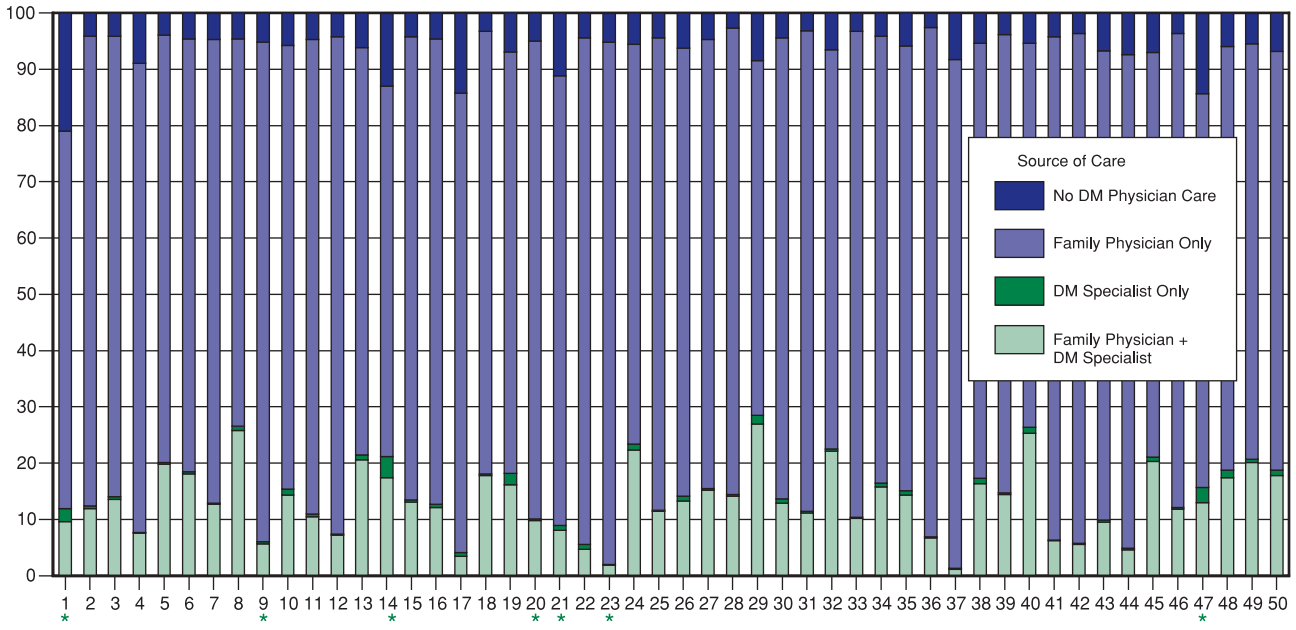
This chapter describes provider care by individual physicians. It does not describe care provided by groups of physicians and non-physician health care providers. In addition, only physicians paid on a fee-for-service basis who submitted claims to the Ontario Health Insurance Plan were included. Physicians participating in alternative payment mechanisms, community health centres or health service organizations are not included. Frontenac County, Algoma District and the Hamilton-Wentworth Regional Municipality have the highest proportion of physicians participating in alternative payment mechanisms (37.5%, 25.9% and 18.3% respectively), with another four counties (Lanark County, Leeds and Grenville United Counties, Waterloo Regional Municipality and Manitoulin District) having just over 10% participating physicians. Furthermore, care provided outside the province is not included. For example, some residents of northwestern Ontario may receive physician care (particularly specialist care), in Winnipeg, Manitoba.

Key Research Findings

- About three-quarters of people with diabetes mellitus (DM) in Ontario receive their physician care from family physicians only.
- The proportion of people receiving care from DM specialists decreases with increasing age.
- People with DM tend to see the same family physician for most of their ambulatory visits.
- Over the last five years, there has been a slight increase in the proportion of people with DM who are not receiving any physician care.
- Data sources did not allow for comment on the contribution of non-physicians (nurses, nurse practitioners, dieticians etc.) to the care of persons with DM.

Exhibit 9.3 Sources of Care for Adults with DM Averaged by County, 1999–2000

There is significant variation in the use of DM specialists across different regions of the province.



	Family Physician + DM Specialist	DM Specialist Only	Family Physician Only	No DM Physician Care
1. Algoma District*	9.6%	2.3%	67.1%	21.0%
2. Brant County	11.9%	0.5%	83.5%	4.1%
3. Bruce County	13.6%	0.4%	81.9%	4.1%
4. Cochrane District	7.6%	0.1%	83.4%	8.9%
5. Dufferin County	19.8%	0.3%	76.0%	3.9%
6. Durham Regional Municipality	18.1%	0.4%	76.9%	4.6%
7. Elgin County	12.7%	0.2%	82.4%	4.6%
8. Essex County	25.8%	0.8%	68.7%	4.7%
9. Frontenac County*	5.7%	0.3%	88.7%	5.2%
10. Grey County	14.3%	1.1%	78.8%	5.9%
11. Haldimand-Norfolk Regional Municipality	10.5%	0.5%	84.3%	4.7%
12. Haliburton County	7.2%	0.2%	88.5%	4.1%
13. Halton Regional Municipality	20.6%	0.9%	72.5%	6.1%
14. Hamilton-Wentworth Regional Municipality *	17.4%	3.8%	65.8%	12.9%
15. Hastings County	13.1%	0.4%	82.3%	4.2%
16. Huron County	12.1%	0.6%	82.7%	4.6%
17. Kenora District	3.4%	0.7%	81.7%	14.3%
18. Kent County	17.8%	0.3%	78.6%	3.3%
19. Lambton County	16.2%	2.0%	74.9%	6.9%
20. Lanark County*	9.8%	0.3%	85.0%	5.0%
21. Leeds and Grenville United Counties*	8.1%	0.8%	79.9%	11.2%
22. Lennox and Addington County	4.7%	0.9%	90.0%	4.4%
23. Manitoulin District*	1.9%	0.1%	92.8%	5.1%
24. Middlesex County	22.3%	1.1%	71.0%	5.6%
25. Muskoka District	11.4%	0.2%	84.0%	4.4%

	Family Physician + DM Specialist	DM Specialist Only	Family Physician Only	No DM Physician Care
26. Niagara Regional Municipality	13.3%	0.8%	79.7%	6.2%
27. Nipissing District	15.2%	0.3%	79.8%	4.6%
28. Northumberland County	14.1%	0.3%	82.9%	2.8%
29. Ottawa-Carleton Regional Municipality	27.0%	1.5%	63.0%	8.4%
30. Oxford County	12.9%	0.8%	81.9%	4.4%
31. Parry Sound District	11.2%	0.2%	85.4%	3.3%
32. Peel Regional Municipality	22.1%	0.4%	71.0%	6.5%
33. Perth County	10.2%	0.2%	86.3%	3.3%
34. Peterborough County	15.8%	0.7%	79.4%	4.1%
35. Prescott and Russell United Counties	14.3%	0.8%	79.0%	5.9%
36. Prince Edward County	6.7%	0.2%	90.5%	2.7%
37. Rainy River District	1.1%	0.2%	90.4%	8.3%
38. Renfrew County	16.4%	0.9%	77.3%	5.4%
39. Simcoe County	14.4%	0.3%	81.5%	3.9%
40. Stormont, Dundas and Glengarry United Counties	25.3%	1.1%	68.2%	5.4%
41. Sudbury District	6.2%	0.1%	89.5%	4.2%
42. Sudbury Regional Municipality	5.6%	0.2%	90.6%	3.6%
43. Thunder Bay District	9.5%	0.4%	83.4%	6.7%
44. Timiskaming District	4.6%	0.3%	87.7%	7.4%
45. Toronto Metropolitan Municipality	20.3%	0.8%	71.9%	6.9%
46. Victoria County	11.8%	0.3%	84.3%	3.5%
47. Waterloo Regional Municipality*	13.0%	2.7%	70.0%	14.2%
48. Wellington County	17.4%	1.4%	75.2%	6.1%
49. York Regional Municipality	20.1%	0.6%	73.9%	5.4%
50. Ontario	17.85%	0.93%	74.36%	6.87%

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). *These counties have high proportions of physicians participating in alternative payment mechanisms, and the physician visit data is not complete. Caution is required with the interpretation of these results.

The identification of a referring physician in DM specialists' OHIP claims is an indirect method of measuring shared care between family physicians and DM specialists. Submission of a referring physician number is mandatory only for initial consultations; only about 30% of subsequent visits with the specialist include this number, even if the person's care continues to be shared. Furthermore, the algorithm used in the analysis would not consider care shared if the referring physician listed in the OHIP claim was another specialist the person was seeing or was the person's previous family physician, regardless of whether or not care was in fact shared between the DM specialist and the current family physician. While these problems would lead to an underestimation of shared care, it could also lead to an overestimation if a specialist indicated the family physician as the referring physician, but no communication between the physicians took place.

Some specialists who were not studied here (e.g., cardiologists) may have provided treatment aimed at reducing DM-related complications in the course of their consultations, which would not be captured in these data, and could also result in an underestimation of specialist care delivered to persons with DM.

The continuity of family physician care is evaluated by determining the proportion of all family physician billings submitted by the most frequently seen family physician. However, some family physicians may operate in group practices with several different physicians. In these instances, only the billings submitted by the most frequently seen family physician, and not his or her colleagues, would be counted in the numerator of the continuity of care measurement. However, previous studies have suggested that continuity of care with the individual physician is more important than continuity with the practice site or office.[4] The continuity of care estimates are also only based on office/ambulatory visits made to family physicians. Emergency room visits made by people with DM, including those not resulting in an admission to hospital, are not included. The inclusion of emergency room visits would decrease the continuity of care estimates.

The CDA recommends an interdisciplinary DM health care team, which includes physicians, nurses, dietitians and other important practitioners. However, with administrative data, only care provided by physicians could be measured.

Findings and Discussion

The distribution of providers of physician care for individuals with DM in Ontario is illustrated in Exhibit 9.1. Among all individuals with DM, approximately 75% received their care from family physicians only. When compared to all people with DM, those newly diagnosed were less likely to see no physician and more likely to see only a family physician. There was a slight increase in the proportion of people already diagnosed with DM not receiving any care from physicians between 1995–1996 and 1999–2000. To examine this further, the distribution of providers seen two years after people were first diagnosed with DM was determined. It similarly demonstrated an increased proportion receiving no physician care over time. Among those seeing both family physicians and DM specialists, approximately half appeared to have had shared care between the family physician and the DM specialist.

Variations in care by county

The sources of care for people with DM by county are shown in Exhibit 9.2, and shown graphically for 1995–2000 in Exhibit 9.3. Significant regional variations in the physician sources of DM care are demonstrated. While Frontenac County was below the provincial mean for use of specialists, likely because physicians affiliated with Queen's University in Kingston have an alternative payment program and do not submit billings to OHIP, the other counties containing academic medical centres had high specialist use. The top counties for specialist use include: three counties in the Greater Toronto Area, and Essex, Stormont/Dundas/Glengary United and Dufferin counties. The proportions of people not seeing either a family physician or a DM specialist were highest in Kenora District, Cochrane District, Ottawa-Carleton Regional Municipality and Rainy River District.

Variations in care by age and sex

The sources of care for people with DM, broken down by their age and sex, are shown in Exhibit 9.4. The most striking finding is that the proportion of people seeing specialists declined with advancing age. For example, in 1995 to 1996, 38.2% of people aged 20 to 34 saw DM specialists, while only 11.2% of people aged 75 and over did. For all but the very elderly, women saw DM specialists more than men, while in all ages, a slightly higher proportion of men than women saw no DM physicians.

Variations in care by socioeconomic status

The sources of care for people with DM by socioeconomic status (SES), as defined by neighbourhood income quintiles, are shown in Exhibit 9.5. For all time frames, the proportion of people receiving their care from family physicians alone is similar for the four lowest SES levels. However, the proportion of persons with DM seeing a family physician alone was slightly lower in the highest SES category. Conversely, a slightly higher proportion of people with DM in the highest SES category received their care from both family physicians and DM specialists compared to all other SES categories.

Family physician continuity of care

Compared with the general population, a higher proportion of people with DM saw a family physician (Exhibit 9.6). While the family physician continuity of care index was quite high for

Exhibit 9.4 Distribution of Sources of Care for Adults with DM by Age and Sex in Ontario, 1995–2000

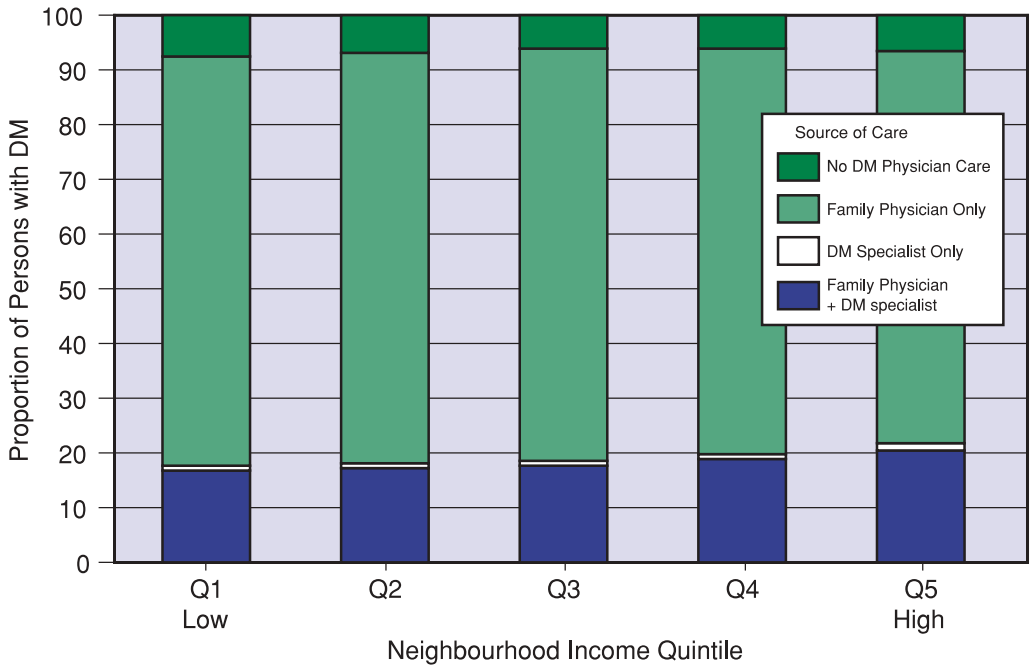
The proportion of people seeing DM specialists decreases with age, and is lower for men than women. Men are also more likely to not see any physician for DM care.

	1995–1996				1997–1998				1999–2000			
	Family Physician + DM Specialist	DM Specialist Only	Family Physician Only	No DM Physician Care	Family Physician + DM Specialist	DM Specialist Only	Family Physician Only	No DM Physician Care	Family Physician + DM Specialist	DM Specialist Only	Family Physician Only	No DM Physician Care
	%	%	%	%	%	%	%	%	%	%	%	%
Women												
20–34	39.0	1.8	54.0	5.2	34.8	1.5	57.1	6.5	32.7	1.2	58.9	7.1
35–49	27.5	1.3	67.6	3.6	25.5	1.1	68.3	5.1	24.6	0.8	68.7	5.8
50–64	22.2	1.0	72.6	4.2	22.3	1.1	71.8	4.8	21.9	0.9	72.1	5.1
65–74	17.5	1.1	76.9	4.5	17.6	0.9	76.0	5.4	17.5	0.8	75.7	6.0
75 +	10.2	0.7	82.8	6.3	10.0	0.6	82.5	6.9	9.8	0.5	82.1	7.6
Men												
20–34	31.8	3.4	56.5	8.4	28.1	3.1	57.3	11.4	27.3	2.5	57.4	12.8
35–49	22.4	1.6	9.6	6.4	21.0	1.5	69.5	8.1	20.7	1.3	69.3	8.6
50–64	18.9	1.5	74.6	5.1	18.5	1.4	73.8	6.3	18.3	1.1	73.8	6.8
65–74	15.3	1.3	78.3	5.1	15.5	1.1	77.5	5.9	15.2	0.9	77.5	6.4
75 +	10.6	1.0	81.9	6.5	10.6	0.9	80.9	7.6	10.5	0.7	80.4	8.4
Total												
20–34	35.7	2.5	55.2	6.7	31.8	2.2	57.2	8.8	30.3	1.8	58.3	9.7
35–49	24.7	1.5	68.7	5.2	23.0	1.3	68.9	6.7	22.5	1.1	69.1	7.3
50–64	20.3	1.3	73.7	4.7	20.1	1.2	73.0	5.7	19.9	1.0	73.1	6.1
65–74	16.4	1.2	77.6	4.8	16.5	1.0	76.8	5.7	16.3	0.8	76.6	6.2
75 +	10.4	0.8	82.4	6.4	10.2	0.7	81.9	7.2	10.1	0.6	81.3	7.9

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

Exhibit 9.5 Sources of Care for Adults with DM by Neighbourhood Income Level, 1999–2000

People with the highest income level have a higher proportion of care provided by both family physicians and DM specialists and a lower proportion of care provided by family physicians only than people with lower income levels.



Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

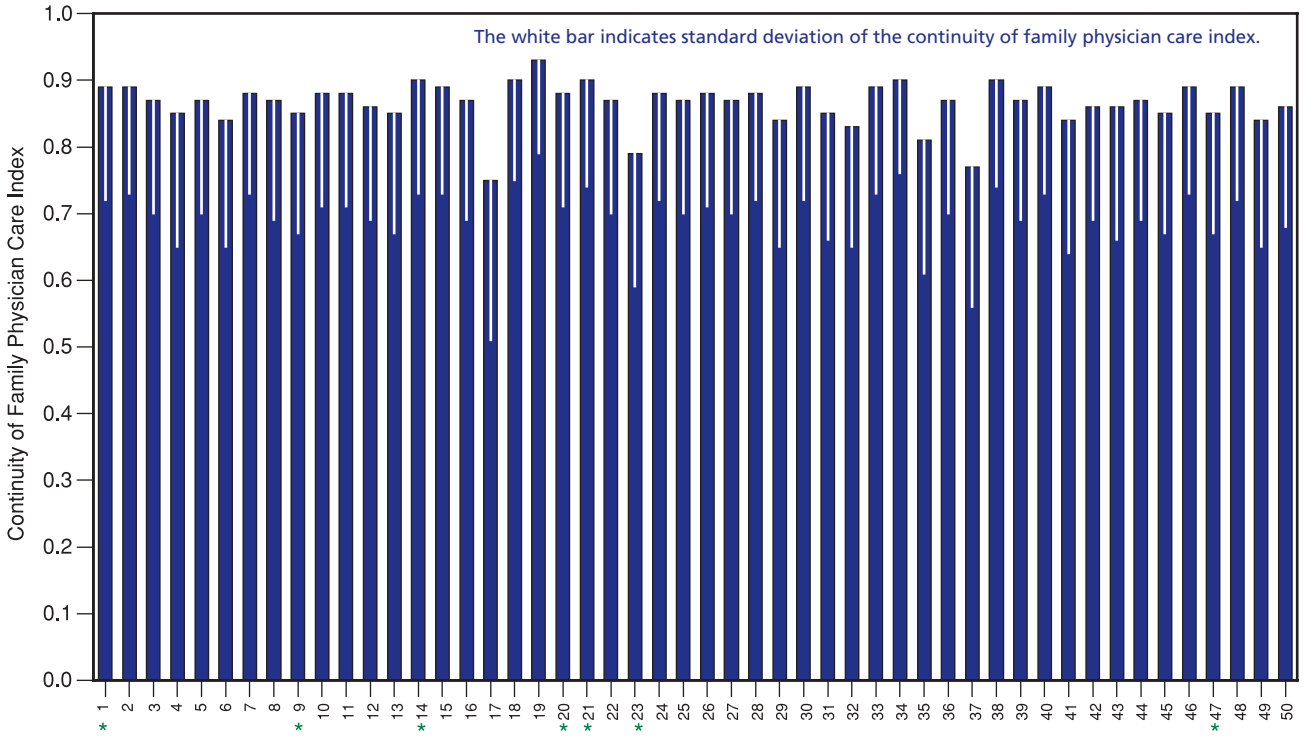
Exhibit 9.6 Family Physician Continuity of Care Indices for Adults with/without DM in Ontario, 1999–2000

	Proportion Seeing Family Physicians	Continuity of Family Physician Care Index*	
		Mean	Std Dev
People with DM			
Also seeing DM specialists	95.1%	0.84	0.19
Not seeing DM specialists	91.5%	0.86	0.18
People without DM	83.5%	0.85	0.19

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP), Registered Persons Database (RPDB). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995. * The continuity of family physician care index is the proportion of all family physician visits made with the most-frequently seen physician. Therefore, if all visits are with the same physician, the index equals 1.00.

Exhibit 9.7 Family Physician Continuity of Care Indices for Adults with DM (mean and standard deviation) by County, 1999–2000

Continuity of care is lower in many Northern Ontario Counties.

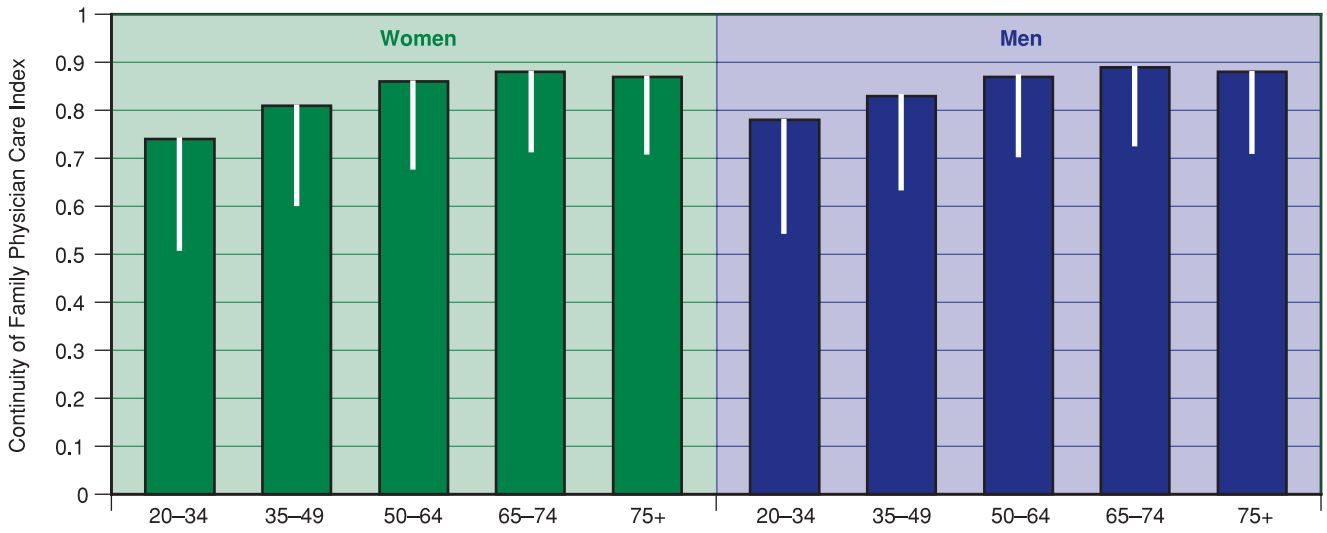


1. Algoma District*
2. Brant County
3. Bruce County
4. Cochrane District
5. Dufferin County
6. Durham Regional Municipality
7. Elgin County
8. Essex County
9. Frontenac County*
10. Grey County
11. Haldimand-Norfolk Regional Municipality
12. Haliburton County
13. Halton Regional Municipality
14. Hamilton-Wentworth Regional Municipality*
15. Hastings County
16. Huron County
17. Kenora District
18. Kent County
19. Lambton County
20. Lanark County*
21. Leeds and Grenville United Counties*
22. Lennox and Addington County
23. Manitoulin District*
24. Middlesex County
25. Muskoka District
26. Niagara Regional Municipality
27. Nipissing District
28. Northumberland County
29. Ottawa-Carleton Regional Municipality
30. Oxford County
31. Parry Sound District
32. Peel Regional Municipality
33. Perth County
34. Peterborough County
35. Prescott and Russell United Counties
36. Prince Edward County
37. Rainy River District
38. Renfrew County
39. Simcoe County
40. Stormont, Dundas and Glengarry United Counties
41. Sudbury District
42. Sudbury Regional Municipality
43. Thunder Bay District
44. Timiskaming District
45. Toronto Metropolitan Municipality
46. Victoria County
47. Waterloo Regional Municipality*
48. Wellington County
49. York Regional Municipality
50. Ontario

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995. *Counties with high proportions of physicians participating in alternative payment mechanisms; physician visit data is not complete. Caution required in interpretation of these results.

Exhibit 9.8 Family Physician Continuity of Care Indices for Adults with DM (Mean and Standard Deviation) by Age and Sex, 1999–2000

Continuity of care improves with age and there are no significant differences between men and women.



The white bar indicates standard deviation of the continuity of family physician care index.

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). Note: Fiscal year 1995 = April 1, 1994 to March 31, 1995.

people with DM, there was little difference compared to the family physician continuity of care for the general population.

Family physician continuity of care indices by county in 1999–2000 are displayed in Exhibit 9.7. Many of the counties with lowest continuity indices were in northern Ontario, including Kenora, and Rainy River Districts. However, many urbanized regions also had continuity indices below average.

The family physician continuity of care indices by age and sex in 1999–2000 are shown in Exhibit 9.8. Continuity of primary care did not differ greatly between men and women. However, continuity with the most often seen family physician tended to increase with advancing age.

Conclusions

The current guidelines from the Canadian Diabetes Association suggest that care for people with DM should be made up of interdisciplinary teams including a primary care physician, non-physician health care providers such as dieticians and nurses, and sometimes require a physician DM specialist. In Ontario, fewer than one in five people with DM had contact with a DM specialist, and this proportion decreased slightly between 1995 and 2000. The decreasing availability and accessibility of endocrinologists and general internists in Ontario, driven in part by increasing numbers of people with DM, may contribute to this finding. Furthermore, more than one in twenty did not see any physician for DM care, and this proportion increased slightly over the five year time period. This finding has important implications, as family physicians are the gate-keepers to the medical system for persons with DM. This may reflect a decrease in access to family physicians in Ontario. Given that DM is a common chronic medical condition and given that family physicians are the main physician providers of care for people with DM (almost 75 % of persons with DM in 2000 were cared for by family physicians alone), the importance of targeting practical, evidence-based guidelines to family physicians is emphasized.

Younger people saw DM specialists more often than older people and the proportion of women seeing a DM specialist was slightly higher than men. These variations may be due to differences in people's expectations for their care, or differences in physicians' threshold for referral. For example, continuity of care with a family physician was higher among older persons with DM. This continuous relationship may make it less likely for the family physician to refer them to a specialist. Younger people with DM are more likely to have type 1 DM that requires insulin injections for therapy. The higher referral rate to specialists may reflect less confidence among family physicians with initiating and monitoring insulin therapy in people with type 1 DM. While people with type 2 DM may start with oral hypoglycemic medications initially, they often require insulin later in life. Lower referral rates for the elderly may reflect a higher proportion of elderly only requiring oral hypoglycemic therapy, more confidence among family physicians with initiating insulin therapy for people with type 2 DM or a reluctance to refer elderly patients to DM specialists for consideration of insulin therapy.

There were regional variations in the distribution of sources of DM physician care between different counties in Ontario. This may reflect the different distribution of specialist care in Ontario, along with variations in local practice style of DM care. The availability of non-physician (nurse, pharmacist and dietician) care may also influence these regional variations, and this could not be measured. However, it is not known what level of interdisciplinary care in Ontario is associated with good quality of care for persons with DM, which presumably varies from patient to patient. Further work utilizing quality of care outcomes is needed before commenting on appropriate proportions of interdisciplinary care in any region in Ontario.

Socioeconomic status (SES) has been associated with a person's health status and health needs.[5] The proportion of people seeing both family physicians and DM specialists was highest in the highest SES quintile. This finding is similar to that observed in other chronic and psychiatric diseases where family physicians tend to be the only physician providers of care for persons with lower SES.[6] This may reflect less access to specialist physicians in lower SES neighbourhoods and/or expectation for referral in higher SES groups. However, the absolute difference between the lowest and highest quintile in the proportion of patients seeing both a family physician and a specialist was small (<4%), suggesting that overall, access to physicians was reasonably equitable.

Continuity of family physician care was quite high, both among people with DM who did not see specialists and among those who did. This is generally found in other chronic disease conditions as well.[7] However, regional variations between counties were found, not all explained by counties having a higher proportion of physicians participating in Alternative Payment mechanisms (and therefore not included in the analysis). Although continuity increased with increasing age, no difference between genders was noted.

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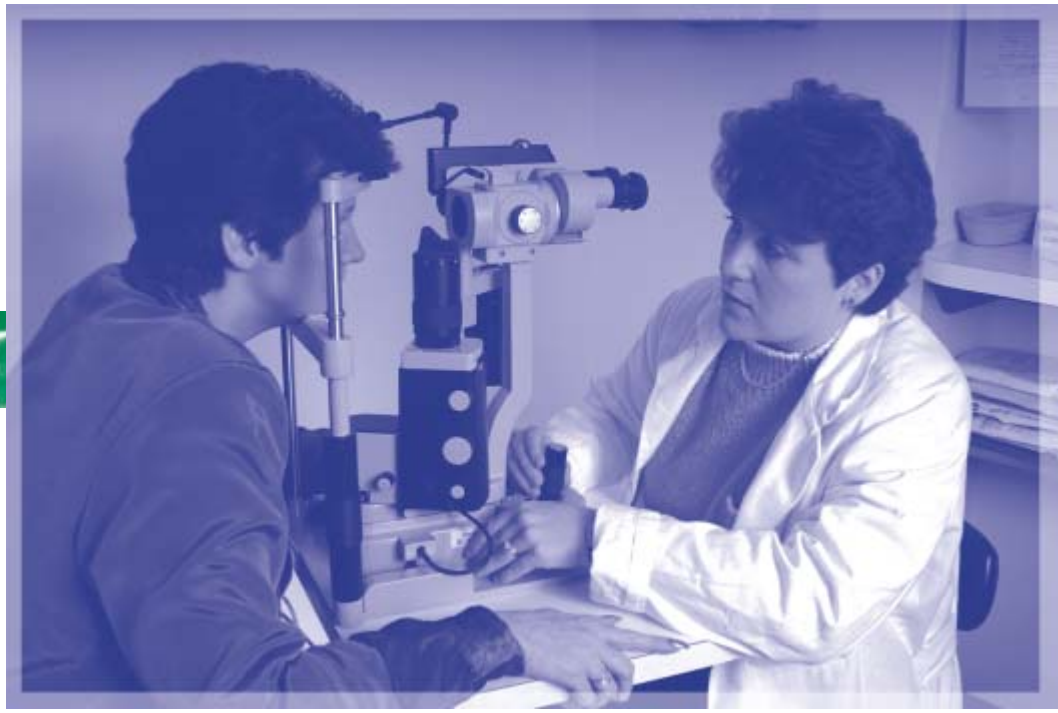
10

Chapter

Diabetes and the Eye

Authors: Ralf Buhrmann, David Assaad, Janet E. Hux, Mei Tang and Kathy Sykora



Key Messages

- Diabetic retinopathy (DR) is a common complication of diabetes mellitus (DM) and is the leading cause of blindness in Canadians between the ages of 30 and 69.
- Most vision loss from diabetic retinopathy can be prevented through periodic retinal screening examinations and timely laser photocoagulation treatment. Rates of these exams fall far short of guideline recommendations for Ontarians with DM.
- The onset and progression of DR can be substantially reduced through tight control of blood glucose and hypertension. Strategies will need to be developed to translate evidence regarding prevention and screening into practice.

Background

Diabetic retinopathy (DR) is a common complication of diabetes mellitus (DM), with a prevalence of about 70% in persons with type 1 diabetes[1,2] and 40% in persons with type 2 diabetes.[3,4] Diabetic retinopathy poses a serious threat to vision and is the leading cause of blindness in Canadians between the ages of 30 and 69.[5]

Early (non-proliferative) DR is seen in nearly all persons with type 1 DM and 60% of those with type 2 after 20 years.[2,4] Non-proliferative DR may progress to proliferative DR, which is characterized by the appearance of new retinal blood vessels (neovascularization). These new vessels have a propensity to bleed and lead to other potentially blinding complications. If proliferative DR is detected early, vision loss may be prevented by retinal laser photocoagulation. Left untreated, proliferative DR leads to blindness in 50% of patients within 5 years.[6] Proliferative DR develops in 50% of people with type 1 DM by the time they have had the disease for 20 years, but in less than 10% of people with type 2 DM.[2,4] One important feature of the epidemiology of type 2 DM is that DR may already be present when the diagnosis of DM is made due to delayed detection of the diabetes. In one study, non-proliferative DR was found in 22% and proliferative DR was present in about 4% of individuals at the time of diagnosis of type 2 DM.[4]

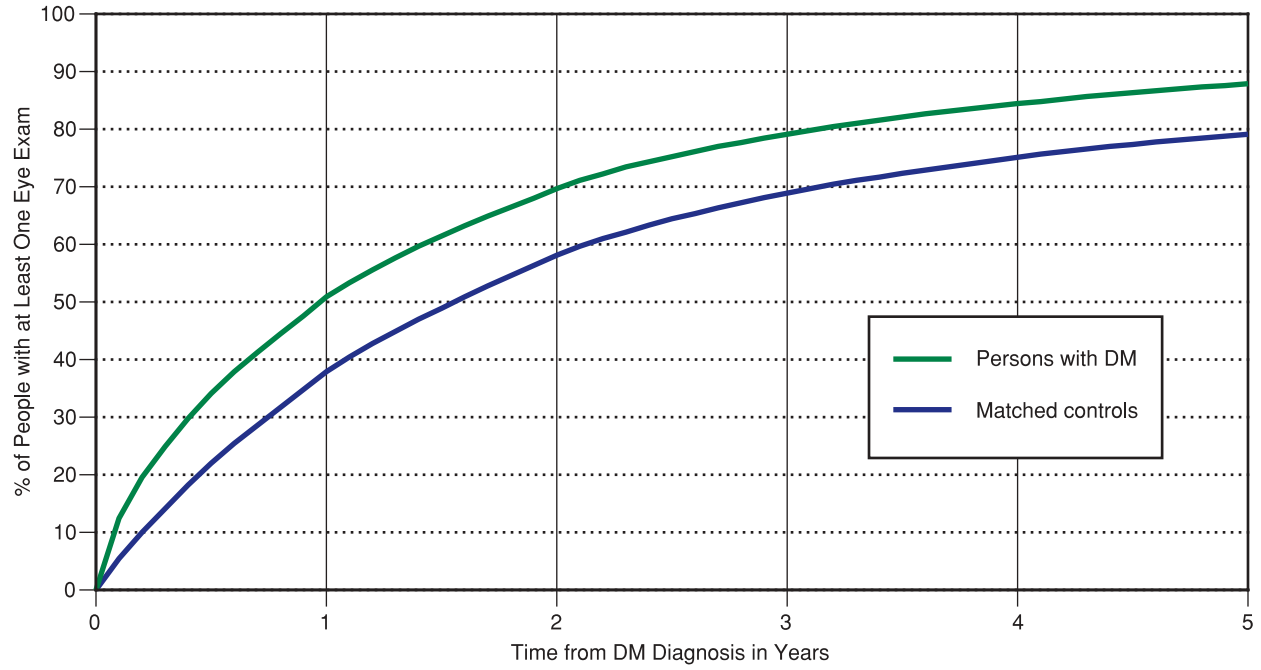
In persons with DR, vision loss may also develop from the accumulation of fluid and lipid in the region of the retina that serves central vision known as the macula. Vision loss in diabetes also results from an increased occurrence of cataracts[7] and open angle glaucoma may occur more frequently as well.[8]

Vision loss from DR may be averted by prevention strategies and by early detection and treatment.[9] Several randomized clinical trials have demonstrated that tight control of blood sugar,[10–12] and hypertension[13,14] decreases the occurrence and progression of DR. Other randomized clinical trials have convincingly demonstrated that early laser treatment (retinal photocoagulation) of sight-threatening DR decreases the risk of severe vision loss from proliferative DR by 90%[15–17] and the risk of vision loss from macular edema by 50%.[18] One particularly important finding from these studies was that the effectiveness of treatment is optimal before vision loss occurs and falls sharply if applied later. This highlights the critical importance of regular screening examinations.

There is widespread agreement that screening for DR should involve a dilated examination of the retina by a trained examiner and that this should occur at the time of diagnosis of type 2 DM and at regular intervals thereafter.[19,20] For type 1 DM, screening should begin 5 years after the diagnosis of DM in persons over 15 years of age and should be done annually.[19] Most guidelines stress the importance of stereoscopic retinal examination to enable the detection of macular edema[20] in addition to proliferative DR. Due to the equipment required, this necessitates referral to an ophthalmologist or optometrist.

Exhibit 10.1 Incidence of Eye Examination within Five Years After Diagnosis of DM in Ontarians Diagnosed at 30 Years of Age and Older

Even five years after diagnosis, 12% of Ontarians aged 30 or older with new-onset DM had not yet had an eye examination. Rates of eye exams in persons with DM are only modestly higher than in matched controls without DM, suggesting low rates of intentional referral for screening.



Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP)

Exhibit 10.2 Cumulative Incidence of Eye Examination One, Two, and Five Years after Diagnosis of DM in Ontarians with/without DM at Diagnosis by Age and Sex

The proportion of persons screened rose rapidly to 51% at one year, findings that fall far short of the current practice guideline recommendation that all people newly-diagnosed with DM 30 years of age or older should promptly undergo a dilated retinal screening examination.

Age at DM Diagnosis		Eye Examination Within One Year of DM Diagnosis			Eye Examination Within Two Years of DM Diagnosis			Eye Examination Within Five Years of DM Diagnosis		
		DM	Matched Controls	Difference	DM	Matched Controls	Difference	DM	Matched Controls	Difference
30–49	Men	42.0	22.4	19.6	60.4	40.2	20.2	82.5	64.6	17.9
	Women	45.1	29.6	15.5	66.4	51.6	14.7	87.7	76.5	11.2
	Overall	43.4	25.7	17.7	63.1	45.4	17.7	84.9	70.0	14.8
50–64	Men	48.3	32.2	16.1	68.4	54.1	14.3	88.1	77.5	10.6
	Women	52.1	38.5	13.6	73.1	63.1	10.0	91.1	85.1	6.0
	Overall	49.9	34.9	15.0	70.4	58.0	12.5	89.4	80.8	8.6
65–79	Men	56.4	46.6	9.8	73.4	65.6	7.8	89.1	83.1	5.9
	Women	61.4	54.2	7.2	78.0	72.8	5.2	90.9	88.2	2.7
	Overall	58.9	50.4	8.5	75.7	69.2	6.5	90.0	85.7	4.3
80+	Men	55.4	51.4	4.0	69.9	65.5	4.4	83.2	78.4	4.8
	Women	53.6	50.0	3.5	66.3	63.2	3.0	77.8	75.7	2.1
	Overall	54.2	50.5	3.7	67.6	64.1	3.5	79.6	76.6	3.0
Overall	Men	49.1	34.5	14.6	67.6	54.0	13.7	86.6	75.5	11.1
	Women	53.3	42.2	11.1	72.3	63.2	9.1	89.3	83.2	6.1
	Overall	51.1	38.1	12.9	69.8	58.3	11.5	87.9	79.1	8.8

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP)

Exhibit 10.3 Cumulative Incidence of Follow-up Eye Examination One, Two, and Four Years after Initial Eye Screening in Ontarians with/without DM by Age and Sex

Four years after an initial screening examination, 16% of Ontarians with DM had not undergone a follow-up eye examination compared to 18% of persons without DM.

Age at DM Diagnosis		Eye Examination Within One Year of Initial Exam			Eye Examination Within Two Years of Initial Exam			Eye Examination Within Four Years of Initial Exam		
		DM	Matched Controls	Difference	DM	Matched Controls	Difference	DM	Matched Controls	Difference
30–49	Men	10.6	4.3	6.3	37.5	19.8	17.7	76.2	68.4	7.8
	Women	11.2	5.4	5.8	40.4	23.7	16.7	81.9	76.9	5.0
	Overall	10.9	4.9	6.0	38.9	21.8	17.1	78.8	72.7	6.2
50–64	Men	15.1	8.8	6.3	46.6	31.8	14.7	82.1	76.7	5.4
	Women	17.0	10.2	6.9	51.8	38.1	13.7	85.7	82.9	2.9
	Overall	16.0	9.4	6.5	48.9	34.7	14.2	83.7	79.5	4.2
65–79	Men	26.0	21.9	4.1	71.1	67.3	3.8	89.0	88.0	1.1
	Women	28.1	24.3	3.9	74.0	72.4	1.6	89.4	90.0	-0.7
	Overall	27.1	23.1	3.9	72.6	70.0	2.6	89.2	89.0	0.1
80+	Men	31.6	29.9	1.7	74.5	74.1	0.5	86.7	86.8	-0.1
	Women	32.5	31.1	1.4	72.6	73.5	-0.9	83.9	86.0	-2.1
	Overall	32.2	30.7	1.5	73.3	73.7	-0.4	84.9	86.3	-1.4
Total	Men	17.8	13.0	4.8	52.6	42.6	10.0	82.8	79.0	3.9
	Women	20.3	15.7	4.6	57.8	49.8	8.00	85.9	84.3	1.6
	Overall	19.0	14.4	4.7	55.1	46.2	8.9	84.3	81.7	2.6

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). Note: 1) Based on people (cases and controls) who did receive a first eye exam—N=337,661. 2) The follow-up eye exam had to occur eight months or more after the initial one.

Exhibit 10.4 Estimates of Adherence to Screening Guidelines for Diabetic Retinopathy after Diagnosis of DM in Ontario

Recommended for Timing of Screening	Surrogate Measure Used in this Analysis	Estimated Adherence to Screening Recommendation
• At diagnosis.	(a) ocular exam within one year of diagnosis	51.1%
Canadian Diabetes Assocation—1998 Clinical Practice Guidelines • Follow-up screening for "no or mild diabetic retinopathy" within 4 years of initial screening	(b) ocular exam within 4 years of initial exam*	84.3% of those initially screened
• At diagnosis + 4 year follow-up	(a) x (b)	43.1% of DM population
American Academy of Ophthalmology—1998 Preferred Practice Pattern • Follow-up screening for "no or mild diabetic retinopathy" within 1 year of initial screening	(c) ocular exam within 2 years of initial exam*	55.1% of those initially screened
• At diagnosis + 1 year follow-up	(a) x (c)	28.1% of DM population

Sources: *CMAJ* 1998; 159 (Suppl 8): S1–S29 and American Academy of Ophthalmology–1998 Preferred Practice Pattern. http://www.aao.org/aao/education/library/loader.cfm?url=/commonspot/security/getfile.cfm&PageID=6542 * excludes eye exams within 8 months of initial exam.

Exhibit 10.5 Predictors of Initial Eye Examination in the First Year after DM Diagnosis

Women and those in older age groups were more likely to seek out eye examination.

	% Having Eye Exam Within One Year	Adjusted Hazard Ratio (95%CI)
Income Quintiles		
Q1 (low)	47.0	1.0
Q2	48.5	1.03 (1.0,1.0)
Q3	50.3	1.08 (1.1,1.1)
Q4	50.6	1.09 (1.1,1.1)
Q5 (high)	53.2	1.17 (1.1,1.2)
Age at DM Diagnosis		
30–49	43.0	1.0
50–64	49.2	1.21 (1.2,1.2)
65–79	56.5	1.53 (1.5,1.6)
80+	48.0	1.36 (1.3,1.4)
Sex		
Men	47.8	1.0
Women	51.8	1.11 (1.1,1.1)
Rural		
No	49.5	1.0
Yes	50.8	1.00 (1.0,1.0)

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP), Statistics Canada Census Data 1996

Screening and treatment for DR have been shown to be cost-effective for preventing vision loss, and may also be cost-saving from a societal perspective.[21] Despite their tremendous potential health and economic benefits, there is little evidence that screening guidelines have been widely implemented. An audit of primary care charts of persons in Newfoundland with type 2 DM showed that only 54% had been referred to an eye care professional,[22] and available data from the US describe similarly low rates of screening.[23,24] On the other hand, a national screening program in Iceland[25] and regional efforts in Denmark[26] and Sweden[27] appear to have substantially lowered the incidence and prevalence of vision loss from DM.

This chapter describes patterns of eye examinations and retinal laser treatment over time and across geographic regions in Ontarians with DM. The use of vitrectomy is also examined as a marker of adverse ocular outcomes from DR. Finally, this chapter explores the frequency of cataract surgery in people with DM.

Data Sources

Persons with DM were identified using the Ontario Diabetes Database (ODD) (see Chapter 1, Technical Appendix TA1.A). Selected eye examinations by ophthalmologists, optometrists, and refracting physicians (general practitioners who devote a substantial portion of their practice to eye examinations) were identified using service claims from the Ontario Health Insurance Plan (OHIP) database (see Technical Appendix TA10.A). OHIP service claims by ophthalmologists were also used to identify cataract surgery, vitrectomy and retinal laser photocoagulation (see Technical Appendix TA10.A). Information regarding the demographics of persons eligible for health care coverage in Ontario came from the Registered Persons Database (RPDB). Records from all these sources were linked using a unique encrypted patient identifier. Census data from Statistics Canada were used to assign socioeconomic status on the basis of neighborhood of residence. Population denominators were derived from Statistics Canada inter- and post-censal estimates.

How We Did the Analysis

In order to examine the adherence to screening recommendations for DR, a cohort consisting of all residents of Ontario aged 30 years or older who were newly-diagnosed with DM between Nov 1994 and March 1999 were identified. Age 30 or more at diagnosis of DM was used as a working definition of new onset type 2 DM; prompt screening would be recommended for such individuals. Unfortunately, there is no specific OHIP fee code for retinopathy screening. Accordingly, the OHIP database was used to identify claims for physician visits which might represent an opportunity to perform a retinal screening exam, i.e. any visit to an ophthalmologist, optometrist or a refracting physician, in which the examining professional could reasonably have been expected to have carried out a dilated retinal

Key Research Findings

- Screening rates for diabetic retinopathy (DR) fall far below those recommended by evidence-based practice guidelines. Although guidelines recommend screening at the time of diagnosis in type 2 diabetes mellitus (DM) (the commonest form of DM), only 51% of such persons undergo an eye exam within one year of diagnosis.
- Rates of eye exams were, in general, only minimally higher in persons with DM than in those without DM, suggesting low levels of purposeful screening. Among persons with DM, younger age groups, those in lower income quintiles and men were least likely to obtain an eye examination.
- In fiscal 1998, the overall rate of eye examination in persons with DM dropped by 4.5/100. This drop in rate coincided with a restriction in the frequency of ocular examinations reimbursed by OHIP, a policy from which persons with DM are exempt.

Exhibit 10.6 Trends in Rates* of Eye Examinations in Ontarians with DM per 100 population, 1995–1999

The overall rates of eye examination increased slightly until 1999, when the numbers of examinations dropped by approximately five per cent, coinciding with a change in the reimbursement of routine eye examinations by OHIP (persons with DM were exempt from the restricted reimbursement).

Sex	1995	1996	1997	1998	1999
Men	48.5	48.6	48.8	50.4	46.5
Women	53.0	52.9	53.5	54.8	49.6
Total	50.5	50.5	50.9	52.4	47.9

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). * Standardized to the 1996 DM population.

Exhibit 10.7 Rates of Annual Eye Examinations per 100 Ontarians with DM by County, 1995–1999

Rate = per 100 persons	Age-/Sex-adjusted Rate*
Algoma District	56.0
Brant County	51.4
Bruce County	51.4
Cochrane District	40.6
Dufferin County	47.9
Durham Regional Municipality	52.3
Elgin County	52.3
Essex County	48.1
Frontenac County **	43.2
Grey County	48.1
Haldimand-Norfolk Regional Municipality	50.8
Haliburton County	54.3
Halton Regional Municipality	53.5
Hamilton-Wentworth Regional Municipality	53.6
Hastings County **	48.8
Huron County	51.3
Kenora District	51.6
Kent County	52.3
Lambton County	50.3
Lanark County **	49.8
Leeds and Grenville United Counties **	45.8
Lennox and Addington County **	44.1
Manitoulin District	55.6
Middlesex County	50.2
Muskoka District	56.2
Niagara Regional Municipality	52.9
Nipissing District	54.1
Northumberland County	53.4
Ottawa-Carleton Regional Municipality	57.4
Oxford County	51.2
Parry Sound District	53.9
Peel Regional Municipality	45.7
Perth County	57.2
Peterborough County	49.0
Prescott and Russell United Counties	53.0
Prince Edward County **	46.5
Rainy River District	50.8
Renfrew County	53.1
Simcoe County	50.8
Stormont, Dundas and Glengarry United Counties	49.9
Sudbury District	47.9
Sudbury Regional Municipality	52.4
Thunder Bay District	59.9
Timiskaming District	49.9
Toronto Metropolitan Municipality	47.9
Victoria County	54.7
Waterloo Regional Municipality	52.0
Wellington County	54.7
York Regional Municipality	49.9
Provincial-wide Age-/Sex-adjusted Rate	50.4
Extremal Quotient [EQ]	1.5
Coefficient of Variation (%) [CV]	6.9
Systematic Component of Variation [SCV]	4.9
Adjusted Chi-square (likelihood ratio, DF=48)	2076.2 P-value <0.0001

*All rates standardized to 1996 DM population

** Alternate funding Plan (AFP) in place

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP)

Exhibit 10.8 Rates of Eye Exams per 100 Ontarians with/without DM by Socio-demographic Factors, 1996

Rates of eye examination among all Ontarians with DM were lower in low-income neighbourhoods, among men and in younger age groups. Rurality had little impact on rates.

	Crude Rate: Persons with DM	Crude Rate: Persons without DM	Difference Between Standardized Rates
Income Quintile			
Q1 (low)	48.2	28.4	11.9
Q2	50.1	30.9	11.6
Q3	51.7	32.7	11.5
Q4	52.1	33.5	11.2
Q5 (high)	54.8	35.8	11.6
Age, in Years			
30–49	42.7	25.2	18.3
50–64	49.8	37.0	13.8
65–79	57.0	49.6	8.3
80+	50.2	49.2	1.3
Sex			
Men	48.7	27.7	12.6
Women	53.4	36.5	10.5
Rural/Small Town			
No	50.7	32.0	11.5
Yes	52.2	33.7	11.9

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP), Statistics Canada Census Data 1996. Rates standardized to 1996 DM population and adjusted for all remaining variables in the table.

Exhibit 10.9 Trends in Rates of Retinal Photocoagulation per 1,000 Ontarians with DM

Rates of retinal photocoagulation were approximately 19 per 1,000 persons with DM (or roughly one retinal photocoagulation for every 25 eye exams).

Sex	1995	1996	1997	1998	1999
Men	17.4	17.4	19.1	19.2	18.7
Women	18.7	18.6	19.3	19.7	18.6
Total	18.0	18.0	19.2	19.4	18.7

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). * Standardized to the 1996 DM population.

examination (or to have assured that this was done). The selected codes included any ocular evaluation by an ophthalmologist and any comprehensive ocular examination by an optometrist or a refracting physician. In addition, partial ocular assessments with a retinal or diabetes diagnostic code were included for optometrists and refracting physicians (see Technical Appendix TA 10.A). The cumulative incidence of eye examination after the diagnosis of DM was determined using survival analysis methods and compared to controls matched for age, sex and county. This approach was also used to determine the cumulative incidence of a second eye examination after the initial evaluation, but excluded any examinations that occurred within eight months after the initial examination. The rationale for this "lock out" period was to exclude visits scheduled to follow-up acute ophthalmic conditions or for additional assessments to complete diagnostic testing.

In contrast to the cohort analysis described above, the remaining analyses included all individuals with newly-diagnosed and with pre-existing DM. Annual rates of eye examination, retinal photocoagulation, vitrectomy and cataract surgery in all individuals with DM aged 30 and older were calculated from OHIP claims for fiscal 1995 (April 1, 1994 to March 31, 1995) through fiscal 1999 (see Technical Appendix TA10.A). Comparison rates for age, sex and county of residence-matched controls were selected. To facilitate examination of time trends and comparison between sub-groups, rates were standardized to the 1996 ODD population. Summary rates of annual eye examinations over the 1995–1999 fiscal years were tabulated as weighted averages. The rates of retinal photocoagulation (E154), vitrectomy (E148) and cataract surgery (E140) that could be attributed to DM were estimated by subtracting the standardized rates in controls from those in persons with DM. This approach was necessary in part because procedure fee codes for retinal photocoagulation and vitrectomy are used for indications other than those that relate to DR. Small area rate variation (SARV) analysis was conducted to compare rates of ocular examination, retinal photocoagulation, vitrectomy and cataract surgery across counties or DHC regions (a full discussion of SARV statistics appears in Technical Appendix TA2.C).

Multivariable techniques (Cox Proportional Hazards Modeling) or standardized rate comparisons were used to identify the determinants of eye examination, retinal photocoagulation, vitrectomy and cataract surgery. Factors tested included age, sex, rurality (urban vs. rural) and socioeconomic status (SES). Rurality was assigned based on postal code using census definitions. In Ontario, personal income is not available in administrative data sources. Therefore, neighbourhood level median income was attributed to the individuals studied. Neighbourhood level income quintiles were obtained from the 1996 census data at the level of the enumeration area. This method defines quintiles separately for census metropolitan areas (CMA) or census agglomerations (CA) and areas not in any CMA or CA, so that the measure is relative to the larger area in which a person resides.[28]

Interpretive Cautions

These analyses rely on administrative data, which lack detailed clinical information. In particular, information on the severity of DR found at baseline screening is needed to fully interpret rates of subsequent screening and treatment. The data do not distinguish between individuals with type 1 and type 2 DM. Moreover, information is not captured on important risk factors for DR, such as hypertension and adequacy of blood glucose control; accordingly, these confounders cannot be controlled for in our analyses.

It is not possible to specifically identify screening for DR by dilated retinal examination using administrative data. Instead, we have attempted to identify all reasonable opportunities for retinal screening by including all professional groups involved in screening for DR, along with a wide range of fee codes. This approach may have missed some retinal screening exams, such as those by optometrists, that were billed as partial assessments but not coded with a retina or diabetic diagnostic code. However the inclusive approach taken has included a great many eye exams conducted specifically for other conditions in which effective retinal screening may not have been carried out. As a result, our estimates of retinal screening lie at the upper end of what could have occured with the current pattern of utilization of eye care.

Physicians in some counties operate under Alternate Funding Plans (AFPs) in which physicians are salaried and are not required to submit OHIP billings claims. Although "shadow billing" practices are encouraged, they are not required practice. As a result, analyses by county for certain areas will most likely

Exhibit 10.10 Overall Rates of Retinal Photocoagulation per 1,000 Ontarians with DM by County (1995–1999)

Rate = per 100 persons	Age-/Sex-adjusted Rate*
Algoma District	29.5
Brant County	14.0
Bruce County	17.8
Cochrane District	18.2
Dufferin County	24.6
Durham Regional Municipality	24.4
Elgin County	14.1
Essex County	14.1
Frontenac County **	4.1
Grey County	17.3
Haldimand-Norfolk Regional Municipality	19.4
Haliburton County	16.1
Halton Regional Municipality	21.9
Hamilton-Wentworth Regional Municipality	24.9
Hastings County **	7.2
Huron County	10.2
Kenora District †	3.1
Kent County	15.6
Lambton County	19.4
Lanark County **	22.6
Leeds and Grenville United Counties **	12.5
Lennox and Addington County **	4.2
Manitoulin District	24.2
Middlesex County	16.7
Muskoka District	21.4
Niagara Regional Municipality	22.5
Nipissing District	38.7
Northumberland County	14.7
Ottawa-Carleton Regional Municipality	23.5
Oxford County	14.2
Parry Sound District	31.7
Peel Regional Municipality	19.3
Perth County	17.3
Peterborough County	19.0
Prescott and Russell United Counties	20.2
Prince Edward County **	7.8
Rainy River District †	11.9
Renfrew County	20.8
Simcoe County	24.5
Stormont, Dundas and Glengarry United Counties	12.1
Sudbury District	24.7
Sudbury Regional Municipality	24.9
Thunder Bay District	23.0
Timiskaming District	31.0
Toronto Metropolitan Municipality	17.1
Victoria County	16.7
Waterloo Regional Municipality	17.2
Wellington County	15.9
York Regional Municipality	16.2
Provincial-wide Age-/Sex-adjusted Rate	18.7
Extremal Quotient [EQ]	12.6
Coefficient of Variation (%) [CV]	26.3
Systematic Component of Variation [SCV]	126.0
Adjusted Chi-square (likelihood ratio, DF=48)	601.5 P-value <0.0001

*All rates standardized to 1996 DM population

** Alternate funding Plan (AFP) in place

† Northwestern Ontario - procedures referred to Winnipeg, Manitoba not measured

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP)

Exhibit 10.11 Rates of Retinal Photocoagulation per 1,000 Ontarians with/without DM by Socio-demographic Factors in 1996

Rates of retinal photocoagulation were highest in the 50–64 year group and decline with increasing age and were perceptibly lower in the lowest and highest income quintiles.

	Crude Rate: Persons with DM	Crude Rate: Persons without DM	Difference Between Standardized Rates
Income Quintiles			
Q1 (low)	18.5	0.6	17.6
Q2	19.6	0.6	18.4
Q3	19.5	0.6	18.3
Q4	20.3	0.6	18.9
Q5 (high)	19.0	0.7	17.7
Age in Years			
30–49	14.4	0.2	14.3
50–64	22.6	0.7	22.0
65–79	21.6	1.9	19.7
80+	9.3	2.7	6.5
Sex			
Men	18.9	0.7	18.0
Women	19.6	0.6	18.0
Rural/Small Town			
No	19.4	0.7	18.1
Yes	18.6	0.5	17.8

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP), Statistics Canada Census Data 1996. Rates standardized to 1996 DM population and adjusted for all remaining variables in the table.

Exhibit 10.12 Trends in Rates of Vitrectomy per 1,000 Ontarians with DM

Rates of vitrectomy in persons with DM over the five-year study period remained relatively stable.

Sex	1995	1996	1997	1998	1999
Men	2.1	2.2	2.0	2.3	2.4
Women	2.1	2.3	2.0	2.2	2.2
Total	2.1	2.2	2.0	2.2	2.3

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). * Standardized by the 1996 DM population.

Exhibit 10.13 Overall Annual Rates of Vitrectomy per 1,000 Ontarians with DM by DHC 1995–1999

Annual rates of vitrectomy in Ontarians with DM showed some variation across DHCs.

District Health Council	Age-/Sex-adjusted Rate*	
Algoma, Cochrane, Manitoulin & Sudbury	2.1	
Champlain	2.8	
Durham, Haliburton, Kawartha & Pine Ridge	1.8	
Essex, Kent, and Lambton	2.5	
Grand River	1.8	
Grey, Bruce, Huron, Perth	2.3	
Halton-Peel	1.9	
Hamilton-Wentworth	3.5	
Metropolitan Toronto	2.4	
Muskoka, Nipissing, Parry Sound & Timiskaming	1.6	
Niagara Region	1.6	
Northwestern Ontario †	0.9	
Quinte, Kingston, Rideau **	1.0	
Simcoe-York	2.0	
Thames Valley	2.7	
Waterloo Region-Wellington-Dufferin	2.3	
Extremal Quotient [EQ]	4.0	
Coefficient of Variation (%) [CV]	24.1	
Systematic Component of Variation [SCV]	61.6	
Adjusted Chi-square (likelihood ratio, DF=15)	57.9	P-value<0.0001

*All rates standardized to 1996 DM population
** Alternate funding Plan (AFP) in place
† Northwestern Ontario – procedures referred to Winnipeg, Manitoba not measured

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP)

show conservative numbers which underestimate the activity of ophthalmologists. Kingston and the surrounding counties that it serves have the highest proportion of care delivered under alternative payment mechanisms. Specialized procedures may also be under-detected in Northwestern Ontario—particularly in Kenora and Rainy River districts—where patients are often referred to Winnipeg, Manitoba for care.

Findings and Discussion

Screening

Exhibits 10.1 and 10.2 show the incidence of an eye examination after the diagnosis of DM in Ontarians 30 years of age and older and among matched controls. Among those with DM, the proportion of persons screened rose rapidly to 51% at one year, ranging from 43% in the 30–49 age group to almost 59% in the 65–79 age bracket. These findings fall far short of the recommendation of all current practice guidelines that newly-diagnosed people with DM 30 years of age or older should promptly undergo a dilated retinal screening examination. Even at five years after diagnosis, 12% of Ontarians aged 30 or older with new-onset DM had not yet had an eye examination. Rates of eye exams in persons with DM are only modestly higher than in matched controls without DM, suggesting low rates of awareness or uptake of screening recommendations. As expected, the difference decreased with advancing age, presumably due to the increased incidence of eye examinations in the control population for various age-related eye diseases.

Rates of follow-up examination after an initial eye evaluation for those persons who were assessed within a year of the diagnosis of DM are reported in Exhibit 10.3. One year after the initial eye exam, the overall rate of undergoing a follow-up examination was only 19%, partly as a result of excluding all exams within eight months of the initial assessment (see methods for rationale). However, the overall rate of a follow-up exam climbed to 55% at two years and 84% at four years after the initial assessment.

Estimated levels of adherence to screening recommendations for DR after the diagnosis of DM are shown in Exhibit 10.4. Appropriate screening intervals depend upon findings at the initial evaluation. These estimates, which have been derived from the data in Exhibit 10.2 and 10.3, assume that all persons with DM had "no or mild DR" at the time of initial examination. Since 5 to 10% of persons with newly-diagnosed DM have DR that would require more intensive follow-up, these rates may overestimate guideline adherence. The clinical practice guidelines of the Canadian Diabetes Association (CDA)[19] are the most influential recommendations for screening for DR among general practitioners and diabetes specialists in Canada. Only 43% of those with newly diagnosed DM met the CDA recommendation for both an initial and follow-up eye examination. The guidelines of the American Academy of Ophthalmology (AAO)[20] may be the most influential guidelines among eye care professionals. Estimation of rates of both a prompt initial eye examination and follow-up at one year utilizing the AAO guideline recommendation was 28% overall, and lowest in the 30–49 age group at almost 17%.

The incidence of initial and follow-up eye examination was strongly related to increasing age and was highest in the 65–79 age bracket. Multivariable analysis (Exhibit 10.5) of predictors

of initial eye exam found that younger individuals, men, and individuals of lower socioeconomic status were less likely to undergo an eye examination. Rural residence did not appear to be a barrier to screening.

In contrast to the preceding analyses, the rates of annual eye examinations shown in Exhibits 10.6, 10.7, and 10.8 are not restricted to those with newly-diagnosed DM, but include those with pre-existing DM as well. Exhibit 10.6 shows rates of annual eye examinations for all persons with DM over the five years of the study. The overall rates of eye examination increased slightly until 1999, when the numbers of examinations dropped by approximately five per cent. This drop in rates was seen across the province (data not shown) and coincided with a change in the reimbursement of routine eye examinations by OHIP. Persons with DM were exempt from the policy that limited reimbursement for routine eye exams to once every two years from age 20 to 64, yet it still appeared to have an impact on persons with DM. This drop is worrisome and may warrant education of both patients and practitioners.

County-specific rates of annual eye exams in persons with DM are shown in Exhibit 10.7. Rates ranged from almost 41/100 (Cochrane District) to 60/100 (Thunder Bay). Exhibit 10.8 describes the rates of eye examination among all Ontarians with DM stratified by socio-demographic factors. Similar to the analyses in persons with newly-diagnosed DM, lower rates of eye exams were observed in lower income neighbourhoods, among men and in younger age groups, while rurality had little impact on rates.

Retinal Photocoagulation

The rates of retinal photocoagulation (Exhibit 10.9) are approximately 19/1,000 persons with DM (or roughly one retinal photocoagulation for every 25 eye exams). While rates of this procedure increased modestly over the first four years of the study period, they fell in 1999 in a similar manner to the drop in rates of eye examination in that year. Rates of retinal photocoagulation vary considerably across counties (Exhibit 10.10), ranging nearly four-fold, from about 10/1,000 to 39/1,000 (excluding counties with AFP in place). In general, the rates of photocoagulation were markedly higher across most of Northern Ontario, despite potential geographic obstacles to access.

The rates of retinal photocoagulation shown in Exhibit 10.11 are stratified by socio-demographic variables. There was no important association between SES and photocoagulation. Since persons from low-income neighbourhoods are at greater risk for sight-threatening diabetic macular edema/retinopathy,[29] these similar rates of photocoagulation may indicate inadequate access to specialty services. The final column in this table shows the difference between standardized rates in persons with and without DM, and provides the best estimate of the rate of retinal photocoagulation for the treatment of DR. Rates were highest in the 50–64 year group and declined with increasing age. There were no significant differences in the rates of retinal photocoagulation between men and women, despite the higher rates of eye examination in women.

Exhibit 10.14 Rates of Vitrectomy per 1,000 Ontarians with/without DM by Socio-demographic Factors in 1996

Annual rates of vitrectomy in Ontarians with DM showed only modest variation by neighbourhood income quintile, age and rurality.

	Crude Rate: Persons with DM	Crude Rate: Persons without DM	Difference Between Standardized Rates
Income Quintiles			
Q1 (low)	2.0	0.3	1.5
Q2	2.0	0.3	1.4
Q3	2.2	0.3	1.7
Q4	2.2	0.3	1.6
Q5 (high)	1.8	0.3	1.3
Age in Years			
30–49	1.8	0.1	1.8
50–64	2.1	0.3	1.8
65–79	2.2	0.9	1.3
80+	1.5	1.0	0.6
Sex			
Men	2.0	0.3	1.6
Women	2.0	0.3	1.4
Rural/Small Town			
No	2.0	0.3	1.5
Yes	1.9	0.3	1.5

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP), Statistics Canada Census Data 1996. Rates standardized to 1996 DM population and adjusted for all remaining variables in the table.

Exhibit 10.15 Trends in Rates of Cataract Surgery per 1,000 Ontarians with DM

Overall rates of cataract surgery in the Ontarians with DM rose steadily between 1995 and 1998. A modest drop in rate was seen in 1999.

Sex	1995	1996	1997	1998	1999
Men	22.1	23.5	25.0	27.5	26.1
Women	26.5	28.1	30.8	33.4	30.8
Total	24.2	25.7	27.8	30.3	28.4

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). * Standardized to the 1996 DM population.

Vitrectomy

Vitrectomy is a surgical procedure used to treat end-stage complications of DR and hence may be regarded as a marker of poor outcome. Exhibit 10.12 presents rates of vitrectomy in persons with DM over the five-year study period. Annual rates of vitrectomy in Ontarians with DM showed some variation across DHCs (Exhibit 10.13). Rates in Northwestern Ontario and Quinte/Kingston/Rideau are artefactually low, due to out-of-province referral patterns and AFP reimbursement, respectively. When rates of vitrectomy were examined by socio-demographic factors in persons with DM (Exhibit 10.14), little variation by neighbourhood income quintile, age, gender and rurality was found.

Cataract Surgery

Rates of cataract surgery in persons with DM are presented in Exhibits 10.15, 10.16 and 10.17. Cataract formation is the most common cause of new-onset vision loss in adults apart from refractive error, and occurs more frequently in persons with DM.[7,30] In contrast to vision loss from DR, visual impairment from cataracts is usually completely reversible. Overall rates of cataract surgery in the Ontarians with DM rose steadily between 1995 and 1998. A modest drop in rate was seen in 1999, which may be related to the fall in eye examinations detailed previously. Rates of cataract surgery showed little variation across DHCs (Exhibit 10.16). The rates of cataract surgery stratified by sociodemographic variables are reported in Exhibit 10.17. These data support previous reports of substantially higher rates of cataract surgery in persons with DM compared to those without DM. As expected, the rates of cataract surgery increase steeply with age in those with and without DM, such that the difference between the two groups actually fell in the oldest age group. Rates of cataract surgery were higher in women than men; no difference in rates was observed between residents of rural and urban areas.

Exhibit 10.16 Overall Annual Rates of Cataract Surgery per 1,000 Ontarians with DM by DHC, 1995–1999

Rates of cataract surgery showed little variation across DHCs.

District Health Council	Age-/Sex-adjusted Rate*	
Algoma, Cochrane, Manitoulin & Sudbury	27.4	
Champlain	35.6	
Durham, Haliburton, Kawartha & Pine Ridge	28.5	
Essex, Kent, and Lambton	32.5	
Grand River	30.6	
Grey, Bruce, Huron, Perth	27.6	
Halton-Peel	25.6	
Hamilton-Wentworth	27.2	
Metropolitan Toronto	24.6	
Muskoka, Nipissing, Parry Sound & Timiskaming	29.0	
Niagara Region	31.4	
Northwestern Ontario †	20.6	
Quinte, Kingston, Rideau **	26.2	
Simcoe-York	25.7	
Thames Valley	29.1	
Waterloo Region-Wellington-Dufferin	25.1	
Extremal Quotient [EQ]	1.7	
Coefficient of Variation (%) [CV]	12.8	
Systematic Component of Variation [SCV]	13.9	
Adjusted Chi-square (likelihood ratio, DF=15)	193.0	P-value<0.0001

*All rates standardized to 1996 DM population
** Alternate funding Plan (AFP) in place
† Northwestern Ontario – procedures referred to Winnipeg, Manitoba not measured

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP)

Conclusions

DR is a common complication of DM and is the leading cause of blindness in Canadians between the ages of 30–69. Most vision loss from DR can be prevented through periodic retinal screening examinations and timely retinal photocoagulation of sight-threatening disease. Screening and photocoagulation for DR are cost-effective; economic analyses have shown that these interventions may be cost-saving from a societal perspective.[21,31]

It is not possible to determine the rate of screening for DR among persons with DM in Ontario from administrative data alone. However, even using an inclusive definition of provider visits that might represent an opportunity for screening, rates are far below guideline-recommended levels and are only modestly higher than in persons without DM. Similar gaps in care have been reported in other jurisdictions. For example, studies in the United States have found rates of dilated retinal exam among adults with DM from 34% to 49%.[23,24]

Rates of eye examination were not uniform across the province, with lower rates seen in males, among persons who were younger, and those residing in low income neighbourhoods. Rurality had little impact on screening rates, and county level rate variations were smaller than seen for many other types of services.

An evaluation of eye exam rates over time showed a significant decrease in the final year of the study period. This drop in rate coincided with a policy that limited reimbursement for routine eye exams to once every two years for persons aged 20–64. Even though the policy explicitly excluded persons with DM, it may have had the unintended effect of decreasing screening. The parallel finding of a decline in rates of retinal photocoagulation procedures in 1999 raises the possibility that the missed screening opportunities translated into missed opportunities to treat sight-threatening DR. The persistence of this drop in screening rates will need to be examined as data for subsequent years become available.

This chapter provides a broad description of the utilization of eye care by persons with DM in Ontario. The low adherence to guidelines for screening for DR in Ontario suggests that many Ontarians with DM are not benefiting from preventive eye care and are at risk of experiencing potentially avoidable vision loss from DR. Strategies will need to be developed to promote broad implementation of screening guidelines and, in particular, to address persons in whom rates are lowest. Such strategies should be based on a more complete understanding of barriers to effective eye care at the patient, provider and policy levels. The minimal impact of diabetic status on rates of eye examinations suggest that new approaches are required to assure periodic screening for DR.

Exhibit 10.17 Rates of Cataract Surgery in Ontarians with/without DM by Socio-demographic Factors per 1,000 Population in 1996

Rates of cataract surgery were higher in women than men. No difference in rates was observed between residents of rural and urban areas.

	Crude Rate: Persons with DM	Crude Rate: Persons without DM	Difference Between Crude Rates	Difference Between Standardized Rates
Income Quintiles				
Q1 (low)	28.1	8.6	19.5	9.2
Q2	29.3	8.2	21.1	10.9
Q3	28.3	8.0	20.4	10.3
Q4	25.8	7.1	18.7	8.9
Q5 (high)	27.5	7.7	19.8	9.5
Age in Years				
30–49	3.6	0.5	3.1	3.1
50–64	14.8	4.9	9.9	10.0
65–79	46.6	32.1	14.5	15.0
80+	55.4	52.0	3.4	4.3
Sex				
Men	23.5	6.2	17.3	8.9
Women	32.6	9.6	23.0	10.9
Rural/Small Town				
No	27.7	7.8	20.0	9.8
Yes	28.2	8.8	19.4	9.5

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP), Statistics Canada Census Data 1996. Rates standardized to 1996 DM population and adjusted for all remaining variables in the table.

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Technical Appendices (Exhibits TA10.A and TA10.B)

Data Sources, Definitions and Recommendations

Exhibit TA10.A Data Sources and Definitions

Case-Control	NOTE: Some of the Exhibits are based on a cohort analysis; other Exhibits are cross-sectional. Most of the cohort Exhibits are also presented with matched controls.
Cases	**All persons with DM who are resident in Ontario and aged 30+ on the date of diagnosis i.e. : In ODD, valid encrypted health card (IKN), valid CD, aged 30+ at DM dx, DM diagnosis between Nov 1 1994 and March 31 1999 N=225,231**
Controls	**Matched to cases on age (year of birth), sex, and county of residence One control per case, sampled without replacement Not in ODD Must be alive at the time of the case's diagnosis Based on data set created for Chapters 7, 8, 9**
Definitions	
Eye exam	**Any claim with OHIP fee code in: A111, A112 - as long as treating physician specialty (spec)=00 or spec=23 A233, A234, A235, A236, A238, A239, A240 - as long as spec=23 C233, C234, C235, C236, C238, C239 - as long as spec=23 V401, V405, V406, as long as spec=56 V402, V407 as long as spec=56 and diagnosis code (ICD-9) 250 or 362 A114 as long as diagnosis code 250 or 362 and (spec=00 or spec=23)**
Follow-up eye exam	**First eye exam that took place 8 months or more after the initial eye exam (This is referred to as the 8-month lockout period)**
Photocoagulation	**Any claim with fee code E154**
Vitrectomy	**Any claim with fee code E148**
Cataract surgery	**Any claim with fee code E140**
Postal code	**From RPDB**
SES	**From census data linked to postal code using postal code conversion file**

Exhibit TA10.B Canadian Diabetes Association Recommendations for Diabetic Retinopathy Screening

- The development and progression of retinopathy may be prevented through intensive diabetes management achieving optimal metabolic control [Grade A, Level I] and treatment of elevated blood pressure or lipid levels [Grade D, Level 4].
- In people with DM, screening for sight-threatening retinopathy should be performed by experienced professionals highly trained in direct ophthalmoscopy through dilated pupils or by retinal specialists [Grade A, Level I].
- Screening and evaluation for retinopathy should be performed annually five years after the onset of diabetes in postpubertal patients (age 15 years or over) with type 1 diabetes and in everyone with type 2 diabetes at the time of diagnosis [Grade A, Level I]. The interval for follow-up assessments should be tailored to the severity of the retinopathy. In those with type 2 diabetes who have no or minimal retinopathy, the recommended interval is two years and should not exceed four years [Grade A, Level I].
- Proliferative or severe non-proliferative retinopathy necessitates referral to an ophthalmologist or retinal specialist with access to surgical facilities [Grade A, Level I].

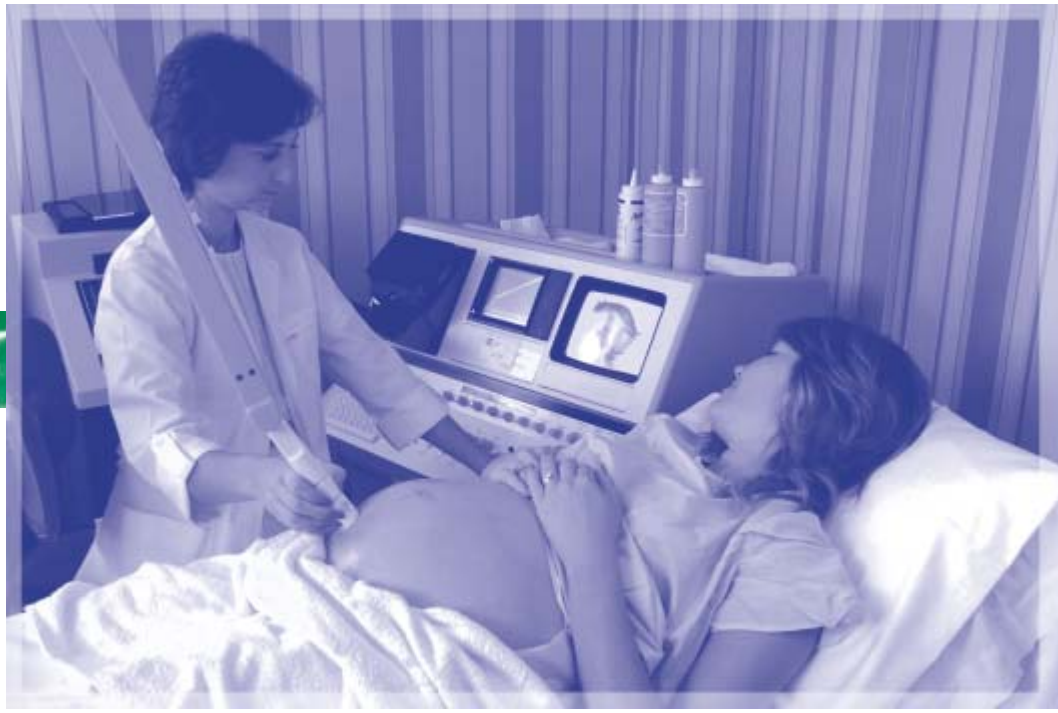
Source: *CMAJ* 1998; 159 (Suppl 8): S1–S29.

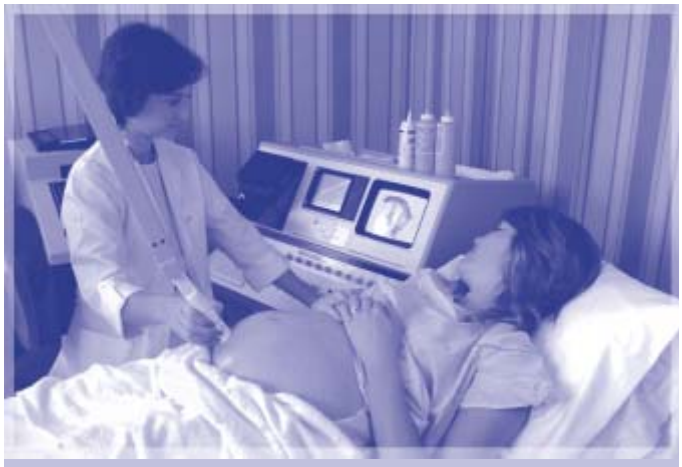
11

Chapter

Pregnancy in Women with Diabetes

Authors: Denice S. Feig, Alexander Kopp and Geoffrey M. Anderson





Key Messages

- Careful blood sugar control, particularly prior to conception and during organ development in the first few weeks of pregnancy in women with diabetes mellitus (DM) can significantly reduce the risk of congenital abnormalities and macrosomia.
- The complications of DM can worsen during pregnancy and women with DM should also be screened for the presence of kidney and eye disease (diabetic nephropathy and retinopathy).

Background

Poorly controlled diabetes mellitus (DM) can have deleterious effects during pregnancy. Because glucose crosses the placenta freely, the fetus is exposed to similar glucose concentrations as the mother. High blood sugar levels in the fetus at the time of conception and in the first few weeks of development are associated with higher rates of congenital anomalies.[1] High blood sugars throughout pregnancy are associated with higher rates of maternal complications including hypertension and preeclampsia.[2] Furthermore, babies born to mothers with DM are more likely to develop macrosomia (birth weight over 4 kg), which can lead to injuries at the time of birth and obstructed labour, and thus, higher rates of cesarean section.[3–5]

Despite apparent declines in pregnancy-related complications among women with DM, recent studies continue to show increased rates of perinatal mortality and congenital anomalies in these women compared to the non-DM population.[6–9] Most of the published figures on complication rates pertain to women with type 1 DM. However, type 2 DM may confer an even higher risk of perinatal mortality due to factors such as obesity, higher maternal age, and an increased incidence of hypertension.[6] Women with type 2 DM also tend to seek antenatal care later than women with type 1 DM, suggesting a lack of awareness in these women and their physicians of the importance of preconception counselling and blood sugar control early in pregnancy.

Studies have shown that congenital anomalies can be almost entirely avoided with careful blood sugar control prior to conception and during organ development in the first few weeks of pregnancy.[10–12] A recent meta-analysis showed that women who received pre-conceptional care had over 60% fewer babies with congenital anomalies.[13] Tight blood sugar control has also been shown to decrease macrosomia rates. In a study of women with type 1 DM, the incidence of large-for-gestational age babies was significantly lower as was overall fetal morbidity in women whose blood sugar levels were near-normal compared to those with high blood sugar levels during the second and third trimester.[14]

It has been suggested that optimal prenatal care for women with DM should involve access to a high risk pregnancy team including an endocrinologist or internist, nurse and dietician who are experts in both intensive DM management and the special circumstances of pregnancy. The 1998 clinical practice guidelines from the Canadian Diabetes Association recommend that before pregnancy women with DM should attend a high-risk pregnancy clinic, and should attempt to achieve optimal blood glucose control.[15] Because diabetic complications can worsen during pregnancy, these women should also be screened for the presence of microvascular disease (diabetic nephropathy and retinopathy).[16] During pregnancy the guidelines continue to focus on the importance of blood glucose control, as well as monitoring for obstetric outcomes and for progression of DM complications with

regular retinal examinations and assessment of kidney function. The St. Vincent Declaration on DM care has challenged health care systems with the notion that appropriate care for women with DM could lead to the virtual elimination of DM-related complications in pregnancy and that such care is a potentially attainable goal.[17]

The purpose of this chapter is to provide Ontario data on recent temporal trends and regional variations in the incidence of DM in pregnancy, as well as obstetrical complications and use of the health care system by women with and without DM.

Data Sources

The Canadian Institute of Health Information (CIHI) discharge abstract database and the Registered Persons Data Base (RPDB) were used to identify all women who gave birth in Ontario hospitals between fiscal years 1997 and 2000, and who were eligible for coverage under the Ontario Health Insurance Program (OHIP). An algorithm based on case mix group and patient service codes was used to identify hospital admissions for delivery.[18] CIHI records were also used to identify obstetrical procedures or complications that occurred during the hospital stay. Women were classified as having DM if they had a pre-pregnancy diagnosis of DM based on their inclusion in the Ontario Diabetes Database (ODD). The ODD contains records on all persons with DM in the province, excluding those with gestational diabetes (GD) (DM that develops only during pregnancy) [see Chapter 1: Technical Appendix TA 1.A]. The OHIP database was used to identify each woman's source of care in the 270 days (nine months) prior to the delivery. Records from each of these sources were linked together using a unique anonymous identifier for each person.

How the Analysis Was Done

The percentage of childbirths to women who had DM was calculated as the number of women with DM who delivered divided by the total number of Ontario women who delivered in the same year. These percentages were calculated for specific age groups. In order to take into account differences in the age distribution between pregnant women with and without DM, the proportion of women with DM was directly age-adjusted using age-specific rates and using the entire population of women in Ontario who gave birth as the standard population.

Exhibit 11.1 Number of Deliveries and Percentage of All Deliveries in Ontario Women with DM by Fiscal Year

The number of women with DM who delivered increased by 12% between 1996 and 1999.

Year	1996	1997	1998	1999
Number of Deliveries in Women with DM	1,665	1,768	1,826	1,900
Percentage of all Deliveries	1.26%	1.36%	1.44%	1.50%
Percentage of all Deliveries Adjusted for Age*	1.26%	1.35%	1.42%	1.47%

Source: Ontario Diabetes Database (ODD). * Direct Age Adjustment with 1996 as Standard. All fiscal years are from April 1st to March 31st (eg, April 1, 1995–March 31, 1996 = 1996).

The comparison of the incidence of various complications and obstetrical procedures in women with and without DM used indirect standardization methods, to take into account differences in age distributions in these two groups. This involved using age-specific incidence rates in the women without DM and the age distribution for women with DM to calculate the expected number of events in the population with DM if they had the same rates as the population without DM. The ratio of the observed number of events in the women with DM to this expected rate is the standardized ratio.

Interpretive Cautions

The ODD does not distinguish between individuals with type 1 and type 2 DM. The analysis is limited to women who gave birth in Ontario hospitals and therefore excludes pregnancies that end in spontaneous or therapeutic abortions and deliveries that take place outside the hospital or outside the province of Ontario. The information on complications and procedures is based on data collected in the mother's hospital chart from the delivery hospitalization, as recorded by trained abstractors in the hospitalization abstract submitted to CIHI. Therefore, the data may not be completely accurate and further diagnostic and procedural information may be available from other sources not used in this study, such as the hospital discharge abstract for the newborn or the birth certificate. Data on use of medical specialists and retinal examinations is based on OHIP claims submitted by physicians. Specialists in the Kingston area who participate in an Alternative Funding Plan (AFP) are not paid in the usual way through OHIP billing claims; therefore, the Quinte/Kingston/Rideau district health council (DHC) is excluded from all analyses using OHIP claims data.

Exhibit 11.2 Number of Deliveries in Ontario Women with DM and Percentage of All Deliveries by DHC**

Women with DM accounted for between one and two per cent of in-hospital births.

District Health Councils	Number of Deliveries in Women with DM	Percentage of all Deliveries in DHC	Percentage of all Deliveries Adjusted for Age*
Algoma, Cochrane, Manitoulin & Sudbury	226	1.3	1.4
Champlain	461	1	1
Durham, Haliburton, Kawartha & Pine Ridge	401	1.1	1.1
Essex, Kent, and Lambton	504	1.8	1.9
Grand River	111	1.1	1.2
Grey, Bruce, Huron, Perth	101	0.9	1
Halton-Peel	1,120	1.6	1.5
Hamilton-Wentworth	197	0.9	0.9
Metropolitan Toronto	2,181	1.8	1.7
Muskoka, Nipissing, Parry Sound & Timiskaming	81	1	1
Niagara Region	166	1	1
Northwestern Ontario	156	1.3	1.5
Quinte, Kingston, Rideau	159	0.8	0.8
Simcoe-York	659	1.4	1.4
Thames Valley	302	1.1	1.2
Waterloo Region-Wellington-Dufferin	298	0.9	0.9

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD). * Direct Age Adjustment with 1996 as Standard. ** Study period averaged.

Exhibit 11.3 Incidence of Obstetrical Complications in Women with DM in Ontario Hospitals by Fiscal Year

When compared to women without DM, women with DM were more than twice as likely to have a diagnosis of preeclampsia or hypertension. Rates of obstructed labour and stillbirths were double those found in women without DM.

Complication	1996	1997	1998	1999
Preeclampsia				
Incidence per 100 Cases	6.5%	8.0%	6.5%	6.8%
Standardized Incidence Ratio	2.22	2.61	2.30	2.36
Hypertension				
Incidence per 100 Cases	13.6%	14.2%	12.7%	13.3%
Standardized Incidence Ratio	2.64	2.61	2.35	2.38
Obstructed Labor				
Incidence per 100 Cases	7.0%	6.3%	7.3%	8.1%
Standardized Incidence Ratio	1.20	1.12	1.28	1.43
Stillbirth				
Incidence per 100 Cases	1.3%	1.4%	1.6%	1.5%
Standardized Incidence Ratio	2.09	2.26	2.58	2.41

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD). All fiscal years are from April 1st to March 31st (eg, April 1, 1995–March 31, 1996 = 1996).

Findings and Discussion

In 1996, 1,665 women with DM delivered in Ontario hospitals (Exhibit 11.1). This number increased by 12% to 1,900 in 1999. These women accounted for 1.3% of all deliveries in 1996 and 1.5% of all deliveries in 1999. There is little change in these crude percentages when they are adjusted for age, indicating that differences in the age of women giving birth had little impact on the incidence of deliveries in women with DM. Within different DHC's (Exhibit 11.2), women with DM, as a proportion of all women who gave birth in hospitals ranged from just under 1% to nearly 2% (Essex, Kent and Lambton).

Obstetrical and Fetal Complications
(Exhibits 11.3 and 11.4)

Exhibit 11.3 shows the incidence of obstetrical complications in pregnant women with DM while Exhibit 11.4 presents the incidence of obstetrical complications in pregnant women by DHC.

From 1996 to 1999, women with DM were more than twice as likely to have a diagnosis of preeclampsia or hypertension than women without DM. Obstructed labour was found in 6 to 8% of deliveries in Ontario women with DM from 1996–1999, making these women between 1.2 and 1.4 times more likely to experience obstructed labour than women without DM. Although stillbirths occurred in only about one or two percent of women with DM in 1999, these rates were consistently more than double those found in women without DM. The number of stillbirths and the number of cases of

Exhibit 11.4 Incidence of Obstetrical Complications in Women with DM by DHC in Ontario*

Regional analysis showed a consistently higher rate of hypertension and preeclampsia among pregnant women with DM.

	Eclampsia			Hypertension		
District Health Councils	Number	Rate per 100	SIR**	Number	Rate per 100	SIR**
Algoma, Cochrane, Manitoulin & Sudbury	10	4.4	2.37	32	13.7	2.32
Champlain	30	6.4	1.75	78	16.4	2.57
Durham, Haliburton, Kawartha & Pine Ridge	46	11.3	3.39	67	16.4	3.10
Essex, Kent, and Lambton	28	5.6	2.65	62	12.1	2.71
Grand River	9	7.8	2.87	16	13.1	2.57
Grey, Bruce, Huron, Perth	12	12.0	3.65	20	19.1	4.07
Halton-Peel	66	5.8	2.49	139	12.0	2.49
Hamilton-Wentworth	11	5.5	2.23	18	8.7	1.36
Metropolitan Toronto	129	5.8	2.38	244	10.6	2.51
Muskoka, Nipissing, Parry Sound & Timiskaming	6	7.3	3.23	11	13.5	3.05
Niagara Region	7	4.2	1.91	20	11.9	2.58
Northwestern Ontario	11	7.1	2.05	30	18.9	2.99
Quinte, Kingston, Rideau	11	7.1	1.59	29	18.4	1.89
Simcoe-York	44	6.8	2.24	81	12.2	2.48
Thames Valley	46	15.3	2.68	63	20.6	2.77
Waterloo Region - Wellington-Dufferin	30	10.0	3.44	48	15.8	3.41

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD). * Averaged over the study period. **SIR= Standardized Incidence Ratio.

obstructed labour in women with DM were too small to support meaningful analysis at the DHC level; however, the regional analysis demonstrated a consistently higher rate of hypertension and preeclampsia among pregnant women with DM in every DHC throughout the period of study (Exhibit 11.4).

Cesarean Section and Induction Rates

(Exhibits 11.5 and 11.6)

During the study period, about 30% of women with DM had inductions of labour, a rate that is nearly 50% higher than that found in women without DM. Studies suggest that in many cases, induction of labour is performed because of the concern for late stillbirths in this population. Similarly, just over 30% of women with DM were delivered by cesarean section (C-section), more than 50% higher than the rate observed in women without DM even after adjustment for age. (Exhibit 11.5) High C-section rates likely result from a combination of factors. The indications for C-sections can range from failure of labour to progress (43%), previous C-section (20%), fetal distress (17%), malpresentation (13%), and a threat to the mother's health (6%).[3] As indicated above, there is a very high rate of induction of labour in these women, which often leads to labour that fails to progress and therefore a subsequent need for C-section. These increased rates of obstetrical care interventions (Exhibit 11.6) are consistent over time and across the DHCs.

Exhibit 11.5 Incidence of Cesarean Sections and Inductions per 100 Deliveries in Ontario Women with DM by Fiscal Year

About 30% of women with DM had inductions of labour and similar rates (30%) of C-section were seen. These rates were almost 50% higher than in women without DM.

	1996	1997	1998	1999
Induction of Labor				
Incidence per 100 Deliveries	33.0%	31.3%	29.4%	32.4%
Standardized Incidence Ratio	1.56	1.40	1.37	1.43
Cesarean Section				
Incidence per 100 Deliveries	31.0%	30.7%	31.2%	33.1%
Standardized Incidence Ratio	1.57	1.52	1.53	1.56

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD). Indirectly age-adjusted. All fiscal years are from April 1st to March 31st (eg, April 1, 1995–March 31, 1996 = 1996).

Exhibit 11.6 Incidence of Cesarean Sections and Inductions per 100 Deliveries in Ontario Women with DM by DHC**

Increased rates of obstetrical care interventions were seen across the DHCs.

	C-Section			Induction of Labor		
District Health Councils	Number	Rate per 100	SIR*	Number	Rate per 100	SIR*
Algoma, Cochrane, Manitoulin & Sudbury	87	36.7	1.68	90	40.3	1.59
Champlain	139	28.8	1.62	194	42.2	1.69
Durham, Haliburton, Kawartha & Pine Ridge	123	23.3	1.34	180	35.9	1.43
Essex, Kent, and Lambton	139	32.4	1.53	141	35.4	1.50
Grand River	40	33.3	1.94	49	43.0	1.59
Grey, Bruce, Huron, Perth	35	32.1	1.71	39	39.5	2.11
Halton-Peel	319	26.7	1.41	338	30.2	1.47
Hamilton-Wentworth	85	40.2	2.19	67	33.4	1.52
Metropolitan Toronto	668	28.1	1.43	524	24.2	1.27
Muskoka, Nipissing, Parry Sound & Timiskaming	31	36.6	1.51	24	30.2	1.43
Niagara Region	52	30.0	1.65	66	40.0	1.42
Northwestern Ontario	66	40.4	2.04	56	35.8	1.61
Quinte, Kingston, Rideau	55	34.0	1.66	60	38.5	1.66
Simcoe-York	224	32.3	1.61	155	23.7	1.16
Thames Valley	91	28.3	1.90	154	51.6	1.64
Waterloo Region - Wellington-Dufferin	93	30.1	1.70	103	34.8	1.95

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD). *SIR= Standardized Incidence Ratio. ** Averaged over the study period.

Exhibit 11.7 Length of Stay in Days for Ontario Women with/without DM by Fiscal Year

Women with DM spent an additional 1.5 to 2 days longer in hospital during both pregnancy and delivery.

		Hospital Length of Stay (LOS) in days			
		1996	1997	1998	1999
C-Section: Birth Admission Only	Women with DM	6.27	5.54	5.52	5.42
	Women without DM	4.67	4.49	4.42	4.37
Vaginal Birth: Birth Admission Only	Women with DM	2.78	2.46	2.52	2.61
	Women without DM	2.23	2.14	2.07	2.18
270 Days Prior to Birth (Including Birth Admission)	Women with DM	5.05	4.36	4.55	4.44
	Women without DM	3.07	2.95	2.87	2.97

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD). All fiscal years are from April 1st to March 31st (eg, April 1, 1995–March 31, 1996 = 1996).

Exhibit 11.8 Percentage of Ontario Women with/without DM Admitted to Teaching Hospitals, Visiting Medical Specialists, or Having a Retinal Exam During Pregnancy by Fiscal Year

Over 60% of pregnant women with DM were seen by an endocrinologist or internist who was caring for their DM.

Patient Group		1996 (%)	1997 (%)	1998 (%)	1999 (%)
Women with DM	Admissions to Teaching Hospital	27.7	28.3	29.1	30.1
	Visit to Medical Specialist	61.2	60.4	60.6	60.7
	Retinal Exam*	24.6	26.9	25.1	23.8
Women without DM	Admissions to Teaching Hospital	23.6	24.2	24.5	25.7
	Visit to Medical Specialist	3.9	4.0	3.9	3.9
	Retinal Exam*	12.2	12.7	9.6	9.2

Sources: Canadian Institute for Health Information (CIHI), Ontario Diabetes Database (ODD). * excludes DHC (Quinte, Kingston, Rideau). All fiscal years are from April 1st to March 31st (eg, April 1, 1995–March 31, 1996 = 1996).

Length of Hospital Stay (Exhibit 11.7)

Through pregnancy and delivery, women without DM spent an average of three days in an acute care hospital, whereas women with DM spent an additional 1.5 to 2 days (Exhibit 11.7). This pattern of longer hospital stays for women with DM holds true for both C-sections and vaginal deliveries. The increased rate of C-sections in women with DM, combined with the longer lengths of stay for this procedure, explains part of the overall longer lengths of stay for women with DM; the other part is explained by higher rates of admission for care prior to delivery.

Visits to Medical Specialists and Care in Teaching Hospitals (Exhibits 11.8 and 11.9)

Consistently over the four-year study period, over 60% of women with DM were seen during their pregnancy by an endocrinologist or internist who was caring for their DM. These rates varied from 70% in Essex, Kent and Lambton to a low of 29% in Northwestern Ontario (Exhibit 11.9). About one-quarter of women with DM had a retinal exam by either an ophthalmologist or optometrist during pregnancy. These rates are much higher than those found in women without DM indicating that purposeful screening is occurring, yet still falling short of guideline recommendations. Rates of retinal examinations during pregnancy varied across DHCs, ranging from a low of 19% in Halton-Peel to a high of 45% in Niagara Region. Women with DM were somewhat more likely to be delivered in a teaching hospital than women without DM (30 vs. 26% in 1999). (Exhibit 11.8).

Key Research Findings

- When compared to women without DM, women with DM were more than twice as likely to have a diagnosis of preeclampsia or hypertension. Obstructed labour was found in 6 to 8% of deliveries, and stillbirths occurred in about one to two percent of women, double the ratio found in women without DM
- About 30% of women with DM had inductions of labour, a rate that is almost 50% higher than in women without DM. Similar findings are reported for cesarean section (C-section) deliveries, the method of delivery for over 30% of women with DM—more than 50% higher than the rate observed in women without DM—even after adjustment for age.
- About one-quarter of women with DM had a retinal exam by either an ophthalmologist or optometrist during pregnancy.

Conclusions

In Ontario, between 1 and 2% of pregnancies occur in women with DM and these rates appear to be increasing. In addition, these rates are higher than those reported in other studies,[19–21] possibly because of differences in the data sources used to identify this population of women. This study used the ODD to identify women with DM, while other studies used data found on birth certificates or hospital charts which may lead to an underdetection of these cases. Another explanation is that the rate of DM has increased, and that the rates provided in this study reflect the increased incidence of type 2 DM compared to earlier studies, many of which were conducted prior to 1980. There are some data from Ojibwa-Cree women of northwestern Ontario that indicate a rate of DM in pregnancy as high as 3.2%.[22]

Among women with DM, maternal and fetal rates of morbidity and mortality continue to be higher than those seen women without DM. We need improved stillbirth data to help us understand the increases; definitions need to be standarized and data sources need to be made consistent. While the stillbirth rates in the ODD cohort are lower than those reported in British population studies,[8,9] they are still twice that of the non-diabetic population, and higher than rates reported by a tertiary high-risk pregnancy clinic in British Columbia.[3] Studies suggest that congenital anomalies are the most common cause of perinatal mortality. Congenital anomalies can be potentially prevented by good glycemic control in the earliest stages of pregnancy, highlighting the importance of care provided in the pre-conception period.

In Ontario, pregnant women with DM are much more likely than those without DM to be cared for by a medical specialist; however, only 60% of women with DM receive such care during their pregnancy. There is some evidence that centralized care may lead to improved outcomes in this population, possibly due to the involvement of medical specialists in these centres.[23,24] Medical specialists are likely to be key members of the multi-disciplinary teams suggested by

Exhibit 11.9 Percentage* of Ontario Women with/without DM Visiting Specialists (Endocrinologist or Internist) During Pregnancy (Including Birth) and Having Retinal Exams During Pregnancy by DHC.‡**

About one-quarter of women with DM had a retinal exam by either an ophthalmologist or optometrist during pregnancy.

	Visit Medical Specialist				Retinal Exam			
	Women with DM		Women without DM		Women with DM		Women without DM	
District Health Councils‡	n	%	n	%	n	%	n	%
Algoma, Cochrane, Manitoulin & Sudbury	91	40	127	1	76	34	2,198	13
Champlain	281	61	1,368	3	159	34	4,820	11
Durham, Haliburton, Kawartha & Pine Ridge	279	70	5,851	17	124	31	3,815	11
Essex, Kent, and Lambton	387	77	1,013	4	109	22	3,300	12
Grand River	50	45	74	1	36	32	1,234	12
Grey, Bruce, Huron, Perth	56	55	126	1	33	33	1,476	13
Halton-Peel	684	61	2,141	3	216	19	6,903	10
Hamilton-Wentworth	124	63	275	1	81	41	2,056	10
Metropolitan Toronto	1,335	61	5,417	4	392	18	11,457	9
Muskoka, Nipissing, Parry Sound & Timiskaming	51	63	169	2	33	41	1,046	13
Niagara Region	109	66	184	1	74	45	1,764	11
Northwestern Ontario	45	29	96	1	50	32	1,699	15
Simcoe-York	349	53	1,421	3	169	26	5,333	12
Thames Valley	198	66	578	2	100	33	3,068	12
Waterloo Region - Wellington-Dufferin	189	63	486	2	93	31	3,920	12

Source: Ontario Diabetes Database (ODD). *averaged over the study period. **with a Dx Code 250. ‡excludes DHC 63 (Quinte, Kingston, Rideau).

the Canadian Diabetes Association (CDA) as the appropriate source of care for pregnant women with DM.[15] We found a significant amount of variation in specialist use by DHC, suggesting that women in some regions of the province may have better access to specialist care than others. New technologies, such as telemedicine techniques, may prove to be of use in areas with less access to specialized care.

Complications of DM, including retinopathy, can progress during pregnancy depending on the level of glucose and blood pressure control, as well as other factors.[25] The risk of retinopathy progression can be reduced by tight glycemic control during pregnancy. Further, for those with severe forms of diabetic retinopathy, laser therapy can be performed either prior to or during pregnancy to prevent visual loss. Based on this evidence, the CDA has recommended the following for women with pre-existing DM in pregnancy: "a retinal examination should be performed regularly, at least once in the first trimester with subsequent frequency adjusted to the severity of the retinopathy".[15]

Despite this recommendation, our data shows that only one-quarter of Ontario women with DM have a retinal examination during pregnancy. This rate varied substantially across DHCs, raising concerns regarding access to services and the need to educate women with DM and their physicians about the importance of this practice.

Our data confirm a higher rate of pregnancy-related complications among women with DM compared to women without DM. Many adverse outcomes in this population may be preventable through high quality care prior to conception and throughout pregnancy. Strategies are required to ensure accessibility of such specialized services throughout the province and to promote appropriate referral for care. At the same time, ongoing research is needed to determine whether this care leads to improved maternal and fetal outcomes and to define optimal models of care for Ontario.

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12

Chapter

Diabetes in Children

Authors: Teresa To, Jacqueline R. Curtis and Denis Daneman

Key Messages

- Incidence and prevalence of diabetes mellitus (DM) are increasing in Ontario children, particularly younger children.
- Studies have documented that ambulatory care strategies are particularly effective for disease education and self–management training of children with new onset DM. The effectiveness of patient education and the availability of advice via a 24-hour telephone hotline can reduce the incidence of DKA associated with intercurrent illness.

Background

Prior to the discovery of insulin in 1921, children with type 1 diabetes mellitus (DM) inevitably died of diabetic ketoacidosis (DKA). Despite major advances in DM care, DKA remains a leading cause of hospitalization and the leading cause of death and morbidity in children and adolescents with type 1 DM.[1,2] Most DKA–related mortality and morbidity arises as a consequence of the development of cerebral edema, a complication of DKA and/or its management, which is not completely understood.[3–5] There is little information on hospitalization trends for DKA in children and adolescents at the population level. A recent report based on Ontario data by Curtis et al reported a 19% relative decrease in the overall DM–related admission rate from 1991 to 1999. Non–DKA admissions decreased by 29%, whereas DKA admissions remained stable.[6]

Since the1990's in the province of Ontario, total annual pediatric inpatient admissions for both medical and surgical conditions have fallen.[7] This is due, in part, to a shift in care from resource-intensive inpatient care services to outpatient disease management and home care strategies for children with both chronic and subacute conditions. Ambulatory care strategies have been particularly effective for disease education and self–management training of children with new onset DM. Outpatient care for this group has been shown to significantly reduce health care costs, while being equivalent to or better than inpatient care in other DM-specific outcome measures, including hospital readmission rates, HbA1c (glycated hemoglogin blood test), and frequency of hypoglycemia and diabetic ketoacidosis (DKA).[8–19]

Recent data suggest that simple community interventions which are put into place at the time of diagnosis of DM may prevent or reduce the incidence of DKA.[20] DKA in established DM is most often due to inappropriate intercurrent illness management or deliberate insulin omission.[21–23] At least two studies document the effectiveness of patient education and the availability of advice via a 24-hour telephone hotline in reducing the incidence of DKA associated with intercurrent illness.[22,23] Insulin omission may also be preventable by having a set of educational, supervisory and psychosocial interventions available which are aimed at determining the reason for the insulin omission and preventing its recurrence.[21]

In this chapter, we examine recent temporal and regional variation trends in DM prevalence and incidence, and in the patterns of hospitalization for both general DM and DKA admissions among Ontario children.

Data Sources

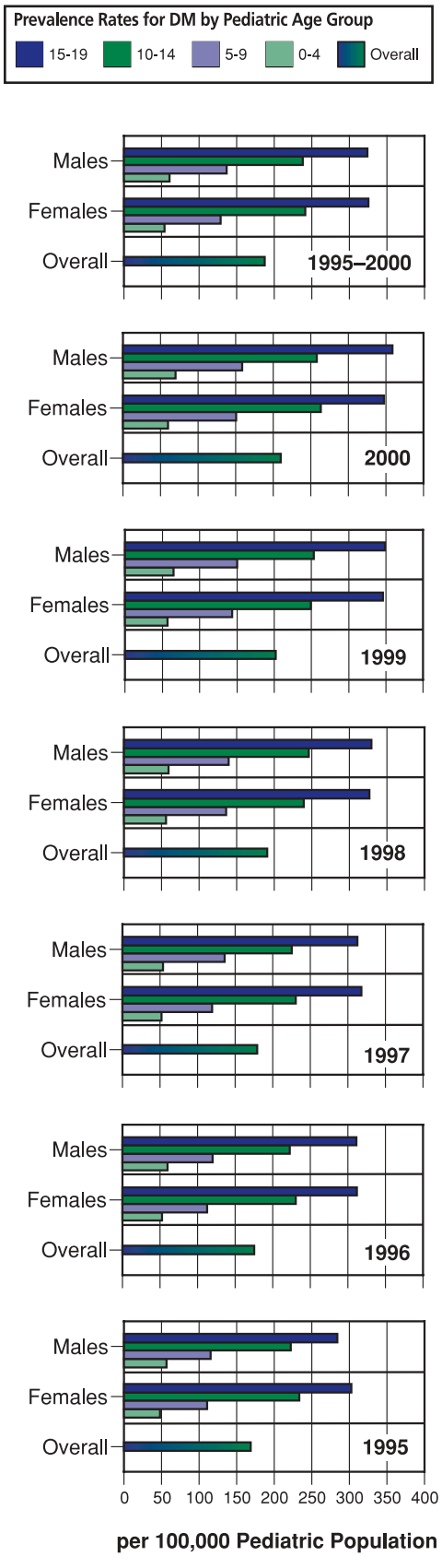
Incidence and prevalence data for this chapter were obtained from the Ontario Diabetes Database (ODD), previously described in Chapter 1. Creation of the ODD is described in Chapter 1, Technical Appendix TA1.A. Age- and sex-specific and adjusted

Exhibit 12.1 Age-/Sex-specific DM Prevalence Rates in Ontario per 100,000 Pediatric Population Less Than 19 Years of Age, Fiscal 1995–2000

Overall, there was an almost 20% increase in DM prevalence in children in all age groups between 1995 and 2000. Both boys and girls aged five to nine years showed the highest increase in prevalence.

Fiscal Year	Overall Rate	Females by Age Group				Males by Age Group			
		0–4	5–9	10–14	15–19	0–4	5–9	10–14	15–19
1995	168.9	47.8	110.8	233.3	302.4	56.9	115.7	222.4	284.2
1996	175.1	52.4	112.1	230.6	311.9	60.0	119.4	222.2	310.9
1997	179.5	52.4	119.9	230.7	318.4	54.4	136.1	225.8	313.1
1998	190.7	56.2	136.3	239.5	326.4	59.1	139.7	246.0	329.7
1999	201.9	56.7	143.8	249.2	346.2	65.0	150.1	253.2	348.9
2000	209.8	59.9	150.2	263.3	346.9	69.7	158.3	257.8	358.5
1995–2000	187.6	54.2	128.8	241.1	325.3	60.9	136.6	237.9	324.2

Source: Ontario Diabetes Database (ODD). All fiscal years are from April 1st to March 31st (eg, April 1, 1994–March 31, 1995 = 1995).



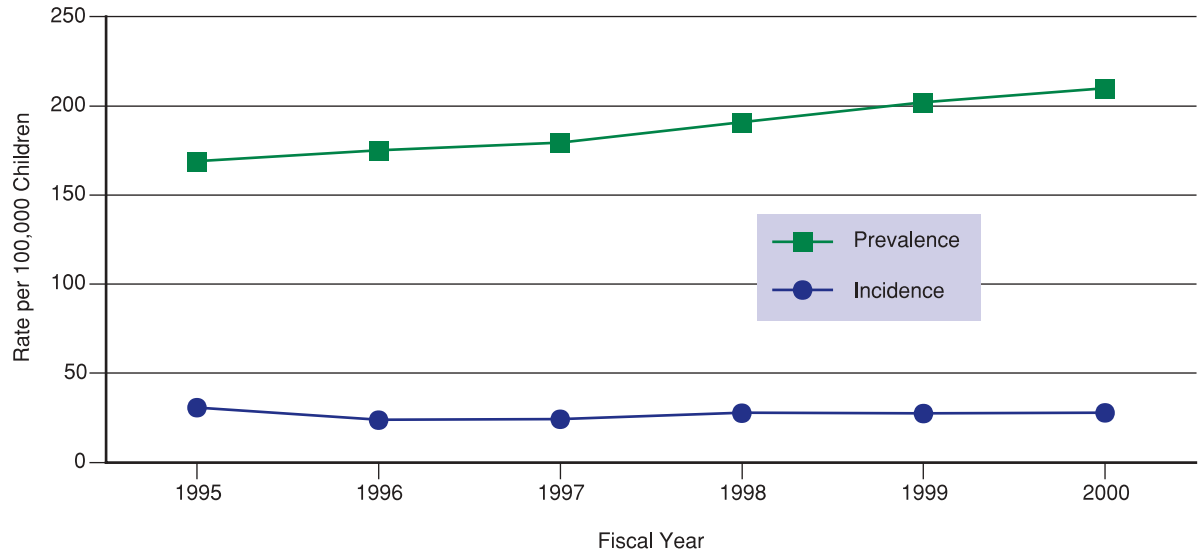
prevalence and incidence rates were calculated per 100,000 children in the Ontario population. Records for DM–related hospitalizations were obtained from the Canadian Institute for Health Information (CIHI) database. Age- and sex-adjusted annual rates of hospitalizations were calculated per 100 children with DM. P-values shown in area variation analysis are based on the one-degree of freedom chi-square statistic, which compares the rate of the District Health Council (DHC) to the overall province-wide age- and sex-adjusted rate.

How the Analysis was done

The pediatric population was defined as male and female persons in Ontario, 19 years of age and younger. Data on all patients with International Classification of Disease 9th Edition (ICD–9) diagnosis codes 250.0–250.9 during the period of April 1, 1994 to March 31, 2000 (fiscal years 1994–1999) were studied.[24] Hospitalization for DKA was defined by ICD-9 discharge codes 250.1–250.3. Hospital admissions **not** due to DKA ("non-DKA") were defined by ICD-9 discharge codes 250.0 or 250.4–250.9 Age trends were evaluated for the following groups: infants and preschool (0–4 years), school age (5–9 years), early adolescent (10–14 years) and late adolescent (15–19 years). Age- and sex-adjusted annual rates of DM prevalence and incidence were calculated per 100,000 in the Ontario pediatric population. Age- and sex-adjusted annual rates of DM-related hospitalizations were calculated per 100 children with DM based on the fiscal 1995–2000 ODD data. The average length of stay was calculated by dividing the total number of hospitalization days by the number of admissions.

Small area rate variation (SARV) analysis was performed as described in Technical Appendix TA2.A in *Chapter 2: Acute Complications of Diabetes*. Admission rates were reported by the child's county of residence as determined by the residence codes. All rates were adjusted for age and sex and were reported for three-year intervals to ensure stability of rates.

Exhibit 12.2 Age-/Sex- Adjusted Prevalence and Incidence of DM in Ontario Children Less Than 19 Years of Age 1995–2000



Source: Ontario Diabetes Database (ODD)

Exhibit 12.3 Age-/Sex-Adjusted Prevalence of DM per 100,000 Children in the Population Less Than 19 Years of Age by DHC of Patient Residence in Ontario, Fiscal 1998–2000

There is a 1.6-fold difference between the highest and the lowest DM prevalence rates in DHCs.

	Prevalence by Year	
District Health Council (DHC)	**Fiscal 1995–1997**	**Fiscal 1998–2000**
Algoma, Cochrane, Manitoulin & Sudbury	216.9***	237.1**
Champlain	177.8	203.2
Durham, Haliburton, Kawartha & Pine Ridge	186.6	220.2*
Essex, Kent, and Lambton	213.0***	239.3***
Grand River	217.1**	251.0**
Grey, Bruce, Huron, Perth	167.7	208.8
Halton-Peel	161.2	188.2
Hamilton-Wentworth	190.5	207.0
Metropolitan Toronto	128.8***	154.2***
Muskoka, Nipissing, Parry Sound & Timiskaming	180.6	232.9
Niagara Region	206.6*	226.4
Northwestern Ontario	202.0	238.2*
Quinte, Kingston, Rideau	167.1	203.7
Simcoe-York	166.7	193.9
Thames Valley	183.4	211.0
Waterloo Region-Wellington-Dufferin	195.7*	214.4
Provincial-wide Age-/Sex-adjusted Rate	174.1	200.3
Extremal Quotient [EQ]	1.7	1.6
Ratio of Third Quartile over First Quartile	1.2	1.2
Coefficient of Variation (%) [CV]	15.6	13.8
Systematic Component of Variation [SCV]	17.2	14.4
Adjusted Chi-square (likelihood ratio, DF=15)	126.7***	116.9***
* P-value <0.05 ** P-value <0.01 *** P-value <0.0001		

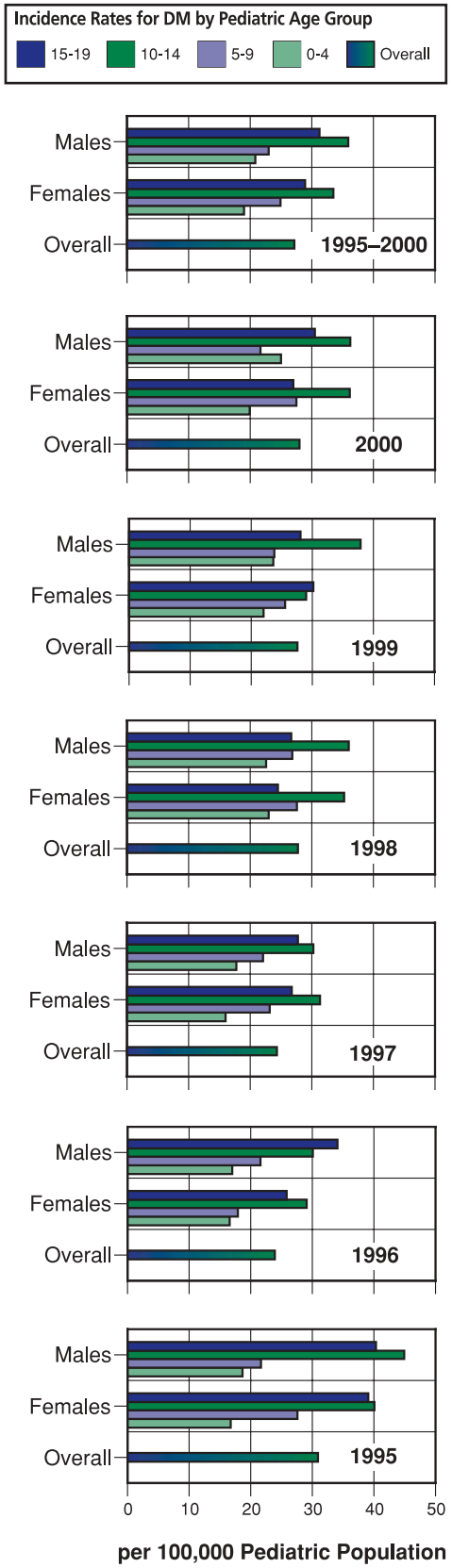
Source: Ontario Diabetes Database (ODD). All fiscal years are from April 1st to March 31st (eg, April 1, 1994–March 31, 1995 = 1995).

Exhibit 12.4 Age-/Sex-specific DM Incidence Rates per 100,000 Children in the Ontario Population Less Than 19 Years of Age, Fiscal 1995–2000

An overall 17.2 % increase in DM incidence rates was observed (from 24 in 1996 to 28/100,000 in 2000).

Fiscal Year	Overall Rate	Females by Age Group				Males by Age Group			
		0–4	5–9	10–14	15–19	0–4	5–9	10–14	15–19
1995	30.9	16.8	27.6	40.1	39.1	18.7	21.7	44.9	40.3
1996	23.9	16.6	17.9	29.1	25.8	17.0	21.6	30.1	34.1
1997	24.4	16.0	23.2	31.4	26.8	17.8	22.1	30.3	27.8
1998	27.8	23.0	27.6	35.3	24.5	22.6	26.9	36.0	26.7
1999	27.6	22.0	25.6	29.0	30.2	23.6	23.8	37.9	28.1
2000	28.0	19.9	27.5	36.1	27.0	25.0	21.6	36.2	30.5
1995-2000	27.1	19.0	24.9	33.5	28.9	20.8	23.0	35.9	31.2

Source: Ontario Diabetes Database (ODD). All fiscal years are from April 1st to March 31st (eg, April 1, 1994–March 31, 1995 = 1995).



Interpretive Cautions

Apart from the usual limitations inherent in analyzing and interpreting administrative data, there is specific interpretive caution when utilizing the ODD to determine DM incidence and prevalence in children. This methodology has not been specifically validated in the pediatric population. Because of the relatively low prevalence of DM in children, the application of an algorithm validated in adults may lead to a higher proportion of false positives. Of further concern in this age group is the reliance of the ODD on OHIP claims to identify cases, since several pediatric providers are remunerated under alternate payment mechanisms. Administrative data do not allow one to differentiate between types 1 and 2 DM or diabetes arising secondary to another illness or medication (e.g., CF-related DM, steroid-induced DM). In this report, readmissions of individuals have not been separated out from first admissions. For this population, readmissions may account for a significant proportion of total admissions, and for this reason, further analysis of readmissions is warranted in the future.

Findings

Prevalence of Diabetes Mellitus in Children

Exhibits 12.1 and 12.2 show the age- and sex-specific DM prevalence rates per 100,000 population of children under 19 years of age for the fiscal periods from fiscal 1995–2000. Since fiscal 1995 was the first study period used to define incident cases, some prevalent cases might have been misclassified as incident. Therefore, when reporting the percent change in incidence or prevalence over time, we started from fiscal 1996. Overall, there was an almost 20% increase from 175 in 1996 to 210/100,000 in 2000. A similar increase was observed in all age groups. However, children aged five to nine years showed the highest increase in prevalence; rates did not differ significantly between males and females (32.5% in males and 34.1% in females respectively).

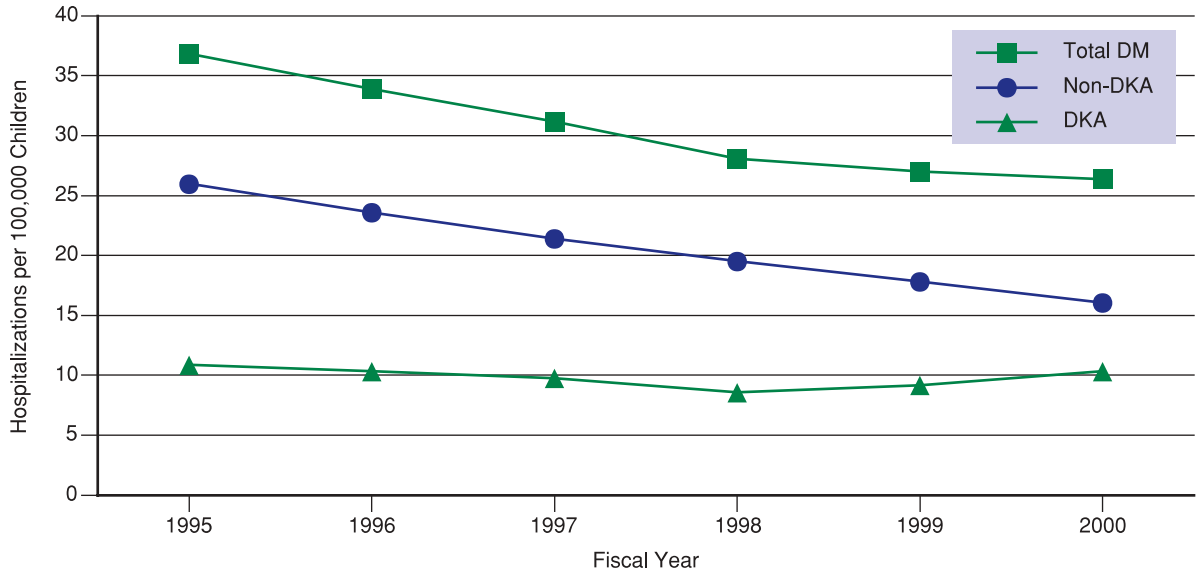
Exhibit 12.5 Age-/Sex-adjusted Incidence of DM per 100,000 Children in the Population Less than 19 years of Age by DHC of Patient Residence, Fiscal 1995–2000

There is a 1.5-fold difference between the highest and the lowest incidence rate among DHCs.

	Incidence by Year	
District Health Council (DHC)	**Fiscal 1995–1997**	**Fiscal 1998–2000**
Algoma, Cochrane, Manitoulin & Sudbury	28.1	26.6
Champlain	25.1	27.0
Durham, Haliburton, Kawartha & Pine Ridge	26.0	31.9
Essex, Kent, and Lambton	30.3	34.1
Grand River	31.2	26.8
Grey, Bruce, Huron, Perth	25.3	27.9
Halton-Peel	25.5	26.8
Hamilton-Wentworth	24.8	23.5
Metropolitan Toronto	25.6	23.1*
Muskoka, Nipissing, Parry Sound & Timiskaming	26.3	30.4
Niagara Region	27.4	31.1
Northwestern Ontario	32.7	32.6
Quinte, Kingston, Rideau	27.3	31.2
Simcoe-York	26.0	28.8
Thames Valley	24.4	27.3
Waterloo Region-Wellington-Dufferin	24.5	30.2
Provincial-wide Age-/Sex-adjusted Rate	26.3	27.7
Extremal Quotient [EQ]	1.3	1.5
Ratio of Third Quartile over First Quartile	1.1	1.2
Coefficient of Variation (%) [CV]	7.2	11.9
Systematic Component of Variation [SCV]	-19.9	-14.9
Adjusted Chi-square (likelihood ratio, DF=15)	4.0	12.0
* P-value <0.05		

Source: Ontario Diabetes Database (ODD). All fiscal years are from April 1st to March 31st (eg, April 1, 1994–March 31, 1995 = 1995).

Exhibit 12.6 Age-/Sex- Adjusted DKA and Non-DKA Hospitalization Rates per 100 Children with DM Less Than 19 Years of Age in Ontario, Fiscal 1995–2000



Source: Ontario Diabetes Database (ODD)

Exhibit 12.3 shows the age- and sex-adjusted prevalence rate of DM by the district health council (DHC) of patient residence in Ontario. Due to small numbers, the fiscal periods from 1997–1999 were combined to generate an average annual rate per 100,000 children in the population of Ontario by DHC. Metropolitan Toronto DHC had the lowest age- and sex-adjusted prevalence rate (154/100,000, $p<0.0001$), while Grand River DHC had the highest (251/100,000, $p<0.01$), yielding a 1.6–fold difference between the highest and the lowest DHCs.

Incidence of Diabetes Mellitus in Children

Exhibits 12.2 and 12.4 show the age- and sex-specific DM incidence rates per 100,000 population of children under 19 years of age for fiscal periods 1995–2000. An overall 17.2 % increase in incidence (from 24 in 1996 to 28/100,000 in 2000) was observed. The biggest increases in incidence were seen in younger children (47.1% in male children aged 0–4 years and 53.8% in females aged 5–9 years).

Exhibit 12.5 shows the age- and sex-adjusted incidence rate of DM by DHC. Between 1997 and 2000, the Metropolitan Toronto DHC had the lowest age-adjusted incidence rate (23/100,000, $p<0.0001$), while the Essex, Kent, and Lambton DHC had the highest (34/100,000), yielding a 1.5-fold difference between the highest and the lowest DHCs.

DKA and Non-DKA Admissions

DM-related admissions in Ontario children totalled 10,150 during the fiscal period from 1995–2000 (Exhibit 12.6). Of these, 3,293 were due to DKA and 6,857 were due to non-DKA causes. The hospital admission rates for DKA and non-DKA among children with DM and by fiscal year are shown in Exhibit 12.6. There was a steady 38.2% decrease over the 1995–2000 period in non-DKA admissions; however, there was no significant change in DKA admissions.

Exhibit 12.7 shows that the total days of hospital care fell by approximately 316 days per year for non-DKA admissions and by 9.3 days per year for DKA admissions for the study period of fiscal 1995–2000. There was a small decrease in the average lengths of stay (ALOS) for both groups from 4.3 to 3.5 days for the non-DKA and from 3.8 to 3.2 days for the DKA group.

Area Variations in Hospital Admissions for DKA and Non-DKA

Exhibit 12.8 shows the age- and sex-adjusted rates of hospitalization for DKA among children with DM by DHC of patient residence in Ontario for two time periods—fiscal 1995–1997 (earlier) and 1998–2000 (more recent). Durham, Haliburton, Kawartha and Pine Ridge DHC had the highest rate (13.4%, $p<0.01$) in the earlier period, but the lowest rate in the recent period (6.5%), representing an over 50% decline. In the more recent time period, Algoma, Cochrane, Manitoulin and Sudbury DHC had the highest rate (15.2%). This

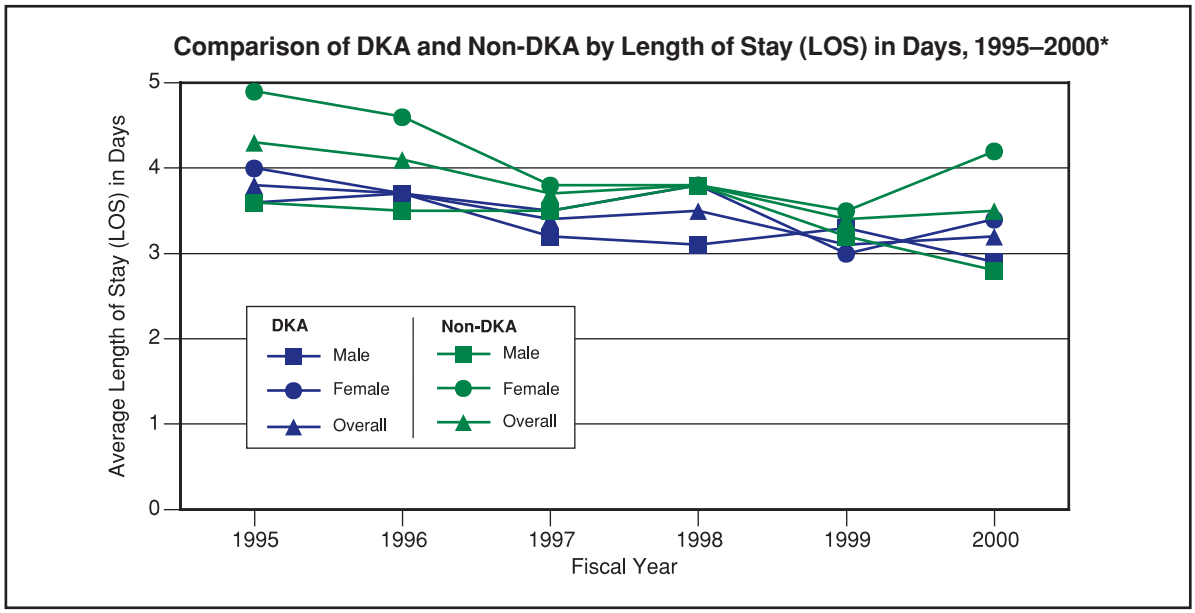
Key Research Findings

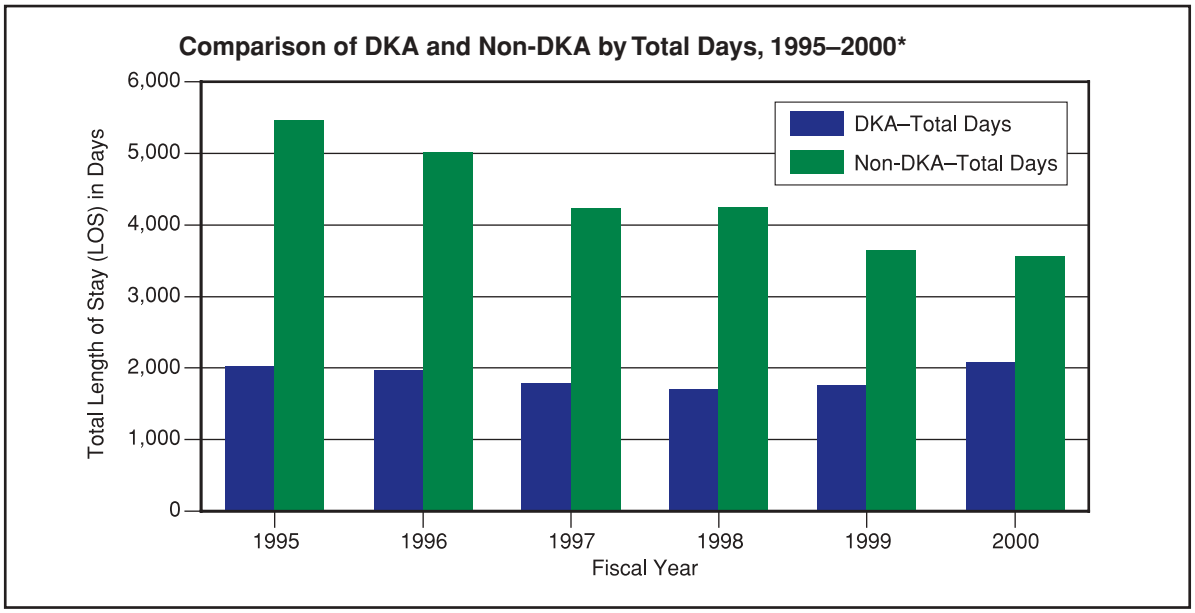
- Between 1996 and 2000, an overall 17% increase in incidence of DM in children was observed. The larger increases in incidence were seen in younger children.
- Overall, there was an almost 20% increase in DM prevalence in children in all age groups between 1996 and 2000. Both boys and girls aged five to nine years showed the highest increase in prevalence.
- There was a steady 38% decrease over the 1995–2000 period in non-DKA admissions; however, there was no significant change in DKA admissions. The average lengths of stay were also slightly shorter.

Exhibit 12.7 Average Length of Stay following Admission for DKA and Non-DKA in Ontario Children with/without DM, Fiscal 1995–2000

Total days of hospital care fell by approximately 316 days per year for non-DKA admissions and by 9.3 days per year for DKA admissions between fiscal 1995–2000.

Fiscal Year	DKA Average Length of Stay (LOS) in days				Non-DKA Average Length of Stay (LOS) in days			
	Male	Female	Overall	Total Days	Male	Female	Overall	Total Days
1995	3.6	4.0	3.8	2,030	3.6	4.9	4.3	5,459
1996	3.7	3.7	3.7	1,967	3.5	4.6	4.1	5,008
1997	3.2	3.5	3.4	1,779	3.5	3.8	3.7	4,226
1998	3.1	3.8	3.5	1,710	3.8	3.8	3.8	4,244
1999	3.3	3.0	3.1	1,759	3.2	3.5	3.4	3,652
2000	2.9	3.4	3.2	2,086	2.8	4.2	3.5	3,563





Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). *All fiscal years are from April 1st to March 31st (eg, April 1, 1994–March 31, 1995 = 1995).

Exhibit 12.8 Age-/Sex-adjusted Rates of Hospitalization for DKA per 100 Children with DM Less Than 19 years of Age by DHC of Patient Residence in Ontario, Fiscal 1995–2000

In the more recent time period, there is a 2.3-fold variation between the highest and lowest rates of hospitalization for DKA.

District Health Council (DHC)	Fiscal 1995–1997	Fiscal 1998–2000
Algoma, Cochrane, Manitoulin & Sudbury	12.8*	15.2
Champlain	7.8	8.7
Durham, Haliburton, Kawartha & Pine Ridge	13.4**	6.5
Essex, Kent, and Lambton	9.7	12.3*
Grand River	6.6	10.1
Grey, Bruce, Huron, Perth	13.2	7.9
Halton-Peel	6.4*	10.2
Hamilton-Wentworth	11.1	9.7
Metropolitan Toronto	7.4*	6.7**
Muskoka, Nipissing, Parry Sound & Timiskaming	8.3	8.9
Niagara Region	13.2**	12.4*
Northwestern Ontario	7.2	10.4
Quinte, Kingston, Rideau	9.8	8.2
Simcoe-York	7.5	7.9
Thames Valley	8.9	10.7
Waterloo Region-Wellington-Dufferin	11.7**	14.0***
Provincial-wide Age-/Sex-adjusted Rate	9.3	9.3
Extremal Quotient [EQ]	2.1	2.3
Ratio of Third Quartile over First Quartile	1.6	1.4
Coefficient of Variation (%) [CV]	26.1	26.0
Systematic Component of Variation [SCV]	50.2	29.6
Adjusted Chi-square (likelihood ratio, DF=15)	51.5***	44.0***
* P-value <0.05 ** P-value <0.01 *** P-value <0.0001		

Source: Ontario Diabetes Database (ODD). All fiscal years are from April 1st to March 31st (eg, April 1, 1994–March 31, 1995 = 1995).

highest rate when compared to the lowest rate in Durham, Haliburton, Kawartha and Pine Ridge DHC yields a 2.3-fold variation.

Exhibit 12.9 shows the age- and sex-adjusted rates of hospitalization for non-DKA among children with DM by DHC of patient residence in Ontario for the same two time periods. Champlain had the lowest recent rate; Thames Valley DHC had the lowest rate in the earlier and second lowest rate in the recent period (12.9% and 13.3% respectively, p<0.0001). Durham, Haliburton, Kawartha and Pine Ridge DHC had the highest rate in the recent period (27.1%) while Muskoka, Nipissing, Parry Sound and Timiskaming DHC had the highest rate in the earlier period (43.3%, p<0.001). This highest rate when compared to the lowest rate showed a 3.3-fold and 2.2-fold variation in the earlier and recent periods respectively.

Discussion

Canadian estimates of the incidence of type 1 DM in children and teens are from the 1970s and 80s. Ehrlich et al estimated an incidence of 9/100,000 children under 19 years of age with type 1 DM in Toronto during a two-year prospective study in the late 1970's.[25] Similar incidence for the same time period was reported in Montreal by West et al.[26] An active search of hospital records was conducted in this study to survey type 1 juvenile-onset DM younger than 17 years who were residents in Greater Montreal at the time of onset of symptoms during a seven-year period (1971–1977). A mean annual incidence of 9/100,000 was found with variation from year to year (5.8 to 10.3). Recently, however, much higher levels of incidence of type 1 DM were reported in Alberta and Manitoba.[27,28] The average annual incidence and prevalence were 20/100,000 and 120/100,000 respectively for children aged 0–14 years.[29] The highest incidence of type 1 DM in Canada, however, was found in Prince Edward Island (26/100,0000).[30] Our Ontario study using data for fiscal years 1994 to 1997 showed an annual incidence of 27/100,000 for children aged 0–19 years. This

Exhibit 12.9 Age-/Sex-adjusted Rates of Non-DKA Hospitalizations per 100 Children with DM Less Than 19 years of Age by DHC of Patient Residence in Ontario, Fiscal 1995–2000

Non-DKA admissions among children with DM showed a 3.3-fold and 2.2-fold variation in the earlier and recent periods respectively between highest and lowest rates.

District Health Council (DHC)	Fiscal 1995–1997	Fiscal 1998–2000
Algoma, Cochrane, Manitoulin & Sudbury	24.7	25.2
Champlain	25.0*	12.3
Durham, Haliburton, Kawartha & Pine Ridge	33.7*	27.1
Essex, Kent, and Lambton	27.9	20.9
Grand River	20.5	25.1
Grey, Bruce, Huron, Perth	39.7*	25.7
Halton-Peel	26.4	23.2
Hamilton-Wentworth	21.6	25.9
Metropolitan Toronto	21.6*	16.1
Muskoka, Nipissing, Parry Sound & Timiskaming	43.3**	24.3
Niagara Region	30.5	25.7
Northwestern Ontario	24.1	24.2
Quinte, Kingston, Rideau	30.1	22.7
Simcoe-York	29.2	22.1
Thames Valley	12.9***	13.3
Waterloo Region-Wellington-Dufferin	29.9	24.9
Provincial-wide Age-/Sex-adjusted Rate	26.2	20.8
Extremal Quotient [EQ]	3.3	2.2
Ratio of Third Quartile over First Quartile	1.3	1.2
Coefficient of Variation (%) [CV]	22.1	22.6
Systematic Component of Variation [SCV]	46.4	33.0
Adjusted Chi-square (likelihood ratio, DF=15)	72.5	61.8
* P-value <0.05 ** P-value <0.01 *** P-value <0.0001		

Source: Ontario Diabetes Database (ODD). All fiscal years are from April 1st to March 31st (eg, April 1, 1994–March 31, 1995 = 1995).

estimate is comparable to that reported in a Manitoba study from 1985 to 1993 (20/100,000 estimate for children aged 0–14 years). However, our average prevalence estimate of 188/100,000 was higher than that reported in Manitoba (120/100,000).

The incidence figures reported in the literature pertained to type 1 DM. Estimates of type 2 DM in Canada are practically nonexistent. Compared to the late 1970s published incidence in Toronto (9/100,000),[25] our current Toronto estimate of 23/100,000 indicated a greater than two-fold rise in DM incidence. This increase may imply the combination of rising incidences in both type 1 and type 2 DM in this age group, while the rise in type 2 would largely be reflected in the increase in the 10–14 and 15–19 year olds. Similar to observations Harris et al[31] made in the Sandy Lake community, our estimates in Northern Ontario are likely accounted for by the increasing incidence and prevalence of type 2 DM in teens and even some children in the 8–12 age range. Different approaches to prevention and management of type 1 and type 2 DM make the distinction between the two conditions an important next step in research.

The DM incidence and prevalence estimates calculated in this study were based on the algorithm previously developed and applied in Manitoba. To our knowledge, this is the first time that this algorithm was applied to our Ontario administrative database and in our Ontario population of children. While there is no solid reason to speculate that the algorithm may work differently in our data, the higher incidence and prevalence of DM in the Ontario childhood population warrant further studies on the accuracy of the methods used in defining DM in our population. A validation study to examine the sensitivity and specificity of the algorithm and to determine the optimal algorithm to define DM in children using administrative databases is currently in progress. Results of that work will provide more precise estimates required for disease surveillance and health planning.

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13

Chapter

Diabetes and First Nations People

Authors: Baiju R. Shah, Sonia Anand, Bernie Zinman and Minh Duong-Hua

Key Messages

- This chapter describes diabetes mellitus (DM) and its outcomes in a small number of First Nations (FN) communities. Further research is required to describe the impact of DM in the broader aboriginal community of Ontario.
- Diabetes mellitus (DM) is much more common among FN people in Ontario than in the general population.
- Mortality rates and complications are more common among FN people with DM than non–FN people with DM
- While declines in the rates of some of the major DM complications over time may represent better treatment and outcomes, it may also be due to increased vigilance for DM.
- FN people are receiving fewer invasive procedures that treat cardiovascular and cerebrovascular diseases and diabetic eye disease. Given the high rates of disease, these low treatment rates suggest reduced access for people from remote FN communities. It is not clear to what extent this is due to lower rates of screening and detection of complications.
- In collaboration with FN groups, culturally appropriate strategies to reduce the rates of DM and its complications need to be developed and implemented.

Background

In most Western countries, people from various sub-populations and ethnic groups have higher rates of diabetes mellitus (DM) than the general population. This is particularly true for North American aboriginal populations. The Pima Indians of the southwestern United States have the highest rate of DM of any population in the world, with up to 40–50% of adults over the age of 35 affected.[1] In Canada, high rates have been described among many First Nations (FN) communities across the country,[2–6] although there is significant variability, with some communities even reporting rates of DM lower than the general population.[6,7]

Many theories have been put forth as to why FN peoples have a high prevalence of DM. Overweight and abdominal obesity have a high prevalence in many aboriginal communities, and are primary determinants of DM.[8–10] Similarly, low levels of physical activity have been observed in both aboriginal adults and children.[11,12] As in other populations, low levels of physical activity have been associated with an increased risk of DM among aboriginal people.[13] Aboriginal people may also have a genetic predisposition toward developing DM. Some have suggested that genes promoting caloric conservation during times of plenty offered an evolutionary advantage to aboriginal people by protecting them during times of starvation, but that with changes in food availability and Westernization of lifestyles, this once protective advantage now leads to the accumulation of abdominal fat and the development of DM.[14] A specific variant of the gene hepatic nuclear factor-1α has been discovered in the Oji-Cree of Northwestern Ontario. This is associated with early onset of type 2 DM and accounts for 40% of the DM in the community of Sandy Lake.[15,16] Other investigators have shown that abnormal birth weight is associated with the development of DM in aboriginal people and in other populations, suggesting that intrauterine factors may affect metabolism in adulthood.[17,18] Finally, many FN people believe that DM results from eating the "junk foods" introduced by Europeans.[19]

As a result of these high rates of DM, the mortality associated with DM among aboriginal people is significant. Studies have shown that the age-adjusted DM death rate for aboriginal people in the United States was up to 4.3 times greater than that of the general population.[20] In Canada, DM-related deaths were 2.2 times higher among FN men and 4.1 times higher among FN women when compared to the general Canadian population.[21] Another study also found increased DM-related mortality rates for FN men and women compared to non-FN people in British Columbia.[22]

Furthermore, many of the co-morbidities resulting from DM are more frequent among aboriginal people than in the general population. In fact, many studies have shown that aboriginal people with DM have a greater risk of long-term DM complications than non-aboriginal people with DM. End-stage renal disease is more common among aboriginal people in both Canada and the United States.[20,23,24] The prevalence of retinopathy is higher.[20] Risk factors

Exhibit 13.1 Ontario Prevalence of DM in First Nations and Non-First Nations People, 1994 and 1998

Prevalence of DM among First Nations people was three times higher than among non-First Nations people, and was particularly higher among women and young people.

Age-/Sex-specific Prevalence Rates (per 100 people)	First Nations People		Non-First Nations People	
	1994	1998	1994	1998
Women				
20–34	3.5	5.7	0.7	1.0
35–49	12.6	14.9	1.8	2.5
50–64	24.8	31.6	5.9	7.3
65–74	29.3	37.2	10.3	13.5
75 +	27.0	32.6	10.9	14.1
Men				
20–34	1.4	1.8	0.6	0.8
35–49	8.1	11.2	2.2	2.9
50–64	18.2	25.4	7.8	9.9
65–74	23.7	29.0	13.0	17.1
75 +	15.3	25.9	13.6	17.5
Overall Prevalence Rates (per 100 people)				
Unadjusted	9.9	13.2	4.0	5.3
Age-/Sex-adjusted	12.5	16.3	4.1	5.3

Sources: Ontario Diabetes Database (ODD), Registered Persons Database (RPDB). Note: Groups were defined cross-sectionally on April 1, 1994 and April 1, 1998.

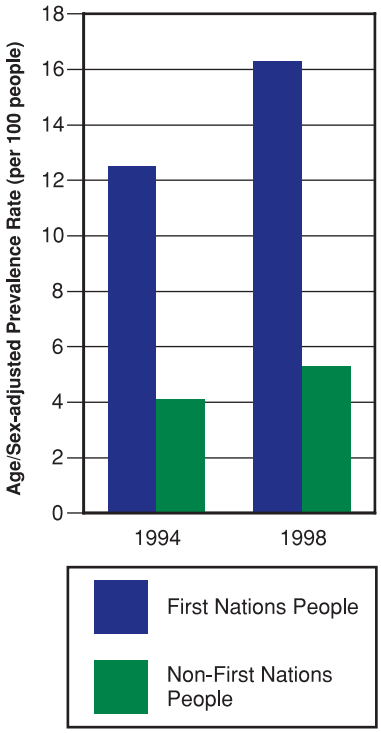


Exhibit 13.2 Ontario Incidence of DM in First Nations and Non-First Nations People, 1995 and 1999

Incidence of DM among First Nations people was three times higher than among non-First Nations people, and was particularly higher among women and young people.

Age-/Sex-Specific Incidence Rates (per 100 people)	First Nations People		Non-First Nations People	
	1995	1999	1995	1999
Women				
20–34	1.1	1.0	0.1	0.2
35–49	1.7	1.7	0.4	0.4
50–64	2.9	2.4	1.0	0.9
65–74	3.0	2.5	1.4	1.3
75 +	3.3	1.7	1.4	1.2
Men				
20–34	0.4	0.3	0.1	0.1
35–49	1.7	1.4	0.5	0.5
50–64	2.2	2.0	1.3	1.2
65–74	2.0	2.3	1.8	1.7
75 +	3.2	2.7	1.7	1.5
Overall Incidence Rates (per 100 people)				
Unadjusted	1.5	1.3	0.6	0.6
Age-/Sex-adjusted	1.8	1.5	0.7	0.6

Sources: Ontario Diabetes Database (ODD), Registered Persons Database (RPDB)

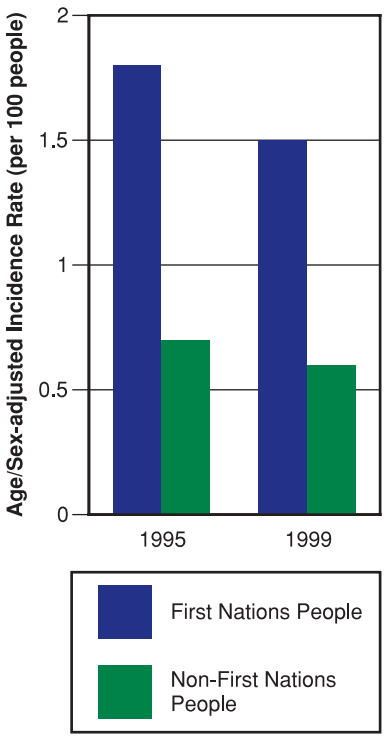
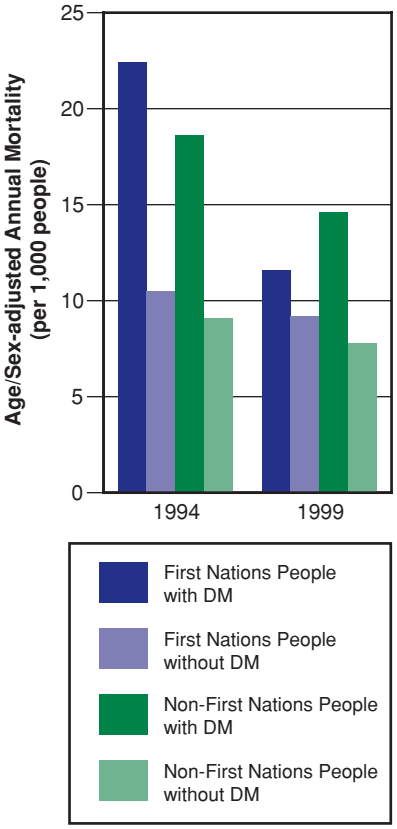


Exhibit 13.3 Annual Mortality Rates in Ontario for First Nations and Non-First Nations People with/without DM, 1994 and 1999

Mortality rates were approximately double for people with DM compared to those without, with significant excess mortality seen among young people.

Age-/Sex-specific Annual Mortality Rates (per 1,000 people)	First Nations People with DM		First Nations People without DM		Non-First Nations People with DM		Non-First Nations People without DM	
	1994	1999	1994	1999	1994	1999	1994	1999
Women								
20–34	*	*	0.8	1.4	2.4	1.7	0.3	0.3
35–49	*	5.5	3.3	1.9	5.1	3.8	1.2	1.0
50–64	11.9	11.8	5.9	7.0	15.4	11.0	4.9	3.9
65–74	57.8	24.7	18.3	12.5	36.7	29.3	15.7	14.1
75 +	117.3	68.4	61.6	54.3	103.2	87.3	66.7	61.4
Men								
20–34	*	*	2.9	3.7	4.3	3.4	0.9	0.6
35–49	*	*	3.4	3.5	8.1	5.7	2.0	1.5
50–64	30.5	18.3	12.6	7.4	21.3	15.3	8.2	5.9
65–74	34.5	37.4	24.1	26.5	51.7	41.1	28.2	23.8
75 +	144.7	52.2	92.9	76.9	124.9	103.6	86.5	76.2
Overall Annual Mortality Rates (per 1,000 people)								
Unadjusted	26.9	15.4	6.5	5.5	40.4	32.7	8.0	6.8
Age-/Sex-adjusted	22.4	11.6	10.5	9.2	18.6	14.6	9.1	7.8

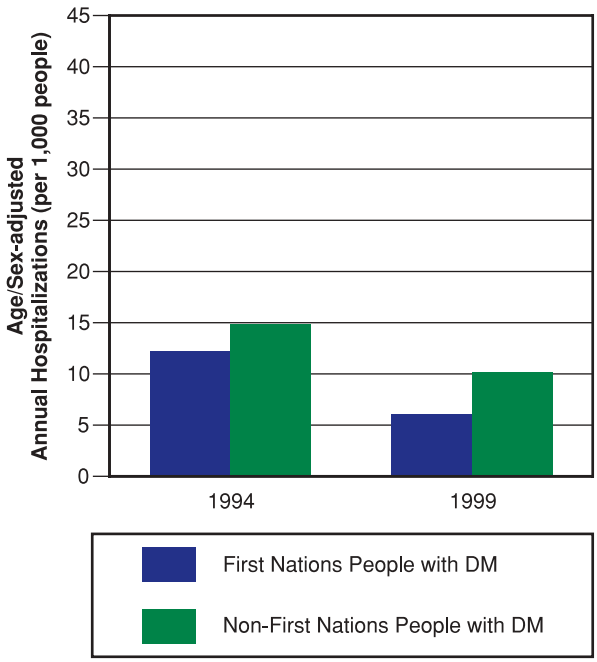


Sources: Canadian Institutes of Health Information (CIHI), Ontario Diabetes Database (ODD), Registered Persons Database (RPDB). Note: Groups were defined cross-sectionally on April 1, 1994 and April 1, 1999.
* Suppressed due to small cell size.

Exhibit 13.4 Frequency of Hospitalizations for Acute Metabolic Complications of DM for First Nations and Non-First Nations People with DM in Ontario, 1994 and 1999

First Nations people had fewer hospitalizations for acute metabolic complications of DM than non-First Nations people.

Overall Annual Hospitalizations (per 1,000 people)	First Nations People with DM		Non-First Nations People with DM	
	1994	1999	1994	1999
Unadjusted	9.5	4.3	7.2	4.4
Age-/Sex-adjusted	12.2	6.1	14.9	10.2



Sources: Canadian Institutes of Health Information (CIHI), Ontario Diabetes Database (ODD), Registered Persons Database (RPDB). Note: Groups were defined cross-sectionally on April 1, 1994 and April 1, 1999.

for coronary artery disease such as obesity, cigarette smoking and high cholesterol levels are common among Ontario FN peoples.[25,26] As a result, rates of coronary artery disease hospitalizations and myocardial infarctions in FN people are elevated and increasing.[27]

The utilization of medical services by FN people may differ from the general population in a number of ways. The FN communities being examined in this study are remote, isolated centres, located mostly in northern Ontario, many without road access. Therefore, access to high quality primary care providers is limited in these communities, and access to medical specialists and technologies will be even more restricted.[28] Furthermore, there may be differences in the biologic presentation of disease, and in cultural perceptions about health and wellness, which lead to differences in care-seeking behaviour.

This chapter examines the incidence and prevalence of DM among people living in FN communities in Ontario, and evaluates the rates of DM-related complications.

Data sources

People with DM (excluding cases of gestational DM) were identified using the Ontario Diabetes Database (ODD), which is described in detail in the Technical Appendix TA1.A to Chapter 1. The Registered Persons Database (RPDB) provided information on birth dates, gender and place of residence for all people with and without DM in Ontario. The Canadian Institutes of Health Information (CIHI) database gave detailed information on all hospitalizations of Ontario residents. The Ontario Health Insurance Plan (OHIP) database lists all claims for medical services provided by fee-for-service Ontario physicians for Ontario residents. Census data were used to define FN communities.

How the analysis was done

The Canadian census identifies 142 communities within Ontario as being "Indian reserves" or "Indian settlements." All postal codes in Ontario were examined, and the proportion of FN people within each postal code was estimated by calculating the proportion of people within the given postal code who live in one of these 142 communities. Postal codes for the study were only selected if at least 85% of the population within that postal code lived within one of these 142 communities. The postal codes and communities included in the study are shown in Technical Appendices TA13.A and TA13.B. All people identified in the RPDB as living in one of these postal code areas were defined, for the purposes of this report, as FN; all others were defined as non-FN people. In 1994, there were 16,614 people defined as FN and 8,040,903 people defined as non-FN.

The proportion of FN people who had DM as of April 1, 1994 was determined and compared to the proportion of non-FN people with DM at this same point in time. The prevalence rates were

Key Research Findings

- The prevalence of diabetes mellitus (DM) in people of the First Nations (FN) is three-fold higher than in non-FN Ontarians, with over 13% of adults affected. Incidence rates are similarly elevated. Prevalence and incidence are particularly high among women and young people.
- Mortality rates for people with DM are greatly in excess of those without DM. FN people have slightly higher mortality than non-FN people when controlling for the presence of DM.
- Acute complications and most macrovascular and microvascular chronic complications of DM are more common in FN people with DM compared to non-FN people.
- Although hospitalizations for cardiovascular and cerebrovascular diseases are more common for FN people, the use of specialized procedures to treat these problems is lower.

determined for both FN and non-FN people on April 1, 1998. Rates between time periods were compared. As well, incidence rates were determined for FN and non-FN people who developed DM in the fiscal years 1995 and 1999.

To evaluate the complications and consequences of DM, the entire population of Ontario was then divided into four groups: FN people with DM as of April 1, 1994; FN people without DM as of April 1, 1994; non-FN people with DM as of April 1, 1994; and non-FN people without DM as of April 1, 1994. The average annual mortality rate over the subsequent two years in each group was evaluated from the RPDB and the CIHI database. Using the CIHI database, the number of hospitalizations over the subsequent two years with each of the following conditions listed as the "most-responsible diagnosis" for the hospitalization was determined in each group: unstable angina, acute myocardial infarction (AMI), congestive heart failure (CHF), stroke, acute metabolic complication (hypoglycemia or hyperglycemia) and infectious diseases. Multiple hospitalizations for the same person were counted separately, but transfers between hospitals were not. For each diagnosis, the average annual frequency of hospitalization was determined for each group. The number of hospitalizations during the subsequent two years in which each of the following procedures was performed was determined in each group: coronary artery by-pass grafting (CABG), percutaneous transluminal coronary angioplasty (PTCA, also called percutaneous coronary intervention), carotid endarterectomy and non-traumatic lower extremity amputation (LEA). For each procedure, the average annual frequency of hospitalization was determined for each group. Using the OHIP database, the number of people over the subsequent two years in each group who had physician claims for renal dialysis that suggested end-stage renal disease was determined. The number of claims over the subsequent two years in each group for retinal photocoagulation was determined, and the average annual claim frequency was determined.

All rates were age- and sex-adjusted to the Ontario population aged 20 and over from the 1996 census. These analyses were repeated using groups defined on April 1, 1999. The codes for each outcome are detailed in Technical Appendix TA13.C.

Interpretive Cautions

Using the data sources for this study, it was not possible to identify a person's ethnic origins, and hence, there was no way to specifically examine health status in a group of aboriginal people. Instead, the FN population was defined based on postal codes that covered FN communities. As a result, the FN people included this study represent fewer than 7% of the aboriginal people in Ontario; the remainder are included among the non-FN people in this study. The study does not address off-reserve aboriginal people, including Métis and Inuit. The health status of the included FN people may not accurately reflect the health status of all people living in FN communities, nor aboriginal people living in non-FN communities, particularly in urban environments. Of note, FN people with DM who move to larger communities to get better access to health services (such as dialysis) would not be included in this study.

In addition, there are non-FN people living in the selected postal codes. While data from the Canadian census suggests that there are few such people, they would be included in the FN population of these analyses. As a result of these dilution effects, the differences reported between FN and non-FN people are likely an under-estimation of the true differences.

Many of the communities included in the study are isolated, northern settlements. As a result, some receive health care from "outpost nurses" or nurse practitioners, hired by the federal government, who do not submit claims to OHIP. Some communities have physicians who are paid through alternative programs, and who also do not submit claims to OHIP. Since the ODD uses OHIP data to identify people with DM (see Technical Appendix TA 1.A, Chapter 1), some people with DM may have been missed, and classified as not having DM. In the analyses, any differences between people with and without DM would be artificially narrowed as a result of this misclassification. Similarly, care received by northwestern Ontario residents in Manitoba may have been missed from the analyses.

There are some limitations in the way the data were assembled that reduce the capacity to make comparisons, both over time and between this work and other chapters in the *Atlas*. The definition of incident DM is less specific in the earlier time periods under study than at the end of the study period. Accordingly, a number of the persons labeled with incident DM in 1995 probably had pre-existing DM that had not been detected by the administrative data algorithm. A fall in incidence seen over the study period is likely attributable to this bias. Another factor influencing the examination of trends over time is the growing awareness of DM as a major issue for FN people. Whereas previously, people with DM may only have been diagnosed when they presented with advanced complications, more concerted efforts to diagnose those with DM throughout the 1990s led to a significant expansion of the population of diagnosed DM, and in particular, inclusion of those with earlier stages of the disease. Such persons would contribute to the denominator in rates of complications but would be less likely to contribute to the numerator because of their earlier stage of disease. This may exaggerate apparent improvements in the rates of complications over time. Finally, in the analyses of rates of complications and procedures, data from two years were averaged and multiple procedures within the same person were counted. This approach allowed more precise measurement of rates when numbers were small, but precludes direct comparisons

to data from some other *Atlas* chapters where the number of people who had a given complication or procedure were counted over a single year, and only one event per person was counted.

Findings and discussion

Prevalence, Incidence and Mortality

Prevalence and incidence of DM are shown in Exhibit 13.1 and Exhibit 13.2, respectively. As has been previously described, DM is more common among FN people than in the general population. The age-/sex-adjusted prevalence of DM in the FN population was three times higher than that in the non-FN population, while incidence was about 2.5 times that of the non-FN population. Prevalence and incidence rates were higher, particularly among women and among younger people, with incidence rates five to seven times those of non-FN people for women less than 50 years of age. Although the absolute prevalence of DM increased between 1994 and 1998, the relative prevalence between FN and non-FN people did not change over time.

Annual mortality rates for FN and non-FN people with and without DM are presented in Exhibit 13.3. Mortality rates were approximately double for people with DM compared to those without, with significant excess mortality seen among young people. FN people had slightly higher mortality rates than non-FN people, controlling for the presence of DM. However, FN people with DM had a more dramatic reduction in mortality between 1994 and 1999 than any of the other populations, perhaps reflecting both improved and earlier identification and treatment of DM as well as movement to urban centres to receive specialized services (for example dialysis). The recent increase in prevalence of DM among FN people may not yet have impacted on the mortality rate in this population.

Acute Complications of DM

The annual frequencies of hospitalizations for acute metabolic complications of DM (hypoglycemia and hyperglycemia) are shown in Exhibit 13.4, comparing FN and non-FN people with DM. Hospitalization rates were very high for young people. In general, FN people had lower rates of hospitalization for acute complications than did non-FN people. This may reflect discretionary hospitalizations in the general population that are less likely to occur in isolated FN communities. Strikingly, the frequency of hospitalization for acute complications in the FN population halved between 1994 and 1999. This change may be due to increasing recognition of and services for DM in these communities, reducing the need for hospital admission simply for blood sugar control.

Exhibit 13.5 illustrates the annual frequencies of hospitalization for infectious diseases. FN people with DM had a very high frequency of these hospitalizations, with 41.9 hospitalizations per 1,000 people in 1994, over three times the frequency of their non-FN counterparts with DM. Such hospitalizations were also common among FN people without DM, with frequencies more than four times those of non-FN people without DM. Hospitalization was much more frequent for older people than younger people.

Cardiovascular Disease

The frequencies of hospitalizations for unstable angina, AMI and CHF are illustrated in Exhibit 13.6, Exhibit 13.7 and Exhibit 13.8, respectively. For each diagnosis, FN people with DM had more hospitalizations than non-FN people with DM, and FN people without DM had more hospitalizations than non-FN people without DM. This may be due to other risk factors for cardiovascular disease that are common in FN populations, such as hypertension, abnormal lipid levels and cigarette smoking. The presence of DM substantially increased the number of hospitalizations in both populations. However, between 1994 and 1999, hospitalizations declined for all groups and for all diagnoses. This finding mirrors previous data, which showed a slight decline in cardiovascular disease admissions after a peak in the mid-1990s.[27]

While the higher frequency of hospitalization suggests that the burden of cardiovascular disease was higher for FN people, the utilization of procedures for the treatment of cardiovascular disease was lower. The frequency of CABG and PTCA are shown in Exhibit 13.9 and Exhibit 13.10. In general, procedure use increased between 1994 and 1999, especially for FN people. FN people with and without DM had lower rates of procedure use than their non-FN counterparts in 1994. In 1999, this was again true for FN people without DM. Although those with DM had substantial increases in procedure use over this time, the relative procedure frequency compared to non-FN people with DM was still much lower than the relative frequency of cardiovascular disease hospitalizations. The lack of data when patients were referred for specialty procedures at hospitals in Winnipeg, Manitoba would lead to undercounting of those procedures in the FN population.

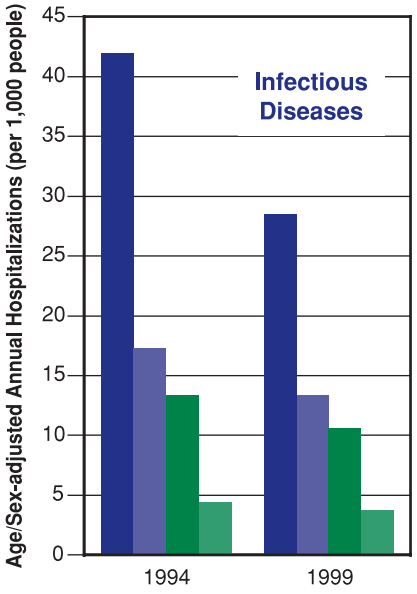
Cerebrovascular Disease

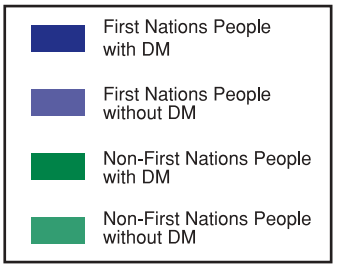
The frequency of hospitalization for stroke is illustrated in Exhibit 13.11. People with DM in both populations had more than twice the number of hospitalizations for stroke as those without DM, mirroring the results for cardiovascular disease, although with a smaller relative increase. In general, FN people had more hospitalizations than non-FN people. Exhibit 13.12 illustrates the frequency of carotid endarterectomy. As with procedures for cardiovascular diseases, FN people had fewer procedures than non-FN people in 1994, while in 1999, the number of procedures was similar, but still lower than expected given the relative frequency of stroke hospitalizations.

Exhibits 13.5 and 13.6 Frequency of Hospitalization for Infectious Diseases and Unstable Angina for First Nations and Non-First Nations People with/without DM, 1994 and 1999

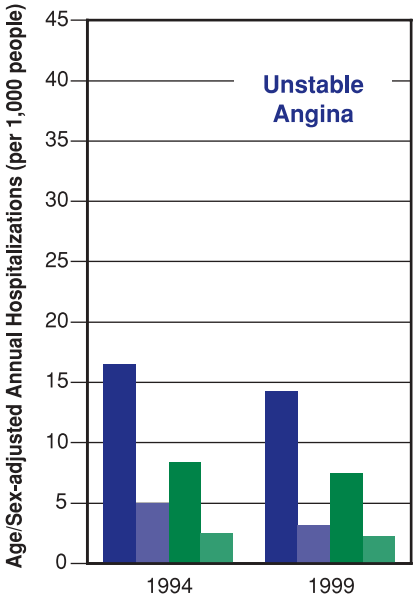
First Nations people with DM had over three times as many hospitalizations for infectious diseases as their non-First Nations counterparts. First Nations people had more hospitalizations for unstable angina than non-First Nations people.

Infectious Diseases	First Nations People with DM		First Nations People without DM		Non-First Nations People with DM		Non-First Nations People without DM	
Age-/Sex-specific Annual Hospitalizations (per 1,000 people)	1994	1999	1994	1999	1994	1999	1994	1999
Women								
20–34	34.9	10.7	5.4	3.7	9.6	7.6	1.8	0.3
35–49	45.8	20.9	11.1	4.8	10.7	7.6	1.7	1.0
50–64	50.7	39.3	11.8	12.6	13.7	10.2	3.2	3.9
65–74	44.2	49.3	49.3	46.7	19.9	17.5	7.6	14.1
75 +	92.6	85.5	91.3	47.8	36.6	32.9	22.1	61.4
Men								
20–34	*	*	6.6	4.4	7.8	5.7	1.4	0.8
35–49	29.3	12.7	7.5	6.0	9.0	6.6	1.9	1.2
50–64	34.6	32.0	11.3	8.7	12.1	9.2	3.7	2.8
65–74	69.0	71.8	29.4	19.5	23.1	19.1	11.1	10.2
75 +	144.7	119.4	88.1	112.6	49.9	43.8	33.0	30.7
Overall Annual Hospitalizations (per 1,000 people)								
Unadjusted	47.3	35.0	11.7	8.3	20.0	16.7	4.1	3.3
Age-/Sex-adjusted	41.9	28.5	17.3	13.4	13.4	10.6	4.4	3.7





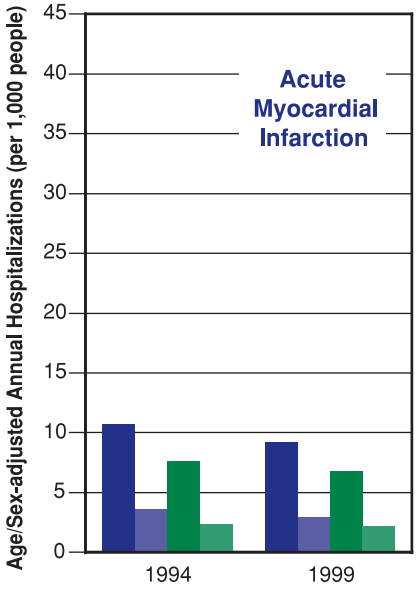
Unstable Angina	First Nations People with DM		First Nations People without DM		Non-First Nations People with DM		Non-First Nations People without DM	
Age-/Sex-specific Annual Hospitalizations (per 1,000 people)	1994	1999	1994	1999	1994	1999	1994	1999
Women								
20–34	*	*	*	*	0.3	0.4	0.0	0.0
35–49	*	8.8	2.0	1.0	5.6	5.0	0.4	0.4
50–64	26.9	26.5	4.4	3.7	13.4	11.5	2.5	2.1
65–74	23.8	15.7	8.5	4.7	19.9	17.2	6.4	6.0
75 +	24.7	21.4	38.8	13.0	19.6	20.0	9.5	9.8
Men								
20–34	*	*	*	0.0	1.0	0.5	0.0	0.0
35–49	19.5	21.1	2.4	2.3	7.9	6.8	1.2	1.0
50–64	28.5	34.3	8.6	7.0	15.6	12.7	5.0	4.2
65–74	60.3	28.7	10.7	8.4	18.7	18.2	9.5	9.5
75 +	*	*	14.3	19.2	19.7	20.3	11.7	12.4
Overall Annual Hospitalizations (per 1,000 people)								
Unadjusted	21.7	19.8	2.9	2.0	14.9	13.5	2.2	2.1
Age-/Sex-adjusted	16.5	14.3	5.0	3.2	8.4	7.5	2.5	2.3

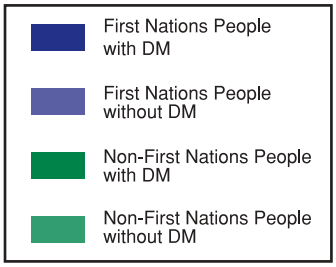


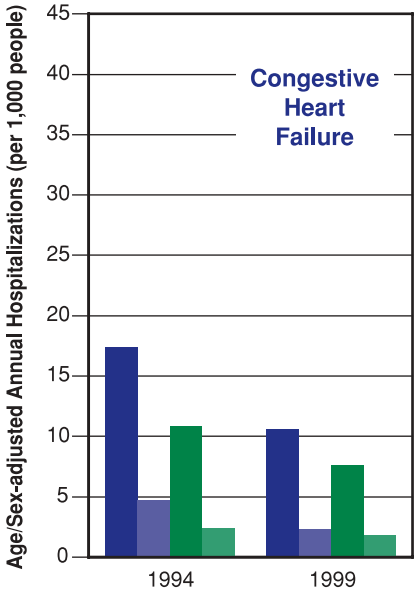
Sources: Canadian Institutes of Health Information (CIHI), Ontario Diabetes Database (ODD), Registered Persons Database (RPDB). Note: Groups were defined cross-sectionally on April 1, 1994 and April 1, 1999. * Suppressed due to small cell size.

Exhibits 13.7 and 13.8 Frequency of Hospitalization for Acute Myocardial Infarction and Congestive Heart Failure in First Nations and Non-First Nations People with/without DM, 1994 and 1999

First Nations people had more acute myocardial infarction and congestive heart failure hospitalizations than non-First Nations people.







Acute Myocardial Infarction	First Nations People with DM		First Nations People without DM		Non-First Nations People with DM		Non-First Nations People without DM	
Age-/Sex-specific Annual Hospitalizations (per 1,000 people)	1994	1999	1994	1999	1994	1999	1994	1999
Women								
20–34	*	*	*	*	0.9	0.4	0.0	0.0
35–49	1.8	*	1.0	*	3.1	2.6	0.3	0.2
50–64	6.0	8.8	*	*	9.0	7.5	1.5	1.2
65–74	37.4	24.7	7.0	6.2	17.5	14.6	4.4	4.0
75 +	49.4	17.1	27.4	*	23.1	22.3	9.1	9.7
Men								
20–34	*	*	*	*	0.9	1.1	0.1	0.1
35–49	9.8	16.9	1.7	1.4	6.9	5.9	1.4	1.2
50–64	26.4	14.9	5.0	7.4	14.2	12.2	5.1	4.2
65–74	21.6	*	10.7	16.7	20.2	18.7	9.2	8.6
75 +	*	*	19.1	30.2	26.6	27.8	14.1	15.6
Overall Annual Hospitalizations (per 1,000 people)								
Unadjusted	14.7	10.9	2.0	1.7	14.5	13.2	2.1	1.9
Age-/Sex-adjusted	10.7	9.2	3.6	2.9	7.6	6.8	2.3	2.2

Congestive Heart Failure	First Nations People with DM		First Nations People without DM		Non-First Nations People with DM		Non-First Nations People without DM	
Age-/Sex-specific Annual Hospitalizations (per 1,000 people)	1994	1999	1994	1999	1994	1999	1994	1999
Women								
20–34	*	*	*	*	0.5	0.3	0.0	0.0
35–49	*	*	1.8	*	2.3	1.9	0.1	0.1
50–64	28.4	17.7	1.5	0.5	14.0	8.1	0.9	0.6
65–74	71.4	53.8	11.3	1.6	30.3	21.4	4.4	3.5
75 +	49.4	34.2	41.1	23.9	55.1	39.8	20.1	15.4
Men								
20–34	*	*	*	*	0.9	1.1	0.0	0.0
35–49	*	*	*	*	3.4	2.5	0.2	0.2
50–64	32.5	5.7	3.6	*	14.7	9.6	1.9	1.1
65–74	43.1	31.6	9.4	*	35.3	23.5	8.0	5.6
75 +	118.4	59.7	40.5	16.5	54.2	41.0	24.1	19.4
Overall Annual Hospitalizations (per 1,000 people)								
Unadjusted	26.0	14.9	2.4	1.0	24.4	16.9	2.1	1.5
Age-/Sex-adjusted	17.4	10.6	4.7	2.3	10.8	7.6	2.4	1.8

Sources: Canadian Institutes of Health Information (CIHI), Ontario Diabetes Database (ODD), Registered Persons Database (RPDB). Note: Groups were defined cross-sectionally on April 1, 1994 and April 1, 1999. * Suppressed due to small cell size.

Exhibits 13.9, 13.10, 13.11 and 13.12 Frequency of CABG, PTCA, Hospitalizations for Stroke and Carotid Endarterectomy for First Nations and Non-First Nations People with/without DM in Ontario, 1994 and 1999

First Nations people had fewer coronary artery bypass graft surgeries, percutaneous transluminal coronary angioplasties and carotid endarterectomies than their non-First nations counterparts in 1994. First Nations people with DM had a substantial increase in procedures by 1999, but this was not the case for First Nations people without DM. First Nations people had more hospitalizations for stroke than non-First Nations people.

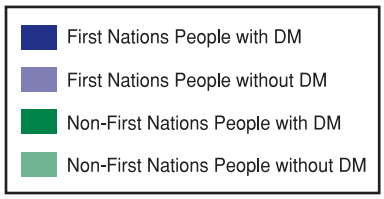


Exhibit 13.9 Frequency of Coronary Artery Bypass Graft

	First Nations People with DM		First Nations People without DM		Non-First Nations People with DM		Non-First Nations People without DM	
	1994	1999	1994	1999	1994	1999	1994	1999
Overall Annual Procedures (per 1,000 people)								
Unadjusted	2.1	3.2	0.2	0.2	4.2	4.8	0.7	0.7
Age-/Sex-adjusted	1.3	3.0	0.3	0.3	2.5	2.7	0.7	0.8

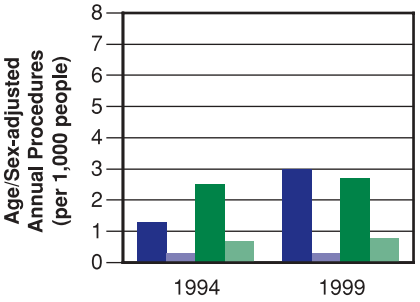


Exhibit 13.10 Frequency of Percutaneous Transluminal Coronary Angioplasty

	First Nations People with DM		First Nations People without DM		Non-First Nations People with DM		Non-First Nations People without DM	
	1994	1999	1994	1999	1994	1999	1994	1999
Overall Annual Procedures (per 1,000 people)								
Unadjusted	0.9	3.6	0.2	0.2	2.2	3.8	0.5	0.8
Age-/Sex-adjusted	0.6	3.0	0.3	0.2	1.7	2.4	0.5	0.9

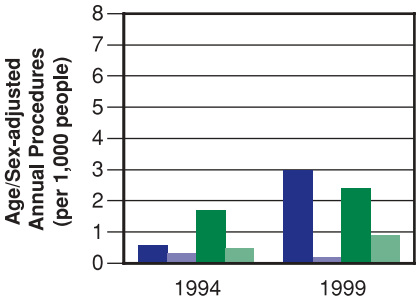


Exhibit 13.11 Frequency of Hospitalizations of Stroke

	First Nations People with DM		First Nations People without DM		Non-First Nations People with DM		Non-First Nations People without DM	
	1994	1999	1994	1999	1994	1999	1994	1999
Overall Annual Hospitalizations (per 1,000 people)								
Unadjusted	9.2	4.7	1.5	0.9	10.4	7.7	1.5	1.2
Age-/Sex-adjusted	6.2	3.2	2.8	1.6	4.7	3.5	1.7	1.4

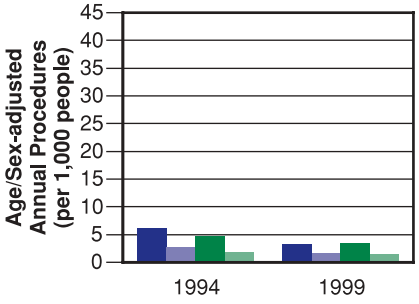
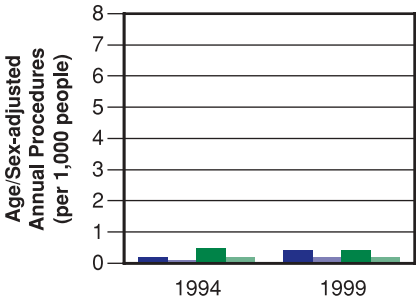


Exhibit 13.12 Frequency of Carotid Endarterectomy

	First Nations People with DM		First Nations People without DM		Non-First Nations People with DM		Non-First Nations People without DM	
	1994	1999	1994	1999	1994	1999	1994	1999
Overall Annual Procedures (per 1,000 people)								
Unadjusted	0.3	0.6	0.1	0.1	0.9	0.9	0.2	0.1
Age-/Sex-adjusted	0.2	0.4	0.1	0.2	0.5	0.4	0.2	0.2



Sources: Canadian Institutes of Health Information (CIHI), Ontario Diabetes Database (ODD), Registered Persons Database (RPDB). Note: Groups were defined cross-sectionally on April 1, 1994 and April 1, 1999.

Non-traumatic Lower Extremity Amputation

The frequency of non-traumatic LEA procedures is shown in Exhibit 13.13. Foot ulcers and infections that necessitate this procedure are a consequence of peripheral vascular disease and of peripheral neuropathy, both complications of DM. Most people undergoing this procedure had DM, and it occurred more commonly in older people, particularly men. However, the frequency among FN people was much higher than among non-FN people.

End-stage Renal Disease

The proportion of each population who underwent chronic dialysis for end-stage renal disease is presented in Exhibit 13.14. Rates of dialysis were 1½ to 2 times higher for FN people compared to non-FN people. However, the proportion of people receiving chronic dialysis did not change significantly between 1994 and 1999 in all groups.

Diabetic Retinopathy

Diabetic retinopathy is a common problem for people with long-standing DM. Laser photocoagulation of affected blood vessels at the back of the eye can prevent the progression of this disorder. Exhibit 13.15 portrays the frequency of retinal photocoagulation claims. Fewer claims were made for this procedure for FN people than non-FN people. This observation raises concerns regarding the adequacy of access to treatment.

Comparison to Other Studies

The Six Nations Reserve was not included in this analysis, but the prevalence of DM and cardiovascular risk factors in this community has been studied in detail.[26] The Six Nations Reserve, in Brant County, which took its present form of 20,000 hectares in 1847, is now home to over 12,000 FN people, and is the largest reserve in Canada. A random cross-section of 301 men and women was studied between 1998 and 2000, and the prevalence of established DM was 23.6%. All participants who reported no DM had blood tests, and an additional 11.7% of them were found to actually have DM. Another 14.0% had "impaired glucose tolerance," or abnormal blood sugars that did not reach the levels required to diagnose DM. Therefore, the overall prevalence of any blood sugar abnormality was approximately 50%, which was 2½ times higher than a random cross-section of non-FN Canadians who were assessed in an identical manner. Furthermore, the prevalence of obesity (body-mass index ≥ 30) was 68.1% among men and 58.4% among women, and abdominal adiposity (waist-to-hip ratio ≥ 0.90) was present among 95.8% of men and 45.2% of women. In addition to these factors, the prevalence of tobacco use was also high. The high prevalence of these risk factors contributes to an age– and sex-adjusted prevalence of cardiovascular disease (heart disease and strokes) of 18.5% among the Six Nations people, approximately two times higher than non-FN Canadians.

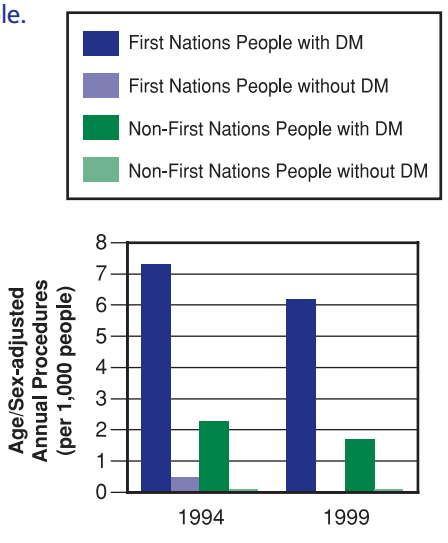
Exhibits 13.13 Frequency of Non-traumatic LEA for First Nations People and Non-First Nations People with/without DM in Ontario, 1994 and 1999

First Nations people had many more non-traumatic LEAs than non-First Nations people.

Exhibit 13.13 Frequency of Non-traumatic LEA

	First Nations People with DM		First Nations People without DM		Non-First Nations People with DM		Non-First Nations People without DM	
	1994	1999	1994	1999	1994	1999	1994	1999
Overall Annual Procedures (per 1,000 people)								
Unadjusted	10.7	8.9	0.3	0.1	4.0	2.9	0.1	0.1
Age-/Sex-adjusted	7.3	6.2	0.5	0.0	2.3	1.7	0.1	0.1

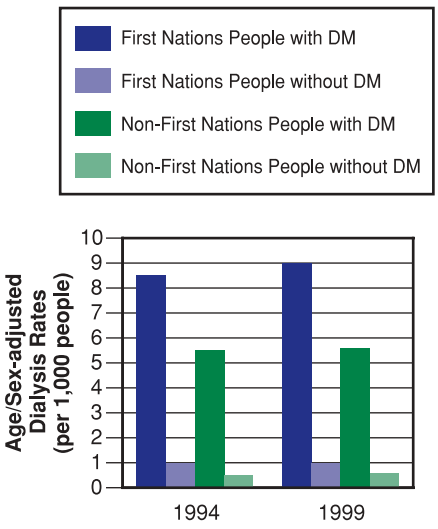
Sources: Canadian Institutes of Health Information (CIHI), Ontario Diabetes Database (ODD), Registered Persons Database (RPDB). Note: Groups were defined cross-sectionally on April 1, 1994 and April 1, 1999.



Exhibits 13.14 Proportion of First Nations and Non-First Nations People Receiving Chronic Dialysis with/without DM in Ontario, 1994 and 1999

About 1½ times as many First Nations people were receiving chronic dialysis as non-First Nations people.

	First Nations People with DM		First Nations People without DM		Non-First Nations People with DM		Non-First Nations People without DM	
	1994	1999	1994	1999	1994	1999	1994	1999
Overall Rates (per 1,000 people)								
Unadjusted	11.0	13.6	0.7	0.8	4.9	6.5	0.4	0.5
Age-/Sex-adjusted	8.5	9.0	1.0	1.0	5.5	5.6	0.5	0.6

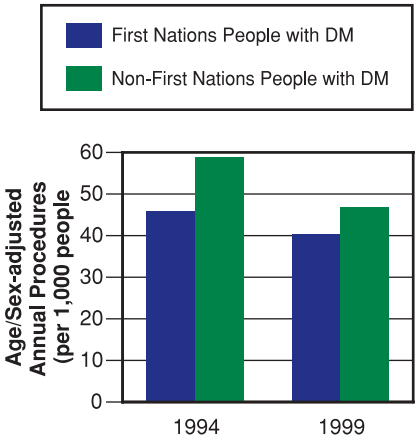


Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP), Registered Persons Database (RPDB). Note: Groups were defined cross-sectionally on April 1, 1994 and April 1, 1999.

Exhibits 13.15 Frequency of Retinal Photocoagulation Procedures for First Nations People and Non-First Nations People with DM in Ontario, 1994 and 1999

First Nations people had fewer retinal photocoagulation procedures than non-First Nation people.

	First Nations People with DM		Non-First Nations People with DM	
Age-/Sex-Specific Annual Procedures (per 1,000 people)	1994	1999	1994	1999
Women				
20–34	*	*	56.8	39.4
35–49	31.7	41.9	41.5	31.4
50–64	67.2	38.3	68.6	57.9
65–74	47.6	67.3	52.6	56.7
75 +	*	85.5	24.4	23.1
Men				
20–34	*	29.4	95.1	62.0
35–49	146.3	28.2	54.1	44.3
50–64	73.2	68.6	64.1	63.5
65–74	*	120.7	45.2	47.8
75 +	*	44.8	18.2	23.6
Overall Annual Procedures (per 1,000 people)				
Unadjusted	54.4	49.0	50.7	47.0
Age-/Sex-adjusted	45.8	40.2	58.7	46.8



Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP), Registered Persons Database (RPDB). Note: Groups were defined cross-sectionally on April 1, 1994 and April 1, 1999. * Suppressed due to small cell size.

Conclusions

DM is common among FN people. Prevalence rates of DM exceeded 13% in 1998, more than three times the age–and sex-adjusted rates in the general population. As a result, DM plays a significant role in the health of FN people in Ontario. Because of initiatives like the Northern Diabetes Health Network, awareness and recognition of DM in FN communities is increasing.

Mortality rates are higher among people with DM than those without. FN people had even higher rates than non-FN people when controlling for DM. Similarly, hospitalizations for cardiovascular and cerebrovascular disease were more frequent for FN people, controlling for DM, as were non-traumatic LEA and chronic dialysis. However, the frequencies of CABG, PTCA and carotid endarterectomy were not higher for FN people, suggesting under-identification and potential underuse of these health technologies among FN people. The frequency of retinal photocoagulation was also lower than among non-FN people. Unlike hospitalizations for vascular diseases or life-sustaining chronic dialysis, these procedures are, to some extent, discretionary. This apparent decrease in access to health services among FN people may reflect reduced identification of the underlying medical problems necessitating the procedures, or reduced referral for diagnostic tests and other specialized health care services from remote FN communities. Strategies to improve health care accessibility in the future may require cooperation between the federal and provincial governments, as both provide health services to FN people.

Between 1994 and 1999, the mortality rate and the frequency of hospitalizations for most of the diagnoses studied declined. This decline was more pronounced for FN people. This finding is in part the result of the growing awareness of DM and its complications among FN people and among their health care providers. Biases in the estimation of rates because of more concerted efforts to diagnose DM at earlier stages may have also contributed to trends in measured rates. Since DM is a relatively recent phenomenon in FN populations and is affecting much younger individuals than in non-FN populations, the full expression of the long-term complications of the disease may just be evolving.

The epidemic of DM in FN populations will require interventions that target primary prevention, secondary intervention, and complication management. Primary prevention programs should focus both on individuals at high risk for DM and on the community as a whole by encouraging healthy lifestyle changes. Community programs must be culturally appropriate, utilizing traditional FN values (e.g., walking trails and emphasis on traditional foods). One such initiative, a healthy living school curriculum for grades three to five, has proven to be particularly valuable for the community of Sandy Lake. FN communities need better complication surveillance and DM management programs for those who already have DM. Finally, FN communities must have access to effective therapies like laser photocoagulation and end stage renal disease treatment, particularly those from remote areas.

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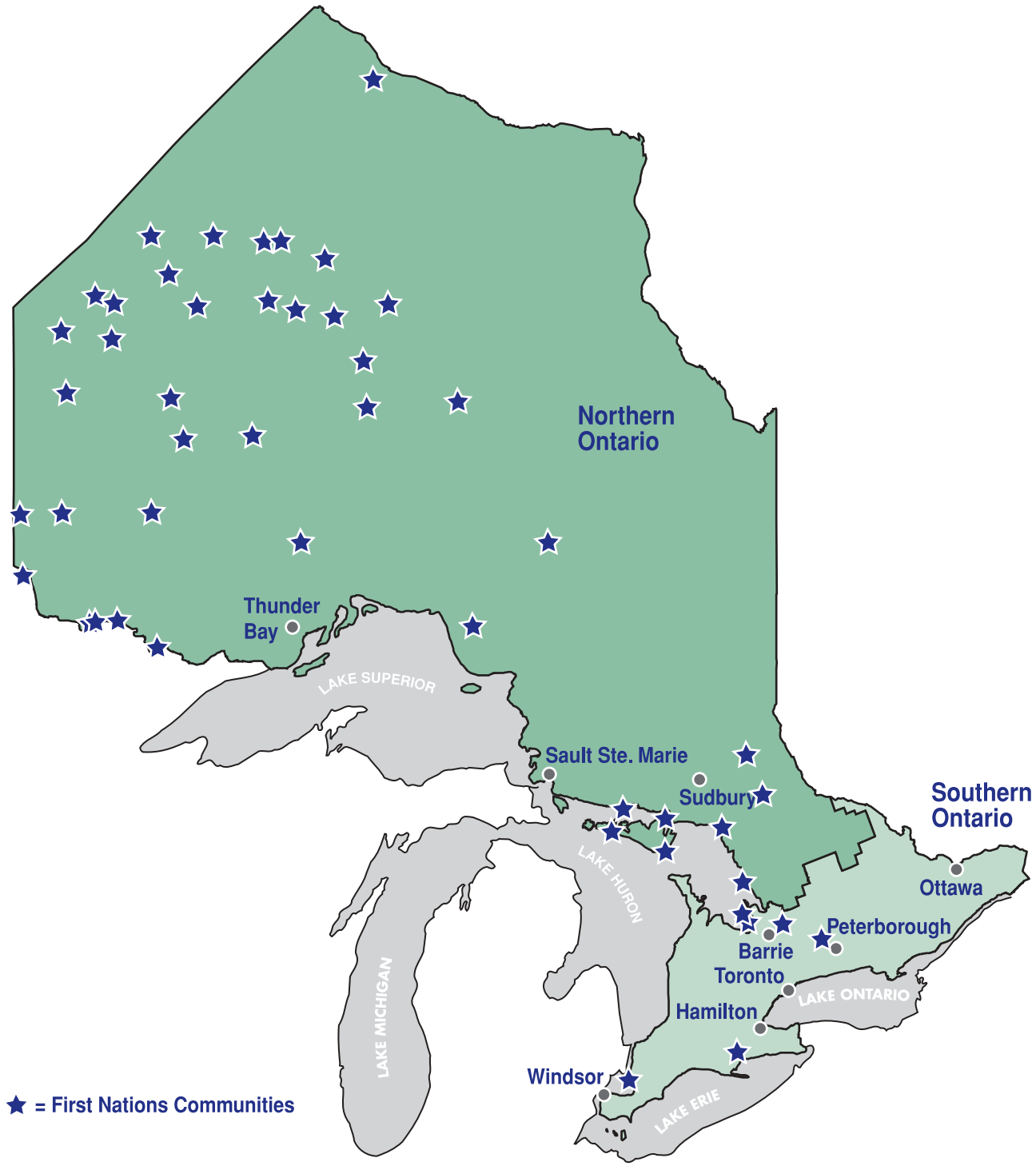
Technical Appendices (Exhibits TA13.A, TA13.B and TA13.C)

Postal Codes, Map and Diagnotic Codes in First Nations Communities

Exhibit TA13.A Postal codes and communities included in this Chapter

Postal Codes	Communities
K0L 1R0	Curve Lake First Nation 35
L0K 1C0	Christian Island 30, Christian Island 30A
L0K 1T0	Rama 32
N0A 1M0	New Credit 40A
N8A 4K9	Walpole Island 46
P0G 1J0	French River 13
P0H 1C0	Bear Island 1
P0L 1B0	Constance Lake 92
P0M 2J0	Pic Mobert North, Pic Mobert South
P0P 1A0	Whitefish River 4
P0P 1B0	Serpent River 7
P0P 1X0	Sheshegwaning 20
P0P 2J0	Wikwemikong 26
P0T 1L0	Fort Hope 64
P0T 1P0	Gull River 55
P0T 1Z0	Lansdowne House
P0T 2L0	Marten Falls 65
P0T 3A0	Webequie
P0T 3B0	Summer Beaver
P0V 1B0	Wapekeka 2
P0V 1E0	Bearskin Lake
P0V 1G0	Big Trout Lake
P0V 1J0	Slate Falls, Cat Lake 63C
P0V 1N0	Deer Lake
P0V 1V0	Sandy Lake 88, Kee-Way-Win
P0V 1W0	Fort Severn 89
P0V 1Y0	Kasabonika Lake
P0V 1Z0	Kingfisher 1
P0V 2A0	Lac Seul 28
P0V 2G0	North Spirit Lake
P0V 2H0	Osnaburgh 63B
P0V 2L0	Pikangikum 14
P0V 2P0	Sachigo Lake 1
P0V 2Y0	Weagamow Lake 87
P0V 2Z0	Wunnumin 1
P0V 3B0	Muskrat Dam Lake
P0X 1B0	English River 21
P0X 1L0	Lake of the Woods 37
P0X 1P0	Islington 29
P1B 8G5	Nipissing 10
P2A 2X1	Parry Island 16
P9A 3M6	Rainy Lake 18C, Rainy Lake 26A
P9A 3M9	Neguaguon Lake 25D, Couchiching 16A
P9A 3N1	Couchiching 16A

Exhibit TA13.B Locations of First Nations Communitites included in this Chapter



Technical Appendix TA13.C Codes to Define Events in this Chapter

Diagnosis	"Most-responsible" diagnosis code
Acute metabolic complication	250.1, 250.2, 250.3, 251.0
Unstable angina	411.x, 413.x
Acute myocardial infarction	410.x
Congestive heart failure	428.x
Stroke	431.x, 434.x, 436.x
Infection	003.1, 036.2, 038.x, 040.0, 481.x, 482.x–486.x, 590.1–590.9, 595.0, 599.0, 680.x, 681.1–681.9, 682.1–682.9, 683.x, 684.x, 685.0, 685.1, 686.x, 729.4, 785.4

Procedure	Procedure code
Coronary artery by-pass graft	48.1x
Percutaneous transluminal coronary angioplasty	48.02, 48.03
Carotid endarterectomy	50.12
Nontraumatic lower extremity amputation	96.11–96.15*

Procedure	Physician claim fee code
Dialysis services	G323, G326, G330–G333, G860–G866, R849†
Retinal photocoagulation	E154

* Excluding those with "most-responsible" diagnosis code of 170.x, 171.x, 213.x, 730.x, 740.0–759.9, 800.0–904.9, 940.0–949.9.

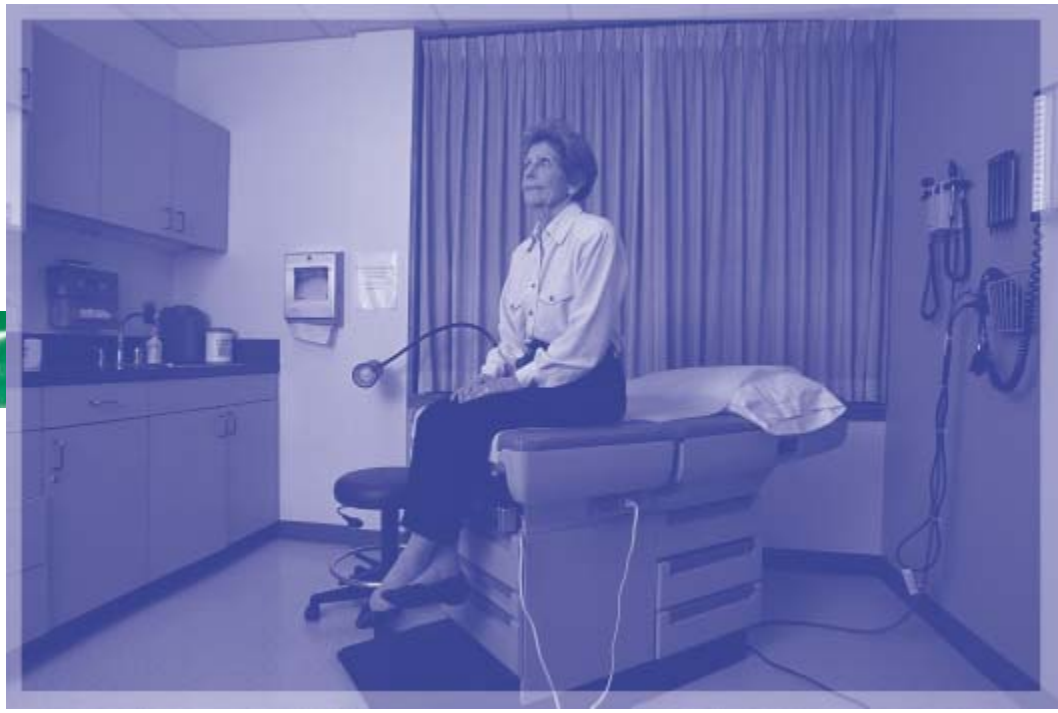
† Including only those individuals who had these claims submitted for a period of at least 90 days, excluding gaps where no claims were submitted for greater than 21 days.

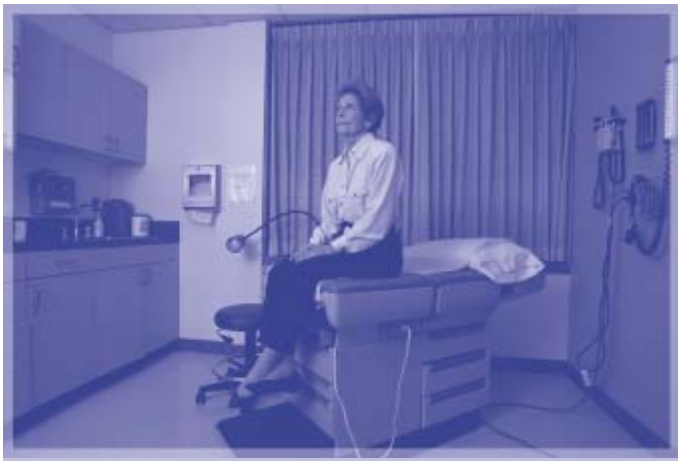
14

Chapter

Supply and Utilization of Health Care Services for Diabetes

Authors: Benjamin T.B. Chan and Melanie Harju





Key Messages

- Persons with diabetes mellitus (DM) use twice the amount of physician and optometry services as patients without DM. Planners should account for this fact when allocating resources and designing non-fee-for-service remuneration formulas.
- Persons with DM aged 75 and over visit a family physician, specialist or optometrist almost twice per month on average. Planners should consider the impact of an aging population and growing prevalence of type 2 DM on future requirements for health professionals in Ontario.
- The average number of visits to family doctors and for eye care varies little between counties and is comparable to visit rates in the United States. This suggests that the health care system is providing reasonably equitable access to primary care for persons with DM throughout the province.
- The average number of visits to internal medicine specialists and endocrinologists does vary heavily and is related to the supply of specialists. The health care system may not be providing as equitable a level of access to more advanced services across the province.

Background

Access to appropriate diabetes mellitus (DM) care depends on having enough health care personnel to provide essential services. Such personnel may include general practitioners and family physicians (GP/FPs), specialists, optometrists, nurses, diabetes educators, podiatrists and dieticians. Over the past three years, professional organizations and policy-makers have raised concern about a potential shortage of both doctors and nurses in Canada.[1–3] In order to meet future demands on the health care system, it is important to examine the typical health care utilization patterns for patients, anticipate how these patterns might change in the future, and identify areas of inadequate access and opportunities to use services more efficiently and effectively.

This chapter has three objectives. First, it aims to document the pattern and volume of health care resources used by persons with DM, and how these utilization patterns vary by patient demographics and geographic location. Second, it examines the supply of health care providers by region, and the workload which these providers currently take on. Third, it examines the relationship between the use of services and the supply of health care personnel.

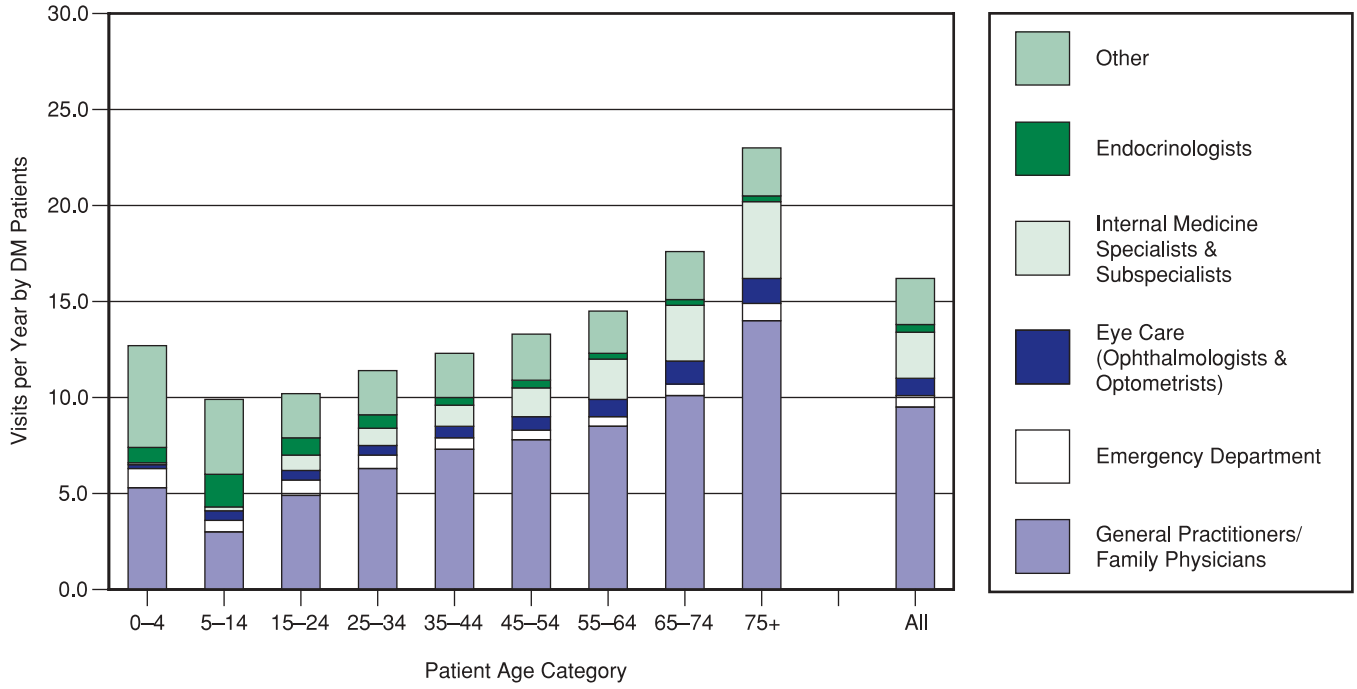
The descriptive information presented in this chapter is intended to help planners in a number of ways. First, variations in utilization may suggest inequitable access to care, or may identify the existence of different models of care or combinations of care providers being used in different communities. This paves the way for future research on which configurations of health care providers offer the highest quality of care. Second, data on current utilization patterns by the diabetic population represent one of the building blocks of information needed by planners to estimate future requirements for health human resources. If planners also have information on the projected prevalence of DM, then they can estimate the future requirements for patient visits for DM. Such models would also have to take into account the possibility that utilization rates might decrease, if there are opportunities to deliver care more efficiently or effectively through an alternate model of care, or increase if new technologies or guidelines dictate closer scrutiny of persons with DM.

Methods

The time frame for this study was fiscal year 2001 (April 1, 2000 to March 31, 2001). Exhibit TA14.A in the Technical Appendix lists the different data sources used in this chapter. The most important source is the Ontario Health Insurance Plan (OHIP) claims database, which tracks almost all physician and optometry services provided to each patient in Ontario. In this database, health care providers and patients were assigned anonymous, scrambled unique identifiers to protect confidentiality. The Institute for Clinical Evaluative Sciences (ICES) also holds the Registered Persons Database (RPDB), which identifies the age, gender and location of the patient, as well as the Corporate Provider Database (CPDB), which provides information about the specialty and practice location of each physician in

Exhibit 14.1: Average Visits per Year by Ontarians with DM to OHIP Health Care Providers by Patient Age Group, 2001

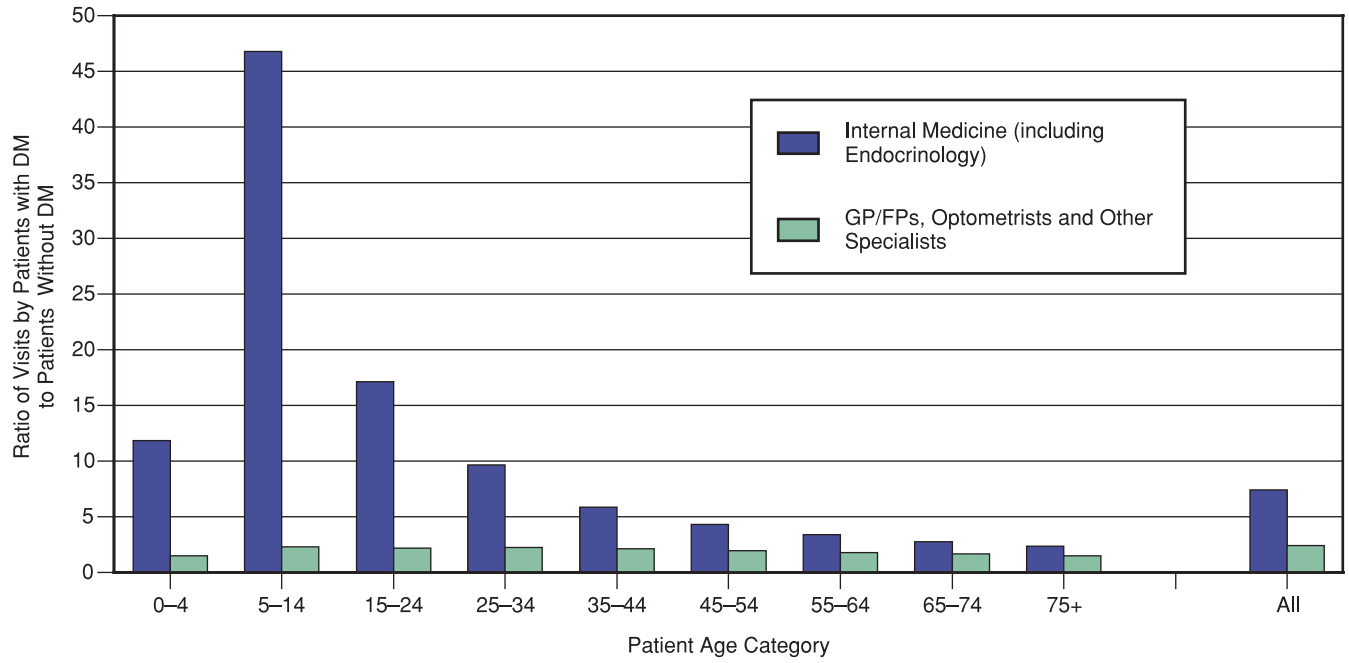
Patients with DM aged 75 and over saw a health care provider almost twice a month. In most age groups, GP/FPs accounted for the majority of the visits. Patients with DM under age 35 saw endocrinologists much more frequently than older patients.



Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). Endocrinologists are excluded from the Internal Medicine category in this exhibit.

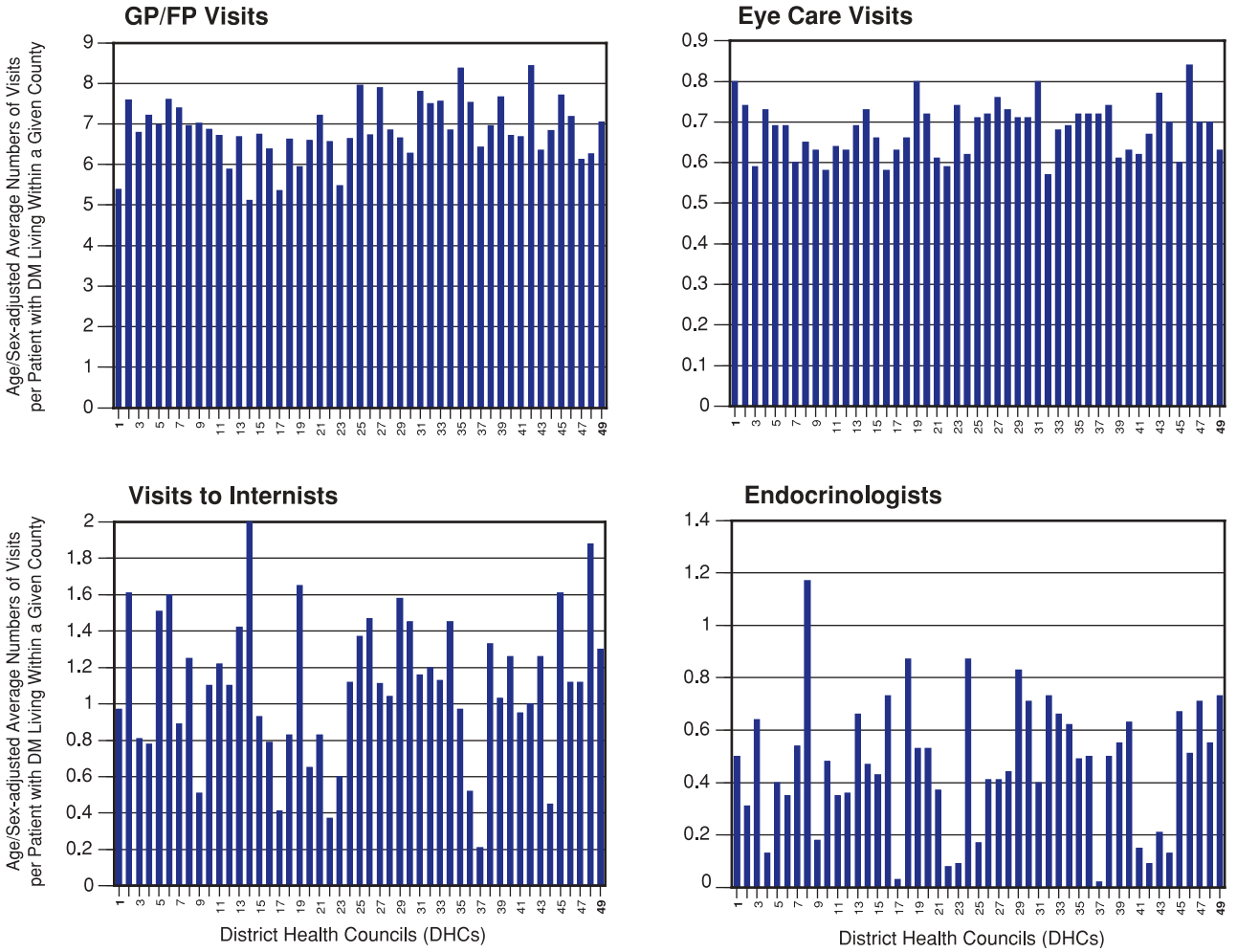
Exhibit 14.2: Ratio of Physician and Optometry Visits by Ontarians with DM to Ontarians without DM, 2001

Patients with DM visited a physician or optometrist more than twice as often as patients without DM. This difference was greatest in the 5–14 year old age group and for endocrinology/ internal medicine visits.



Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP)

Exhibit 14.3 Age-/Sex-adjusted Vists by Ontarians with DM to Different Types of OHIP Health Care Providers by County, 2001



1. Algoma District
2. Brant County
3. Bruce County
4. Cochrane District
5. Dufferin County
6. Durham Regional Municipality
7. Elgin County
8. Essex County
9. Frontenac County
10. Grey County
11. Haldimand-Norfolk Regional Municipality
12. Haliburton County
13. Halton Regional Municipality
14. Hamilton-Wentworth Regional
15. Hastings County
16. Huron County
17. Kenora District
18. Kent County
19. Lambton County
20. Lanark County
21. Leeds and Grenville United Counties
22. Lennox and Addington County
23. Manitoulin District
24. Middlesex County
25. Muskoka District Municipality
26. Niagara Regional Municipality
27. Nipissing District
28. Northumberland County
29. Ottawa-Carleton Regional Municipality
30. Oxford County
31. Parry Sound District
32. Peel Regional Municipality
33. Perth County
34. Peterborough County
35. Prescott and Russell United Counties
36. Prince Edward County
37. Rainy River District
38. Renfrew County
39. Simcoe County
40. Stormont, Dundas and Glengarry United Counties
41. Sudbury District
42. Sudbury Regional Municipality
43. Thunder Bay District
44. Timiskaming District
45. Toronto Metropolitan Municipality
46. Victoria County
47. Waterloo Regional Municipality
48. Wellington County
49. York Regional Municipality

Age-/Sex-adjusted Rates	GP/FP Visits	Eye Care Visits	Visits to Internists	Endocrinologists
Average	7.09	0.65	1.35	0.61
Minimum	5.12	0.57	0.21	0.02
Maximum	8.43	0.84	2.07	1.17

Measures of Variation	GP/FP Visits	Eye Care Visits	Visits to Internists	Endocrinologists
Extremal Quotient	1.65	1.47	9.94	57.84
Systematic Coefficient of Variation	10.17	8.72	142.94	338.76

Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). Endocrinologists are excluded from the internists in this exhibit.

Ontario. The accuracy of the CPDB data was verified for data quality against a second source with the same information, the Ontario Physician Human Resource Data Centre (OPHRDC) database, where available.

Five different types of health care visits are described: GP/FP visits; emergency department visits; endocrinologist visits; internal medicine specialist visits (including general internal medicine and subspecialties of internal medicine other than endocrinology); visits for eye care (either an oculovisual assessment by an optometrist or family physician, or a visit to an ophthalmologist); and all other visits to a physician. Technical Appendix TA14.B offers a detailed description of definitions used in this classification scheme. Data on individual patient encounters with other health care personnel (e.g. dieticians, nurse educators, etc.) were not available.

The use of physician and optometry services for patients with DM was measured in two ways. First, the total number of patient visits, consultations and counselling sessions among patients in the Ontario Diabetes Database (ODD) was examined. Second, the total number of such visits where there was a diagnosis of DM (truncated ICD-9 code 250) was identified. The second measure is more specific to DM. The first measure may still represent some degree of DM care, because the OHIP billing system allows for only one diagnosis; hence, a person with hypertension, coronary artery disease and DM may still have had DM issues reviewed during that visit, even if it was coded with a different diagnosis.

Physician supply was reported as both 'head counts' and full-time equivalents (FTEs). The FTE estimation was based on the physician's billings relative to the typical billings within his/her specialty. The formula used for this calculation is described in Technical Appendix TA 14.B. The significance of the relationship between visits to physicians and physician supply was tested using linear regression techniques (also described in detail in the Technical Appendix TA 14.B).

Limited information about non-physician providers was available from a survey of Diabetes Education Centres (DECs) in Ontario, conducted by the Northern Diabetes Health Network/Diabetes Complications Prevention Co-operative in 2001. This survey asked DECs about the number and types of different health care providers employed. Information on the number of new clients served per year was collected, but due to the incomplete response rates, was not considered reliable enough to be reported.

Interpretive Cautions

This is a descriptive analysis about supply of health care providers and resource utilization of patients with DM. It cannot make any pronouncements about the appropriateness of current utilization patterns. In this analysis, information is missing on the small proportion of physicians (approximately six per cent) who are not reimbursed on a fee-for-service basis and who do not submit shadow billings (the equivalent to OHIP billing, with a zero dollar value) for the purpose of tracking utilization. The proportion of GP/FPs in this category is higher in the counties of Hamilton-Wentworth, Algoma and Waterloo. The proportion of specialists in this category is higher in Kingston due to their participation in the South East Academic Medical Organization (SEAMO). This primarily affects the neighbouring counties of Frontenac, Lennox and Addington, and Leeds-Grenville.

There were numerous problems with the data from the DEC survey on non-physician providers. Standardized definitions were not used in describing the different types of health care providers, their workload, nor the number of clients served. The survey included only Ministry-funded Centres, and not other sources of patient education such as pharmacies. Because of concerns about data quality, only highly aggregated data are reported from this survey. Accordingly, we have a very limited ability to evaluate access to and utilization of this important component of DM care.

Findings and Discussion

Average Annual Number of Visits to Physicians and Optometrists by Patient Age and Gender

Exhibit 14.1 displays the average number of patient visits per year among persons with DM, by specialty type. Young persons with DM under age 35 visited an OHIP-billing health care provider (family physician, specialist or optometrist) 11 times per year, while those age 75 and over visited 23 times per year. However, young persons with DM visited endocrinologists three times more often than those aged 75 years and over (0.88 vs 0.28 visits per year). Within most age groups, GP/FPs accounted for the majority of visits.

Exhibit 14.2 compares utilization patterns between patients with and without DM. After adjusting for differences between these two groups in age and gender, patients with DM visited a physician or optometrist 2.2 times more frequently compared to patients without DM. The difference in use of these health services was greatest in the 5–14 year old age group and for endocrinology/internal medicine visits.

Regional Variations in Visits to Physicians and Optometrists by County

The degree of regional variation in visit volumes is relatively small for GP/FP and eye care visits, high for internal medicine, and highest for endocrinology visits (Exhibit 14.3; see Technical Appendix TA14.C for data by county). The variation is described quantitatively by measures such as the extremal quotient and the systematic coefficient of variation, which are much higher for specialty physician care.

Exhibit 14.4 Supply of GP/FPs and Optometrists by County in Ontario, 2001

The supply of GP/FPs varied widely across the province. Highest numbers were in Frontenac, Toronto, Ottawa-Carleton and Middlesex which have urban centres with medical schools. Lowest numbers were in Sudbury District and Southern Ontario (Dufferin, Lambton, Oxford, Kent, Elgin, Essex and Niagara). Optometrist services also varied widely.

		General Practitioners/Family Practitioners				Optometrists			
County	Population	Number	FTEs	Number per 10,000 Population	FTEs 10,000 Population	Number	FTEs	Number per 10,000 Population	FTEs 10,000 Population
Algoma District	125,523	112	97.1	8.92	7.74	15	8.6	1.20	0.68
Brant County	126,319	91	88.5	7.20	7.00	15	8.8	1.19	0.69
Bruce County	66,649	49	48.4	7.35	7.26	7	5.4	1.05	0.81
Cochrane District	91,767	82	75.2	8.94	8.19	13	9.1	1.42	0.99
Dufferin County	50,520	29	29.3	5.74	5.80	8	4.4	1.58	0.87
Durham Regional Municipality	512,443	329	350.6	6.42	6.84	44	23.7	0.86	0.46
Elgin County	84,138	49	46.1	5.82	5.48	6	2.6	0.71	0.31
Essex County	383,880	248	255.8	6.46	6.66	43	22.1	1.12	0.58
Frontenac County	140,204	194	153.4	13.84	10.94	11	5.1	0.78	0.37
Grey County	91,303	85	76.1	9.31	8.34	11	6.0	1.20	0.66
Haldimand-Norfolk Regional Municipality	109,193	71	75.3	6.50	6.90	15	9.9	1.37	0.91
Haliburton County	16,257	13	11.4	8.00	7.04	1	*	0.62	*
Halton Regional Municipality	378,132	306	282.5	8.09	7.47	39	24.9	1.03	0.66
Hamilton-Wentworth Regional Municipality	498,195	437	363.0	8.77	7.29	39	19.7	0.78	0.39
Hastings County	124,470	103	94.0	8.28	7.55	18	11.1	1.45	0.89
Huron County	60,952	52	47.2	8.53	7.74	7	3.4	1.15	0.56
Kenora District	68,613	71	51.5	10.35	7.50	8	5.5	1.17	0.80
Kent County	112,464	66	70.2	5.87	6.24	12	4.7	1.07	0.42
Lambton County	132,014	73	74.3	5.53	5.63	19	8.8	1.44	0.67
Lanark County	63,210	71	61.8	11.23	9.78	8	4.7	1.27	0.75
Leeds and Grenville United Counties	100,450	72	64.0	7.17	6.37	6	4.2	0.60	0.42
Lennox and Addington County	40,803	40	32.7	9.80	8.02	2	*	0.49	*
Manitoulin District	12,996	17	12.5	13.08	9.61	0	0.0	0.00	0.00
Middlesex County	413,563	419	365.0	10.13	8.83	49	25.9	1.18	0.63
Muskoka District Municipality	54,632	68	62.7	12.45	11.47	7	4.0	1.28	0.74
Niagara Regional Municipality	424,238	284	271.5	6.69	6.40	42	23.8	0.99	0.56
Nipissing District	84,971	86	77.2	10.12	9.08	15	9.3	1.77	1.10
Northumberland County	86,724	63	57.6	7.26	6.64	8	3.9	0.92	0.45
Ottawa-Carleton Regional Municipality	784,234	909	700.7	11.59	8.93	81	39.7	1.03	0.51
Oxford County	102,532	57	62.3	5.56	6.08	10	5.6	0.98	0.55
Parry Sound District	41,916	33	26.6	7.87	6.35	3	*	0.72	*
Peel Regional Municipality	1,009,636	709	735.9	7.02	7.29	87	42.3	0.86	0.42
Perth County	75,508	59	53.2	7.81	7.04	15	11.6	1.99	1.54
Peterborough County	129,083	126	108.3	9.76	8.39	12	8.1	0.93	0.62
Prescott and Russell United Counties	79,152	75	62.5	9.48	7.89	11	4.6	1.39	0.59
Prince Edward County	26,330	28	22.8	10.63	8.66	1	*	0.38	*
Rainy River District	23,239	24	18.7	10.33	8.04	5	3.5	2.15	1.51
Renfrew County	100,700	84	77.0	8.34	7.64	13	10.2	1.29	1.01
Simcoe County	378,230	305	296.2	8.06	7.83	33	13.5	0.87	0.36
Stormont, Dundas and Glengarry United Counties	115,456	99	84.0	8.57	7.28	17	8.3	1.47	0.72
Sudbury District	25,617	10	10.8	3.90	4.21	2	*	0.78	*
Sudbury Regional Municipality	161,607	139	142.7	8.60	8.83	26	13.2	1.61	0.82
Thunder Bay District	157,877	145	122.9	9.18	7.79	12	6.6	0.76	0.42
Timiskaming District	36,432	42	35.2	11.53	9.65	6	3.7	1.65	1.01
Toronto Metropolitan Municipality	2,534,823	2,872	2,656.9	11.33	10.48	226	123.9	0.89	0.49
Victoria County	73,293	48	47.6	6.55	6.49	6	2.8	0.82	0.38
Waterloo Regional Municipality	447,850	335	300.8	7.48	6.72	92	43.4	2.05	0.97
Wellington County	191,758	154	130.6	8.03	6.81	23	14.6	1.20	0.76
York Regional Municipality	735,408	518	508.8	7.04	6.92	54	29.8	0.73	0.41

Sources: Corporate Provider Database, Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). Physician specialty and location verified against the Ontario Physician Human Resource Data Centre Database. FTE = Full Time Equivalent. * data suppressed due to small size.

Exhibit 14.5 Supply of Internal Medicine, Endocrinology and Ophthalmology Specialists by District Health Council (DHCs) in Ontario, 2001

The supply of specialists varied widely by DHC. Metro Toronto had the highest specialist supply, while Grand River, Northwestern Ontario and Grey-Bruce-Huron-Perth had consistently low specialist supply.

		Internal Medicine				Endocrinologists				Ophthalmology			
District Health Council (DHC)	Population	Number	FTEs	Number per 10,000 Persons	FTEs per 10,000 Persons	Number	FTEs	Number per 10,000 Persons	FTEs per 10,000 Persons	Number	FTEs	Number per 10,000 Persons	FTEs per 10,000 Persons
Algoma, Cochrane, Manitoulin & Sudbury	417,510	53	60.7	1.27	1.45	1	*	0.02	*	15	11.3	0.36	0.27
Champlain	1,079,542	300	244.3	2.78	2.26	23	18.4	0.21	0.17	63	50.8	0.58	0.47
Durham, Haliburton, Kawartha & Pine Ridge	817,800	86	106.6	1.05	1.30	3	5.9	0.04	0.07	15	17.0	0.18	0.21
Essex, Kent, and Lambton	628,358	72	79.4	1.15	1.26	5	6.9	0.08	0.11	17	17.5	0.27	0.28
Grand River	235,512	18	19.4	0.76	0.82	0	0.0	0.00	0.00	6	6.0	0.25	0.25
Grey, Bruce, Huron, Perth	294,412	14	15.2	0.48	0.52	1	*	0.03	*	5	5.7	0.17	0.19
Halton-Peel	1,387,768	153	184.2	1.10	1.33	12	15.7	0.09	0.11	26	27.1	0.19	0.20
Hamilton-Wentworth	498,195	214	189.1	4.30	3.80	7	5.3	0.14	0.11	21	18.6	0.42	0.37
Metropolitan Toronto	2,534,823	870	808.4	3.43	3.19	68	65.9	0.27	0.26	155	141.9	0.61	0.56
Muskoka, Nipissing, Parry Sound & Timiskaming	217,951	20	22.2	0.92	1.02	1	*	0.05	*	7	7.2	0.32	0.33
Niagara Region	424,238	56	59.9	1.32	1.41	1	*	0.02	*	15	13.3	0.35	0.31
Northwestern Ontario	249,729	29	33.0	1.16	1.32	0	0.0	0.00	0.00	5	4.9	0.20	0.20
Quinte, Kingston, Rideau	495,467	103	92.6	2.08	1.87	5	4.5	0.10	0.09	22	19.4	0.44	0.39
Simcoe-York	1,113,638	102	119.8	0.92	1.08	10	11.9	0.09	0.11	16	16.0	0.14	0.14
Thames Valley	600,233	165	139.5	2.75	2.32	15	10.7	0.25	0.18	29	23.6	0.48	0.39
Waterloo Region - Wellington-Dufferin	690,128	83	89.4	1.20	1.30	5	5.4	0.07	0.08	15	12.7	0.22	0.18

Sources: Corporate Provider Database, Ontario Health Insurance Plan (OHIP). Physician specialty and location verified against the Ontario Physician Human Resource Data Centre Database. FTE = Full Time Equivalent. * data suppressed due to small size.

Supply of health care providers

The supply of GP/FPs varies widely across the province (Exhibit 14.4). The number of GP/FPs per 10,000 persons is high in four of the five counties with large cities and medical schools (Frontenac, Toronto, Ottawa-Carleton and Middlesex), but also relatively high in the rural counties of Manitoulin, Muskoka, Lanark and Timiskaming. The Sudbury District (not including the Regional Municipality of Sudbury) had the lowest GP/FP supply, and the other five counties with physician supply of 6.0 per 10,000 or below were all located in rural Southwestern Ontario (Dufferin, Lambton, Oxford, Kent and Elgin).

The supply of optometrists also varied widely (Exhibit 14.4). However, there was no obvious relationship between optometry supply and whether the county was predominantly urban or rural. The five counties with large urban areas and medical schools (Toronto, Ottawa, Hamilton-Wentworth, Middlesex and Frontenac) tended to have average or below average supplies of optometrists. Rural counties were among those with high supply (e.g. Perth, Rainy River) and low supply (e.g. Manitoulin, Prince Edward County).

For specialists, results are reported by District Health Councils (DHCs) instead of county because specialists tend to have a broader catchment area than GP/FPs or optometrists. The supply of ophthalmologists varied widely (Exhibit 14.5). Metro Toronto had the highest specialist supply of all the DHCs, while Grand River, Northwestern Ontario, and Grey-Bruce-Huron-Perth had consistently low specialist supply.

Relationship between visit volume and health care provider supply

Exhibits 14.6a to 14.6f show the relationship between physician supply and patient visit volumes among counties in Ontario, for different types of services. For each type of provider, patient visit volumes tend to increase as the provider supply increases. The slope is relatively modest in the case of GP/FP services (Exhibit 14.6a) and is steeper for internist and endocrinologist services (Exhibits 14.6b, 14.6c).

In the case of optometrists and ophthalmologists, it is also true that more visits per year occurred where there were more providers (Exhibits 14.6d, 14.6e). However, when one examines eye care provided by either optometrists or ophthalmologists, there is no relationship between eye care visits and the combined supply of these two groups of providers (Exhibit 14.6f). Exhibit 14.7 sheds light on why this is the case. In counties with relatively low use of ophthalmology services, use of optometry services tended to be higher.

Exhibit 14.6a: GP/FP Visits by Patients with DM vs Supply of GP/FPs in Ontario Counties, 2001*

General Practitioners/Family Practitioners (GP/FPs) visits increase only modestly as the physician supply increases.

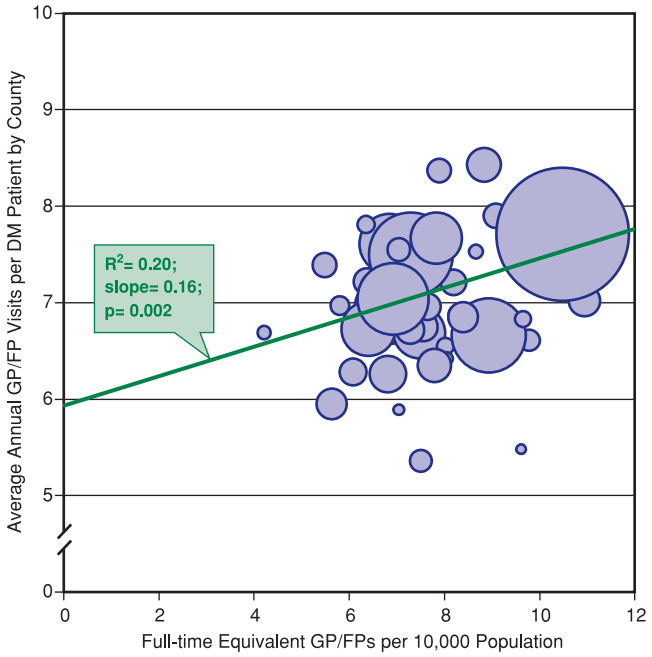


Exhibit 14.6b: Internist Visits by Patients with DM vs Supply of Internists in Ontario Counties, 2001*

General Internist visits increase as the physician supply increases.

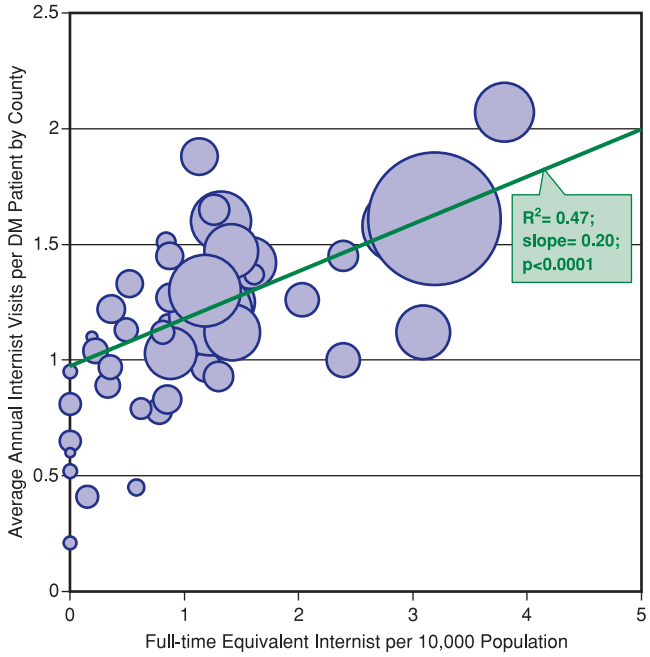


Exhibit 14.6c: Endocrinologist Visits by Patients with DM vs Supply of Endocrinologists in Ontario Counties, 2001*

Endocrinologist visits increase as the physician supply increases.

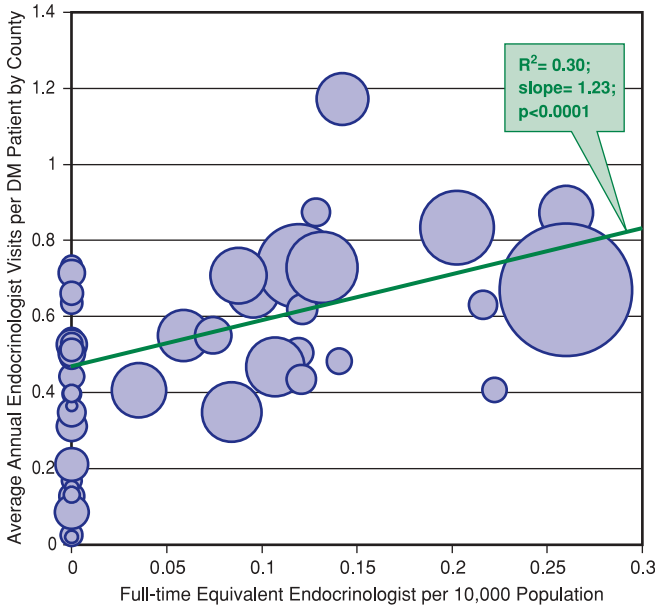


Exhibit 14.6d: Optometry Visits by Patients with DM vs Supply of Optometrists in Ontario Counties 2001*

Optometrist visits increase as the supply of optometrists increases.

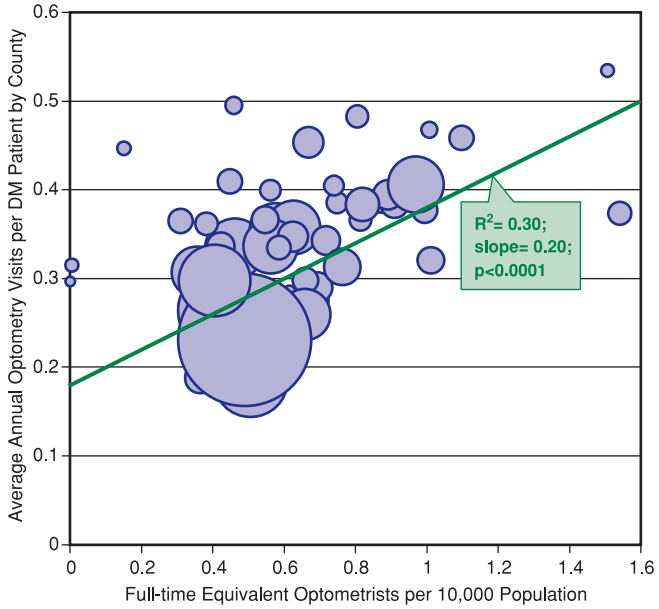


Exhibit 14.6e: Ophthalmologist Visits by Patients with DM vs Supply of Ophthalmologists in Ontario Counties, 2001*

Ophthalmologist visits increase as the physician supply increases.

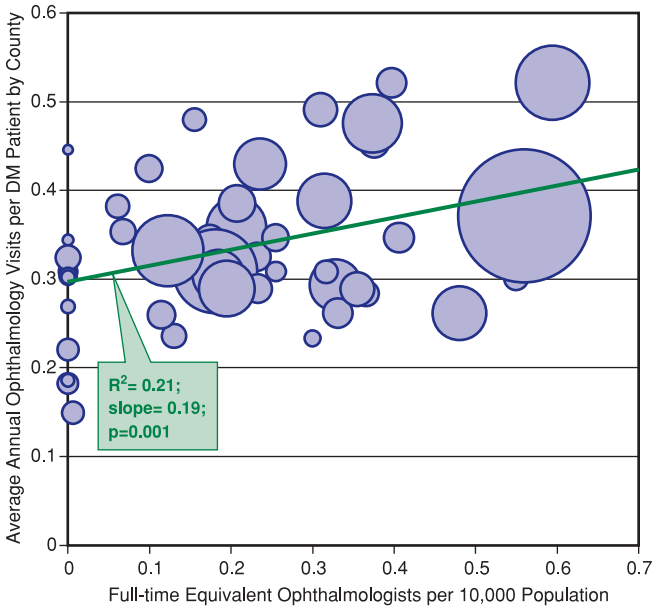


Exhibit 14.6f: Eye Care Visits by Patients with DM vs Supply of Eye Care Professionals in Ontario Counties, 2001*

There is no relationship between combined supply of optometrists/ophthalmologists and eye care visits.

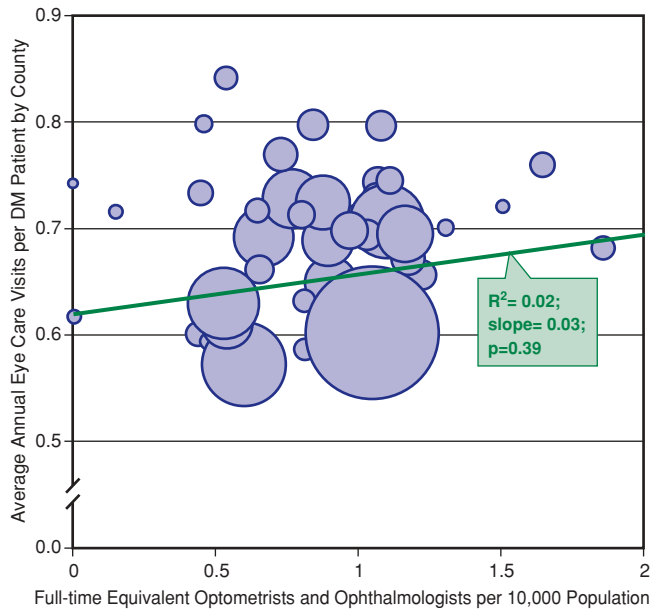
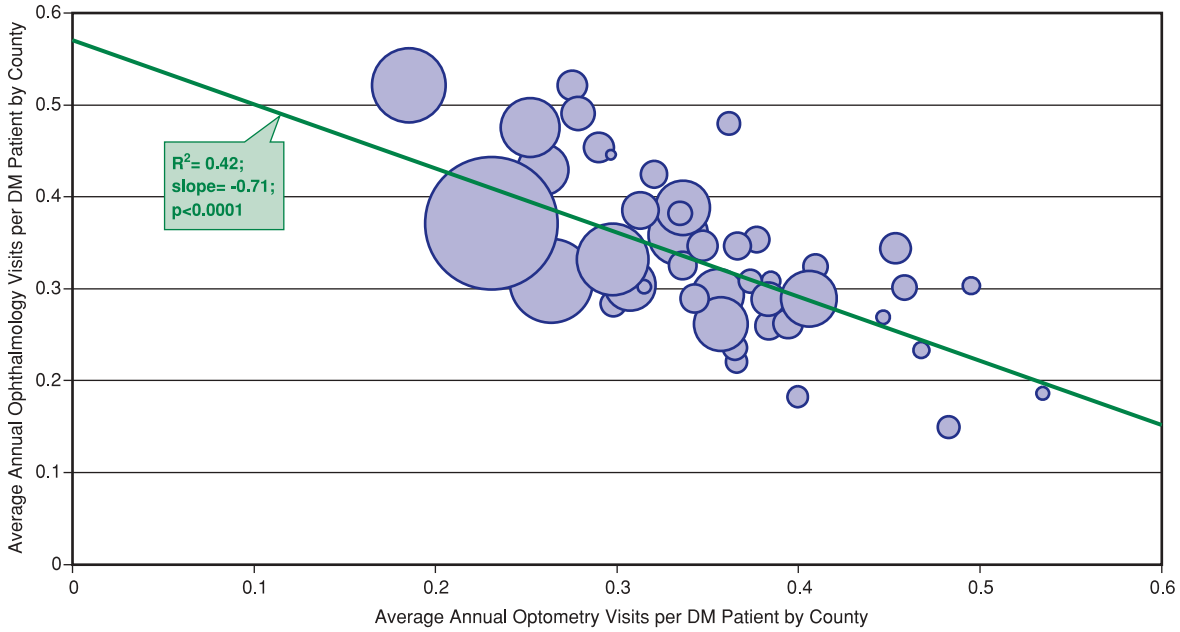


Exhibit 14.7: Relationship Between Ophthalmologist and Optometrist Visit Rates by Patients with DM in Ontario Counties, 2001*

In counties with relatively low use of ophthalmologist services, the use of optometrist services tends to be higher.



Sources for Exhibits 14.6a–f and 14.7: Corporate Provider Database, Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). *Each circle represents a county and size is proportional to county population. Each green line represents the trend in the data points, as determined by linear regression techniques.

Provider Workload Attributable to Diabetes

Exhibit 14.8 describes the proportion of physician workload within different specialties for which patients with DM account. Endocrinologists devote half of their patient visits to caring for persons with DM; for other internists and ophthalmologists, this proportion is about one in five.

Diagnoses Recorded on Persons with Diabetes

Exhibit 14.9 lists the frequency of diagnoses coded during visits to physicians and optometrists for persons with DM. Coding of "Diabetes Mellitus" accounts for the minority of visits by persons with DM. Among young persons, psychiatric and social problems, obstetrical and gynaecological conditions and minor upper respiratory conditions were common. Among the elderly, cardio-vascular disease was cited more frequently as the main diagnosis than DM.

Other health care providers

There were 149 Ministry-funded Diabetes Education Centres (DEC) in Ontario identified by the Diabetes Complications Prevention Co-operative in its 2001 survey. DECs were located in 48 of 49 counties in Ontario. Exhibit 14.10 shows the location of these Centres. Most serve patients of all ages, but some specialize in pediatric care. The average DEC reported having 1.0 FTE nurses and 1.0 FTE registered dieticians on staff. Some DECs provided additional services including chiropody, social work, psychology, physiotherapy and pharmacy.

Exhibit 14.8: Proportion of Health Care Provider Workload Attributable to Ontarians with DM, 2001

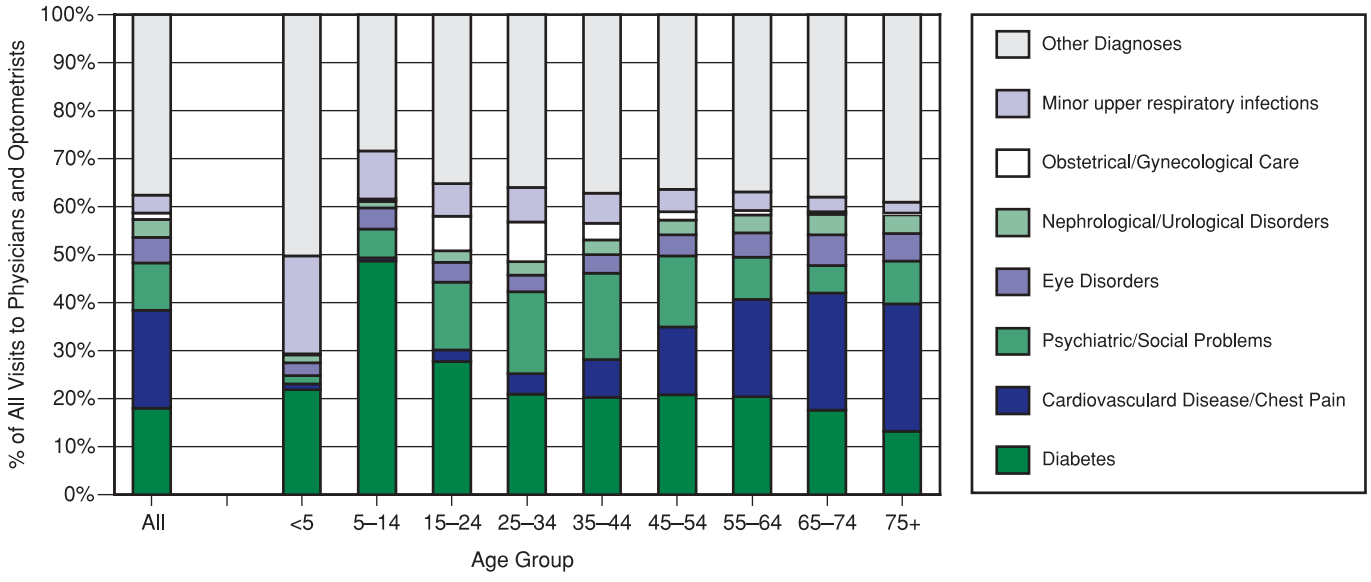
Endocrinologists spent half their patient visits caring for persons with DM. For other internists and ophthalmologists, the proportion was one in five.

Provider Type	Total visits	% of Total Visits by Patients with DM	% of Total Visits by Patients with DM and Where the Diagnosis is DM
GP/FPs	54,673,005	10.9	2.4
Internists	6,489,162	21.7	1.7
Endocrinologists	442,500	50.0	39.9
Optometrists	2,882,109	7.1	0.0
Ophthalmologists	1,778,328	19.6	5.2
Other Physicians	18,259,445	8.2	0.3

Sources: Corporate Provider Database, Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP). Physician specialty verified against the Ontario Physician Human Resource Data Centre Database.

Exhibit 14.9 Diagnoses Coded During Visits to OHIP Health Care Providers by Ontarians with DM, 2001

The diagnosis of "diabetes mellitus" accounted for the minority of physician visits for patients with DM. The most common diagnoses among younger persons with DM include psychiatric/social problems, minor upper respiratory conditions and obstetrical/gynecological visits, while older persons were often cited as having cardiovascular disorders.



Sources: Ontario Diabetes Database (ODD), Ontario Health Insurance Plan (OHIP)

Conclusions

The care of patients with DM involves many different types of health care providers. The GP/FP plays a central role in the management of the patient, and is the number one source of contact with the health care system. This finding is consistent with those in Chapter 9, which suggest that most patients receive medical management exclusively through GP/FPs, and a smaller proportion are co-managed by GP/FPs and specialists. Any effort to strengthen the quality or access to care for persons with DM should take into account the pivotal role which GP/FPs play in their management.

Patients with DM visit physicians and optometrists more than twice as often as patients without DM. Planners may wish to consider this fact when making resource allocation decisions, such as where to invest in preventive health measures which could potentially improve population health and reduce future resource utilization. In Ontario, efforts to reform the organization of primary care are underway, and one component of these efforts is a capitation formula for physician remuneration, adjusting for differences in patient age and gender.[4] This analysis demonstrates that it is also important to adjust for differences in the patient's chronic disease profile. Without such adjustments, physicians who care for large numbers of DM patients in their practice may be at a financial disadvantage compared to those who look after patients with fewer chronic diseases.

It is reassuring that the use of primary care services among persons with DM does not vary considerably across the province. In areas with low GP/FP supply, persons with DM use primary care only slightly less than in areas with higher supply. This suggests that access to primary care for patients with DM is reasonably well distributed throughout the province. The findings also suggest that there may be some degree of prioritization which takes place within low physician supply communities, such that those with well-defined medical needs are seen first.

Variations in visits to an eye care professional were also relatively modest. The guidelines for DM management emphasize periodic assessments to screen for DM retinopathy, but are not specific about what type of provider should be performing such services.[5] Data from other jurisdictions suggest that optometrists play an important role in providing these tests and that the sensitivity of screening by optometrists is high.[6-8] The data from this analysis suggests that there is some degree of substitution taking place between these two provider groups, such that in areas with low use of ophthalmology services, patients use optometrists more intensely. This substitution effect has helped maintain relatively even access to an eye care professional for screening throughout the province.

Although variations in use of eye care are relatively modest, the reader is reminded that the findings in Chapter 10 of this Atlas suggest that the province-wide rate of screening for retinopathy appeared to fall short of recommended guidelines. Problems in

Key Research Findings

- Patients with DM visited a physician or optometrist more than twice as frequently as the general population.
- Persons with DM over age 75 visit health care providers (family physician, specialist or optometrist) more than twice as frequently as younger persons with DM; however, persons with DM under age 35 visited endocrinologists much more frequently than those over age 65.
- Within all age groups, GP/FPs accounted for the majority of visits. Most patients receive medical management exclusively through GP/FPs, with a smaller proportion being co-managed by GP/FPs and specialists.
- Endocrinologists devote almost half of their patient visits to caring for persons with diabetes; for other internists and ophthalmologists, this proportion is almost one in five.
- In areas with low GP/FP supply, persons with DM use primary care only slightly less than in areas with higher supply, suggesting that access to primary care for patients with DM is reasonably well distributed throughout the province.

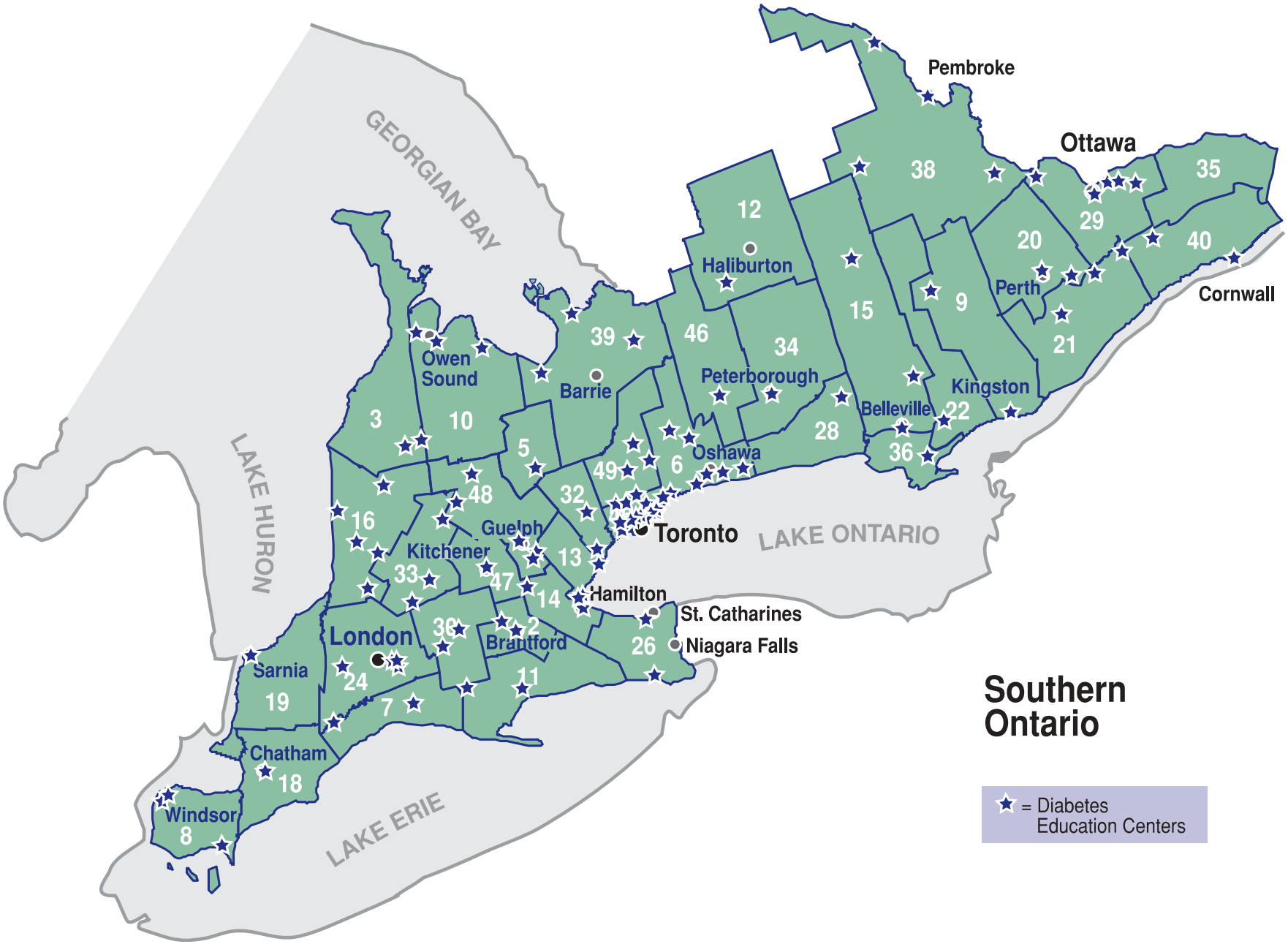
Exhibit 14.10a Diabetes Education Centres in Northern Ontario, 2001

Ontario Counties

1 Algoma District
2 Brant County
3 Bruce County
4 Cochrane District
5 Dufferin County
6 Durham Regional Municipality
7 Elgin County
8 Essex County
9 Frontenac County
10 Grey County
11 Haldimand-Norfolk Regional Municipality
12 Haliburton County
13 Halton Regional Municipality
14 Hamilton-Wentworth Regional Municipality
15 Hastings County
16 Huron County
17 Kenora District
18 Kent County
19 Lambton County
20 Lanark County
21 Leeds and Grenville United Counties
22 Lennox and Addington County
23 Manitoulin District
24 Middlesex County
25 Muskoka District
26 Niagara Regional Municipality
27 Nipissing District
28 Northumberland County
29 Ottawa-Carleton Regional Municipality
30 Oxford County
31 Parry Sound District
32 Peel Regional Municipality
33 Perth County
34 Peterborough County
35 Prescott and Russell United Counties
36 Prince Edward County
37 Rainy River District
38 Renfrew County
39 Simcoe County
40 Stormont, Dundas and Glengarry United Counties
41 Sudbury District
42 Sudbury Regional Municipality
43 Thunder Bay District
44 Timiskaming District
45 Toronto Metropolitan Municipality
46 Victoria County
47 Waterloo Regional Municipality
48 Wellington County
49 York Regional Municipality

Source: Northern Diabetes Health Network/Diabetes Complications Prevention Cooperative Survey, 2001

Exhibit 14.10b Diabetes Education Centres in Southern Ontario, 2001



Note: See Exhibit 14.10a for County definitions.

Source: Northern Diabetes Health Network/Diabetes Complications Prevention Cooperative Survey, 2001

accessing appropriate care do not appear to be due to variations in provider supply, but may be due to other factors such as patient and provider awareness of the importance of retinopathy screening. Further research is needed to identify strategies to improve screening rates among all patients with DM. Furthermore, optometrists can screen for retinopathy, but the treatment of retinopathy remains within the scope of practice of ophthalmologists. Future research should also examine whether patients in areas of low ophthalmologist supply are having problems in accessing care for treatment of retinopathy.

The level of contact with other types of specialist care did vary more dramatically according to specialist supply. While there is strong agreement that regular contact with a primary care provider is essential to good health maintenance for persons with DM, the indications for specialist referral are less clear. One multi-centre cohort study in the United States in found no strong evidence to suggest that specialists handled routine DM care better than generalist physicians,[9] while other single institution studies with weaker study designs did find some modest improvements in outcomes with specialist care.[10,11] The decision to refer to a specialist may be more discretionary in nature and hence more subject to the number and availability of providers. The implication of this finding is that access to more advanced services may not be as equitably distributed as the basic services. Future research should examine whether patient outcomes are any different among those patients co-managed with specialists, in the Ontario context. Examples of such outcomes could include glycosylated hemoglobin (HbA1C) measures, or rates of chronic DM complications such as dialysis, myocardial infarction, diabetic retinopathy or amputations due to peripheral vascular disease.

This chapter demonstrates very frequent visitation rates to family physicians and specialists, at least once a month, and almost twice a month among the elderly. There are no clear guidelines for the "correct" number of annual visits. However, we note that the Canadian guidelines for DM management recommend, at a minimum, a glycosylated hemoglobin measurement every three to four months; lipid screening every one to three years; an annual foot exam; annual screening for peripheral neuropathy; and an eye exam every two years if no retinopathy is present.[5] In the United Kingdom Prospective Diabetes Study, patients with type 2 DM were monitored every three to four months, even if they had multiple comorbidities and were part of the intensive treatment arm of the study.[12] In the Diabetes Control and Complications Trial, type I DM patients on an intensive, three times per day insulin regime were seen once a month.[13] In a population-based survey in the United States, patients with DM had a face-to-face encounter with a physician 13.7 times per year in 1990,[14] compared to a rate of 16.2 in this study. All of these comparisons suggest that patients with DM in Ontario visited physicians at a rate which equalled or exceeded the typical rates noted in the literature. Further research is still needed to examine whether all of the recommended evidence-based practices are taking place during these visits by patients with DM, and whether some of these physician encounters could be handled by other health professionals instead in order to reduce the burden on physician workload.

Elderly persons with DM use the health care system very frequently. Patients aged 75 and over visit a physician or optometrist twice a month and have important comorbidities such as cardiovascular disease. Census Canada projects that this age group will increase by 25% over the next 10 years.[15] The prevalence of DM may also be expected to rise; as noted in Chapter 1, prevalence rose from 13% to 16% among women and from 16% to 20% among men. Health planners need to consider the impact of these trends on future requirements for physicians, optometrists and other health care personnel. One approach may be to project current visitation rates onto the projected increase in the elderly population with DM to determine the total visits required in the population. If we estimate a reasonable workload for health providers (i.e. a typical number of visits per year which a provider can be expected to provide), then we can estimate future health professionals needed. The above approach, however, does not take into account alternate models of care, which may use more nurses or educators rather than physicians, and does not consider that current rates may reflect either unnecessary care being provided or inadequate access to care. Future research should consider the impact of these different models of care, both on effectiveness of DM control and resources used, and consider what the human resource requirements would be if the best practice models were implemented province-wide.

Much of the analysis in this chapter is focused on fee-for-service physicians and optometrists, because good utilization data are available for these professions. Other health professionals, however, play an important role in diabetes management. This study shows that Diabetes Education Centres have proliferated to all regions of the province. Most of these Centres offer access to a variety of different health personnel, including educators, chiropodists, social worker, psychologists, physiotherapists and pharmacists. There is good clinical trial evidence that patient education improves glycemic control[16] and reduces the rate of foot ulcers[17] and limb amputations.[18] One recent meta-analysis of diabetes education studies suggested that the impact of diabetes education interventions tends to diminish after three months.[19] Further, repeated interventions may be necessary to sustain good preventive health practices over the long term.

Future research should examine how many patients with DM are receiving diabetes education, at what frequency and by what type of health care provider. Patient outcomes such as HbA1C measures and DM complication rates should also be monitored. At present, data for such analyses are unavailable. The authors strongly recommend that at a minimum, collection of data

documenting the health human resources devoted to DM care be done annually. Eventually, data on each individual patient-provider encounter should also be collected. Such data collection could be mandated by the Ministry as a condition of funding, with similar safeguards for patient confidentiality that currently exist for other types of patient data. Such information is essential to describing the different models of health care delivery available, and to analyzing whether certain types of models have better outcomes than others.

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Technical Appendices (Exhibits TA14.A, TA14.B and TA14.C)

Data Sources and Methods

Exhibit TA14.A: Data Sources for Chapter 14

Data Source	Type of Information
Information on Patients	
Ontario Diabetes Database (ODD)	Each patient identified as having DM; the patient's postal code; and age
Information on Providers	
Corporate Provider Database, MOHLTC	Each physician's practice location (postal code) and specialty *
Diabetes Complications Prevention Co-operative	Survey data on nurses, dieticians, podiatrists and other staff at Diabetes Education Centres in Ontario
Information on Patient-Provider Encounters	
Ontario Health Insurance Plan, MOHLTC	Information about each visit to a physician or optometrist, including the type of service, location (e.g. office vs emergency department) and service date
Other Information	
Postal Code Conversion File, Statistics Canada	The county associated with each postal code in Ontario
Census Canada	Population counts by patient age and gender in each county

* the accuracy of this information was verified against the Ontario Physician Human Resource Data Centre database.
MOHLTC = Ministry of Health and Long-term Care (Ontario).

Technical Appendix TA14.B Detailed Methods found in Chapter 14

Time Frame

All analyses were conducted for the fiscal year 2000/01, which began on April 1st, 2000 and ended on March 31st, 2001.

Data Sources

Table TA14.A lists the different data sources used in this chapter.

Inclusion and Exclusion Criteria for Patients

This analysis examined all patients in the Ontario Diabetes Database (ODD) who were alive for at least one day during the fiscal year. For comparison, it also examined a 5% random sample of all patients in the Registered Persons Database (RPDB) who were not in the ODD, and who were also alive for at least one day during the fiscal year.

If a person was alive for only a portion of the fiscal year, then that person was assigned a weight equal to the proportion of the year that he or she was alive. Hence, if a person visited a doctor three times and was alive for 9 months, then the annual visit rate for that patient would be four visits per year.

Inclusion and Exclusion Criteria for Physicians

A physician was included in this analysis if he or she was in the Corporate Provider Database and had OHIP billings in the fiscal year. Physicians enrolled in non-fee-for-service plans were also included; these physicians were identified in the Ontario Physician Human Resource Data Centre (OPHRDC) database.

A small number of physicians are registered with OHIP as being outside Ontario but do a small amount of clinical practice within Ontario (e.g. locums). These physicians were not counted in analyses of physician supply.

A number of methods were used to verify a physician's specialty. First, each physician has a registered specialty with OHIP for billing purposes. However, this billing specialty often does not consistently distinguish between subspecialties of internal medicine. The OPHRDC database served as a second source of information on subspecialty. Third, an algorithm was developed to identify a physician's functional specialty. For each combination of feecode, diagnosis and patient age group, the physician specialty which billed the combination most frequently was identified. Then, each doctor's billings were analyzed to determine whether most of their billings were for services which were associated to a particular subspecialty. This measure of functional specialty was used in instances where OPHRDC data were not available on a particular physician.

For the purpose of this study, endocrinologists (subspecialists of internal medicine) and pediatric endocrinologists were both considered to be endocrinologists.

Defining Categories of Patient Visits

A patient visit is an assessment or consultation performed by a physician on a patient. Patient visits can be identified by the specific feecode which physicians bill OHIP. Such visits included selected feecodes starting with the letters A (office or ED visit), B (home visit), C (hospital visit), H (ED or hospital) and W (visit in a long-term care facility). Selected K-series feecodes for psychotherapy and counselling were also chosen. This definition excludes procedures performed for diagnosis or treatment.

In this chapter, we distinguished between visits to GP/FPs, emergency departments (EDs); endocrinologists, and other internal medicine specialists; visits for eye care; and all other visits.

A visit to a GP/FP is defined as a patient assessment or consultation billed by a GP/FP outside of an emergency department and excluding oculovisual assessments. The visit may take place in an office setting, during a home visit or when the patient is admitted to hospital or residing in a long-term care facility. Such visits also include psychotherapy and counselling sessions. Each unit of psychotherapy or counselling is counted as one visit.

A visit to an ED is defined as a patient assessment or consultation billed by the physician who is on call in the ED. It does not include instances where a patient is referred to a specialist by another physician and is seen by the specialist in the ED. ED visits were identified in one of two ways. First, in EDs in large cities which require the ED physician to be on-site at all times, the physician bills certain feecodes starting with the letter H which clearly identify the service as occurring in an ED (H101-104; H121-124; H151-154; H055 and H065). In EDs in rural areas where on-call duties can be taken from home, the physician bills a regular patient assessment plus a feecode for a special visit to the ED (K990 to K997). We identified all instances where a patient assessment was billed with a special visit code on the same day on the same patient by the same physician.

A visit for eye care could be any visit performed by an opthalmologist, or an oculovisual assessment. The latter are usually performed by optometrists (feecodes V401-407) but can sometimes be billed by GP/FPs (feecodes A110-4). An endocrinologist visit was defined as any visit billed by an endocrinologist. An internal medicine visit was defined as any visit billed by either a general internist or a subspecialist in internal medicine (e.g. cardiologist) other than an endocrinologist.

Identification of Optometrist Practice Location

We did not have access to a master file of optometrists in Ontario. Nonetheless, we identified all optometrists who billed OHIP in 2001, and then examined the community of residence for the patients seen by each optometrist. The most common community of patient residence for each optometrist was selected as the optometrist's de facto practice location.

Definition of Full-time Equivalent Physicians and Optometrists

Full-time equivalents (FTE) were calculated as follows. First, we calculated a standard price for each feecode in the OHIP fee schedule, equal to total billings for that feecode divided by the total number of services. Then, we calculated, for each physician and each feecode, the price-adjusted billings, which equals the total services times the standard price. Then, for each physician, we calculated the total price-adjusted billings summed across all feecodes. The total price-adjusted billings was used as a marker of the physician's overall level of activity.

Price-adjusted billings were used instead of actual billings, because a small number of doctors are paid through an alternate funding plan but submit shadow billings for the purpose of tracking utilization. In these shadow billings, the same feecodes are used and the number of services is reported but the amount billed is zero. If we used total billings, then the level of activity of these physicians would have been under-estimated.

We then calculated the 40th and 60th percentile of price-adjusted billings for each physician specialty and for optometry. (Subspecialties of internal medicine, such as endocrinology, were considered distinct specialties.) The FTE workload level for each health care provider was then calculated using the following formula developed by the Canadian Institute for Health Information:[i]

FTE =	B/B_{40}	if billings (B) are below the 40th percentile for the physician's specialty (B_{40}).
	1	if billings are between the 40th and 60th percentile
	$1+\log (B/B_{60})$	if billings (B) are above the 60th percentile for the physician's specialty (B_{60})

[i] Full-time equivalent physicians report, Canada, 1989/90 to 1993/94. Ottawa: Canadian Institute for Health Information; 1998.

Testing the relationship between visit volume and health care provider supply

We used weighted ordinary least squares to examine the significance of the relationship between visit volume and physician supply. The unit of analysis was an Ontario county, and the weight was the county population. For the analysis of each specialty, counties which had a significant degree of non-fee-for-service activity were excluded. In the analysis of GP/FP services, the excluded counties were Algoma, Hamilton-Wentworth and Waterloo. For ophthalmology, combined eye care, internal medicine and endocrinology services, the excluded counties were Frontenac; Leeds and Grenville; and Lennox and Addington. For optometry, no counties were excluded. Sensitivity analyses were performed where the excluded counties were included, and the results were robust except for GP/FP services, where the relatively weak but significant relationship between annual visits and provider supply became insignificant.

Classification of Diagnoses

On each fee-for-service billing claim for a patient visit, one diagnosis is recorded by the physician. OHIP uses a modified and truncated version of the International Classification of Diseases for categorizing diagnoses. The following table describes the definitions of diagnostic categories for physician visits used in this study:

Diagnostic Category	OHIP Diagnosis Codes
Diabetes Mellitus	250
Eye Disorders	360–379
Psychiatric / Social problems	290–319 or 897–909
Cardiovascular Disease / Chest Pain	390–459 or 785
Minor upper respiratory infections*	460–466, 477
Nephrological / Urological Disorders	580–609
Obstetrical / Gynecological Disorders	610–629, 895
Other Diagnoses	All Other Diagnoses

* includes upper respiratory infections, pharyngitis, sinusitis, rhinitis, otitis media, bronchitis.

Exhibit TA14.C Regional Variations in Visits to Physicians and Optometrists by Ontario County, 2000–2001

County	GP/FP visits		Eye Care visits		Internal Medicine visits		Endocrinology visits	
	Age-/Sex-adjusted Visits per Patient with DM	Ranking	Age-/Sex-adjusted Visits per Patient with DM	Ranking	Age-/Sex-adjusted Visits per Patient with DM	Ranking	Age-/Sex-adjusted Visits per Patient with DM	Ranking
Algoma District	5.38	47	0.80	4	0.97	33	0.50	22
Brant County	7.59	9	0.74	8	1.61	5	0.31	38
Bruce County	6.79	26	0.59	46	0.81	39	0.64	13
Cochrane District	7.21	15	0.73	11	0.78	41	0.13	44
Dufferin County	6.97	19	0.69	25	1.51	8	0.40	33
Durham Regional Municipality	7.61	8	0.69	26	1.60	6	0.35	36
Elgin County	7.39	13	0.60	44	0.89	36	0.54	18
Essex County	6.96	21	0.65	32	1.25	18	1.17	1
Frontenac County	7.02	18	0.63	38	0.51	45	0.18	40
Grey County	6.86	22	0.58	48	1.10	27	0.48	26
Haldimand-Norfolk Regional Municipality	6.72	30	0.64	33	1.22	19	0.35	37
Haliburton County	5.89	45	0.63	36	1.10	28	0.36	35
Halton Regional Municipality	6.69	32	0.69	27	1.42	12	0.66	11
Hamilton-Wentworth Regional Municipality	5.12	49	0.73	12	2.07	1	0.47	27
Hastings County	6.75	27	0.66	31	0.93	35	0.43	29
Huron County	6.37	39	0.58	47	0.79	40	0.73	5
Kenora District	5.36	48	0.63	34	0.41	47	0.03	48
Kent County	6.62	35	0.66	30	0.83	38	0.87	2
Lambton County	5.95	44	0.80	3	1.65	3	0.53	20
Lanark County	6.61	36	0.72	14	0.65	42	0.53	19
Leeds and Grenville United Counties	7.22	14	0.61	42	0.83	37	0.37	34
Lennox and Addington County	6.55	37	0.59	45	0.37	48	0.08	47
Manitoulin District	5.48	46	0.74	9	0.60	43	0.09	45
Middlesex County	6.64	34	0.62	39	1.12	23	0.87	3
Muskoka District Municipality	7.96	3	0.71	18	1.37	13	0.17	41
Niagara Regional Municipality	6.73	28	0.72	13	1.47	9	0.41	31
Nipissing District	7.90	4	0.76	6	1.11	26	0.41	30
Northumberland County	6.86	23	0.73	10	1.04	29	0.44	28
Ottawa-Carleton Regional Municipality	6.66	33	0.71	20	1.58	7	0.83	4
Oxford County	6.28	41	0.71	19	1.45	11	0.71	8
Parry Sound District	7.81	5	0.80	2	1.16	21	0.40	32
Peel Regional Municipality	7.50	12	0.57	49	1.20	20	0.73	6
Perth County	7.55	10	0.68	28	1.13	22	0.66	12
Peterborough County	6.85	24	0.69	24	1.45	10	0.62	15
Prescott and Russell United Counties	8.37	2	0.72	16	0.97	32	0.49	25
Prince Edward County	7.53	11	0.72	17	0.52	44	0.50	24
Rainy River District	6.42	38	0.72	15	0.21	49	0.02	49
Renfrew County	6.96	20	0.75	7	1.33	14	0.50	23
Simcoe County	7.67	7	0.61	41	1.03	30	0.55	17
Stormont, Dundas and Glengarry United Counties	6.72	29	0.63	35	1.27	16	0.63	14
Sudbury District	6.69	31	0.62	40	0.95	34	0.15	42
Sudbury Regional Municipality	8.43	1	0.67	29	1.00	31	0.09	46
Thunder Bay District	6.35	40	0.77	5	1.26	17	0.21	39
Timiskaming District	6.83	25	0.70	21	0.45	46	0.13	43
Toronto Metropolitan Municipality	7.71	6	0.60	43	1.61	4	0.67	10
Victoria County	7.18	16	0.84	1	1.12	25	0.51	21
Waterloo Regional Municipality	6.13	43	0.69	23	1.12	24	0.71	9
Wellington County	6.26	42	0.70	22	1.88	2	0.55	16
York Regional Municipality	7.04	17	0.63	37	1.30	15	0.73	7

Source: Ontario Health Insurance Plan (OHIP), Corporate Provider Database

Key Findings & Policy Options

In this section we have taken two different approaches to make the Atlas more useful and accessible to you the reader. First, the editorial team has identified what we see to be important Atlas findings coupled with our spin on potential policy options. These are not necessarily the "final word" on what policy implications can be taken from the extensive research findings of the Atlas, yet they are a beginning, and we will look forward to working with policy makers to develop others to help deal with the serious and growing health problem of DM in Ontario.

While our insiders' perspective on the Atlas findings puts us in a unique position to identify the key findings and their policy implications, we felt it might also be helpful to our readers to hear excerpts of outsiders' perspectives from a range of relevant stakeholders. Accordingly, we asked a number of leaders in the diabetes field to discuss the potential implications of the Atlas, providing critical perspectives on key findings and their implications particularly as relevant for the stakeholder groups they represented.

1

Finding: The incidence and prevalence of diabetes is increasing in the population as a whole, with a particularly high prevalence in the elderly.

Policy Option: Institute an intensive public education and lifestyle modification program to decrease the risk factors for developing diabetes, most importantly obesity and physical inactivity. This program should be designed with awareness of the cultural, educational and economic factors that are unique to various segments of the Ontario population.

2

Finding: Smoking, obesity, physical inactivity, high blood pressure, and high cholesterol markedly increase the chance that persons with diabetes will develop vascular complications such as heart attacks and strokes. These risk factors are common among Ontarians with diabetes.

Policy Option: Aggressively implement strategies to promote lifestyle modification (smoking cessation, increased physical activity and a healthy diet) and appropriate medication use (to control blood sugar, blood pressure and cholesterol).

3

Finding: In persons with diabetes, the rate of admissions for high or low blood sugar has decreased during the last 5 years, as have the rates of myocardial infarction, heart failure, stroke and lower extremity amputation.

Interpretation: This suggests that health professionals and patients recognize the importance of good management of blood sugar levels and other risk factors (e.g. high blood pressure) in persons with diabetes, and they have started to manage them more aggressively.

4

Finding: Despite the foregoing, persons with diabetes continue to have a markedly increased chance of having a heart attack or stroke, requiring dialysis, or undergoing an amputation, compared to people without diabetes. The likelihood of developing these complications can be considerably decreased with more aggressive use of medications to manage blood sugar, high blood pressure, high cholesterol, and protein in the urine. Although the frequency of such medication use is increasing in Ontario, it still lags behind recommended practice.

Policy Option 1: Aggressively disseminate guidelines about ideal medication use in persons with diabetes to physicians (especially family physicians) and patients.

Policy Option 2: Establish risk factor modification clinics throughout the province aimed at persons with diabetes. These need not be run by specialists, but could be coordinated by appropriately trained teams of nurse practitioners, family physicians, and general internists.

Policy Option 3: Review cost barriers (e.g. co-payments) to the use of drugs and testing agents aimed at blood sugar control and risk factor modification, given that persons with diabetes are often on many of these medications at the same time.

5

Finding: About 75% of persons with diabetes are managed by their family physician, and do not see a diabetes specialist. As the prevalence of diabetes increases, it is likely that an even greater portion of persons with diabetes will be managed without involvement of medical specialists.

Policy Option: Tailor educational efforts and guideline dissemination to the needs of busy family practitioners. Risk factor modification clinics (see above) should be locally available, as should educators and other health professionals involved in diabetes care.

6

Finding: Continuity of care with a family physician is generally good in Ontario. Those individuals who do not see their physician regularly are more likely to be admitted with both acute and chronic complications of diabetes.

Policy Option 1: Ensure that there are sufficient family physicians and appropriately trained nurse practitioners in Ontario to provide good continuity of care to persons with diabetes.

Policy Option 2: Ensure that alternative physician reimbursement schemes adequately account for the intensity of service utilization required by persons with diabetes.

7

Finding: Individuals with lower incomes are, in general, more likely to suffer complications from their diabetes than those with higher incomes, and are less likely to regularly see a physician.

Policy Option: Target areas of lower socioeconomic status for intensive educational efforts, making sure that these efforts are culturally and literacy-level appropriate. Ensure that individuals of lower income levels are able to afford the necessary medications and blood sugar monitoring devices, and have access to the appropriate health professionals.

8

Finding: Despite excellent evidence that eye screening for diabetic eye disease leads to a decrease in blindness, the frequency of eye examination in Ontario is much lower than suggested by guidelines. Indeed, there has recently been a slight decrease in the proportion of persons with diabetes undergoing screening eye examinations, possibly related to a change in the OHIP fee schedule related to eye examinations.

Policy Option 1: Increase awareness of the need for regular eye examinations by disseminating guidelines to both patients and physicians.

Policy Option 2: Re-evaluate the OHIP fee schedule to see if it has had any unintended consequences.

Policy Option 3: Ensure that there are an adequate number of eye care professionals highly trained to examine the eyes of persons with diabetes. Consider greater use of mobile units that take high quality retinal photographs, with subsequent central reading in areas where access to eye care professionals is reduced.

9

Finding: Persons with diabetes living in rural or remote communities have higher rates of hospitalization for acute and chronic complications of diabetes.

Policy Option: Ensure an adequate supply of family physicians and access to diabetes services in all regions of the province.

10

Finding: Pregnant women with diabetes are more likely to have a number of complications of pregnancy such as pre-eclampsia, high blood pressure, obstructed birth and stillbirth. The frequency of these complications appears to be higher in Ontario than in some other countries. Although pregnant women with diabetes make more use of specialist prenatal and obstetrical care than pregnant women without diabetes, an important proportion do not appear to do so.

Policy Option: Determine why some pregnant women with diabetes are not receiving specialist prenatal and obstetrical care, and ensure that such care is made available to all of them.

11

Finding: Despite a decrease in the rate of complications associated with diabetes (e.g. heart attacks, end stage kidney disease) between 1995 and 1999, the actual number of persons with such complications is increasing (because of the increasing prevalence of diabetes). This trend is likely to continue for the foreseeable future, and will place increasing pressures upon the hospital sector.

Policy Option: Regularly monitor the trend in the number of such complications over time, and use this information to plan for services in the future, such as dialysis and specialized cardiac procedures.

12

Finding: There is no reliable information about the availability of nurse practitioners or diabetes clinics caring for persons with diabetes in Ontario.

Policy Option: Information about the number, location, workload and outcomes associated with these health care professionals needs to be collected on a regular basis. These groups should be networked with each other, to facilitate sharing of best practices.

13

Finding: Aboriginal people have a high prevalence of diabetes and its associated complications.

Policy Option 1: Target culturally appropriate preventive and therapeutic interventions to the aboriginal communities, making sure that they have access to the full range of services needed.

Policy Option 2: Work with First Nations Health Directors to evaluate the impact of diabetes in the full aboriginal population in Ontario and to develop programs of ongoing surveillance.

Commentaries

Diane T. Finegood, PhD, Scientific Director, Canadian Institutes of Health Research commented:

"The ICES Practice Atlas *"Diabetes in Ontario"* is an extremely important resource for a diverse range of stakeholders including policymakers, researchers and people afflicted with diabetes. There is a wealth of evidence in this document on which policymakers can base key decisions that will not only affect the health of Canadians, but will also help us to sustain our health care system in the face of an increasing incidence and prevalence of diabetes.

This document is an important resource for researchers and research funding agencies such as the Canadian Institutes of Health Research, as it highlights areas where more research will be essential to effectively tackle the problems identified. The authors clearly demonstrate that factors such as smoking, obesity, physical inactivity, high blood pressure and high cholesterol markedly increase the chance that persons with diabetes will develop vascular complications. They suggest that this points to the need to aggressively implement strategies to promote lifestyle modification including a healthy diet and increased physical activity. Yet we know little about what strategies are effective in modifying behaviour. This lack of information suggests that focusing research funding and effort in this area will be essential to reducing morbidity associated with vascular complications. Many other research questions arise from the evidence provided in the atlas. Questions such as: why so many pregnant women with diabetes do not make use of specialist prenatal and obstetrical care when they are at greater risk of complications of pregnancy, or how can we effectively overcome the increased rates of hospitalization for acute and chronic complications of diabetes in people living in remote and rural communities, will help to focus researchers on the most important problems.

In summary, while the ICES Practice Atlas provides an excellent foundation of information about diabetes in Ontario, it also serves to highlight the many important gaps that need to be filled. Filling these gaps will take the cooperation and collaboration of governments, nongovernmental organizations and health researchers from across Canada."

Alwyn Moyer, Chair Diabetes Nursing Interest Group (DNIG), Registered Nurses Association of Ontario (RNAO) provided:

"The atlas graphically describes the burden of diabetes in the province and its impact on individuals, families, communities and the health care system. There is consistent effort to identify the determinants of health and opportunities for health promotion and prevention.

DM makes a significant contribution to the burden of illness in Ontario. There are inequities in the distribution of this burden across the province, which should be addressed. Persons living in the Northern Ontario, low income neighbourhoods, Aboriginal people and people of South East Asian origin bear a disproportionate amount of the burden compared with other Ontarians.

Team approach to diabetes care

The CDA practice guidelines recommend an interdisciplinary team approach to diabetes management based on Grade D consensus (Canadian Diabetes Association, 1998). The family physician is identified as the most appropriate team leader with diabetes educators—nurses and dietitians—as part of the core team. Unfortunately, only physician care, which can be measured using administrative data, is addressed in the ICES report. We lack information on the distribution of specialized nursing resources and on nurses' contribution to care. The nursing profession can endorse the need to determine the contribution of non-physician specialists to quality care of persons with DM identified in the report.

A significant proportion of people with diabetes fail to access diabetes health services. The report found more than one in twenty persons with DM did not see any physician for diabetes care. People who were older, male, or poor were all less likely to see a DM specialist. Given the increased prevalence of diabetes, especially in older adults, and the availability of registered nurses, the role of the registered nurse in diabetes care should be explored. Registered nurses are the most diversified workers in health care and have been shown to be those most linked to holistic and non-fragmented client care."

Kue Young, MD DPhil, Professor, Department of Public Health Sciences, University of Toronto wrote:

"The ICES Diabetes Atlas continues the high standards of previous practice atlases – authoritative, informative, and visually appealing. It will be of use to administrators, clinicians, epidemiologists, and planners. It will be a great teaching tool for graduate students and research trainees. The text is succinct, while the maps and graphs bring to life the rich compendium of data. The technical appendices are particularly helpful, as they provide much needed background to evaluate the quality of the data and the rigour of the analyses.

In terms of a comparison publication, Diabetes in America, published in the US by the National Institutes of Health, immediately comes to mind. Indeed, the publication of Diabetes in Ontario brings up the somewhat embarrassing question, "why isn't there a Diabetes in Canada Atlas?" It is perhaps a sad commentary on the state of diabetes surveillance in this country that only a handful of provinces are capable of generating the type of data that this atlas has produced. ICES has therefore taken the lead in demonstrating what can be done with administrative data. One certainly hopes that the much heralded National Diabetes Surveillance System will come to fruition. Until such time, one simply has to assume what's true for Ontarians must be true for Canadians! At least this is a major step forward from the practice of taking US data and dividing everything by 10."

Michael M. Engelgau, MD, MS, Chief, Epidemiology and Statistics Branch Division of Diabetes Translation Centers for Disease Control and Prevention Atlanta, Georgia USA observed:

"*Diabetes in Ontario* is a comprehensive atlas of the diabetic burden in Ontario, Canada. Descriptions of incidence and prevalence show only one dimension of the diabetes burden. However, the 14 chapters in this atlas show several dimensions: data on acute complications such as hypoglycemia and hyperglycemia, and chronic complications such as heart disease, stroke, eye disease, kidney disease, and lower extremity disease give a much broader picture of the true diabetes burden. The atlas also examines some of the major challenges to health care delivery and the excess use of medications and medical care services. The authors also discuss special populations who experience an excess burden of diabetes. These included the indigenous First Nations People, children, and women with diabetes during pregnancy. Altogether, a detailed picture of the effect of diabetes on the population of Ontario emerges.

Bad news

The prevalence of diabetes increased from 1995 to 1999 by about 31% while the incidence remained unchanged. From the health care delivery and health policy perspectives, the absolute number of affected persons is the "true" burden that needs attention. This number is more useful for planning. Prevalence rates are of limited value in that they do not reflect the size of the affected population. As noted on a number of occasions in the atlas, even if rates decline or remain stable, as the general population and number of persons with diabetes increases, the absolute number of cases or events could continue to increase. Hence, unadjusted rates, and absolute numbers of the people affected give a picture of true burden being experienced.

Good news

In the midst of the bad news, there is some good news. Hospital admissions for both elevated and low blood sugar and emergency room visits declined during the study period. In addition, amputation rates have declined. Taking advantage of preventive care to address these high-risk situations in a timely fashion appears to be yielding short-term benefits.

Areas for Improvement

The atlas shows that most people with diabetes receive their care from family physicians. This is likely to continue and may be an opportunity. Although specialty care may seem to be a desired goal, the growing number of people with diabetes and limited resources for any care make specialty care unlikely for most people in the future. The opportunity is 1) to equip family practitioners with the skills needed to provide quality diabetes care and 2) to establish a health care system that can provide the services needed to reduce the risk of bad outcomes. This opportunity is highlighted by data on eye care. Only half of the people with diabetes are getting an annual eye examination. This need not be the case. Health care providers, the health care system, and empowered patients can improve this trend.

Summary

Diabetes in Ontario provides a deep look into the multiple dimensions of diabetes and the burden it imposes in Ontario. Although some trends are troubling, there are also a number of encouraging trends. Many highly effective interventions now exist and the opportunity to slow or stop this epidemic is at hand and should be pursued."

The editors respond:

The goal of the ICES Atlas series is to examine patterns of health care delivery (the "is") in the context of the best evidence regarding effective practice (the "ought"). In defining the current patterns of diabetes care in the province, we have found heartening signs of evidence-based care leading to improving outcomes. At the same time, we have pinpointed significant gaps between the "is" and the "ought" in the delivery of diabetes care in the province.

We are grateful to our external commentators, for their affirmation of the value of the data we have assembled and their insights regarding the importance of various aspects of the work. Finegood sees a role for the Atlas in asking questions about diabetes—as a tool for scientists advancing the diabetes research agenda in the country. Others note the clear mandate it provides for intervention on the clinical front to address gaps between current practice and best evidence. Young notes that the Atlas represents both the promise of what a national diabetes surveillance program could provide, and a challenge to those developing such a program.

While acknowledging the rich data resource that the Atlas represents, the commentators defined gaps between the data presented and the information needs of the stakeholder audiences they represent. Engelgau reminds us that while we have taken a standard epidemiologic approach in reporting rates of disease, it is the numbers of people affected that provides the true metric of disease burden. The good news of the falling complication rates we have reported obscures the alarming trend of growing numbers of persons experiencing those complications and the consequent demand on resources. Our inability to examine the vital care delivered by non-physician providers was noted by Moyer. She argues that nurses in particular have skill sets which will be needed in the provision of preventive care to a growing diabetes population.

We close by inviting the readers of this atlas—the diabetes community most broadly defined—to work with us to continue the task of interpreting and disseminating these findings. Use these data to answer questions but, just as importantly, to stimulate more questions. We invite you to respond to us with comments, suggestions and opportunities for collaboration as we move this work forward.

The editors

Janet E Hux • Gillian L Booth • Pamela M Slaughter • Andreas Laupacis

Index