# Alberta Diabetes Atlas 2011

ADSS

Alberta Diabetes
Surveillance System

ACHORD
Alliance for Canadian Health Outcomes Research in Diabetes

IHE
INSTITUTE OF HEALTH ECONOMICS
ALBERTA CANADA

**Published by the Institute of Health Economics.**

Design: Dimensions Graphic Studio

How to cite the publication:

The production of the *Alberta Diabetes Atlas* 2011 was a collaborative venture. Accordingly, in addition to the book title and publisher, to give credit to individual authors, please cite individual chapter using chapter authors and title. For example, Johnson JA, Balko SU. Chapter 2: Epidemiological Trends of Diabetes in Alberta. In Johnson JA, editor, *Alberta Diabetes Atlas* 2011. Edmonton: Institute of Health Economics; 2011: 11-24.

For more information please see:
www.achord.ca or www.albertadiabetes.ca

ISBN: 978-1-897443-95-8 (Print)
ISBN: 978-1-897443-96-5 (Online)

Funded by Government of Alberta

© 2011 Institute of Health Economics

# Alberta Diabetes Atlas 2011

## Table of Contents


| | | |
|---|---|---|
| | Acknowledgements | iii |
| Chapter 1 | Background and Methods | 1 |
| Chapter 2 | Epidemiological Trends of Diabetes in Alberta | 11 |
| Chapter 3 | Diabetes in Children and Adolescents | 25 |
| Chapter 4 | Diabetes and Health Care Utilization in Alberta | 35 |
| Chapter 5 | Use of Indicated Laboratory Testing among People with Diabetes in Alberta | 59 |
| Chapter 6 | Diabetes and Cardiovascular Disease in Alberta | 75 |
| | Diabetes and Acute Coronary Syndrome | 77 |
| | Diabetes and Heart Failure | 89 |
| | Diabetes and Stroke | 97 |
| | Diabetes and Hypertension | 107 |
| Chapter 7 | Diabetes, Foot Disease and Lower Limb Amputations in Alberta | 115 |
| Chapter 8 | Diabetes and Kidney Disease in Alberta | 129 |
| Chapter 9 | Diabetes and Eye Disease in Alberta | 141 |
| Chapter 10 | Diabetes and Mental Health Disorders in Alberta | 163 |
| Chapter 11 | Diabetes and the Status Aboriginal Population in Alberta | 177 |
| Chapter 12 | Gestational Diabetes in Alberta | 203 |
| Chapter 13 | Key Findings and Policy Options | 213 |
| | Glossary | 221 |
| | Abbreviations | 229 |

# ACKNOWLEDGEMENTS

The conceptualization, writing and production of the *Alberta Diabetes Atlas* 2011 would not have been possible without the direction and support from a large number of individuals. The Alberta Diabetes Surveillance System (ADSS) staff would like to thank the ADSS Steering Committee, and the ADSS Working Group Members who contributed as authors. We would especially like to thank **Greg Hugel** who conducted the majority of the data analyses for the *Alberta Diabetes Atlas* 2011.

As well, Alberta Health and Wellness provided us with consistent and valuable data management, and we particularly thank **Fred Ackah** (Health Data Analyst) for his support on this project.

## ADSS Staff

| | |
|---|---|
| Jeffrey A. Johnson PhD | **Principal Investigator** |
| Stephanie U. Balko MSc | **Project Manager** |
| Greg Hugel MSc | **Data Analyst** |
| Sherry Lydynuik | **ACHORD Office Coordinator** |
| Shirley Ewmett | **Administrative Assistant** |

## ADSS Steering Committee Members

Jeffrey A. Johnson PhD (Chair)
School of Public Health
University of Alberta

Gillian L. Booth MD, MSc, FRCPC
Institute for Clinical Evaluative Sciences
And University of Toronto

Alun L. Edwards MD
Division of Endocrinology
University of Calgary

William A. Ghali MD, MPH
Department of Medicine and Community Health Sciences
University of Calgary

Brenda R. Hemmelgarn PhD, MD
Division of Nephrology
University of Calgary

Richard Lewanczuk MD, PhD
Division of Endocrinology
University of Alberta

Sumit R. Majumdar MD, MPH
Division of General Internal Medicine
University of Alberta

W. Keith McLaughlin MLS, MEd
Public Health Strategic Policy and Planning Branch
Alberta Health and Wellness

Hude Quan MD, PhD
Department of Community Health Sciences
University of Calgary

Larry W. Svenson BSc
Surveillance and Assessment Branch
Alberta Health and Wellness

## ADSS Working Group Members

Stephanie U. Balko MSc
Institute of Health Economics
Edmonton, Alberta

C. Keith Bowering MD, FRCPC, FACP
Division of Endocrinology
University of Alberta

Samantha L. Bowker PhD
School of Public Health
University of Alberta

Lauren C. Bresee PhD
Department of Medicine
University of Calgary

Constance L. Chik MD, PhD
Division of Endocrinology
University of Alberta

Fiona Clement PhD
Department of Community Health Sciences
University of Calgary

Robert M. Couch MSc, MD, FRCPC
Department of Pediatrics,
Division of Endocrinology
University of Alberta

Lynden Crowshoe MD
Department of Family Medicine
University of Calgary

Alun L. Edwards MD
Division of Endocrinology
University of Calgary

Dean T. Eurich PhD
School of Public Health
University of Alberta

Michelle M. Graham MD, FRCP(C)
Division of Cardiology
University of Alberta

Brent D. Haverstock DPM, FACFAS
Division of Podiatric Surgery
University of Calgary

Brenda R. Hemmelgarn PhD, MD
Division of Nephrology
University of Calgary

Michael D. Hill MD, MSc, FRCPC
Department of Clinical Neurosciences & Hotchkiss Brain Institute
University of Calgary

Kailash K. Jindal MD
Division of Nephrology
University of Alberta

Jeffrey A. Johnson PhD
School of Public Health
University of Alberta

Padma Kaul PhD
Division of Cardiology
University of Alberta

Malcolm King PhD
Division of Pulmonary Medicine
University of Alberta

Scott Klarenbach MD, MSc
Division of Nephrology
University of Alberta

Sumit R. Majumdar MD, MPH
Division of General Internal Medicine
University of Alberta

Braden J. Manns MD
Department of Medicine
University of Calgary

Seth D. Marks MD, MSc, FRCPC
Department of Pediatrics,
Division of Endocrinology
University of Alberta

Finlay A. McAlister MD, MSc
Division of General Internal Medicine
University of Alberta

Logan McLeod PhD
School of Public Health
University of Alberta

M. Sean McMurtry MD, PhD
Division of Cardiology
University of Alberta

Colleen M. Norris MSc, PhD
Faculties of Nursing and Medicine
University of Alberta

Richard T. Oster, MSc
Department of Medicine
University of Alberta

Danièle Pacaud, MD FRCPC
Department of Paediatrics, Division of Paediatric Endocrinology and Diabetes
University of Calgary

Scott B. Patten MD, FRCPC, PhD
Departments of Community Health Sciences & Psychiatry
University of Calgary

Hude Quan MD, PhD
Department of Community Health Sciences
University of Calgary

Doreen M. Rabi MD, MSc.
Division of Endocrinology
University of Calgary

Christopher J. Rudnisky MD, MPH, FRCSC
Department of Ophthalmology
University of Alberta

Edmund A. Ryan MD
Division of Endocrinology
University of Alberta

Peter A. Senior MBBS, PhD. MRCP(UK)
Division of Endocrinology
University of Alberta

Scot H. Simpson BSP, PharmD, MSc.
Faculty of Pharmacy
University of Alberta

Larry W. Svenson BSc.
Surveillance and Assessment Branch
Alberta Health and Wellness

Zhi Tan MSc
Alberta Kidney Disease Network
University of Calgary

Matthew T.S. Tennant BA, MD, FRCSC
Department of Ophthalmology
University of Alberta

Marcello Tonelli MD, SM, FRCP(C)
Division of Nephrology
University of Alberta

Ellen L. Toth MD
Department of Medicine
University of Alberta

Ross T. Tsuyuki BSc(Pharm), PharmD, MSc,
Professor of Medicine (Cardiology),
Director, EPICORE Centre
University of Alberta

# Chapter 1

# Background and Methods

Jeffrey A. Johnson
Stephanie U. Balko
Greg Hugel

# BACKGROUND AND METHODS

The Alberta Diabetes Surveillance System (ADSS) was created in 2006 in partnership with Alberta Health and Wellness (AHW) and the Institute of Health Economics (IHE). The purpose of the ADSS is to provide information about diabetes within the province of Alberta. This information includes the incidence, prevalence and use of health care services for people with diabetes, along with information about their related comorbidities and complications.

Ongoing surveillance of diabetes through the ADSS will, over time, help to inform health professionals, primary care networks, regional health zones and AHW as to whether efforts to reduce the overall burden of diabetes are effective.

The first comprehensive report from the ADSS was the *Alberta Diabetes Atlas* 2007. It contained a broad perspective of the impact that diabetes has on Albertans and on the health care system. To enhance interpretability and usability, trends in diabetes and related conditions were presented over time (1995-2005), across ages and by geographic region. In 2007, nine Alberta health regions existed; however, in 2009, these health regions were combined to form five zones under one provincial health authority, Alberta Health Services (AHS). Geographically, the North zone encompasses the area of Peace Country, Northern Lights and Aspen health regions; Central zone encompasses David Thompson and East Central health regions; and South zone encompasses Chinook and Palliser health regions. The areas for the Calgary and Capital Health regions stayed the same except for renaming them the Calgary and Edmonton zones, respectively. These five zones are still in effect today and are reflected on the provincial map (Figure 1.1) with white lines. The dark lines represent the nine former health regions from before 2009. Information contained in the previous 2009 Atlas and the current *Alberta Diabetes Atlas* 2011 is summarized at the provincial and zone level.

**The *Alberta Diabetes Atlas* 2011 is a standalone report, and trend data should not be directly compared with the previous two editions (2007 and 2009) of the *Alberta Diabetes Atlas*. The numbers and figures will be similar, but direct comparisons cannot be made due to methodological differences in case definitions and revisions to AHW's historical data.**

The content in the second version of the *Alberta Diabetes Atlas* (released in 2009) was an enhancement of the information that was presented in the first edition. For example, epidemiologic and health care utilization trends for children and adolescents were added, as well as trends of health care utilization in the Status Aboriginal population. The "Diabetes and Stroke" chapter had also been expanded to include different types of stroke, such as hemorrhagic and ischemic; and the "Diabetes and Lower Limb Amputations" chapter had also been expanded to include information about foot disease.

The above content will appear updated in this version of the *Alberta Diabetes Atlas* (2011), in addition to the inclusion of two new chapters: "Use of Indicated Laboratory Testing among People with Diabetes" and "Gestational Diabetes".

## BACKGROUND

Diabetes is a chronic disease affecting more than 6% of Canadians over 20 years of age.[1] It is a serious and growing public health concern in Canada, where health care costs of patients with diabetes were projected to be in excess of $6 billion in 2006.[2] Surveillance of diabetes is therefore essential for quantifying the burden of disease and related complications, monitoring resource utilization, developing and evaluating policies and programs, and stimulating research.[3,4]

To that end, the National Diabetes Surveillance System (NDSS) was launched in Canada in 1999 as part of the Canadian Diabetes Strategy. The NDSS model has been now extended to other chronic diseases, referred to as the Canadian Chronic Disease Surveillance System (CCDSS), which utilizes existing provincial and territorial administrative health care data to identify cases of diabetes and other chronic conditions.[1,4-6] Prior to the development of the NDSS, estimates of the diabetes burden in Canada were based upon self-reported diabetes in surveys, hospital and mortality data, or extrapolated from figures within the U.S.[7] The goals of the CCDSS included further development and maintenance of a national, comprehensive, standardized database for diabetes and chronic disease surveillance and provision of population-based information in order to evaluate health care utilization, policy and process.[1,5] While very valuable, the information available from the NDSS/CCDSS is limited when considering local strategies and policy decisions. Provinces such as Alberta are able to produce substantially richer information in a timelier manner with the broad scope of administrative data.

Figure 1.1 **Alberta Health Zones**


In May 2003, AHW announced the Alberta Diabetes Strategy 2003-2013, which has a focus on the primary prevention of type 2 diabetes. Epidemiologic research has shown that key risk factors for type 2 diabetes (e.g. physical inactivity, obesity and dietary factors) may be changed by focusing on healthy living practices, particularly healthy eating and active living. Consequently, primary prevention is the focus and key to reducing the risk of developing type 2 diabetes. Additionally, the Alberta Diabetes Strategy also addresses the challenges faced by those who have already been diagnosed with diabetes. Helping those with diabetes to prevent and reduce serious complications is the focus of the secondary and tertiary prevention components of the Alberta Diabetes Strategy.

## DIABETES

Diabetes mellitus (DM) is a chronic health condition that is associated with increased morbidity and early mortality. Although there are different types of diabetes, administrative data such as those used for the NDSS and ADSS, is presently unable to distinguish between them. It is still important, however, to recognize the different disease processes in order to assess the overall burden.

When someone has diabetes, it means that their body has difficulty making insulin and/or using the insulin that they produce. This is problematic because insulin is required to move glucose into cells so that it can be used by body tissues and organs. When glucose remains in the blood, blood glucose levels can rise to dangerously high levels and result in acute complications. Higher than normal blood glucose levels also can result in long-term organ damage and affect the eyes, kidneys and cardiovascular system.

Type 1 diabetes usually occurs early in life during childhood or adolescence when an organ called the pancreas is unable to produce insulin. This is why individuals with type 1 diabetes need to inject insulin several times a day. Type 1 diabetes accounts for 5% to 10% of all diabetes cases.

Type 2 diabetes is usually associated with onset after 30 to 40 years of age; however, during the past decade, type 2 diabetes has become much more prevalent in younger individuals. This is thought to be associated with lifestyle factors, including physical inactivity and obesity. In type 2 diabetes, the pancreas does not produce enough insulin, or the body does not properly use the insulin it makes. Type 2 diabetes accounts for 90% to 95% of all diabetes cases.

Gestational diabetes (GDM) occurs only in pregnant women. It is a form of glucose intolerance which usually disappears after six weeks postpartum. There is evidence to suggest that women with gestational diabetes are at a higher risk of developing type 2 diabetes later in life. Gestational diabetes should not be confused with women who already have diabetes who become pregnant. The former (women who develop GDM) will be the focus of the new chapter, “Gestational Diabetes”.

Physical activity and a healthy diet are indicated for all individuals with diabetes. As stated above, regular insulin injections are required for people with type 1 diabetes, while those who have type 2 diabetes can sometimes be managed with exercise and diet alone. Depending on the severity of the disease, certain people who have type 2 diabetes may also need oral antidiabetic agents (e.g. pills) or even insulin to better control their blood glucose levels.

## METHODS

The *Alberta Diabetes Atlas* is organized into several main chapters, each focusing on an important aspect of diabetes in Alberta. Each chapter is organized in the same way. A short background is provided, though the focus of each chapter is on the trends over time, age-specific rates and geographical variation. Comments on these trends are provided and key points are highlighted.

Below is a general overview of the methods used in creating the *Alberta Diabetes Atlas*. Specific methods for each of the different topic areas are highlighted in the respective chapters.

### Data Sources

The *Alberta Diabetes Atlas* contains data derived from a single source: the administrative databases of AHW. Publicly funded health insurance systems routinely generate person-specific administrative data every time a diagnosis is made or a procedure is billed to a provincial government. From a health surveillance perspective, the ADSS is able to capitalize on this information in order to report on the burden of diabetes in Alberta. The databases that we use contain de-identified information at the personal level on demographics (e.g. age, sex and Aboriginal status); health care utilization (hospitalizations, physician services and ambulatory care); as well as diagnostic and procedural codes. Trends in diabetes and complications are reported over a 15-year period, from 1995-2009, unless otherwise specified.

The ADSS reports on diabetes and comorbidities and complications by employing data from the following AHW databases:

1. Discharge Abstract Database (hospital morbidity)
2. Alberta Physician Claims Data
3. Ambulatory Care Classification System (includes emergency department encounters)
4. Vital Statistics (including mortality)

### Diabetes Case Definition

In order to identify a case of diabetes from the administrative databases, we applied a modified version of the NDSS algorithm. The current ADSS case definition requires that an individual must have **either:**

- *One hospitalization* with an ICD-9 code of 250 (diabetes mellitus), selected from all available diagnostic codes on the Hospital Discharge Abstract for years 1995-2001, or equivalent ICD-10 codes (E10-14) diabetes for years after 2001-2002;

**or**

- *Two physician claims* with an ICD-9 code of 250 (diabetes mellitus) *within 2 years*, selected from any of the three available diagnostic codes.

The case date is defined as the date of qualifying hospitalization, or the latter of the two physician claims that contribute to the case definition.[1,5] In validation studies, this case definition has been found to have a sensitivity ranging from 69% to 91% when compared with diabetes registries, medical charts, health survey data or drug claim data.[6,8,9] The NDSS case definition has also been validated in individuals aged 20 years and younger and therefore, can be applied across all ages.[10] Therefore, similar to the last version of the *Atlas*, we present diabetes trends for the entire population (for those who are 1 year or older). While we demonstrate that diabetes in children is also increasing, the majority of people with diabetes are still adults. In the previous two *Atlas* versions, we did not exclude women who may have had gestational diabetes, as indicated by codes for pregnancy or obstetric procedures. We included these cases due to the elevated risk of subsequently developing diabetes, thus allowing the ADSS to assess that risk on a population basis in the future. In this version of the *Atlas* however, we have now adopted the NDSS diabetes case definition, which excludes women with gestational diabetes. As there is an algorithm to identify such cases as an exclusion, we have adopted it as the case definition for GDM, and as stated above, we have added a chapter that reports on women who develop gestational diabetes.

## Incidence, Prevalence and Mortality Rates

In order to interpret the results of this *Atlas*, it is important to understand the terms *incidence* and *prevalence*.

**Incidence** is a measure of new diabetes cases arising within a particular timeframe. Therefore, diabetes incidence is the number or the rate of new cases each year in Alberta. To calculate diabetes incidence, the following formula is used:

$$\frac{\text{Total \# of people with a diabetes incident date in the current calendar year}}{\text{(Total population count for current calendar year)} - \text{(Prevalent diabetes cases)} + \text{(Incident diabetes cases)}}$$

It is important to subtract the prevalent or existing diabetes cases from the denominator because those who already have diabetes are not at risk of developing it.

**Prevalence** is the number or rate of diabetes cases existing within a population during a particular time period. Prevalence includes incidence, or in other words, existing cases include new cases. For example, if an individual becomes incident one year, they are also considered prevalent in that year and every subsequent year. The following formula is used to calculate diabetes prevalence:

$$\frac{\text{Total \# of people with diabetes in the current calendar year}}{\text{Total population count for current calendar year}}$$

Estimates of incidence, prevalence and total population counts in Alberta are taken from the mid-year AHW data. The calculated rates are also reported as age- and sex-adjusted to the Alberta population from the 2006 Canadian Census in order to account for differences in population age structure over time.[11]

The *Alberta Diabetes Atlas* also reports on mortality in Alberta. The mortality rates among people with and without diabetes are compared in chapter 2, “Epidemiological Trends of Diabetes in Alberta,” and in chapter 11, “Diabetes and the Status Aboriginal Population in Alberta.” The ratio between the two rates reflects the significance of diabetes mortality in the population in question. The following formula is used to calculate mortality rate:

$$\text{Mortality (with diabetes)} = \frac{\text{Total \# of deaths among people with diabetes during the current calendar year}}{\text{Total \# of people with diabetes during the current calendar year}}$$

$$\text{Mortality (without diabetes)} = \frac{\text{Total \# of deaths among people without diabetes during the current calendar year}}{\text{Total \# of people without diabetes during the current calendar year}}$$

$$\text{Mortality rate ratio} = \frac{\text{Mortality rate among persons with diabetes}}{\text{Mortality rate among persons without diabetes}}$$

## Health Care Utilization

It is intuitive that individuals who are sicker consume more health care resources. This is the case in people with diabetes due to the amount of complications and comorbidities they suffer.[12,13] Use of physician services in the community, and admissions to the emergency department and hospital, are reported for people with and without diabetes.

## Diabetes and Laboratory Data

Regular monitoring of several laboratory tests is an important aspect of care for people with diabetes. Clinical practice guidelines identify specific targets for these laboratory parameters. In particular, the measurement of three specific laboratory tests; glycosylated hemoglobin (A1C), low-density lipoprotein (LDL), and urine albumin to creatinine ratio (ACR), are important in the prevention and management of complications associated with diabetes. [14] In people with diabetes, frequency of laboratory testing and the actual laboratory values are reported in the new chapter, “Use of Indicated Laboratory Testing among People with Diabetes”.

## Diabetes Complications and Comorbidities

Higher or lower than normal blood glucose levels are associated with acute complications of diabetes that can be life-threatening. Mild lows can be treated by taking some sugar or juice. More severe blood sugar lows or highs may require medication or use of emergency services.

In addition to these acute complications, chronic complications tend to occur over time and are responsible for the majority of the morbidity and mortality for people with diabetes. Chronic complications that can occur include blindness and other forms of eye disease, cardiovascular disease, kidney problems and nerve damage. Furthermore, the impact of chronic medical conditions, such as diabetes on mental health, is becoming increasingly recognized.

The *Alberta Diabetes Atlas 2011* contains chapters on these important complications and comorbidities associated with diabetes. For each specific topic, rates will be compared in people with diabetes and people without diabetes. As with the case definition for diabetes itself, case definitions for the specific complications and comorbidities are based on diagnostic or procedural codes contained in the administrative databases. The specific case definitions for these are identified and listed in the appendix of each relevant chapter.

### Diabetes and the Status Aboriginal Population

The epidemiology of diabetes in the Status Aboriginal population is considerably different from the general population in Canada.[15] In addition, mortality rates are higher and diabetes complications are more common among Status Aboriginals. The ongoing surveillance of diabetes in the Status Aboriginal population is an important part of the ADSS. We report on the incidence, prevalence and age-specific trends of diabetes in the Status Aboriginal population compared to the general population of Alberta with and without diabetes. We also report on the under-20-year-old Status Aboriginal population, as well as on health care utilization.

## SUMMARY

Clearly, diabetes is a significant and contemporary health concern that will continue to have an increasing impact on provincial and federal health care systems and on the health of all Canadians. The ADSS is a key component of the Alberta Diabetes Strategy, which is aimed at reducing the burden of diabetes for Albertans. This *Alberta Diabetes Atlas* provides a broad perspective of the burden that diabetes has on Alberta.

## References

1. Public Health Agency of Canada. Report from the National Diabetes Surveillance System: Diabetes in Canada, 2009. [cited 2011 August 9]. Available from: http://www.phac-aspc.gc.ca/publicat/2009/ndssdic-snsddac-09/index-eng.php.
2. Ohinmaa A, Jacobs P, Simpson SH, Johnson JA. The projection of prevalence and cost of diabetes in Canada: 2000 to 2016. Can J Diabetes 2004;28:116-23.
3. Safran MA, Vinicor F. The war against diabetes. How will we know if we are winning? Diabetes Care 1999;22:508-516.
4. Saydah SH, Geiss LS, Tierney E, Benjamin SM, Engelgau M, Brancati F. Review of the performance of methods to identify diabetes cases among vital statistics, administrative, and survey data. Ann Epidemiol 2004;14:507-516.
5. Health Canada. Responding to the challenge of diabetes in Canada. First report of the National Diabetes Surveillance System. Health Canada; 2003.
6. Hux JE, Ivis F, Flintoft V, Bica A. Diabetes in Ontario: determination of prevalence and incidence using a validated administrative data algorithm. Diabetes Care 2002;25:512-16.
7. Clottey C, Mo F, LeBrun B, Mickelson P, Niles J, Robbins G. The development of the National Diabetes Surveillance System in Canada. Chronic Dis Can 2001;22:67-9.
8. LeBlanc J, Kephart G. Assessment of the sensitivity and specificity of Nova Scotia administrative databases for detecting diabetes mellitus. Report to NDSS Validation Working Group. Halifax: Population Health Research Unit;1998.
9. Van Til, L. Report to NDSS Validation Working Group. Charlottetown: Document Publishing Center; 2001.
10. Guttman A, Nakhla M, Henderson M, To T, Daneman D, Cauch-Dudek K, Wang X, Lam K, Hux J. Validation of a health administrative data algorithm for assessing the epidemiology of diabetes in Canadian children. Pediatr Diabetes. 2009 Jun 5 [Epub ahead of print].
11. Statistics Canada. Age and sex for population, for Canada, provinces, territories, census metropolitan areas and census agglomerations. 2001 Census. 2007. Accessed Catalog Number: 95F0300XCB2001004.
12. Hux JE, Booth GL, Slaughter PM, Laupacis A, editors. Diabetes in Ontario: An ICES Practice Atlas: Institute for Clinical Evaluative Sciences. 2003.
13. Simpson SH, Corabian P, Jacobs P, Johnson JA. The cost of major comorbidity in people with diabetes mellitus. CMAJ 2003;168:1661-7.
14. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2008 clinical practice guidelines for the prevention and management of diabetes in Canada. Canadian Journal of Diabetes 2008;32(Suppl 1):S1-S201.
15. Oster RT, Johnson JA, Hemmelgarn BR, King M, Balko SU, Svenson LW, Crowshoe L, Toth EL. Recent epidemiologic trends of diabetes mellitus among status Aboriginal adults. CMAJ. 2011 July 25 [Epub ahead of print].

# Chapter 2

# Epidemiological Trends of Diabetes in Alberta

Jeffrey A. Johnson
Stephanie U. Balko

# EPIDEMIOLOGICAL TRENDS OF DIABETES IN ALBERTA

## KEY MESSAGES

- Diabetes is a large and growing health problem for Albertans.
- In 2009, there were nearly 206,000 people living with diabetes in Alberta, 2.5 times more people compared to 15 years ago.
- There were about 19,300 new cases of diabetes identified in Alberta in 2009.
- Males have higher rates of diabetes incidence and prevalence compared to females across older age groups.
- People with diabetes are about twice as likely to die each year compared to people without diabetes.
- Diabetes is most prevalent in the aging population, who tend to have additional health problems that subsequently increase the burden on Alberta's health care system.
- The North, Edmonton and South zones have the highest age-adjusted prevalence of diabetes, while the Calgary and Central zones are below the provincial rate.
- The Calgary and Central zones have a lower age-adjusted incidence of diabetes compared to the rest of the province.

## BACKGROUND

According to the National Diabetes Surveillance System (NDSS), between 2005-2006 approximately 1.9 million Canadian men and women had been diagnosed with diabetes. This represents about 1 in 17 Canadians, or 5.5% of all women and 6.2% of all men.(1) This year, the number of Canadians diagnosed with diabetes is expected to be about 2.6 million, which is an average annual percent increase of almost 7% and an increase of about 33% from 2006.(2) The prevalence of type 2 diabetes is also increasing worldwide. In the United States, the age-adjusted prevalence of known diabetes increased from 2.8% in 1980 to 5.3% in 2005.(3) Canadian adults with diabetes are twice as likely to die prematurely than those without diabetes and are also more likely to be afflicted with other health problems (see other *Atlas* chapters).(4) These figures are staggering, and as we report here, these trends are all too similar while observing the story of diabetes in Alberta.

This chapter will examine incidence, prevalence and mortality of those with diabetes in Alberta, from 1995-2009. Results will be presented as crude rates, that is, the actual counts and rates on a population basis, as well as age-adjusted rates for the purpose of comparison. Rates will also be presented by health zone in order to establish a geographic representation of diabetes across Alberta. We report on the entire population ages 1 year and over. More detail about the under-20-year-old population can be found in the "Diabetes in Children and Adolescents" chapter. These general epidemiological trends of diabetes serve as a starting point when trying to assess the burden of diabetes in Alberta.

## METHODS

In order to interpret the results of this report it is important to understand the terms *incidence* and *prevalence*. These concepts along with their formulas are covered in more depth in the "Background and Methods" chapter of this *Atlas*.

Incidence is a measure of new cases arising within a particular timeframe. Therefore, diabetes incidence is the number of new cases in Alberta each year. The incidence rate is the number of new cases of diabetes relative to the total population at risk in each calendar year.

Prevalence is the number of cases existing within a population at any point in time. Diabetes prevalence includes new and existing cases in Alberta for each calendar year. For example, if an individual becomes incident one year, they are also considered prevalent in that year and every subsequent year.

Diabetes incidence and prevalence rates are estimated based on the total population counts for Albertans registered with Alberta Health and Wellness (AHW) as of June 30th in each year.

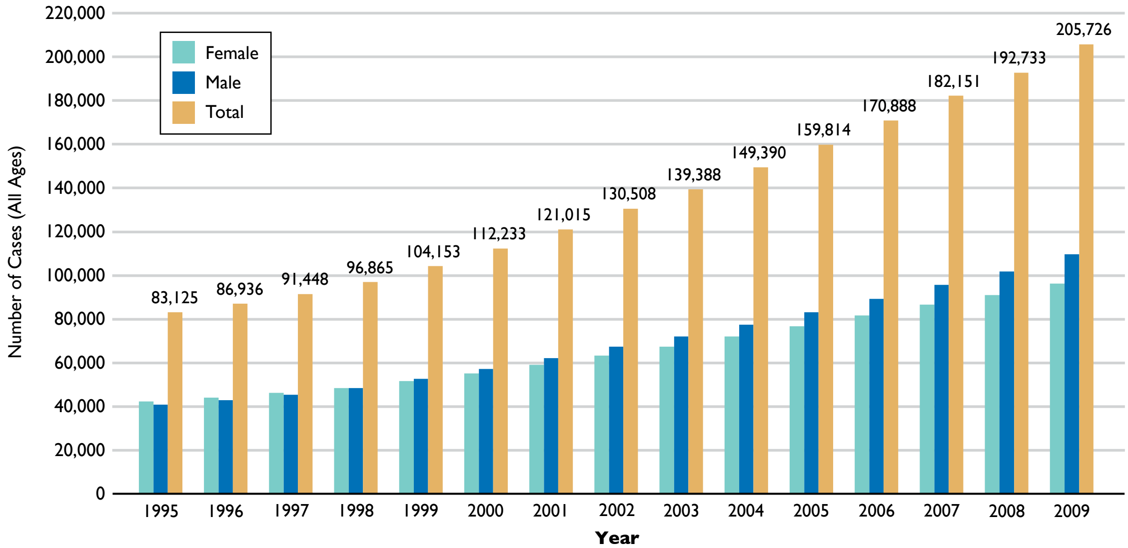
The calculated rates are also reported as age-adjusted in order to account for differences in population age structure across health zones over time. We used a method of direct standardization,[5] using the 2006 Canadian Census for Alberta as the reference population.[6]

Mortality is reported as the proportion of people who die each year, and is compared between people with and without diabetes. Because of the small number of deaths in children and adolescents (i.e. the population aged 1-19 years), we have only reported mortality rates for adults 20 years of age and older.

## PREVALENCE

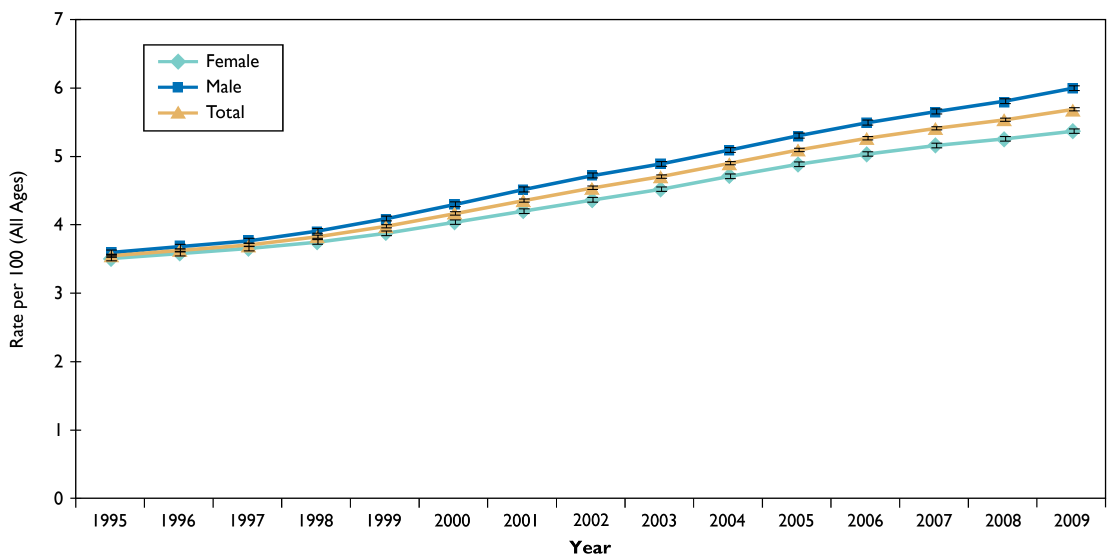
Nearly 206,000 individuals were living with diabetes in Alberta in 2009, a number that has more than doubled over the last fifteen years (Figure 2.1). Diabetes was slightly more prevalent in women up to about 1998, when it became more prevalent in men, most obviously in the last few years.

Figure 2.1 **Prevalent Diabetes Cases, 1995-2009**



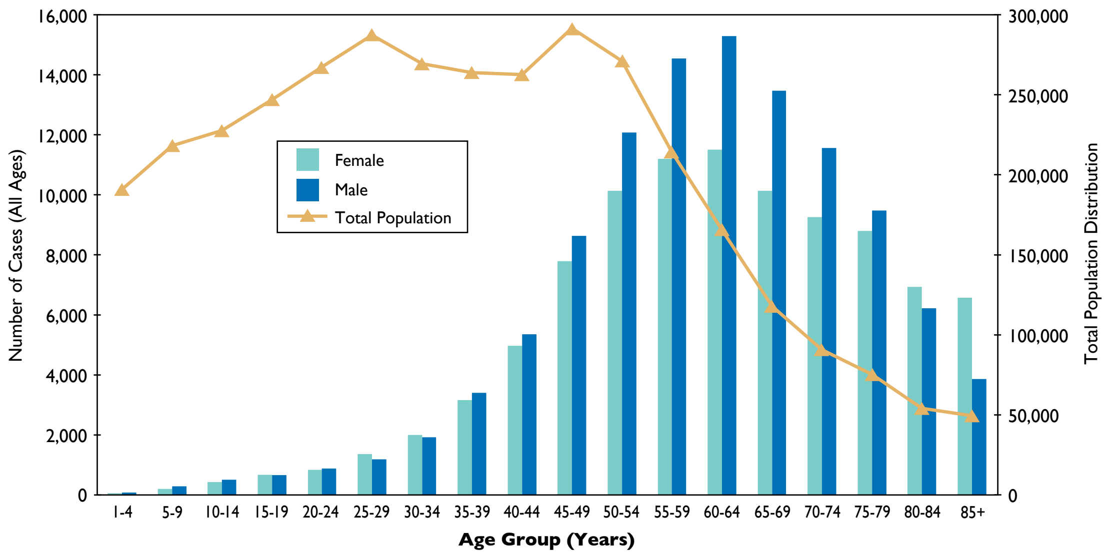

The prevalence of diabetes has been steadily increasing in both men and women over the past decade. In 2009, the age-adjusted prevalence of diabetes in Alberta was 5.7%. Men have a slightly higher prevalence than women. Over the 1995-2009 period, the male age-adjusted rate increased by 67% overall, while the female rate increased by 53% (Figure 2.2).

Figure 2.2 **Age-Adjusted Diabetes Prevalence Rates, 1995-2009**



Due to the chronic nature of diabetes, the number of cases increases as people become older, peaking in the age group 60-64 for men and women (Figure 2.3). When people with diabetes become older than 64 years, the prevalence remains high, but begins to decrease, presumably as people die.

Figure 2.3 **Age Distribution of Prevalent Diabetes Cases, 2009**




Male cases outnumber female cases beginning in the age group 35-39 years until the age group 75-79. From age groups 80 and older, diabetes is more prevalent in female cases, perhaps due to women having longer life expectancies. Women also have a higher prevalence of diabetes in the younger ages, most notably in the 25-29 and 30-34 year age groups. This is due, in part, to the risk of gestational diabetes during women's childbearing years. Although our diabetes case definition now excludes cases of gestational diabetes, it is possible that some cases are still being included, thus inflating the numbers. The higher prevalence of diabetes in women in these age groups may also be due to increased screening for diabetes during pregnancies in these child-bearing years, and in addition, women who develop gestational diabetes are at increased risk of subsequently developing type 2 diabetes.[4]

Although the fewest cases of diabetes can be found in the under-20-year-old population, these numbers are also increasing over time (see "Diabetes in Children and Adolescents," chapter 3).

Diabetes prevalence rates increase with age in both sexes, rising considerably after ages 45-49 (Figure 2.4). Diabetes prevalence is similar in younger age groups, but is higher in men over 50 years old. The highest prevalence rates can be found in the age group 80-84, where women have a 22.2% prevalence and men have a 27.2% prevalence.

Figure 2.4 **Age-Specific Diabetes Prevalence Rates, 2009**

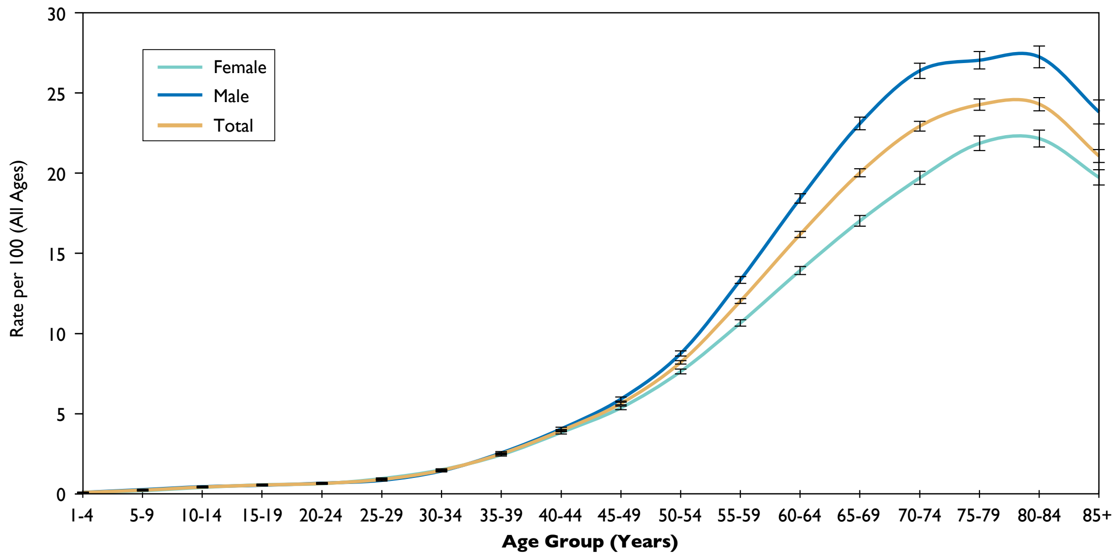
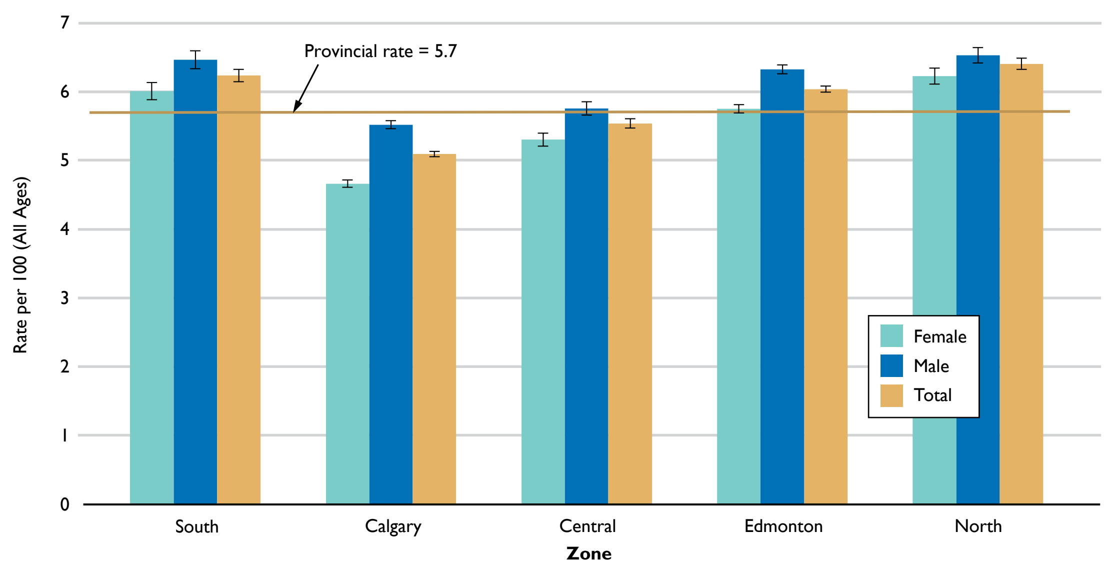
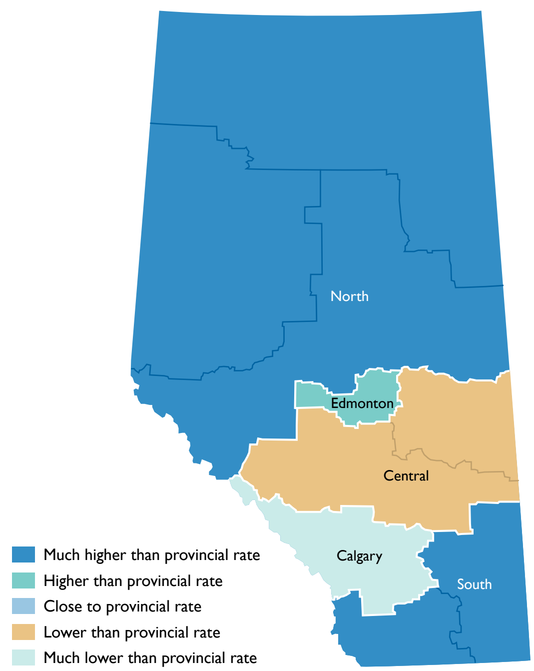



Figure 2.5 **Age-Adjusted Diabetes Prevalence Rates by Zone, 2009**



The age-adjusted prevalence of diabetes varies across the province. The prevalence rates for the North, Edmonton and South zones are the highest in the province and higher than the provincial rate of 5.7% (Figure 2.5 and 2.6). This is in contrast to the Central zone and Calgary zone, which have prevalence rates lower than the provincial prevalence rate. Men had a higher prevalence of diabetes than women in all heath zones (Figure 2.5).

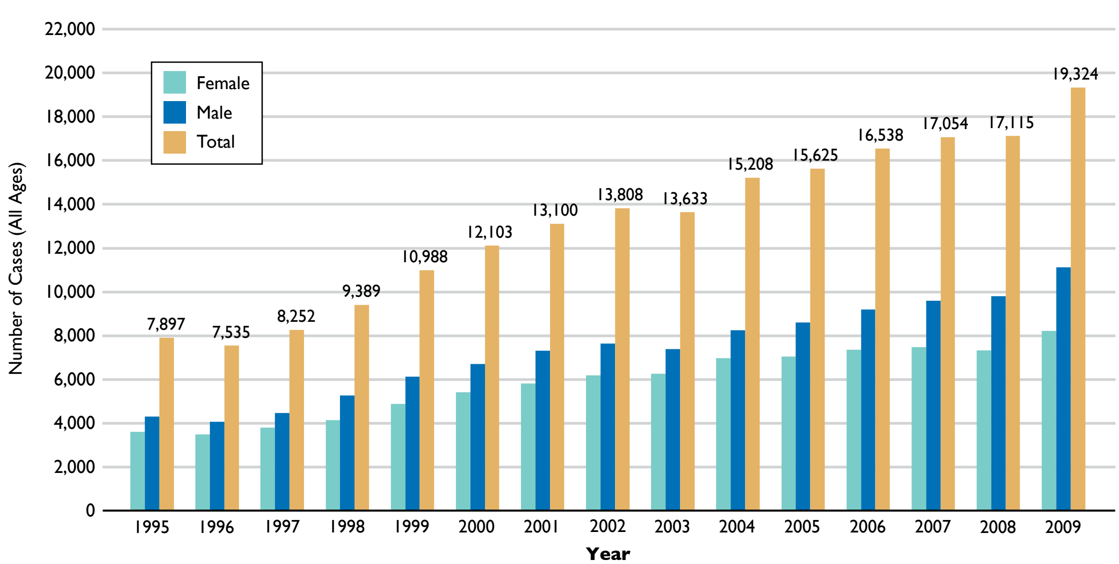
Figure 2.6 **Age-Adjusted Diabetes Prevalence Rates for All Ages by Zone, 2009**




## INCIDENCE

During the time period 1995-2009, there were 197,569 new cases of diabetes identified in Alberta (Figure 2.7). The number of diabetes cases identified in 2009 (n = 19,324) was more than double that of the new cases identified in 1995 (n = 7,897).

Figure 2.7 **Incident Diabetes Cases, 1995-2009**



After adjusting for age, the incidence of diabetes appears to be increasing steadily over the past decade, with more new cases being diagnosed in men compared to women across the years (Figure 2.8).

Figure 2.8 **Age-Adjusted Diabetes Incidence Rates, 1995-2009**

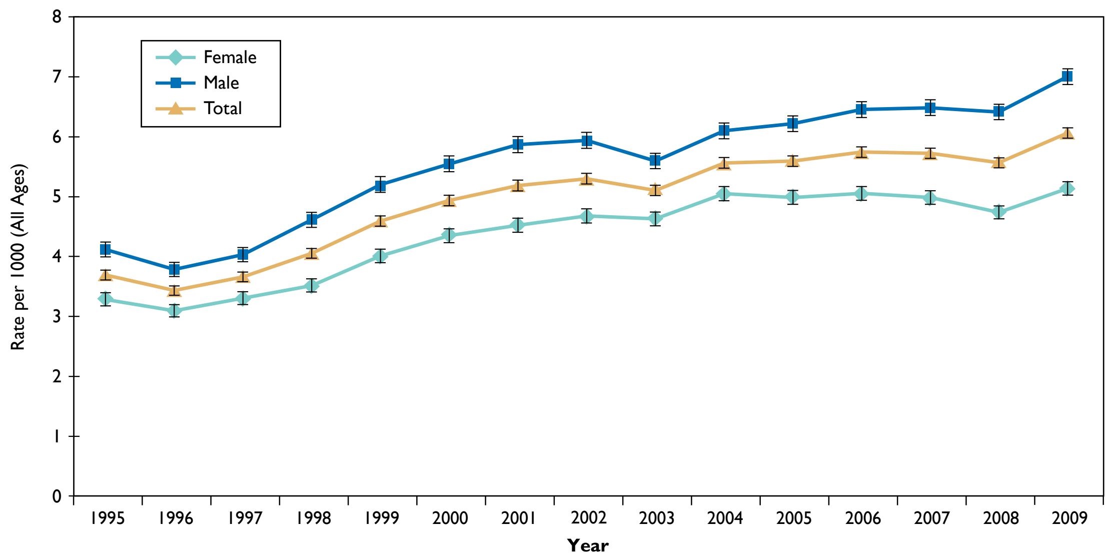



Figure 2.9 **Age-Specific Diabetes Incidence Rates, 2009**

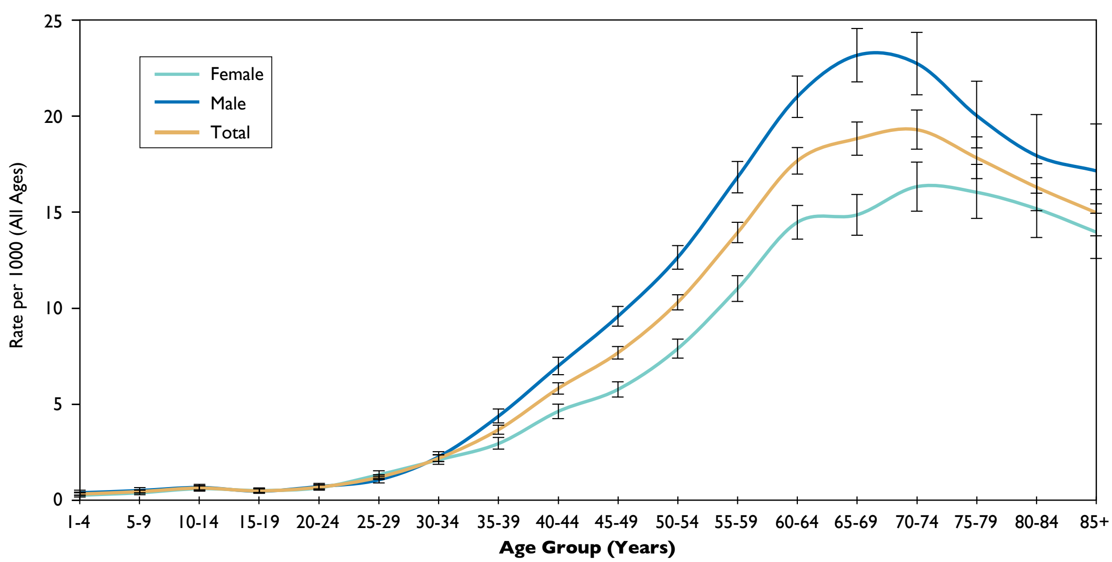
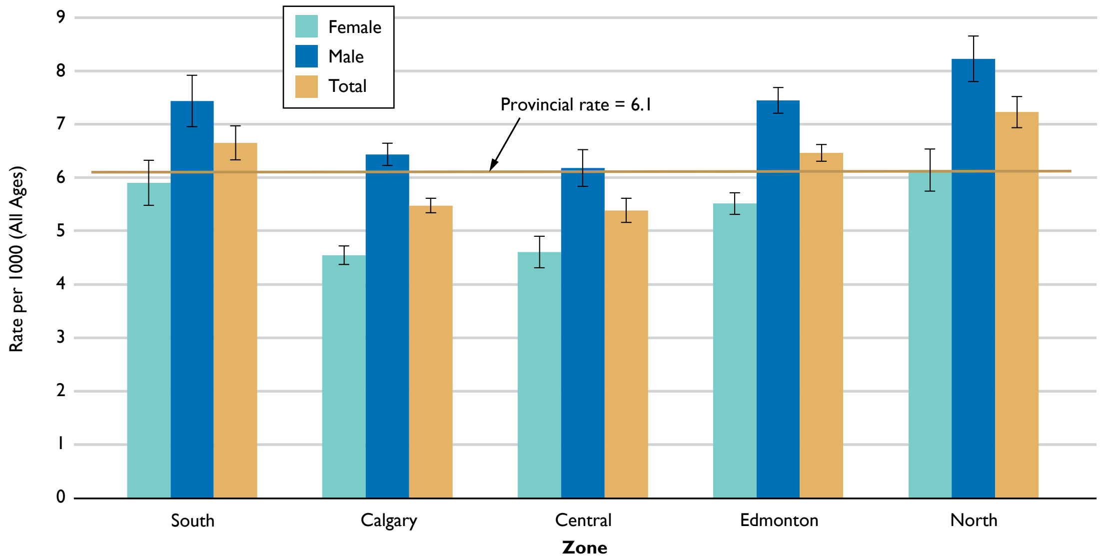


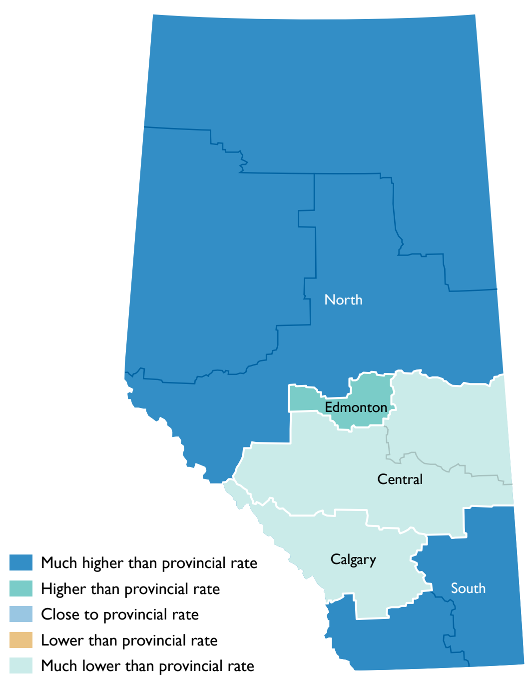
Figure 2.10 **Age-Adjusted Diabetes Incidence Rates by Zone, 2009**




Diabetes incidence increases with age until 65-69 years in men and 70-74 years in women, after which it decreases (Figure 2.9). Women aged 25-29 years have greater incidence rates compared to men, likely due to the risk of gestational diabetes in the childbearing years. However, males have higher diabetes incidence rates compared to females across all ages beginning at 30-34 years until 85-plus years. The lowest rates of incidence can be found in the under-20-year-old population, where there do not seem to be noticeable differences between girls and boys. For more information on diabetes incidence in children and adolescents, see chapter 3.

As with prevalence, age-adjusted diabetes incidence varies across the province (Figure 2.10 and 2.11). As opposed to the rest of the province, the incidence of diabetes in the Calgary and Central zones are much lower than the provincial rate. Men have a greater rate of diabetes incidence than women across all zones in Alberta.

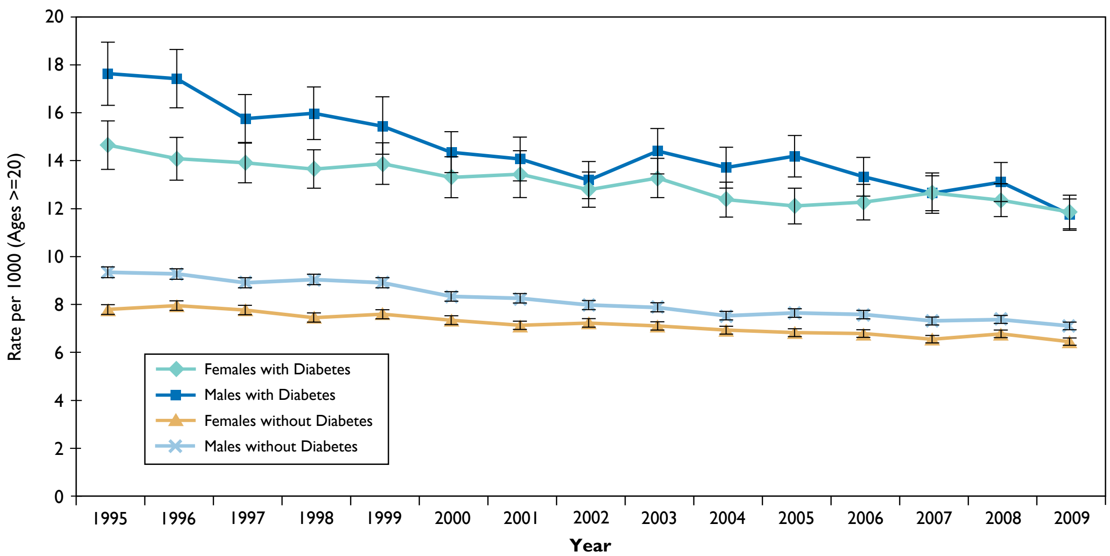
Figure 2.11 **Age-Adjusted Diabetes Incidence Rates for All Ages by Zone, 2009**



## MORTALITY

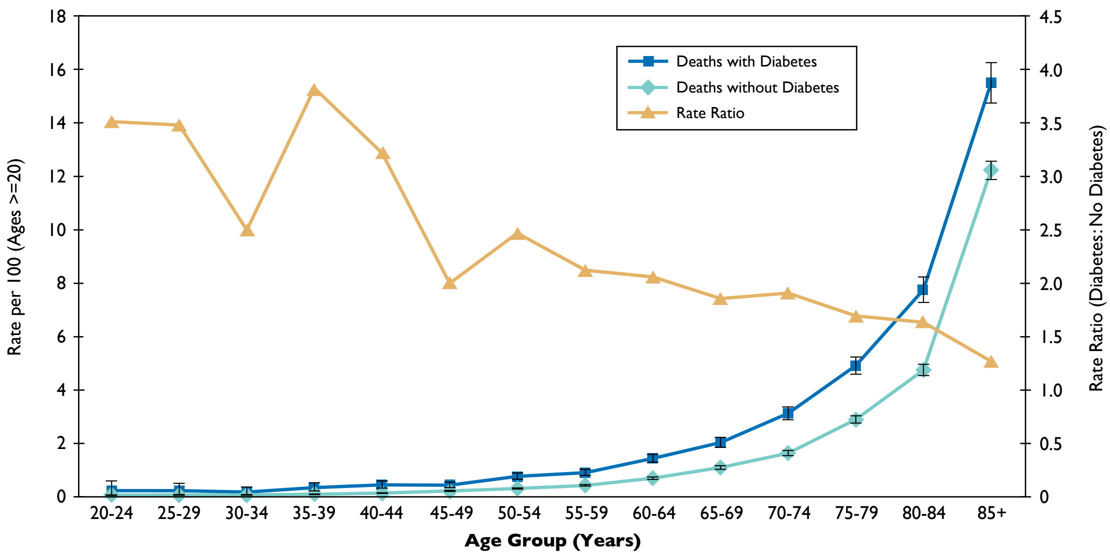
Mortality rates among people with diabetes are higher than mortality rates among people without diabetes. The ratio between the two rates reflects the significance of diabetes on overall mortality. As previously noted, only mortality rates in the adult population were calculated due to the small number of events in the under-20-year-old population.

Figure 2.12 **Age-Adjusted Mortality Rates, 1995-2009**




It is apparent that those who have diabetes have much higher mortality rates than those without diabetes, regardless of sex (Figure 2.12). In the past 15 years, the overall mortality rates have declined in the population, but have consistently been almost twice as high in the diabetic population compared to those without diabetes. Differences between mortality rates in men and women in both populations have narrowed over the past 15 years. Women with diabetes actually had higher mortality rates compared to men with diabetes in 2007 and 2009. The mortality rate-ratio is also decreasing over time. For example, in 1995, men with diabetes had mortality rates almost 2.0 times higher than men without diabetes, but, in 2009, men with diabetes had mortality rates that were only 1.7 times higher than their non-diabetic counterparts. This finding is also found in women; however, it is less dramatic (a ratio of 1.9 in 1995 versus 1.8 in 2009).

Figure 2.13 **Age-Specific Mortality Rates, 2009**




Mortality rates for those who have diabetes are consistently higher at all ages compared to mortality rates for those who do not have diabetes (Figure 2.13). The mortality rate ratio demonstrates that younger people with diabetes have a much higher risk of dying compared to older individuals who have diabetes, both compared to their non-diabetic counterparts. In fact, individuals with diabetes between the ages of 20-39 years died at rates that are 2.5 to almost 4 times higher compared to those without diabetes in 2009. This is not quite as dramatic as an NDSS report where younger adults aged 20-44 with diabetes died at rates that were 4 to 6 times higher than those without diabetes in 2005-2006.[2] Reduction in the relative risk of death as the population ages is due to increasing mortality rates with increasing age for all adults, and competing causes of death in the older ages regardless of diabetes status.

## DISCUSSION

The observed diabetes trends in the Alberta population are similar to trends in the rest of Canada,[2] the US[3] and the rest of the world.[7] This confirms that diabetes is a large and growing health problem for Alberta.

Of particular note is the more than doubling of the number of people living with diabetes in Alberta over the past 15 years of observation. While people with diabetes are still almost 2 times more likely to die than people without diabetes, the mortality rates over the period of observation have declined, which is encouraging. This trend is likely due to fewer heart attacks and strokes for people with diabetes, which has also been seen in other parts of Canada.[8] The troubling news is that while the heart attack and stroke rates have declined, the actual number of heart attacks and strokes are increasing as the number of people with diabetes grows (See “Diabetes and Cardiovascular Disease” chapter).

While the information presented in the *Alberta Diabetes Atlas* provides a valuable representation of the burden of diabetes in our province, we recognize that there are several important limitations in using the administrative data from AHW. We have used a case definition to identify people with diabetes that requires individuals to have been diagnosed with diabetes by a physician, or be admitted to hospital with a diabetes code. It is well recognized that many people who have diabetes are not yet diagnosed.[9] Further, there are likely some individuals who have been diagnosed with diabetes and are relatively healthy who have not seen a physician frequently enough to qualify as a diabetes case under the current definition.[10] Because of these limitations, it is thought that the ADSS generally underestimates the true burden of diabetes on a population basis.

Nonetheless, in applying the case definition in a consistent way across the time period, we can be confident that we are observing the true trends of the epidemiology of diabetes in Alberta. Surveillance systems such as the Alberta Diabetes Surveillance System (ADSS) are intended to provide a broad, population-based perspective and guide further detailed surveillance where data anomalies or interesting patterns can be explored in greater detail.

Surveillance of a chronic disease such as diabetes is an ongoing process with a focus to improve effective and efficient policy planning.[11] Presenting the number of cases with diabetes over the past 15 years also provides us with a hint of what we can expect for the future. Without tremendous effort by our social and public health care systems, it is entirely likely that the upward trends in both incidence and prevalence of diabetes will continue for the next decade. Like the rest of Canada and the world, the prevalence of diabetes in Alberta could more than double again in the next 5 to 6 years.

## CONCLUSION

Information such as the trends presented here should be viewed as a call to action. Provincial and health zone decision-makers will find this information useful in the consideration and evaluation of efforts to curb the burden of diabetes. Information available in future versions of the *Alberta Diabetes Atlas* will tell us how well we are doing in achieving that goal.

## References

1. Public Health Agency of Canada. Report from the National Diabetes Surveillance System: Diabetes in Canada, 2008. 2009 [cited 2009 March 19]. Available from: http://www.phac-aspc.gc.ca/publicat/2008/ndssdic-snsddac-08/pwdd-iadd-eng.php?option.
2. Health Canada. 2nd report on the National Diabetes Surveillance System. Ottawa: Health Canada; 2007.
3. Center for Disease Control and Prevention. Crude and age-adjusted prevalence of diagnosed diabetes per 100 population. 2006 [cited 2009 March 25]. Available from: http://www.cdc.gov/diabetes/statistics/prev/national/figage.htm.
4. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2008 clinical practice guidelines for the prevention and management of diabetes in Canada. Can J Diabetes 2008;32(suppl 1):S1-S201.
5. Hennekens CH, Buring JE, Mayrent SL, editors. Epidemiology in Medicine. 1st ed. Boston: Little, Brown; 1987.
6. Statistic Canada. Age (122) and sex (3) for population, for Canada, provinces, territories, census metropolitan areas and census agglomerations. 2001 Census. 2002 [cited 2009 March 17]. Available from: http://www12.statcan.ca/english/census01/products/standard/themes/RetrieveProductTable.cfm?.
7. Roglic G, Unwin N, Bennett P, Mathers C, Tuomilehto J, Nag S, et al. The burden of mortality attributable to diabetes: realistic estimates for the year 2000. Diabetes Care 2005;28(9):2130-5.
8. Booth GL, Kapral MK, Fung K, Tu JV. Recent trends in cardiovascular complications among men and women with and without diabetes. Diabetes Care 2006;29(1):32-7.
9. Young TK, Mustard CA. Undiagnosed diabetes: does it matter? CMAJ 2001;164(1):24-8.
10. Harris MI, Flegal KM, Cowie CC, Eberhardt MS, Goldstein DE, Little RR, et al. Prevalence of diabetes, impaired fasting glucose, and impaired glucose tolerance in U.S. adults. The Third National Health and Nutrition Examination Survey, 1988-1994. Diabetes Care 1998;21(4):518-24.
11. Solomon P, Isham V. Disease surveillance and data collection issues in epidemic modelling. Stat Methods Med Res 2000;9(3):259-77.

Chapter 3

# Diabetes in Children and Adolescents

Jeffrey A. Johnson
Robert M. Couch
Seth D. Marks
Danièle Pacaud

# DIABETES IN CHILDREN AND ADOLESCENTS

## KEY MESSAGES

- Diabetes is a growing health issue for children and adolescents in Alberta.
- In 2009, there were nearly 3,000 children and adolescents living with diabetes in Alberta.
- Over 400 new cases of diabetes were identified in the under-20-year-old population in 2009.

## BACKGROUND

Within the last couple of years, the National Diabetes Surveillance System (NDSS) has adopted their adult diabetes case definition for the under-20-year-old population. Similarly, we have applied this definition to the under-20-year-old population to expand our surveillance methods. In this chapter, we will look at prevalence and incidence trends of diabetes among the under-20-year-old population in Alberta between 1995-2009.

While the majority of diabetes cases occur among adults, the prevalence and incidence of diabetes among children and adolescents are on the rise. In the adult population, type 1 diabetes accounts for approximately 5% to 10% of all cases.(1) In children and adolescents, however, type 1 has traditionally been the main form of the disease.(2) Furthermore, in children under the age of 10, type 1 diabetes is almost always observed.(2) As a result, the majority of the research and literature addressing diabetes in children and adolescents has focused on type 1. That said, increasing diagnoses of type 2 diabetes have also been reported in the younger population.(3) This trend parallels the increasing prevalence of childhood overweight and obesity worldwide.(4)

While national estimates of diabetes incidence for children and adolescents are not currently available, past estimates for Alberta have ranged from 20.6 to 23.3 per 100,000/year.(5) These estimates put our population near the higher end of the global scale, below countries such as Finland and the United Kingdom.(5)

## METHODS

Children and adolescents with diabetes were identified within Alberta Health and Wellness (AHW) administrative databases by applying a modified version of the NDSS algorithm (see "Background and Methods" chapter). Unfortunately, this definition does not allow us to distinguish between type 1 or type 2 diabetes.

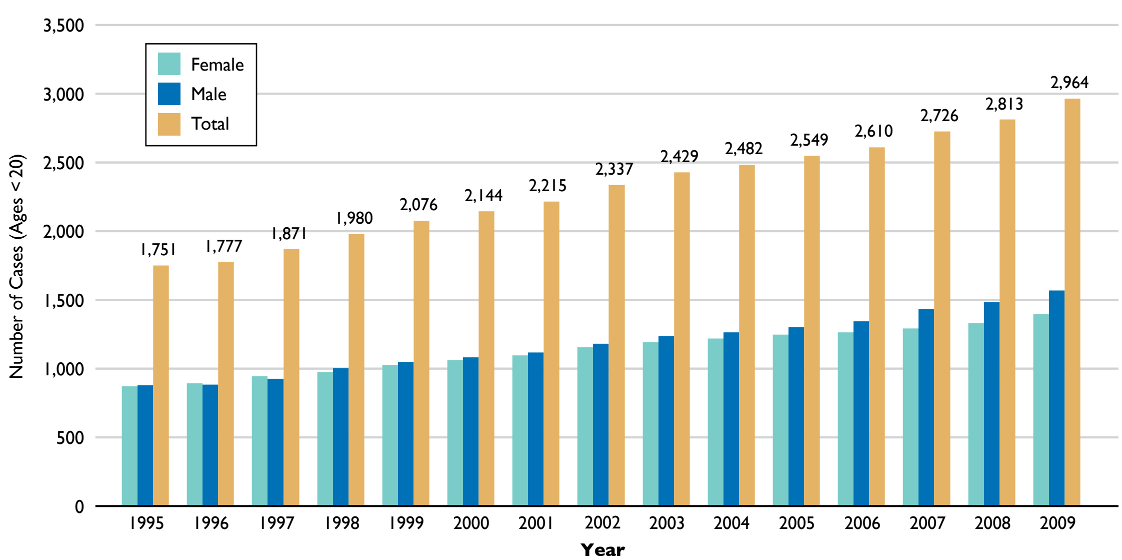
We have identified cases as children or adolescents if they were aged less than 20 years old as of June 30th in the respective year. Therefore, throughout the *Atlas*, the terms "children and adolescents" and "under-20-year-old population" will be used interchangeably.

In order to calculate the age-specific rates, the number of cases in each age group was divided by the estimated number of children and adolescents in the province in that age group registered with AHW as of June 30th each year. For these analyses, we have separated the under-20-year-old cases into 4-year age groups, consistent with groupings used by pediatric endocrinologists in the province: ages 1-4, 5-9, 10-14 and 15-19 years.

## PREVALENCE

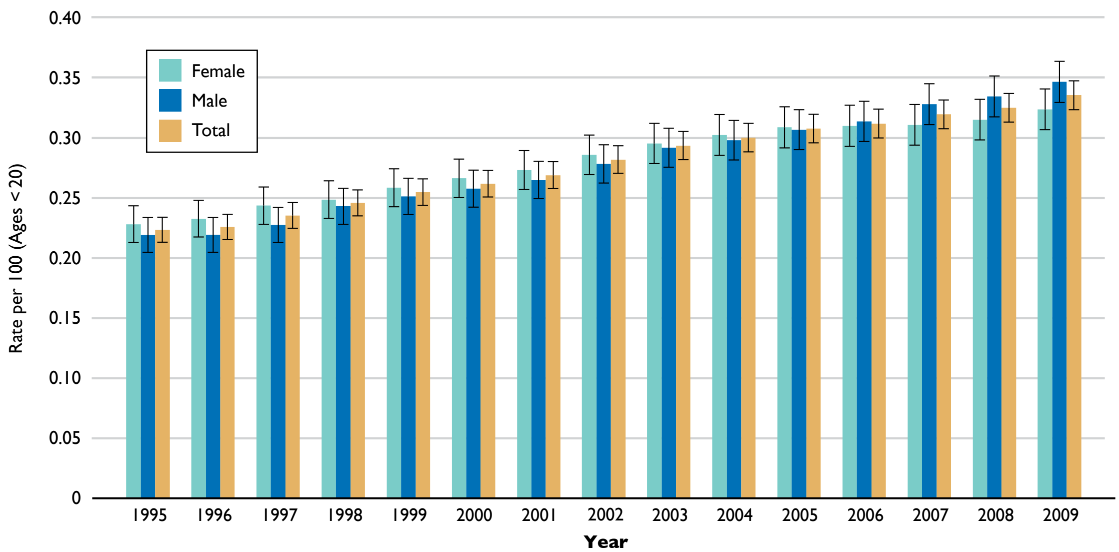
In 2009, approximately 3,000 children and adolescents were living with diabetes in Alberta. This represents over 1,200 more cases than 15 years earlier (Figure 3.1). Over this time period, the number of males with diabetes compared to females was very similar. In recent years, the proportion of prevalent cases that are males has increased slightly relative to females.

Figure 3.1 **Prevalent Diabetes Cases, 1995-2009**



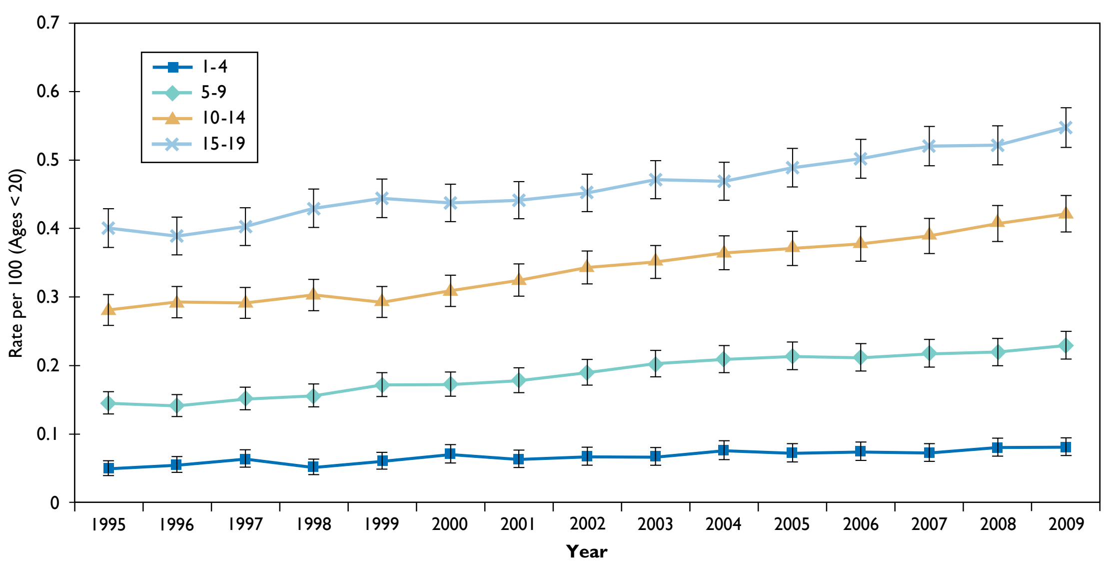
Between 1995-2009, the prevalence of diabetes in children and adolescents increased by 50%, from 0.22 to 0.34 per 100 (Figure 3.2). This increase was observed for both sexes, but was larger in males than in females (58% and 42% respectively).

Figure 3.2 **Crude Diabetes Prevalence Rates, 1995-2009**




The age-specific trends for diabetes in the under-20-year-old population show a steady increase in the prevalence of diabetes for all age groups (Figure 3.3). The largest increase in prevalence was observed in the youngest age group (1-4 year olds), where the estimated rate increased from 0.05 to 0.08 per 100. The prevalence rates increased by approximately 59%, 50% and 37% in the 5-9, 10-14 and 15-19-year-old age groups, respectively. Overall, the prevalence rates increased with age, with the highest rates observed in the 15-19 age group.

Figure 3.3 **Age-Specific Diabetes Prevalence Rates, 1995-2009**



The prevalence of diabetes in the under-20-year-old population is highest in the Central zone (Figures 3.4 and 3.5). Males had a higher prevalence rate in all zones except for the South zone. Because the numbers of new cases of diabetes in children and adolescents is relatively small, we are unable to present separate estimates of diabetes incidence by the health zones.

Figure 3.4 **Crude Diabetes Prevalence Rates for Children and Adolescents by Zone, 2009**

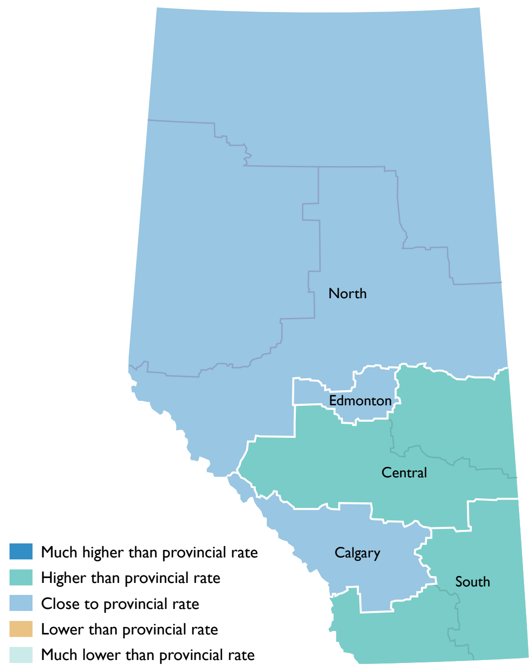
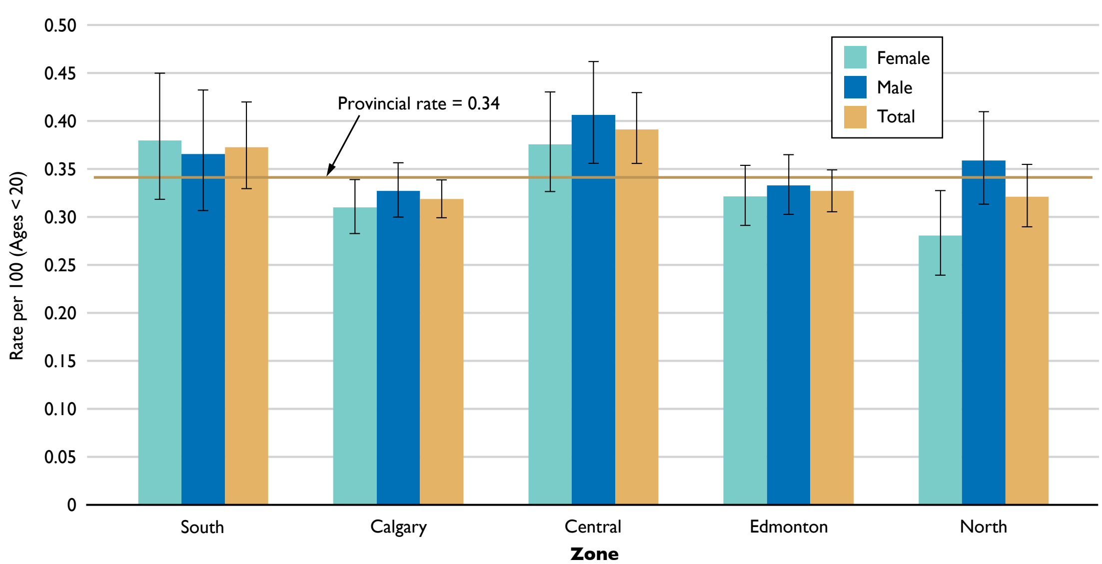


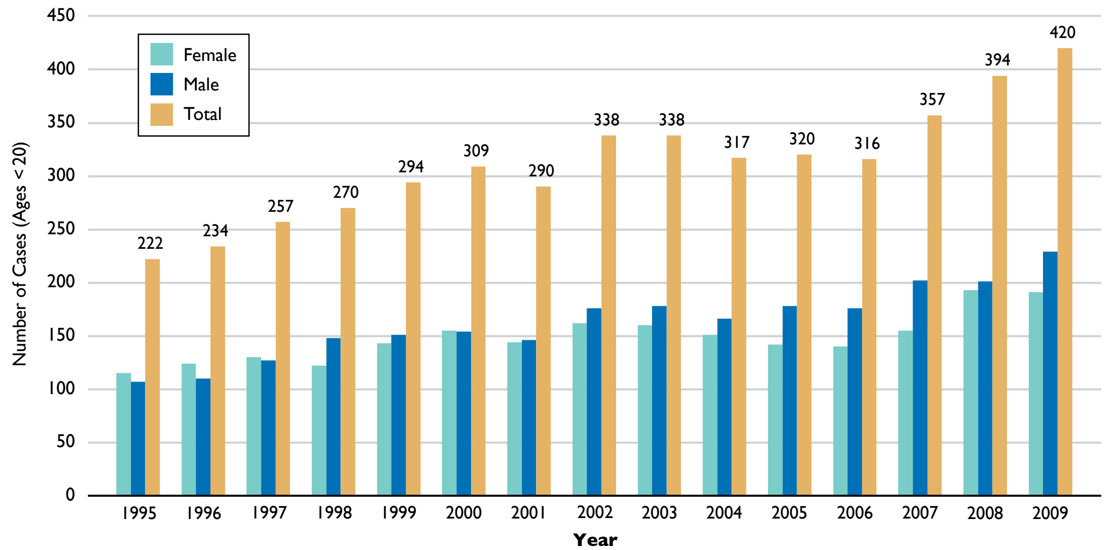

Figure 3.5 **Crude Diabetes Prevalence Rates by Zone, 2009**



## INCIDENCE

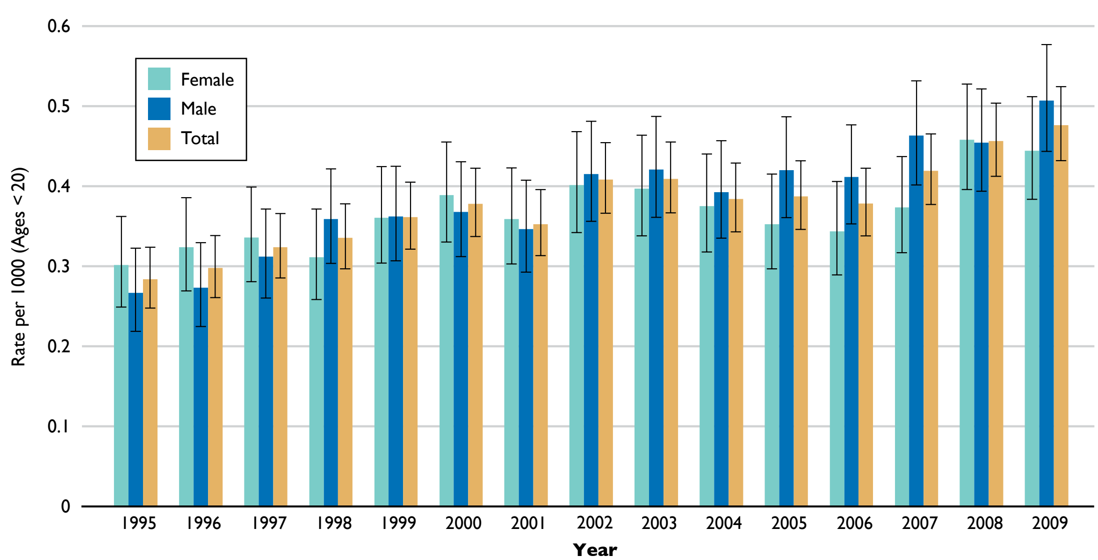
The number of incident diabetes cases in the under-20-year-old population increased by almost 90% between 1995-2009 in Alberta (Figure 3.6). This increase was modest up until 2006, but 2007 saw a much higher case count of 357 newly identified children and adolescents with diabetes which reached 420 cases by the year 2009.

Figure 3.6 **Incident Diabetes Cases, 1995-2009**



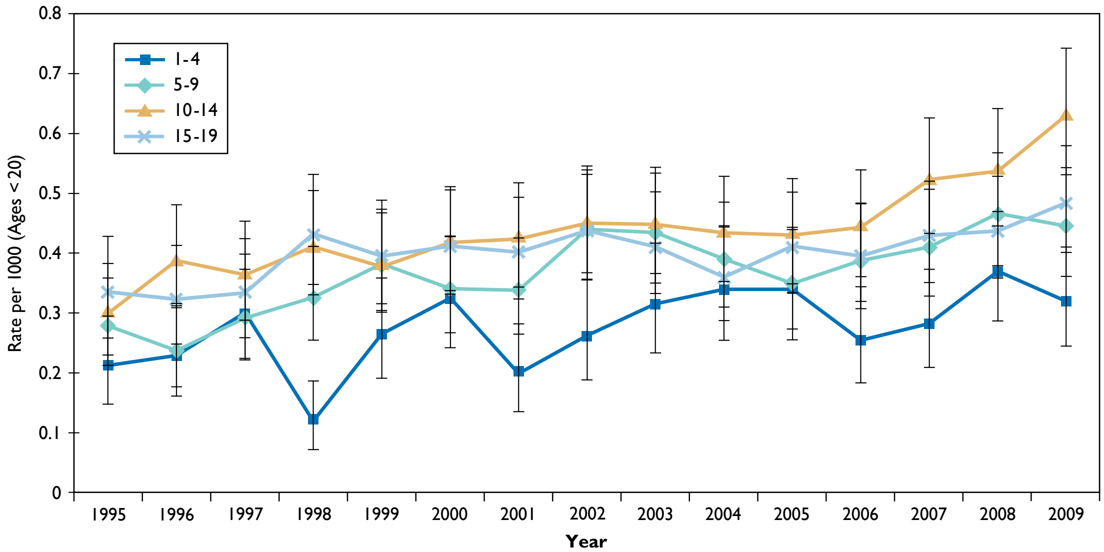

Diabetes incidence rates increased rapidly between 1995-2002, declined until 2006, then increased sharply from 2007 until 2009 (Figure 3.7). Overall, incident diabetes rates increased about 68% (90% in boys and 47% in girls) over the last 15 years.

Figure 3.7 **Crude Diabetes Incidence Rates, 1995-2009**



Looking more closely at the age-specific diabetes incidence rates (Figure 3.8), we observed that the trends seen in the crude incidence rates (Figure 3.7) appear most prominent in older children and adolescents (an increase in incidence until the year 2002, followed by declining rates with a spike in 2005-2006). Between 1995-2009, the lowest overall increase in incidence rates was observed in the 15-19 age group (44%), and the highest was observed in the 10-14 age group (111%).

Figure 3.8 **Age-Specific Diabetes Incidence Rates, 1995-2009**




## DISCUSSION

In Canada, our publically funded model of health care provides a valuable resource of administrative health information for population-level disease surveillance. The sources that we draw from for the *Alberta Diabetes Atlas* are provincial hospitalization discharge codes from discharge abstract summaries and physician billing claims. A limitation of the analyses in this chapter is that these data were not collected for the purposes of research and may be vulnerable to error.

One example may be the observed incidence trends for the under-20-year-old population in Alberta. From 1995-2002, we noted a rise in the number of children and adolescents with diabetes. However, the dip and plateau in incidence rates are not in agreement with historical and international trends. One possible explanation for these observations may be specific policy changes in Alberta which may have affected the quality of the administrative data on which the Alberta Diabetes Surveillance System (ADSS) is based; in particular, the introduction of Alternative Relationship Plans in 2003 and the updated ICD-10-CA diagnostic coding in 2001-2002.

In Canada, our publicly-funded health care system provides a rich source of health information to researchers. This system has typically reimbursed physicians on a fee-for-service (FFS) basis. Under this model, physicians must submit billing claims for each patient seen in order to receive payment. These service claims contribute to our knowledge of disease prevalence and distribution in Canada by comprehensively accounting for each health encounter an individual has with their health provider. This FFS data has been the basis for the development of the NDSS, and for its current expansion to surveillance of other chronic conditions. Recently, however, several jurisdictions across the country have implemented alternative approaches to payment known as Alternative Payment Plans (APPs) or in Alberta, Alternate Relationship Plans (ARPs). These ARPs were signed between the provincial government and pediatric endocrinologists in Alberta in 2003. The introduction of APPs across Canada has changed the way that many physicians are reimbursed. While they are contractually required to continue submitting billing claims, a practice known as shadow billing, physicians are often not paid for the time spent doing this and the importance of this continued practice is not often emphasized. In 2005-2006, 10% of physicians in Alberta were receiving some form of alternate payments.(6) If shadow-billing is not occurring at physician-patient encounters at the same rate as the FFS model, then it may lower our case capture under the NDSS and ADSS definition.

A second possible source of error may be associated with the transition to the latest revision of the International Classification of Diseases, Canadian Enhancement (ICD-10-CA), implemented in Alberta in 2001-2002. Currently, ICD-10-CA is used for coding discharge or death from hospitals, with ICD-9 coding still used by outpatient physicians.(7) While ICD-10-CA may remain comparable to ICD-9, it is unclear whether the new coding structure will affect disease surveillance.

To address these potential limitations in our surveillance system, we are continuing to explore the administrative records in more detail. We aim to determine the extent to which ARPs or changes in billings played a role in differences in incidence rates over time. This will include analyses of the age-specific incidence rates for children and adolescents living in different areas of the province, as well as the source of the case identification claim (i.e. physician claim or hospital discharge). If the observed incidence rate trends are explained by changes to policies such as these, we can help inform both surveillance systems and future policy changes.

## CONCLUSION

It is unfortunate that children and adolescents appear to be following the increasing rates of diabetes seen in adults. Data validity will be essential to our continued understanding of these trends. To achieve the highest possible accuracy in our estimates, we will continue to scrutinize and improve our data collection methods.

## References

1. National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention. National diabetes fact sheet 2007. 2009 [cited 2009 July 21]. Available from: http://www.cdc.gov/diabetes/pubs/factsheet07.htm.
2. National Diabetes Education Program. Overview of diabetes in children and adolescents: a fact sheet from the National Diabetes Education Program, 2009. 2009 [cited 2009 July 21]. Available from: http://ndep.nih.gov/media/diabetes/youth/youth_FS.htm.
3. Pinhas-Hamiel O, Dolan LM, Daniels SR, et al. Increased incidence of non-insulin-dependent diabetes mellitus among adolescents. J Pediatr 1996;128:608-15.
4. Wang Y, Lobstein T. Worldwide trends in childhood overweight and obesity. Int J Pediatr Obes 2006;1:11-25.
5. Bessaoud K, Boudraa G, Molinero de Ropolo M, et al. Incidence and trends of childhood type 1 diabetes worldwide 1990-1999. Diabetic Medicine 2006;23:857-66.
6. Canadian Institute for Health Information: Physicians in Canada. The status of alternative payment programs, 2005-2006. Ottawa: Canadian Institute for Health Information; 2008.
7. Public Health Agency of Canada. Injury surveillance online - glossary, 2005. [cited 2009 July 22]. Available from: http://dsol-smed.phac-aspc.gc.ca/dsol-smed/is-sb/glossa-eng.php.

Chapter 4

# Diabetes and Health Care Utilization in Alberta

Jeffrey A. Johnson
Logan McLeod
Alun L. Edwards
Doreen M. Rabi
Stephanie U. Balko

# CHAPTER 4

# DIABETES AND HEALTH CARE UTILIZATION IN ALBERTA

## KEY MESSAGES

- Adults with diabetes see general practitioners (GPs) almost twice as often, and specialists more than 3 times as often, than people without diabetes.
- There has been a steady increase in the number of total physician visits for people with diabetes, with the total number of GP visits in adults almost tripling in the last 15 years.
- A steady increase in the average number of specialists visits can be seen in adults with diabetes over the past 15 years.
- Among the under-20-year-old population with diabetes, children aged 1-4 years had the highest average number of emergency department encounters and total days in hospital.
- Adults with diabetes spend over 3 times the number of days in hospital each year than people without diabetes; and children and adolescents spend almost 9 times the number of days in hospital than those without diabetes.

## BACKGROUND

The societal impact of diabetes mellitus (DM) can be captured in many ways. Information on the prevalence, incidence, morbidity and mortality all help to capture the social burden of diabetes. Another important aspect is the excess health care utilization and costs of care for people with DM compared to people without DM.[1,2] According to statistics from the World Health Organization, in the year 2000, the prevalence of diabetes in Canada was more than 2 million and the estimated prevalence for the year 2030 was approximated to be 3.5 million. These numbers illustrate the impact of diabetes on health care resources, and the need for advanced health care planning.[3] Management of chronic medical conditions such as DM can place tremendous strains on our already burdened health care system. There is a cost associated with each unit of health care such as a visit to a physician, emergency department (ED) or a day spent in hospital. Each unit consumed contributes to total health care costs. The more units of health care consumed, the higher total health care costs.

Utilization is the outcome of demand for health care services interacting with the supply of health care services. Demand for health care depends on an individual's preferences, constraints (e.g. access to care, health insurance), and need (e.g. diabetes care). The supply of health care services is affected by models of care delivery, number of providers, service intensity per provider, among other things. Access to appropriate care contributes to better quality of care and better outcomes for people with DM. Health professional organizations and policy-makers have raised concerns about potential shortages of many health professionals; for example, the *Canadian Diabetes Association 2008 Clinical Practice Guidelines* recommend a multidisciplinary team approach to DM care,[4] yet such resources may not always be in place. Furthermore, observed variations in the utilization of health care services may simply reflect variations in demand due to variations in patient preferences or variations in health care need. Variations in observed utilization may also indicate inequities in access to care or may identify different models of health care delivery being used in different communities.

This chapter provides a picture of the level of health care utilization for people with and without diabetes in Alberta. This chapter provides an overview of the utilization of physicians, EDs and hospital services separately for the adult population (> = 20 years) and for children and adolescents (< 20 years). Information on patterns of health care utilization can help policy-makers to estimate future requirements for health human resources.[2,5]

## METHODS

Data from Alberta Health and Wellness (AHW) administrative databases were utilized for these analyses. People with DM were identified by applying a modified version of the National Diabetes Surveillance System (NDSS) algorithm (see "Backgrounds and Methods" chapter). Individuals of all ages were included in these analyses, however, were reported on separately.

We compared average health care utilization for those with and without diabetes for each service. For each category, the total number of each specific type of health care encounter for each group (numerator) was divided by the total number of people in the zone or province in that group (denominator), respectively. As with other rates in the *Atlas*, we used a direct standardization to age- and sex-adjust rates of health care utilization in the adult population, using the Alberta population from the 2006 Canadian Census. We present trends of health care utilization over time (1995-2009 unless otherwise specified), and across age groups and health zones for the most recent year (2009).

### Physician Visits

Data were obtained from the Physician Claims database, which captures information on all physician visits and procedures completed in an inpatient or outpatient environment for Alberta residents. For adults, we identified physician visits to include a visit to either a GP or a specialist. For visits to specialists, we included cardiologists, endocrinologists, internists, nephrologists, ophthalmologists and psychiatrists, as these were specialties most relevant to comorbidities associated with diabetes.

For the under-20-year-old population, we report on *total* physician visits instead of by GP or specialist individually. This is due to different practices in the large urban centers. For example, in Edmonton, children tend to be followed by a pediatrician; while in Calgary, children tend to be followed by a GP. Total physician visits include all contacts with any type of physician (i.e., not limited to only GPs and the six specialists reported on in the adult population).

**Emergency Department Encounters**

Data were obtained from the Ambulatory Care Classification System (ACCS) database, which was established in 1998, with rates being presented for total ED encounters for the over- and under-20-year-old populations. Because individuals may have multiple ED encounters in any given year, averages for the number of ED encounters were calculated by year, by age group and by zone.

**Hospitalizations**

Data for use of hospital services were obtained from the Discharge Abstracts Database (DAD), which records information including dates, diagnoses and procedures on all admissions to any of the 128 acute care facilities in Alberta. Because individuals may have multiple hospitalizations in a given year, we calculated the average number of total hospital days per year for the over- and under-20-year-old populations, and compared this average for people with and without diabetes.

## FINDINGS

### Physician Visits in the Adult Population (Ages >= 20 years)

#### General Practitioner Visits

From 1995-2009, the *average* number of GP visits remained fairly stable in adults. Adults with diabetes had about 75% more GP visits per year compared to adults without diabetes (Figure 4.1). For example, in 2009, adults with diabetes had over 9 GP visits, on average, while adults without diabetes had just over 5 GP visits. While the *average* number of GP visits remained stable, the *total* number of GP visits for people with diabetes almost tripled between 1995-2009, growing from 809,500 visits in 1995, to over 2.3 million in 2009 (Figure 4.2). In 2009, the ratio of excess GP visits among diabetic adults compared to non-diabetic adults was slightly higher in the younger age groups; however, there was an increase in the number of GP visits for both people with and without diabetes with increasing age (Figure 4.3). People with diabetes were more likely to see a GP in all zones, although the number of GP visits for people with diabetes was lower in the Calgary and Edmonton zones than the provincial average, and higher than the average for the South, Central, and North zones (Figure 4.4).

Figure 4.1 **Age- and Sex-Adjusted Average Number of General Practitioner Visits for Adults, 1995-2009**

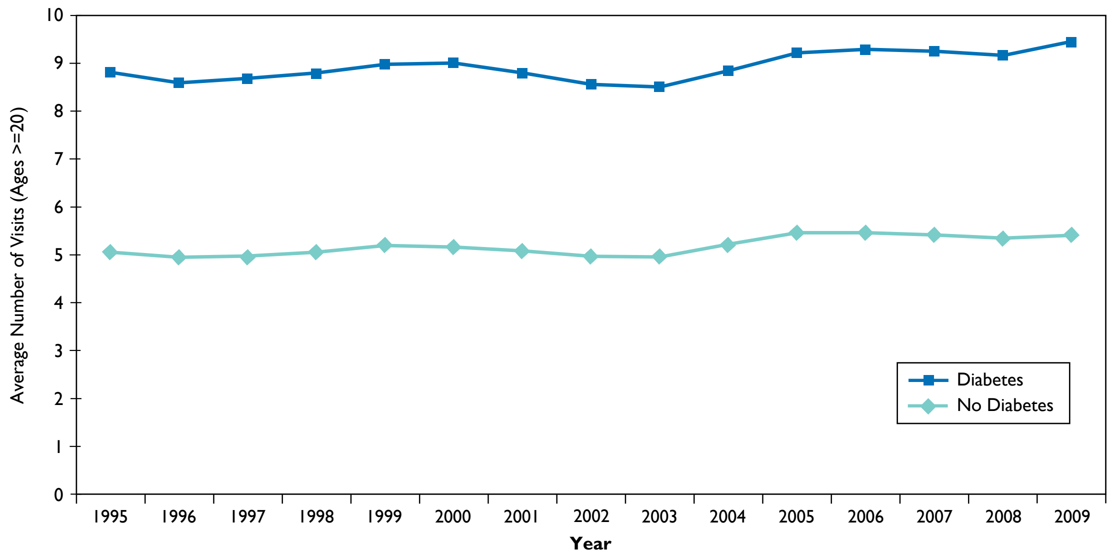



Figure 4.2 **Total Number of General Practitioner Visits for Adults with Diabetes, 1995-2009**

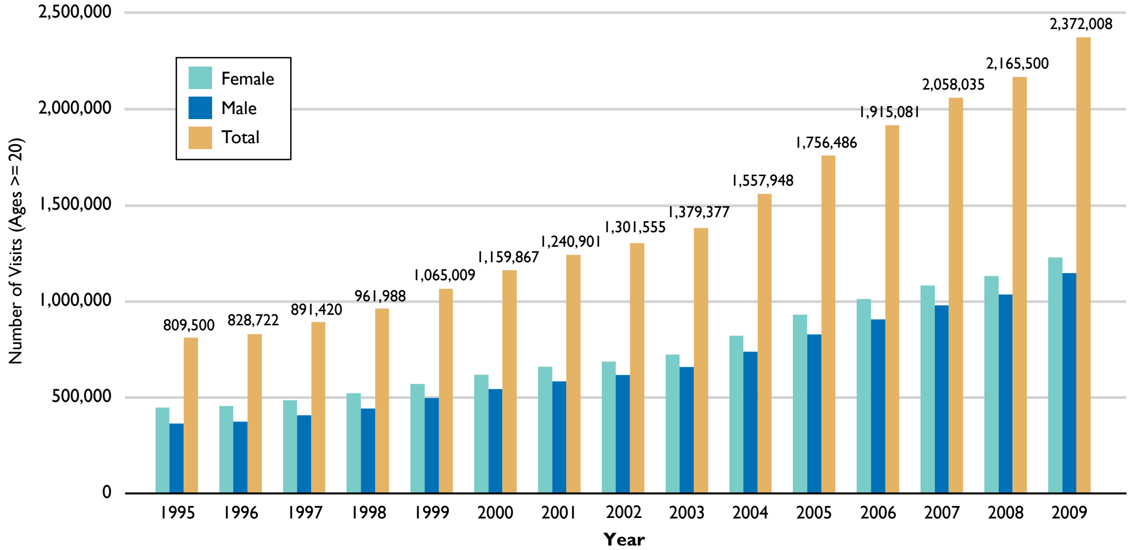


Figure 4.3 **Average Number of General Practitioner Visits by Age for Adults, 2009**

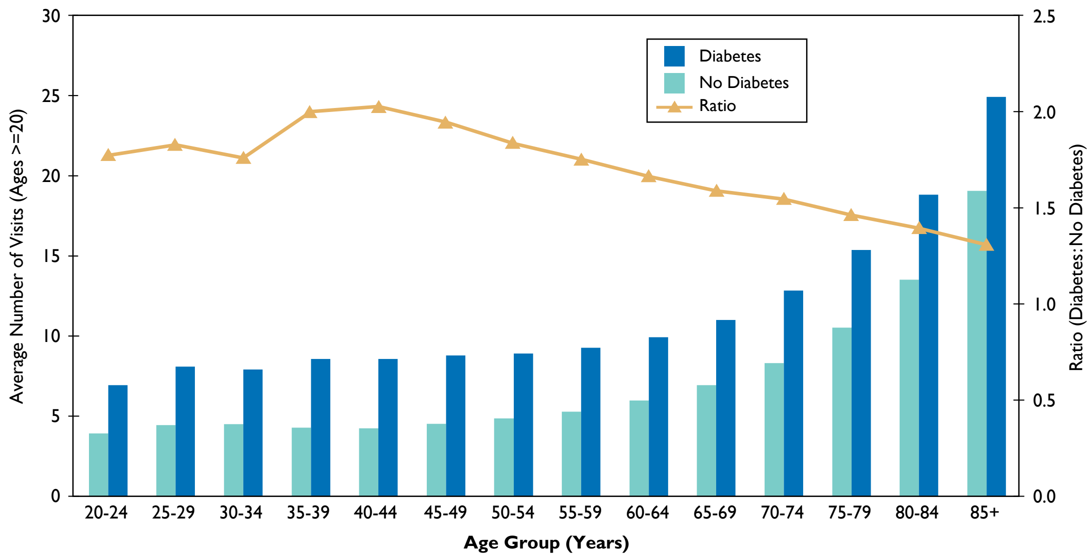
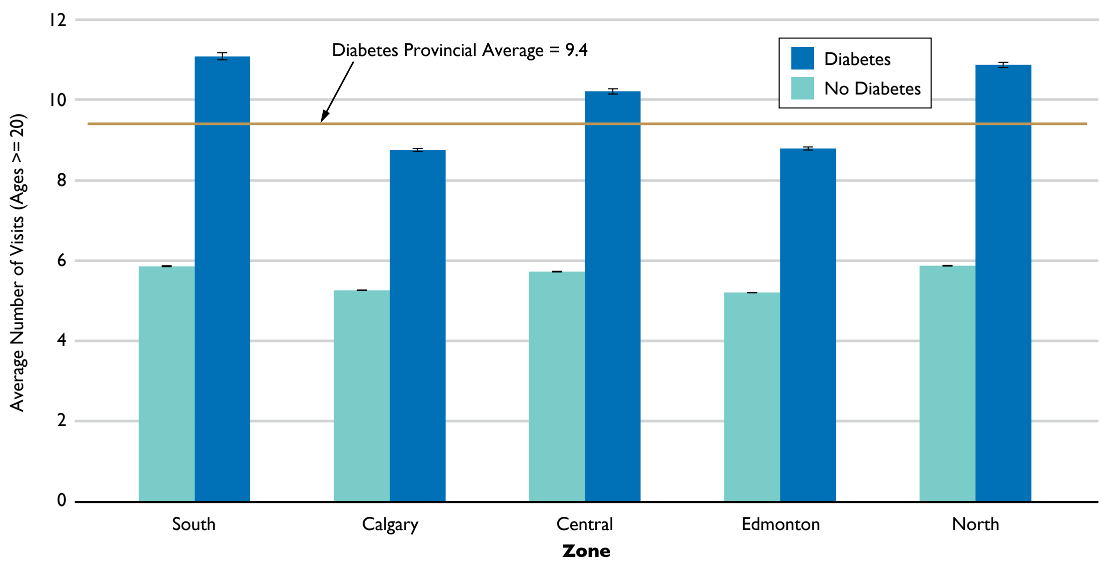



Figure 4.4 **Age-Adjusted Average Number of GP Visits for Adults by Zone, 2009**



## Specialists Visits

The *average* number of visits to medical specialists has increased at a faster rate in adults with diabetes (40%) compared to adults without diabetes (20%) over the last 15 years of observation (Figure 4.5). The diabetic adult population saw an increase from an average of 3 specialist visits in 1995 to over 4 visits in 2009. Generally, adults with diabetes saw specialist physicians more than 3 times as often than adults without diabetes. Similar to what was observed with the total number of GP visits over time, the total number of specialist visits have more than tripled over the last 15 years (Figure 4.6). Adult males with diabetes had more specialist visits than adult females across all years.

Figure 4.5 **Age- and Sex-Adjusted Average Number of Specialist Visits for Adults, 1995-2009**

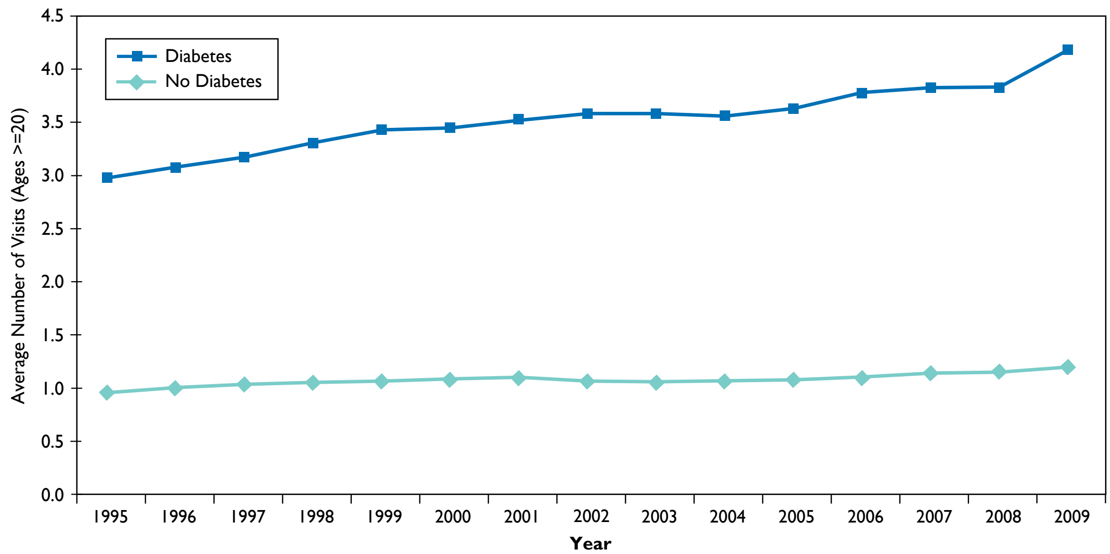
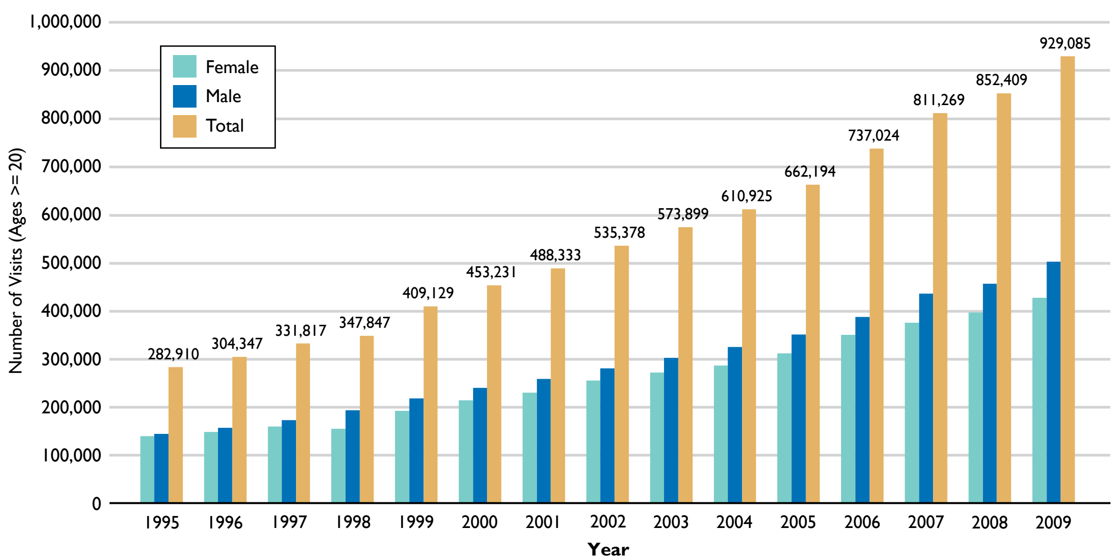



Figure 4.6 **Total Number of Specialist Visits for Adults with Diabetes, 1995-2009**



The average number of specialist visits was higher in patients with diabetes compared to those without diabetes and the ratio of specialist visits is higher in the younger population compared to the older population (Figure 4.7). The ratio of specialist visits for older adults is less, partly due to increased specialist visits for all older adults (and particularly the large increase in the non-diabetic population), but may also be due to age-related differences in the *type* of diabetes. For example, type 1 diabetes is most frequently encountered in younger individuals and its treatment with insulin regimens often requires specialist assistance whereas the oral agents used to treat type 2 diabetes, prevalent in middle age and older, are comfortably managed by primary care physicians. People with diabetes living in Edmonton and Calgary zones were more likely to see a specialist than those living in the South, Central or North zones (Figure 4.8).

Figure 4.7 **Average Number of Specialist Visits by Age for Adults, 2009**

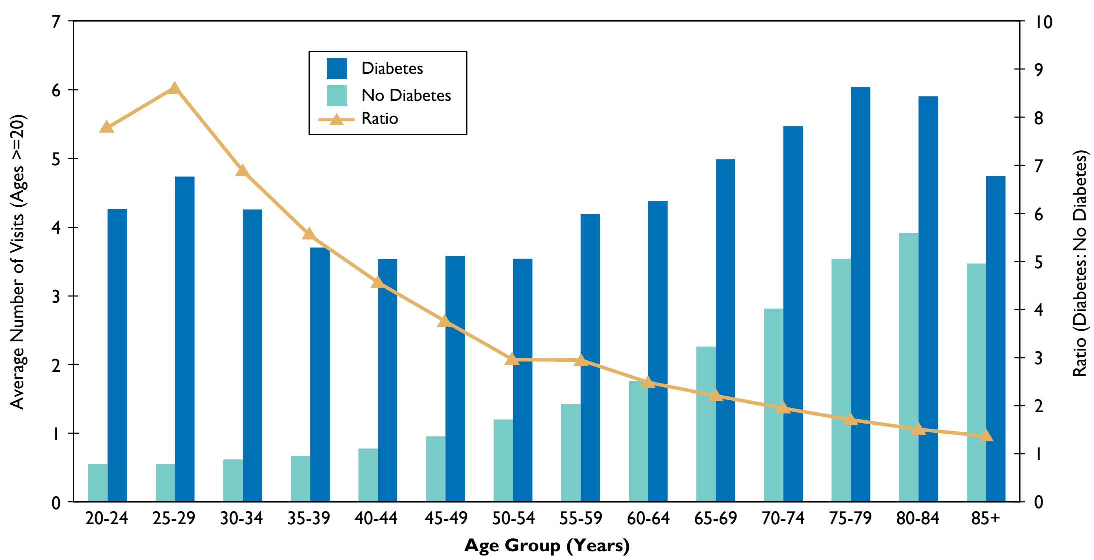
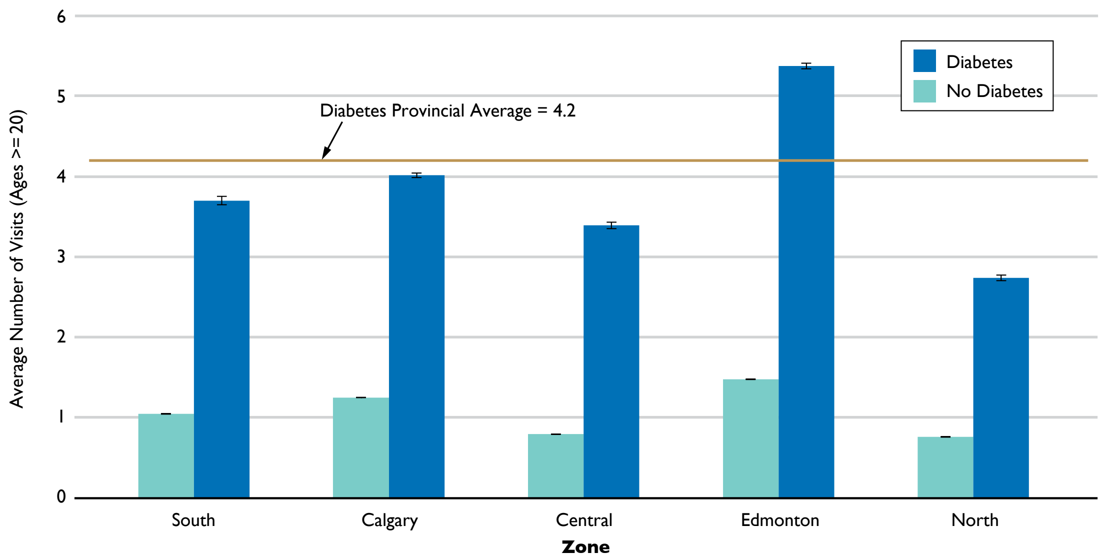


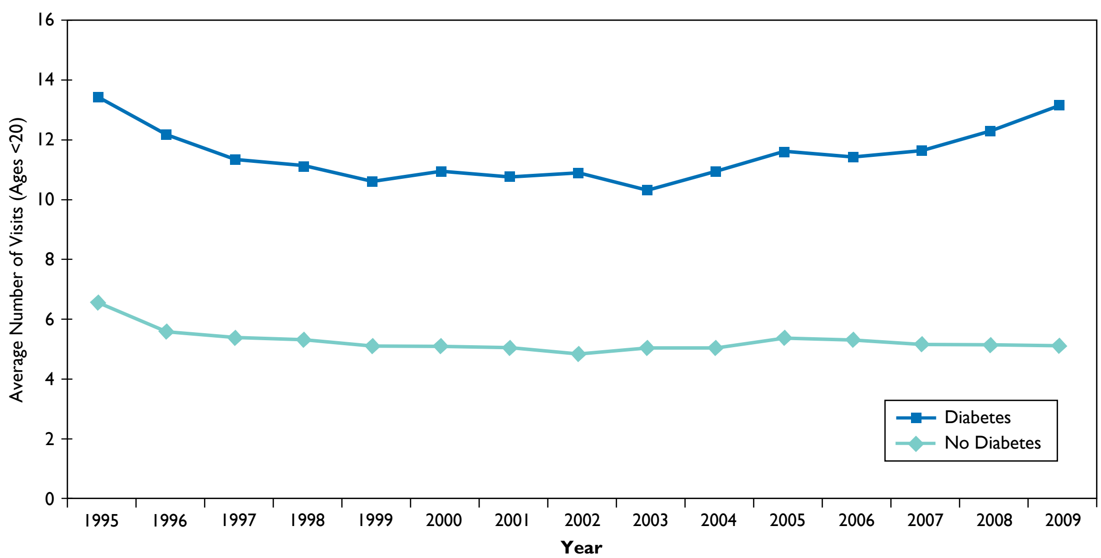
Figure 4.8 **Age-Adjusted Average Number of Specialist Visits for Adults by Zone, 2009**




## Physician Visits in Children and Adolescents (Ages < 20 years)

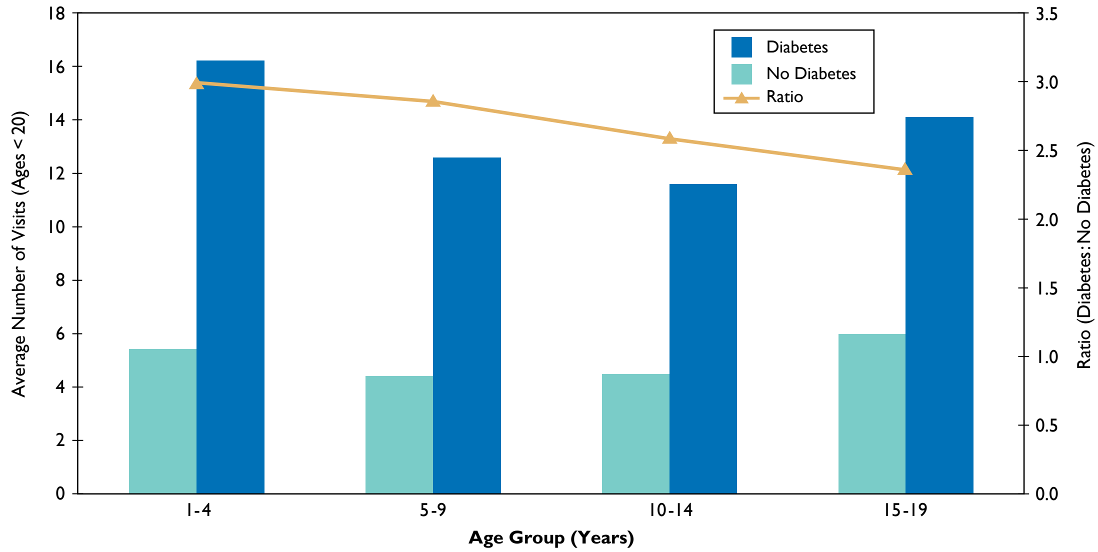
On average, children and adolescents with diabetes visited their physician about 13 times per year in 2009. The non-diabetic children and adolescent population had less than half that amount of visits at about 5 per year (Figure 4.9).

Figure 4.9 **Crude Average Number of Physicians Visits for Children and Adolescents, 1995-2009**



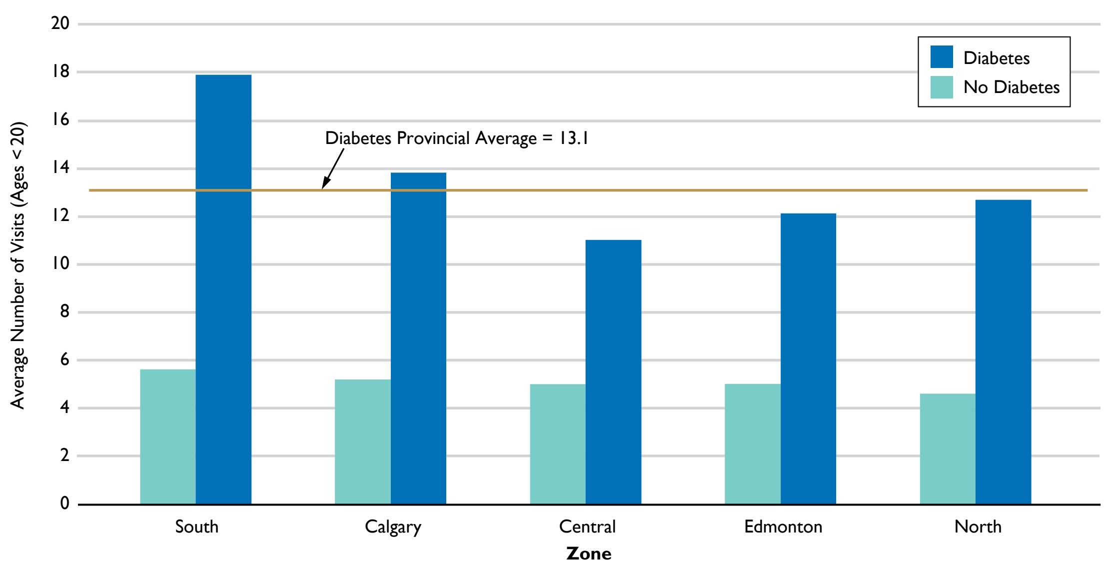

In 2009, the average number of physician visits was the highest among the youngest population (1-4 year olds) at just over 16 visits per year (Figure 4.10). The ratio of average physician visits between children with and without diabetes was the highest for the youngest population.

Figure 4.10 **Average Number of Physician Visits by Age for Children and Adolescents, 2009**




Children and adolescents with diabetes were 2 to 3 times more likely to see a physician in all health zones compared to those without diabetes. The total number of physician visits for the under-20-year-old population with diabetes were higher than the provincial average for the South and Calgary zones and lower than the provincial average for the Central, Edmonton and North zones. The South zone had the highest average number of physician visits in the province at almost 18 visits per person in 2009 compared to the provincial average of 13.1 (Figure 4.11).

Figure 4.11 **Crude Average Number of Physician Visits for Children and Adolescents by Zone, 2009**



## Emergency Department Encounters

### Adult Population (Ages >=20 years)

The *average* number of ED encounters has remained relatively stable in absolute magnitude from 1998 to 2009 for adults with and without diabetes (Figure 4.12). In relative magnitude, however, there was a 7.5% decrease in ED encounters for people with diabetes and a 3.0% decrease for the non-diabetic population. Adults with diabetes had more than twice as many ED encounters compared to adults without diabetes. The *total* number of ED encounters for adults with diabetes had increased steadily from just over 98,000 in 1998 to just under 186,000 encounters in 2009, with females having slightly more encounters than males from 1998 to 2002, and males having more encounters from 2003 to 2009 (Figure 4.13). We observed an interesting U-shaped curve for age-specific ED encounters for both patients with and without diabetes (Figure 4.14). In addition, the ratio of ED encounters for diabetes compared to no diabetes was highest in the younger population. This, again, raises the possibility that type 1 diabetes in this younger adult population predisposes to more acute emergencies, such as ketoacidosis or hypoglycemia, than the more stable patterns of control seen in type 2 diabetes in older adults.

Figure 4.12 **Age- and Sex-Adjusted Average Number of Emergency Department Encounters for Adults, 1998-2009**

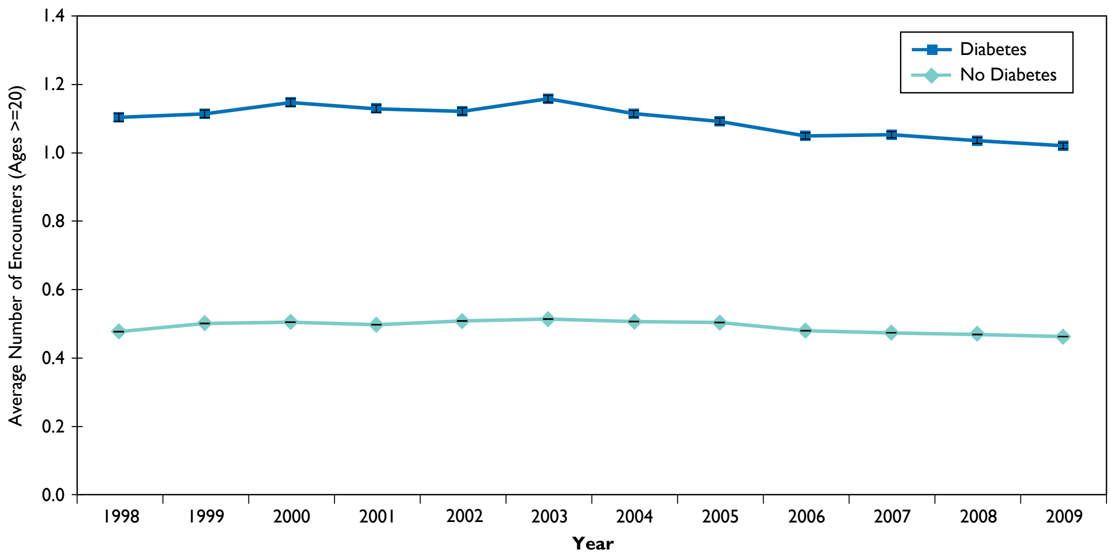


Figure 4.13 **Total Number of Emergency Department Encounters for Adults with Diabetes, 1998-2009**

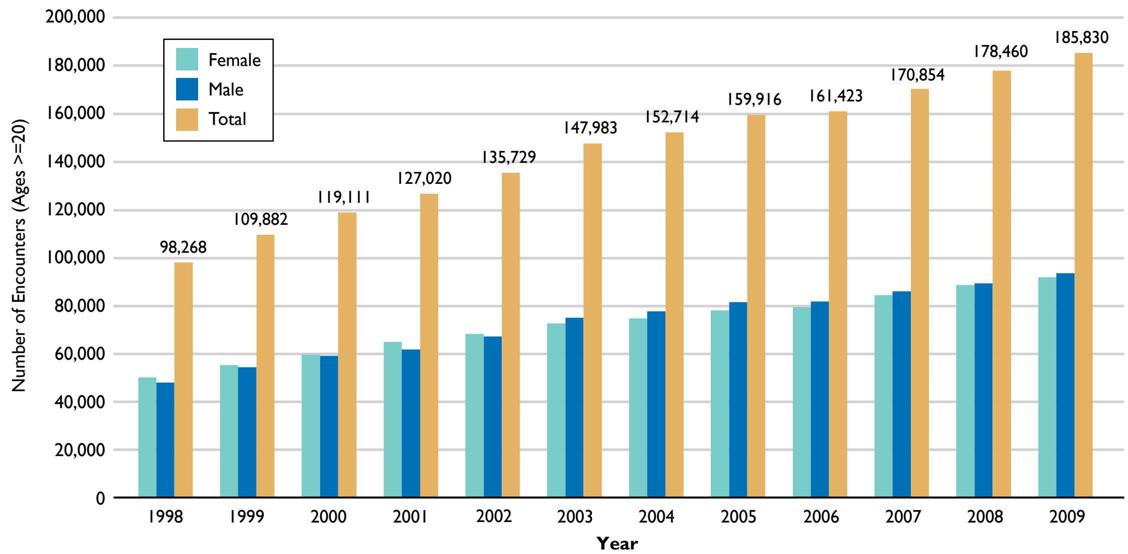
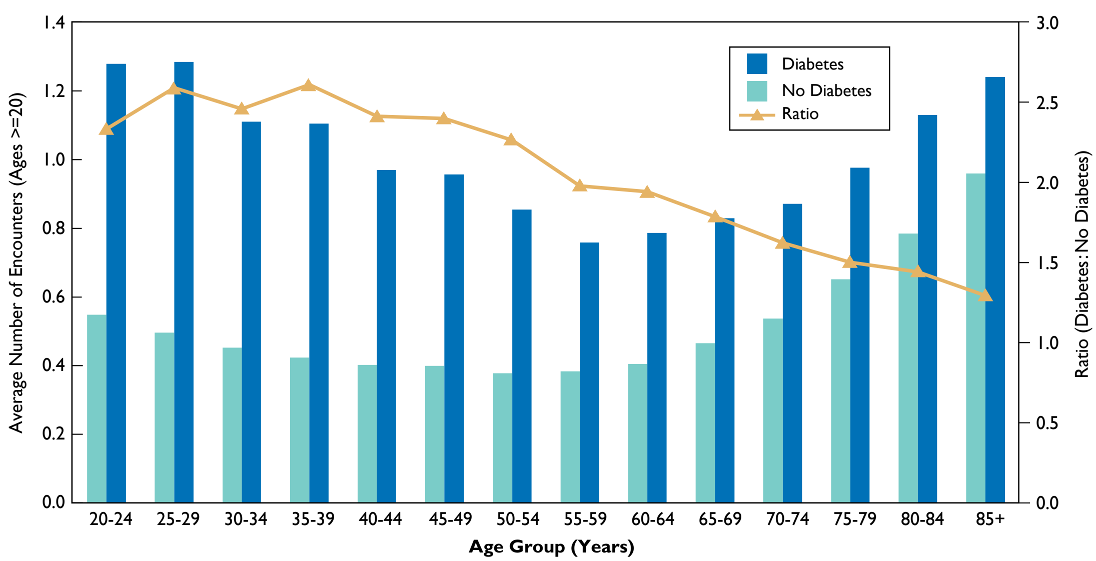
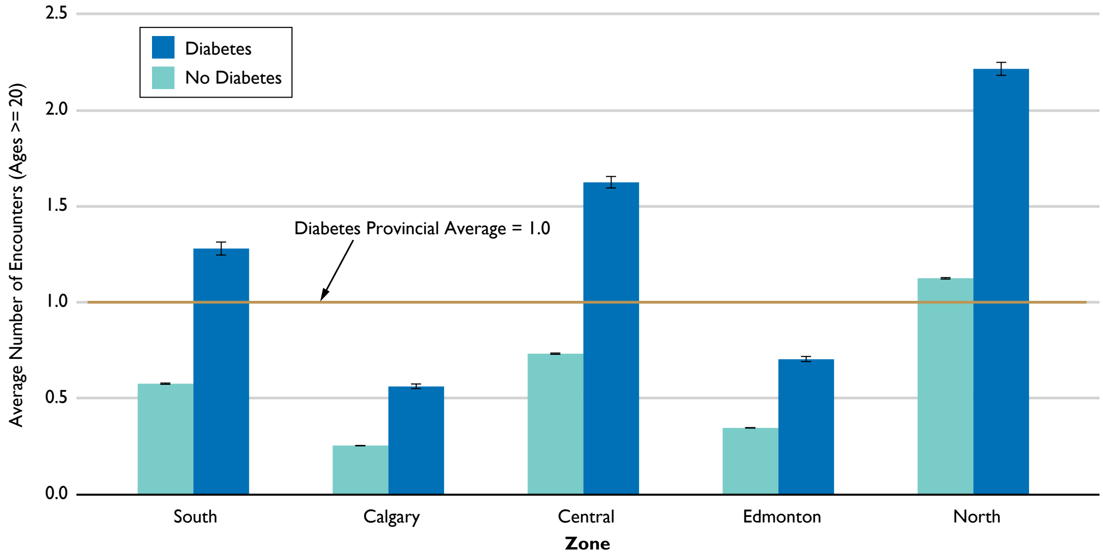



Figure 4.14 **Average Number of Emergency Department Encounters by Age for Adults, 2009**



For people with and without diabetes, the average number of ED encounters was highest in the South, Central and North zones and lowest in the Edmonton and Calgary zones (Figure 4.15). However, people with diabetes had twice as many ED encounters compared to people without diabetes in all zones.

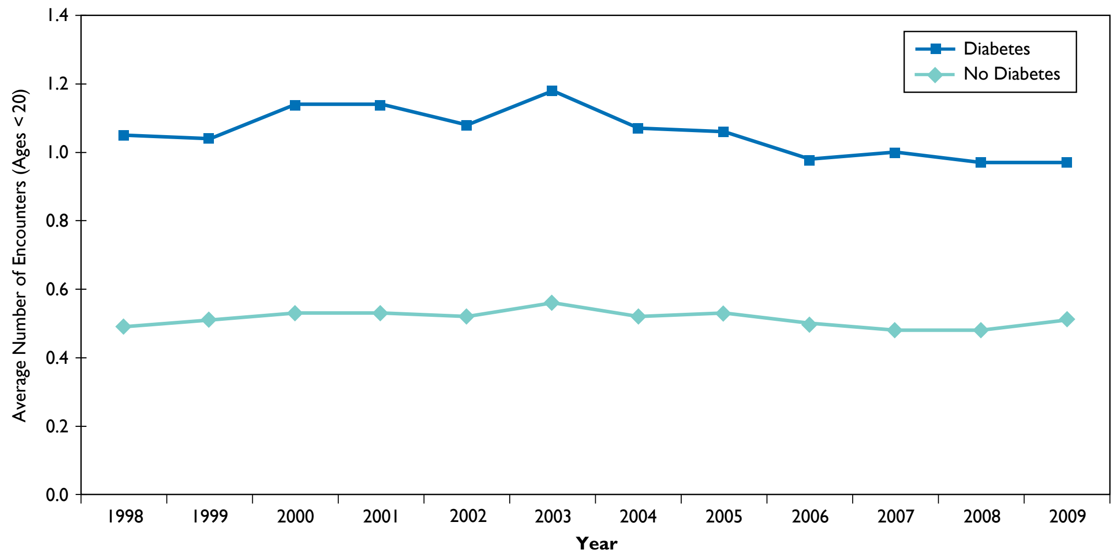
Figure 4.15 **Age-Adjusted Average Number of Emergency Department Encounters for Adults by Zone, 2009**




## Children and Adolescents (Ages <20 years)

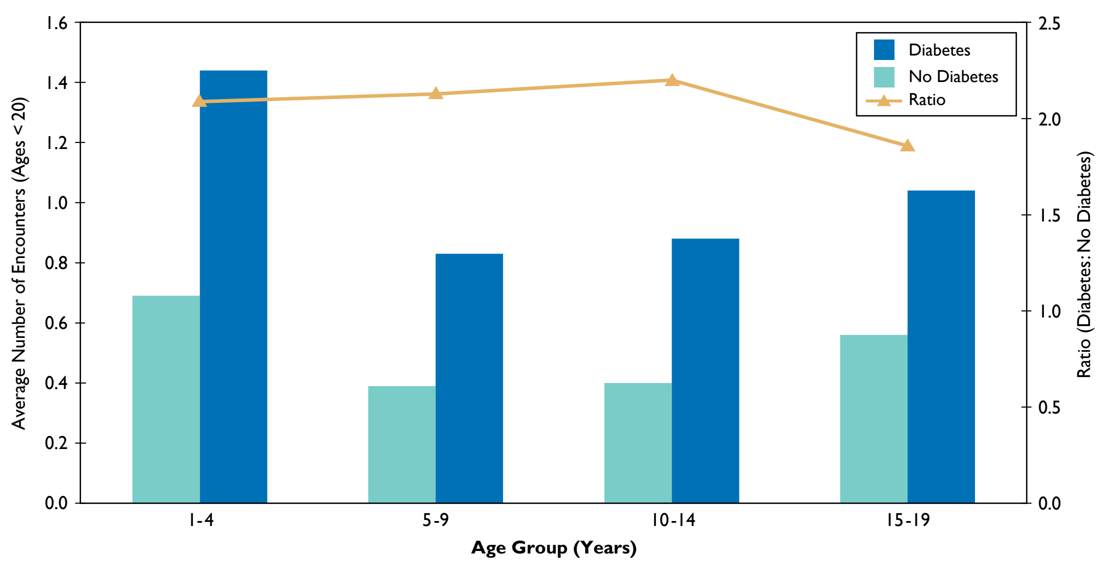
From 1998-2009, the average number of ED encounters remained fairly stable for children and adolescents in absolute magnitude, regardless of their diabetes status. However, the change in relative magnitude over the same time period was more marked with a decrease of 7.6% for ED encounters for children and adolescents with diabetes and a 4% increase in ED encounters for children and adolescents without diabetes. Similar to the adult population, those with diabetes had more than twice as many ED encounters than those without diabetes (Figure 4.16).

Figure 4.16 **Crude Average Number of Emergency Department Encounters for Children and Adolescents, 1998-2009**



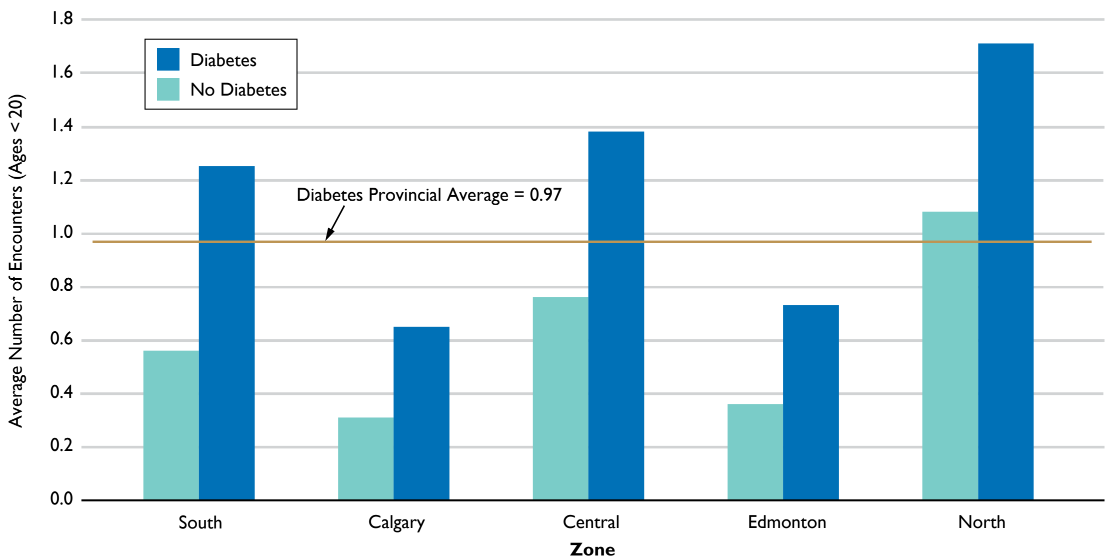

Children aged 1-4 years had the highest average number of ED encounters, regardless of DM status (Figure 4.17). The largest ratio was observed for the 10-14 year old age group, where those with diabetes had over 2.2 times more ED encounters compared to those without diabetes. The older age group (15-19 years) had the smallest ratio of 1.9 times.

Figure 4.17 **Average Number of Emergency Department Encounters by Age for Children and Adolescents, 2009**



As with adults, the likelihood of an ED encounter for a child or adolescent in the non-metro zones was higher than the provincial average while the metro zones of Calgary and Edmonton were below the provincial average (Figure 4.18).

Figure 4.18 **Crude Average Number of Emergency Department Encounters for Children and Adolescents by Zone, 2009**




### Hospitalization

#### Adult Population (Ages >=20 years)

Similar to what has been observed with other health care services, the *average* number of days in hospital for adults has remained fairly steady over the past 15 years, for both people with and without diabetes (Figure 4.19). However, adults with diabetes have over 3 times the average number of hospital days compared to adults without diabetes. As might be expected, older adults had, on average, more days in hospital than younger adults, and people with diabetes had a greater average number of hospital days across all ages (Figure 4.20). In 2009, younger adults with diabetes spent 5 to 6 times the number of days in hospital relative to their non-diabetic counterparts. These differences were lower in older age groups.

Figure 4.19 **Age- and Sex-Adjusted Average Number of Hospital Days for Adults, 1995-2009**

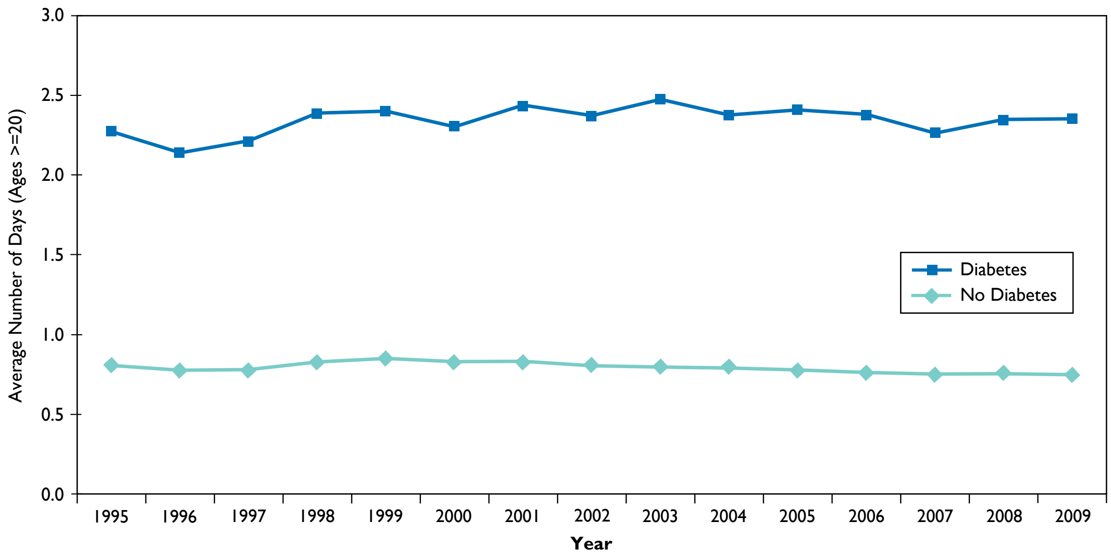
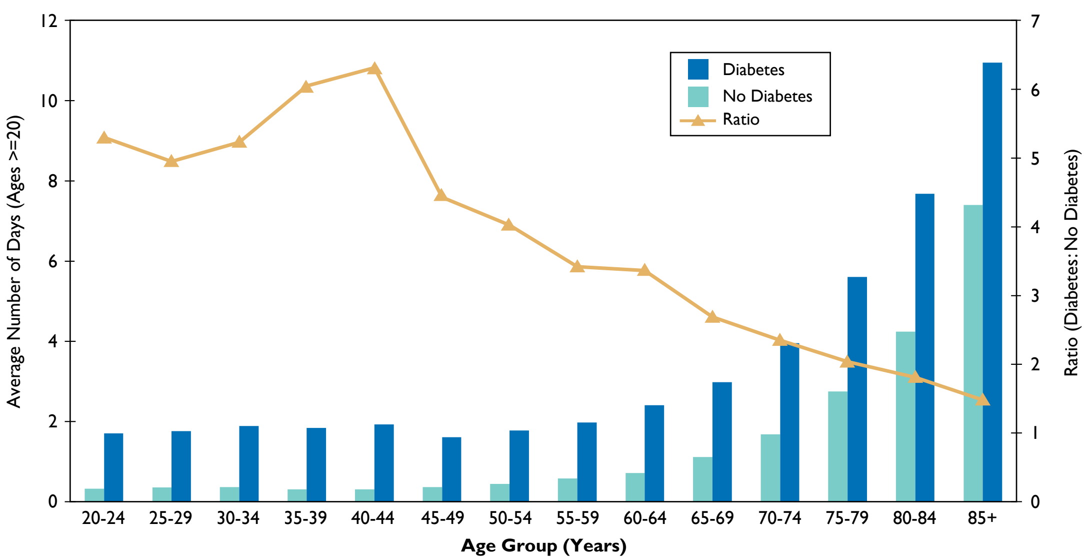
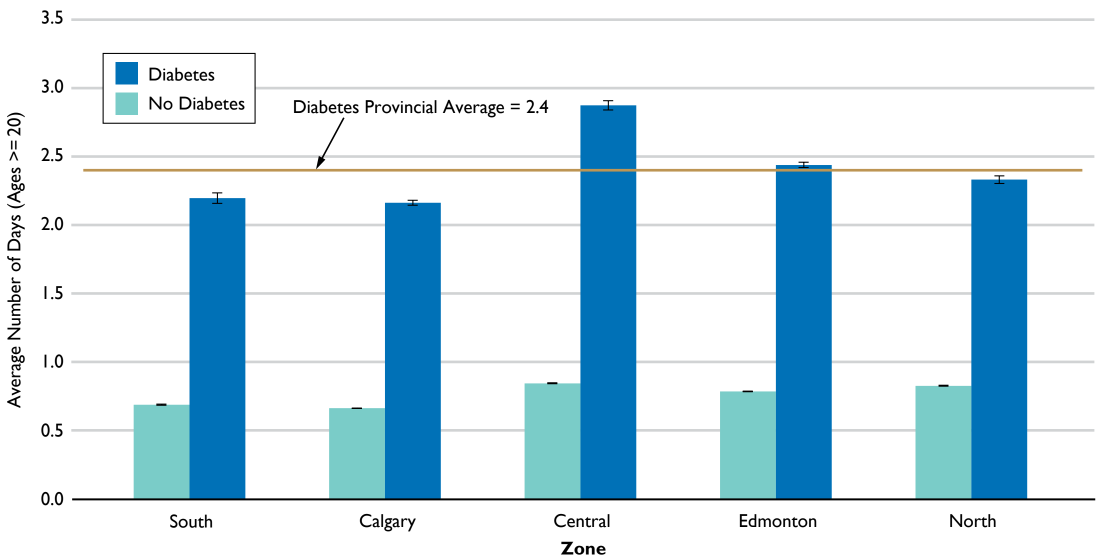



Figure 4.20 **Average Number of Hospital Days by Age for Adults, 2009**



After adjusting for age, adults with diabetes living in the South, Calgary and North zones had the fewest days in hospital in 2009, while adults living with diabetes in the Central zone had the most days in hospital (Figure 4.21).

Figure 4.21 **Age-Adjusted Average Number of Hospital Days for Adults by Zone, 2009**




## Children and Adolescents (Ages <20 years)

While the average number of hospital days per year remained constant over time for children and adolescents without diabetes, there was considerable variation for those with diabetes (Figure 4.22). This is likely due to the relatively small number of hospitalizations in this population. The differences between the two populations are very notable. In 2009, children and adolescents with diabetes had almost 9 times the number of hospital days than those without diabetes. Consistent with the use of other health care services, the youngest diabetic population (1-4 years) had the highest average number of hospital days in 2009 at about 1.4 per year; however the 5-9 year old age group had the largest ratio of use (Figure 4.23). Children and adolescents with diabetes spend 6 to 18 times the average number of days in hospital compared to those without diabetes.

Figure 4.22 **Crude Average Number of Hospital Days for Children and Adolescents, 1995-2009**

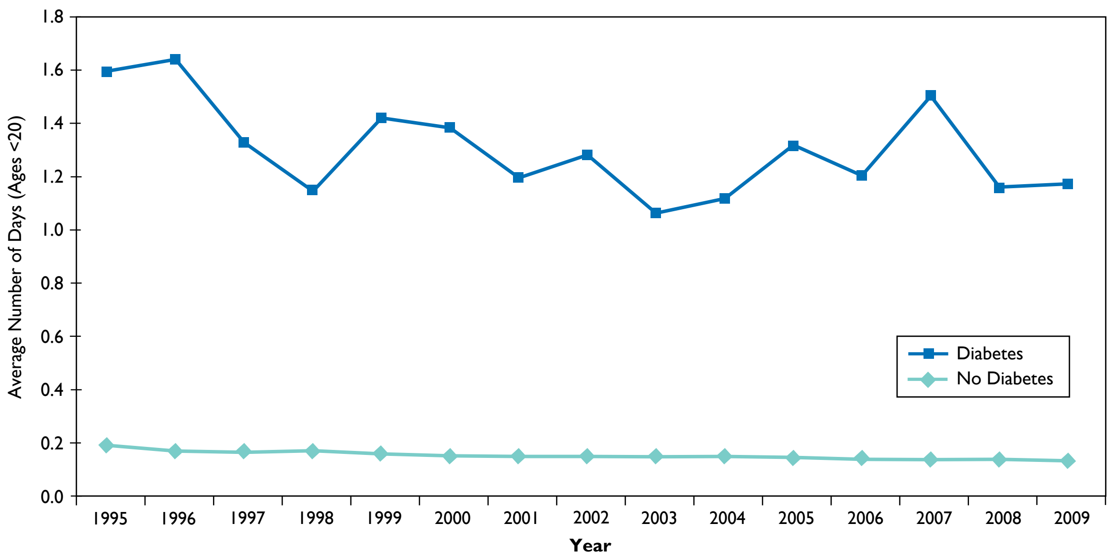
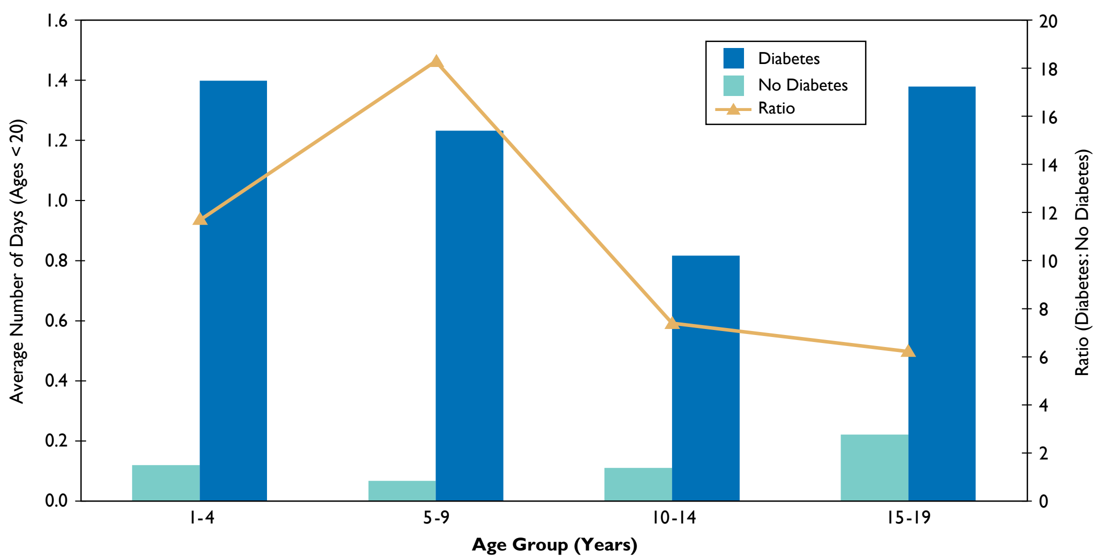
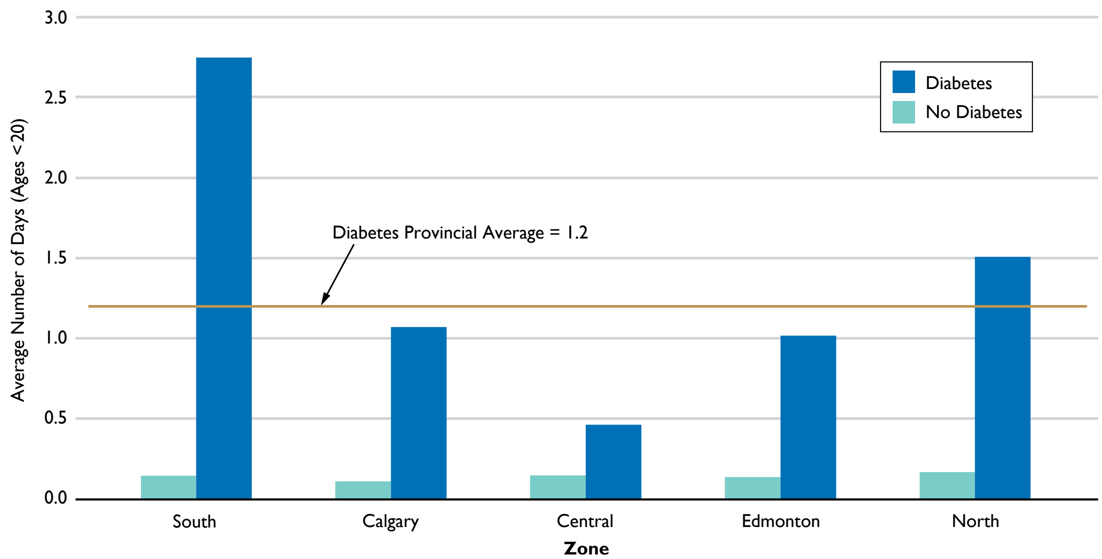



Figure 4.23 **Average Number of Hospital Days by Age for Children and Adolescents, 2009**



The under-20-year-old population with diabetes living in the South zone spent more than twice the provincial average number of days in hospital and while those in the Calgary, Central and Edmonton zones spent less than the provincial average number of days in hospital (Figure 4.24).

Figure 4.24 **Crude Average Number of Hospital Days for Children and Adolescents by Zone, 2009**



## DISCUSSION

The findings of increased utilization of all health care services for people with diabetes in Alberta are similar to patterns reported in most other jurisdictions.[2,5,6] In general, relative to adults without diabetes, adults with diabetes make almost twice as many visits to the GP, three times as many visits to the specialist, have twice as many ED encounters, and spend more than three times the number of days in hospital. Interestingly, while the overall level of utilization has increased, there has been a differential effect in the two populations. Physician use is up (particularly specialist use by adults with diabetes), while ED encounters have decreased. In percentage terms, over the last 15 years, the number of hospital days have increased for adults with diabetes (3.5%) but decreased for those without diabetes (-7.2%).

The growing burden on our health care system is highlighted by the difference between average use of health care and the total number of visits or encounters for people with diabetes compared to people without diabetes. For example, while the average rate of GP visits for adults with diabetes has remained fairly stable over the last 15 years, the total number of GP visits has almost tripled driven by the growing number of Albertans living with diabetes. The same picture was seen for visits to specialist physicians over the same time period. Since the observed patterns of utilization are the outcome of demand for health care services interacting with the supply of health care services, these patterns may raise concerns for access to care for people with diabetes. For example, from 1999-2009, the growth in the number of physicians in Alberta (52.2%) is higher than Alberta's population growth (24.8%), while the ratio of physicians per 100,000 population has grown by 22.0%.[7] While this suggests more physicians may be working, it does not account for the intensity of their services, nor the number of hours they work or patients they see. The increasing total number of physician visits for people with diabetes (and likely other chronic conditions in our aging population) may grow faster than increases in physician supply, and not be sustainable in the future. It is important to recognize that demand for services may also vary with the natural history of diabetes: thus a cohort with diabetes who are developing complications two decades later might require more specialist care. A population of newly diagnosed diabetics may, however, need more primary care – and if effectively treated, following guidelines for newer therapies and up-to-date evidence, may not develop complications (or need specialist attention) at the historical rates.

One important aspect of the overall care for people with diabetes is the combination of GP and specialists services.[8,9] It is generally agreed that the majority of health care for people with diabetes should be provided by GPs.[4] Overall, adults with diabetes see a GP over 2 times more often than they see a specialist, but in more recent years, the relative use of specialists has increased. Given that, on average, the cost per specialist visit is higher than the cost per GP visits, substituting more specialist visits for GP visits would lead to higher health care costs, again speaking to the need for effective primary prevention and management strategies for people with diabetes. What is not considered in the data presented in this chapter are the long-term outcomes associated with the different mix of available health care services (e.g. GP vs. specialist care). This information is available in the administrative health care data and could be explored in future analyses.

This also raises a limitation of how the current picture of physician services utilization by adults is presented in this *Atlas*. For example, how specialist's services have been limited to only six areas, and that these have been lumped together. Future surveillance reports might consider presenting utilization for individual specialty areas, and perhaps cross-referencing these with the indicators in the other chapters of this *Atlas* (e.g., renal disease and nephrologists visits; depression and psychiatric visits; etc). A better understanding of the demand for those specialist's services may inform discussions of the overall quality of care for people with diabetes earlier in the disease, where prevention of complications is advocated by clinical practice guidelines.

It is also clear from these findings that the total use of health care services increases with age for people with and without diabetes. Additionally, according to Statistics Canada, Alberta continued to be the province posting the country's highest population growth in 2009; at 1.8%, the pace of Alberta's population growth is almost twice the national rate.[10] With our provincial population growing every year, coupled with a shift to an older age demographic, the demand for health care services will continue to be high.

Due to the growing number of complications in people with diabetes, especially among the older population, higher rates of health care utilization, are likely necessary. In fact, studies in Alberta[11-14] and other provinces in Canada[15-18] suggest that the current levels of health care utilization may actually be sub-optimal in managing the risk of developing complications for people with diabetes. It is important to recognize that enhancing the quality of care for people with diabetes to the levels recommended in clinical practice guidelines[4] may actually require an increase in utilization of certain health care services to avoid devastating and costly complications down the road.[6]

The *Canadian Diabetes Association 2008 Clinical Practice Guidelines* encourage the use of integrated diabetes health care.[4] Multidisciplinary health care teams are an effective way to provide education and support to patients and families living with diabetes and have been shown to be associated with improved health outcomes.[19-22] It is important to note that the findings presented in this chapter of the *Alberta Diabetes Atlas* provide only a general overview of selected health care services for people with diabetes. We do not have information on access and use of diabetes education centers which house integrated diabetes health care and the use of many allied health professionals who care for people with diabetes, such as nurses, dieticians, pharmacists, podiatrists, etc. As these services are generally managed privately or regionally within their own global budgets, there are no central databases that capture information on utilization of these health care providers. Nonetheless, given the findings on the utilization of physician and acute care services, there is every reason to believe that the demand for all health care services for people with diabetes is continuing to increase.[6,23] As we move forward, those involved in health care policy and provision should ensure resources are directed not only to the acute health care services related to diabetes, but also ensure adequate support of integrated health care directed at prevention of complications.

In presenting information on utilization of health care services, we condensed and summarized a tremendous amount of data into more easily digestible portions. We recognize, however, that this sometimes conceals the detail that may be desirable for making specific decisions. In the future, we hope to be able to report on other complementary data sources such as prescription drug use in order to enhance the type of surveillance that we are able to provide.

## Reference:

1. Ettaro L, Songer TJ, Zhang P, Engelgau MM. Cost-of-illness studies in diabetes mellitus. Pharmacoeconomics 2004;22(3):149-64.
2. Johnson JA, Pohar SL, Majumdar SR. Health care use and costs in the decade after identification of type 1 and type 2 diabetes: a population-based study. Diabetes Care 2006;29(11):2403-8.
3. WHO. Country and regional data.2009 [cited 2009 July 7]. Available from: http://www.who.int.login.ezproxy.library.ualberta.ca/diabetes/facts/world_figures/en/index3.html.
4. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2008 clinical practice guidelines for the prevention and management of diabetes in Canada. Can J Diabetes. 2008;32(suppl1);S1-S201.
5. Chan BTB, Harju M. Supply and utilization of health care services for diabetes. In: Hux JE, Booth GL, Slaughter PM, Laupacis A, editors. An ICES practice atlas: institute for clinical evaluative sciences. Ontario: Institute of Clinical Evaluation Sciences; 2003:14.249.
6. Health Council of Canada. Why health care renewal matters : lessons from diabetes. Toronto, ON: Health Council of Canada=Conseilcanadien de la santé; 2007.
7. Canadian Institute for Health Information. Supply, Distribution and Migration of Canadian Physicians, 2009 (Ottawa, Ont.: CIHI, 2010).
8. Shah BR, Hux JE, Laupacis A, Zinman B, van Walraven C. Clinical inertia in response to inadequate glycemic control: do specialists differ from primary care physicians? Diabetes Care 2005;28(3):600-6.
9. McAlister FA, Majumdar SR, Eurich DT, Johnson JA. The effect of specialist care within the first year on subsequent outcomes in 24,232 adults with new-onset diabetes mellitus: population-based cohort study. Qual Saf Health Care 2007;16(1):6-11.
10. Statistics Canada. Annual Demographic Estimates: Canada, Provinces and Territories. [cited 2011 Sept 7]. Available from: http://www.statcan.gc.ca/pub/91-215-x/91-215-x2010000-eng.pdf.
11. Toth EL, Majumdar SR, Guirguis LM, Lewanczuk RZ, Lee TK, Johnson JA. Compliance with clinical practice guidelines for type 2 diabetes in rural patients: treatment gaps and opportunities for improvement. Pharmacotherapy 2003;23(5):659-65.
12. Klinke JA, Johnson JA, Guirguis LM, Toth EL, Lee TK, Lewanczuk RZ, et al. Underuse of aspirin in type 2 diabetes mellitus: prevalence and correlates of therapy in rural Canada. Clin Ther 2004;26(3):439-46.
13. Rucker D, Johnson JA, Lee TK, Eurich DT, Lewanczuk RZ, Simpson SH, et al. The natural history of LDL control in type 2 diabetes: a prospective study of adherence to lipid guidelines. Diabetes Care 2006;29(11):2506-8.
14. Supina AL, Guirguis LM, Majumdar SR, Lewanczuk RZ, Lee TK, Toth EL, et al. Treatment gaps for hypertension management in rural Canadian patients with type 2 diabetes mellitus. Clin Ther 2004;26(4):598-606.
15. Alter DA, Khaykin Y, Austin PC, Tu JV, Hux JE. Processes and outcomes of care for diabetic acute myocardial infarction patients in Ontario: do physicians undertreat? Diabetes Care 2003;26(5):1427-34.
16. Brown LC, Johnson JA, Majumdar SR, Tsuyuki RT, McAlister FA. Evidence of suboptimal management of cardiovascular risk in patients with type 2 diabetes mellitus and symptomatic atherosclerosis. CMAJ 2004;171(10):1189-92.
17. Shah BR, Mamdani M, Jaakkimainen L, Hux JE. Risk modification for diabetic patients are other risk factors treated as diligently as glycemia? Can J Clin Pharmacol 2004;11(2):e239-44.
18. Chan BTB, Klomp K, Cascagnette P. Quality of diabetes management in Saskatchewan. Health Quality Council, 2006.2008. Available from: Gibson Library Connections.
19. Brown SA. Effects of educational interventions in diabetes care: a meta-analysis of findings. NursRes 1988;37(4):223-30.
20. Renders CM, Valk GD, de Sonnaville JJJ, Twisk J, Kriegsman DMW, Heine RJ, et al. Quality of care for patients with type 2 diabetes mellitus-a long-term comparison of two quality improvement programmes in the Netherlands. Diabetic Med 2003;20(10):846-52.
21. Renders CM, Valk GD, Griffin SJ, Wagner EH, Eijk van JT, Assendelft WJ. Interventions to improve the management of diabetes in primary care, outpatient, and community settings: a systematic review. Diabetes Care 2001;24(10):1821-33.
22. Brown SA. Meta-analysis of diabetes patient education research: variations in intervention effects across studies. Res Nurs Health 1992;15(6):409-19.
23. Shiu JR, Simpson SH, Johnson JA, Tsuyuki RT. Quantifying opportunities to affect diabetes management in the community. Canadian Pharmacists Journal 2006;139(3):37-8.

Chapter 5

# Use of Indicated Laboratory Testing among People with Diabetes in Alberta


Lauren C. Bresee
Brenda R. Hemmelgarn
Fiona Clement
Zhi Tan
Braden J. Manns
Marcello Tonelli

# USE OF INDICATED LABORATORY TESTING AMONG PEOPLE WITH DIABETES IN ALBERTA

## KEY MESSAGES

- People with diabetes in Alberta are not obtaining the recommended laboratory tests, particularly those in younger age groups.
- Urine albumin to creatinine ratio (ACR) was the least frequently utilized among recommended tests in 2008; only 41% of people with diabetes had an ACR.
- Many individuals, particularly those in the younger age groups, were above the target laboratory levels recommended by the Canadian Diabetes Association 2003 Clinical Practice Guidelines.

## BACKGROUND

The development of macrovascular (coronary artery disease, cerebrovascular disease, and peripheral arterial disease) and microvascular (nephropathy, neuropathy, and retinopathy) complications contribute to increased morbidity and mortality in individuals with diabetes.[1-6] Laboratory monitoring, including measurement of glycated hemoglobin (A1C), low-density lipoprotein (LDL), and urine albumin to creatinine ratio (ACR), is an important part of the prevention and management of complications associated with diabetes.[1] A1C provides a measure of glycemic control over the previous three to four months, and is important because poor glycemic control increases the development of microvascular complications in people with diabetes,[1,5,6] and therapy aimed at lowering elevated A1C has been shown to improve microvascular outcomes.[5,6] Elevated LDL is a risk factor for cardiovascular disease, and therapies which lower LDL have been shown to improve survival and reduce cardiovascular events.[1,7,8] Lastly, diabetes is the leading cause of end-stage renal disease, and ACR is a useful screening tool for detecting diabetic nephropathy. Screening for diabetic nephropathy is critical since kidney failure can be prevented or delayed using angiotensin blockade and control of hypertension.[1,9]

Despite the availability of clinical practice guidelines for laboratory monitoring of people with diabetes, evidence has demonstrated that A1C and LDL testing in people with diabetes is underutilized. Woodward and colleagues found that, of 64,000 patients with diabetes in Ontario in 1999/2000, 58% had at least one A1C test done in a one year period, and of those patients, only 45% were at or below the recommended target for A1C (defined as $<7.0\%$).[10,11] More recently, Klomp and colleagues used data from Saskatchewan to demonstrate that 67% of people with diabetes had at least one A1C test completed in 2005/06, and of those tested, only 48% were at or below target ($\leq 7.0\%$).[12,13] Similarly, Wilson et al found that only 64% of people with diabetes living in Ontario had at least one A1C test conducted in 2005.[14] In terms of LDL testing, only 50% of people with diabetes in Saskatchewan had their LDL measured, and 45% of those tested were at the recommended target of $<2.5$ mmol/L in 2005.[13]

Screening for diabetic nephropathy in patients with diabetes in Canada seems to occur less frequently than A1C or LDL testing. Harris and colleagues reported that only 17.5% of people received an ACR test based on a national physician survey conducted in Canada from 1998 until 1999.(15) Similarly, Ludwig and colleagues found that 16.5% of Manitobans with diabetes were screened for diabetic nephropathy in 1999/2000.(16)

The results of the above studies suggest that a significant portion of people with diabetes are not being monitored as frequently as is recommended by clinical practice guidelines, and in those who are tested, less than half are at recommended targets for LDL and A1C.

Our objective was to describe the frequency of laboratory testing for A1C, LDL, and ACR in adults with diabetes in Alberta in 2008. As well, we aimed to evaluate the proportion of individuals who achieved recommended targets for each laboratory test. The Canadian Diabetes Association (CDA) 2003 Clinical Practice Guidelines (CPGs) were available for the time period of the data used, and are therefore used to interpret the results of this chapter.(12) The CDA 2003 CPGs recommend monitoring A1C every 3 months to ensure the target A1C of ≤ 7.0% is met and maintained.(12) The target LDL for a person with diabetes is < 2.5 mmol/L; LDL testing should occur at the time of diabetes diagnosis, and then every 1 to 3 years as clinically indicated, although individuals who are receiving pharmacotherapy for dyslipidemia should be monitored more frequently.(12) ACR should be measured at the time of diagnosis and then annually for someone with type 2 diabetes, and annually in postpubertal individuals with type 1 diabetes who have had diabetes for ≥ 5 years.(12) The normal range for ACR for women is < 2.8 mg/mmol, and < 2.0 mg/mmol for men.(12)

## METHODS

Information from the Alberta Kidney Disease Network (AKDN) was used to evaluate the objectives of this chapter.(14) The data holdings of the AKDN include laboratory data that is then linked to administrative data from Alberta Health and Wellness to provide demographic and comorbidity information on residents of Alberta. Data from January 1, 2008 until December 31, 2008 were used, and individuals 20 years and older as of January 1, 2008 were included in the analysis.

Individuals with diabetes were identified as discussed in the Methods chapter of this Atlas. The denominator was based on all adults with diabetes who were alive and had a valid postal code in Alberta as of December 31, 2007. The proportion of individuals who received at least one A1C, LDL, or ACR test was evaluated among all adults with diabetes in Alberta, and the average number of tests is also reported for these individuals. In addition, we report the descriptive statistics (mean, median, and interquartile range (IQR)) for those receiving at least one of the above lab tests in 2008. Lastly, the proportion of subjects at or below target laboratory levels based on the 2003 CPGs were evaluated for those who received at least one test. For individuals who underwent more than one test in 2008, the overall average test result was used to assess achievement of the recommended laboratory target. All laboratory testing was completed on an out-patient basis, and analyses are presented stratified by age and sex.

## FINDINGS

A total of 180,120 adults 20 years of age and older were identified as having diabetes in 2008. Of these individuals, 118,296 (65.7%) had at least one A1C test, 108,386 (60.2%) had at least one LDL test, and 73,649 (40.9%) had at least one ACR test in 2008.

### Frequency of Laboratory Testing

The proportion of people with diabetes who had at least one A1C test in 2008, by age and sex, is provided in Figure 5.1. Over 70% of people with diabetes aged 60 to 74 years received an A1C test in 2008, whereas just over 40% of people with diabetes aged 20 to 34 years old had their A1C tested. Males with diabetes aged 30 to 49 years underwent A1C testing more frequently than their female counterparts, whereas other age groups demonstrated a similar frequency of testing between males and females.

Approximately 60.2% of people with diabetes received at least one LDL test in 2008 (Figure 5.2). Similarly to A1C testing, LDL testing occurred most frequently in people with diabetes 60 to 74 years of age, and least frequently in those less than 30 years old. Males with diabetes aged 30 to 39 years were more likely to have their LDL tested compared to females of the same age. All other age groups were similar in terms of likelihood of receiving an LDL test in 2008 for males and females.

Figure 5.1 **Percentage of individuals with at least one out-patient A1C test, Among patients with Diabetes, 2008**

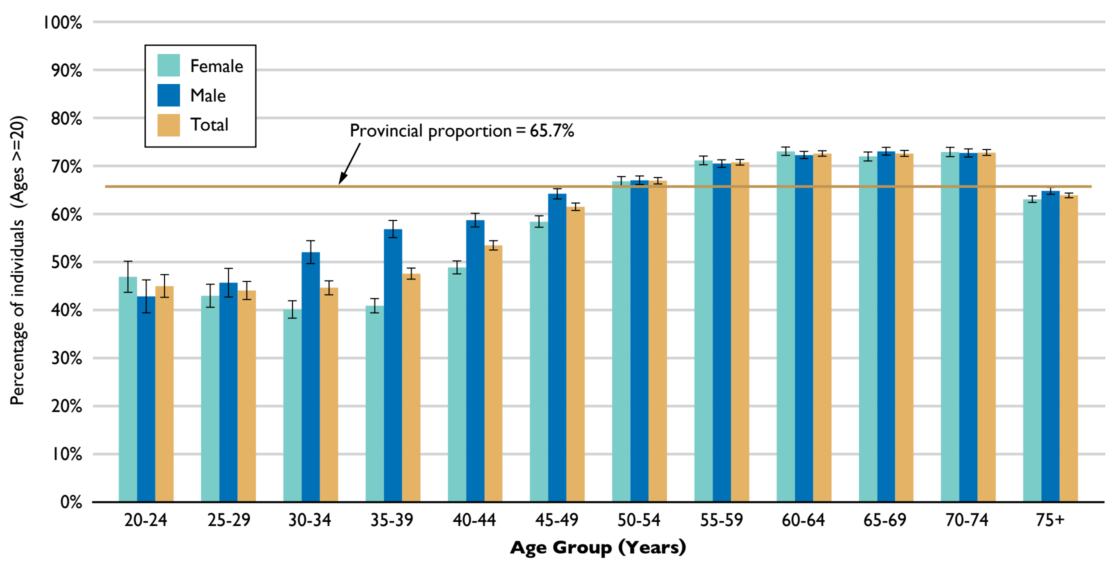
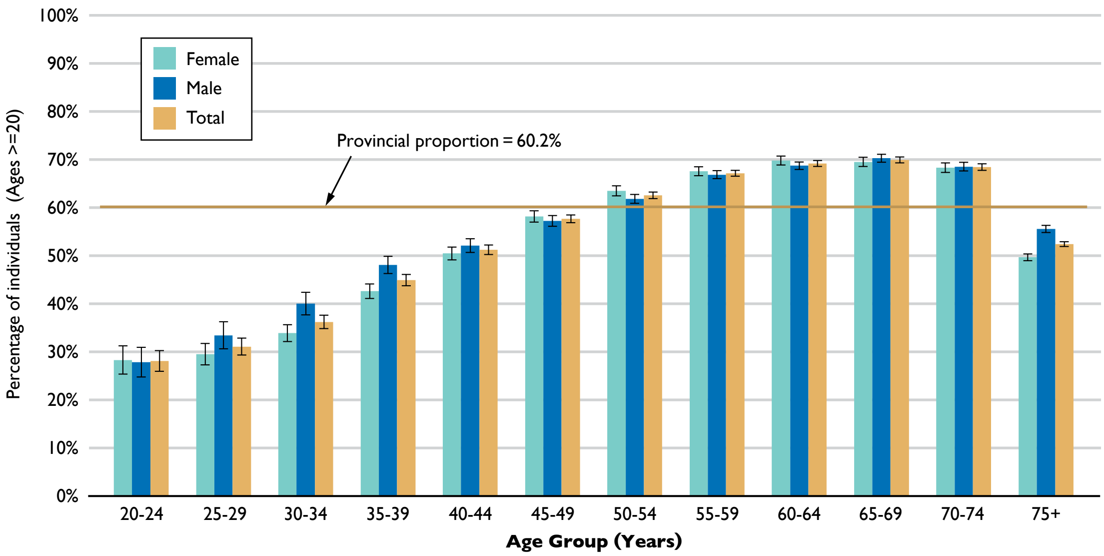


Figure 5.2 **Percentage of individuals with at least one out-patient LDL test, Among patients with Diabetes, 2008**




Among laboratory tests examined, ACR was the least frequently conducted test, with 40.9% of people with diabetes receiving at least one ACR test in 2008 (Figure 5.3). Individuals with diabetes under 30 years were the least likely to have an ACR completed. People with diabetes aged 60 to 64 years had the highest proportion of having an ACR, but the proportion was still less than 50%. Similarly to A1C, males with diabetes aged 25 to 49 years were more likely to undergo an ACR test relative to females of the same age.

Figure 5.3 **Percentage of individuals with at least one out-patient ACR test, Among patients with Diabetes, 2008**

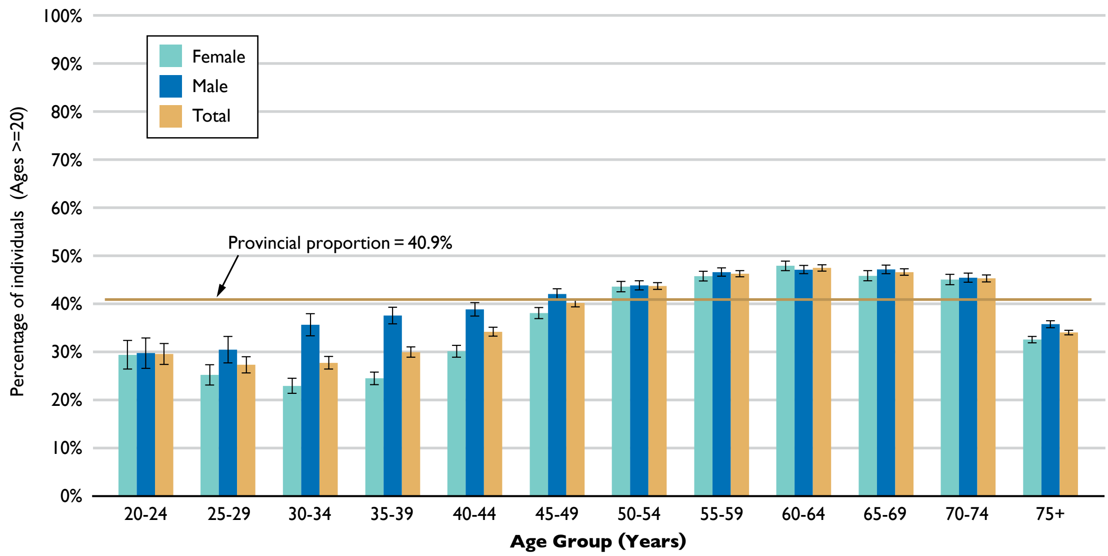



Figure 5.4 demonstrates the proportion of people who underwent 0, 1, 2, 3, or 4 or more tests in 2008. The figure demonstrates that laboratory testing for the majority of people with diabetes in Alberta was underutilized based on the 2003 CPG recommendations. Excess testing, however, did occur in a small number of individuals.

Figure 5.4 **Percentage of individuals by Frequency of out-patient A1C, LDL and/or ACR tests, Among patients with Diabetes, 2008**

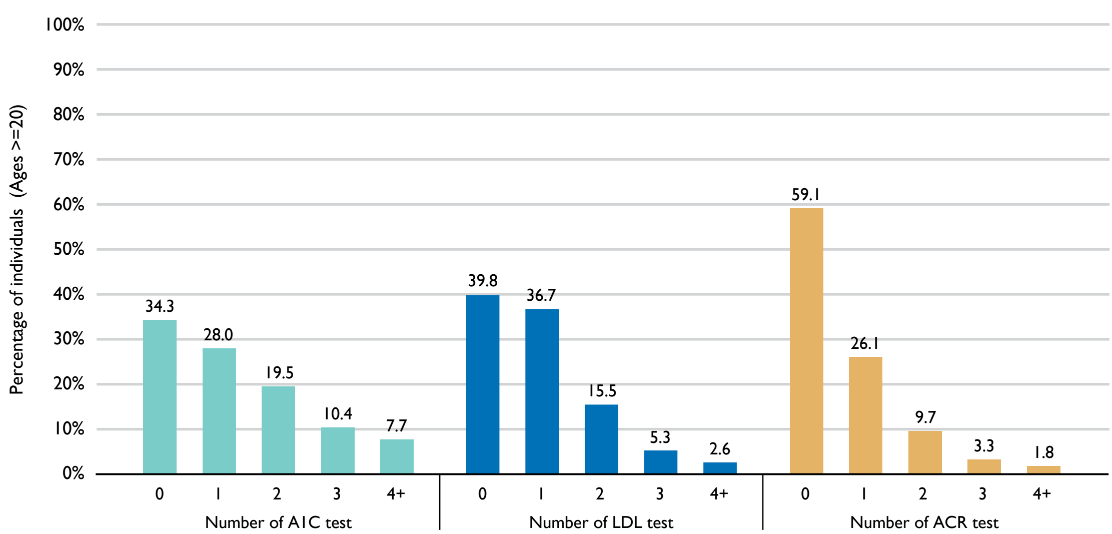


Table 5.1 reports the descriptive statistics relating to A1C testing, among people with at least one A1C test. The mean number of A1C tests in females with diabetes ranged from 1.86 to 2.29 between age groups, and from 1.62 to 2.18 in males in 2008.

Table 5.1 **Descriptive statistics for number of A1C tests, Among patients with Diabetes who had at least one A1C test, by age, 2008**

| | Number of patients | Statistics for number of A1C tests | | |
|---|---|---|---|---|
| | | Mean | Median | IQR† |
| **Female** | | | | |
| 20-24 | 421 | 1.99 | 2 | 1 |
| 25-29 | 688 | 2.29 | 2 | 2 |
| 30-34 | 1,110 | 2.00 | 1 | 1 |
| 35-39 | 1,687 | 1.95 | 1 | 1 |
| 40-44 | 2,626 | 1.86 | 2 | 1 |
| 45-49 | 3,910 | 1.93 | 2 | 1 |
| 50-54 | 5,546 | 1.99 | 2 | 2 |
| 55-59 | 6,820 | 2.01 | 2 | 2 |
| 60-64 | 6,969 | 2.05 | 2 | 2 |
| 65-69 | 6,369 | 2.10 | 2 | 2 |
| 70-74 | 6,041 | 2.14 | 2 | 2 |
| 75+ | 12,329 | 2.07 | 2 | 2 |
| **Male** | | | | |
| 20-24 | 344 | 1.62 | 1 | 1 |
| 25-29 | 490 | 1.62 | 1 | 1 |
| 30-34 | 876 | 1.80 | 1 | 1 |
| 35-39 | 1,691 | 1.89 | 2 | 1 |
| 40-44 | 2,750 | 1.89 | 2 | 1 |
| 45-49 | 4,875 | 1.96 | 2 | 2 |
| 50-54 | 7,163 | 2.00 | 2 | 2 |
| 55-59 | 8,991 | 2.04 | 2 | 2 |
| 60-64 | 9,483 | 2.08 | 2 | 2 |
| 65-69 | 8,629 | 2.13 | 2 | 2 |
| 70-74 | 7,445 | 2.18 | 2 | 2 |
| 75+ | 11,043 | 2.13 | 2 | 2 |

† IQR is the difference between the third quartile and the first quartile.

Descriptive statistics for LDL testing in people with diabetes, among those with at least one LDL measurement, is provided in Table 5.2. The mean number of LDL tests in 2008 ranged from 1.28 to 1.62 in females with diabetes and 1.26 to 1.64 in males.

Table 5.2 **Descriptive statistics for number of LDL tests, Among patients with Diabetes who had at least one LDL out-patient test, by age, 2008**

| | Number of patients | Statistics of number of LDL tests | | |
|---|---|---|---|---|
| | | Mean | Median | IQR† |
| **Female** | | | | |
| 20-24 | 254 | 1.28 | 1 | 0 |
| 25-29 | 473 | 1.33 | 1 | 0 |
| 30-34 | 939 | 1.36 | 1 | 1 |
| 35-39 | 1,759 | 1.36 | 1 | 1 |
| 40-44 | 2,714 | 1.42 | 1 | 1 |
| 45-49 | 3,894 | 1.49 | 1 | 1 |
| 50-54 | 5,273 | 1.61 | 1 | 1 |
| 55-59 | 6,479 | 1.59 | 1 | 1 |
| 60-64 | 6,657 | 1.61 | 1 | 1 |
| 65-69 | 6,151 | 1.62 | 1 | 1 |
| 70-74 | 5,661 | 1.62 | 1 | 1 |
| 75+ | 9,711 | 1.54 | 1 | 1 |
| **Male** | | | | |
| 20-24 | 224 | 1.26 | 1 | 0 |
| 25-29 | 359 | 1.34 | 1 | 0 |
| 30-34 | 674 | 1.44 | 1 | 1 |
| 35-39 | 1,431 | 1.52 | 1 | 1 |
| 40-44 | 2,441 | 1.53 | 1 | 1 |
| 45-49 | 4,346 | 1.55 | 1 | 1 |
| 50-54 | 6,609 | 1.59 | 1 | 1 |
| 55-59 | 8,530 | 1.62 | 1 | 1 |
| 60-64 | 9,018 | 1.64 | 1 | 1 |
| 65-69 | 8,302 | 1.64 | 1 | 1 |
| 70-74 | 7,016 | 1.64 | 1 | 1 |
| 75+ | 9,471 | 1.57 | 1 | 1 |

† IQR is the difference between the third quartile and the first quartile.

Table 5.3 provides descriptive information regarding frequency of ACR testing in people with diabetes, among those having at least one ACR test in 2008. Males and females underwent ACR testing to a similar extent.

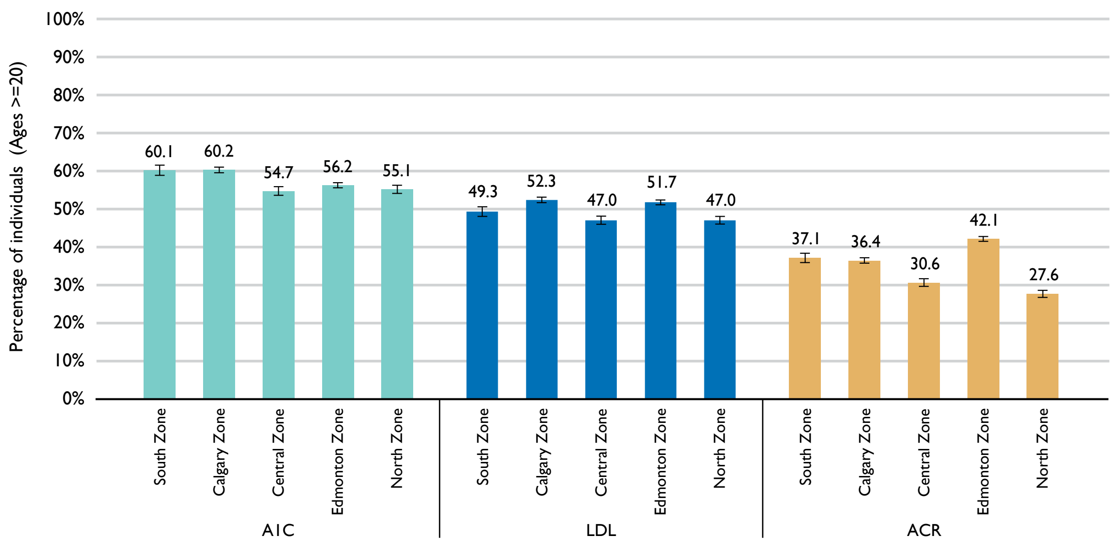
Table 5.3 **Descriptive statistics for number of ACR tests, Among patients with Diabetes who had at least one ACR out-patient test, by age, 2008**

| | Number of patients | Statistics of number of ACR tests | | |
|---|---|---|---|---|
| | | Mean | Median | IQR† |
| **Female** | | | | |
| 20-24 | 264 | 1.48 | 1 | 1 |
| 25-29 | 404 | 1.46 | 1 | 1 |
| 30-34 | 635 | 1.46 | 1 | 1 |
| 35-39 | 1,011 | 1.48 | 1 | 1 |
| 40-44 | 1,620 | 1.45 | 1 | 1 |
| 45-49 | 2,548 | 1.45 | 1 | 1 |
| 50-54 | 3,619 | 1.53 | 1 | 1 |
| 55-59 | 4,387 | 1.52 | 1 | 1 |
| 60-64 | 4,571 | 1.54 | 1 | 1 |
| 65-69 | 4,057 | 1.58 | 1 | 1 |
| 70-74 | 3,733 | 1.59 | 1 | 1 |
| 75+ | 6,364 | 1.57 | 1 | 1 |
| **Male** | | | | |
| 20-24 | 229 | 1.22 | 1 | 0 |
| 25-29 | 327 | 1.24 | 1 | 0 |
| 30-34 | 600 | 1.45 | 1 | 1 |
| 35-39 | 1,118 | 1.48 | 1 | 1 |
| 40-44 | 1,821 | 1.45 | 1 | 1 |
| 45-49 | 3,192 | 1.49 | 1 | 1 |
| 50-54 | 4,686 | 1.53 | 1 | 1 |
| 55-59 | 5,947 | 1.54 | 1 | 1 |
| 60-64 | 6,184 | 1.57 | 1 | 1 |
| 65-69 | 5,573 | 1.61 | 1 | 1 |
| 70-74 | 4,655 | 1.61 | 1 | 1 |
| 75+ | 6,094 | 1.62 | 1 | 1 |

† IQR is the difference between the third quartile and the first quartile.

In terms of regional variation, the proportion of people with diabetes receiving laboratory testing did not significantly differ between Alberta Health Zones, with the exception that more people in the Edmonton zone underwent ACR testing relative to other health zones (Figure 5.5).

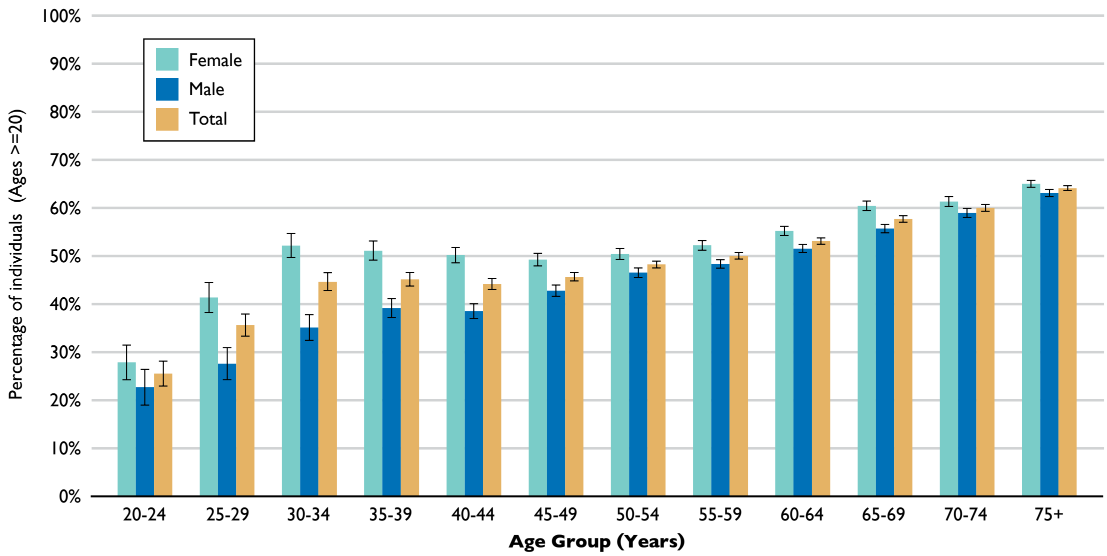
Figure 5.5 **Age- and sex-adjusted percentage of individuals with at least one out-patient A1C, LDL and/or ACR lab test, Among patients with Diabetes, by Zone, 2008**




## Achievement of Target Laboratory Levels

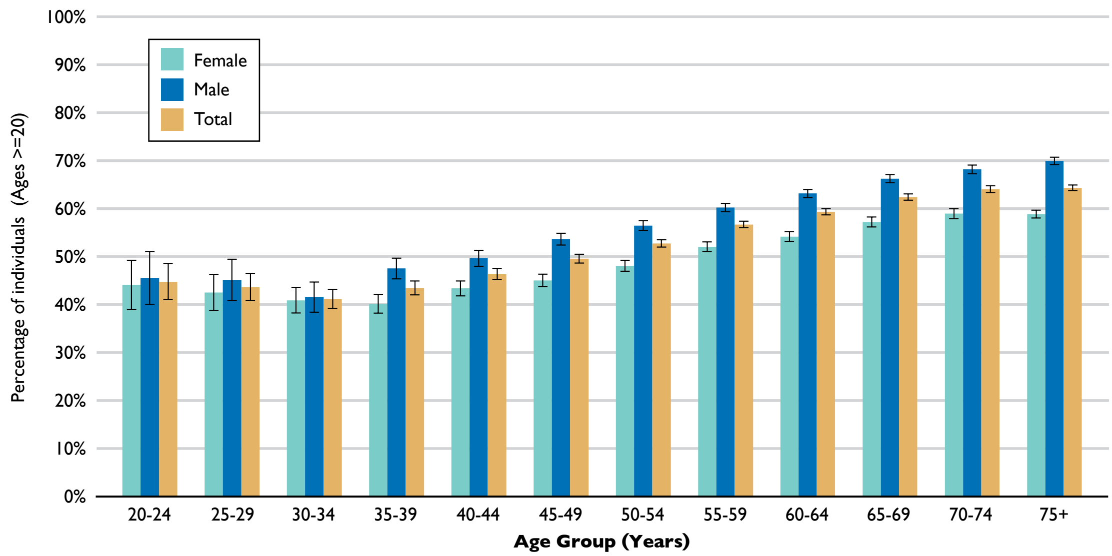
Of people with diabetes who underwent at least one A1C test in 2008, the majority were higher than the target of ≤ 7.0% as recommended by the 2003 CPGs, particularly those in the younger age groups (Figure 5.6).[12] These results must be interpreted with caution, however, as the proportion of subjects aged 20 to 24 years who underwent at least one A1C test was less than 50% of people with diabetes in that age group and this subset may represent a sicker population. In addition, for many of the age group comparisons, a higher proportion of females were more likely to be at the target A1C of ≤ 7.0% compared to males. The overall mean A1C for people with diabetes in 2008 was 7.31% (standard deviation (SD): 1.51).

Figure 5.6 **Percentage of individuals with a mean A1C <=7.0% who had at least one out-patient A1C lab test, Among patients with Diabetes, 2008**



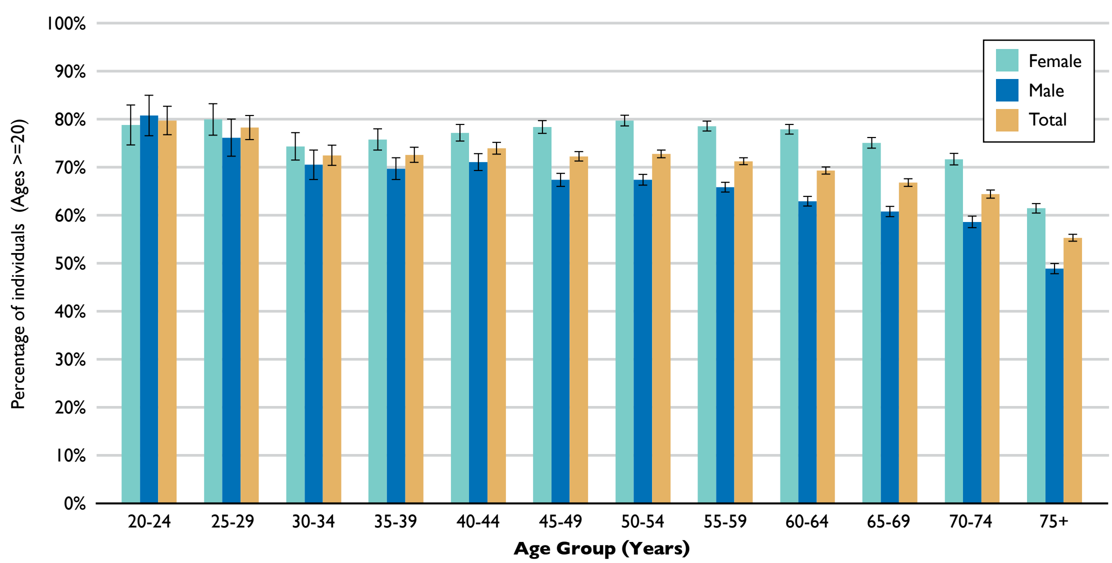

The proportion of people with diabetes who were at or below the LDL target of < 2.5 mmol/L are included in Figure 5.7. Similar to the A1C results, younger individuals were less likely to have an LDL of < 2.5 mmol/L relative to older individuals. These results must also be interpreted with caution given the low proportion of people receiving at least one LDL test in the younger age groups. Males with diabetes aged 35 years and older were more likely to have an LDL of less than 2.5 mmol/L compared to their female counterparts. The overall mean LDL for the population with diabetes was 2.42 mmol/L (SD: 0.83) in 2008.

Figure 5.7 **Percentage of individuals with a mean LDL of <2.5 mmol/L who had at least one out-patient LDL lab test, Among patients with Diabetes, 2008**




Of individuals who underwent an ACR test in 2008, the majority were within the targeted range as defined above (Figure 5.8).[12] The proportion of people with diabetes below the recommended target for ACR declined with age. In addition, women with diabetes aged 35 years and older were more likely to be below target compared to men in the same age group. The median ACR was 1.12 mg/mmol (IQR: 3.67) for men and 1.10 mg/mmol (IQR: 2.3) for women with diabetes in 2008.

Figure 5.8 **Percentage of individuals with a mean ACR of <2.0 mg/mmol for men and <2.8 mg/mmol for women, who had at least one out-patient ACR lab test, Among patients with Diabetes, 2008**



## DISCUSSION

Based on CDA Clinical Practice Guideline recommendations available in 2003,[12] and consistent with the results of previously published studies,[10,13-16] laboratory tests in individuals with diabetes in 2008 were underutilized. A1C was the most common test conducted, with 66% of people receiving at least one A1C test, whereas only 41% had an ACR test in 2008. In addition, although 66% of individuals with diabetes had their A1C tested in 2008, the majority of people only had 2 tests per year, which is less than the four tests per year recommended by the CDA 2003 CPGs.[12]

Treating patients to achieve target levels of an A1C of ≤ 7.0%, hypercholesterolemia, and an ACR of < 2.0 mg/mmol for men and < 2.8 mg/mmol for women, has been shown to improve outcomes in those with diabetes.[4-9] The results from this chapter demonstrate that, of individuals who underwent out-patient laboratory testing in 2008, many had A1C and LDL levels which were above the recommended targets. This is particularly worrisome in the younger population, where, although a small proportion of individuals with diabetes in younger age groups underwent A1C and LDL testing, of those tested, many were not at target. For example, only 25% of individuals with diabetes aged 20 to 24 years were at or below target for A1C, increasing the likelihood of developing microvascular complications.[4-6] Also, while the target LDL from the 2003 CPGs was less than 2.5 mmol/L,[12] the updated target was reduced in the CDA 2008 CPGs to less than 2.0 mmol/L.[1] Given the results of our analysis and the more aggressive target of < 2.0 mmol/L, it is likely that an even greater proportion of people are currently not at LDL target.

In summary, use of recommended laboratory testing in people with diabetes was underutilized, and of those who did undergo testing, many were not at recommended targets for LDL and A1C. Given the increased risk of micro- and macrovascular complications associated with elevated A1C, LDL, and ACR, and the availability of effective therapies for patients with these characteristics, strategies to increase appropriate lab monitoring in these individuals is warranted. In addition, policy and health care interventions are needed to ensure those who are not at target laboratory values are closely monitored and appropriately treated to prevent the onset or delay the progression of complications associated with diabetes.

## References

1 Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2008 clinical practice guidelines for the prevention and management of diabetes in Canada. Canadian Journal of Diabetes 2008;32(Suppl 1):S1-S201.

2 Barrett-Connor E, Pyorala K. Long-term complications: diabetes, coronary artery disease, stroke and lower extremity arterial disease. In: Ekoe J-M, Zimmet P, Williams R, eds. The Epidemiology of Diabetes Mellitus: An International Perspective. Chinchester, UK: John Wiley & Sons, Ltd.;2001:301-19.

3 Booth GL, Kapral MK, Fung K, et al. Relation between age and cardiovascular disease in men and women with diabetes compared with non-diabetic people: a population-based retrospective cohort study. Lancet 2006;368:29-36.

4 Stratton IM, Adler AI, H Neil AW, et al for the United Kingdom Prospective Diabetes Study group. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. BMJ 2000;321:405-12.

5 UK Prospective Diabetes Study Group. Intensive blood-glucose control with sulfonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). Lancet 1998;352:837-53.

6 The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. N Engl J Med 1993;329:977-986.

7 Colhoun HM, Betteridge DJ, Durrington PN, et al for the CARDS Investigators. Primary prevention of cardiovascular disease with atorvastatin in type 2 diabetes in the Collaborative Atorvastatin Diabetes Study (CARDS): multicentre randomised placebo-controlled trial. Lancet 2004;364:685-696.

8 Shepherd J, Barter P, Carmena R, et al. Effect of lowering LDL cholesterol substantially below currently recommended levels in patients with coronary heart disease and diabetes: the Treating to New Targets (TNT) study. *Diabetes Care*. 2006;29:1220-1226.

9 Keane WF, Brenner BM, De Zeeuw D, et al for the Renal Study Investigators. The risk of developing end-stage renal disease in patients with type 2 diabetes and nephropathy: the RENAAL Study. Kidney Int 2003;63:1499-1507.

10 Woodward G, van Walraven C, Hux JE. Utilization and outcomes of HbA1C testing: a population-based study. CMAJ 2006;174:327-329.

11 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.

12 Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian clinical practice guidelines for the prevention and management of diabetes in Canada. Canadian Journal of Diabetes 2003;27(Suppl 2):S1-S152.

13 Klomp H, Dyck RF, Sidhu N, Cascagnette PJ, Teare GF. Measuring quality of diabetes are by linking health care system administrative databases with laboratory data. BMC Research Notes 2010;3:233.

14 Wilson SE, Lipscombe LL, Rosella LC, Manuel DG. Trends in laboratory testing for diabetes in Ontario, Canada 1995 - 2005: a population-based study. BMC Health Services Research 2009;9:41.

15 Harris SB, Worrall G, Macaulay A, Norton P, Webster-Bogaert S, Donner A, et al. Diabetes management in Canada: baseline results of the Group Practice Diabetes Management Study. Canadian Journal of Diabetes 2006;30:131-137.

16 Ludwig SM, Griffith EJ, McQuillen KI, Anderson WA, Kvern BL, for the Manitoba Diabetes Care Project Executive Committee. Manitoba Diabetes Care Project: A1C and microalbumin testing. Canadian Journal of Diabetes 2006;30:146-160

17 Hemmelgarn BR, Clement F, Manns BJ, Klarenbach S, James MT, Ravani P, et al. Overview of the Alberta Kidney Disease Network. BMC Nephrology 2009;10:30.

Chapter 6

# Diabetes and Cardiovascular Disease in Alberta

**Diabetes and Acute Coronary Syndrome**

Michelle M. Graham
Sumit R. Majumdar
Colleen M. Norris
Jeffrey A. Johnson

**Diabetes and Heart Failure**

Dean T. Eurich
Finlay A. McAlister

**Diabetes and Stroke**

Michael D. Hill
Scot H. Simpson

**Diabetes and Hypertension**

Brenda R. Hemmelgarn
Hude Quan
Larry W. Svenson

# CHAPTER 6

# DIABETES AND CARDIOVASCULAR DISEASE IN ALBERTA

## Diabetes and Acute Coronary Syndrome

### KEY MESSAGES

- People with diabetes are 2.5 to more than 3 times as likely to suffer heart attacks or episodes of unstable angina than people without diabetes.
- Overall, rates of heart attacks and unstable angina have decreased considerably over the past decade.
- People with diabetes are 3 to 4 times as likely to require coronary revascularization procedures than people without diabetes.
- There has been an increased use of PCI relative to CABG in the past 15 years.
- Rates of PCI had increased until 2005, then substantially decreased after that where CABG rates had increased until about 2001-02, and then also continued to decrease.
- In 2009, women with diabetes were more likely to have heart disease and had similar rates of revascularization as men without diabetes.

## BACKGROUND

The primary cause of death in patients with diabetes is cardiovascular disease.[1] Most of this excess mortality risk is attributable to damage to the coronary arteries due to atherosclerotic disease, which can eventually lead to acute coronary syndromes (ACS), such as unstable angina and acute myocardial infarction (AMI, or also known as a heart attack).[1] The burden of heart disease in the diabetes population has been studied extensively, including numerous reports in Canadian populations.[2,3] In addition to the increased morbidity and mortality, cardiovascular disease is also a leading driver of health care costs for people with diabetes.[4]

The population burden of heart disease can be reported in several ways. In this chapter of the *Alberta Diabetes Atlas*, we report on the clinical outcomes of AMI and unstable angina, as well as the major procedures used to treat and prevent these conditions: percutaneous coronary interventions (PCI) and coronary artery bypass graft (CABG) surgery, collectively referred to as coronary revascularization. PCI is a procedure where a catheter is inserted into an artery in the groin or the wrist and threaded into the heart and coronary blood vessels, where a tiny balloon is inflated to reduce blockages. Generally, a mesh tube, called a stent, is opened up inside the coronary vessel to keep the blocked area open. CABG involves open heart surgery, and inserting bypass grafts (arteries or veins from other areas of the body) on the heart to detour blood flow around the blockages in the coronary vessels.

## METHODS

Data from Alberta Health and Wellness (AHW) administrative databases were utilized for these analyses, which capture Alberta resident demographic information for all physician visits and procedures. People with diabetes were identified within the AHW databases by applying a modified version of the National Diabetes Surveillance System (NDSS) algorithm (see "Background and Methods" chapter). All adult patients aged 20 or older were included in these analyses.

We abstracted diagnostic codes for ACS (AMI and unstable angina) from the provincial Discharge Abstracts Database (see appendix). We also abstracted procedure codes for CABG and PCI from the Physician Claims database (see appendix). Of note, rates of revascularization procedures were not restricted to acute coronary syndromes, and also included non-urgent and elective procedures.

From these data, rates of ACS for those with and without diabetes were calculated. For each group, the number of people with ACS diagnostic or procedure codes (numerator) was divided by the total number of people in the province or zone (denominator), respectively. As with other rates in the *Atlas*, we used direct standardization to age- and sex-adjust rates using the Alberta population from the 2006 Canadian Census. We present trends of ACS or coronary revascularization procedures over time (1995-2009, unless otherwise specified), and across age groups and health zones for the most recent year (2009).

## FINDINGS

### Acute Coronary Syndromes

From 1995-2009, the prevalence *rate* of ACS declined in both the non-diabetic population and in people with diabetes, with this decrease most notable in men and women with diabetes (Figure 6.1). The absolute difference in ACS rates between the population with and without diabetes has also become smaller. The actual *number* of people suffering from ACS, however, has remained fairly stable in people *without* diabetes over that time, between about 4,000-4,500 people per year (Figure 6.2). A different picture is seen when observing people *with* diabetes, where cases of ACS have increased by 53% since 1995. There are also notable sex differences, with the highest ACS rates in males with diabetes, and the lowest in females without diabetes (Figure 6.1). Interestingly, while heart disease is generally more common in men, the rate of ACS in women with diabetes actually exceeds the rate in men without diabetes.

In 2009, people with diabetes were more than 2 times more likely to have ACS than people without diabetes. While older individuals were more likely to have ACS overall, the excess risk associated with diabetes was much higher in younger adults (Figure 6.3).

Figure 6.1 **Age-Adjusted Rates of Acute Coronary Syndrome, 1995-2009**

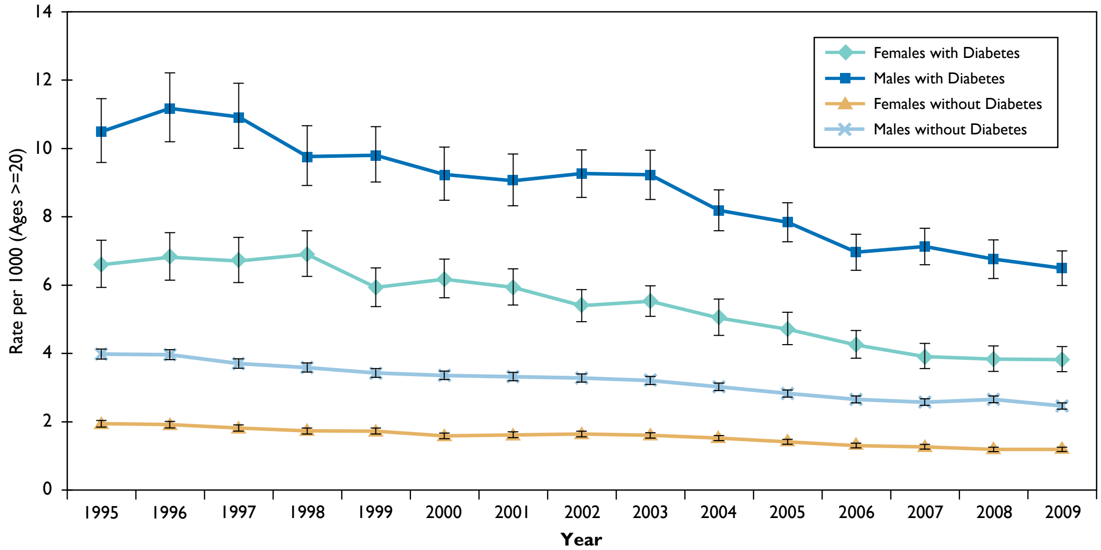



Figure 6.2 **Number of Acute Coronary Syndrome Cases, 1995-2009**

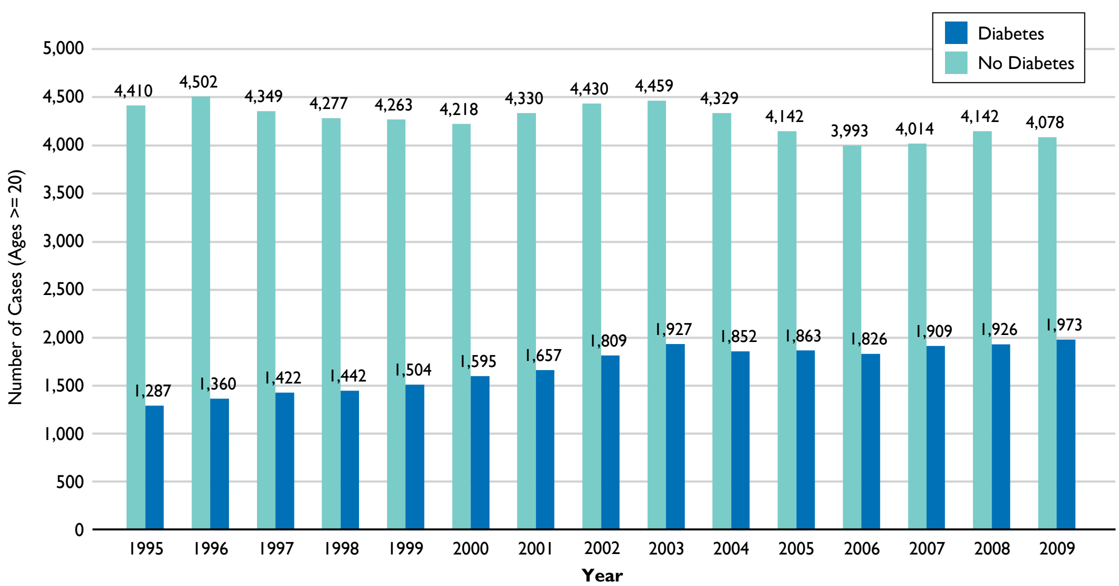
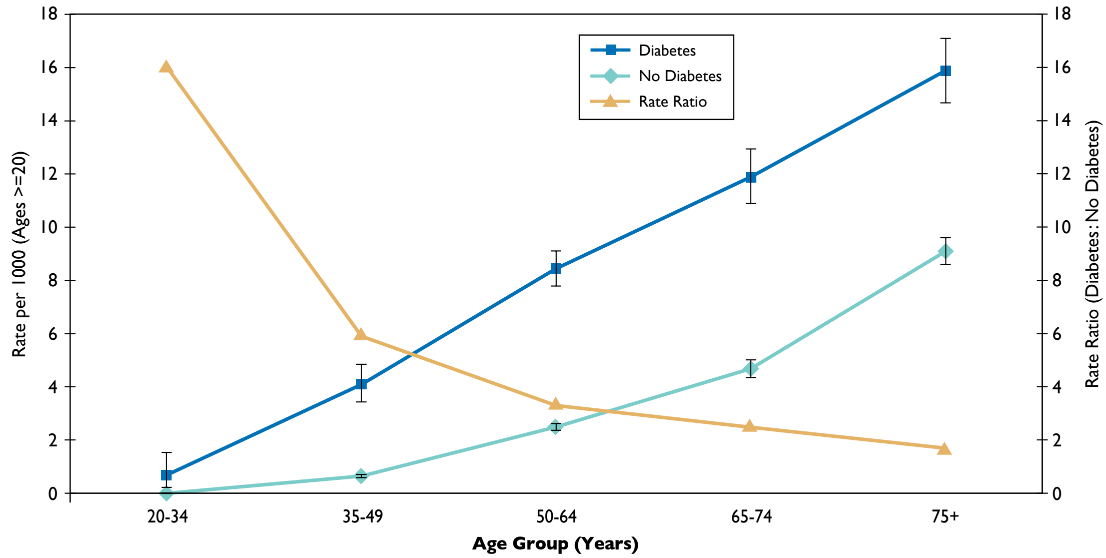
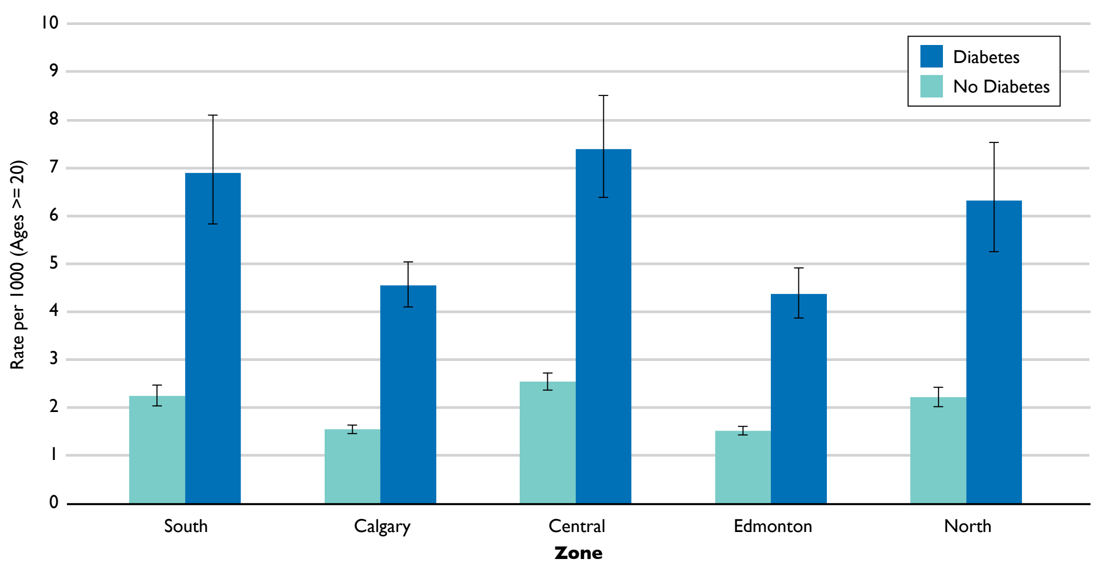


Figure 6.3 **Age-Specific Rates of Acute Coronary Syndrome, 2009**




When examining the age-adjusted rates of ACS across the province in 2009, patients with diabetes were nearly 3 times as likely to have heart disease than patients without diabetes (Figure 6.4). The rate of ACS for patients with diabetes was highest in the Central zone, followed by the South and North zones, with the lowest rates in the Edmonton and Calgary zones. This was also the pattern seen for patients without diabetes.

Figure 6.4 **Age-Adjusted Rates of Acute Coronary Syndrome by Zone, 2009**



## Revascularization Procedures

There has been variation in the rate of PCI and CABG for people with diabetes over the past decade. The total number of revascularization procedures for those with and without diabetes has grown over the past decade (Figure 6.5), particularly due to increased use of PCI, with a 270% increase in PCI procedures in patients with diabetes compared with an 91% increase in PCI use in patients without diabetes (Figure 6.6). Overall, PCI rates gradually increased from 1995-2005, but have fallen from 2005-2009, with that decline particularly noticeable in males with diabetes (Figure 6.7). CABG procedures in Alberta increased by 110% in patients with diabetes (Figure 6.8). Overall, CABG procedures have been on the decline since 2003, and this is again most noticeable in males with diabetes (Figure 6.9).

Figure 6.5 **Total Number of People Undergoing PCI and CABG Procedures, 1995-2009**

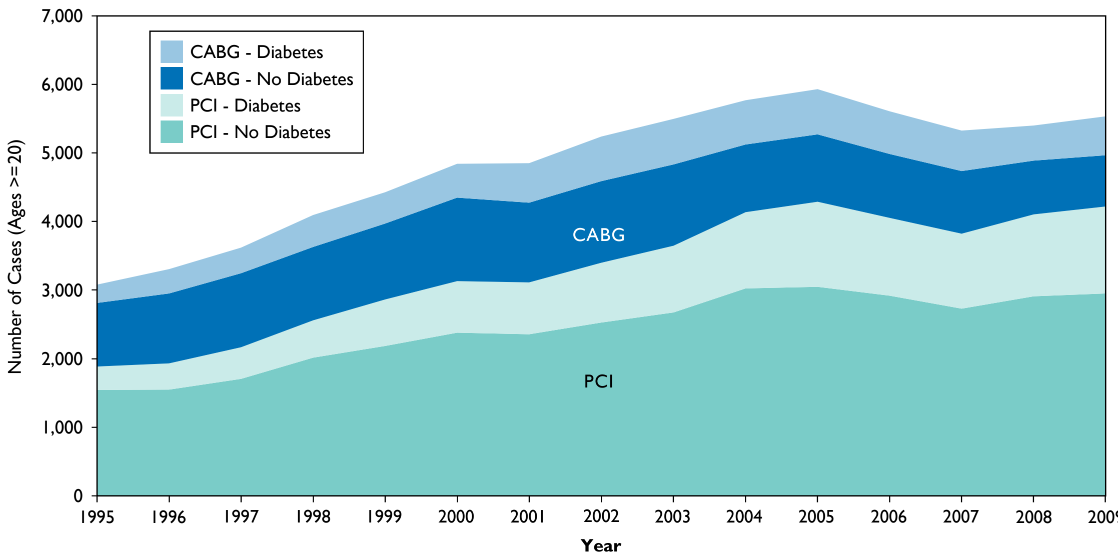



Figure 6.6 **Number of People Undergoing PCI, 1995-2009**

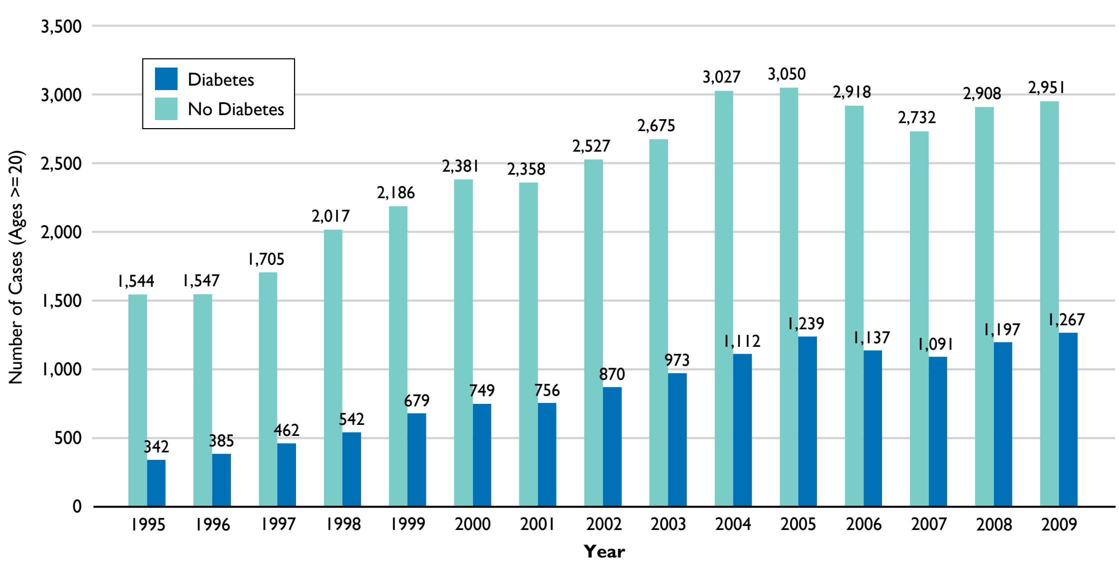


Figure 6.7 **Age-Adjusted Rates of People Undergoing PCI, 1995-2009**

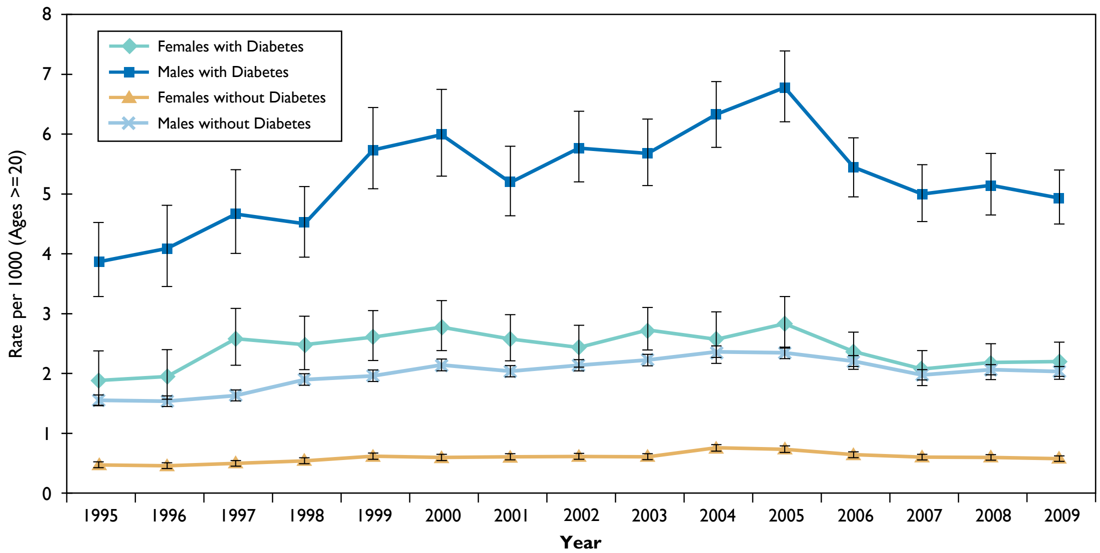



Figure 6.8 **Number of People Undergoing CABG, 1995-2009**

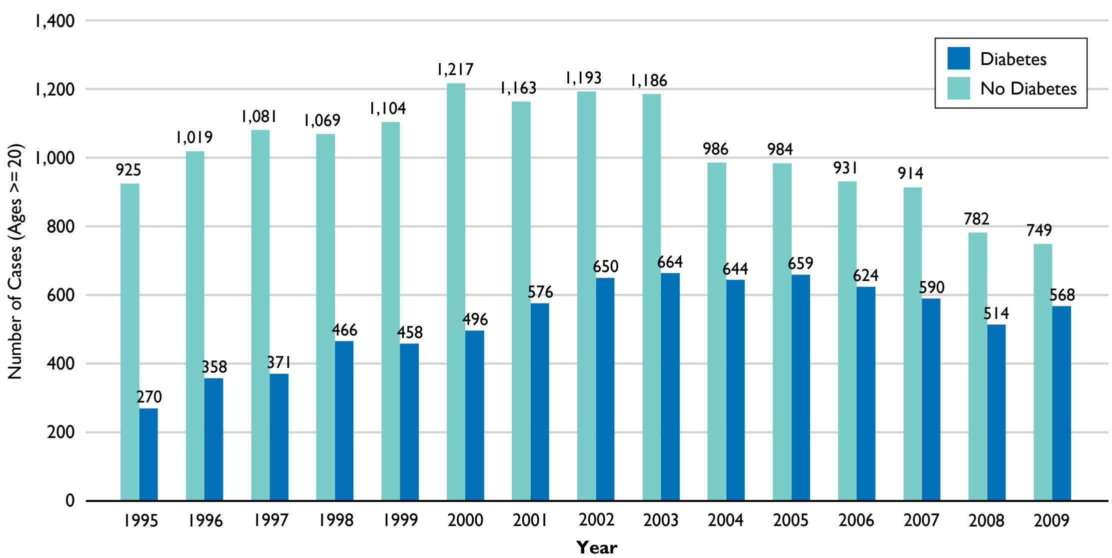
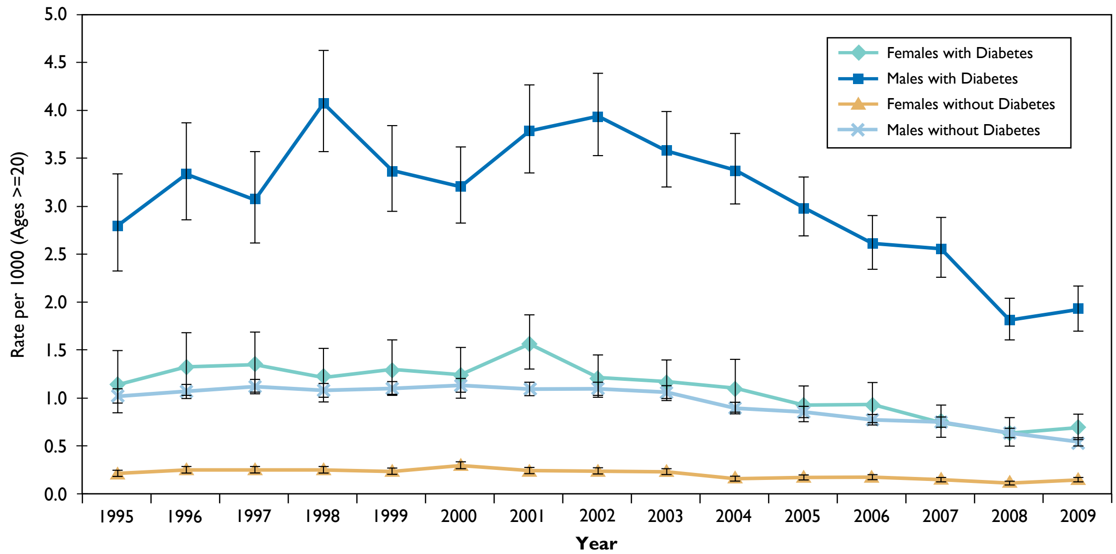


Figure 6.9 **Age-Adjusted Rates of People Undergoing CABG, 1995-2009**




There was variation in the rates of PCI and CABG for people living in different health zones. For people with diabetes, the highest rates of PCI were seen for those living in the Northern zone of the province; and the lowest rates were found in the South zone (Figure 6.10). Interestingly, there appeared to be greater variation in PCI across health zones for patients with diabetes compared to patients without diabetes. The rate of CABG was lowest in the Central zone for patients with diabetes and the lowest in the Calgary zone for patients without diabetes. It was the highest in the Edmonton zone for patients with diabetes and the second highest among the non-diabetes populations (Figure 6.11).

Figure 6.10 **Age-Adjusted Rates of People Undergoing PCI by Zone, 2009**

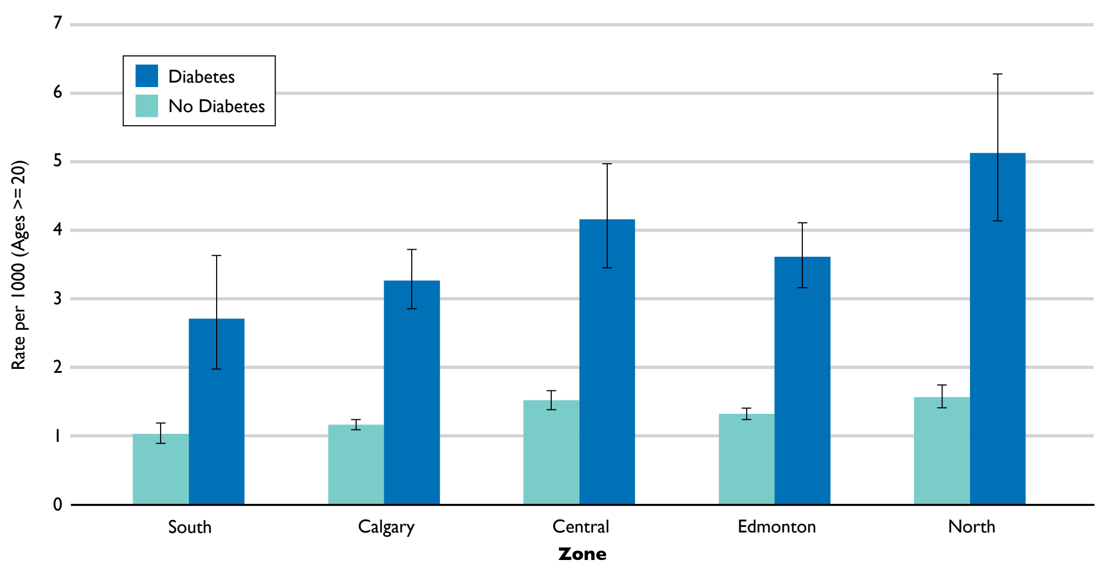
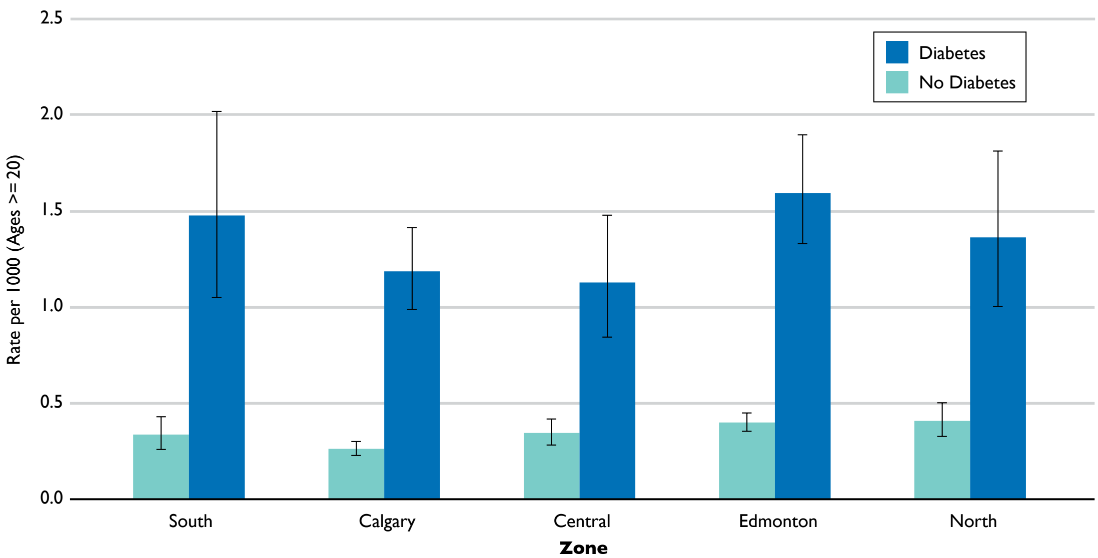
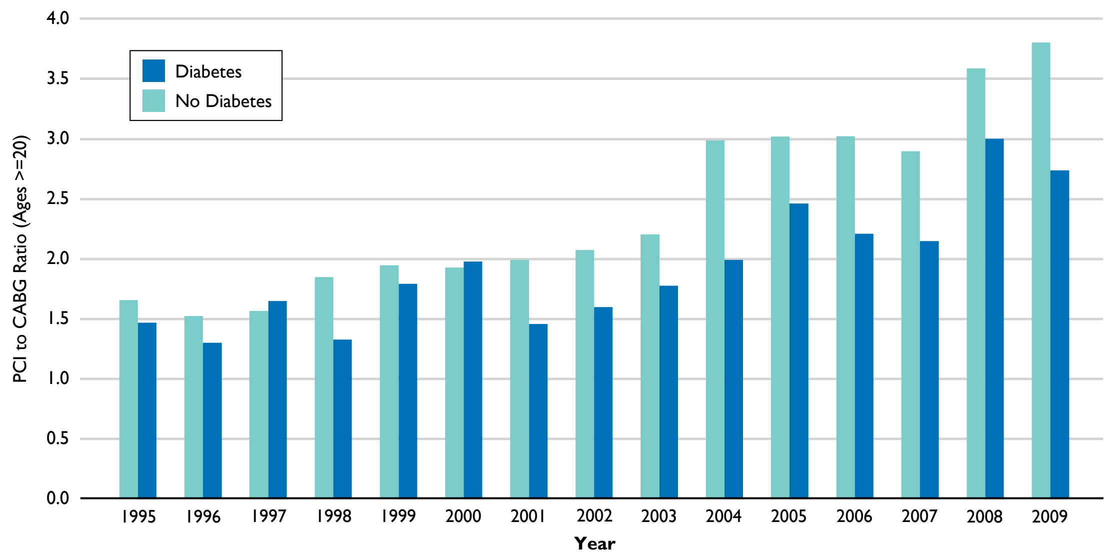


Figure 6.11 **Age-Adjusted Rates of People Undergoing CABG by Zone, 2009**



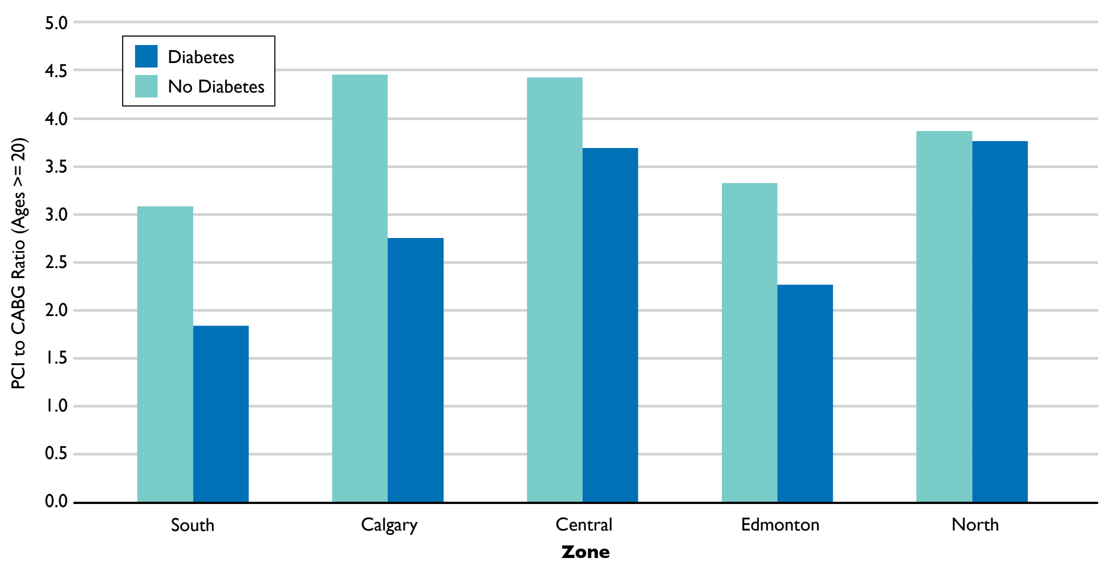

The ratio of PCI to CABG provides an interesting perspective on the use of these two revascularization procedures, and also demonstrates changes in the management of CVD in people with diabetes over the past 15 years. In the non-diabetes population this ratio has increased from 1.7 in 1995 to 3.8 in 2009 (Figure 6.12). This means that PCI was becoming a much more popular treatment strategy in the non-diabetes population over this time period. Interestingly, the ratio of PCI to CABG has generally been lower for people with diabetes over the entire time period.

Figure 6.12 **Age- and Sex-Adjusted Rate Ratios of PCI to CABG, 1995-2009**




The PCI to CABG ratio differed considerably for residents of different zones (Figure 6.13). PCI was 4 times more likely than CABG for the Central and North zones for patients with diabetes, but patients without diabetes were over 4 times more likely to have PCI than CABG in the Central and Calgary zones. Patients from Edmonton and South zones had lower ratios where PCI was approximately 2 times more likely than CABG for those with diabetes, and 3 times more likely for people without diabetes. In contrast to the rest of the province, the ratio of PCI to CABG in the North zone was about the same for people with and without diabetes (Figure 6.13).

Figure 6.13 **Age-Adjusted Rate Ratios of PCI to CABG by Zone, 2009**



## DISCUSSION

Cardiovascular disease is clearly one of the most important comorbidities in people with diabetes. It is the leading cause of death(3,5,6) and one of the largest drivers of health care costs in people with diabetes.(4) In this section of the *Alberta Diabetes Atlas*, we report on both clinical outcomes of ACS (heart attacks and angina) as well as the major revascularization procedures used to manage this condition (PCI and CABG). Both indicators tell a similar bad-news, good-news story. The bad news is that the burden of heart disease continues to grow in the diabetes population; the good news is that some success has been achieved in reducing the risk of severe outcomes.

There is an abundance of evidence for numerous medical strategies to reduce cardiovascular risk, including blood pressure reduction, cholesterol reduction and anti-platelet therapy (e.g. ASA). More widespread use of evidence-based drug treatments have surely decreased patients' risk of cardiovascular death.(3,6,7) In addition to drug therapies, behavioral changes including weight loss and smoking cessation are also important to consider. Most of these risk reduction strategies are supported by the highest level of evidence.(5)

Unfortunately, by all estimates, the attention to reducing cardiovascular risk in patients with diabetes remains dismal,(8-11) including evidence from Alberta.(12-14) The under-treatment of cardiovascular risk remains a problem, even after a major event like a heart attack (so-called secondary prevention).(15) There is room for significant improvement using more aggressive application of the various risk reduction therapies in this population. This may be particularly true for women with diabetes, given their risk of adverse events exceeds even that of men in the general population.

Diabetes clearly places an increased burden on the Alberta health care system, with rates of PCI and CABG for people with diabetes being 3 to 4 times as high compared to those without diabetes. The increasing rate of PCI use in patients with diabetes likely reflects the widespread use of drug eluting stents. These stents are coated with drugs to decrease the risk of coronary blockages returning over time (re-stenosis) and are found to be particularly helpful for patients with diabetes.(16) In addition, patients with acute heart attacks are often treated directly with PCI (primary PCI) rather than with clot-busting drugs. Patients with diabetes often have severe blockages in multiple coronary arteries. In stable patients, including those hospitalized with ACS, CABG remains the preferred treatment strategy, because of the long-lasting benefits.(17) Indeed, this may be part of the explanation for the fact that the ratio of PCI to CABG remains lower in the population with diabetes than the rest of the population.

The decrease in rates of both CABG and PCI since 2002 and 2005 respectively may be a trend that continues given recent evidence that these strategies may not be superior to good medical therapy, including one trial specific to patients with diabetes.(18,19) Further investigation is required to determine whether these findings hold true in "real-world" patients, such as those residing in the province of Alberta.

Interestingly, a north to south gradient for PCI rates can be seen in the whole population, for people with and without diabetes. There was, however, considerably more variation in the use of CABG, particularly for people with diabetes. This is further represented by the ratio of PCI to CABG, which suggests that people with diabetes and heart disease are managed quite differently depending on where they live in the province. Previous reports from the Alberta Provincial Project for Outcomes Assessment in Coronary Heart Disease (APPROACH) data suggested regional variation as well.[20] Given that variation in ACS rates by zone do not necessarily follow the same patterns of revascularization, reasons for these different patterns of care, and whether these differences in management actually lead to different outcomes[21] should be explored in future research.

## APPENDIX

**Acute Coronary Syndrome**

### Alberta Physician Claims Data

| Procedure | Procedure Codes |
|---|---|
| PCI | 51.59A, 51.59C, 51.59D, 51.59E, 51.59F |
| CABG | 48.12, 48.12A, 48.13, 48.13A, 48.14, 48.14A, 48.15A, 48.15E, 48.15B, 48.15F, 48.15C, 48.15G, 48.15D |

### Discharge Abstracts Database

| Diagnosis | ICD-9-CM | ICD-10-CA |
|---|---|---|
| Acute MI | 410.X | I21.X-I22.X |
| Unstable Angina | 411.X, 413.X | I20.X, I24.X |

## References


1. Haffner SM, Lehto S, Ronnemaa T, Pyorala K, Laasko M. Mortality from coronary heart disease in subjects with type 2 diabetes and in nondiabetic subjects with and without prior myocardial infarction. NEJM 1998;339:229-34.
2. Tanuseputro P, Manuel DG, Leung M, Nguyen M, Johansen H. Risk factors for cardiovascular disease in Canada. Can J Cardiol 2003;19(11):1249-59.
3. Booth GL, Kapral MK, Fung K, Tu JV. Recent trends in cardiovascular complications among men and women with and without diabetes. Diabetes Care 2006;29(1):32-7.
4. Simpson SH, Jacobs P, Corabian P, Johnson JA. The cost of major comorbidity in people with diabetes mellitus. CMAJ 2003;168(13):1661-7.
5. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. 2003 clinical practice guidelines for the prevention and treatment of diabetes. Can J Diabetes. 2003;27(Suppl 2):S1-S152.
6. Gaede P, Vedel P, Larsen N, et al. Multifactorial intervention and cardiovascular disease in patients with type 2 diabetes. N Engl J Med. 2003;348:383-93.
7. Eurich DT, Majumdar SR, Tsuyuki RT, Johnson JA. Reduced mortality associated with the use of ACE inhibitors in patients with type 2 diabetes. Diabetes Care 2004;27:1330-34.
8. Alter DA, Khaykin Y, Austin PC, Tu JV, Hux JE. Processes and outcomes of care for diabetic acute myocardial infarction patients in Ontario: do physicians undertreat? Diabetes Care 2003;26:1427-34.
9. Brown LC, Johnson JA, Majumdar SR, Tsuyuki RT, McAlister FA. Evidence of sub-optimal cardiovascular risk management in patients with type 2 diabetes mellitus and symptomatic atherosclerosis. CMAJ 2004;171(10):1189-92.
10. Chan BTB, Klomp H, Cascagnette P. Quality of diabetes management in Saskatchewan. Health Quality Council. January 2006.
11. Shah BR, Mamdani M, Jaakkimainen L, Hux JE. Risk modification for diabetic patients. Are other risk factors treated as diligently as glycemia? Can J Clin Pharmacol 2004;11:e239-44.
12. Toth EL, Majumdar SR, Guirguis LM, Lewanczuk RZ, Lee TK, Johnson JA. Compliance with clinical practice guidelines for type 2 diabetes in rural patients: treatment gaps and opportunities for improvement. Pharmacotherapy 2003;23(5):659-65.
13. Supina AL, Guirguis LM, Majumdar SR, Lewanczuk RZ, Lee TK, Toth EL, Johnson JA. Treatment gaps for hypertension management in rural Canadian patients with type 2 diabetes mellitus. Clin Ther 2004;26:598-606.
14. Klinke JA, Johnson JA, Guirguis LM, Toth EL, Lee TK, Lewanczuk RZ, et al. Underuse of aspirin in type-2 diabetes mellitus: prevalence and correlates of therapy in rural Canada. Clin Ther 2004;26:439-46.
15. Alter DA, Iron K, Austin PC, Naylor CD, SESAMI Study Group. Socioeconomic status, service patterns, and perceptions of care among survivors of acute myocardial infarction in Canada. JAMA 2004;291(9):1100-7.
16. Tu JV, Bowen J, Chiu M, Ko DT, Austin PC, He Y, et al. Effectiveness and safety of drug-eluting stents in Ontario. NEJM 2007;357:1393-1402.
17. Serruys PW, Morice MC, Kappetein AP, Colombo A, Holmes DR, Mack MJ, et al. Percutaneous coronary intervention versus coronary-artery bypass grafting for severe coronary artery disease. NEJM 2009;360:961-72.
18. BARI 2D Study Group. A randomized trial of therapies for type 2 diabetes and coronary artery disease. NEJM 2009;360:2503-15.
19. Boden WE, O'Rourke RA, Teo KK, Hartigan PM, Maron DJ, Kostuk WJ, et al. Optimal medical therapy with or without PCI for stable coronary disease. NEJM 2007;356:1503-16.
20. Seidel JE, Ghali WA, Faris PD, Bow JD, Waters NM, Graham MM, et al. Geographical local of residence and uniformity of access to cardiac revascularization services after catheterization. Can J Cardiol 2004;20:517-23.
21. Ghali WA, Quan H, Norris CM, Dzavik V, Naylor CD, Mitchell LB, et al. Prognostic significance of diabetes as a predictor of survival after cardiac catheterization. Am J Med 2000;109:543-48.

DIABETES AND CARDIOVASCULAR DISEASE IN ALBERTA

# Diabetes and Heart Failure

## KEY MESSAGES

- Heart failure is over 2.5 times more common in people with diabetes than in people without diabetes.
- People with diabetes are 3.6 times more likely to have an emergency department encounter and 4 times more likely to be hospitalized due to heart failure compared to those without diabetes.

## BACKGROUND

Heart failure (HF) causes significant morbidity and mortality. One year mortality rates remain as high as 20% to 30%, even with optimal drug therapy.[1,2] In addition, HF exerts a substantial burden on the health care system. It is the most common primary diagnosis in North America for people over 65 years of age, as well as the fastest-growing cardiovascular diagnosis in North America.[3,4] In 2007, over $35 billion in health care costs and lost productivity were attributed to HF.[2] Indeed, the lifetime risk of developing HF is estimated at 1 in 5 in North America.[5]

Diabetes is a strong risk factor for the development of HF, particularly in women.[6,7] In patients with diabetes, poor glucose control is associated with a higher risk of developing HF and is a common complication in the diabetes population.[8-12] Comorbid diabetes and HF is known to result in worse outcomes (poorer quality of life, increased hospitalization and health care costs, increased mortality) compared to having either condition alone.[12-16] A recent community-based study from the United States reported that the prevalence of diabetes is increasing in patients with HF, such that elderly patients with newly diagnosed HF in 1999 were 4 times more likely to have concomitant diabetes as patients newly diagnosed with HF in 1979.[15]

HF is a frequent but often forgotten comorbidity for people with diabetes, despite the shared risk factors and the tremendous impact it has on people with diabetes and our health care system.[11] We have therefore highlighted this important condition in this chapter of the *Alberta Diabetes Atlas*. Different perspectives on the burden of HF in Alberta are provided by comparing the prevalence of HF in those with and without diabetes over the past 15 years, and across the health zones in Alberta. Emergency department usage and hospitalization for HF in people with and without diabetes will also be compared.

## METHODS

Data from Alberta Health and Wellness (AHW) administrative databases were utilized for these analyses. This dataset captures Alberta resident demographic information, and HF cases (see appendix) in the physician claims data and hospital discharge abstract database. Only the most responsible diagnosis category for these databases were utilized and only one HF claim in either database was needed to satisfy the case definition. All adult residents of Alberta aged 20 years or older were included in these analyses.

From these data, rates of HF for those with and without diabetes were calculated. For each group, the number of people with HF (numerator) was divided by the number of people in the province or zone (denominator), respectively.

Persons with diabetes were identified as described in the “Background and Methods” chapter. Trends over time (1995-2009), as well as age-specific rates for HF were calculated. HF-related hospitalizations and emergency department encounters were also ascertained and rates for people with and without diabetes were compared. Since many hospital admissions represent transfers from one site to another, we are reporting emergency department encounters and hospitalizations as the rate of individuals with one or more visit per year (so that second visits, including transfers between hospitals do not influence the results).

As with other rates in the *Atlas*, direct standardization was used to adjust rates by age and sex for comparisons across time, using the Alberta population according to the 2006 Canadian Census.

## FINDINGS

The *number* of people in Alberta with a physician claim for a diagnosis of HF has increased over the past decade for people with diabetes and has remained relatively stable for people *without* diabetes over that time (Figure 6.14). Overall, about 35% of adults with HF had diabetes in 2009. Among all adults with diabetes, approximately 4% have HF, which increases to over 8% in those over the age of 65 years. However, as the total number of people with diabetes has increased over this time period, the age-adjusted prevalence rate of HF in people with diabetes has actually decreased (Figure 6.15). Similarly, a decrease in the prevalence rate of HF was also seen in people without diabetes. Regardless, HF diagnoses have been approximately 2.5 times more common in people with diabetes compared to people without diabetes each year over the past 15 years. Similar rates of HF were observed in both men and women irrespective of the presence of diabetes.

Figure 6.14 **Number of Heart Failure Cases, 1995-2009**

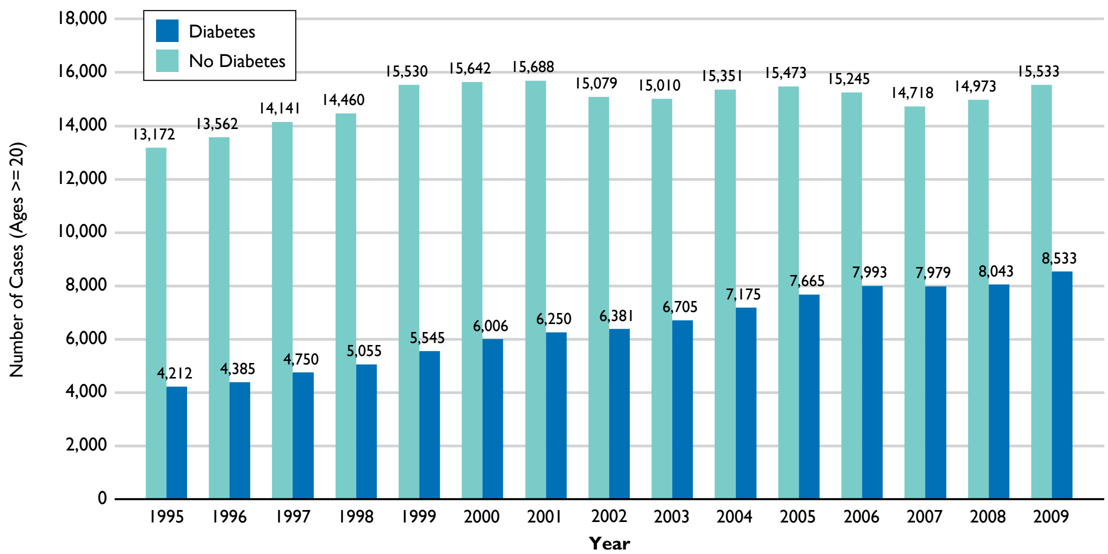
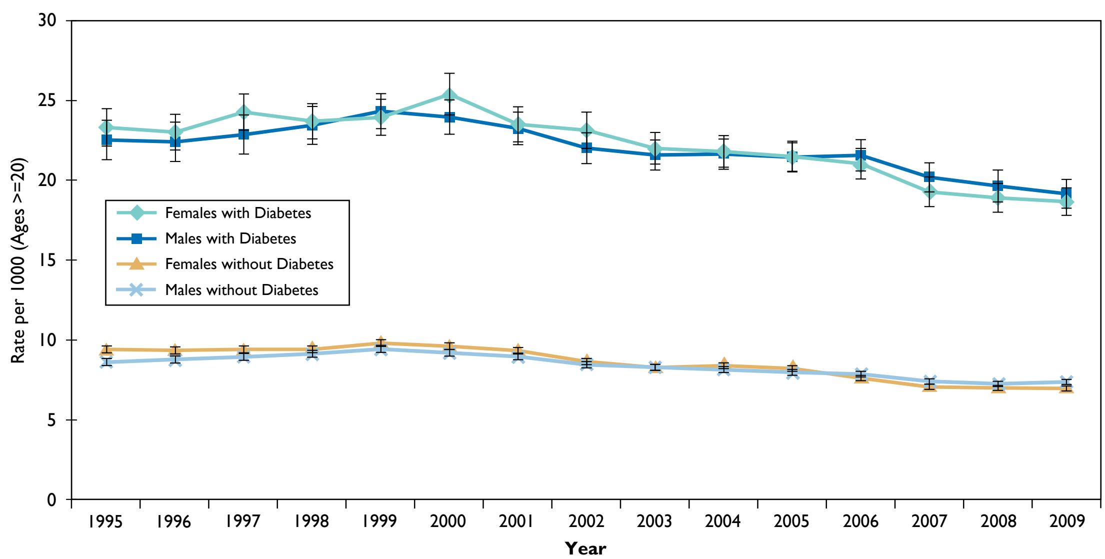



Figure 6.15 **Age-Adjusted Rates of Heart Failure, 1995-2009**



As with other cardiovascular diseases, HF is more common in older adults. However, the excess risk of HF associated with diabetes (represented by the rate ratio) is far greater in younger adults with diabetes compared to their non-diabetic counterparts (Figure 6.16). The age-adjusted rate of HF in patients with diabetes varied across the province in 2009, with Calgary zone having the lowest rate and Central zone having the highest rate (Figure 6.17).

Figure 6.16 **Age-Specific Rates of Heart Failure, 2009**

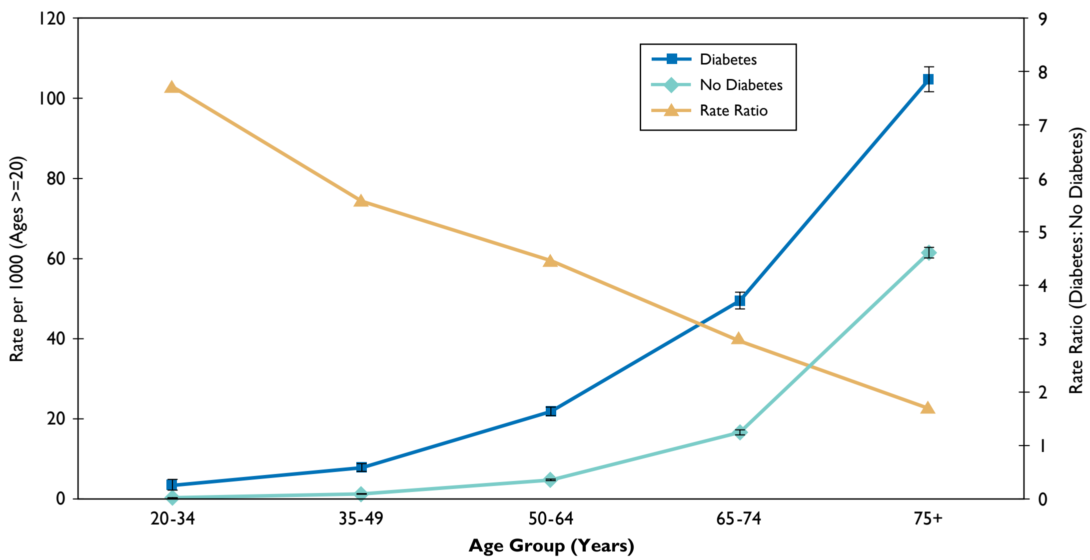
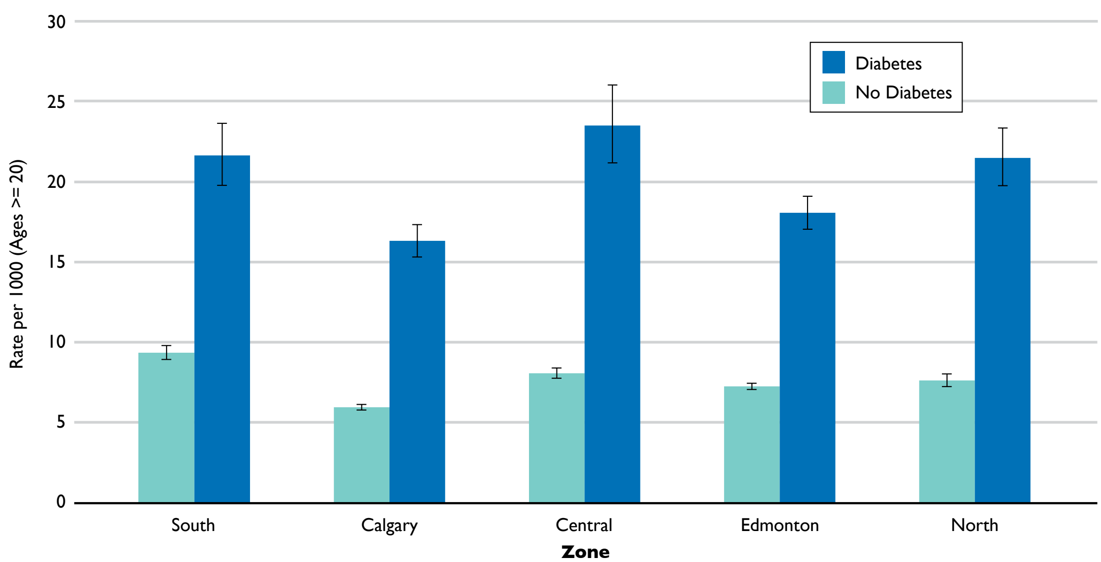
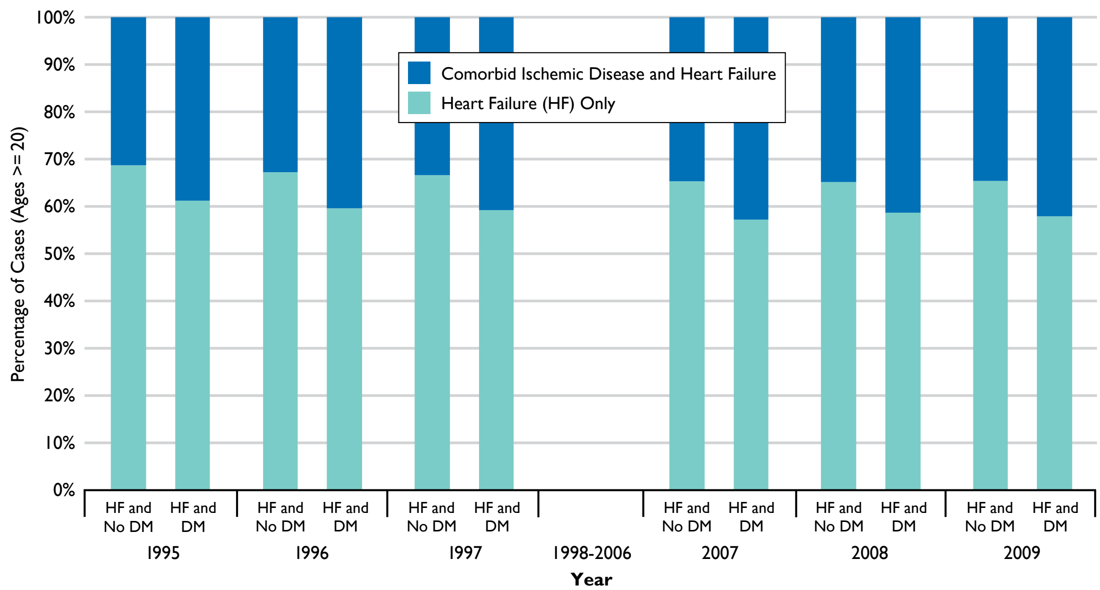



Figure 6.17 **Age- and Sex-Adjusted Rates of Heart Failure by Zone, 2009**



Ischemic heart disease is a strong risk factor for the development of HF in both patients with and without diabetes. Overall, approximately 40% of patients with HF and diabetes also have underlying ischemic heart disease. Patients with diabetes, however, were more likely to have both ischemic heart disease and HF compared to people without diabetes (Figure 6.18). The presence of ischemic heart disease among patients with HF according to diabetes status has increased over the last decade with proportions presented for years 1995-1997 and 2007-2009.

Figure 6.18 **Percentage of Comorbid Ischemic Disease, Among Individuals with Heart Failure, 1995-1997 and 2007-2009**




Heart failure is one of the leading causes of emergency department encounters and hospitalizations in Canada and is more pronounced in people with comorbid diabetes. People with diabetes were 3.6 times more likely to have at least one visit to the emergency department for heart failure (Figure 6.19). People with diabetes were 4 times more likely to be hospitalized for HF compared to people without diabetes (Figure 6.20).

Figure 6.19 **Age-Adjusted Rates of People who had at least one Emergency Department Encounter for Heart Failure, 2009**

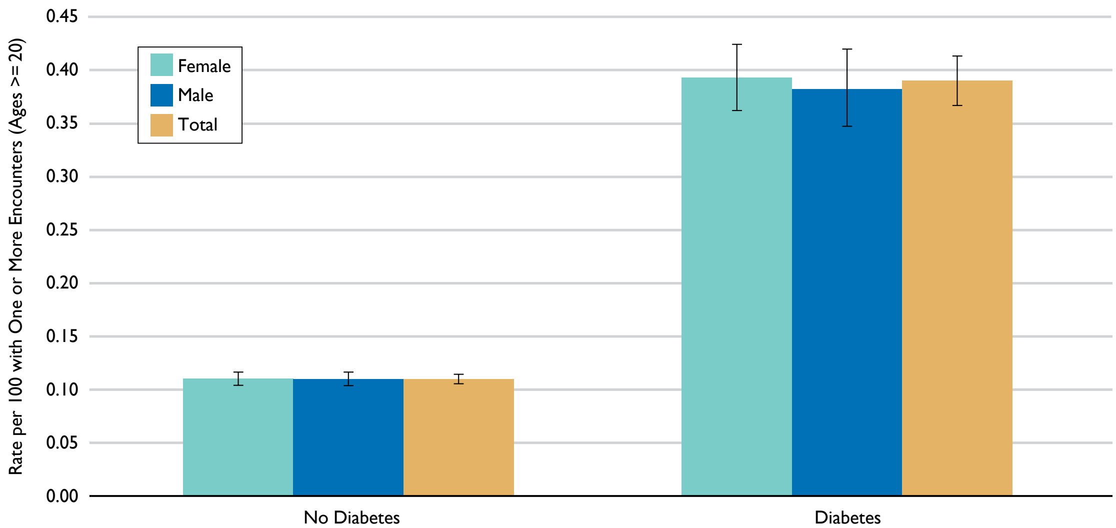
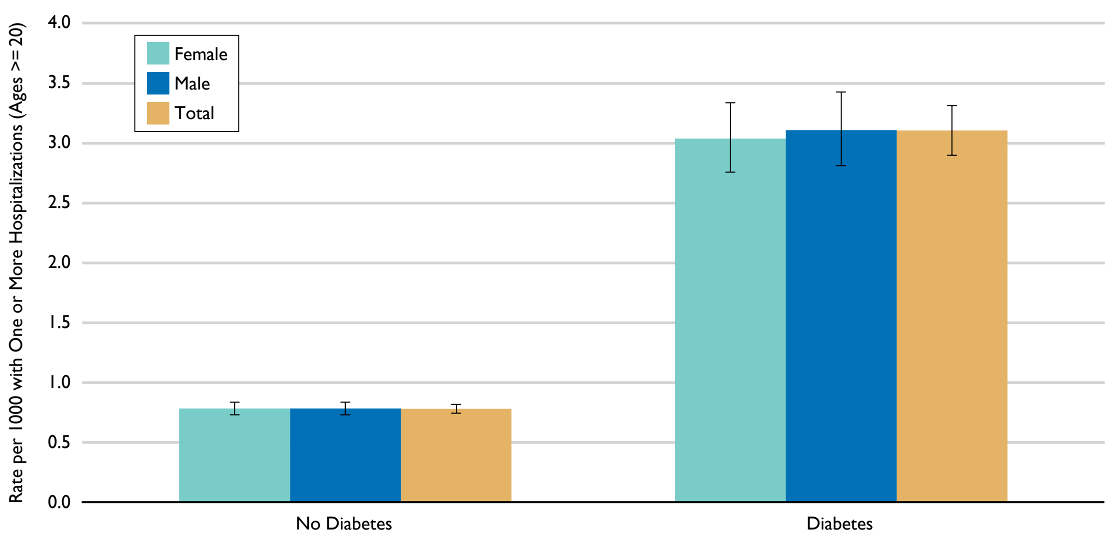



Figure 6.20 **Age-Adjusted Rates of People who had at least one Hospitalization for Heart Failure, 2009**



## DISCUSSION

The data presented in this section confirms the well-known relationship that HF is a common comorbidity in patients with diabetes. It also confirms that both men and women with diabetes have a higher risk of HF than their age-matched controls. Like other cardiovascular conditions presented in the *Alberta Diabetes Atlas* 2011, we have seen a decline in the prevalence rate of HF in the diabetes population in recent years. However, as the total number of people with diabetes continues to increase, so are the numbers of HF cases that present to the health care system.

This trend will continue to result in substantial morbidity and mortality among the diabetes population in coming years.(13) The increasing number of people with HF in the diabetes population is likely to place a greater burden on our health care system as well. This is evidenced by the rates of visits to the emergency department and admissions to hospital for HF being 3.6 and 4 times, respectively, higher in people with diabetes than in people without diabetes.

Since diabetes is associated with worse outcomes in patients with HF, use of evidence-based therapies to improve outcomes is imperative.(12,17,18) Unfortunately, therapies which are proven to improve HF outcomes are underused in the diabetes population.(18-20) Randomized trial evidence suggests that people with HF achieve better outcomes when they receive specialist care and/or are actively followed by multidisciplinary teams.(21) For patients in remote areas, telemonitoring programs also improve HF outcomes.(22) Equally important is the active role of the patient with HF in self-management strategies, such as making dietary changes, daily recording of body weight and use of a patient diary, all of which are associated with more desirable health outcomes.(23) Increased access to these services and coordination of care for people with HF is necessary in order to have a positive impact on health outcomes for people with diabetes in Alberta.

## APPENDIX

**Heart Failure**

### Alberta Physician Claims Data, Discharge Abstract Database

| Diagnosis | ICD-9-CM | ICD-10-CA |
|---|---|---|
| Heart Failure | 428.X | I50.X |
| Ischemic Heart Disease | 410.X-414.X | N/A |

## References

1. MacIntyre K, Capewell S, Stewart S, et al. Evidence of improving prognosis in heart failure: trends in case fatality in 66,547 patients hospitalized between 1986 and 1995. Circulation 2000;102:1126-31.
2. Rosamond W, Flegal K, Friday G, et al. Heart Disease and Stroke Statistic-2007 Update. A Report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Circulation 2007;115:e69-171.
3. Cowie MR, Mosterd A, Wood DA. The epidemiology of heart failure. Eur Heart J 1997;18:208-825.
4. Redfield MM, Jacobsen SJ, Burnett JC Jr, et al. Burden of systolic and diastolic ventricular dysfunction in the community: appreciating the scope of the heart failure epidemic. JAMA 2003;289:194-202.
5. Lloyd-Jones DM, Larson MG, Leip EP, et al. Lifetime risk for developing congestive heart failure: the Framingham Heart Study. Circulation 2002;106:3068-72.
6. Bibbins-Domingo K, Lin F, Vittinghoff E, Barrett-Connor E, Hulley SB, Grady D, et al. Predictors of heart failure among women with coronary disease. Circulation 2004;110(11):1424-30.
7. Kannel WB, Hjortland M, Castelli WP. Role of diabetes in congestive heart failure: the Framingham study. Am J Cardiol 1974;34:29-34.
8. Stratton IM, Adler AI, Neil HAW, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. BMJ 2000;321:405-12.
9. Iribrarren C, Karter AJ, Go AS, et al. Glycemic control and heart failure among adult patients with diabetes. Circulation 2001;103:2668-73.
10. Nichols GA, Gullion CM, Koro CE, et al. The incidence of congestive heart failure in type 2 diabetes: an update. Diabetes Care 2004;27:1879-84.
11. Bell DS. Heart failure: the frequent, forgotten, and often fatal complication of diabetes. Diabetes Care 2003;26:2433-41.
12. Masoudi FA, Inzucchi SE. Diabetes mellitus and heart failure: epidemiology, mechanisms, and pharmacotherapy. Am J Cardiol 2007;99:113B-32B.
13. De Groote P, Lamblin N, Mouquet F, et al. Impact of diabetes mellitus on long-term survival in patients with congestive heart failure. Eur Heart J 2004;25:656-62.
14. Ezekowitz JA, van Walraven C, McAlister FA, Armstrong PW, Kaul P. Impact of specialist follow-up in outpatients with congestive heart failure. CMAJ 2005;172(2):189-94.
15. From AM, Leibson CL, Bursi F, Redfield MM, Weston SA, Jacobsen SJ, et al. Diabetes in heart failure: prevalence and impact on outcome in the population. Am J Med 2006;119:591-99.
16. Majumdar SR, McAlister FA, Cree M et al. Do evidence-based treatments provide incremental benefits to patients with congestive heart failure already receiving angiotensin-converting enzyme inhibitors? A secondary analysis of one-year outcomes from the Assessment of Treatment with Lisinopril and Survival study. Clin Ther 2004;26:694-703.
17. Eurich DT, Majumdar SR, McAlister FA, Tsuyuki RT, Johnson JA. Improved clinical outcomes associated with metformin in patients with diabetes and heart failure. Diabetes Care 2005;28:2345-51.
18. Eurich DT, Majumdar SR, Tsuyuki RT, Johnson JA. Reduced mortality associated with the use of ACE inhibitors in patients with type 2 diabetes. Diabetes Care 2004;27:1330-34.
19. Brown LC, Johnson JA, Majumdar SR, Tsuyuki RT, McAlister FA. Evidence of sub-optimal cardiovascular risk management in patients with type 2 diabetes mellitus and symptomatic atherosclerosis. CMAJ 2004;171(10):1189-92.
20. Toth EL, Majumdar SR, Guirguis LM, Lewanczuk RZ, Lee TK, Johnson JA. Compliance with clinical practice guidelines for type 2 diabetes in rural patients: treatment gaps and opportunities for improvement. Pharmacotherapy 2003;23(5):659-65.
21. McAlister FA, Stewart S, Ferrua S, McMurray JJV. Multidisciplinary strategies for the management of heart failure patients at high risk for admission: A systematic review of randomized trials. J Am Coll Cardiol 2004;44:810-9.
22. Inglis SC, Clark RA, McAlister FA, et al. Structured telephone support or telemonitoring programmes for patients with chronic heart failure. Cochrane Database Syst Rev 2010;8:CD007228.
23. Wright SP, Walsh H, Ingley KM, Muncaster SA, Gamble GD, Pearl A, et al. Uptake of self-management strategies in a heart failure management programme. Eur J Heart Fail. 2003;5(3):371-80.

DIABETES AND CARDIOVASCULAR DISEASE IN ALBERTA

# Diabetes and Stroke

## KEY MESSAGES

- Stroke occurs more than twice as often in people with diabetes compared to people without diabetes.
- Stroke rates are gradually falling in Alberta. However, the absolute number of stroke cases is slowly climbing in those with diabetes but relatively stable in those without diabetes.
- Albertans with diabetes are more likely to suffer ischemic stroke compared to hemorrhagic stroke.
- Stroke rates are the lowest in Calgary compared to the other health zones and highest in the non-metro health zones.

## BACKGROUND

Diabetes is a strong and independent risk factor for stroke,[1] which is a major source of morbidity and mortality in Canada.[2] Previous reports suggest that people with diabetes have a two-fold higher risk of stroke compared to the general population.[3,4] This increased stroke risk in people with diabetes is likely due to a higher prevalence of other risk factors, including high blood pressure and high cholesterol.[5-7] The growing prevalence of diabetes,[8] coupled with the well-documented treatment gap for cardiovascular risk factors in diabetes,[9-11] establishes a strong foundation for early and aggressive stroke prevention strategies.

Stroke is a vascular syndrome of the brain with multiple possible underlying causes. The two major forms are ischemic (lack of blood flow to a region of the brain due to a blocked artery), which accounts for about 86% of all strokes, and hemorrhagic (bleeding into the brain), which accounts for the remaining 14%. Ischemic stroke is further divided into transient ischemic attack (TIA) and acute ischemic stroke (AIS). Hemorrhagic stroke is classified as either intracerebral hemorrhage (ICH) or sub-arachnoid hemorrhage (SAH) depending on location of the bleeding. Identifying a TIA is particularly important because of its significant consequences for the patient and opportunities for prevention strategies. Albertans suffering a TIA have a 20% chance of dying, or suffering a major stroke or heart attack in the following year.[12] Although patients have usually recovered by the time of medical presentation, the TIA presents a golden opportunity for health care providers to prevent subsequent events.[13]

In this iteration of the *Atlas*, we present data on stroke as a whole and then by stroke type to examine the varying effect of diabetes on stroke occurrence and outcome.

## METHODS

Administrative data from Alberta Health and Wellness (AHW) were used in this analysis. The dataset captured Alberta resident demographic information, and stroke diagnoses in the hospital discharge abstracts. All adult residents of Alberta who were 20 years of age or older were included. In 2002, the province switched over to the use of ICD-10 for coding of hospital discharge abstracts; our data therefore contain a blended definition of stroke using both ICD-9 and ICD-10 (see appendix for specific codes used).

Rates of stroke, by type, for those with and without diabetes were calculated from the hospital data. Because the absolute numbers of hemorrhagic stroke were small, both ICH and SAH were combined into an overall category: hemorrhagic stroke. For each group, the number of people with stroke (numerator) was divided by the number of people in the province or zone (denominator), respectively. Trends over time (1995-2009), as well as zone and age-specific rates for stroke were calculated for people with and without diabetes. Persons with diabetes were identified as described in the "Background and Methods" chapter of this *Atlas*. As with other rates in the *Atlas*, direct standardization was used to adjust rates of stroke by age and sex for comparisons across time and zones (using the Alberta population according to the 2006 Canadian Census).

## FINDINGS

After adjusting for age and sex, the rate of stroke continues to decrease in Alberta. From 1995-2009, the age- and sex-adjusted rates of stroke for those without diabetes have declined from 1.6 per 1000 to 1.0 per 1000. Similarly, rates of stroke for those with diabetes declined from 4.1 per 1000 in 1995 to 2.3 per 1000 in 2009 (Figure 6.21). The gradual fall in stroke rate has been evident in the western world for the last half-century. Possible explanations for this trend include improved lifestyle, better blood pressure control, reduced smoking rates and better cardiac care. The relatively recent trend to increasing obesity and type 2 diabetes may reverse this trend but this hypothesis will only be confirmed in retrospect when we look back at the data regarding stroke occurrence a decade from now.

Despite this gradually falling age- and sex-adjusted rate of stroke, the absolute numbers of stroke in those with diabetes are increasing (Figure 6.22). This is in part due to the large increase in the population in Alberta and to the aging demographic. Absolute numbers of stroke in those without diabetes remain relatively stable over the past 15 years. Because stroke is a condition that is strongly associated with age, the increasing proportion of the population over the age of 65 years means that the total number of strokes will continue to increase, even as the age- and sex-adjusted rate remains steady or falls (Figures 6.21-6.25).

Figure 6.21 **Age- and Sex-Adjusted Rates of Any Stroke, 1995-2009**

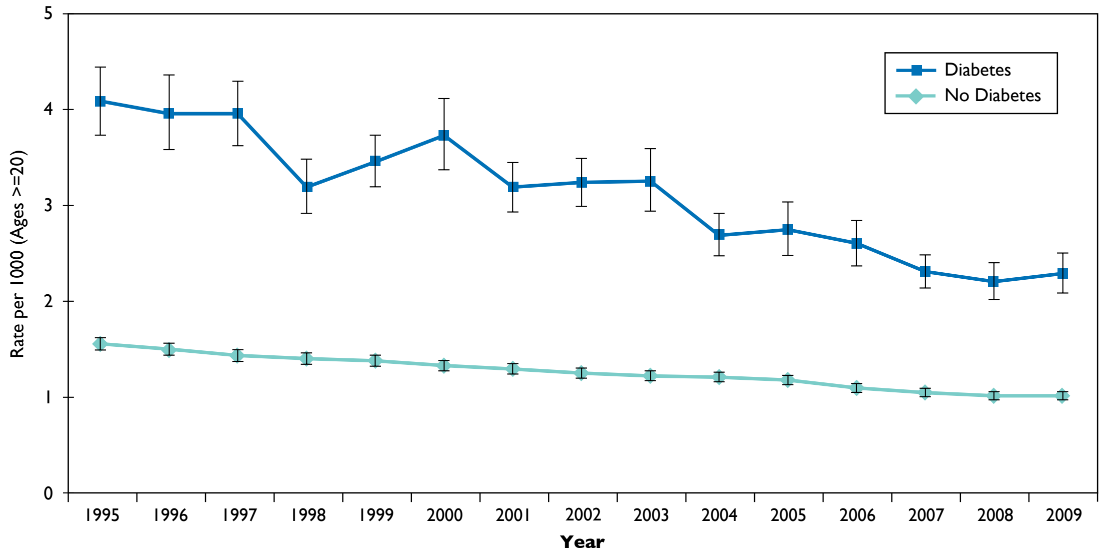
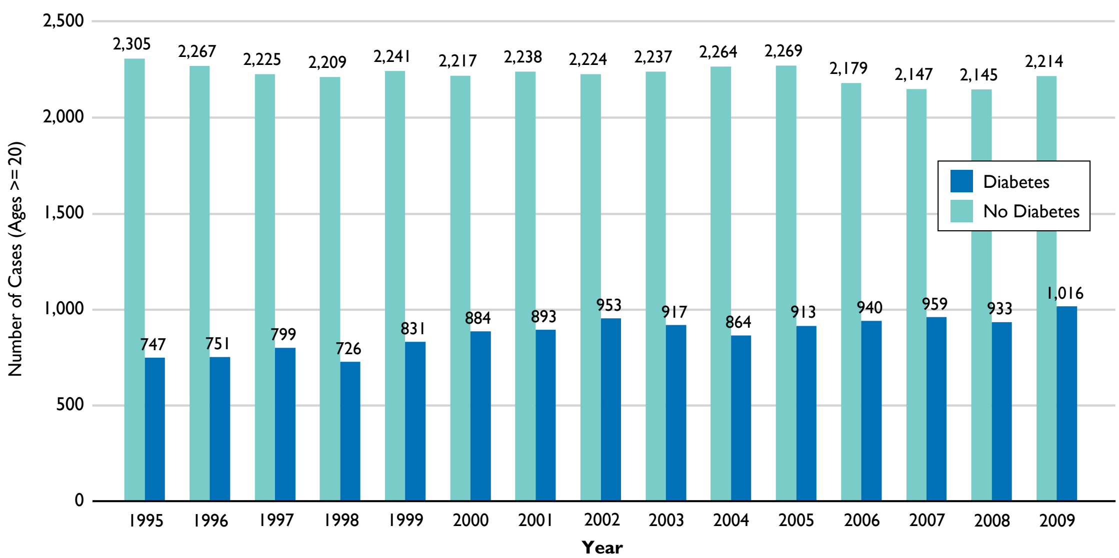



Figure 6.22 **Number of Any Stroke Cases, 1995-2009**



After adjusting for differences in age and sex, the annual rate of stroke was consistently higher among people with diabetes compared to people without diabetes for all stroke types (Figures 6.23-6.25).

Figure 6.23 **Age- and Sex-Adjusted Rates of TIA, 1995-2009**

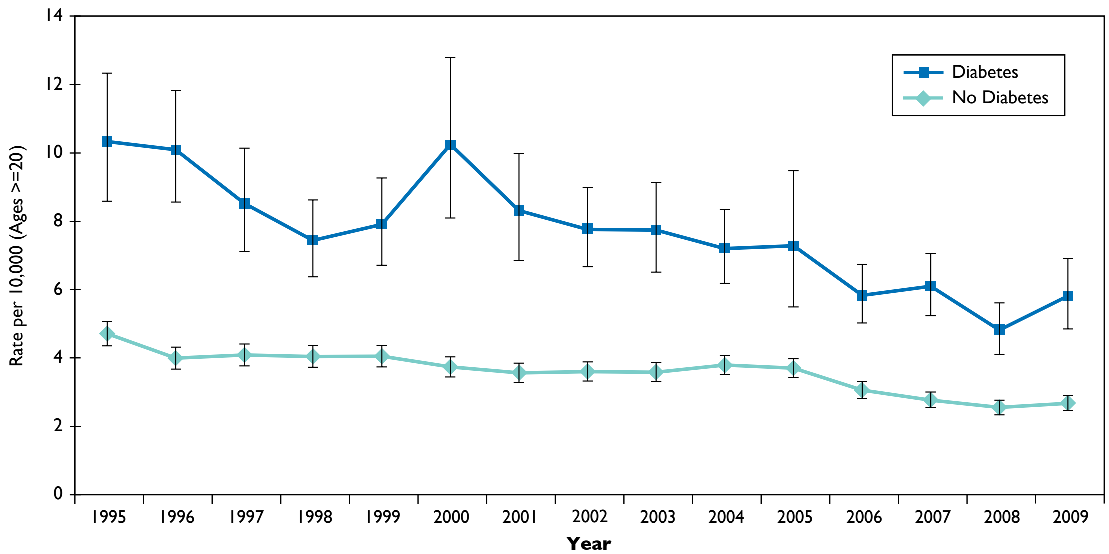



Figure 6.24 **Age- and Sex-Adjusted Rates of AIS, 1995-2009**

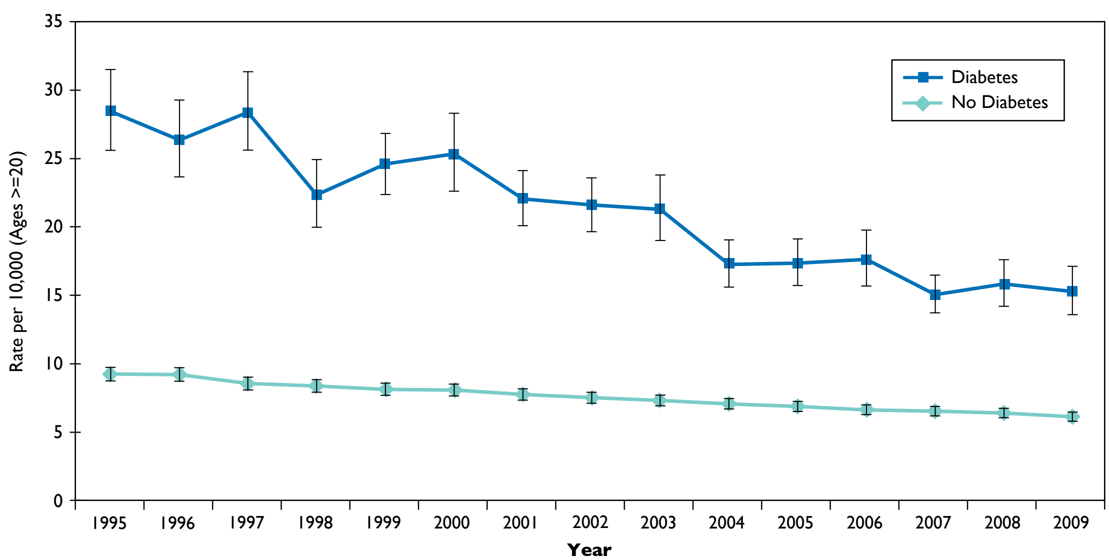
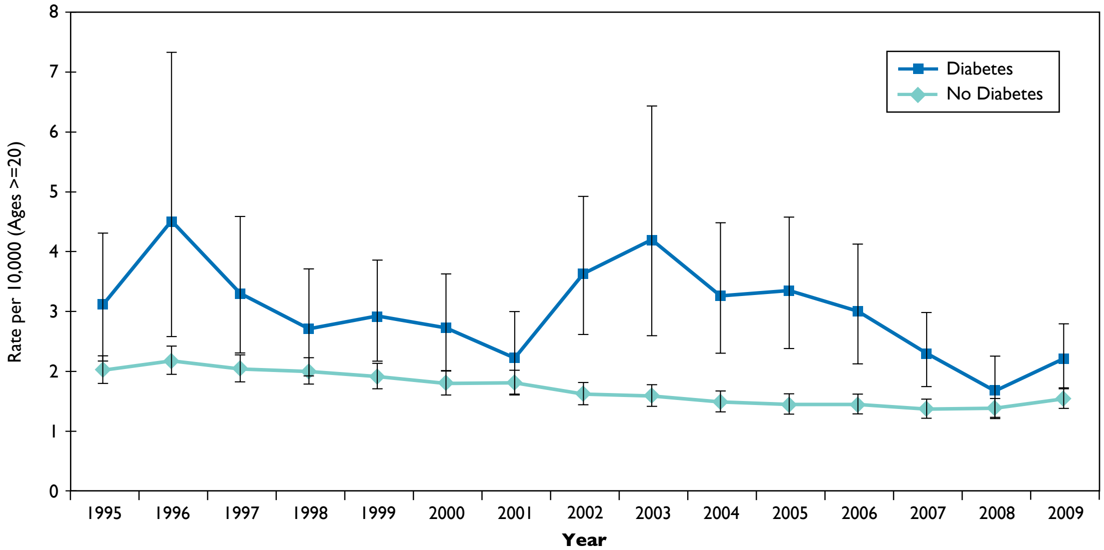
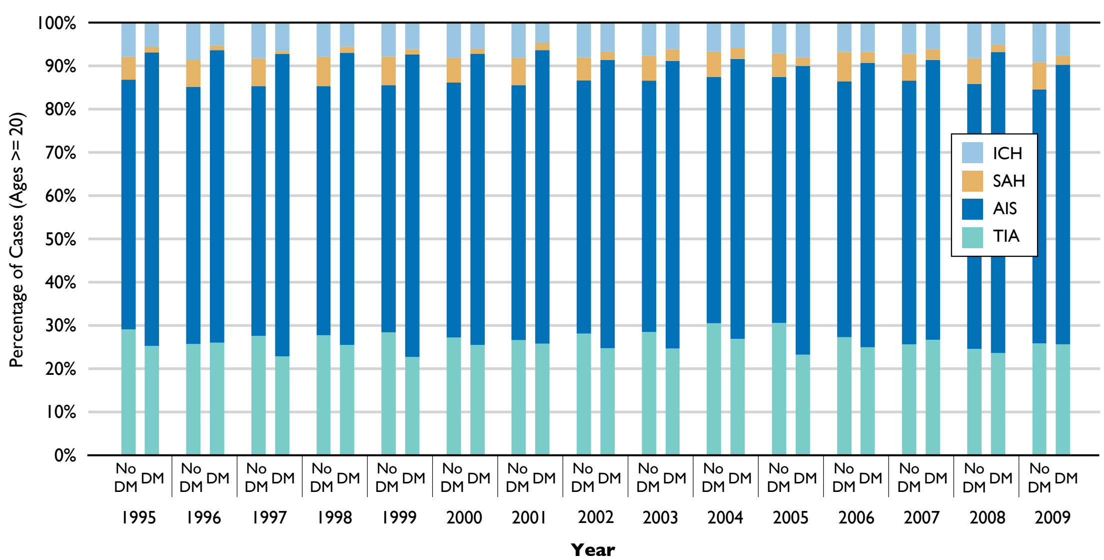


Figure 6.25 **Age- and Sex-Adjusted Rates of Hemorrhagic Stroke (ICH or SAH), 1995-2009**




Among the different stroke types, patients with diabetes have a slightly greater proportion of ischemic stroke types compared to patients without diabetes (Figure 6.26). This difference is dominated by the lesser relative incidence of SAH and ICH (about half the proportion in people with diabetes compared to those without diabetes). Since a major modifiable risk factor for SAH is smoking, it would be intriguing to know if smoking rates were reduced in people with diabetes and whether this is a factor contributing to the difference. These data, however, are not routinely collected in administrative health databases.

Figure 6.26 **Types of Stroke Cases, 1995-2009**



In 2009, the overall provincial age- and sex-adjusted rate for stroke was 2.3 per 1000 Albertans with diabetes (Figure 6.21). There was, however, considerable zone variation of stroke rates in the diabetes population, while the rates appeared fairly constant among the non-diabetic population (Figure 6.27). The stroke rate in 2009 was lowest in the Calgary zone compared to the other zones for most stroke types (Figures 6.27-6.30). People with diabetes living outside of the two metro zones of Calgary and Edmonton were more likely to be hospitalized for a TIA (Figure 6.29).

Figure 6.27 **Age-Adjusted Rates of Any Stroke by Zone, 2009**

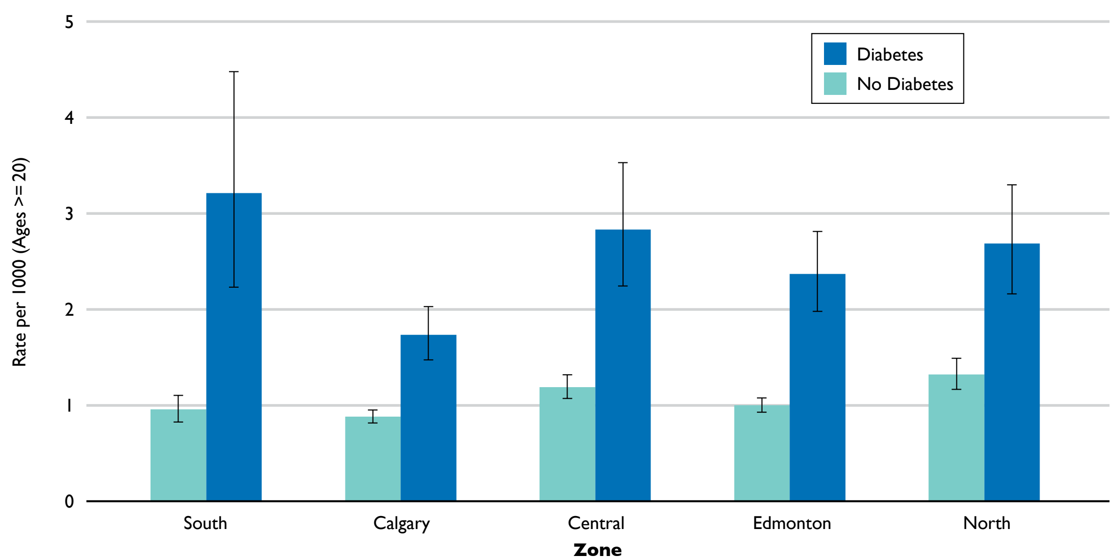



Figure 6.28 **Age-Adjusted Rates of AIS by Zone, 2009**

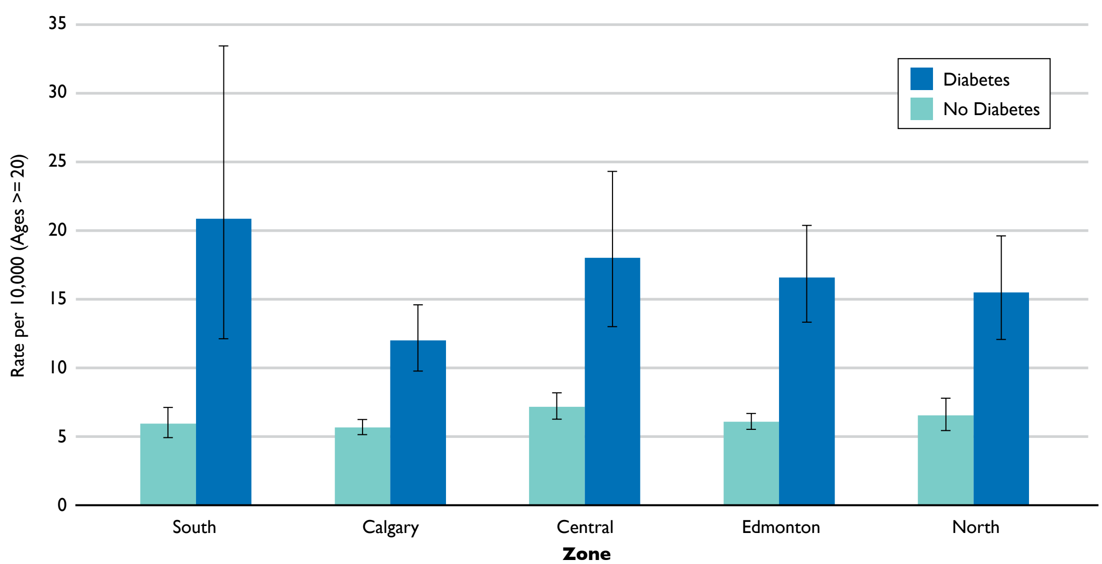


Figure 6.29 **Age-Adjusted Rates of TIA by Zone, 2009**

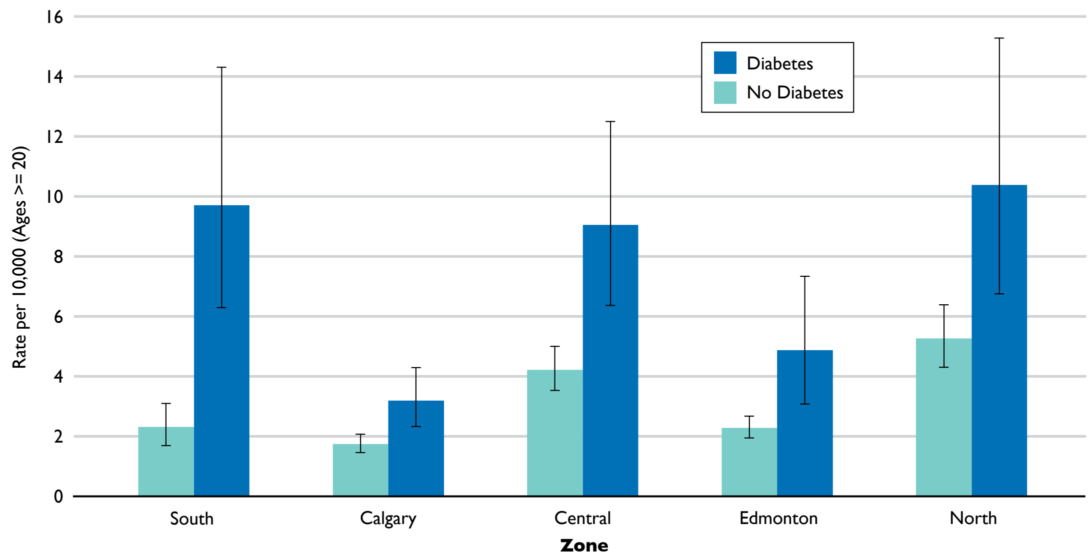
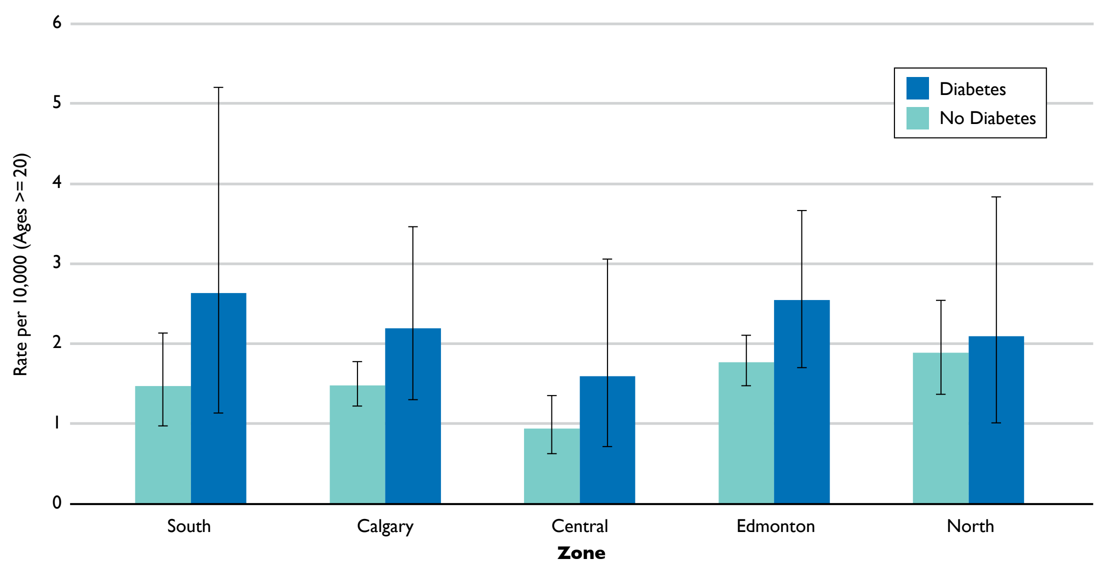



Figure 6.30 **Age-Adjusted Rates of Hemorrhagic Stroke (ICH or SAH) by Zone, 2009**



## DISCUSSION

These observations for Alberta confirm previous studies that stroke is more common in people with diabetes compared to those without diabetes.[3-5] As with trends for other cardiovascular diseases, there is a good-news, bad-news story for stroke in the diabetes population in Alberta. While the *rates* of stroke have decreased over the past 15 years, the *number* of people with diabetes suffering from stroke has increased. This is driven, in part, by the aging of the population and the growing number of people with diabetes in the province.

The increasing *number* of people with stroke represents the real burden to Albertans and to our health care system. People with diabetes visit the emergency department more often for stroke than people without diabetes.[14] These numbers highlight the need for strong prevention strategies, to reduce the number of people with diabetes in the first place, but to also reduce the risk of stroke in those who already have the disease.

The differences in stroke rates across health zones in the province are striking. After adjusting for differences in age, we see that people with diabetes living in the two metropolitan zones generally have lower stroke rates than people with diabetes living in other zones. The exact reasons for these patterns remain unclear, and further investigation into risk factors and prevention strategies should be undertaken.

When interpreting the stroke figures, it is important to note two factors influencing the observed rates. The definition for stroke used in this version of the *Alberta Diabetes Atlas* (and the previous 2009 edition) is more specific than what was used in the first *Atlas* (2007) and therefore rates reported here are lower than the 2007 edition.[15] This definition is generally felt to slightly under-represent the total stroke burden and therefore, our estimates are conservative. We recognize that there may be some difficulty in accurately defining strokes from administrative data.[16-19] In later iterations of the *Alberta Diabetes Atlas*, this definition will continue to be refined using available, evolving information. Second, we did not include emergency department data and physician claims data. This would likely result in us failing to account for all minor strokes and TIAs that take place in the province. Again, this means that our estimates are likely conservative; the problem and burden of stroke among patients with diabetes is even more serious than outlined here. This information is important for the on-going surveillance of diabetes as a risk factor for stroke and will help to improve stroke prevention strategies in Alberta.

# APPENDIX

## Stroke

### Discharge Abstracts Database

| Stroke type | ICD-9 | ICD-10 |
|---|---|---|
| SAH | 430.X | I60.X |
| ICH | 431.X | I61.X |
| AIS | 433.X, 434.X, 436.X, 362.3X | I63.X, I64.X, H34.1 |
| TIA | 435.X | G45, G45.0, G45.1, G45.2, G45.3, G45.8, G45.9 (NOT G45.4) |

Excludes 433.X0, 434.X0, 437.X, 438.X, 165.X, 166.X, 167.X, 169.X, G45.4

## References

1. D'Agostino RB, Wolf PA, Belanger AJ, Kannel WB. Stroke risk profile: adjustment for antihypertensive medication. The Framingham study. Stroke 1994;25(1):40-4.
2. Heart and Stroke Foundation of Canada, Canada, Health C, Statistics C, University of Saskatchewan. Heart disease and stroke in Canada. 1995.
3. Kuusisto J, Mykkanen L, Pyorala K, Laakso M. Non-insulin-dependent diabetes and its metabolic control are important predictors of stroke in elderly subjects. Stroke 1994; 25(6):1157-64.
4. Jeerakathil T, Johnson JA, Simpson SH, Majumdar SR. Short-term risk for stroke is doubled in persons with new type-2 diabetes compared to persons without diabetes: a population-based cohort study. Stroke 2007; 38(6):1739-43.
5. Stamler J, Vaccaro O, Neaton JD, Wentworth D. Diabetes, other risk factors, and 12-yr cardiovascular mortality for men screened in the multiple risk factor intervention trial. Diabetes Care 1993; 16(2):434-44.
6. Nathan DM, Meigs J, Singer DE. The epidemiology of cardiovascular disease in type 2 diabetes mellitus: how sweet it is ... or is it? Lancet 1997; 350(Suppl 1):SI4-9.
7. Kissela B, Air E. Diabetes: impact on stroke risk and poststroke recovery. Semin Neurol 2006;26(1):100-7.
8. Ohinmaa A, Jacobs P, Simpson SH, Johnson JA. Projections of prevalence and direct cost of diabetes in Canada from 2000 to 2016. Can J Diabetes 2004;28(1):116-23.
9. Brown LC, Johnson JA, Majumdar SR, Tsuyuki RT, McAlister FA. Evidence of sub-optimal cardiovascular risk management in patients with type 2 diabetes mellitus and symptomatic atherosclerosis. CMAJ 2004;171(10):1189-92.
10. Toth EL, Majumdar SR, Guirguis LM, Lewanczuk RZ, Lee TK, Johnson JA. Compliance with clinical practice guidelines for type 2 diabetes in rural patients: treatment gaps and opportunities for improvement. Pharmacotherapy 2003;23(5):659-65.
11. Grant RW, Cagliero E, Murphy-Sheehy P, Singer DE, Nathan DM, Meigs JB. Comparison of hyperglycemia, hypertension, and hypercholesterolemia management in patients with type 2 diabetes. Am J Med 2002;112(8):603-9.
12. Hill MD, Yiannakoulias N, Jeerakathil T, Tu JV, Svenson LW, Schopflocher DP. The high risk of stroke immediately after transient ischemic attack: a population-based study. Neurology 2004;62:2015-20.
13. Johnston DCC, Hill MD. The patient with transient cerebral ischemia: a golden opportunity for stroke prevention. CMAJ 2004;170:1134-37.
14. Simpson SH, Quan H. Diabetes and cardiovascular disease in Alberta, stroke and diabetes. In: Johnson JA, editor. Alberta diabetes atlas 2007. Edmonton: Institute of Health Economics; 2007:63-72.
15. Kokotailo RA, Hill MD. Coding of stroke and stroke risk factors using ICD-10 and ICD-9. Stroke 2005;36:1776-81.
16. Leibson CL, Naessens JM, Brown RD, Whisnant JP. Accuracy of hospital discharge abstracts for identifying stroke. Stroke 1994;25(12):2348-55.
17. Liu L, Reeder B, Shuaib A, Mazagri R. Validity of stroke diagnosis on hospital discharge records in Saskatchewan, Canada: implications for stroke surveillance. Cerebrovasc Dis 1999;9(4):224-30.
18. Piriyawat P, Smajsova M, Smith MA, Pallegar S, Al Wabil A, Garcia NM, et al. Comparison of active and passive surveillance for cerebrovascular disease: the brain attack surveillance in corpus christi project. Am J Epidemiol 2002; 156(11):1062-69.
19. Spolaore P, Brocco S, Fedeli U, Visentin C, Schievano E, Avossa F, et al. Measuring accuracy of discharge diagnoses for a region-wide surveillance of hospitalized strokes. Stroke 2005; 36(5):1031-34.

DIABETES AND CARDIOVASCULAR DISEASE IN ALBERTA

# Diabetes and Hypertension

## KEY MESSAGES

- Hypertension shares many of the same risk factors as diabetes.
- Among those with diabetes, the proportion of patients who also had hypertension increased from 35% in 1995 to 66% in 2009.
- In 2009, people with diabetes had nearly 3 times greater incidence of hypertension compared to people without diabetes.

## BACKGROUND

Hypertension is one of the most prevalent conditions in Canada and other countries, estimated to affect 1 in 5 adults.(1) Hypertension commonly co-exists with diabetes, with a reported prevalence of over 50% among patients with type 2 diabetes.(2)

Hypertension shares many of the same risk factors as diabetes, such as obesity and sedentary lifestyle.(3) Therefore, it is not surprising that both of these diseases commonly occur together in the same individuals. Diabetes and hypertension are independent risk factors for arterial remodeling but the co-existence of both conditions additively increases poor prognoses, resulting in stroke, micro-vascular conditions and mortality.(4-6) Therefore, policy makers and health care professionals have made extensive efforts to improve management for patients with these chronic medical conditions with an aim for achieving better outcomes. One such ongoing national knowledge translation strategy to improve diagnosis and control of hypertension is the Canadian Hypertension Education Program.(7,8)

Given the high prevalence of hypertension in general, and among patients with diabetes in particular, we analyzed historical Alberta population based data to describe the incidence and prevalence of hypertension among diabetes patients in Alberta.

## METHODS

Data from Alberta Health and Wellness (AHW) administrative databases were utilized for these analyses. The database captures information on demographics and diagnostic codes for health services used by Alberta residents. All adult residents of Alberta aged 20 years or older were included in these analyses. Status Aboriginal individuals were not excluded.

An individual is identified as having hypertension if they have 2 physician billing claims or 1 hospitalization claim for hypertension (see appendix) within 3 years. Women with pregnancy-induced hypertension, defined as females with a hypertension diagnostic code within 5 months of an obstetrical event with a physician service claim or hospital discharge record, were excluded from these analyses. Once an individual is identified as having hypertension by the above algorithm, they will continue to be flagged as such in all subsequent years unless they move out of the province or die.

From these data, rates (incidence and prevalence) of hypertension for those with and without diabetes, were calculated. For each group, the number of people with hypertension (numerator) was divided by the number of people in the province or zone (denominator), respectively.

The incidence of hypertension is only reported from the year 1997 onward, instead of from the year 1995, because a 2-year washout period was used. Nonetheless, there are likely still some prevalent hypertension cases present in the first couple years of observation (1997-1998). If the individual was identified by the physician claims data, the hypertension incidence date was the second claim.

As with other rates in the *Atlas*, direct standardization was used to adjust rates by age and sex for comparisons across time, using the Alberta population according to the 2006 Canadian Census.[9]

## FINDINGS

### Prevalence of Hypertension

Among those with diabetes, the proportion of patients who also had hypertension increased from 35% in 1995 to 66% in 2009 (Figure 6.31), and has remained relatively constant over the last three years. The actual number of people with both diabetes and hypertension was 28,798 in 1995 and 133,510 in 2009, an increase of 104,712 patients in the period (Figure 6.32). After adjusting for age and sex, the hypertension prevalence was much higher and increased faster among patients with diabetes than among those without diabetes (prevalence in 2009: 41.1% versus 19.2%, see Figure 6.33). The gap of hypertension prevalence between those with and without diabetes was 11.7% in 1995 and 21.9% in 2009.

Figure 6.31 **Prevalent Hypertension Cases for People with Diabetes, 1995-2009**

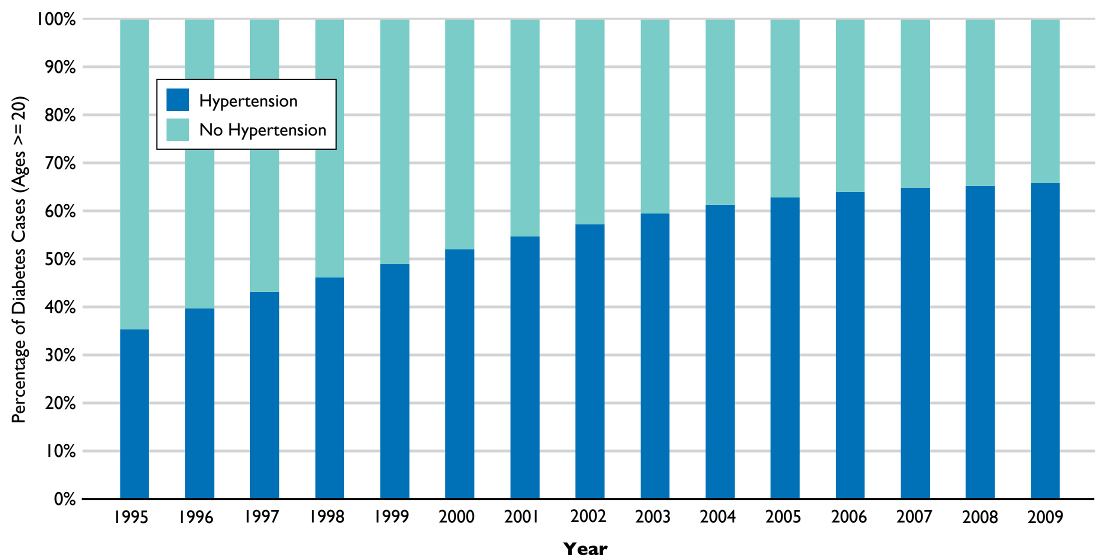



Figure 6.32 **Number of Prevalent Hypertension Cases, 1995-2009**

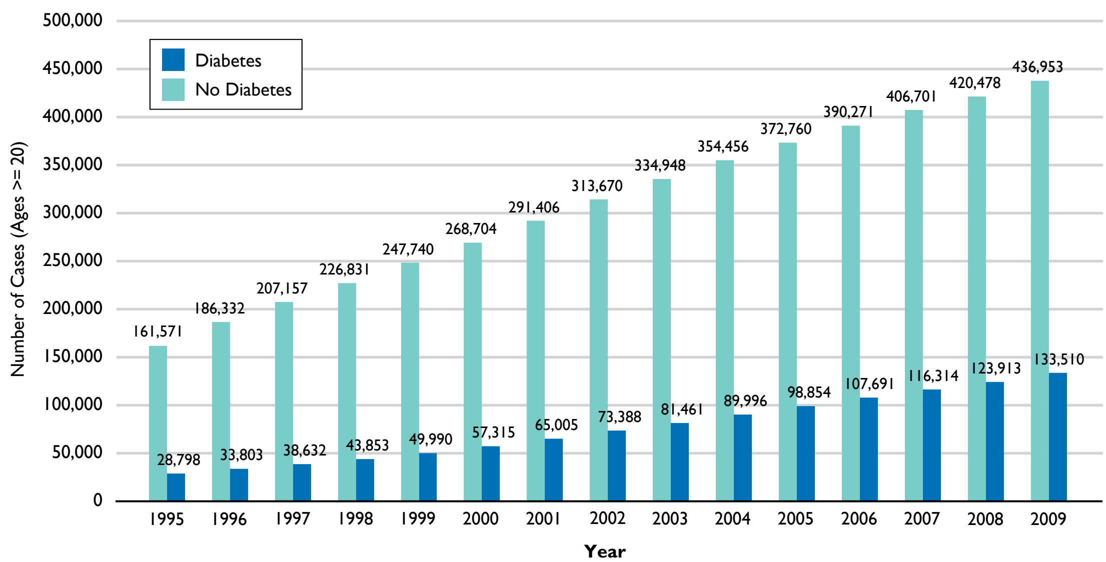
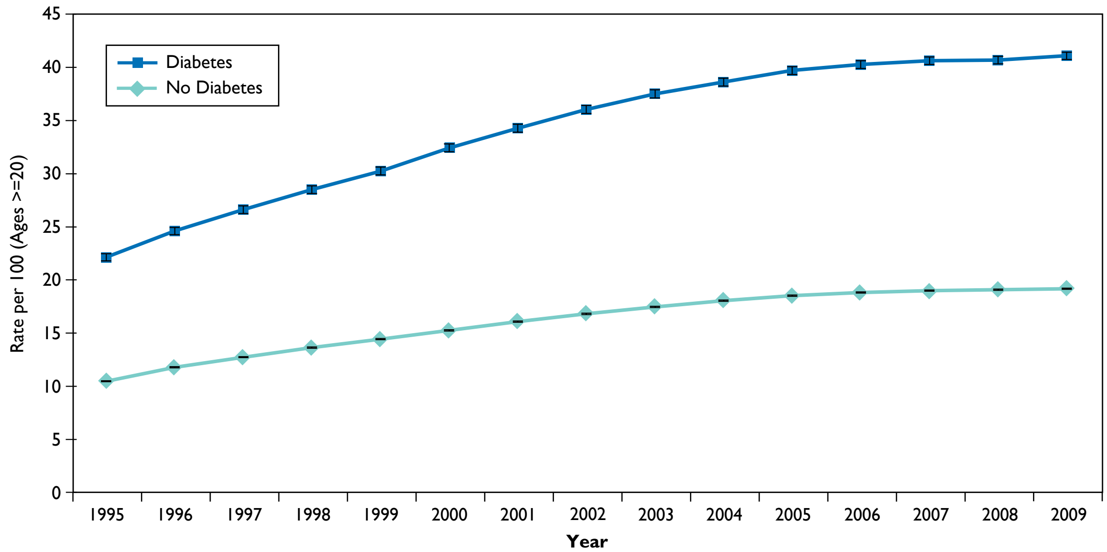


Figure 6.33 **Age- and Sex-Adjusted Prevalence Rates of Hypertension, 1995-2009**




The prevalence of hypertension in people with and without diabetes differed by age and sex (see Figure 6.34). The prevalence increased with age for both males and females. In the age group 35-49 years, men with diabetes had higher hypertension prevalence rates and in the older age groups, women had higher hypertension prevalence rates. The age-adjusted rate of hypertension in people with and without diabetes appeared slightly lower in the Edmonton and Calgary metro areas compared to the other health zones in Alberta in 2009 (Figure 6.35).

Figure 6.34 **Age-Specific Hypertension Prevalence Rates, 2009**

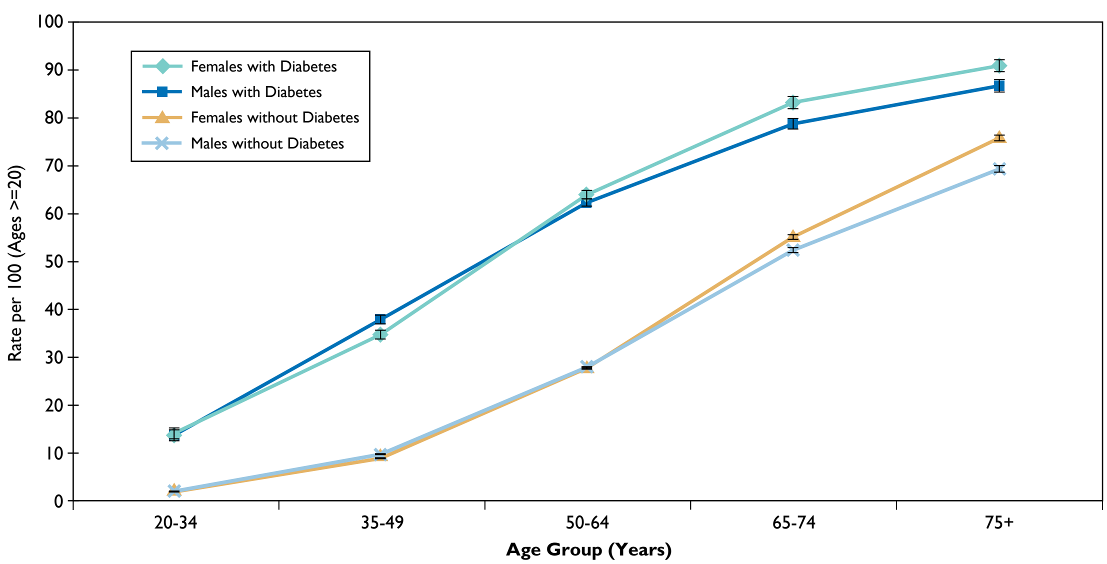
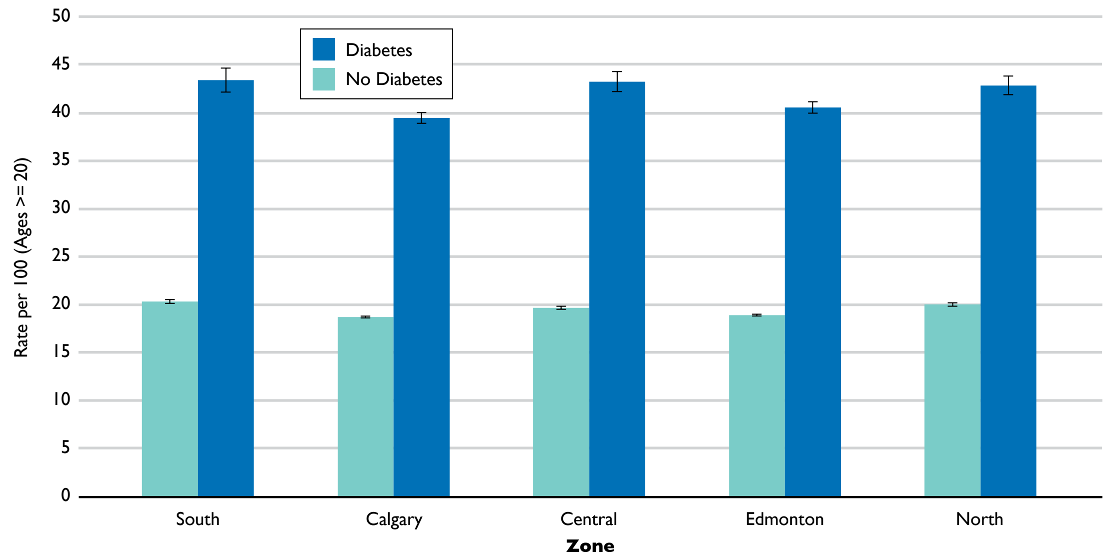


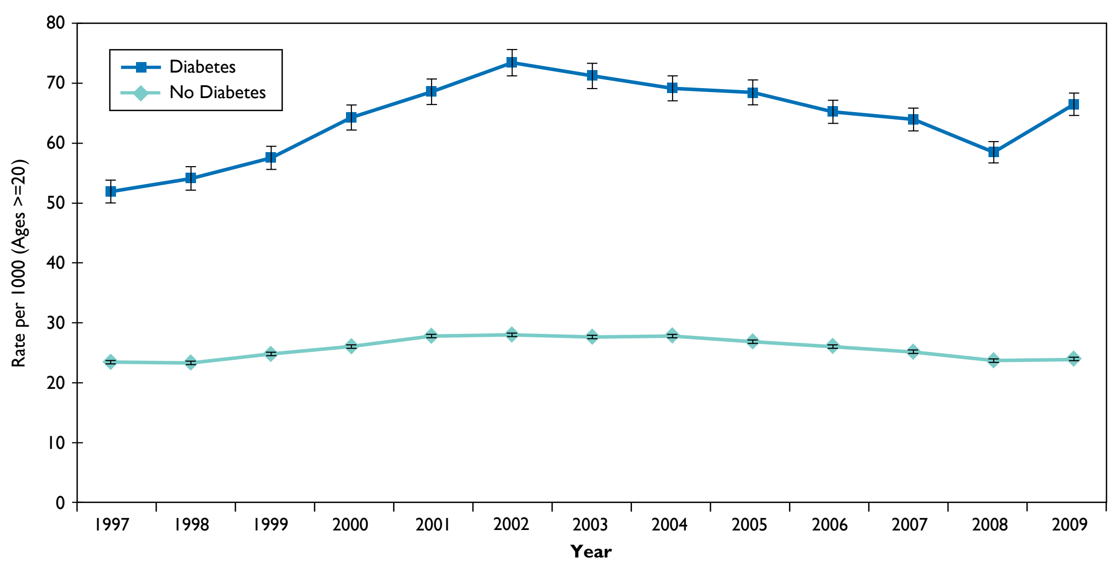
Figure 6.35 **Age-Adjusted Prevalence Rates of Hypertension by Zone, 2009**




## Incidence of Hypertension

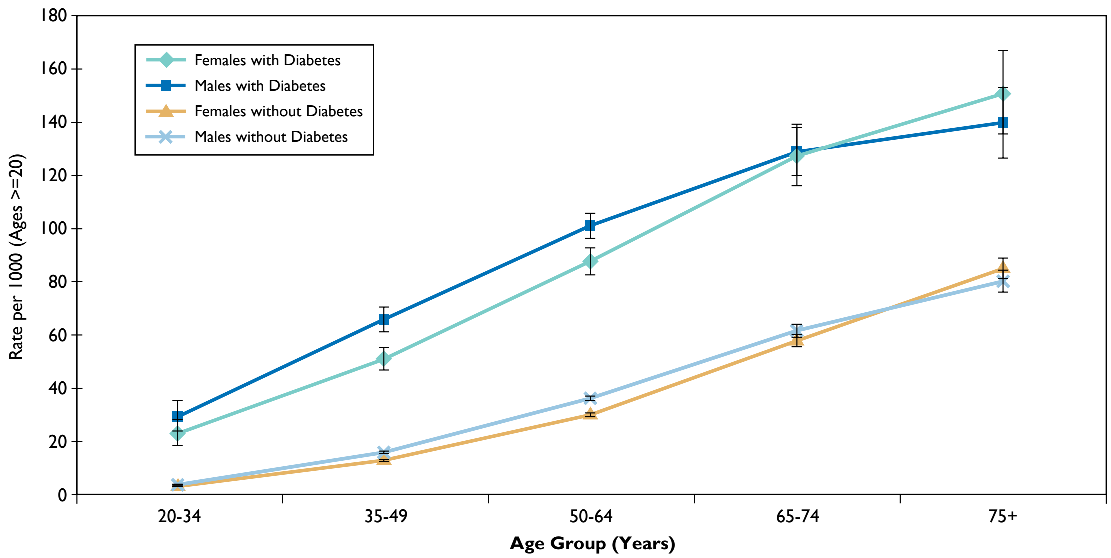
The incidence of hypertension was much higher among patients with diabetes than those without diabetes in the period from 1997-2009 after adjustment for age and sex (see Figure 6.36). Age- and sex-adjusted incidence rates among diabetes patients increased until 2002 and have decreased since 2002, with an increase again in 2009. This pattern was more obvious in the population with diabetes compared to the population without diabetes.

Figure 6.36 **Age- and Sex-Adjusted Incidence Rates of Hypertension, 1997-2009**



Hypertension incidence varied by age and sex (see Figure 6.37). In 2009, the incidence rate of hypertension was higher for females than males with diabetes in the oldest age group, while males had higher incidence rates in the younger age groups compared to females. These differences were more obvious in the diabetes population.

Figure 6.37 **Age-Specific Hypertension Incidence Rates, 2009**




## DISCUSSION

Hypertension is very common among people with diabetes. In Alberta, 66% of the diabetic population had hypertension in 2009. A contributing factor for this may be that people with diabetes are more likely to have their blood pressure monitored; therefore, they are also more likely to be diagnosed with hypertension. That said, overall statistics for hypertension are likely underestimates due to the asymptomatic nature of hypertension; therefore, individuals may be unaware of hypertension presence until their blood pressure is monitored by a health care professional. Strikingly, the trends are increasing due to the chronic nature of the disease and high incidence among older age groups. Thus, it is imperative to promote hypertension prevention, awareness and control.

Hypertension shares common risk factors with diabetes and other cardiovascular diseases.[4] Lifestyle modification including exercise, maintenance of a healthy body weight or weight reduction, a well-balanced diet as well as stress management are all benefits to prevention and management of hypertension as well as other chronic diseases such as diabetes.

Growing evidence specifically highlights the importance of maintaining good blood pressure control.[10-12] Intensive control of glycemia, blood pressure and cholesterol levels have all been demonstrated to improve health outcomes for individuals with diabetes; however, control of blood pressure has been reported to be the most cost-effective intervention.[13]

Canadian health professional associations, including the Canadian Diabetes Association and the Canadian Hypertension Education Program, have developed guidelines for management of hypertension in people with diabetes, including the maintenance of a target blood pressure of less than 130 mm Hg systolic and less than 80 mm Hg diastolic.[14] This may be achieved by lifestyle modification and may also require up to three or more drugs including a diuretic. Blood pressure measurement was also emphasized, including assessment at all health care professional visits, with home blood pressure measurement encouraged.

In Alberta, hypertension incidence has declined since 2002 among people with diabetes. The slope of decline is higher than that among people without diabetes. While data for the year 2009 suggests an increase in the age- and sex-adjusted incidence of hypertension among people with diabetes, further data is required to confirm whether a true trend with increasing incidence is occurring. The findings of a decline in hypertension prior to 2009 should be cautiously explained and further investigation is needed. The first possible reason is that patients with diabetes have more actively and effectively reduced risk factors for hypertension through life-style management for diabetes, such as balanced diet, weight control and exercise. The second possible reason is that physicians less frequently report presence of hypertension among their diabetic patients when they submit billings to Alberta Health and Wellness for their services; however, this could be offset by the fact that people with diabetes have more interactions with the health care system; therefore, there are more opportunities for a hypertension code to be used. The third possible reason is that the diagnosis coding system was changed to ICD-10-CA from ICD-9-CM in 2001 (for hospital in-patient claims) in Alberta. The coding system changes might have resulted in coders not coding hypertension as frequently for patients discharged from hospital with diabetes. However, this may have little impact on the trend.[15] Of interest, the age and sex-adjusted prevalence rates of hypertension among people with diabetes has been relatively stable over the past 4 years.

There are limitations to our analyses. We employed hospital discharge and physician claims administrative data; therefore, hypertensive patients who did not visit physicians in the study period were not captured. We also missed undiagnosed hypertensive patients. The second limitation is that we could not avoid misclassification of hypertensive patients. Hypertension might be coded incorrectly in the available administrative databases. However, our findings of hypertension prevalence among diabetes patients were similar with previous reports.[2]

In summary, the majority of people with diabetes in Alberta have hypertension, particularly among the older age groups. The magnitude of these trends are increasing among all age groups. This indicates that hypertension consumes large amount of health resources and facilitates poor prognosis of diabetes and other chronic conditions.

## APPENDIX

### Alberta Physician Claims Data, Discharge Abstracts Database

| Condition | ICD-9 | ICD-10 |
|---|---|---|
| Hypertension | 401.X, 402.X, 403.X, 404.X, 405.X | I10.X, I11.X, I12.X, I13.X, I15.X |
| Obstetric Event (pregnancy and delivery) | 650.X-669.X | O13, O14, O29, O47, O48, O60-O75, O80-O84 |

## References

1. Joffres MR, Hamet P, MacLean DR, L'italien GJ, Fodor G. Distribution of blood pressure and hypertension in Canada and the United States. Am J Hypertens 2001;14(11 Pt 1):1099-105.
2. Zannad F, Agabiti-Rosei E. Profile of patients with type 2 diabetes in France and Italy. J Hypertens 2008;26(Suppl 3):S3-6.
3. Manson JE, Skerrett PJ, Greenland P, VanItallie TB. The escalating pandemics of obesity and sedentary lifestyle. A call to action for clinicians Arch Intern Med 2004;164(3):249-58.
4. Mourad JJ, Le Jeune S. Blood pressure control, risk factors and cardiovascular prognosis in patients with diabetes: 30 years of progress. J Hypertens 2008;26(Suppl 3):S7-13.
5. Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJ, Comparative risk assessment collaborating g. selected major risk factors and global and regional burden of disease. Lancet 2002;360(9343):1347-60.
6. Lawes CM, Bennett DA, Lewington S, Rodgers A. Blood pressure and coronary heart disease: a review of the evidence. Semin Vasc Med 2002;2(4):355-68.
7. Harris SB, Lank CN. Recommendations from the Canadian Diabetes Association. 2003 guidelines for prevention and management of diabetes and related cardiovascular risk factors. Can Fam Physician 2004;50:425-33.
8. Khan NA, Hemmelgarn B, Herman RJ, Rabkin SW, McAlister FA, Bell CM, et al. The 2008 Canadian Hypertension Education Program recommendations for the management of hypertension: part 2-therapy. Can J Cardiol 2008;24(6):465-75.
9. Statistic Canada. Age (122) and sex (3) for population, for Canada, provinces, territories, census metropolitan areas and census agglomerations. 2001 Census. 2006 [cited 2009 March 17]. Available from: http://www12.statcan.ca/english/census01/products/standard/themes/RetrieveProductTable.cfm?.
10. Hansson L, Zanchetti A, Carruthers SG, Dahlof B, Elmfeldt D, Julius S, et al. Effects of intensive blood-pressure lowering and low-dose aspirin in patients with hypertension: principal results of the hypertension optimal treatment (HOT) randomised trial. HOT Study Group. Lancet 1998;351(9118):1755-62.
11. UKPDS. Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 38. UK prospective diabetes study group. BMJ 1998;317(7160):703-13.
12. Gaede P, Vedel P, Larsen N, Jensen GV, Parving HH, Pedersen O. Multifactorial intervention and cardiovascular disease in patients with type 2 diabetes. N Engl J Med 2003;348(5):383-93.
13. CDC Diabetes Cost-effectiveness Group. Cost-effectiveness of intensive glycemic control, intensified hypertension control, and serum cholesterol level reduction for type 2 diabetes. JAMA 2002;287(19):2542-51.
14. Campbell NR, Leiter LA, Larochelle P, Tobe S, Chockalingam A, Ward R, et al. Hypertension in diabetes: a call to action. Can J Cardiol 2009;25(5):299-302.
15. Quan H, Li B, Saunders LD, Parsons GA, Nilsson CI, Alibhai A, et al. Assessing validity of ICD-9-CM and ICD-10 administrative data in recording clinical conditions in a unique dually coded database. Health Serv Res 2008;43(4):1424-41.

Chapter 7

# Diabetes, Foot Disease and Lower Limb Amputations in Alberta

Brent D. Haverstock
C. Keith Bowering
M. Sean McMurtry
Peter A. Senior
Samantha L. Bowker
Ross T. Tsuyuki

# DIABETES, FOOT DISEASE AND LOWER LIMB AMPUTATIONS IN ALBERTA

## KEY MESSAGES

- In 2009, people with diabetes were twice as likely to have foot disease than people without diabetes.
- The highest rates of foot disease were in people with diabetes who are 75 years or older.
- In 2009, people with diabetes were 15 times more likely to have a lower limb amputation than people without diabetes, a rate which remained steady in the last 15 years.
- Lower limb amputations were twice as common in males than in females with diabetes.
- The rates of diabetic foot disease and lower limb amputations were the lowest in the metro Edmonton and Calgary health zones.

## BACKGROUND

Foot problems are a significant complication for people with diabetes. More specifically, people with diabetes often develop foot disease (i.e., foot ulcer, cellulitis, osteomyelitis) as a result of diabetic peripheral neuropathy (DPN) or atherosclerotic lower extremity peripheral arterial disease (PAD), which may eventually lead to lower limb amputations.(1) In people with diabetes, foot ulceration is usually a consequence of:

1) impaired sensation, which results in the loss of the protective sensation in the foot;

2) structural abnormalities, which result in increased pressure and tissue breakdown;

3) poor blood flow to the injured area, which then interferes with the healing process.

Commonly all these factors operate together. Susceptibility to injury and poor wound healing can lead to ulceration, and unless treated promptly, foot ulcers may become infected particularly when diabetes control is poor. Soft tissue infection may progress to involve the underlying bone. These deeper infections are usually very difficult to treat and may eventually require amputation. Similarly, when the extremities of the body are deprived of oxygen due to PAD, tissue death may result, leading to ulceration and/or gangrene. If revascularization is not possible and gangrene develops, amputation is usually required. People with diabetes who also have PAD are more likely to develop critical limb ischemia compared to people without diabetes.(2)

Lower limb problems are a major cause of morbidity and mortality in people with diabetes and contribute to increased health care costs.[3,4] The risk of lower limb amputations following a diagnosis of diabetes is 6% at 20 years and 11% at 30 years.[5] Similarly, 5-year mortality rates after new-onset diabetic ulceration have been reported between 43% and 55%, and are as high as 74% for patients who had a lower limb amputation.[6] Foot ulcers and amputations can be prevented with proper foot care and prompt treatment of ulcers at their initial stage.[3]

Besides increased health care costs and increased mortality rates, people with foot ulcers and/or lower limb amputations have a lower health-related quality of life.[7,8] These individuals often have long treatment periods that can be both painful and time consuming, with much time spent at clinic visits, hospitalization and frequent foot ulcer dressing changes with or without long term antibiotic therapy.[8] If a lower limb amputation results, patients are faced with many challenges such as needing assistance with activities of daily life.

## METHODS

Data from Alberta Health and Wellness (AHW) Physician Claims databases were utilized for these analyses. This dataset captures Alberta resident demographic information, and procedural and diagnostic codes for lower limb amputations and foot disease, respectively.

We included all related procedures and diagnoses coded by any physician specialty, including podiatrists. Podiatric physician specialty codes were only available past 2006. All residents of Alberta who were 20 years or older were included in these analyses.

From the procedural codes for lower limb amputations and the diagnostic codes for foot disease, we calculated age- and sex-adjusted rates for those with and without diabetes (1995-2009), age-adjusted rates for people with diabetes by sex (1995-2009), and age-specific rates for 2009. For both people with and without diabetes, the number of individuals with lower limb amputations or foot disease (numerator) was divided by the total number of people in the zone or province (denominator), respectively. We also present the counts of lower limb amputations (1995-2009).

## FINDINGS

### Foot Disease

From 1995-2009, people with diabetes were approximately 2 times more likely to have foot disease than people without diabetes, after adjusting for age and sex (Figure 7.1). These rates were relatively stable over the years in both people with and without diabetes. Subtle sex differences were observed, where rates of foot disease were about 6% higher in males with diabetes than in females with diabetes in 1995 (Figure 7.2). From 1995-2009, however, the rates of foot disease declined slightly in males with diabetes and increased slightly in females with diabetes, so that by 2009, the rate of foot disease was 3% lower in males with diabetes.

Figure 7.1 **Age- and Sex-Adjusted Rates of Foot Disease, 1995-2009**

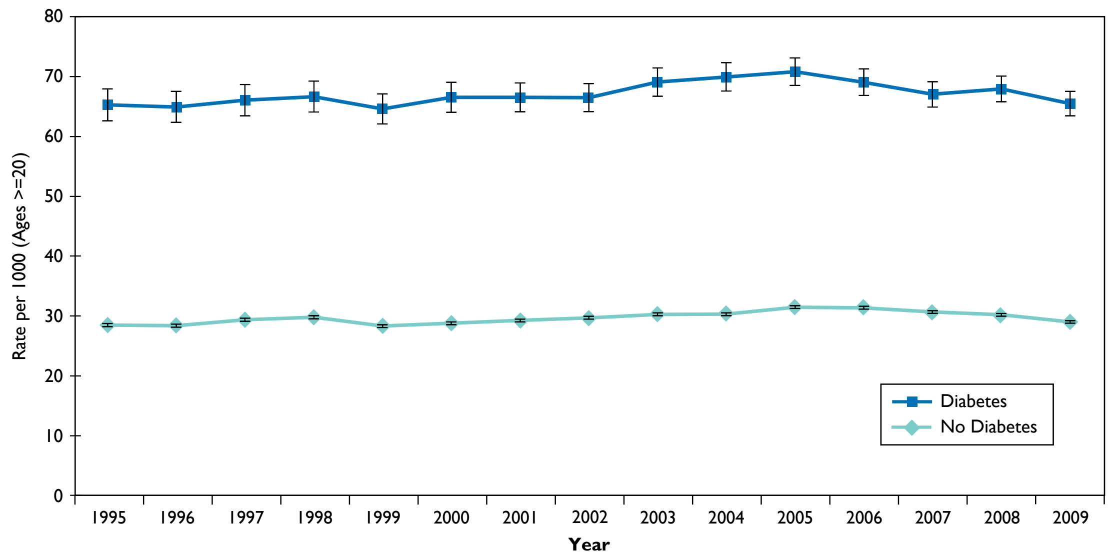
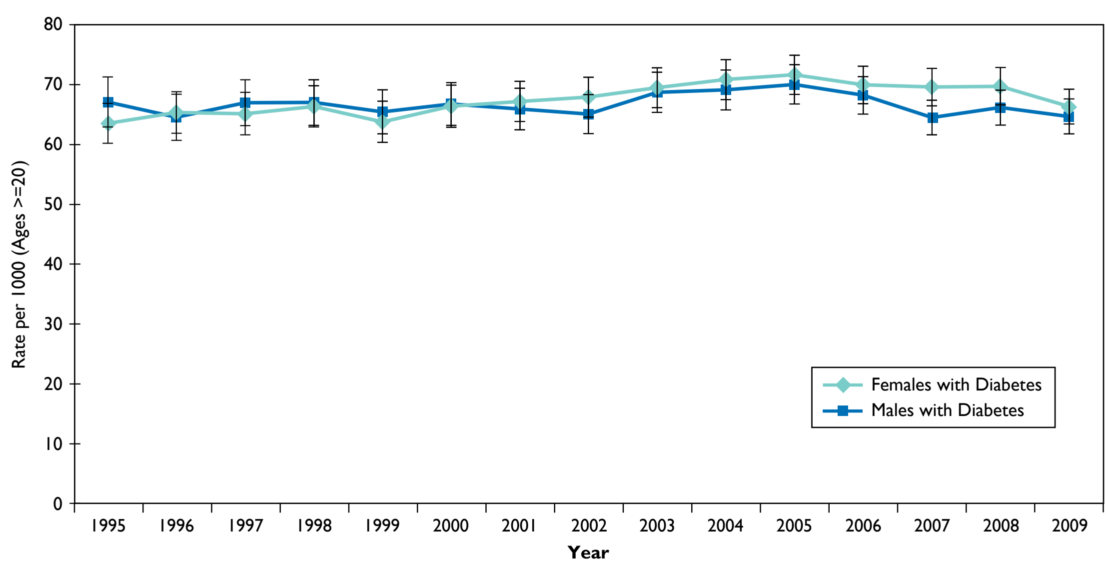



Figure 7.2 **Age-Adjusted Rates of Foot Disease in People with Diabetes, 1995-2009**



The rates of foot disease in people with diabetes are consistently higher compared to people without diabetes, across all age groups (Figure 7.3). There is a trend of increasing rates of foot disease across age groups in both the diabetes and non-diabetes groups, with the highest rates being in the 75-plus age group. However, the rate ratio (or relative risk) of 2.5 is highest in the 35-49-year-old age group, and decreases to 1.5 in the 75-plus age group. Therefore, although there is more foot disease overall in older patients, the relative risk of foot disease is somewhat higher in younger adults compared to older adults.

The age-adjusted rates of foot disease for individuals with diabetes were similar across the health zones. It was notable, however, that for individuals without diabetes, the Edmonton zone had a higher rate of foot disease (Figure 7.4).

Figure 7.3 **Age-Specific Rates of Foot Disease, 2009**

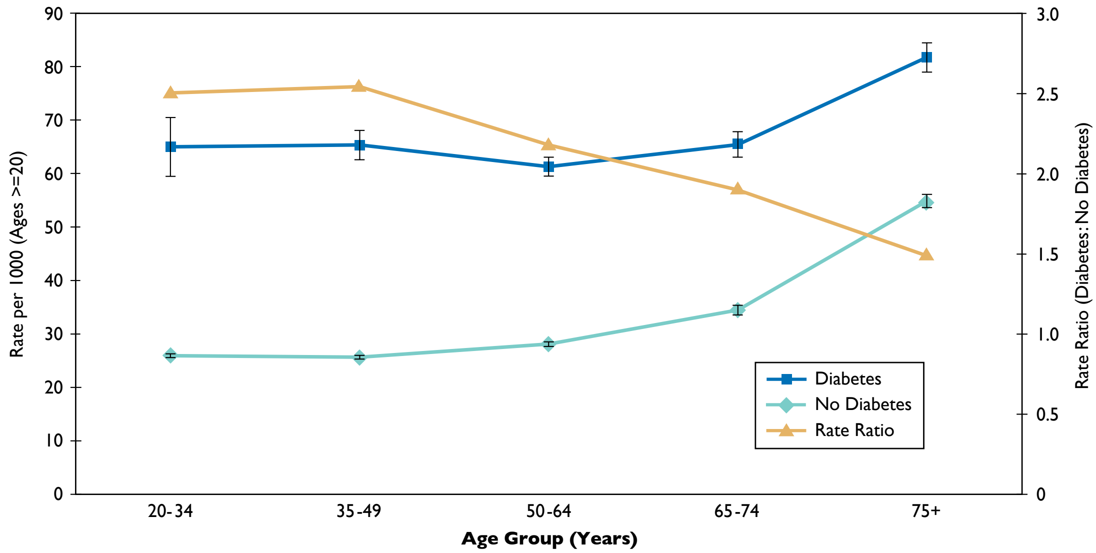
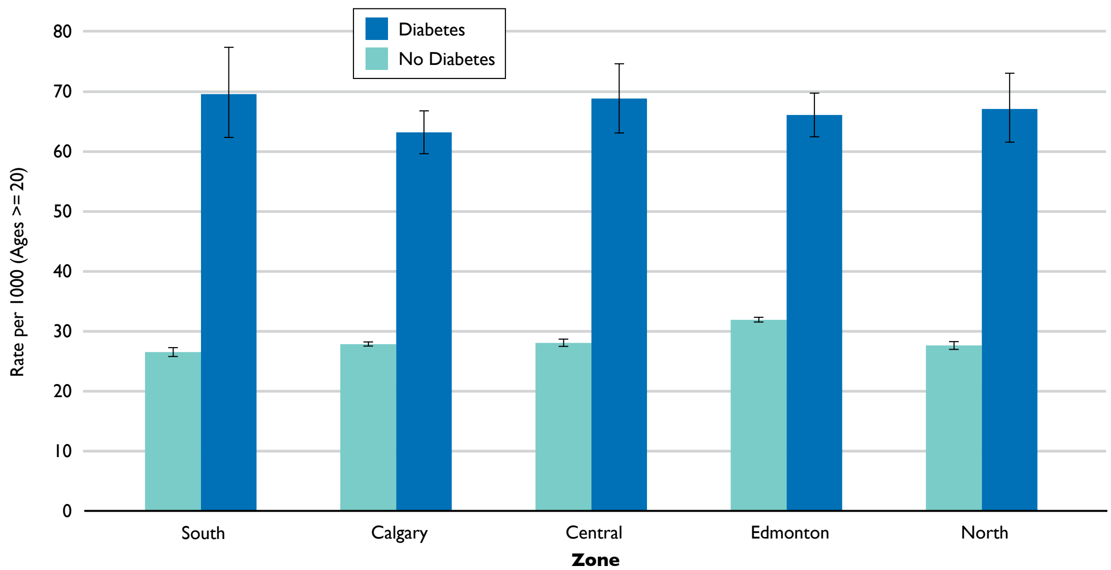


Figure 7.4 **Age-Adjusted Rates of Foot Disease by Zone, 2009**




## Lower Limb Amputations

Lower limb amputation is a serious complication in people with diabetes and is rare in people without diabetes. From 1995-2009, people with diabetes were approximately 15 times more likely to have a lower limb amputation than people without diabetes, after adjusting for age and sex (Figure 7.5). Although the ratio between those with and without diabetes remained constant over the last 15 years, age- and sex-adjusted rates of lower limb amputation have decreased in people with diabetes in the years 1995-2000, but have since plateaued. This is despite an increase in raw numbers of lower limb amputations in people with diabetes. Lower limb amputations were about twice as common in males with diabetes than in females with diabetes (Figure 7.6). Lower limb amputations were not common in young people without diabetes, but become more common in older adults with and without diabetes (Figure 7.7). The rate ratio (or relative risk) demonstrates that the risk of lower limb amputation is much greater for adults with diabetes compared to those without diabetes. While there were a higher number of lower limb amputations in older patients, the relative risk of lower limb amputation is much higher in younger adults compared to older adults. In fact, in the age group of 35-49 years, those with diabetes were 28 times more likely to have a lower limb amputation than those without diabetes. In adults 75 years and older, those with diabetes were 6 times more likely to have a lower limb amputation than those without diabetes. The higher rate of lower limb amputation in the older population is likely due to increased PAD in both groups. The excess of lower limb amputations in younger adults with diabetes is likely due to an excess of peripheral neuropathy rather than PAD alone.

Figure 7.5 **Age- and Sex-Adjusted Rates of People having Lower Limb Amputation(s), 1995-2009**

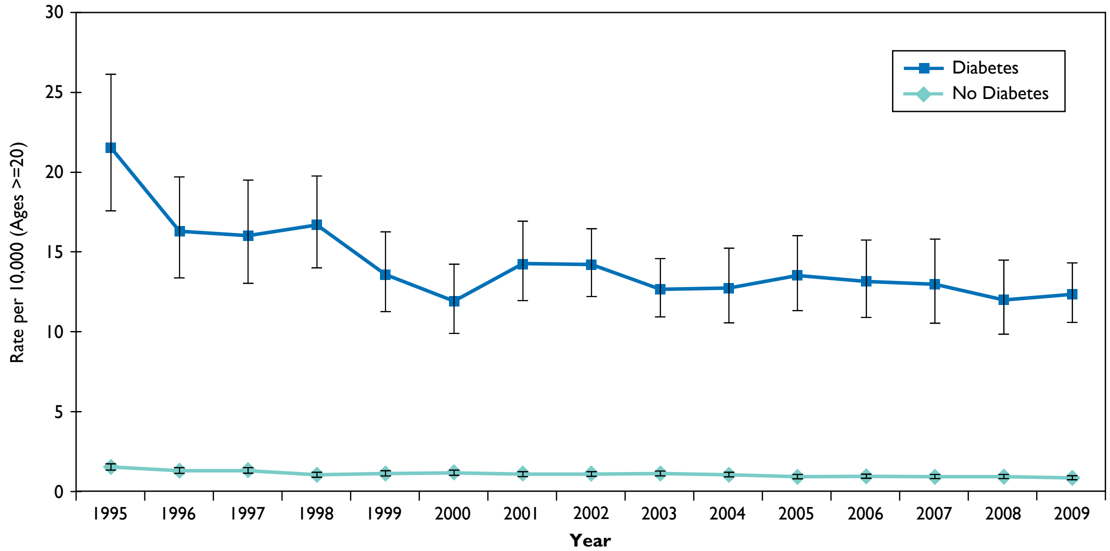



Figure 7.6 **Age-Adjusted Lower Limb Amputation Rates in People with Diabetes, 1995-2009**

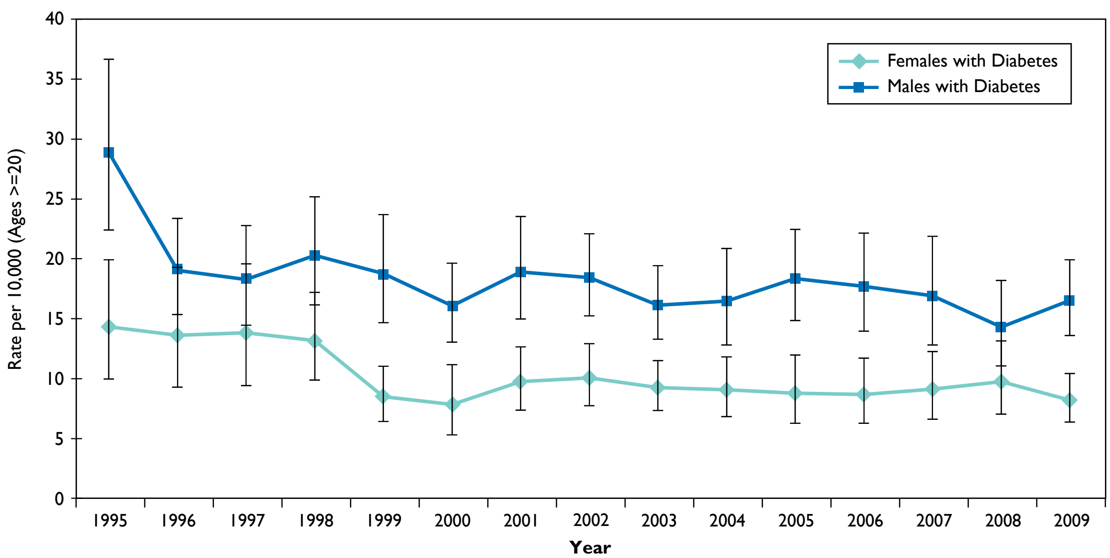
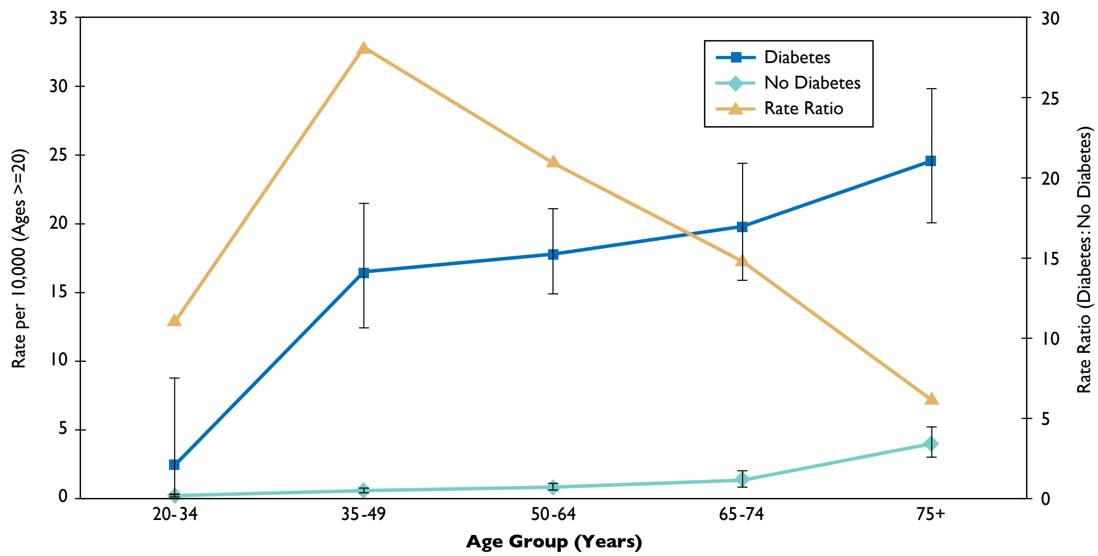
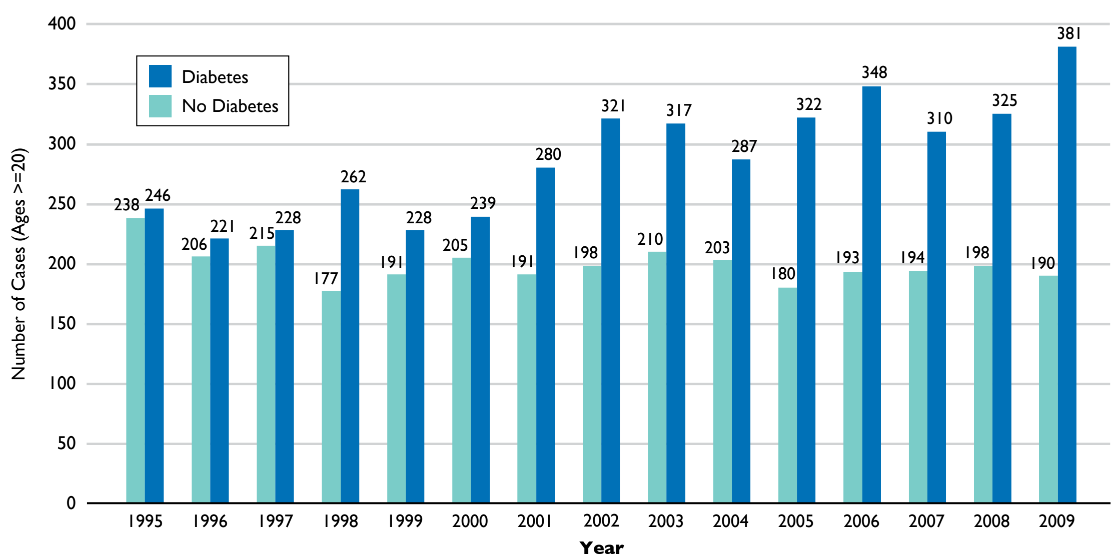


Figure 7.7 **Age-Specific Rates of People having Lower Limb Amputation(s), 2009**



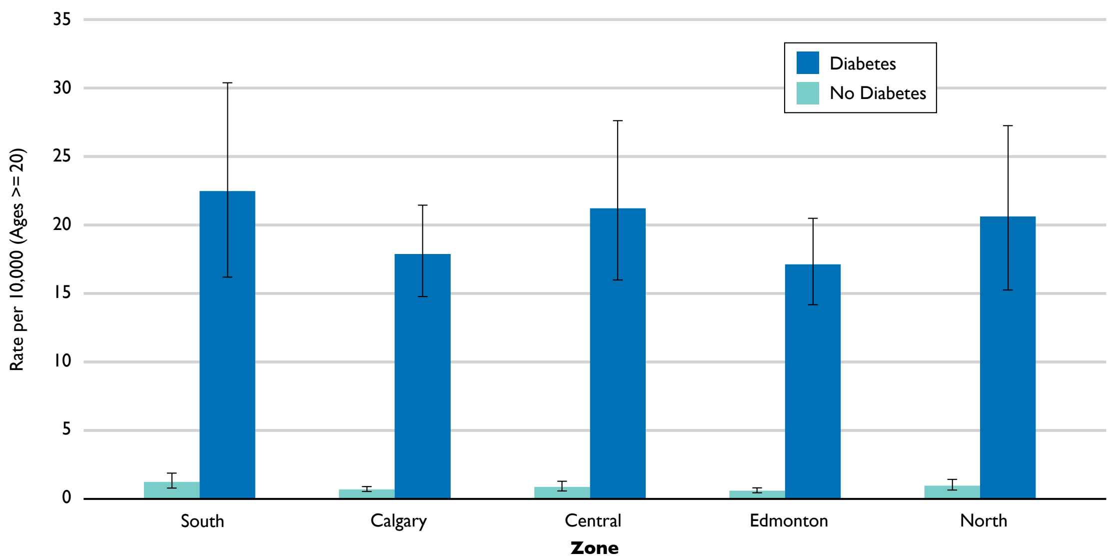

The actual number of lower limb amputations was higher in people with diabetes compared to those without diabetes, across all years (Figure 7.8). The number of lower limb amputations in people with diabetes increased over time from 1995-2009, whereas that number remained fairly constant over time in people without diabetes.

Figure 7.8 **Number of Lower Limb Amputation Cases, 1995-2009**



Here, the rate of lower limb amputations is represented as a crude rate due to the small number of amputations occurring in the zones. The Edmonton and Calgary zones had the lowest rates of lower limb amputations in people with diabetes at 17.1 and 17.9 per 10,000 people, respectively (Figure 7.9).

Figure 7.9 **Crude Rates of People having Lower Limb Amputation(s) by Zone, 2009**




## DISCUSSION

Foot disease (i.e., cellulitis, ulcers, osteomyelitis and gangrene) and lower limb amputations represent a significant morbidity in people with diabetes. The above findings support the importance of life-long surveillance of the diabetic foot and preventative foot care among diabetic patients.[4] Although only some individuals with diabetes ultimately need lower limb amputation, the burden that amputation places on patients and our health care system is very large and the fact that gross numbers of lower limb amputations are increasing is worrisome. Also, due to the preventable nature of lower limb amputations, diabetic foot care is a very important aspect of the management of diabetes in Alberta. The rate of lower limb amputations has been suggested as an indicator of overall quality of care for diabetes.[9]

As previously noted, foot ulcers and lower limb amputations are a result of two different processes in people with diabetes. Decreased sensation due to DPN (nerve damage) makes it hard for people with diabetes to feel small cuts or damage to the foot, and poor blood flow to the legs and feet (PAD) prevents healing of these small cuts, allowing them to worsen. Diabetes itself, particularly if poorly controlled, increases the risk of ulcers becoming infected. Reducing the risk of lower limb amputations therefore requires multiple prevention strategies, including regular foot checks by the individual with diabetes themselves, as well as by their health care providers.[3] The 2011 American Diabetes Guidelines recommends that "initial screening for peripheral arterial disease (PAD) should include a history for claudication and an assessment of the pedal pulses", and that an ankle-brachial index (ABI) should be considered "as many patients with PAD are asymptomatic."[10]

Poor blood circulation in the lower limbs is due to atherosclerosis, the same disease process that affects blood vessels of the heart (leading to heart attacks) and the brain (leading to stroke).[11,12] Atherosclerosis refers to the buildup of cholesterol in the arteries, which over time leads to the narrowing of blood vessels that impairs blood supply. Reducing the risk of lower limb amputation therefore requires the same preventative treatment. Treatment includes cholesterol lowering, blood pressure lowering, anti-platelet (ASA) therapy and revascularization similar to that used to prevent and treat heart attacks and strokes. Unfortunately, there is evidence to suggest that people with diabetes and PAD are not optimally treated to reduce their risk of heart attacks or stroke.[13-15] Notably, lower limb amputation could be thought of as the “tip of the iceberg,” as it is a marker for end stages of DPN and PAD. There are a great deal many more patients with less severe (but still serious) forms of the disease who would benefit from better application of preventive therapies.

It is discouraging to see the rate of lower limb amputation for males and females with diabetes in Alberta stay relatively constant over the last 15 years. That said, the 15-fold increase in lower limb amputations that we observed in people with diabetes compared to people without diabetes was lower than that observed by the Institute for Clinical Evaluative Sciences (ICES) Practice Atlas for Diabetes in Ontario. ICES found that people with diabetes in Ontario were 20 times more likely to have an amputation than people without diabetes.[16] Similar to findings from the ICES, we found that lower limb amputations were more common in males than in females with diabetes. This striking difference is unexplained, but could be due to discrepancies in access to care and compliance with care, as well as a different or more extensive burden of comorbidities. We also observed a two-fold higher rate of foot disease in people with diabetes than in people without diabetes with the highest foot disease rates in the oldest age group (75 years or older). It is concerning, however, that we have not seen a decrease in rates of foot disease over the past 15 years. Therefore, ongoing efforts to prevent and minimize diabetic foot disease in people with diabetes, such as regular foot examinations and annual screening for peripheral neuropathy, are required to further reduce rates of lower limb amputations in this population. Similarly, proper blood pressure, lipid and glucose control may reduce incidence of lower limb amputations in people with diabetes.

There is considerable variation in the rate of lower limb amputations across the health zones of the province. It appears that those living in the non-metro zones have higher rates of limb amputation. This is also true of foot disease, however the differences between zones are not as remarkable. Differences in these amputation rates may reflect different levels of risk for people with diabetes in these zones, different access to health care providers, delay in seeking medical attention or in treating ulcers, or differences in the decision-making to undergo an amputation. As with many other trends observed in this *Alberta Diabetes Atlas*, further investigation is needed to better understand the reasons for the patterns, which, in turn, may inform policy and program planning to support improved access and outcomes for people living with diabetes.

# APPENDIX

## Lower Limb Amputation

### Alberta Physician Claims Data

| Procedure | Procedure Codes |
|---|---|
| Amputation and disarticulation of one toe | 96.11A, 96.11AA, 96.11PA |
| Amputation and disarticulation of foot: Metatarsal | 96.12A, 96.12AA, 96.12AB, 96.12AC |
| Amputation and disarticulation of foot: Transmetatarsal | 96.12B, 96.12PB |
| Amputation and disarticulation of mid-tarsal | 96.12C, 96.12PC |
| Amputation and disarticulation of foot: Metatarsal – whole ray | 96.12PA |
| Amputation and disarticulation of ankle: Symes, Pirogoff | 96.13 |
| Amputation of lower leg below knee | 96.14 |
| Amputation of thigh or disarticulation of knee: Supracondylar Thigh through femur | 96.15 |

## Foot Disease

### Alberta Physician Claims Data

| Diagnosis | ICD-9-CM |
|---|---|
| Cellulitis and abscess of finger and toe | 681 |
| Toe | 681.1X |
| Unspecified digit | 681.9 |
| Other cellulitis and abscess | 682 |
| Leg, except foot | 682.6 |
| Foot, except toes {Excludes: toe (681.1)} | 682.7 |
| Chronic ulcer of skin {Excludes: Gangrene (785.4); Skin infection (680-686) | 707 |
| Decubitus ulcer | 707.0 |
| Ulcer of lower limbs, except decubitus | 707.1X |
| Chronic ulcer of other specified sites | 707.8 |
| Chronic ulcer of unspecified site | 707.9 |
| Ulcer of ankle | 707.13 |
| Ulcer of heel and midfoot | 707.14 |
| Ulcer of other part of the foot | 707.15 |
| Arthropathy associated with other endocrine; metabolic disorders Excludes: arthropathy associated with amyloidosis (713.7); arthropathy associated with diabetic neuropathy (713.5); arthropathy in gout and other crystal deposition disorders | 713.0 |
| Lower leg | 713.06 |
| Ankle and foot | 713.07 |
| Osteomyelitis, periostitis and other infections involving bone | 730 |
| Acute osteomyelitis | 730.0 |
| Lower leg | 730.06 |
| Ankle and foot | 730.07 |
| Chronic osteomyelitis | 730.1 |
| Lower leg | 730.16 |
| Ankle and foot | 730.17 |
| Periostitis without mention of osteomyelitis | 730.3 |
| Lower leg | 730.36 |
| Ankle and foot | 730.37 |
| Gangrene | 785.4 |
| Gas gangrene | 040.0 |

## References

1. Boyko EJ, Ahroni JH, Stensel V, Forsberg RC, Davignon DR, Smith DG. A prospective study of risk factors for diabetic foot ulcer. The Seattle diabetic foot study. Diabetes Care 1999;22(7):1036-42.
2. Bowers BL, Valentine RJ, Myers SI, et al. The natural history of patients with claudication with toe pressures of 40 mm Hg or less. Journal of vascular surgery. 1993;18(3):506-511.
3. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2008 clinical practice guidelines for the prevention and management of diabetes in Canada. Foot Care. Can J Diabetes 2008;32(Suppl 1): S143-6.
4. Reiber GE, Boyko EJ, Smith DG. Lower extremity foot ulcers and amputations in diabetes. In: National Diabetes Data Group, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases. Diabetes in America. 2nd ed. Bethesda (MD): 1995. p. 409-28.
5. Diabetes in Canada. Lower extremity amputations. [cited 2009 July 28]. Available from: http://www.phac-aspc.gc.ca/publicat/dic-dac99/d20-eng.php#jmp-lan23.
6. Robbins JM, Strauss G, Aron D, Long J, Kuba J, Kaplan Y. Mortality rates and diabetic foot ulcers: is it time to communicate mortality risk to patients with diabetic foot ulceration? J Am Podiatr Med Assoc. 2008;98:489-93.
7. Meatherall BL, Garrett MR, Kaufert J, et al. Disability and quality of life in Canadian aboriginal and non-aboriginal diabetic lower-extremity amputees. Arch Phys Med Rehabil 2005;86:1594-602.
8. Tennvall GR, Apelqvist J. Health-related quality of life in patients with diabetes mellitus and foot ulcers. J Diabetes Complications 2000;14:235-41.
9. Majumdar SR, Johnson JA, Bowker SL, Booth GL, Dolovich L, Ghali W, et al. A Canadian consensus for the standardized evaluation of quality improvement interventions in type 2 diabetes: development of a quality indicator set. Can J Diabetes 2005;29:220-9.
10. Executive Summary: Standards of Medical Care in Diabetes – 2011. Diabetes Care January 2011;34(suppl l):S4-S10.
11. Beckman JA, Creager MA, Libby P. Diabetes and atherosclerosis: epidemiology, pathophysiology, and management. JAMA 2002;287:2570-81.
12. Belch JJF, Topol EJ, Agnelli G, et al. Critical issues in peripheral arterial disease detection and management. Arch Intern Med 2003:163:884-92.
13. Hirsch AT, Criqui MH, Treat-Jacobson D, Regensteiner JG, Creager MA, Olin JW, et al. Peripheral arterial disease detection, awareness, and treatment in primary care. JAMA 2001;286:1317-24.
14. McGrae McDermott M, Hahn EA, Greenland P, et al. Atherosclerotic risk factor reduction in peripheral arterial disease: Results of a national physician survey. J Gen Intern Med 2002:17:895-904.
15. Brown LC, Johnson JA, Majumdar SR, Tsuyuki RT, McAlister FA. Evidence of sub-optimal cardiovascular risk management in patients with type 2 diabetes mellitus and symptomatic atherosclerosis. CMAJ 2004;171:1189-92.
16. Institute for Clinical Evaluative Sciences. Diabetes in Ontario: an ICES practice atlas. 2003.

## Chapter 8

# Diabetes and Kidney Disease in Alberta

Scott Klarenbach
Brenda R. Hemmelgarn
Kailash K. Jindal
Marcello Tonelli

# DIABETES AND KIDNEY DISEASE IN ALBERTA

## KEY MESSAGES

- In 2009, the rate of developing end-stage renal disease was over 12 times greater in patients with diabetes compared to patients without diabetes.
- Between 1997 and 2009, the average annual incident ESRD growth rate for people with diabetes was 4.7% compared to 0.04% for people without diabetes.
- From 1997-2009, the proportion of prevalent end-stage renal disease patients with diabetes had increased from 39% to 56%.
- Declining trends in the age- and sex-adjusted incidence and prevalence of end-stage renal disease in people with diabetes has occurred over the last several years of observation.

## BACKGROUND

One of the most serious consequences of diabetes mellitus (DM) is renal or kidney disease, also known as diabetic nephropathy. This frequently progresses to end-stage renal disease (ESRD), a state where life-sustaining treatment of ongoing dialysis therapy (either hemodialysis or peritoneal dialysis) or kidney transplantation is necessary. Patients with DM are at an increased risk of developing ESRD, up to 13 times greater than those without DM.[1]

ESRD patients on dialysis have a very poor quality of life[2-5] and high mortality rates, with 5-year survival rates of less than 30%,[2] worse than many commonly occurring malignancies.[6] While kidney transplantation is the preferred treatment, the limited availability of organs has led to very long waiting list times.

Those with diabetes and ESRD have even poorer health outcomes than non-DM patients receiving dialysis. In addition to reporting a much lower quality of life,[7] persons with diabetes have significantly higher mortality. In Canada, DM as a cause of kidney failure strongly influences survival in adjusted analysis, increasing the risk of death almost two-fold.[8] Finally, patients with ESRD and DM tend to have more comorbid illnesses, such as cardiovascular and peripheral vascular disease, which may preclude treatment with kidney transplantation.

Provision of care to the ESRD population is associated with significant consumption of health care resources. In developed nations, it is estimated that ESRD affects only 0.07% of the population, but consumes 2% to 3% of health care budgets.[9-12]

On a national level, the number of prevalent ESRD patients in Canada continues to grow at approximately 6% per annum,[8,9,13] a rate which would be expected to result in a doubling of the ESRD population every 7 to 10 years. A significant contributor to the growth in ESRD patients is due to increased numbers of persons with DM. The proportion of persons who develop ESRD due to DM in Canada has increased from 25% to 35% from 1993-2005.[8]

Our objective was to describe the epidemiology of ESRD and kidney transplantation in Alberta, from 1997-2009, with specific emphasis on patients with DM.

## METHODS

Data from Alberta Health and Wellness, which provides health care insurance to all permanent residents of Alberta (including Status Aboriginal people), was utilized for this analysis. This administrative dataset captures demographic information, outpatient and inpatient encounters, and physician billing claims. All patients 20 years or older were included in these analyses.

Physician billing claim codes specific for the delivery of maintenance dialysis therapy over the study period (1997-2009) were used to identify dialysis patients (see appendix). The patient population of interest were those receiving chronic dialysis, defined as having at least 2 dialysis billing codes in the same calendar year, >=90 days apart, determined using physician billing claims. The start date of dialysis was defined by the date of the earliest dialysis billing claim.

New or incident dialysis patients for a given year were defined if they met the above criteria, and if their start date of dialysis occurred in that year, without having been a dialysis case in the previous year. A person identified as an incident dialysis patient in a given year would be classified as a prevalent dialysis patient in subsequent years if additional dialysis billing claims occurred in these years.

Kidney transplantation was identified by physician claims for the surgical procedure of kidney transplantation (see appendix).

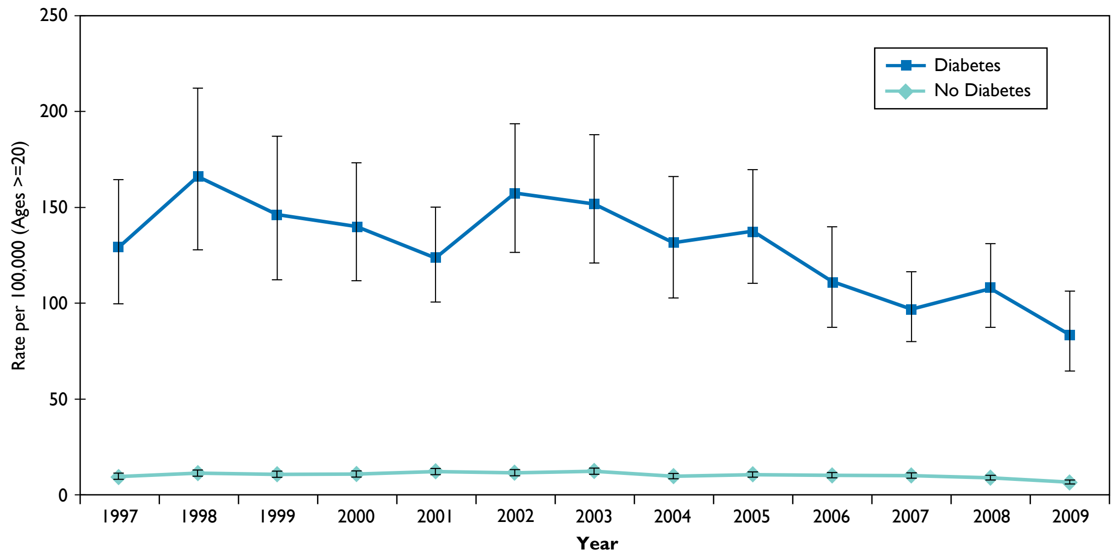
Persons with diabetes were identified as described in the “Background and Methods” chapter. DM and ESRD status of individuals were determined for each year, then incidence and prevalence rates of ESRD were calculated for persons with and without DM for each year. Age-specific rates for ESRD and kidney transplantation are also reported.

## FINDINGS

### Incidence

The age- and sex-adjusted rate of ESRD per 100,000 persons was relatively stable for persons without DM over the decade of observation; however, in those with diabetes an initially stable rate was followed by a declining trend since 2002. In 2009, the rate of developing ESRD for those with DM was over 12 times higher compared to those without DM (Figure 8.1).

Figure 8.1 **Age- and Sex-Adjusted ESRD Incidence Rates, 1997-2009**




The total number of incident ESRD cases per year rose from 291 in 1997 to 498 in 2003, then fell to 347 cases in 2009, with an average annual growth rate of 2.2% over the full 13-year period (Figure 8.2). Over the same time frame, the average annual incident ESRD growth for persons with DM was 4.7%, compared with 0.04% for those without DM. In 1997, 43% of all the incident ESRD cases had DM. This figure increased to 57% in 2009 (Figure 8.3).

Figure 8.2 **Number of Incident ESRD Cases, 1997-2009**

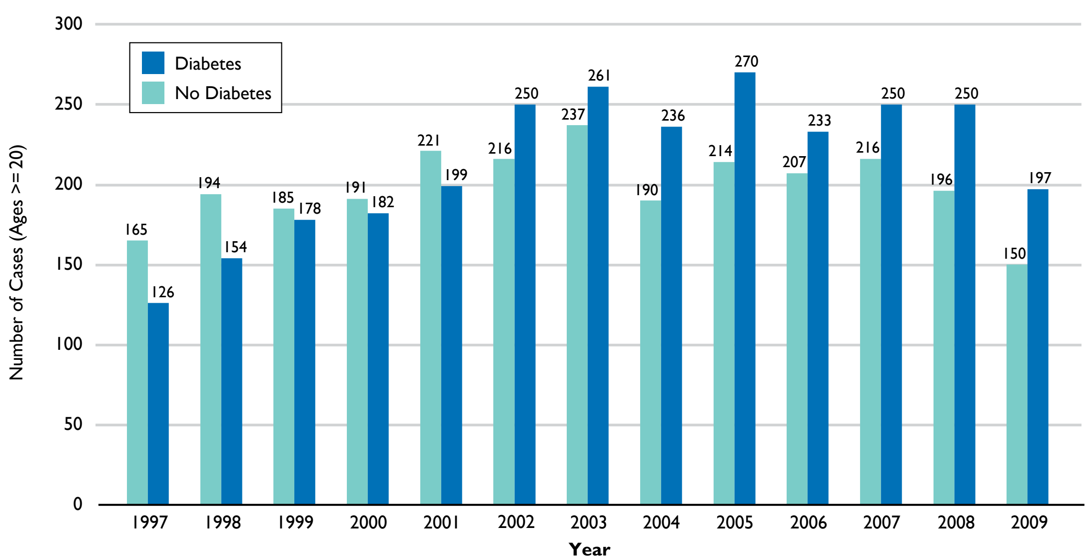
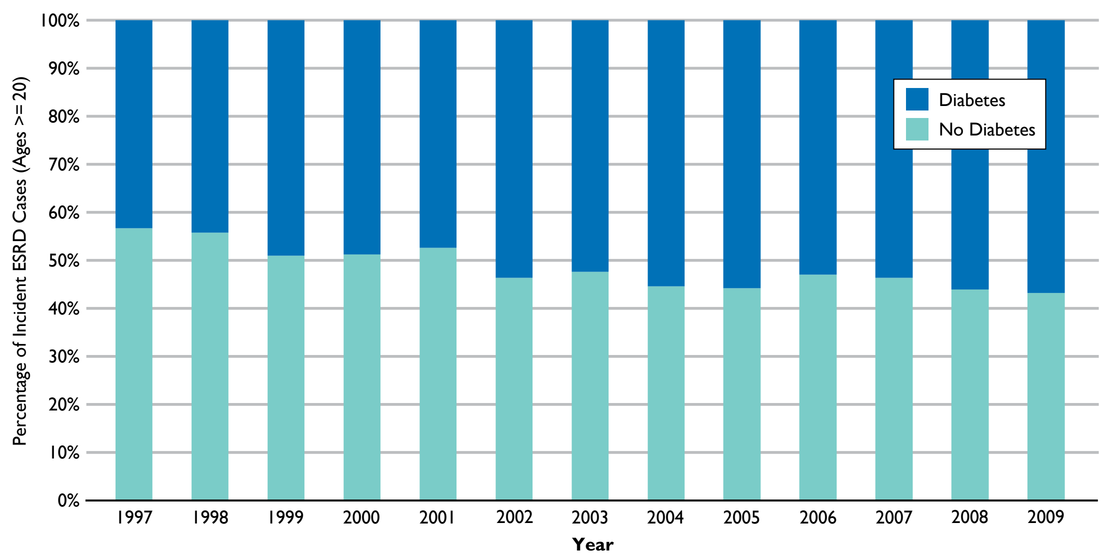


Figure 8.3 **Percentage of Incident ESRD Cases, 1997-2009**




In the year 2009, the 50-64, 65-74 and 75-plus age groups had more people with DM developing ESRD and the 20-34 and 35-49 age groups had more people without DM developing ESRD more often (Figure 8.4). The greatest average annual growth rate over the 13-year period of observation was in patients with DM in the oldest age group (Figure 8.5).

Figure 8.4 **Age-Specific Incident ESRD Cases, 2009**

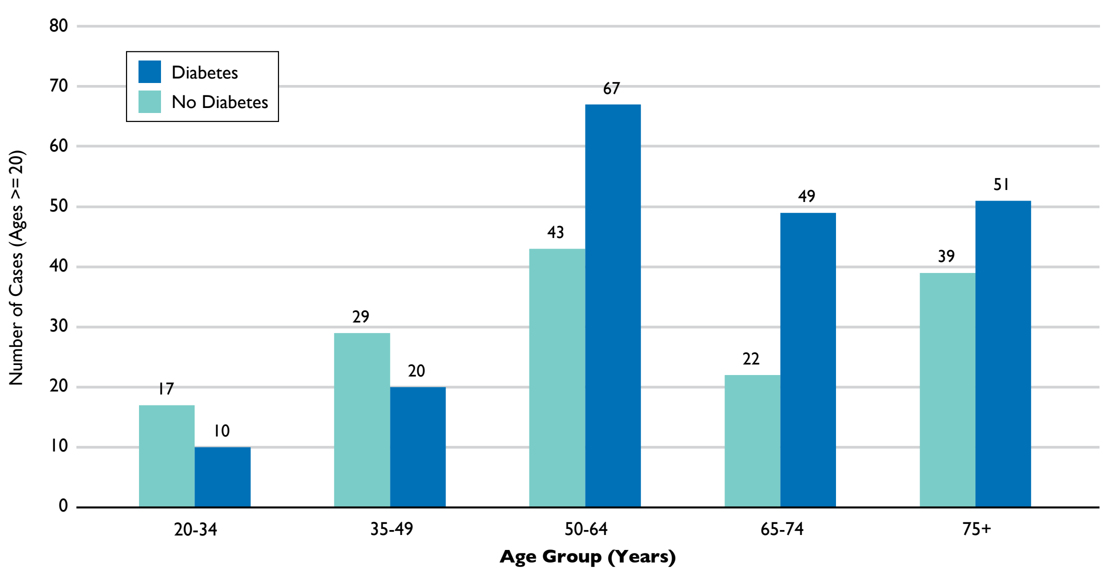
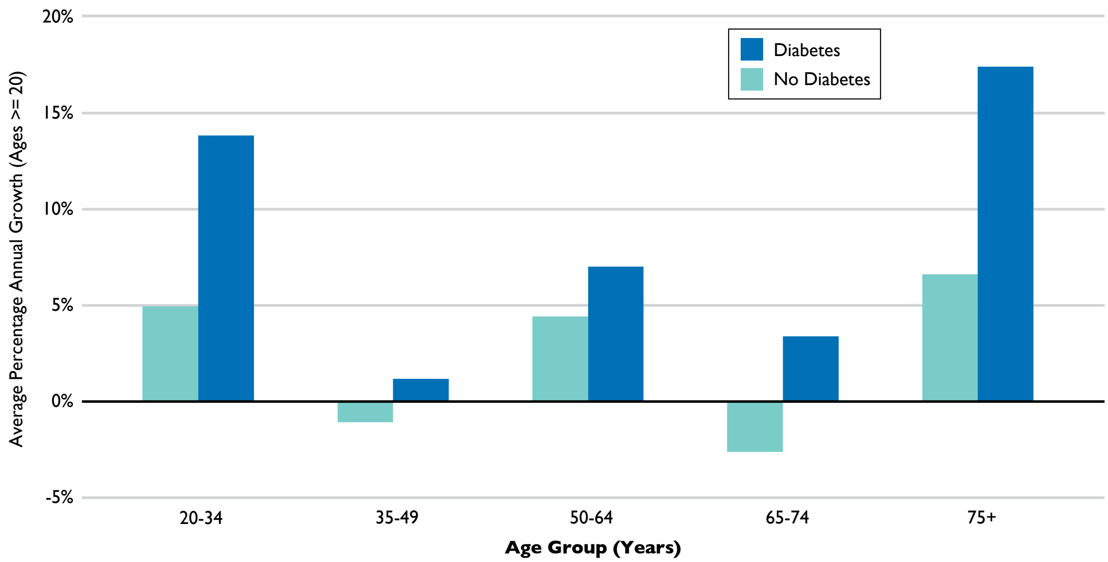


Figure 8.5 **Average Annual Growth of Incident ESRD Cases, 1997-2009**




## Prevalence

The age- and sex-adjusted prevalence rate per 100,000 persons with ESRD requiring dialysis was 11 times higher for patients with DM compared with those without DM from the years 1997-2009 (Figure 8.6). The absolute number of patients with ESRD on dialysis increased from 1,012 to 1,848 from 1997-2009, with an average annual growth rate of 5.3% (Figure 8.7). The average annual growth rate for persons with DM and ESRD was 8.7%, compared to 2.3% for those with ESRD without DM. The proportion of patients with ESRD and DM also increased from 39% to 56% over the period of observation (Figure 8.8).

Figure 8.6 **Age- and Sex-Adjusted ESRD Prevalence Rates, 1997-2009**

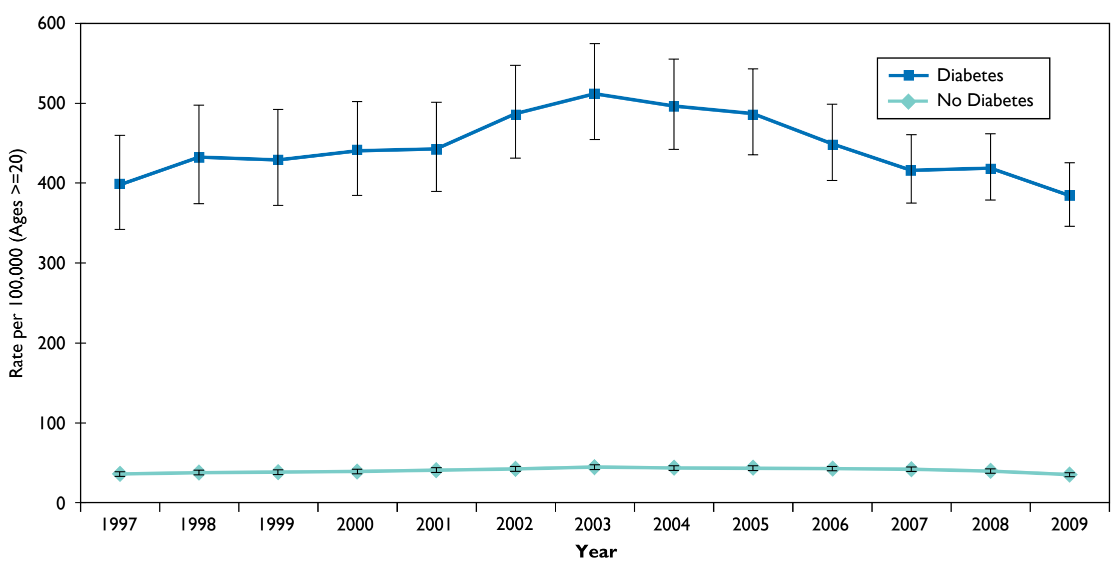


Figure 8.7 **Number of Prevalent ESRD Cases, 1997-2009**

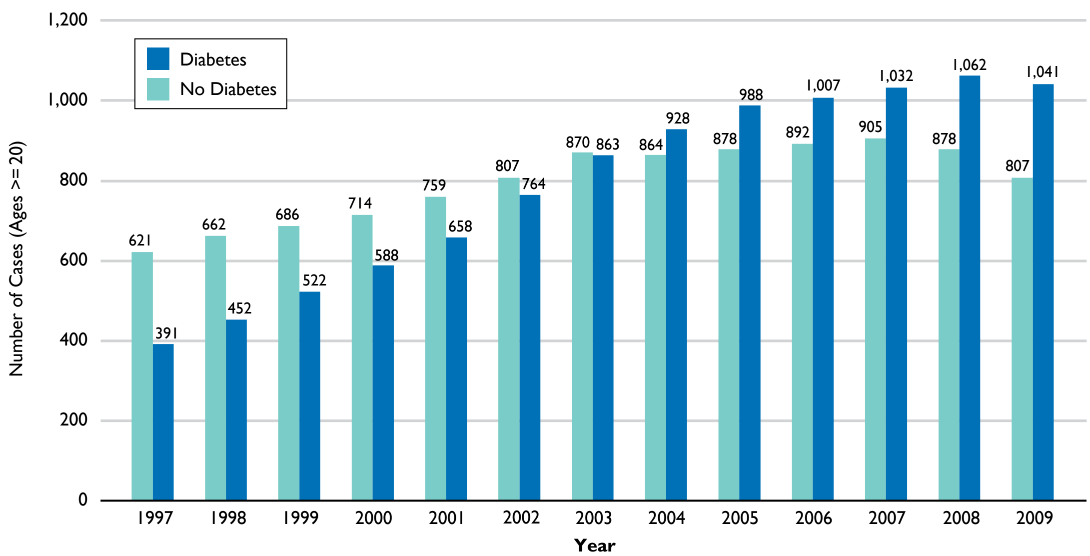
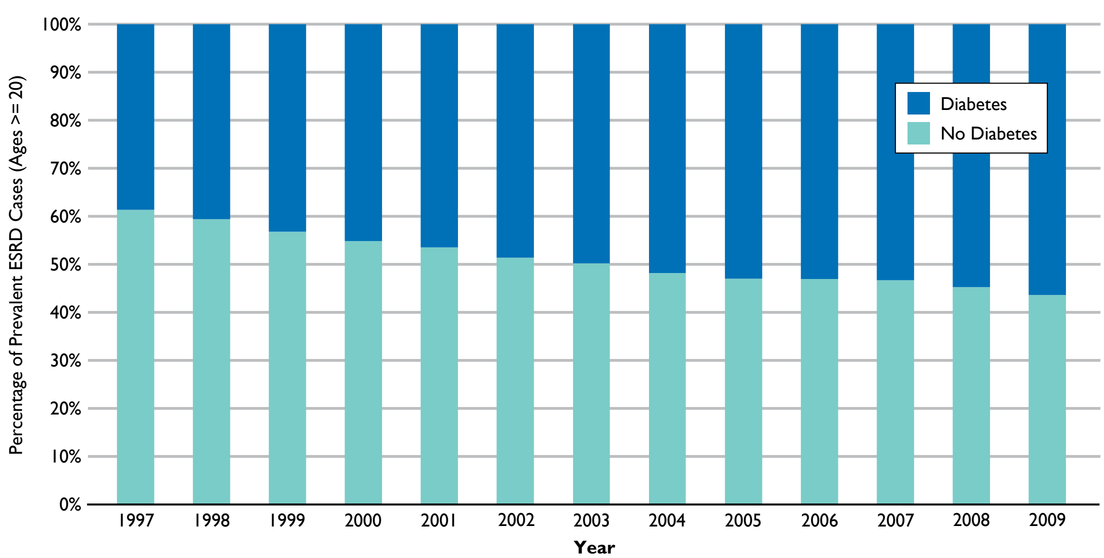



Figure 8.8 **Percentage of Prevalent ESRD Cases, 1997-2009**



## Kidney Transplantation

The younger population without diabetes received kidney transplantation more often, however this was the opposite in the older age groups where more people with diabetes received kidney transplantation (Figure 8.9). Of all kidney transplants in a given calendar year, the fraction of persons with DM receiving a kidney transplant has varied across time, but has increased substantially from 28% in 1995 to 45% in 2009 (Figure 8.10).

Figure 8.9 **Age-Specific Kidney Transplantation Cases, 2009**

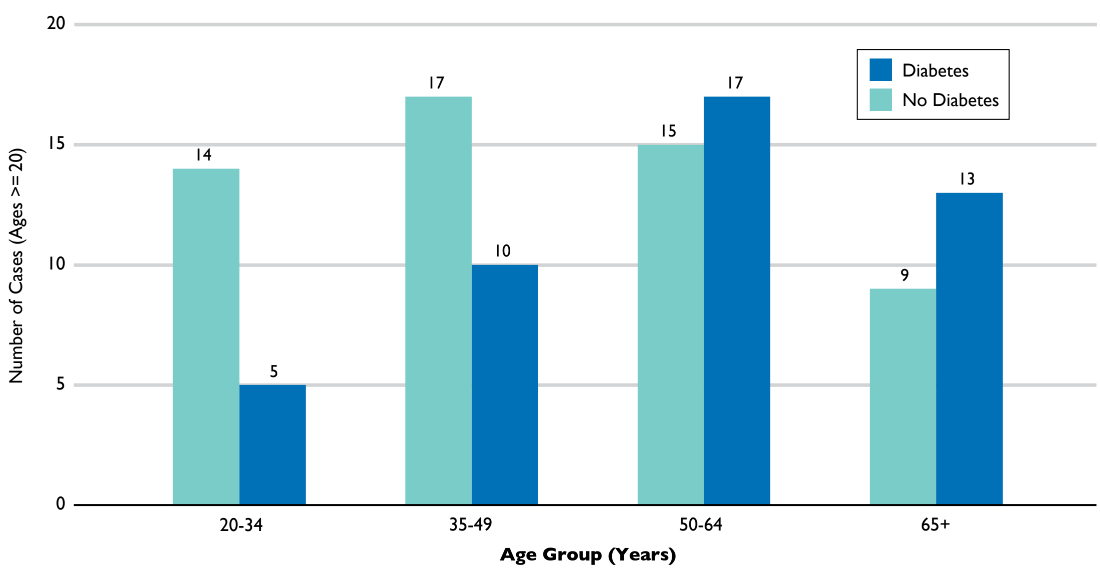
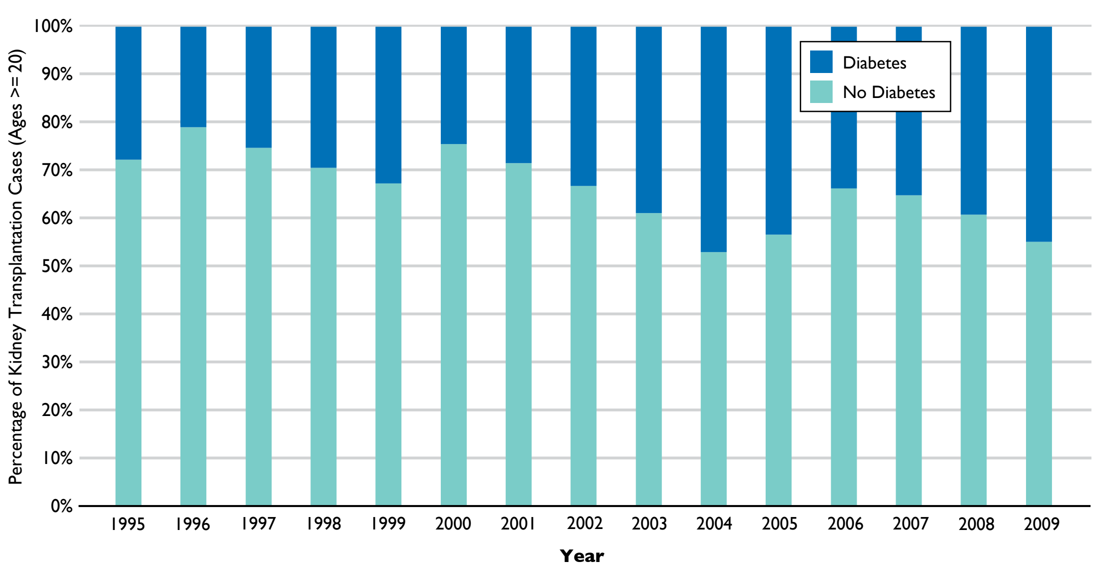



Figure 8.10 **Percentage of Kidney Transplantation Cases, 1995-2009**



## DISCUSSION

Over the past 13 years, the number of patients with DM who are currently receiving dialysis therapy in a given year, have increased in Alberta. Patients with DM now account for over half of the new and existing patients on dialysis, a potential concern given the poor outcomes commonly seen for these patients.

In addition, age groups 50 years and older have the highest number of patients with incident ESRD and DM; the greatest growth in incident ESRD is seen in those over the age of 75. The relative stability, and more recent decrease of incidence and prevalence rates when adjusted for age and sex suggest that this growth trend may not be due to a higher risk of developing ESRD in patients with DM, but instead may indicate that the number of persons with DM is increasing, which is supported by other data in this *Atlas* (see "Epidemiological Trends of Diabetes" chapter). Alternative and potentially complementary explanations are:

1) increases in life expectancy due to advances in medical treatment are allowing more people with diabetes to survive long enough to require and receive dialysis treatment;

2) physicians are more likely at present than in the past to refer elderly patients with diabetes for dialysis treatment; or,

3) improvements in dialysis technology currently allow patients with a heavy burden of disease (such as the elderly with DM) to successfully receive dialysis.

Therapy exists for patients with kidney complications of diabetes to delay or prevent the progression to ESRD. It is encouraging that the age- and sex-adjusted rates of incident and prevalent cases of ESRD in those with DM appears to be declining, a trend noted in other jurisdictions. However, increasing the use of proven prevention strategies remain an important goal.[14]

While use of administrative data provides a population-based method of obtaining disease trends, it also has limitations. Given our definition of chronic dialysis, patients with ESRD who die within 90 days of initiation of treatment will not be captured. We also identified all patients with ESRD, although DM may not have been the cause of ESRD. Given limitations in data and billing codes, we were unable to differentiate between home-based compared to in-hospital dialysis. We also did not assess ESRD-related mortality because of small numbers.

While the fraction of persons with DM receiving a kidney transplant has increased over the last 13 years, it does not appear to have kept pace with the increase of ESRD incidence in patients with DM. This may be due to various factors including decreased eligibility for kidney transplantation, due to concomitant comorbid illness or advanced age, and the greater risk of mortality while patients are on the transplant wait list. More research is needed to confirm these speculations.

In light of poor patient outcomes, high health care costs and continued growth in patient numbers, kidney disease due to diabetes is an emerging public health issue in Canada—and worldwide. Continued efforts to identify patients at risk and institute therapy to slow the progression of diabetic nephropathy to ESRD is warranted to attenuate the impact of this complication.

# APPENDIX

## Alberta Physician Claims Data

| Procedure | Code | Description |
|---|---|---|
| Peritoneal dialysis | 13.99C | Assessment and management of an unstable patient with acute/chronic renal failure treated by peritoneal dialysis |
| | 13.99D | Assessment and management of a stable patient with chronic renal failure treated by peritoneal dialysis |
| Hemodialysis | 13.99A | Hemodialysis treatment, unstable patient |
| | 13.99B | Hemodialysis treatment, stable patient |
| Home based or satellite therapy | 13.99O | Management of dialysis patients on home dialysis or receiving treatment in a remote hemodialysis unit (per week) |
| Kidney Transplantation | 67.59A | Renal transplant (homo, hetero, auto) |

## References

1. Brancati FL, Whelton PK, Randall BL, Neaton JD, Stamler J, Klag MJ. Risk of end-stage renal disease in diabetes mellitus: a prospective cohort study of men screened for MRFIT. Multiple risk factor intervention trial. JAMA 1997;278:2069-74.
2. USRDS: the United States renal data system. Am J Kidney Dis 2003;42:1-230.
3. Fukuhara S, Lopes AA, Bragg-Gresham JL, et al. Health-related quality of life among dialysis patients on three continents: the dialysis outcomes and practice patterns study. Kidney Int 2003;64:1903-10.
4. Gokal R. Quality of life in patients undergoing renal replacement therapy. Kidney Int Suppl 1993;40(Suppl):S23-7.
5. Manns B, Johnson JA, Taub K, Mortis G, Ghali WA, Donaldson C. Quality of life in patients treated with hemodialysis or peritoneal dialysis: what are the important determinants? Clin Nephrol 2003;60:341-51.
6. Kiberd BA, Clase CM. Cumulative risk for developing end-stage renal disease in the US population. J Am Soc Nephrol 2002;13:1635-44.
7. Parsons DS, Harris DC. A review of quality of life in chronic renal failure. Pharmacoeconomics 1997;12:140-60.
8. Canadian Organ Replacement Register. Treatment of end-stage organ failure in Canada 1996 to 2005. 2007 annual report. Canadian Institute for Health Information 2008.
9. Alberta Health and Wellness, Province Wide Services Working Group. 2003 province wide services annual report on activities and outcomes. 2004 July [cited 2005 June].
10. Garella S. The costs of dialysis in the USA. Nephrol Dial Transplant 1997;12(Suppl 1):10-21.
11. Tomson CR. Recent advances: nephrology. BMJ 2000;320:98-101.
12. Mallick NP. The costs of renal services in Britain. Nephrol Dial Transplant 1997;12(Suppl 1):25-8.
13. U.S. Renal Data System, USRDS 2002 Annual Data Report: Atlas of End-Stage Renal Disease in the United States, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2002.
14. U.S. Renal Data System, USRDS 2008 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2008.

# Chapter 9

# Diabetes and Eye Disease in Alberta

Christopher J. Rudnisky
Matthew T. S. Tennant
Jeffrey A. Johnson
Stephanie U. Balko

# DIABETES AND EYE DISEASE IN ALBERTA

## KEY MESSAGES

- Between 2001-2006, the proportion of people with diabetes who had an eye examination within 3 years of diagnosis fell from 58% to 49%, despite a doubling of the number of examinations provided by ophthalmologists to people with diabetes over the past 15 years. This suggests that the prevalence of disease is growing faster than the number of doctors.
- In 2009, cataracts were over 4 times as common in people with diabetes compared to those without diabetes.
- As diabetic retinopathy is becoming more common in people with diabetes, new and innovative strategies to improve diabetic retinopathy screening should be considered.

## BACKGROUND

Diabetic retinopathy (DR) is a common complication of diabetes[(1-4)] and an important cause of vision loss in Canada.[(5)] As the prevalence of diabetes increases within the Canadian population,[(6-8)] it is expected that visual impairment due to DR will also increase. Although screening and treatment of DR are cost-effective methods to reduce vision loss,[(9,10)] many Canadians with diabetes do not receive an annual dilated eye examination as recommended by the *Diabetes Clinical Practice Guidelines*.[(11)] One of the key findings from the 2009 *Alberta Diabetes Atlas* was that only 55% of people with diabetes have had an eye examination by an ophthalmologist within 3 years of being diagnosed with diabetes.[(12)]

In Canada, the current standard of care for identification of diabetic retinopathy is a stereoscopic assessment of the retina through a dilated pupil by an experienced eye-care professional. The purpose of this examination is to identify treatable disease before a patient becomes symptomatic. The timing of these examinations depends on the type of diabetes: in type 1 diabetes, an eye examination should be performed within 5 years of diagnosis, or after the age of 15, and then on an annual basis thereafter. In type 2 diabetes, an eye examination should be performed at the time of diagnosis, and then annually.[(11)]

The prevalence of DR is associated with the quality of glycemic control and the duration of disease. DR is a microvascular complication of diabetes and the risk of developing it is reduced by maintaining blood sugar and blood pressures as close to normal as possible. Unfortunately, the risk of developing DR increases with the duration of disease,[(13-15)] mainly because it is very difficult for most patients to achieve euglycemia indefinitely. The treatment of DR includes laser photocoagulation, intravitreal medication injection and/or vitrectomy, all of which reduce the risk of vision loss.

In addition to DR, people with diabetes are at increased risk of glaucoma and cataracts, both of which lead to vision loss. Glaucoma is most commonly treated medically (topical intra-ocular pressure (IOP) lowering agents), but in some cases requires laser or surgical intervention. Cataracts interfere with vision and can be surgically removed to improve visual function.

## METHODS

Data from Alberta Health and Wellness (AHW) administrative databases were utilized for this analysis. This dataset captures Alberta resident demographic information for Albertans aged 20 or older related to ophthalmologist visits, as well as procedures completed in either an inpatient or outpatient environment. Ophthalmology billing claim codes specific for the procedures of retinal laser treatment, vitrectomy, cataract surgery and glaucoma surgery (see appendix) over the study period (1995-2009) were utilized.

Although the *Canadian Diabetes Association Clinical Practice Guidelines* recommend screening for DR by an experienced eye care professional, they do not specify if this should be an optometrist or an ophthalmologist.[11] Currently, ophthalmology services are reliably captured in the AHW administrative databases, whereas optometry services were not consistently billed during the study period and therefore could not be included. However, as of 2008 the Alberta government began reimbursing optometrists for eye examinations for people with diabetes. This expansion of optometric coverage will be evaluable in subsequent reports as longitudinal data becomes available.

In order to calculate the incidence of an eye examination by an ophthalmologist after the initial diagnosis of diabetes, all contacts with an ophthalmologist within 1, 2 and 3 years of an incident case of diabetes were assessed.

Rates of ophthalmic procedures for those with and without diabetes were also calculated. For each group, the number of people with ophthalmic procedures (numerator) was divided by the total number of people in the province or zone (denominator), respectively.

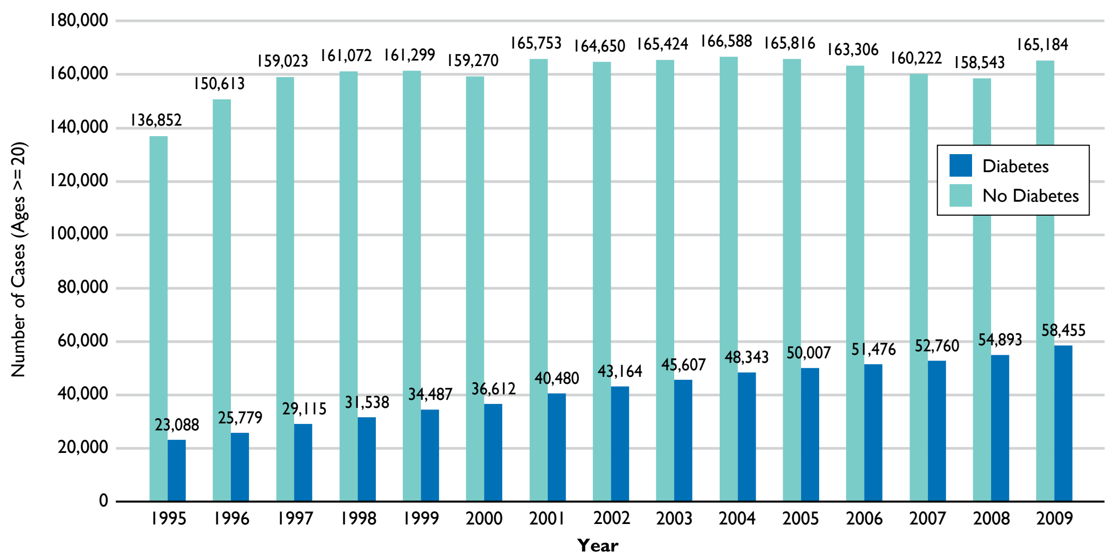
Persons with incident and prevalent diabetes were identified as described in the “Background and Methods” chapter. As with other rates in the *Atlas*, direct standardization to age- and sex-adjusted rates of eye examinations and procedures was performed using the Alberta population according to the 2006 Canadian Census. Due to small numbers of cases per zone for selected ophthalmologic surgical procedures, the crude rates are presented when comparing health zones for retinal laser treatment and cataracts.

## FINDINGS

### Eye Examinations by Ophthalmologists

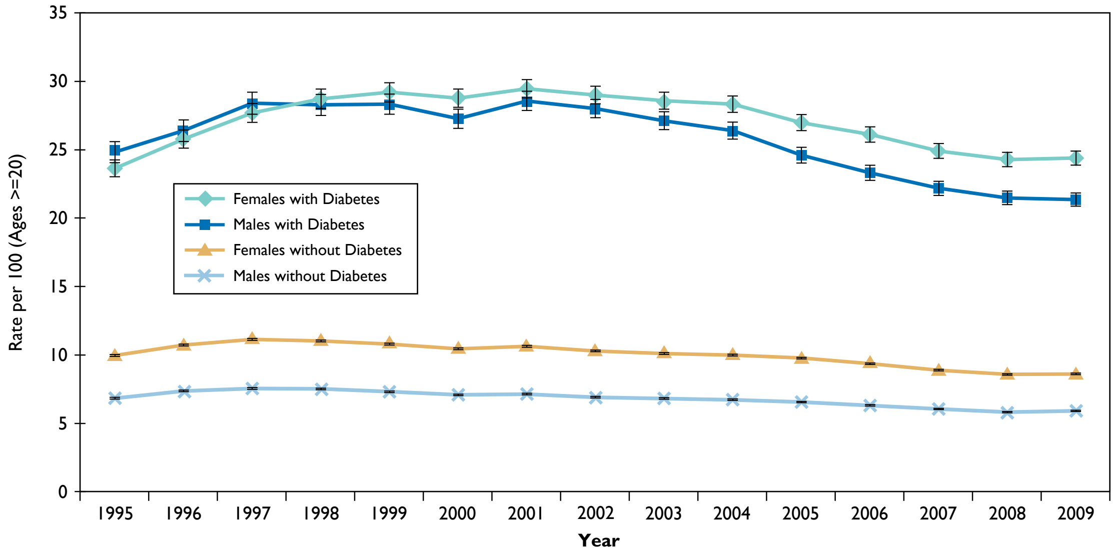
Between 1995-2009 there was more than a doubling of the number of people with diabetes who had an eye examination over the 15-year interval (23,088 to 58,455) (Figure 9.1). When considered as the proportion of patients seen by an ophthalmologist, the number of people with diabetes steadily increased from 14% to 26%. This data suggests that diabetes is consuming an escalating proportion of ophthalmologists' time in clinical practice. If this trend continues, the number of ophthalmologists in the province will have to increase in order to maintain service levels for non-diabetic Albertans.

Figure 9.1 **Number of People who had at least one Eye Examination by an Ophthalmologist, 1995-2009**



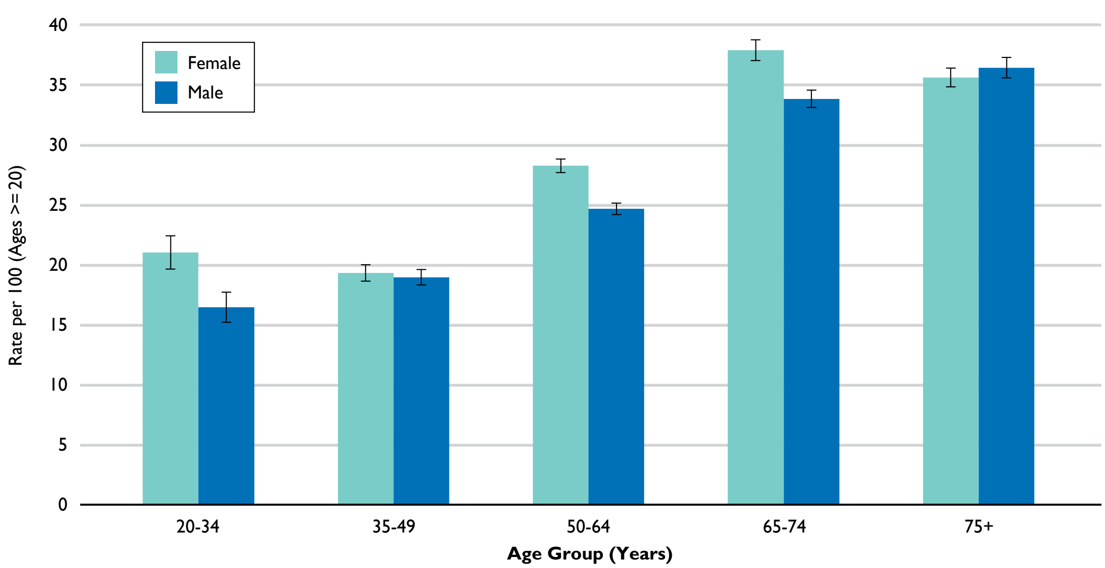

Even after adjusting for age, people with diabetes are about 3 times more likely to have an eye examination in comparison to people without diabetes (Figure 9.2). Since 1995, women are more likely to have an eye examination by an ophthalmologist than men. Overall, the rate of diabetic eye examinations did not change significantly between 1995 and 2009, although there were minor fluctuations over time.

Figure 9.2 **Age-Adjusted Rates of People who had at least one Eye Examination by an Ophthalmologist, 1995-2009**



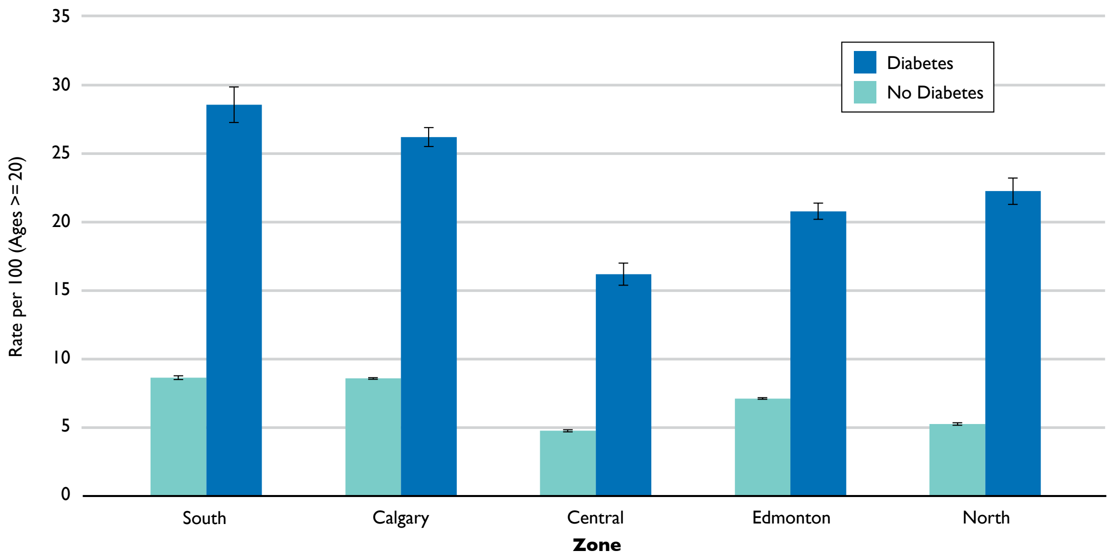

Older people, irrespective of diabetes status, continue to have higher rates of eye examinations (Figure 9.3), perhaps because the prevalence of most ophthalmic conditions increases with age. Similarly, because most diabetic ocular complications are associated with duration of disease, older patients are more likely to have had diabetes longer, and therefore require closer and more frequent examinations. In 2009, women had higher rates of eye examinations in all age groups, except for those 75 years or older.

Figure 9.3 **Age-Specific Rates of People with Diabetes who had at least one Eye Examination by an Ophthalmologist, 2009**



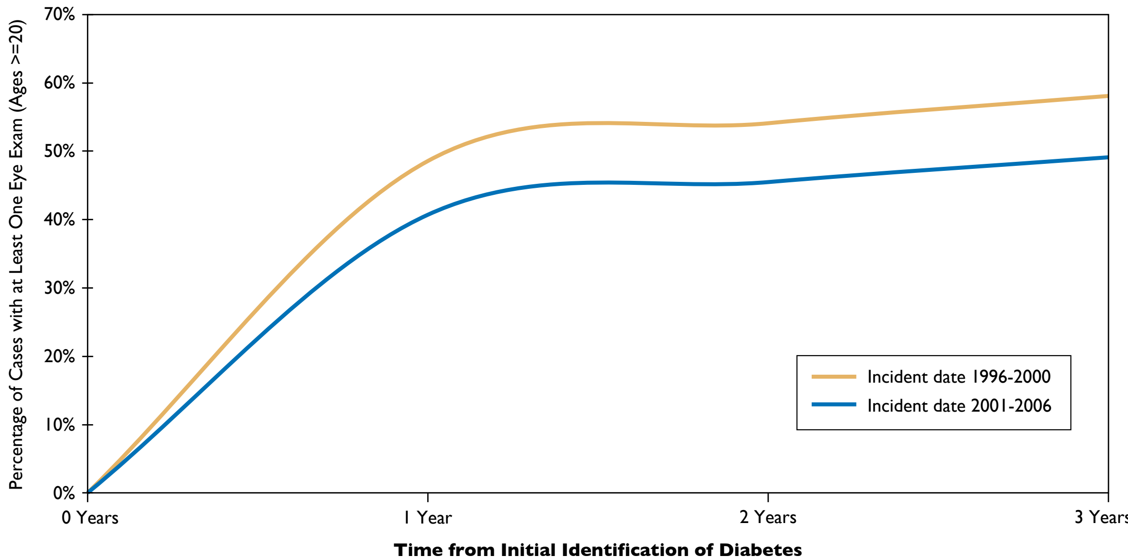
After adjusting for age, the rate of eye examinations varies between health zones. In the South zone, 29% of those with diabetes are examined by an ophthalmologist, compared to only 16% in the Central zone (Figure 9.4). In every health zone, diabetes is associated with much higher rates of eye examinations.

Figure 9.4 **Age-Adjusted Rates of People who had at least one Eye Examination by an Ophthalmologist, by Zone, 2009**



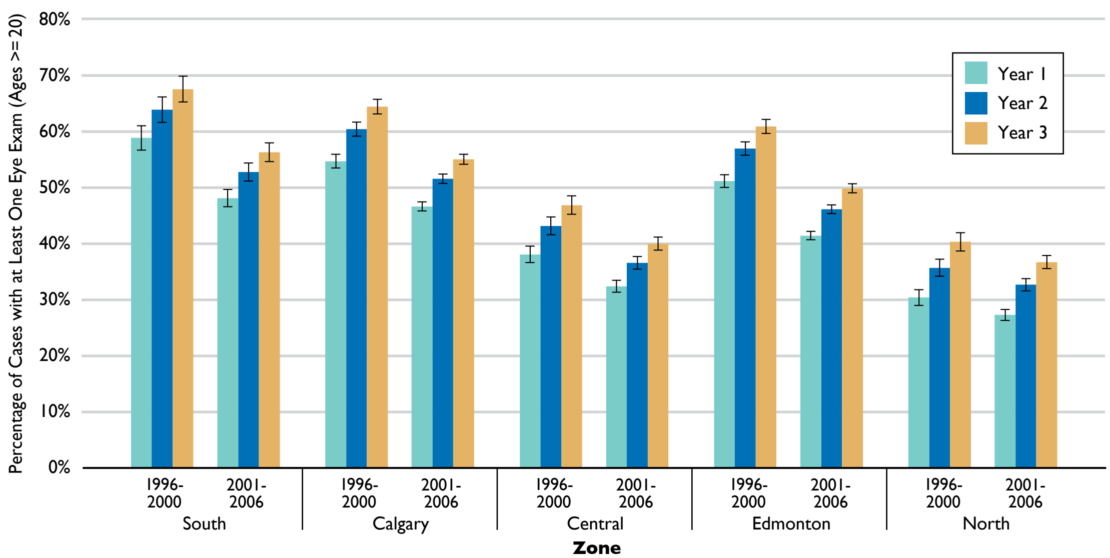

In Alberta, the incidence of an eye examination by an ophthalmologist within 3 years of identification of diabetes continues to be low. For the time period 1996-2000, about 58% of people were assessed by an ophthalmologist within 3 years of diagnosis; however, this decreased to only 49% for the period 2001-2006 (Figure 9.5). This may be due in part to the sharp increase in disease burden relative to the available human health resources. The majority of eye examinations occurred within a year of diagnosis, as recommended by the Canadian Diabetes Association,[11] but then the rate plateaus in the second and third year post-diagnosis. The reasons for this plateau are unclear.

Figure 9.5 **Cumulative Incidence of Eye Examination by an Ophthalmologist within the First 3 Years after Identification of Diabetes (1996-2000) and (2001-2006)**




Just as there is considerable zone variation in the rate of eye examinations, there are similar patterns in the frequency of having an eye exam at the time of diagnosis of diabetes (Figure 9.6). Between the years of 2001-2006, only 37% of people in the North zone had an eye examination within 3 years of their diabetes diagnosis, compared to 56% of people in the South zone.

Figure 9.6 **Cumulative Incidence of Eye Examination by an Ophthalmologist within the First 3 Years after Identification of Diabetes by Zone (1996-2000) and (2001-2006)**



### Retinal Photocoagulation

The age-adjusted rate of retinal photocoagulation in people with diabetes is consistently higher in men, ranging from approximately 1.3 to 1.9 times higher than in women (Figure 9.7). Given that fewer men attend an examination by an ophthalmologist (Figure 9.2), it may be that the gender difference in retinal photocoagulation rates is explained by a delay in presentation for men. In general, DR is asymptomatic until advanced, and as such, men may require laser treatment more often because of more advanced DR at presentation.

There was a steady increase in the rate of retinal photocoagulation in Alberta from 1996-2001 (Figure 9.7), although it has since decreased in both men and women. This may reflect a change in practice patterns, with more patients receiving intravitreal anti-vascular endothelial growth factor injections to treat DR. When observing age-specific rates, there is a bimodal distribution, with the highest rates of laser treatment in the 20-34- and 50-74-year-old age groups (Figure 9.8). This distribution likely follows the bimodal incidence of type 1 and 2 diabetes.

Figure 9.7 **Age-Adjusted Rates of People with Diabetes who had at least one Retinal Laser Treatment, 1995-2009**

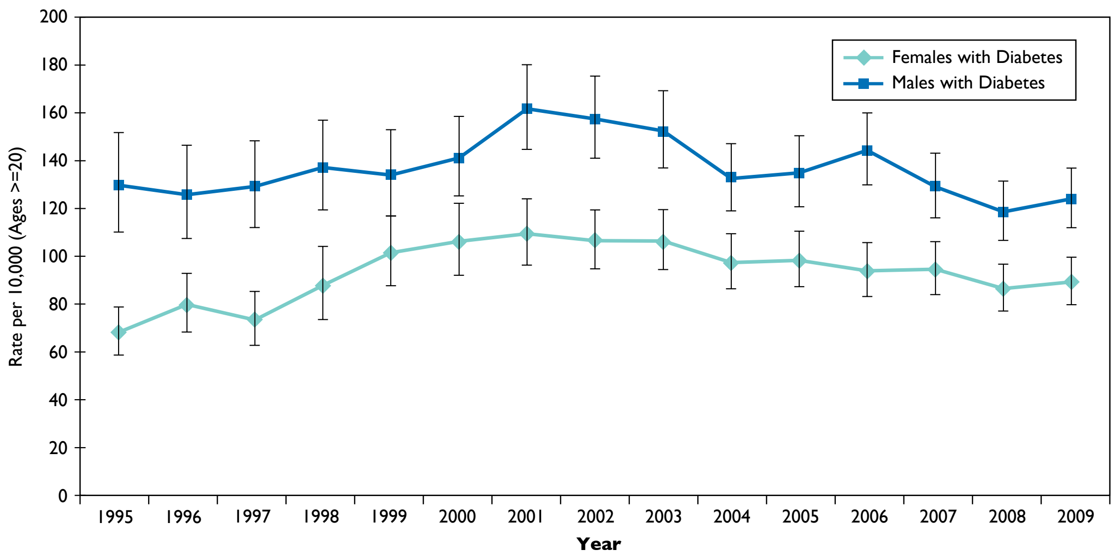
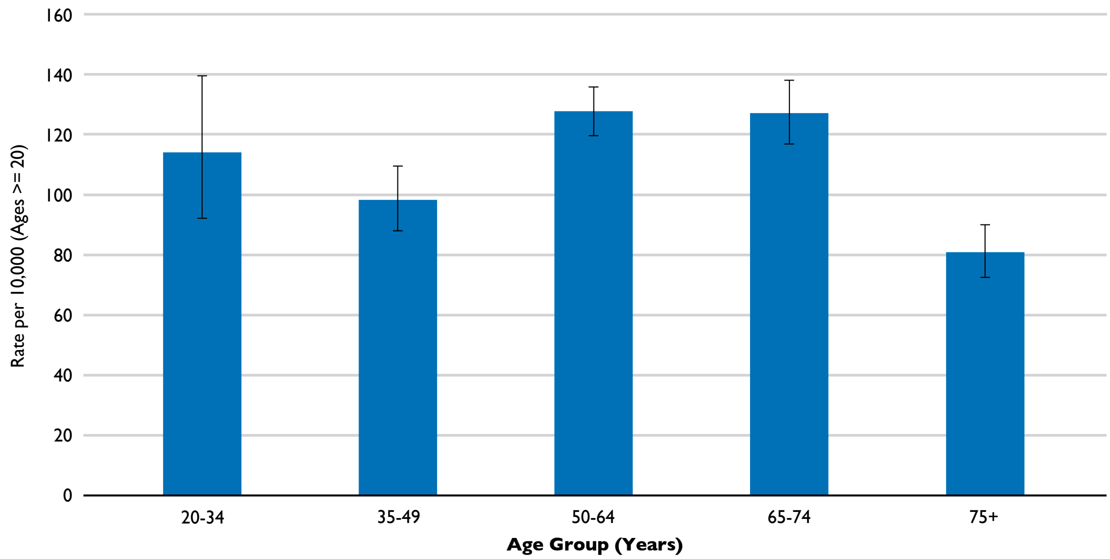
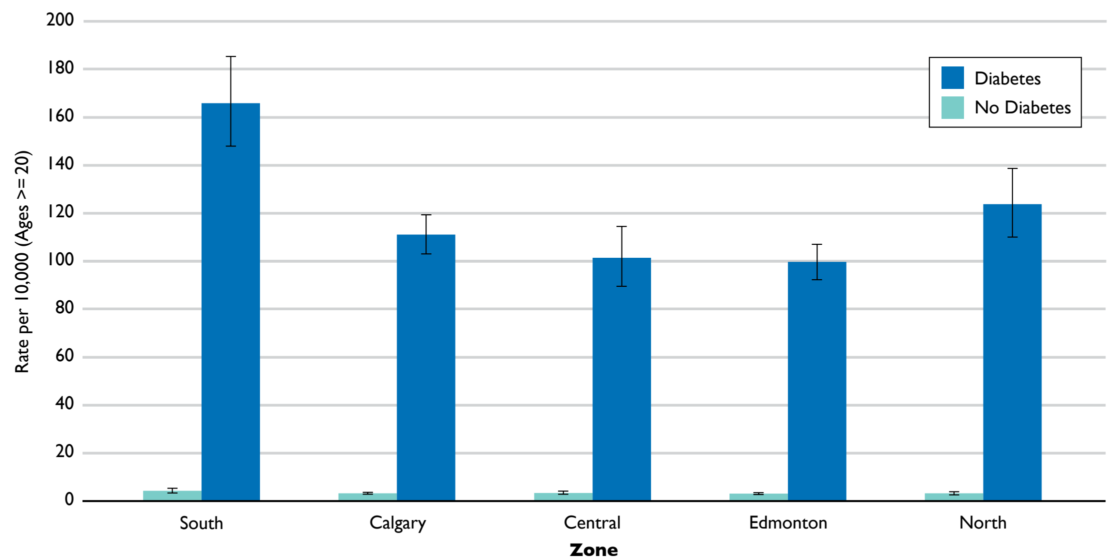


Figure 9.8 **Age-Specific Rates of People with Diabetes who had at least one Retinal Laser Treatment, 2009**




The rate of retinal photocoagulation for adults with diabetes varies among the health zones in the province with the South zone having the highest rate of 166 per 10,000 people and Edmonton zone having the lowest rate of 100 per 10,000 people. (Figure 9.9).

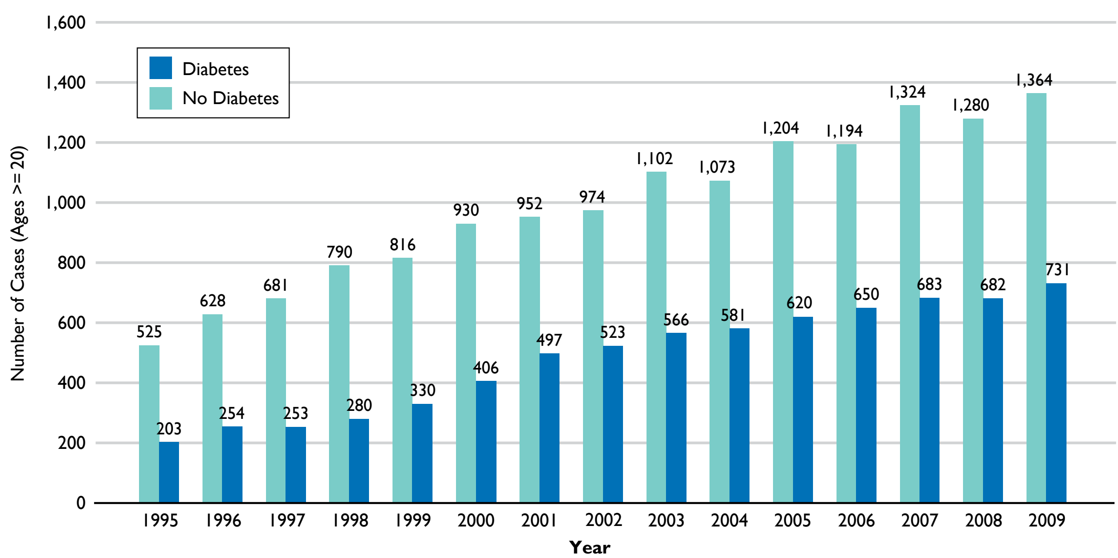
Figure 9.9 **Crude Rates of People who had at least one Retinal Laser Treatment by Zone, 2009**



### Vitrectomy Surgery

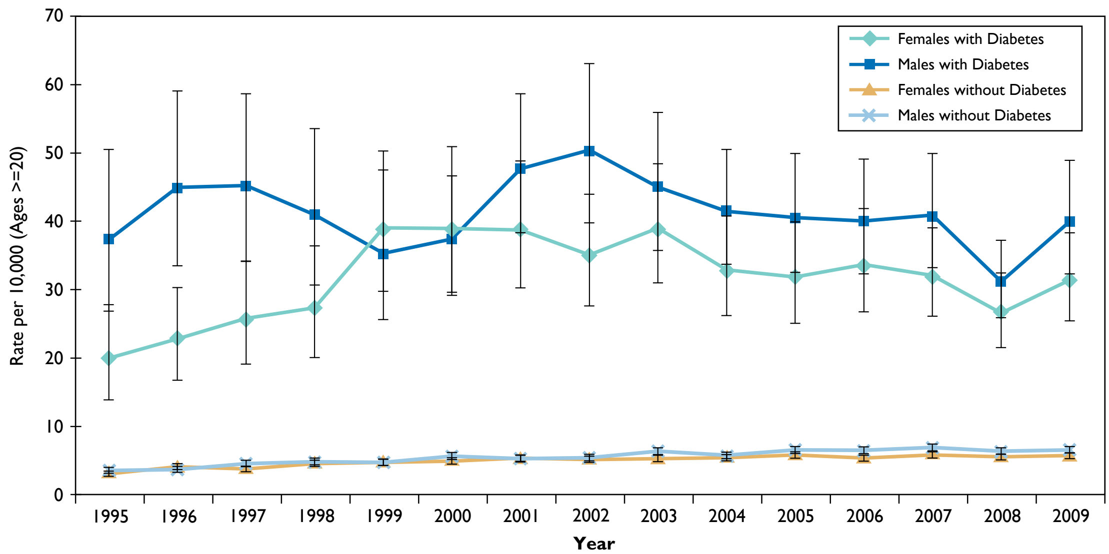
Vitrectomy is a surgical procedure that is used to treat advanced DR, as well as other forms of eye disease. When performed, it suggests that other less invasive treatment options have failed. The number of vitrectomies performed overall is steadily increasing (Figure 9.10). This increase might be explained by worsening of DR in people with diabetes, as well as increasing population and size. The change in population demographics (i.e., an aging population) is the most likely explanation as the rate of vitrectomy has increased in both the diabetic and non-diabetic cohorts. Additional explanations include changes in surgical indications and/or improved vitrectomy instrumentation.

Figure 9.10 **Number of People who had at least one Vitrectomy, 1995-2009**



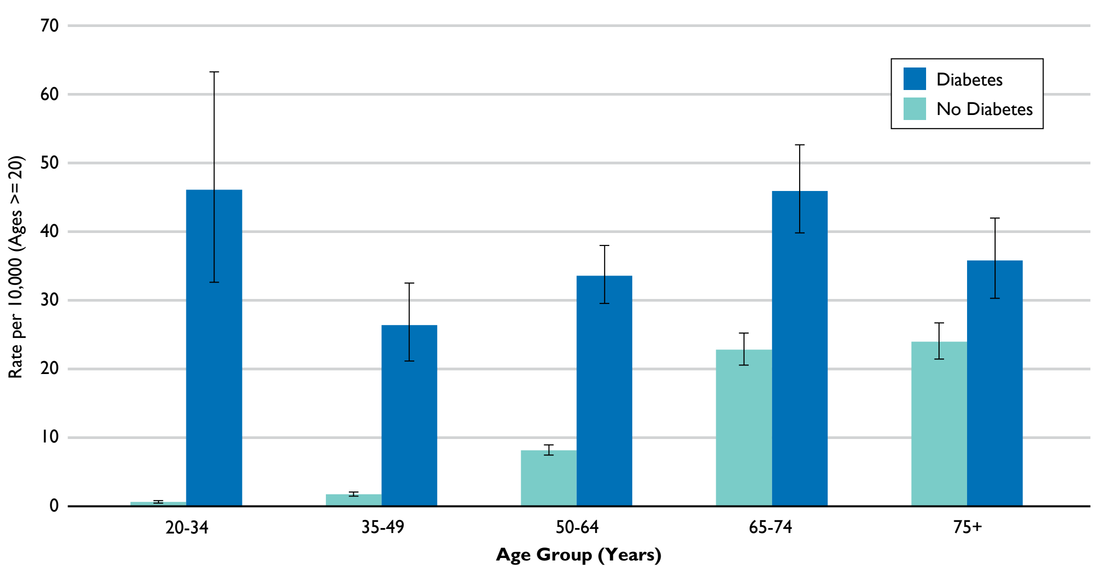

Within the diabetic population, men tend to have higher rates of vitrectomy compared to women, but this gap narrowed in recent years (Figure 9.11). Given that men also have higher photocoagulation rates, the most likely explanation for this would be more severe disease. These sex differences in vitrectomy rates are not apparent in the non-diabetic population. Also of note is that the rate of vitrectomy in people with diabetes ranges between 5 - 8 times higher than in the non-diabetic population.

Figure 9.11 **Age-Adjusted Rates of People who had at least one Vitrectomy, 1995-2009**




Vitrectomy surgery rates demonstrate the same bimodal distribution as seen with laser rates, although the overlap of error bars indicates the differences may not be significant (Figure 9.12). Within each age group, however, are significantly different rates of vitrectomy in people with and without diabetes. The increasing rate of vitrectomy with age in the non-diabetic population likely reflects other age-related pathology, such as epiretinal membrane, macular hole and retinal detachment. The rates of vitrectomy surgery for people with and without diabetes were relatively uniform across the health zones in 2009 (data not shown).

Figure 9.12 **Age-Specific Rates of People who had at least one Vitrectomy, 2009**



### Cataract Surgery

Cataract surgery rates are presented unadjusted for age because it is primarily performed in the elderly; adjusting for age would effectively adjust for the surgical rate itself (Figure 9.13). In 2009, the crude rates for cataract surgery for people with diabetes were 4 to 5 times that of people without diabetes (Figure 9.14). In both populations, women undergo cataract surgery more frequently than men. Over the past decade, the rate of cataract extraction has not increased significantly and has in fact decreased since 2008 in both the diabetic and non-diabetic populations. The decline in cataract extractions likely reflects reductions in funding levels that occurred with the economic down turn of 2008.

Figure 9.13 **Age-Specific Rates of People who had at least one Cataract Surgery, 2009**

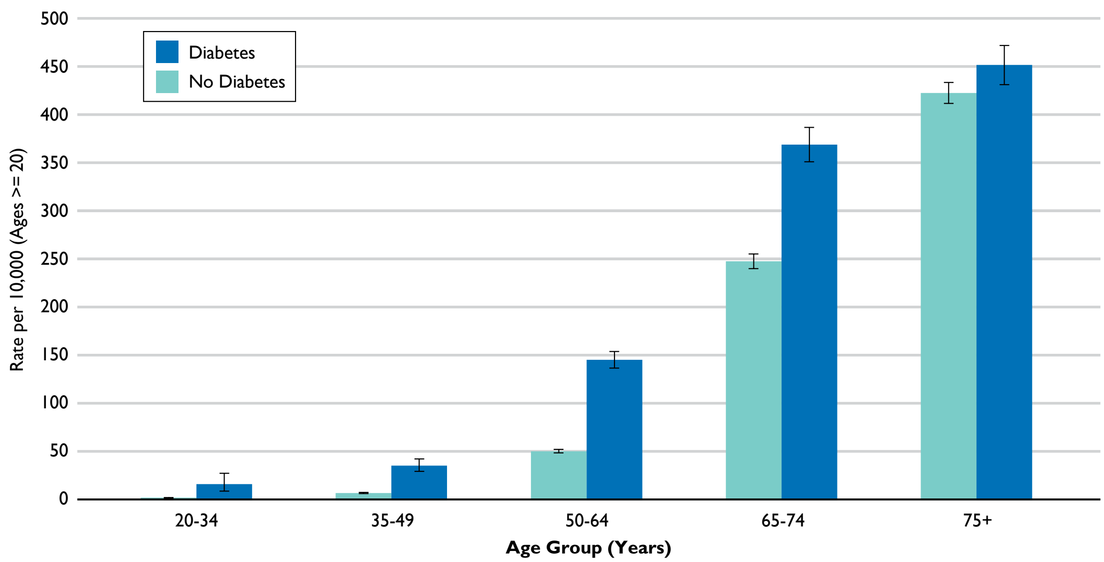
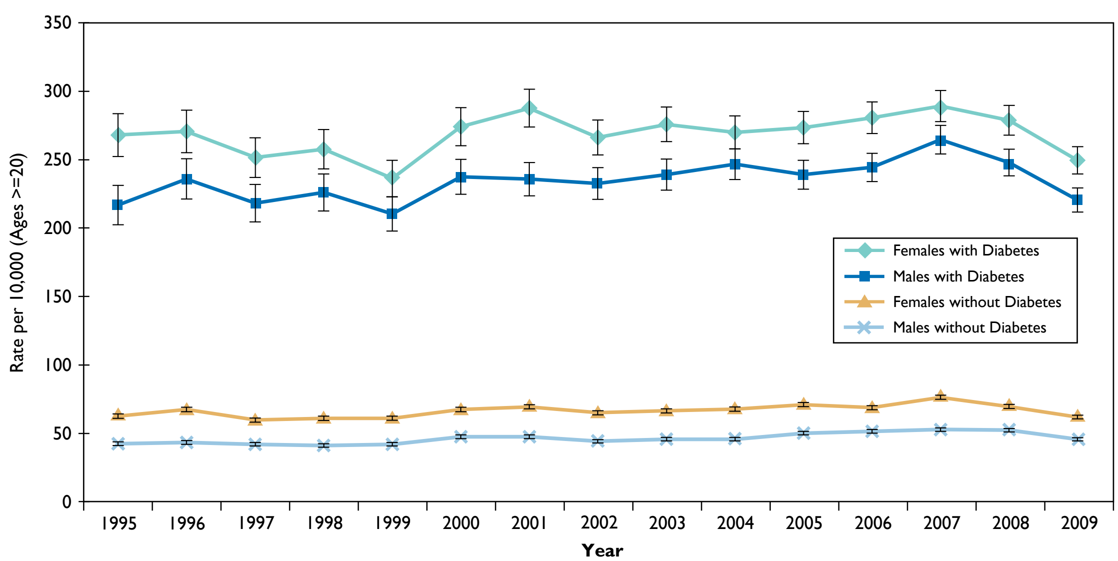
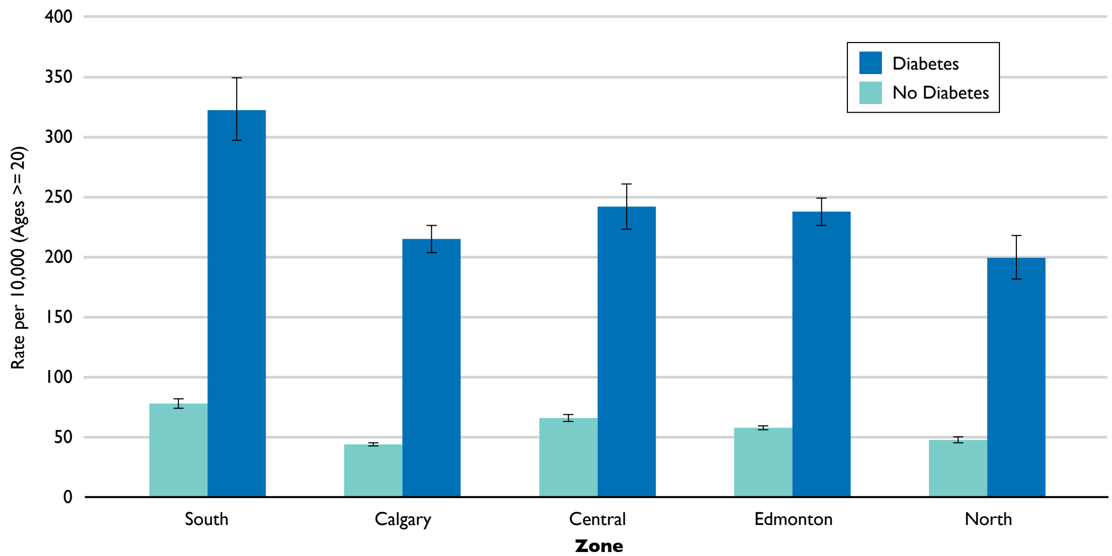



Figure 9.14 **Crude Rates of People who had at least one Cataract Surgery, 1995-2009**



The South zone has the highest crude rate of cataract surgery for people with diabetes in 2009 (Figure 9.15). The differences in average age between zones may be the reason behind this finding as cataracts are more likely to be diagnosed in the older populations living in Southern Alberta.

Figure 9.15 **Crude Rates of People who had at least one Cataract Surgery by Zone, 2009**




## Glaucoma Procedures

Modern glaucoma management generally consists of three modalities: medication, laser and surgery. Given that this dataset does not provide specific information about prescribed topical medication to lower intra-ocular pressure (IOP), we present here the data for laser and surgery. We did not distinguish between open and closed angle glaucoma types.

In defining who to count as having undergone laser for glaucoma, we used the fee code 26.52 for the time period 1995-2004 and 26.52A for 2004-2009. The reason for the change was the addition of an additional fee code for end-stage glaucoma in late 2004: 26.98B (diode cyclophotocoagulation). Therefore, the data in Figures 9.16 and 9.17 represent laser procedures done in the course of managing glaucoma, whereas Figure 9.18 represents advanced glaucoma approaching the unfortunate natural history endpoint: blindness.

The age-adjusted rates of laser treatment for glaucoma for people with diabetes are higher across all years compared to people without diabetes (Figure 9.16). The age-specific rates of laser treatment for glaucoma are different only for Albertans aged 35-64 (Figure 9.17). This difference may be related to several factors: an association between open angle glaucoma and diabetes, glaucoma secondary to proliferative DR, treatments of DR (such as triamcinolone injections and/or vitrectomy) or simply observation bias: diabetic patients are examined more frequently, which presents an increased opportunity to detect glaucoma.

Figure 9.16 **Age-Adjusted Rates of People who had at least one Laser Treatment for Glaucoma, 1995-2009**

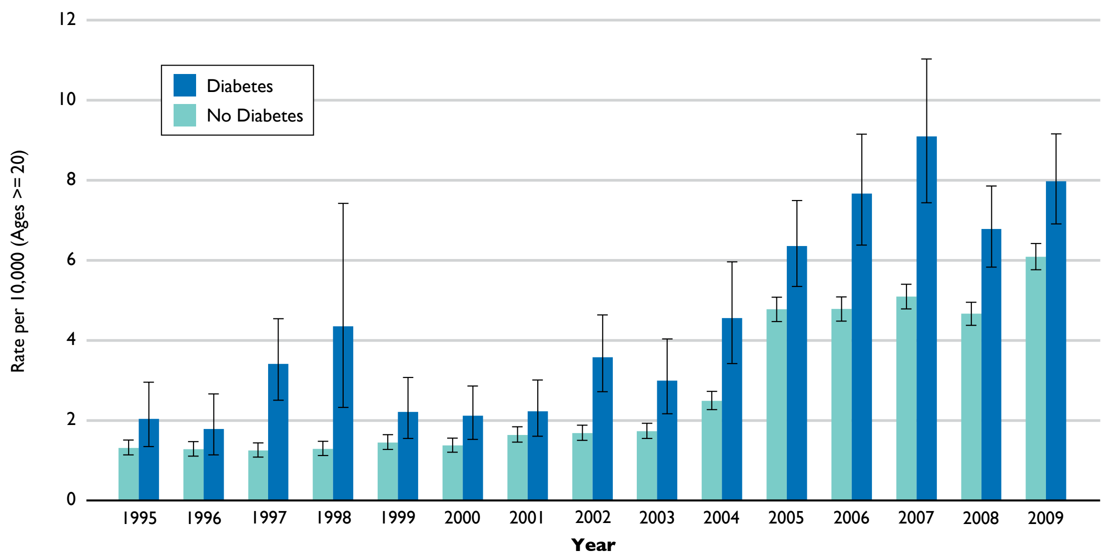
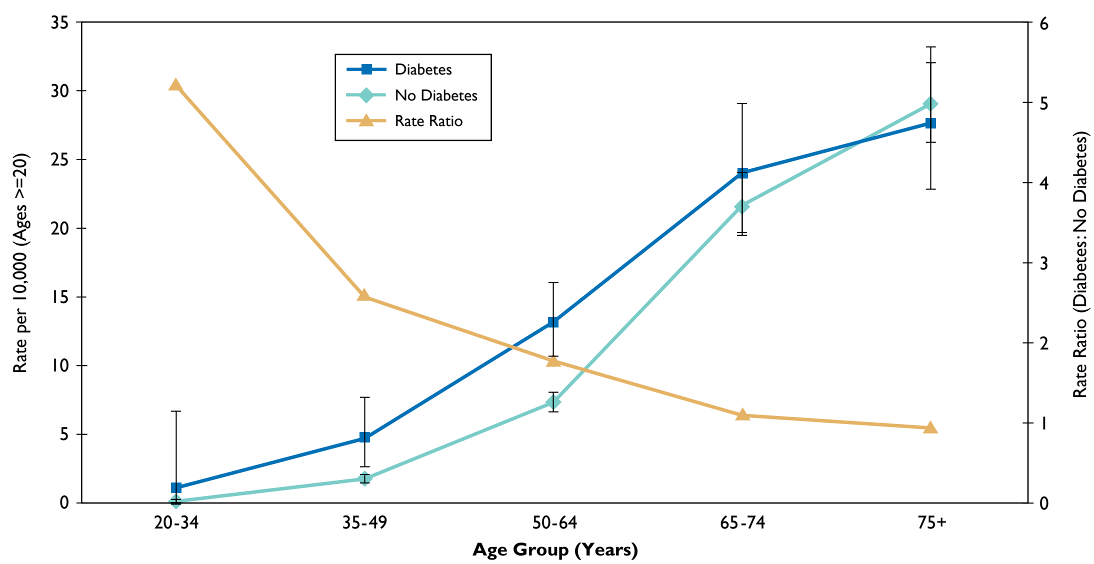
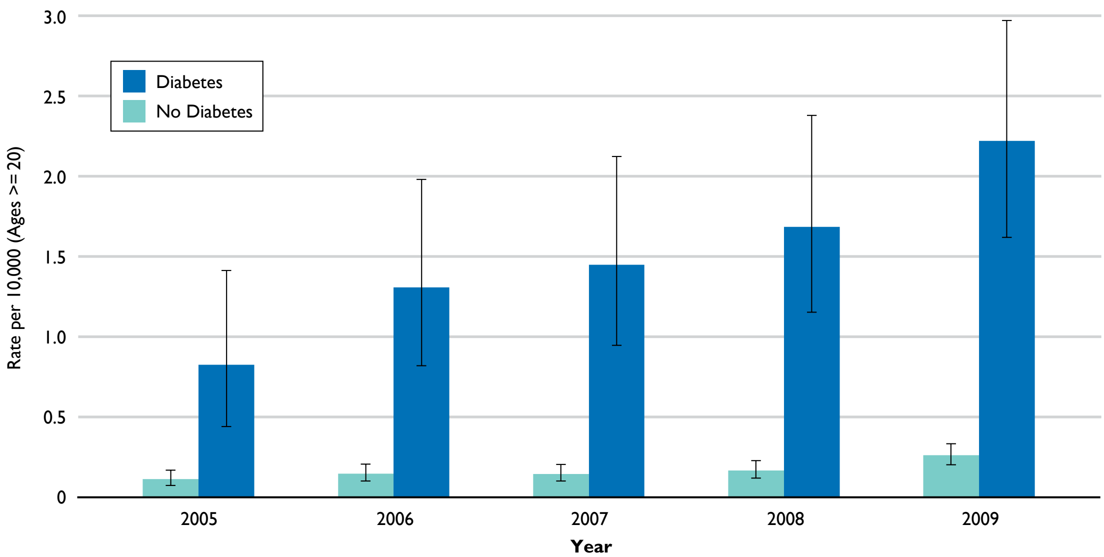



Figure 9.17 **Age-Specific Rates of People who had at least one Laser Treatment for Glaucoma, 2009**



Unfortunately, the rate of end-stage glaucoma (using diode-cyclophotocoagulation as a surrogate indicator) is rising for diabetic patients (Figure 9.18). In 2005, people with diabetes were treated for end stage glaucoma 7 times more frequently than their non-diabetic counterparts. In 2009, this difference increased to 8.5 times. However, it should be noted that the 2005 rate reflects the treatment of only 13 individuals (and likely only 13 eyes), and in 2009, 45 individuals (data not shown). Nonetheless, there is a clear increase in the number of patients with end-stage glaucoma, suggesting that improved efforts to prevent and detect diabetic retinopathy are needed.

Figure 9.18 **Crude Rates of People who had at least one Laser for Treatment of End-Stage Glaucoma, 2005-2009**




The number of surgical glaucoma procedures fluctuates from year to year (Figure 9.19). This may reflect the availability of better medications; latanaprost was the first prostaglandin-based IOP lowering medication and was introduced in 1996. As it would have taken several years for broad incorporation into clinical practice, it is not surprising that the decline in cases stabilizes between 1998-1999. In 2009, the age-adjusted rates for glaucoma surgery for people with diabetes were almost triple that of people without diabetes (Figure 9.20), and a difference is maintained in all age groups (Figure 9.21). Rates were calculated by analyzing the proportion of the diabetic and non-diabetic populations who received surgical glaucoma care using the fee codes 26.2A (1995-2009), 26.2B (1995-2009) or 26.25A (1998-2009).

Figure 9.19 **Number of People who had at least one Glaucoma Surgery, 1995-2009**

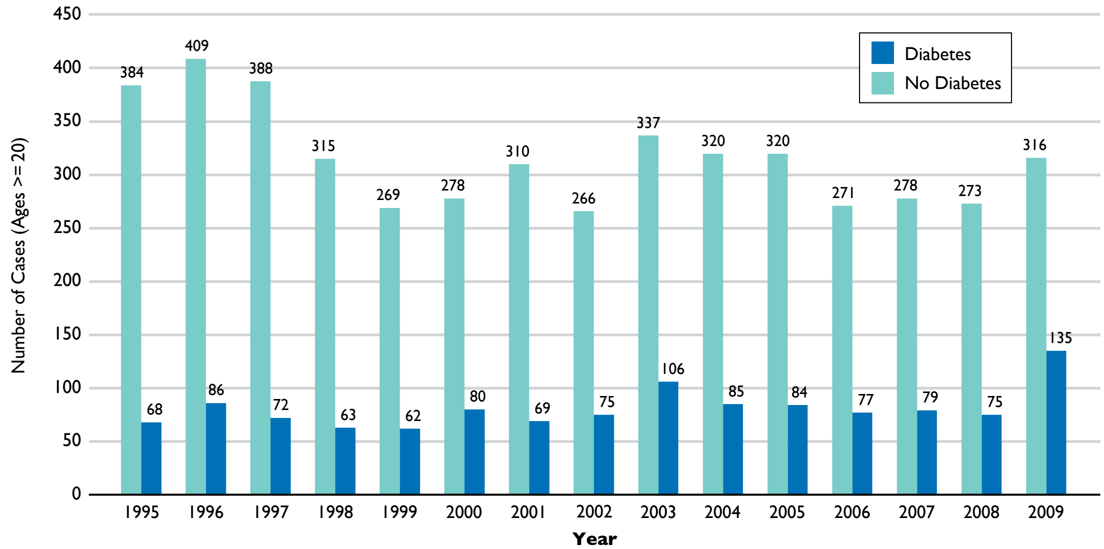



Figure 9.20 **Age-Adjusted Rates of People who had at least one Glaucoma Surgery, 1995-2009**

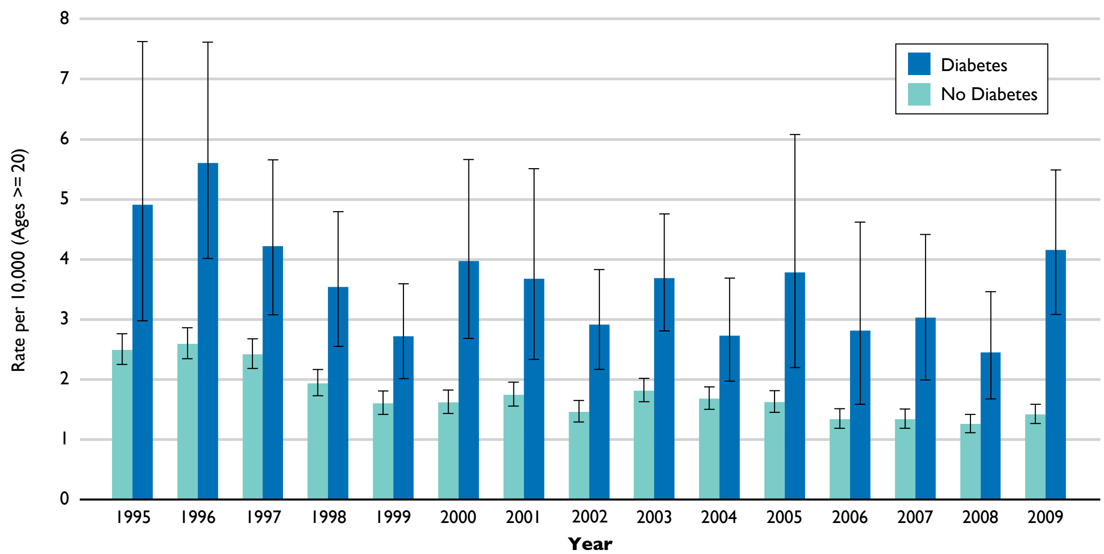
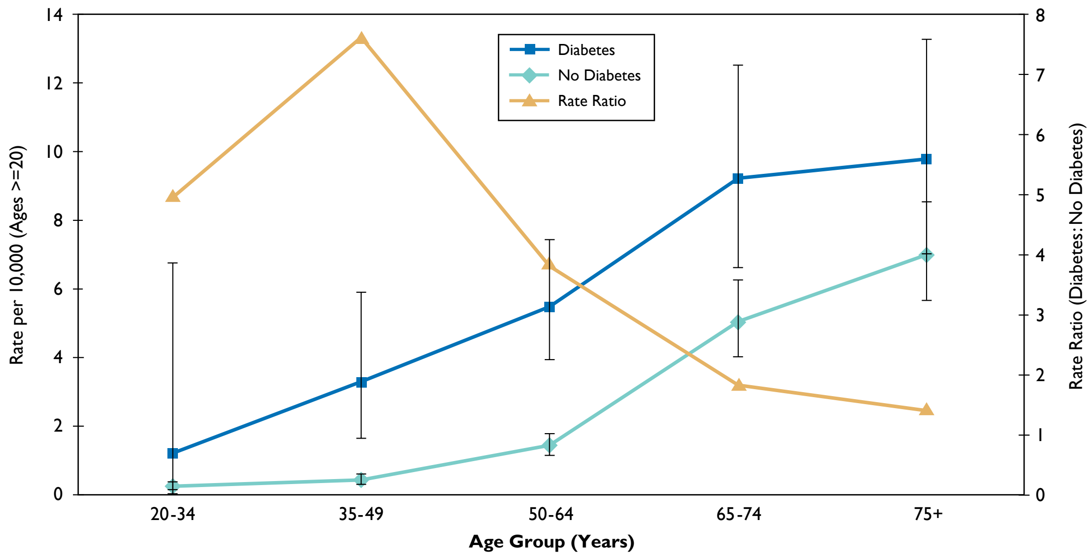
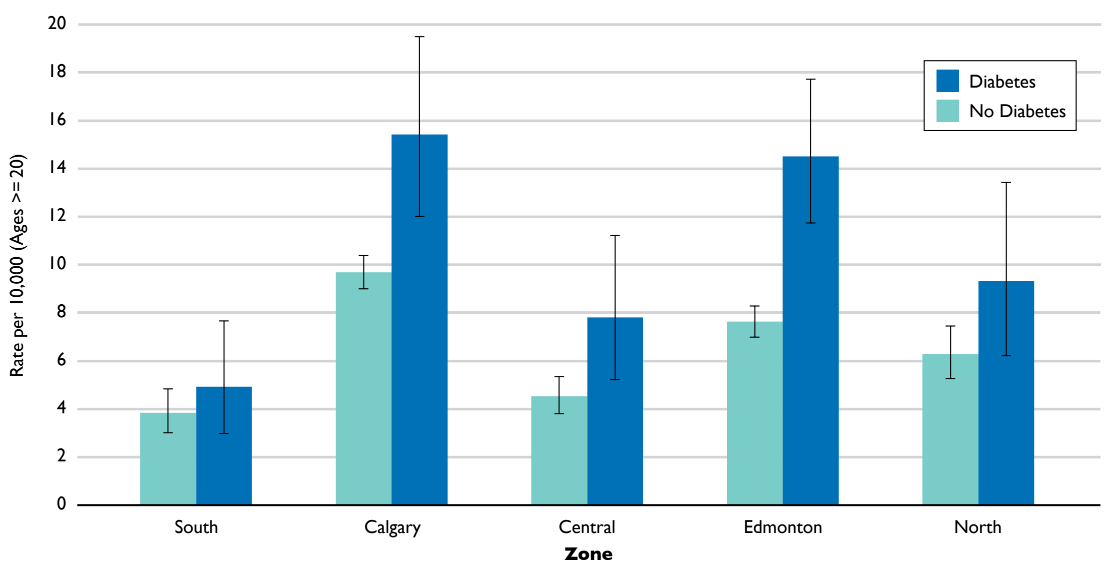


Figure 9.21 **Age-Specific Rates of People who had at least one Glaucoma Surgery, 2009**




When all the previous glaucoma treatments are combined and adjusted for age, the Calgary and Edmonton zones have the highest rates of any glaucoma treatment for a patient with diabetes and the South, Central and North zones have the lowest rates (Figure 9.22). This variation may be due to concentration of glaucoma specialists within the Calgary and Edmonton zones.

Figure 9.22 **Age-Adjusted Rates of People who had at least one Glaucoma-Related Procedure by Zone, 2009**



## DISCUSSION

Diabetic retinopathy is a preventable cause of blindness in Alberta. Screening, in the form of a retinal examination through a dilated pupil, is the most important first step in preventing an epidemic of blindness. Once identified, timely treatment, in the form of laser photocoagulation, intravitreal injection of medication or vitrectomy surgery, can reduce the risk of vision loss. On average, however, less than half of Albertans receive an eye examination by an ophthalmologist within 3 years of diabetes diagnosis. Worse still, this proportion continues to decline (Figure 9.5) despite evidence of the cost-effectiveness(15) of existing screening strategies. Correspondingly, the number of diabetic Albertans with end-stage glaucoma is increasing, suggesting that improved efforts to prevent and detect ophthalmic diabetic complications are needed.

When considered with the data in Figure 9.2, the rate of eye examinations among diabetic individuals dropped to below 25% in 2009 despite a 7% increase in the number of diabetes cases from 2008. This suggests that the problem is expanding faster than our workforce has capacity to handle. Government, health care providers and eye care professionals need to act in concert to improve diabetic eye care using new, efficient methods such as teleophthalmology(16-21) in addition to increasing the number of ophthalmologists in Alberta.

An interesting finding of this review was that 35 to 49-year-old men underwent a similar proportion of eye examinations than similarly aged women, whereas 50-74-year-old women underwent a higher proportion of eye examinations than similarly aged men (Figure 9.3). One possible explanation is that younger type 1 diabetic males are more likely to have worse retinopathy(4) and are therefore examined more frequently due to symptomatic visual loss. However, why older women have more examinations is unclear, although it may relate to increased awareness of their health status.

A similar gender difference was observed in the rates of photocoagulation (Figure 9.7) and vitrectomy (Figure 9.11), with men approximately 1½ times as likely to receive surgical treatment for DR than women. Two possible explanations for this difference include: men have more severe disease (and/or correspondingly poorer glycemic control), or women have decreased access to photocoagulation. Given that women access cataract surgical services more frequently than men (Figure 9.14), the former explanation is more likely than the latter.

The most common ophthalmic surgical procedure that patients with diabetes undergo is cataract extraction (Figure 9.14), which is performed, on average, 4-5 times more frequently than in the non-diabetic population. However, because advanced proliferative DR in patients with type 1 diabetes often requires vitrectomy, the cataract surgery rate in younger diabetic individuals is 19 times the cataract extraction rate in the non-diabetic population (Figure 9.13). This discrepancy can be attributed almost entirely to poor glycemic control. Therefore, if euglycemia in type 1 diabetes is attainable, the rates of laser, vitrectomy and cataract surgery would plummet. Clearly, the answer to this epidemic is prevention.

As in the Blue Mountains Eye Study,(23) which found an increased odds of having glaucoma among those with diabetes (2.12, 95%CI: 1.18, 3.79), it was also observed that those with diabetes underwent glaucoma laser treatment (argon-laser trabeculoplasty or selective laser trabeculoplasty) approximately twice as often as those without diabetes. This is similar to our findings, however the differences are smaller in recent years (Figure 9.16). This study also demonstrated that the diabetic population underwent diode cyclophotogulation (a surrogate marker for end-stage glaucoma) 10 times more frequently than non-diabetic individuals. This difference represents end-stage treatment of patients with neovascular glaucoma secondary to proliferative DR. Again, improvements in glycemic control would reduce the rates of this procedure, and by extension, reduce the number of eyes blinded by advanced DR.

The variation within the province in rates of eye examination by an ophthalmologist and rates of laser photocoagulation are also notable findings. In 2009, people with diabetes living in the South zone, were 1.3 to 1.7 times as likely to have photocoagulation than people with diabetes living in other health zones. It is not clear why this higher rate is seen in the south. Rates of cataract surgery within this health zone are also higher than the other zones across the province. In the 2007 *Atlas*, the difference was observed primarily in the former Palliser region.[24] Further evaluation of the data is needed to help understand the reasons behind this variation.

One major limitation in using only AHW administrative data for reporting on eye disease in Alberta is that only ophthalmology services are reliably captured. Optometrists also perform eye examinations and have recently started billing AHW for their care of patients with diabetes (as of the end of 2007). It will be interesting to see how the data from this report changes in subsequent years.

The ophthalmic data reported here indicates several worrisome trends such as increases in rates of end-stage glaucoma procedures and a decrease in the proportion of individuals receiving an eye examination within 3 years of a DM diagnosis. The provincial government must continue to improve eye care by expanding current strategies via increased ophthalmologic services, implementing new strategies, such as teleophthalmology, but most importantly, embarking on a new path to the prevention of diabetes itself. This can be advanced by reducing obesity, incentivizing positive health behaviors such as exercise and healthy eating choices, disincentivizing adverse health behaviors such as smoking, and improving health education for Alberta's youth.

## APPENDIX

**Examination by an Ophthalmologist**
Defined as any visit by an individual claimed by an Ophthalmologist.

### Alberta Physician Claims Data

| Procedure | Code | Description |
|---|---|---|
| Retinal Laser Treatment (Retinal Photocoagulation) | 28.5A | Focal and/or pan-retinal photocoagulation |
| Vitrectomy Surgery | 28.72A | Vitreous cavity washout |
| | 28.72B | Total vitrectomy |
| | 28.74A | Discission of vitreous/retinal adhesions (membrane peeling alone) |
| | 28.74B | Stripping of premacular membrane, associated vitrectomy and retinal encircling (vitrectomy with membrane peeling) |
| Cataract Surgery | 27.72 | Insertion of intraocular lens prosthesis with cataract extraction, one-stage |
| Laser Treatment for Glaucoma | 26.52 (1995-2004) | Laser peripheral iridotomy |
| | 26.52A (2004-2009) | Either laser peripheral iridotomy or argon laser trabeculoplasty or selective laser trabeculoplasty |
| End-Stage Glaucoma (Laser Treatment) | 26.98B (2005-2009) | Diode laser cyclophotocoagulation (ciliary body ablation) |
| Glaucoma Surgery | 26.2A (1995-2009) | Major glaucoma operation (trabeculectomy, EMS shunt) |
| | 26.2B (1995-2009) | Ahmed shunt or Baerveldt shunt, with scleral patch graft |
| | 26.25A (1998-2009) | Repeat trabeculectomy |

## References


1. Roy MS, Klein R, O'Colmain BJ, et al. The prevalence of diabetic retinopathy among adult type 1 diabetic persons in the United States. Arch Ophthalmol 2004;122(4):546-51.
2. Klein R, Klein BE, Moss SE, Cruickshanks KJ. The Wisconsin epidemiologic study of diabetic retinopathy: XVII. The 14-year incidence and progression of diabetic retinopathy and associated risk factors in type 1 diabetes. Ophthalmology 1998;105(10):1801-15.
3. Klein R, Klein BE, Moss SE, et al. The Wisconsin epidemiologic study of diabetic retinopathy. III. Prevalence and risk of diabetic retinopathy when age at diagnosis is 30 or more years. Arch Ophthalmol 1984;102(4):527-32.
4. Klein R, Klein BE, Moss SE, et al. The Wisconsin epidemiologic study of diabetic retinopathy. II. Prevalence and risk of diabetic retinopathy when age at diagnosis is less than 30 years. Arch Ophthalmol 1984;102(4):520-6.
5. Maberley DA, Hollands H, Chuo J, et al. The prevalence of low vision and blindness in Canada. Eye 2006;20(3):341-6.
6. Seidell JC. Obesity, insulin resistance and diabetes-a worldwide epidemic. Br J Nutr 2000;83(Suppl 1):S5-8.
7. Young TK, Reading J, Elias B, O'Neil JD. Type 2 diabetes mellitus in Canada's first nations: status of an epidemic in progress. CMAJ 2000;163(5):561-6.
8. Tan MH, MacLean DR. Epidemiology of diabetes mellitus in Canada. Clin Invest Med 1995;18(4):240-6.
9. Javitt JC. Cost savings associated with detection and treatment of diabetic eye disease. Pharmacoeconomics 1995;8(Suppl 1):33-9.
10. Javitt JC, Aiello LP. Cost-effectiveness of detecting and treating diabetic retinopathy. Ann Intern Med 1996;124(1 Pt 2):164-9.
11. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2008 clinical practice guidelines for the prevention and management of diabetes in Canada. Can J Diabetes 2008;329(suppl 1):S1-S201.
12. Rudnisky CJ, Tennant MTS, Johnson JA, Balko SU. Diabetes and Eye Disease in Alberta. In: Johnson JA, editor. Alberta Diabetes Atlas 2009. Edmonton: Institute of Health Economics; 2009:153-173.
13. Anonymous. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. The Diabetes Control and Complications Trial Research Group. N Engl J Med 1993;329(14):977-86.
14. Anonymous. Efficacy of atenolol and captopril in reducing risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 39. UK Prospective Diabetes Study Group. BMJ 1998;317(7160):713-20.
15. Anonymous. Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 38. UK Prospective Diabetes Study Group. BMJ 1998;317(7160):703-13.
16. Polak BC, Crijns H, Casparie AF, Niessen LW. Cost-effectiveness of glycemic control and ophthalmological care in diabetic retinopathy. Health Policy 2003;64(1):89-97.
17. Baker CF, Rudnisky CJ, Tennant MT, et al. JPEG compression of stereoscopic digital images for the diagnosis of diabetic retinopathy via teleophthalmology. Can J Ophthalmol 2004;39(7):746-54.
18. Rudnisky CJ, Hinz BJ, Tennant MT, et al. High-resolution stereoscopic digital fundus photography versus contact lens biomicroscopy for the detection of clinically significant macular edema. Ophthalmology 2002;109(2):267-74.
19. Rudnisky CJ, Tennant MT, de Leon AR, et al. Benefits of stereopsis when identifying clinically significant macular edema via teleophthalmology. Can J Ophthalmol 2006;41(6):727-32.
20. Rudnisky CJ, Tennant MT, Weis E, et al. Web-based grading of compressed stereoscopic digital photography versus standard slide film photography for the diagnosis of diabetic retinopathy. Ophthalmology 2007;114(9):1748-54.
21. Tennant MT, Greve MD, Rudnisky CJ, et al. Identification of diabetic retinopathy by stereoscopic digital imaging via teleophthalmology: a comparison to slide film. Can J Ophthalmol 2001;36(4):187-96.
22. Tennant MT, Rudnisky CJ, Hinz BJ, et al. Tele-ophthalmology via stereoscopic digital imaging: a pilot project. Diabetes Technol Ther 2000;2(4):583-7.
23. Mitchell P, Smith W, Chey T, Healey PR. Open-angle glaucoma and diabetes: the Blue Mountains eye study, Australia. Ophthalmology 1997;104(4):712-8.
24. Tennant MTS, Rudnisky CJ, Johnson JA. Diabetes and eye disease in Alberta. In: Johnson JA, editor. Alberta Diabetes Atlas 2007. Edmonton: Institute of Health Economics; 2007:95-112.

# Chapter 10

# Diabetes and Mental Health Disorders in Alberta

Lauren C. Bresee
Larry W. Svenson
Scott B. Patten

ADSS

# CHAPTER 10

Alberta Diabetes Surveillance System

# DIABETES AND MENTAL HEALTH DISORDERS IN ALBERTA

## KEY MESSAGES

- Mental health disorders are more prevalent in people with diabetes compared to people without diabetes.
- Since 1995, age- and sex-adjusted rates of non-organic psychoses have consistently increased in people with diabetes but have remained stable in people without diabetes.
- Affective disorders and anxiety disorders are more prevalent in younger adults with diabetes.
- The South zone has the highest rates of non-organic psychoses and substance use disorders, with increased prevalence in those with diabetes compared to those without diabetes.

## BACKGROUND

Mental health disorders such as depressive disorders, bipolar disorders, anxiety disorders and schizophrenia are chronic medical conditions associated with considerable morbidity.[1-4] Not only are they debilitating due to their associated signs and symptoms, there is a large body of literature demonstrating a relationship between mental health disorders and diabetes. Presence of depressive symptoms or major depressive disorder has been associated with type 2 diabetes in a number of publications.[5,6] Research has also demonstrated an increased prevalence of diabetes in people with schizophrenia, where schizophrenia is considered a risk factor for type 2 diabetes in the *2008 Canadian Diabetes Association Clinical Practice Guidelines.*[7-9] In addition, literature has linked bipolar disorders and anxiety disorders with diabetes.[10,11]

The mechanisms behind these relationships are likely multifactorial. There is some evidence that pharmacological treatment for mental health disorders may increase the risk of diabetes, particularly atypical antipsychotic agents.[12-16] Biochemical changes due to mental health disorders is also a postulated mechanism.[17,18] Lastly, lifestyle changes and symptoms of mental health disorders likely also contribute to the relationship between diabetes and mental health disorders.[18,19]

The relationship between diabetes and comorbid mental health disorders is very important. Compared to those with diabetes only, individuals with diabetes and mental health disorders have decreased medication adherence and adherence to diabetes self care, increased functional impairment, increased risk of complications associated with diabetes, increased health care costs, and an increased risk of mortality.[20-24]

The objective of this chapter is to compare prevalence of diagnosed mental health disorders in people with and without diabetes in Alberta from 1995-2009. The mental health disorders evaluated in this chapter include affective disorders (e.g. depression), anxiety disorders (e.g. post-traumatic stress disorder), non-organic (e.g. schizophrenia) and organic psychoses (e.g. drug psychoses), and substance use disorders (e.g. alcohol dependence).

## METHODS

Data from Alberta Health and Wellness Physician Claims databases were utilized for these analyses. This dataset captures demographic information and mental health disorder diagnoses for Alberta residents (see appendix for a listing of all physician claim codes of the mental health disorders reported in this chapter). Any mental health disorder diagnosis that was present in any of the three diagnostic fields from the physician claims were captured. All residents of Alberta aged 20 years and older were included in these analyses.

From these data, prevalence rates of affective disorders, anxiety disorders, non-organic and organic psychoses, and substance use disorders for those with and without diabetes were calculated. For people with and without diabetes, the number of people with the mental health disorder diagnosis of interest (numerator) was divided by the number of people in the province or zone (denominator), respectively.

Trends over time (1995–2009) and age-specific rates for each of the mental health disorder diagnostic categories were calculated and compared between the diabetic and non-diabetic populations. Rates of mental health disorders in 2009 were also calculated by Alberta health zone. Persons with diabetes were identified as described in the “Background and Methods” chapter.

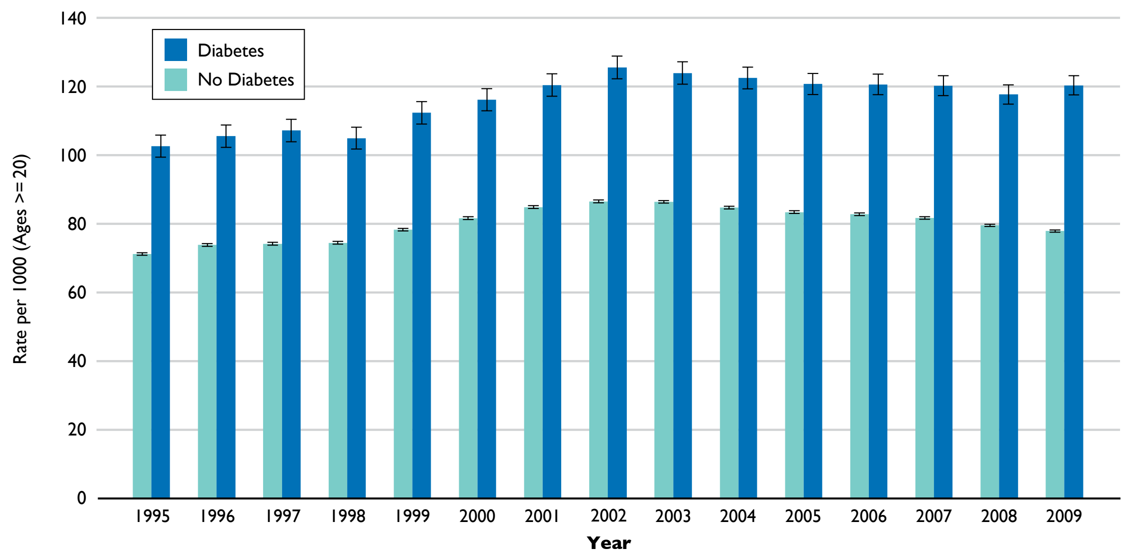
Direct standardization was used to adjust rates by age and sex for comparisons across time, using the Alberta population according to the 2006 Canadian Census.

## FINDINGS

Age- and sex-adjusted rates of mental health disorders were greater in individuals with diabetes compared to those without diabetes. This trend was consistent over the 15-year time period examined (1995–2009) for all of the mental health disorders that were evaluated in the analyses.

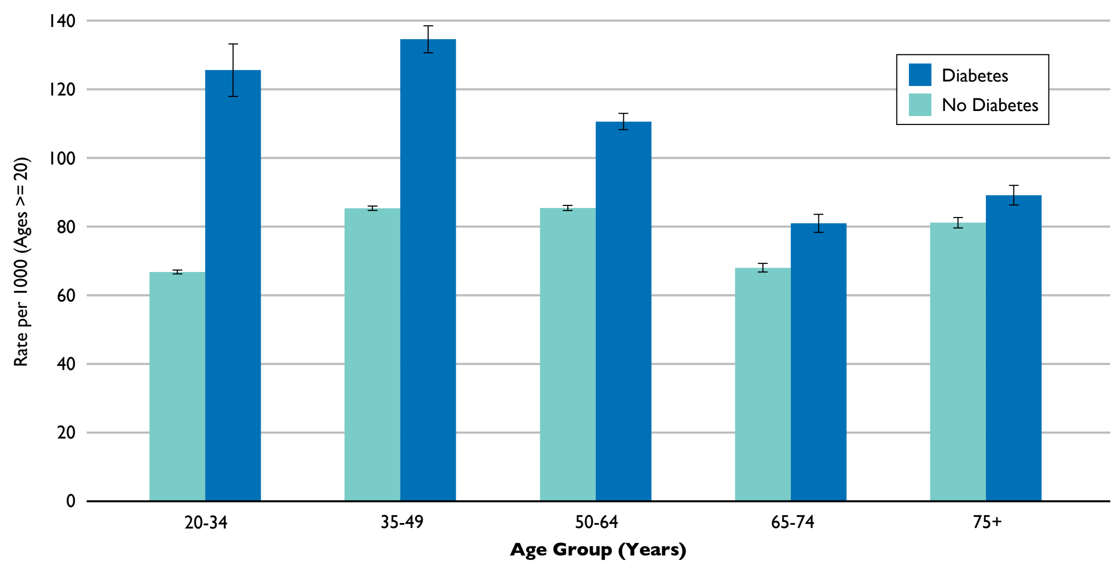
The age- and sex-adjusted rates of affective disorders were higher in people with diabetes over the 15-year time period (Figure 10.1). Rates of affective disorders increased until 2002 and then slightly decreased in people with and without diabetes. Overall, the prevalence of affective disorders increased to a greater extent in the diabetes group compared to people without diabetes, increasing from 102.6 per 1000 in 1995 to 120.3 per 1000 in 2009 among people with diabetes, and from 71.2 per 1000 in 1995 to 77.9 per 1000 in 2009 among the non-diabetes group. In general, the ratio of affective disorders for people with and without diabetes was similar across the five health zones (data not shown).

Figure 10.1 **Age- and Sex-Adjusted Rates of Affective Disorder, 1995-2009**



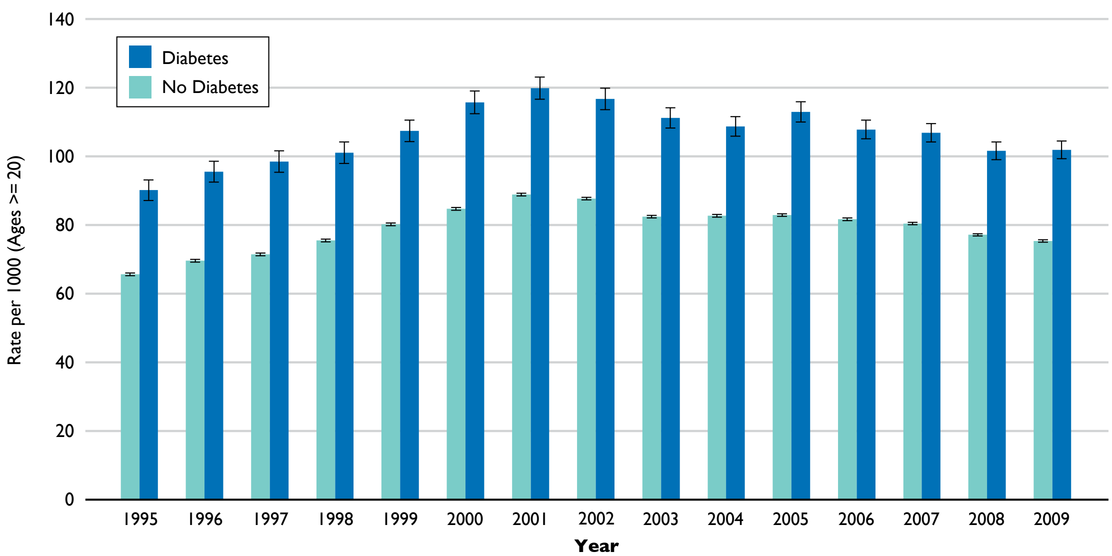

When looking at age-specific rates, the largest discrepancies between people with and without diabetes occurred in the 20-34 and 35-49-year age groups, and the difference between people with and without diabetes was minimal in the older age groups (Figure 10.2).

Figure 10.2 **Age-Specific Rates of Affective Disorder, 2009**



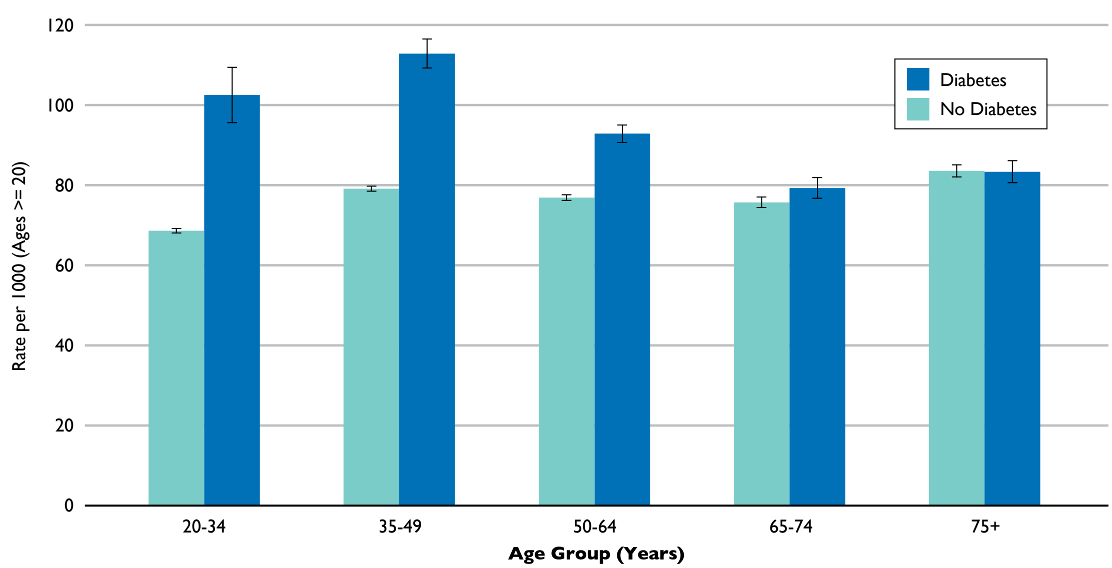
Trends for the association between anxiety disorders and diabetes were found to be similar to those for affective disorders and diabetes. Individuals with diabetes consistently demonstrated higher rates of anxiety disorders over the 15-year time period compared to people without diabetes (Figure 10.3).

Figure 10.3 **Age- and Sex-Adjusted Rates of Anxiety Disorders, 1995-2009**




Age-specific rates of anxiety disorders also demonstrated a similar trend to affective disorders in people with and without diabetes (Figure 10.4). Higher rates of anxiety disorders were seen in individuals with diabetes who were less than 65 years old, whereas little difference was seen in people with and without diabetes 65 years of age and older.

Figure 10.4 **Age-Specific Rates of Anxiety Disorders, 2009**



Within the last decade, individuals with diabetes had more than double the rates of non-organic psychosis compared to people without diabetes (Figure 10.5). The difference in rates of non-organic psychoses in people with and without diabetes increased from 5.3 per 1000 in 1995 to 12.3 per 1000 in 2009. This was the result of a large increase in the rates of non-organic psychoses in people with diabetes (from 11.3 per 1000 in 1995 to 18.9 per 1000 in 2009); the rates of non-organic psychoses in the non-diabetes group remained consistent over the study period (ranging from 6.0 to 6.8 per 1000). The South and Edmonton zones had the highest rates of non-organic psychosis among individuals with and without diabetes (Figure 10.6).

Figure 10.5 **Age- and Sex-Adjusted Rates of Non-Organic Psychoses, 1995-2009**

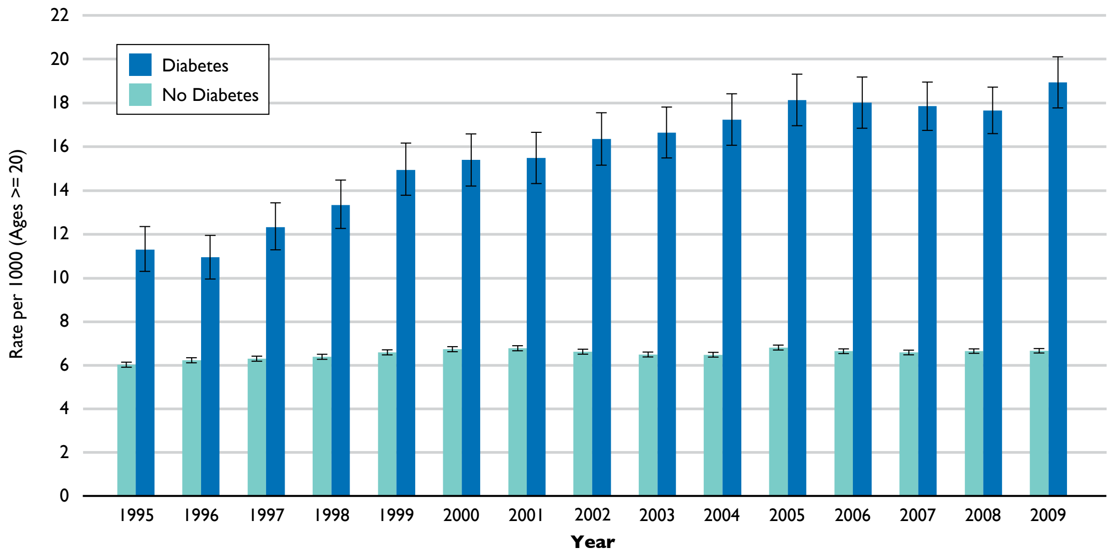
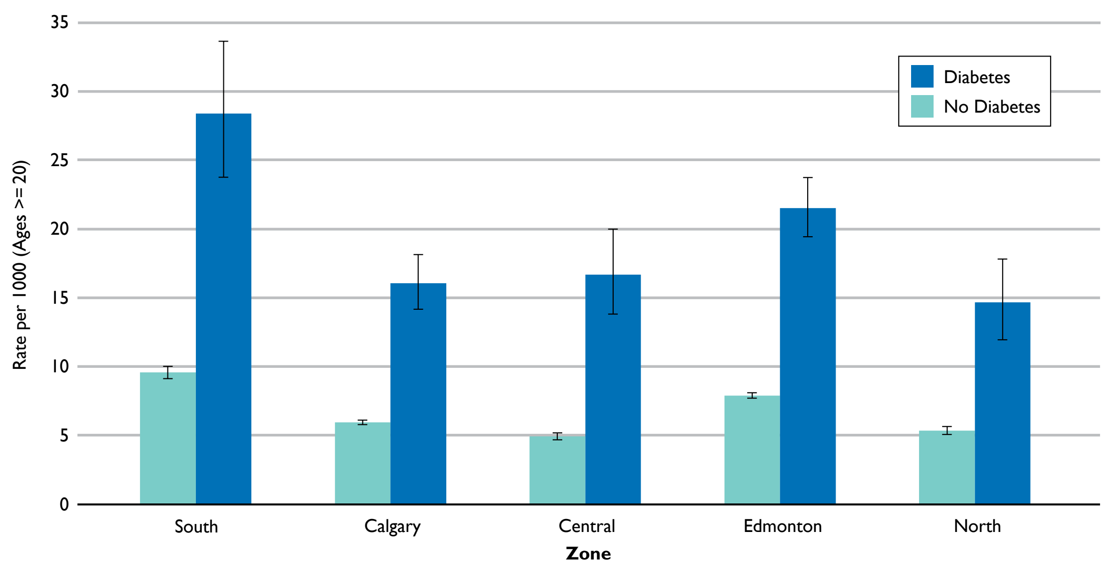
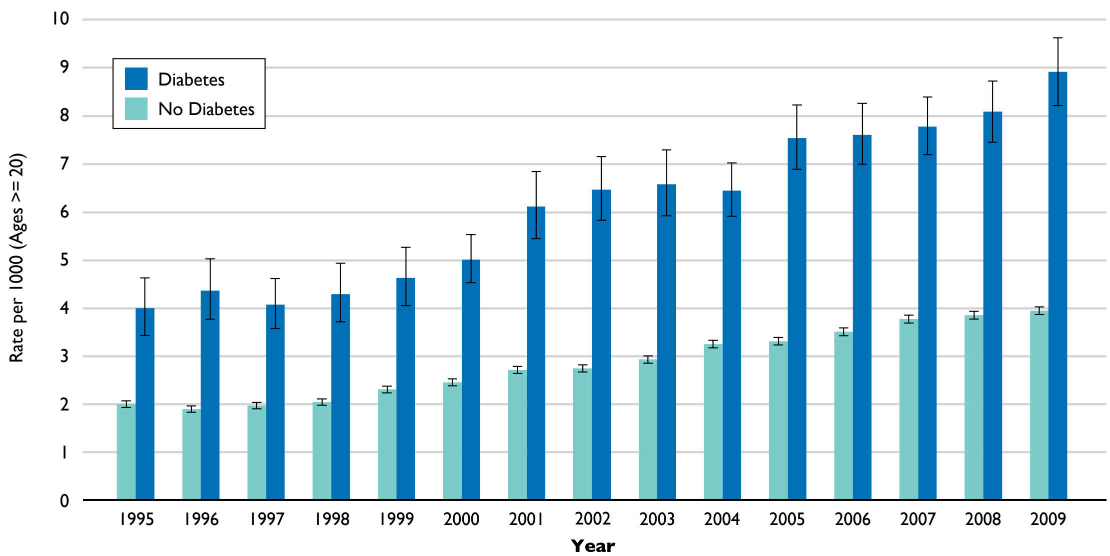



Figure 10.6 **Age-Adjusted Rates of Non-Organic Psychoses by Zone, 2009**



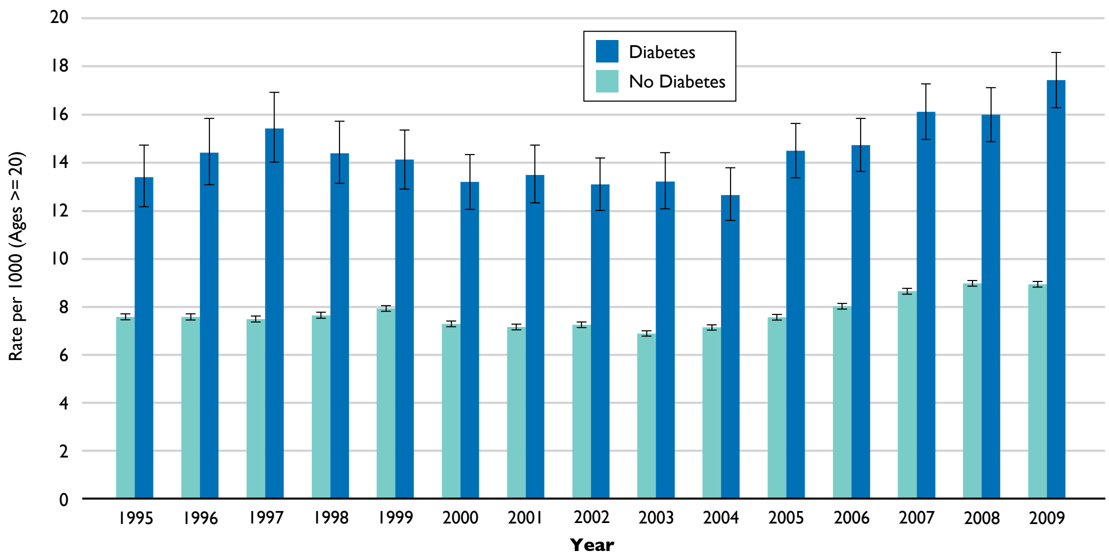
Rates of organic psychoses in people with and without diabetes were lower compared to rates of non-organic psychosis, but a clear difference still existed between people with and without diabetes. Individuals with diabetes had much higher rates of organic psychoses compared to people who did not have diabetes and increasing rates over time were observed in both populations (Figure 10.7).

Figure 10.7 **Age- and Sex-Adjusted Rates of Organic Psychoses, 1995-2009**



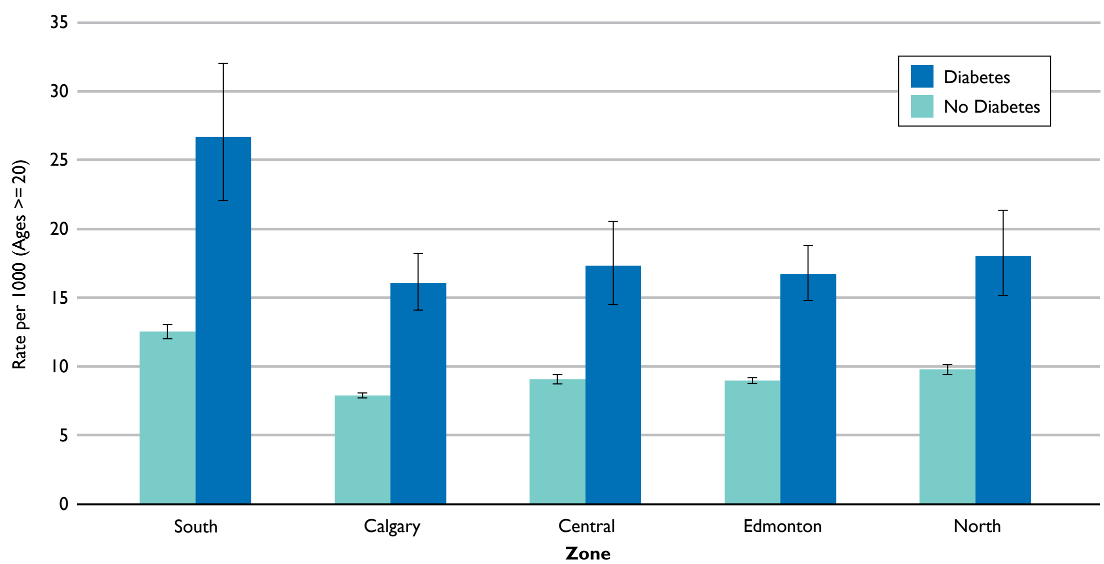

Substance use rates were also consistently higher in people with diabetes, but rates of substance use disorders remained relatively consistent over the 15-year analysis period (Figure 10.8). Figure 10.8 displays the association of substance use disorders and diabetes.

Figure 10.8 **Age- and Sex-Adjusted Rates of Substance Use Disorders, 1995-2009**



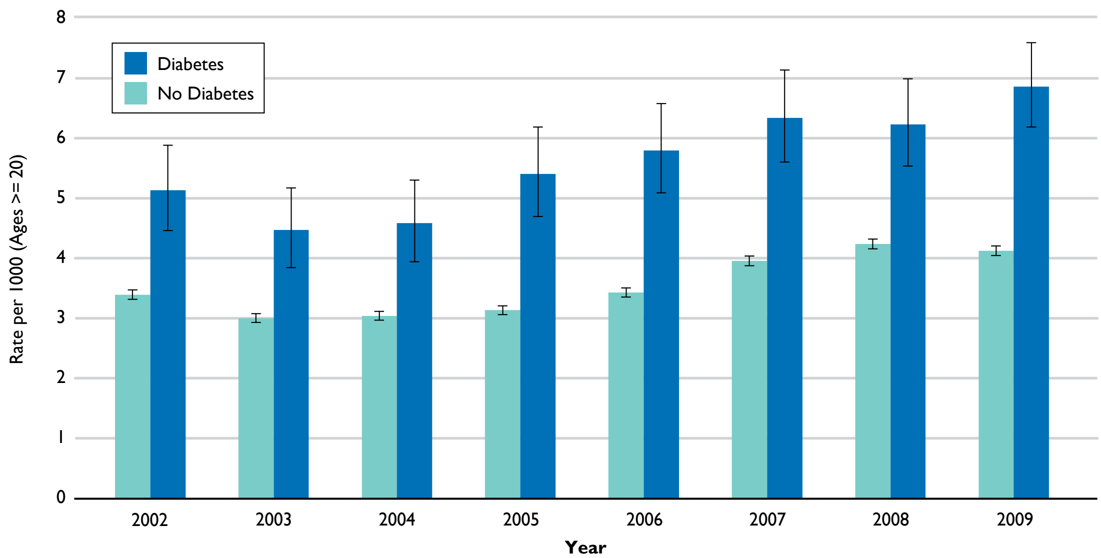

Individuals with diabetes in the South zone had the highest prevalence of substance use disorders in Alberta at 26.7 per 1000 for people with diabetes, which was more than double that of the non-diabetic population in the same zone (12.5 per 1000 people) (Figure 10.9). Rates of substance use were similar in the diabetes population (ranging from 16.1 to 18.0 per 1000) and in the non-diabetic population (ranging from 7.9 to 9.8 per 1000) across all other health zones.

Figure 10.9 **Age-Adjusted Rates of Substance Use Disorders by Zone, 2009**



Given the likelihood of overlap between other mental health disorders and substance use disorders, we evaluated whether this relationship remained after removing individuals with a comorbid alternative mental health disorder from the analysis. Figure 10.10 demonstrates the relationship of substance use and diabetes in those without a comorbid mental health disorder. The rates of substance use disorder are lower than in Figure 10.8, but a difference still exists between those with and without diabetes.

Figure 10.10 **Age- and Sex-Adjusted Rates of Substance Use Disorders, without Comorbid Mental Health Disorders, 2002-2009**



## DISCUSSION

As was previously reported in the 2007 and 2009 issues of the *Alberta Diabetes Atlas*, individuals with diabetes had higher rates of mental health disorders compared to those without diabetes.[25] These results are consistent with the published research evaluating the relationship between diabetes and mental health disorders.

Individuals with diabetes had higher rates of affective disorders and anxiety disorders, but this difference was mainly contained in the younger age groups. In terms of affective disorders, this is consistent with previously published literature based on data from Saskatchewan.[6] As mentioned previously, comorbid affective disorders and diabetes are associated with an increased risk of diabetes complications, healthcare costs and mortality in comparison to those solely with diabetes.[20-24]

The rates of non-organic psychoses were more than double the rates in people with diabetes compared to those without diabetes. Based on the rate increase from 1995–2009 in the diabetes group, rates of non-organic psychoses do not seem to be plateauing, which could indicate further increases in non-organic psychoses rates in people with diabetes in the coming years. This could be reflective of the increasing use of atypical antipsychotic agents in the last 15 years. Use of atypical antipsychotic agents to treat illnesses like schizophrenia has been associated with weight gain, type 2 diabetes, dyslipidemia and metabolic syndrome.[13-16]

Substance use disorders were more common in people with diabetes compared to people without diabetes, and this relationship, although weaker, remained after excluding people with other mental health disorders from the analysis. We did not evaluate the relationship between substance use and Status Aboriginal individuals or socio-economic status, both of which could have an impact on the relationship between substance use disorder and diabetes. For example, Status Aboriginal individuals are at a higher risk of developing diabetes and also have higher reported substance use disorder rates compared to the general population.[9,26] The relationship between substance use and socio-economic status is another area that could be explored. The issue of comorbid substance use and diabetes is a topic requiring further research.

In summary, individuals with diabetes had higher rates of affective disorders, anxiety disorders, organic and non-organic psychoses, and substance use disorders compared to the non-diabetes population. Given the increased prevalence of mental health disorders in people with diabetes, research and health care interventions should focus on strategies to minimize complications, morbidity and mortality in this population.

# APPENDIX

## Alberta Physician Claims Data

| Diagnosis | ICD-9-CM | Description |
|---|---|---|
| Affective disorders | 296.XX | Affective psychoses |
| | 300.4 | Neurotic depression |
| | 301.1X | Affective personality disorder |
| | 309.0 | Brief depressive reaction |
| | 309.1 | Prolonged depressive reaction |
| | 311 | Depressive disorder, not elsewhere classified |
| Anxiety disorders | 300.XX | Neurotic disorders (exclude 300.4- Neurotic depression) |
| | 309.8 | Other specified adjustment reaction |
| | 309.81 | Prolonged post-traumatic stress disorder |
| | 309.82 | Adjustment reaction with physical symptoms |
| | 309.83 | Adjustment reaction with withdrawal |
| | 309.89 | Other |
| | Exclusion criteria for Anxiety disorders | |
| | 300.14 | Multiple Personality (Dissociative identity disorder) |
| | 300.15 | Dissociative disorder or reaction, unspecified |
| | 300.16 | Factitious illness with psychological symptoms (compensation neurosis; Ganser's syndrome, hysterical) |
| | 300.19 | Other and unspecified factitious illness |
| | 300.4 | Neurotic depression |
| | 300.8 | Other neurotic disorders |
| | 300.81 | Somatization disorder |
| | 300.82 | Undifferentiated somatoform disorder |
| | 300.89 | Other (Occupational neurosis, including writers' cramp, psychasthenia, psychasthenic neurosis) |
| Non-organic Psychoses | 295.XX | Schizophrenia |
| | 297.XX | Paranoid states (Delusional disorders) |
| | 298.XX | Other non-organic psychoses |
| Organic Psychoses | 291.XX | Alcohol psychoses |
| | 292.XX | Drug psychoses |
| | 293.XX | Transient organic psychotic conditions |
| | 294.XX | Other organic psychotic conditions (Chronic) |
| Substance Use Disorders | 303.XX | Alcohol dependence syndrome |
| | 305.2-305.9 | Non-dependent abuse of drugs |
| | 304.XX | Drug dependence |

## References

1. Canadian Psychiatric Association Working Group. Clinical practice guidelines: treatment of schizophrenia. Can J Psychiatry 2005;50(Suppl 1):1S-56S.
2. Canadian Psychiatric Association Working Group. Clinical practice guidelines: management of anxiety disorders. Can J Psychiatry 2006;51(Suppl 2):1S-93S.
3. Parikh SV, Lam RW, CANMAT Depression Work Group. Clinical practice guidelines for the treatment of depressive disorders. Can J Psychiatry 2001;46(Suppl 1):1S-90S.
4. Yatham LN, Kennedy SH, O'Donovan C, Parikh SV, MacQueen G, McIntyre RS, et al. Canadian Network for Mood and Anxiety Treatments guidelines for the management of patients with bipolar disorder: update 2007. Bipolar Disorders 2006;8:721-39.
5. Mezuk B, Eaton WW, Albrecht H, Hill Golden S. Depression and type 2 diabetes over the lifespan. Diabetes Care 2008;31:2383-90.
6. Brown LC, Majumdar SR, Newman SC, Johnson JA. History of depression increases risk of type 2 diabetes in younger adults. Diabetes Care 2005;28:1063-67.
7. Curkendall SM, Mo J, Glasser DB, Stang MR, Jones JK. Cardiovascular disease in patients with schizophrenia in Saskatchewan, Canada. J Clin Psychiatry 2004;65:715-20.
8. Dixon L, Weiden P, Delahanty J, et al. Prevalence and correlates of diabetes in national schizophrenia samples. Schizophrenia Bulletin 2000;26:903-12.
9. Canadian Diabetes Association 2008 clinical practice guidelines for the prevention and management of diabetes in Canada. Can J Diabetes 2008;32(Suppl 1):S1-S201.
10. McIntyre RS, Konarski JZ, Misener VL, Kennedy SH. Bipolar disorder and diabetes mellitus: epidemiology, etiology, and treatment implications. Annals of Clinical Psychiatry 2005;17(2):83-93.
11. Fisher L, Skaff MM, Mullan JT, Arean P, Glasgow R, Masharani U. A longitudinal study of affective and anxiety disorders, depressive affect and diabetes distress in adults with type 2 diabetes. Diabetic Medicine 2008;25:1096-101.
12. Brown LC, Majumdar SR, Johnson JA. Type of antidepressant therapy and risk of type 2 diabetes in people with depression. Diabetes Research and Clinical Practice 2008;79:61-7.
13. Lieberman JA, Stroup TS, McEVoy JP, et al, for the Clinical Antipsychotic Trials of Intervention Effectiveness Investigators. Effectiveness of antipsychotic drugs in patients with chronic schizophrenia. N Eng J Med 2005;353:1209-23.
14. Lindenmayer JP, Czobor P, Volavka J, et al. Changes in glucose and cholesterol levels in patients with schizophrenia treated with typical or atypical antipsychotics. Am J Psychiatry 2003;160:290-6.
15. Lund BC, Perry PJ, Brooks JM, et al. Clozapine use in patients with schizophrenia and the risk of diabetes, hyperlipidemia, and hypertension: a claims-based approach. Arch Gen Psychiatry 2002;58:1172-6.
16. Meyer JM. A retrospective comparison of weight, lipid, and glucose changes between risperidone- and olanzapine-treated inpatients: metabolic outcomes after 1 year. J Clin Psychiatry 2002;63:425-33.
17. Talbot F, Nouwen A. A review of the relationship between depression and diabetes in adults: is there a link? Diabetes Care 2000;23:1556-62.
18. Brown ES, Varghese FP, McEwan BS. Association of depression with medical illness: does cortisol play a role? Biol Psychiatry 2004;55:1-9.
19. McCreadie RG, on behalf of the Scottish Schizophrenia Lifestyle Group. Diet, smoking and cardiovascular risk in people with schizophrenia. British Journal of Psychiatry 2003;183:534-9.
20. Egede LE. Effect of depression on work loss and disability bed days in individuals with diabetes. Diabetes Care 2004;27:1751-3.
21. Finkelstein EA, Bray JW, Chen H, et al. Prevalence and costs of major depression among elderly claimants with diabetes. Diabetes Care 2003;26:415-20.
22. Egede LE, Zheng D, Simpson K. Comorbid depression is associated with increased health care use and expenditures in individuals with diabetes. Diabetes Care 2002;25:464-70.
23. de Groot M, Anderson R, Freedland K, et al. Association of depression and diabetes complications: a meta-analysis. Psychosomatic Medicine 2001;63:619-30.
24. Zhang X, Norris SL, Gregg EW, Cheng YJ, Beckles G, Kahn HS. Depressive symptoms and mortality among persons with and without diabetes. Am J Epidemiol 2005;161:652-60.
25. Brown LC, Svenson LW, Beck CA. Diabetes and mental health disorders in Alberta: In Institute of Health Economics. Alberta diabetes atlas 2007. 2007:113-26.
26. Anderson J, McEwan K. Utilization of common analgesic and anxiolytic medications by registered First Nations residents of Western Canada. Subst Use Misuse 2000;35:601-16.

# Chapter 11

# Diabetes and the Status Aboriginal Population in Alberta

Richard T. Oster
Brenda R. Hemmelgarn
Ellen L. Toth
Malcolm King
Lynden Crowshoe

# DIABETES AND THE STATUS ABORIGINAL POPULATION IN ALBERTA

## KEY MESSAGES

- Diabetes is much more common among the Status Aboriginal population, as incidence and prevalence rates are about twice as high in both males and females compared to the general population.
- From 1995-2009, the rate of increase in incidence of diabetes for Status Aboriginal people was slower than for the general population (16% rate of increase compared to 65%, respectively).
- Among Status Aboriginal people, the prevalence of diagnosed diabetes is higher among females compared to males, while incidence rates are similar for both sexes.
- The mortality rate ratio (DM to no DM) was higher for the entire population compared to Status Aboriginals, except in the oldest age group.
- Use of hospital and emergency department services are 2 to 3 times higher for the Status Aboriginal population with diabetes compared the general population.

## BACKGROUND

For Canadian Aboriginal populations, initial contact with Europeans resulted in socially mediated stress from infectious diseases and starvation.[1] However, the past 100 years have brought about an epidemiological shift in prevailing health issues, giving way to chronic diseases, such as obesity, type 2 diabetes (DM), cancer and cardiovascular disease, experienced in an accelerated fashion over a few generations.[1,2] National estimates from the "1997 First Nations and Inuit Regional Health Survey" showed diabetes prevalence rates to be 8% and 13% for First Nations men and women, respectively,[3] or 3 to 5 times the national average. More recently, the "2002/2003 Regional Health Survey" suggested that the prevalence rate for DM among adults has increased to 20%.[4] National and provincial data is less commonly available for the Métis and non-Status Aboriginals and even less is known about the impact and burden of diabetes in these populations, although similar patterns appear to be emerging.[5,6]

Type 2 diabetes among Aboriginal people is also occurring at a much younger age compared to the general population, with prevalence rates of 1.1% reported in the 4-19-year-old age group in northeastern Manitoba.[7] Though a genetic predisposition to type 2 diabetes in Oji-Cree communities in Manitoba and Ontario has been found,[8] experts agree that the primary reasons for increased prevalence of diabetes and its complications are largely due to the changes in lifestyle brought about by colonization.[2,9]

The intent of this chapter is to compare the incidence and prevalence of diagnosed DM among Status Aboriginals and the general population of Alberta from 1995-2009. The chapter will also examine rates of diabetes in the under-20-year-old population, as well as mortality, health care utilization and analyses by Alberta health zone.

## METHODS

Cases of DM were identified using the Alberta Health and Wellness administrative databases by applying a modified version of the National Diabetes Surveillance System (NDSS) algorithm (see "Background and Methods" chapter). Status Aboriginal people were identified from the Alberta Health Care Insurance Plan Central Stakeholder Registry file and were defined as any individual residing in Alberta registered under the federal Indian Act. The Registry file was searched from June 1994-June 2009 and any individual in Alberta with a Status Aboriginal identifier (First Nations or Inuit) was classified as "Status Aboriginal" with all other individuals classified as the "general population." Aboriginal people who were not registered, such as Aboriginals without Treaty status and Métis, were included in the general population comparison group. Status Aboriginal individuals were included whether they were living on or off reserve. There are approximately 100,000 Status Aboriginal people (62% on reserve)[10] and 70,000 Métis people living in Alberta.[11]

When calculating the prevalence of DM, the proportion of Status Aboriginal people who had DM was determined and compared to the proportion of the general population with DM at the same point in time. This was repeated annually from 1995-2009. An incident case of DM was defined as a person who met the NDSS criteria for diabetes with no diabetes claims in the prior 2 years. Incident rates were calculated for Status Aboriginal and the general population who developed DM in the years 1995-2009. All rates were age- and sex-adjusted to the Alberta population from the 2006 Canadian Census.

An independent analysis of prevalence and incidence of DM among the under-20-year-old Status Aboriginal population was conducted. Given that the numbers are very small among this population, only unadjusted crude data is provided.

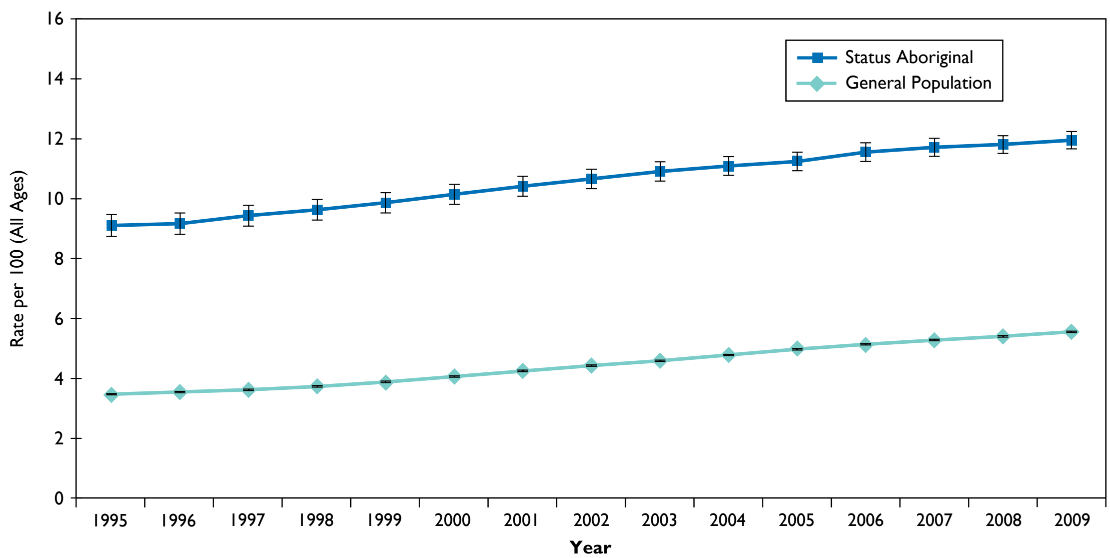
Mortality and health care utilization (general practitioner (GP) and specialist encounters, emergency department (ED) encounters and hospitalizations) data for the years 1995-2009 are also presented in this chapter, where rates are compared between the two populations (Status Aboriginal and the general population).

Data is presented by health zone for diabetes incidence and prevalence in the Status Aboriginal population, for both the total population and for the under-20-year-old population for 2009. Health care utilization (GP and specialist encounters, ED encounters and hospital days) was presented for Status Aboriginals with and without diabetes. The Status Aboriginal population with diabetes was also compared to the general population with diabetes for 2009.

# FINDINGS

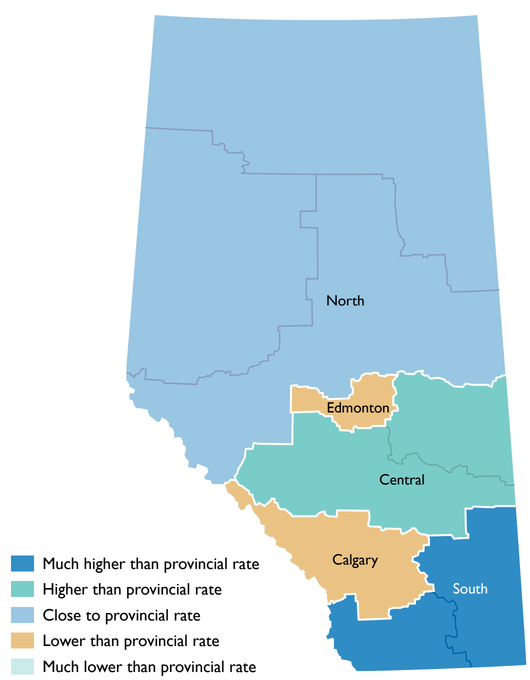
## Epidemiological Trends

Figure 11.1 **Age- and Sex-Adjusted Diabetes Prevalence Rates, among the Status Aboriginal and General Populations, 1995-2009**




In 2009, the overall age- and sex-adjusted prevalence of DM in the Alberta Status Aboriginal population was 11.9%, increasing 31% over the past 15 years of observation (Figure 11.1). This is in contrast to the general population where prevalence has increased 60% over the same time period. The prevalence of diabetes was lower than the provincial rate for Status Aboriginals living in the Calgary and Edmonton zones, close to the provincial rate in the North zone, and was above the provincial rate in the Central and South zone (Figure 11.2). The prevalence was consistently higher in Status Aboriginal females compared to males in each of the health zones and was highest in females in the North, South and Central zones (Figure 11.3).

Figure 11.2 **Age-Adjusted Status Aboriginal Diabetes Prevalence Rates for All Ages, by Zone, 2009**



Adjusted prevalence and incidence rates of DM were roughly twice as high among the Status Aboriginal population compared to the general population (Figure 11.1 and 11.4). Since 2001, however, the incidence rate appears to have stabilized for the Status Aboriginal population in comparison to the general population, where incidence continues to increase. When comparing increases in incidence rates stratified by sex, male Status Aboriginal rates have been increasing faster than female Status Aboriginal rates (32% versus 3%). However, male and female general population incidence rates are increasing the fastest (71% and 58%) (Figure 11.5). Status Aboriginal females have higher incidence rates in all the zones, except in the North where Status Aboriginal males are higher (Figure 11.6).

Figure 11.3 **Age-Adjusted Diabetes Prevalence Rates for the Status Aboriginal Population, by Zone, 2009**

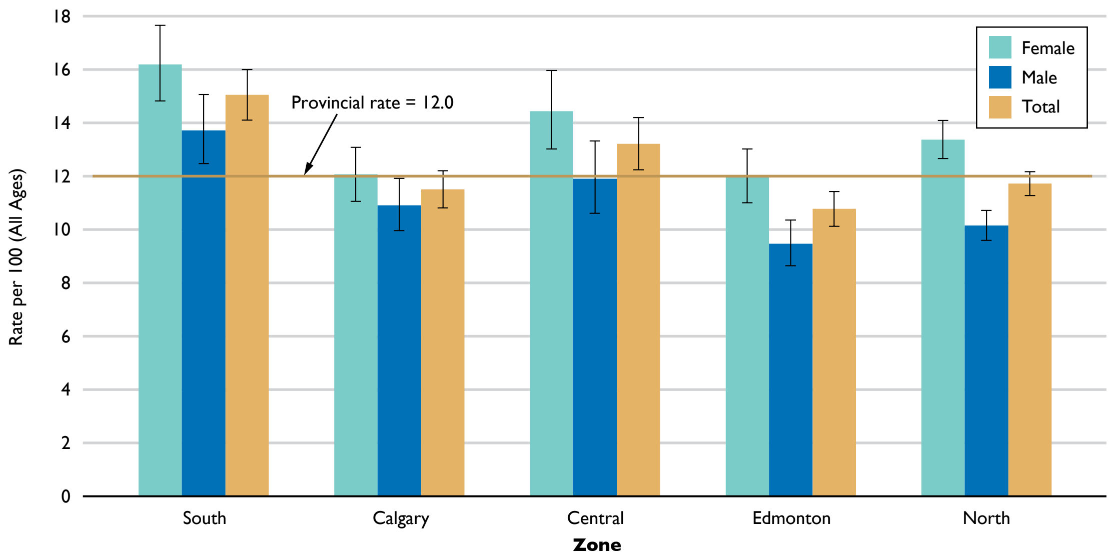



Figure 11.4 **Age- and Sex-Adjusted Diabetes Incidence Rates, among the Status Aboriginal and General Populations, 1995-2009**

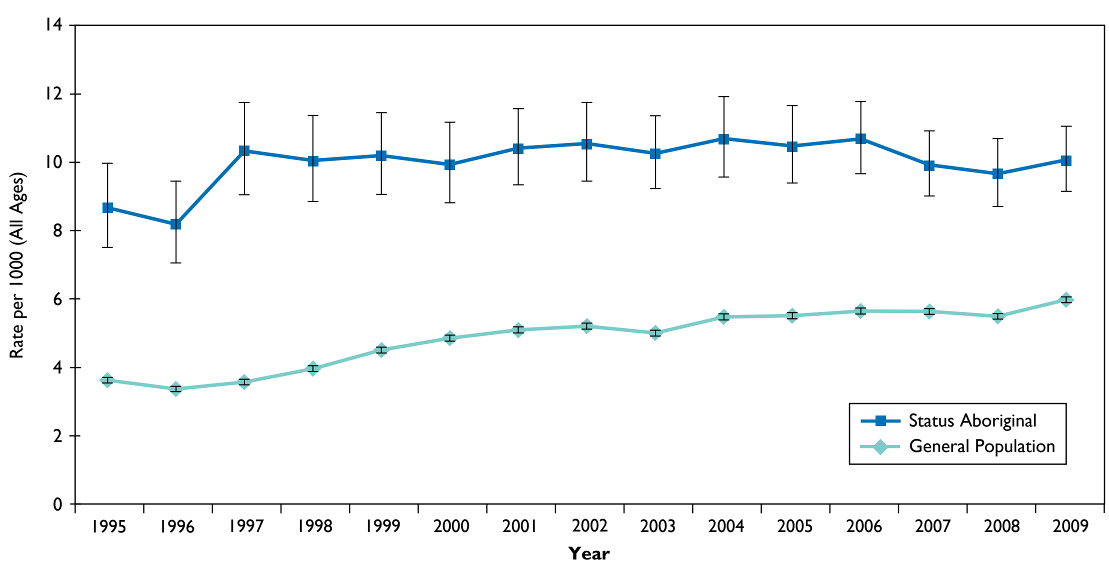


Figure 11.5 **Age-Adjusted Diabetes Incidence Rates by Sex, among the Status Aboriginal and General Populations, 1995-2009**

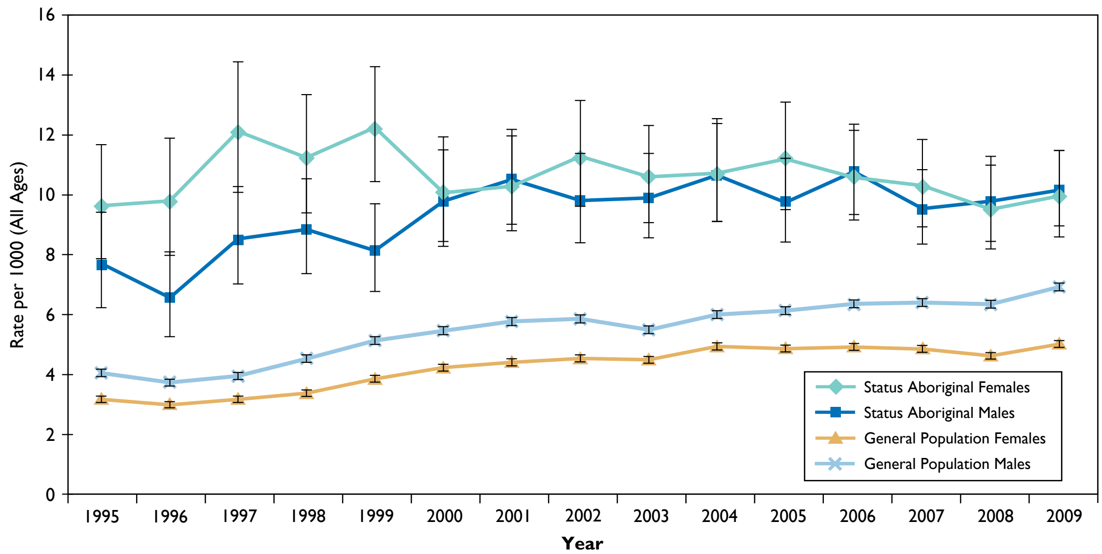
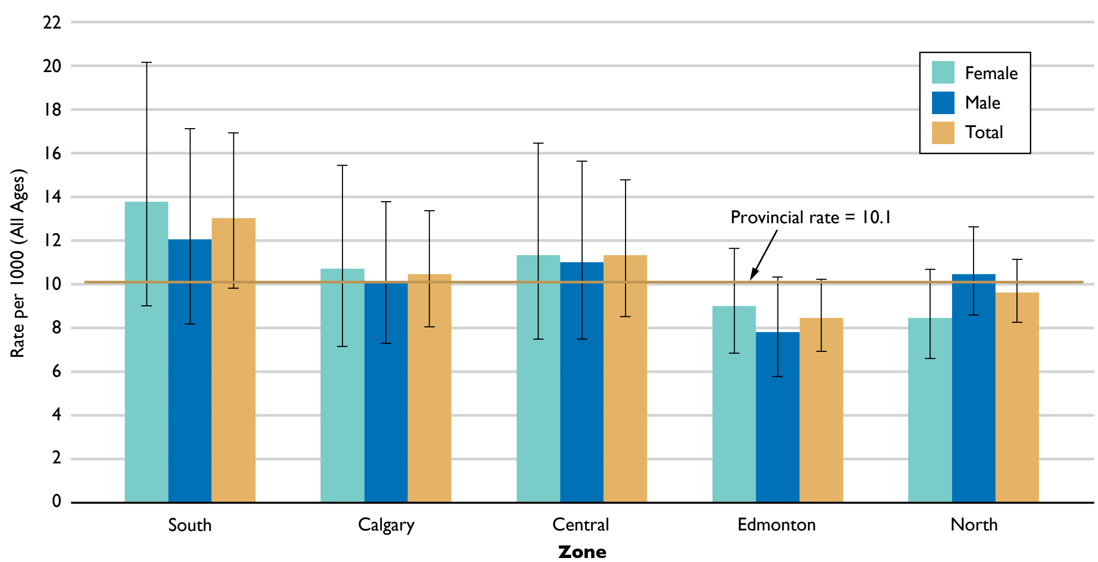



Figure 11.6 **Age-Adjusted Diabetes Incidence Rates for the Status Aboriginal Population, by Zone, 2009**



Diabetes prevalence among Status Aboriginal people and the general population increased in the older age groups for both males and females (Figure 11.7 and 11.8). The prevalence of DM is higher among Status Aboriginal females compared to males, but the opposite is true in the general population. The prevalence of diabetes in Status Aboriginals was highest in the South zone across all the age groups (Figure 11.9). The Central zone had the second-highest rate in the 20 and over age groups and the Edmonton zone had the lowest rates in the 20 to 64 year age groups.

Figure 11.7 **Age-Specific Diabetes Prevalence Rates, among the Female Status Aboriginal and General Populations, 1995 and 2009**

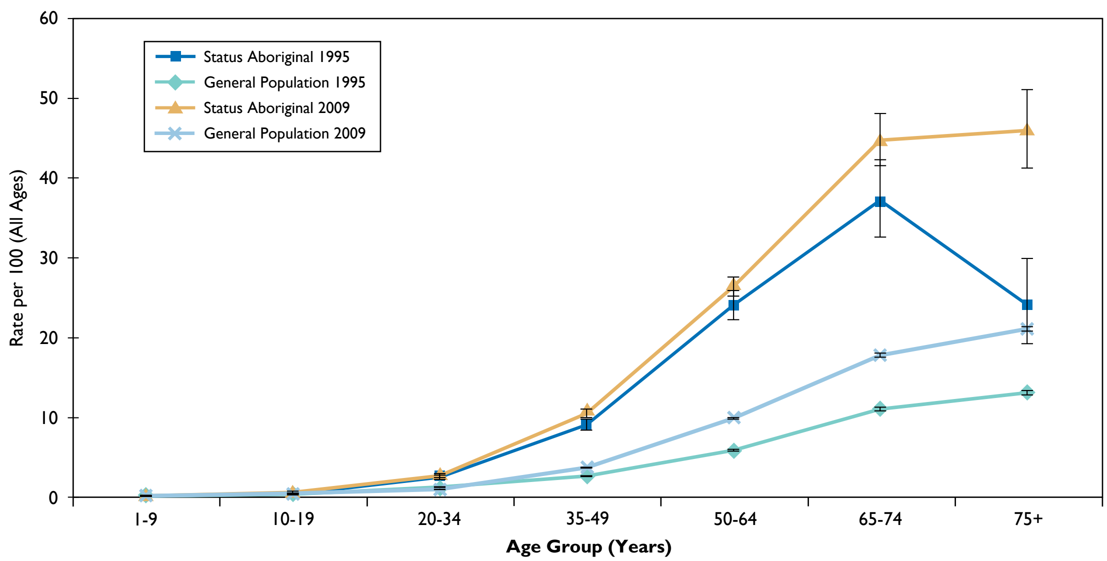



Figure 11.8 **Age-Specific Diabetes Prevalence Rates, among the Male Status Aboriginal and General Populations, 1995 and 2009**

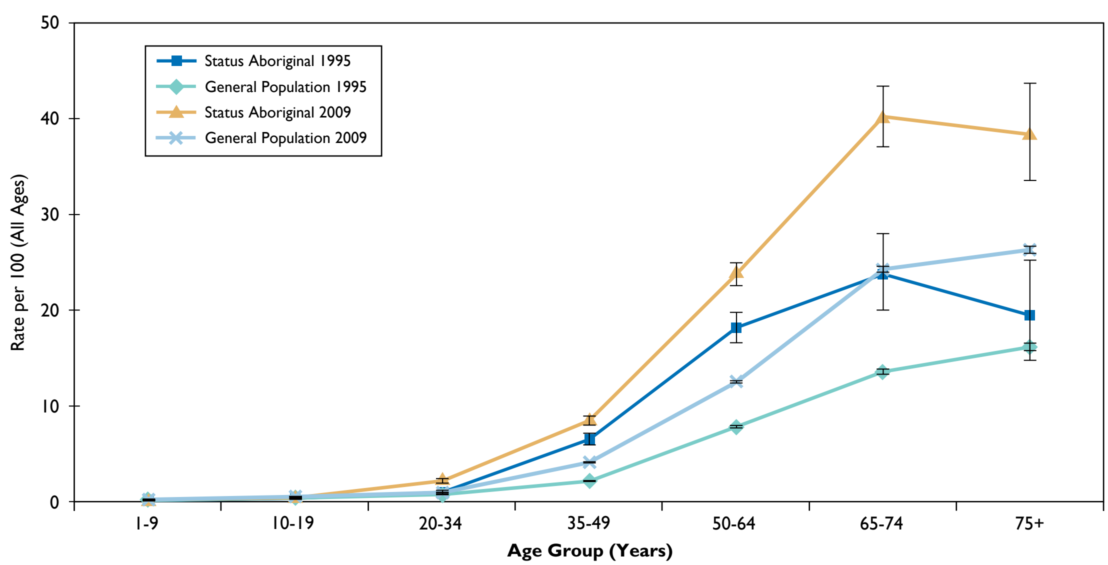
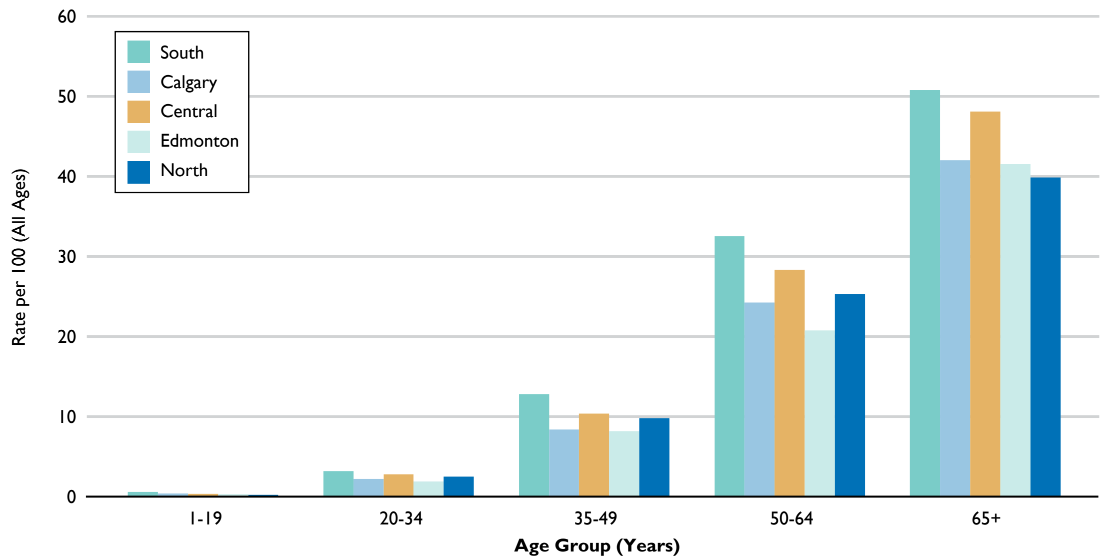


Figure 11.9 **Age-Specific Diabetes Prevalence Rates for the Status Aboriginal Population, by Zone, 2009**




Comparable age-specific results were apparent with respect to the incidence of DM among the Status Aboriginal population (Figure 11.10 and 11.11). The incidence of DM is also associated with increasing age, with rates being highest for Status Aboriginal males and females from 65-74 years of age. These age-specific incidence rates for the Status Aboriginal population should be interpreted with caution, especially in the oldest age categories, because of a small number of cases. Confidence intervals around the Status Aboriginal population point estimates were too large to include in these figures.

Figure 11.10 **Age-Specific Diabetes Incidence Rates, among the Female Status Aboriginal and General Populations, 1995 and 2009**

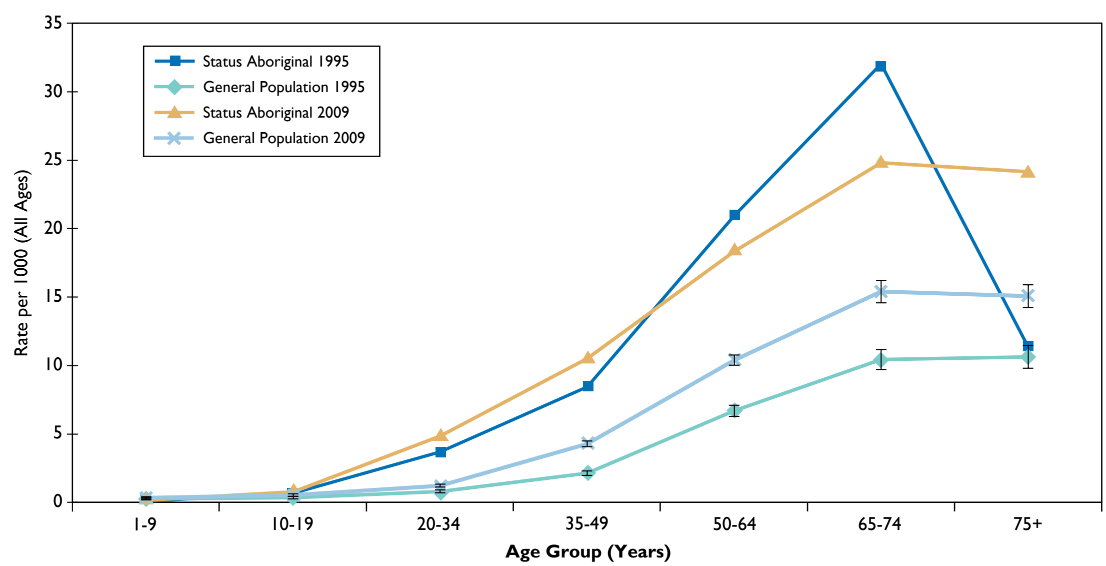
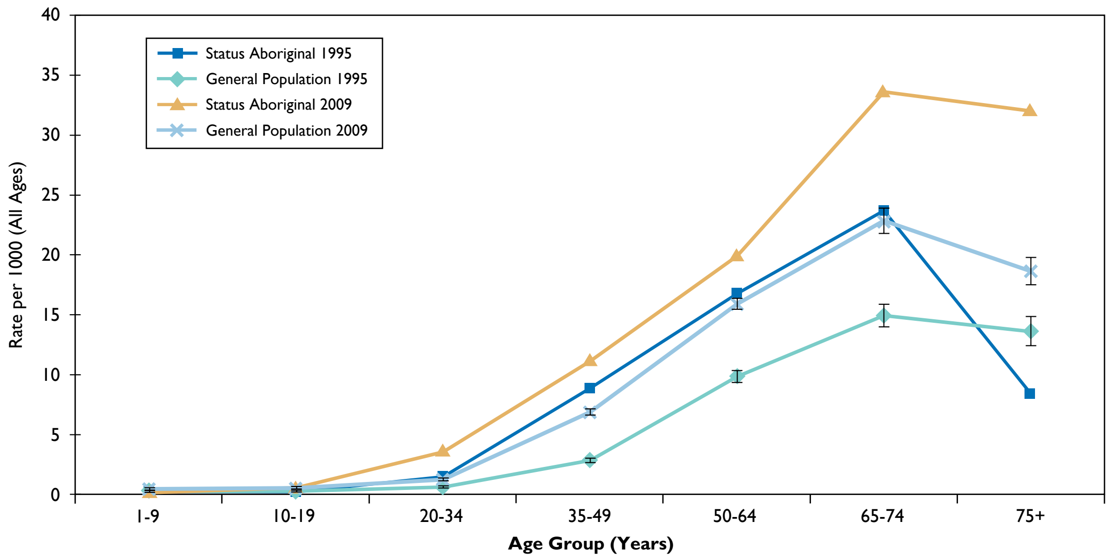


Figure 11.11 **Age-Specific Diabetes Incidence Rates, among the Male Status Aboriginal and General Populations, 1995 and 2009**




Trends in the under-20-year-old Status Aboriginal population were also generated. In Figure 11.12, we see that prevalence of diabetes in both the Status Aboriginal and general populations are increasing over the observation period. General population diabetes prevalence rates are consistently higher than Status Aboriginal rates across most years; however, the differences between the two populations are becoming smaller. Further, when the Status Aboriginal population is stratified by sex, we see that prevalence is highest among girls for the entire time period (Figure 11.13). This higher prevalence among girls is also seen in all the health zones except the North zone, where the boys are higher (Figure 11.14). The rates among girls were highest in the South and Calgary zones and lowest in the North zone. Differences between the Status Aboriginal and general populations are becoming smaller over time due to increasing diabetes incidence rates in the under-20-year-old Status Aboriginal population compared to the general population (Figure 11.15). Caution must be taken when interpreting these findings because the case counts are very small.

There was, in the Status Aboriginal under-20-year-old population, a trend of increasing crude diabetes prevalence and incidence rates over the 15-year time span from 1995-2009 (Figure 11.12 and 11.15). Again, caution is needed when interpreting these data due to the small number of cases and subsequent data variability.

Figure 11.12 **Crude Diabetes Prevalence Rates in the Under-20-Year-Old Population, among the Status Aboriginal and General Populations, 1995-2009**

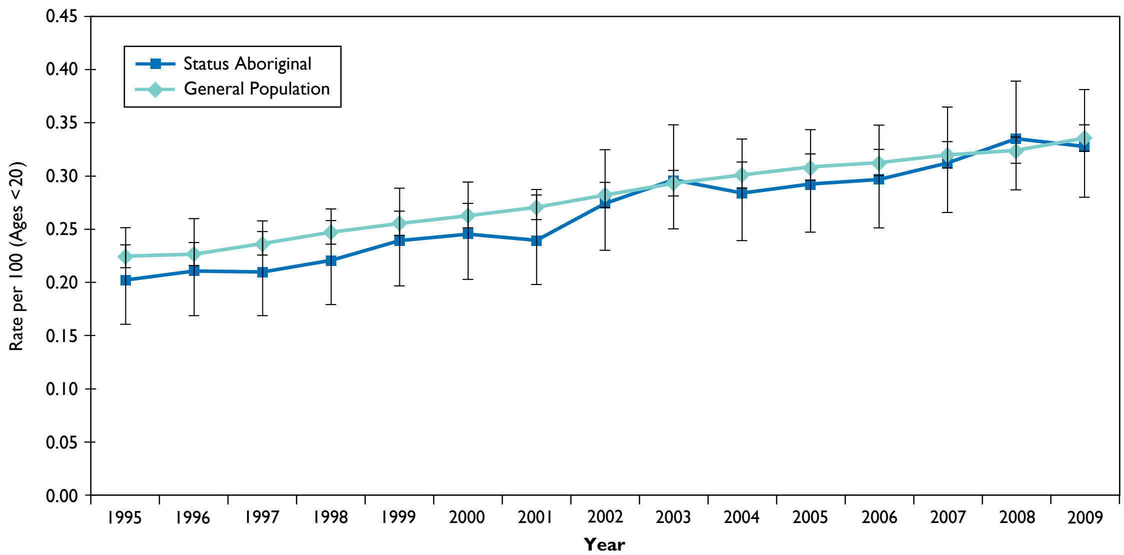



Figure 11.13 **Crude Diabetes Prevalence Rates in the Under-20-Year-Old Status Aboriginal Population, 1995-2009**

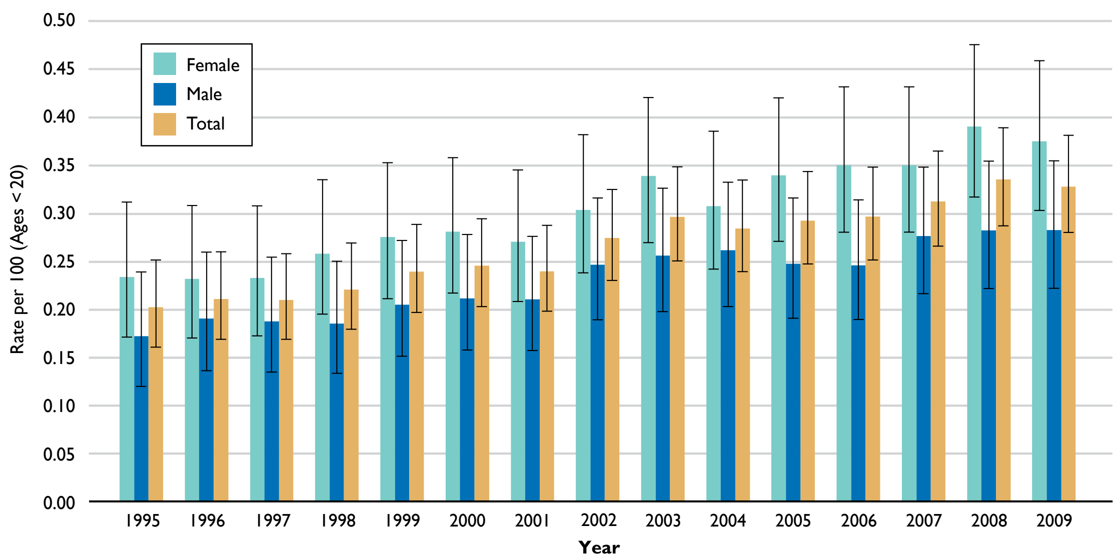


Figure 11.14 **Crude Status Aboriginal Diabetes Prevalence Rates in the Under-20-Year-Old Population, by Zone, 2009**

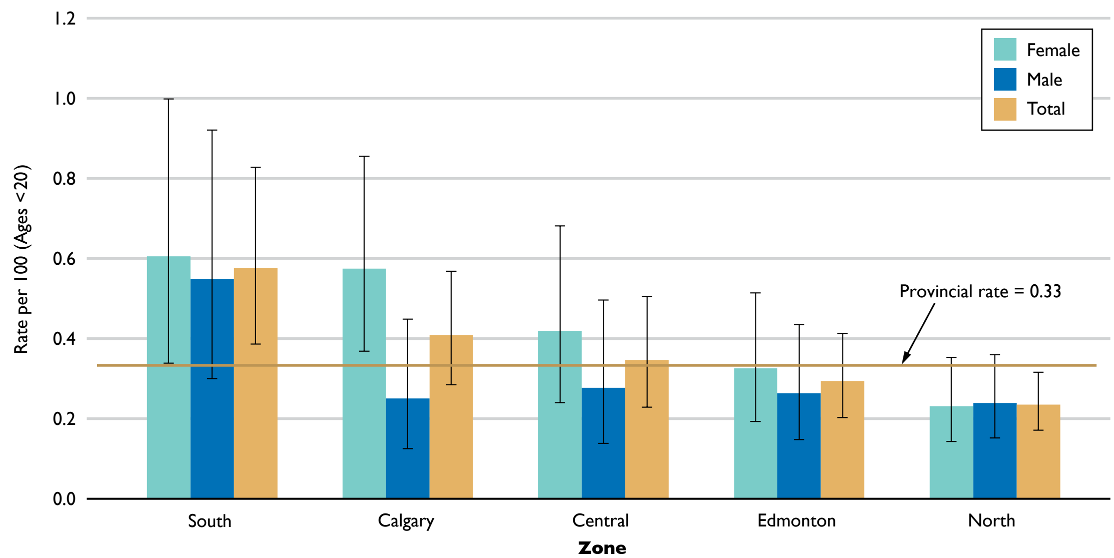
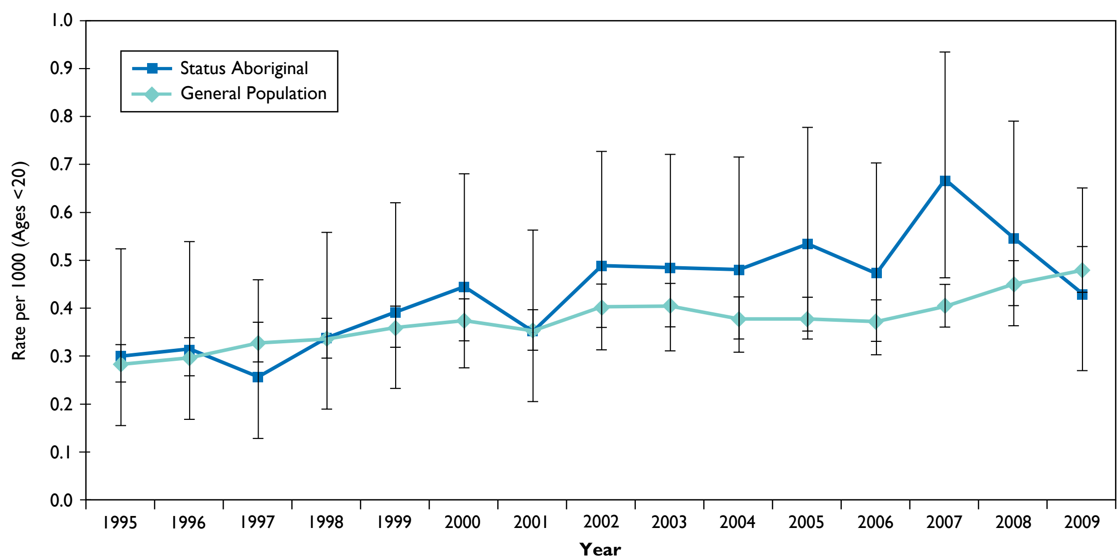



Figure 11.15 **Crude Diabetes Incidence Rates in the Under-20-Year-Old Population, among the Status Aboriginal and General Populations, 1995-2009**



Mortality rates for the Status Aboriginal population are higher for those both with and without diabetes compared to mortality rates in the general population. In fact, the mortality rates of the Status Aboriginal population without diabetes were similar to the mortality rates of the general population with diabetes. This trend was consistent over time (1995-2009) (Figure 11.16). The largest drop in mortality rates occurred in the Status Aboriginal population with diabetes, where rates decreased 38% over the period of observation; however, the smallest drop in mortality rates occurred in the Status Aboriginal population without diabetes (16%). These rates must be interpreted with caution, however, due to the small number of cases. The general population had reductions in mortality rates in both their diabetes and non-diabetes populations (27% and 22% respectively). When observing age-specific mortality rates for both Status Aboriginals and the general population of Alberta in 2009, rates were consistently higher among those with diabetes compared to those without diabetes (Figure 11.17 and 11.18). The mortality rate ratio (DM to no DM) was higher for the entire population compared to Status Aboriginals for all age groups except for the 75+ year old group; however, the largest rate ratio occurred in the youngest age group in the entire population (3.0), while there was less variation in the rate ratio across all ages in the Status Aboriginal population (1.4 to 2.2).

Figure 11.16 **Age- and Sex-Adjusted Mortality Rates, among the Status Aboriginal and General Populations, 1995-2009**

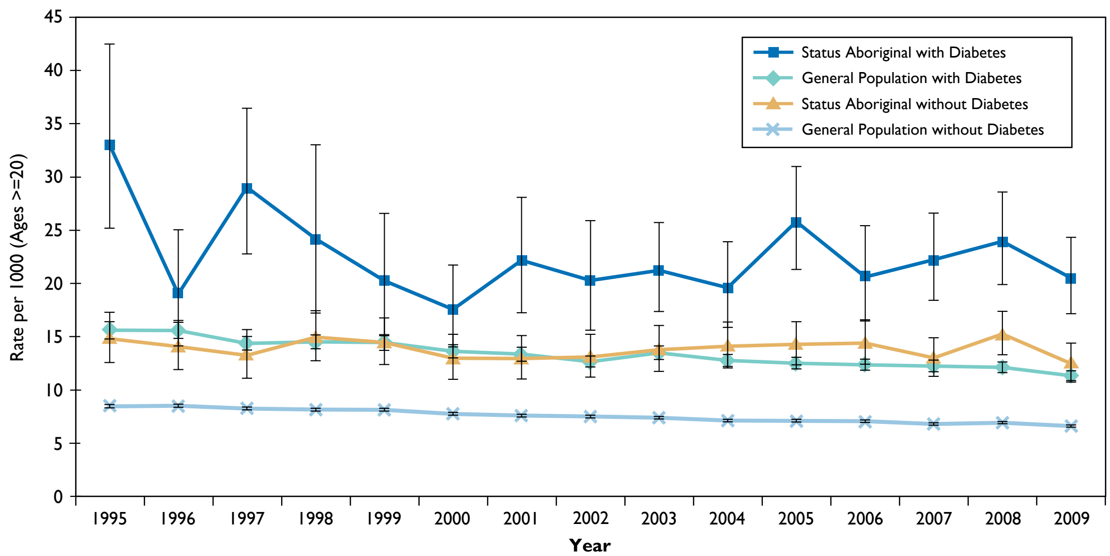


Figure 11.17 **Age-Specific Mortality Rates for the Status Aboriginal Population, 2009**

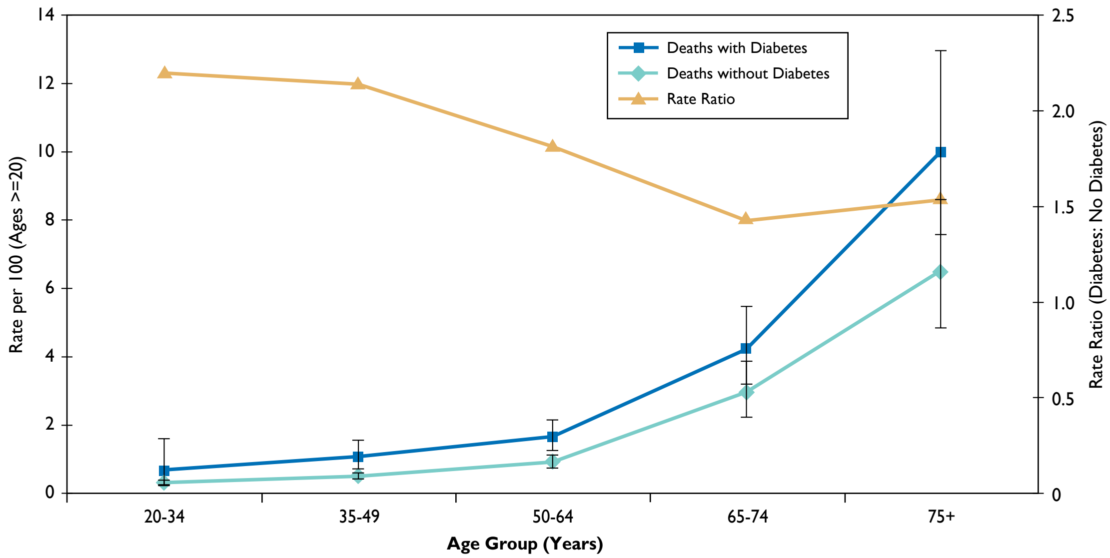
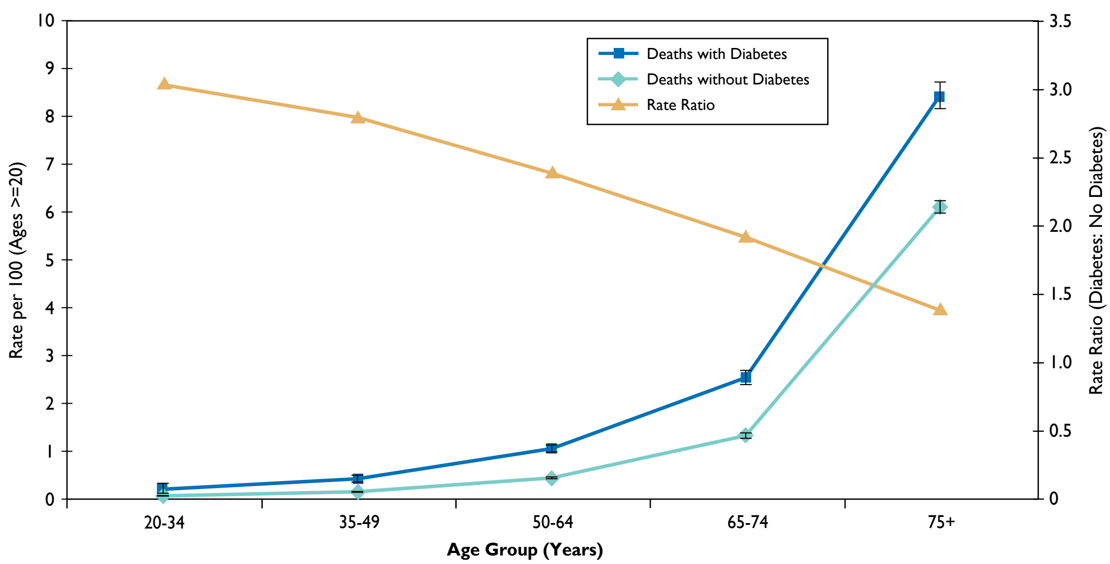



Figure 11.18 **Age-Specific Mortality Rates for the Entire Population (Status Aboriginal and General Population), 2009**



## Health Care Utilization

The average number of specialist encounters was slightly higher among the general population with diabetes in the youngest and oldest age groups, but overall quite similar across the middle age groups (Figure 11.19). A different pattern of health care utilization was observed with respect to GP visits. The Status Aboriginal population had more GP visits compared to the general population in each age group, especially in the younger age groups (Figure 11.20).

Figure 11.19 **Age-Specific Average Number of Specialist Visits for the Population with Diabetes, among the Status Aboriginal and General Populations, 2009**

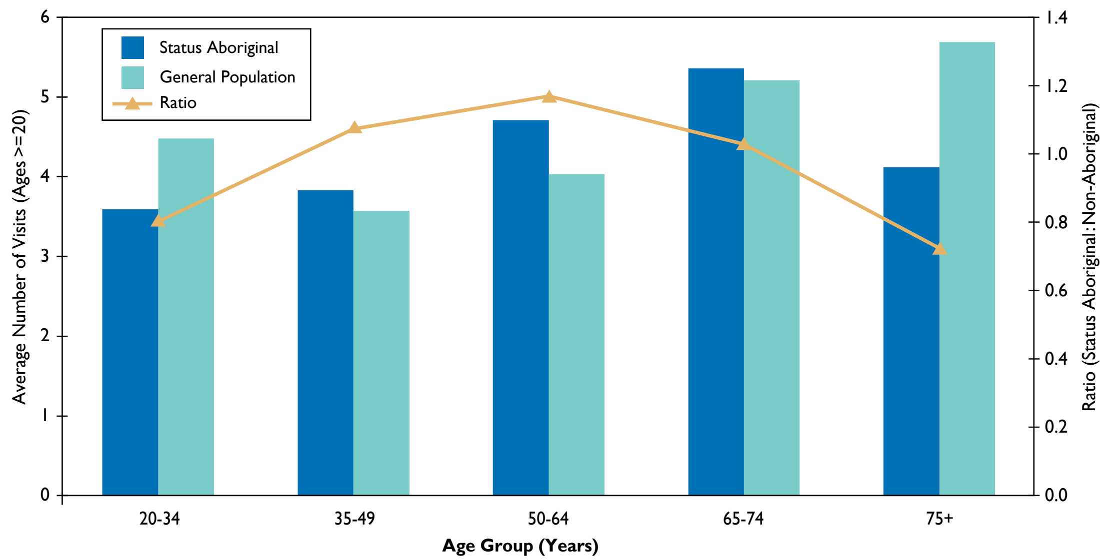
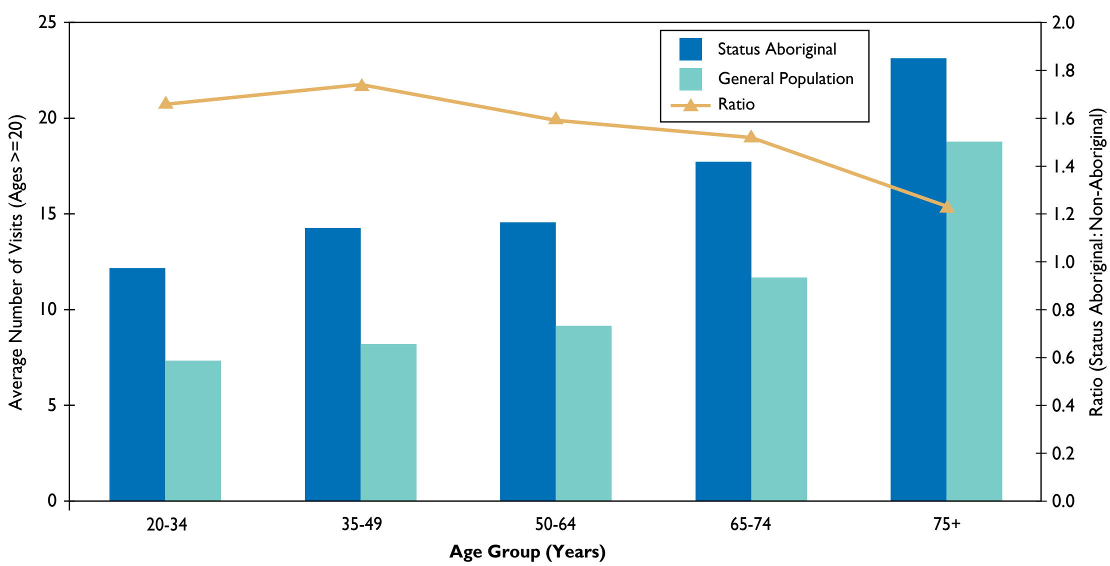



Figure 11.20 **Age-Specific Average Number of General Practitioner Visits for the Population with Diabetes, among the Status Aboriginal and General Populations, 2009**



When the data were examined by health zone, the Status Aboriginal population with diabetes had a higher number of visits to specialists compared to the general population in Calgary, Central and Edmonton zones, and a lower number of visits in the South and North zones (Figure 11.21). This is in contrast to the average number of GP visits where the Status Aboriginal population with diabetes had higher rates across all of the health zones (Figure 11.22). The average numbers of visits to specialists were higher in the Edmonton and Calgary zones and lowest in the North zone (Figure 11.21). The opposite was seen in the number of GP visits by Status Aboriginal people with diabetes, with the North, Central and South zones having a higher number of visits (Figure 11.22).

Figure 11.21 **Age-Adjusted Average Number of Specialist Visits for the Population with Diabetes, among the Status Aboriginal and General Populations, by Zone, 2009**

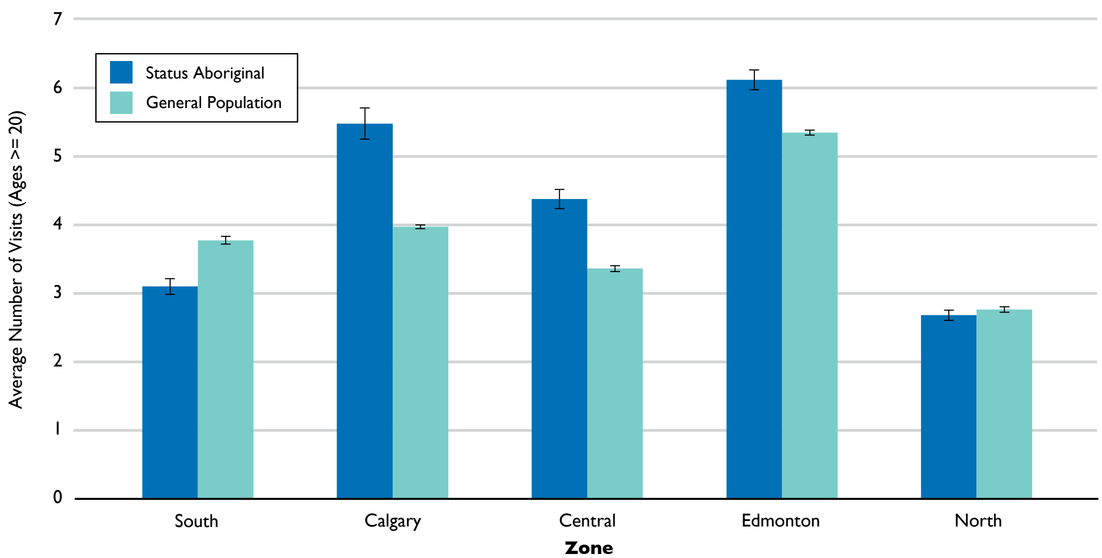
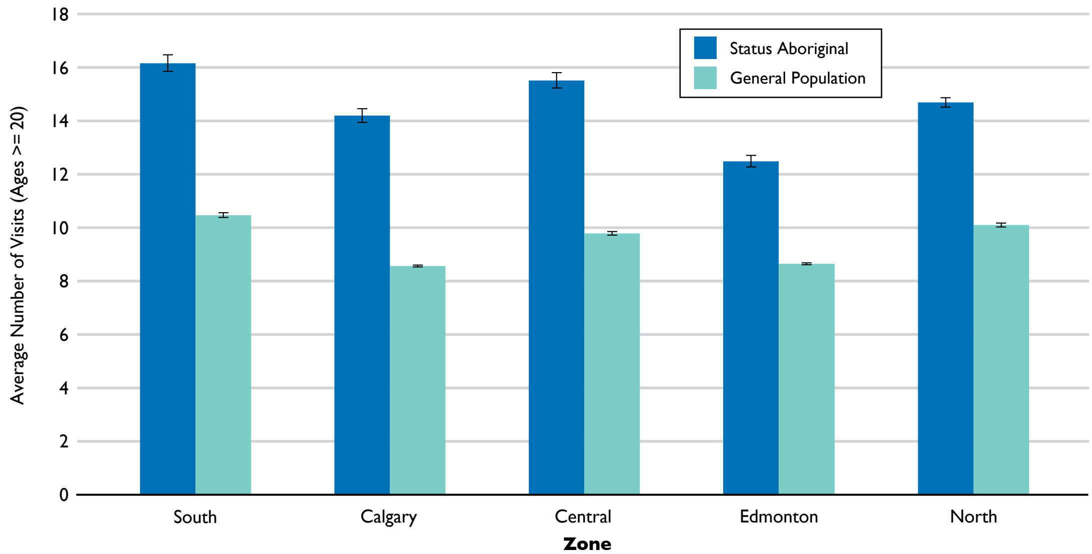


Figure 11.22 **Age-Adjusted Average Number of GP Visits for the Population with Diabetes, among the Status Aboriginal and General Populations, by Zone, 2009**




Similar to the general population, the Status Aboriginal population with diabetes had a higher number of specialist and GP visits than the Status Aboriginal population without diabetes (Figures 11.23 and 11.24). Status Aboriginal people with diabetes had more visits to a specialist in the Edmonton and Calgary zones compared to the non-metro zones of South, North and Central which had higher GP visits.

Figure 11.23 **Age-Adjusted Average Number of Specialist Visits for the Status Aboriginal Population, by Zone, 2009**

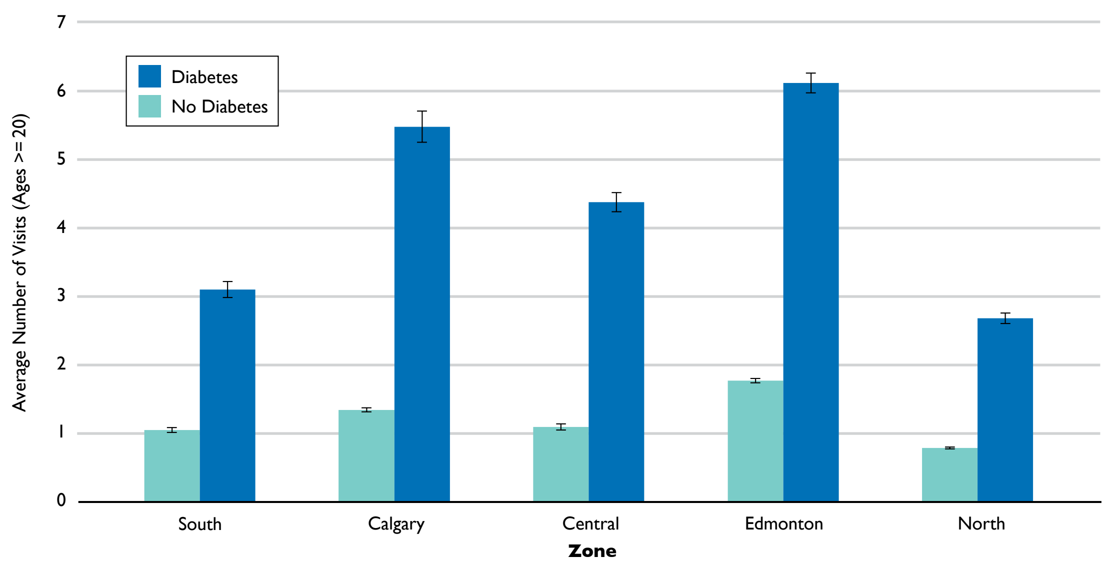
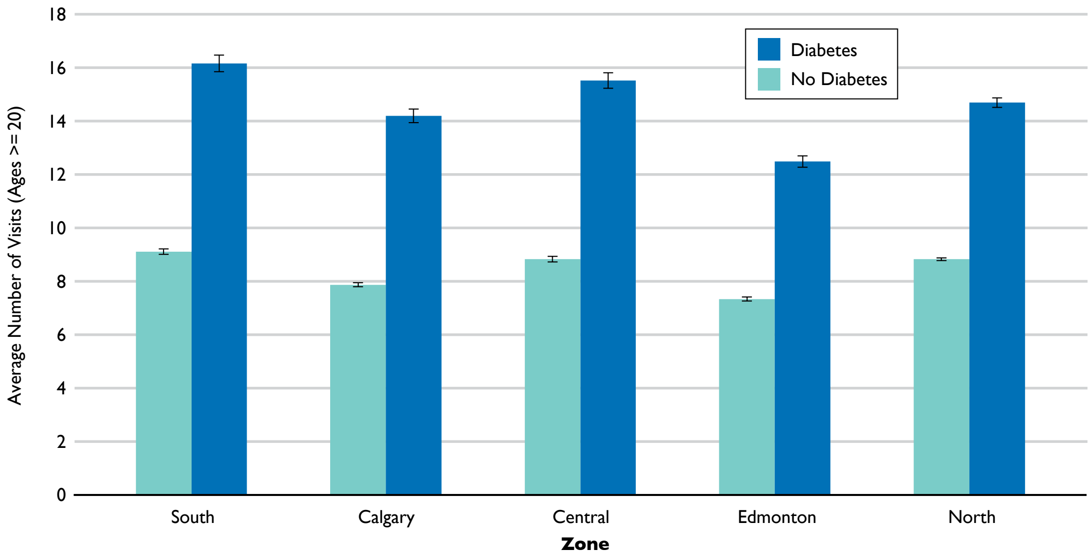
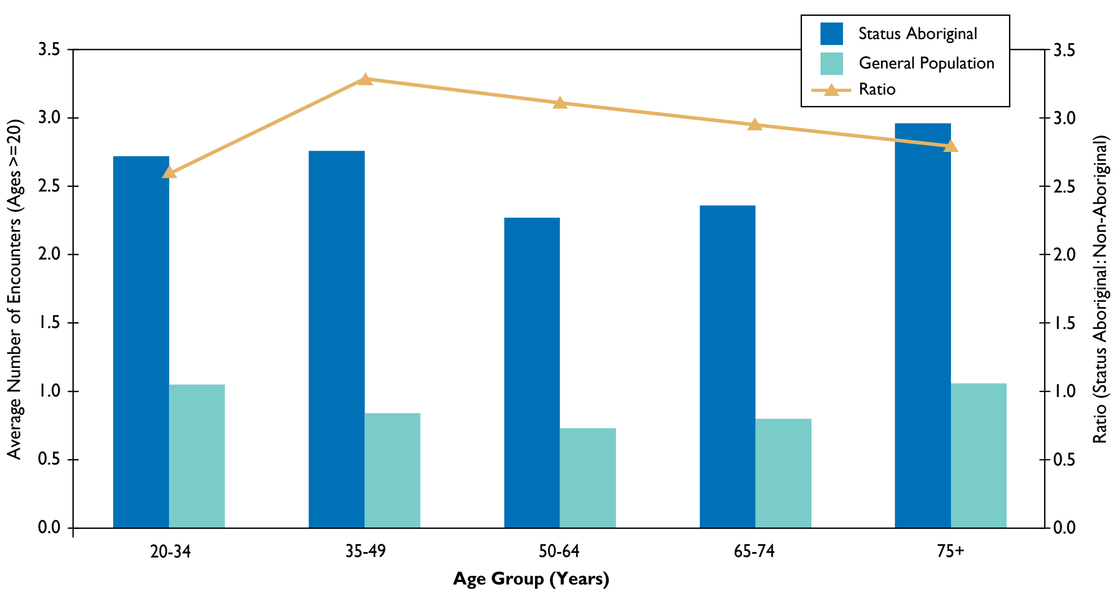


Figure 11.24 **Age-Adjusted Average Number of GP Visits for the Status Aboriginal Population, by Zone, 2009**



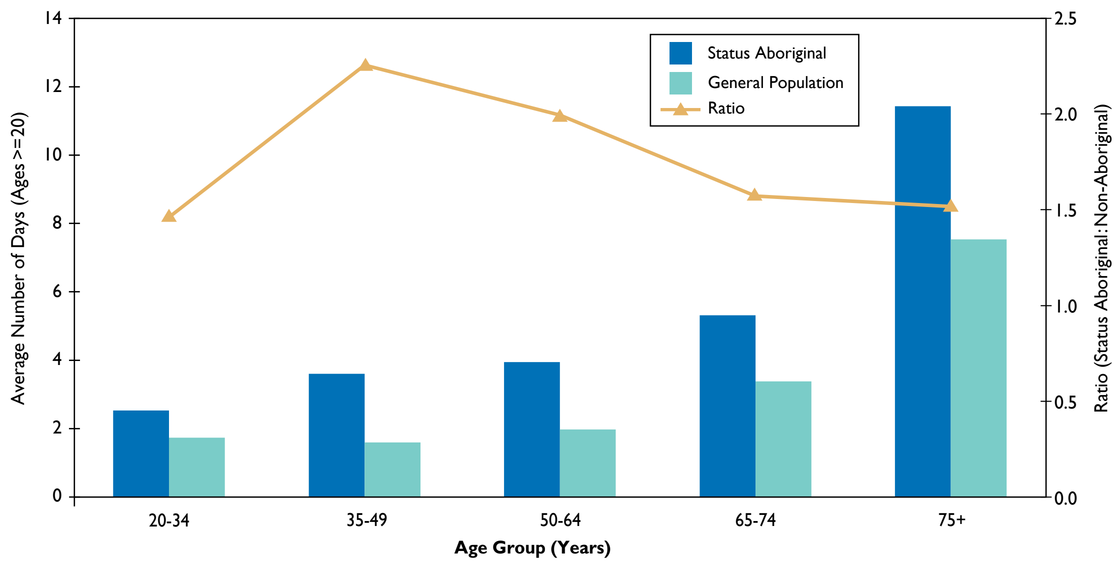

The largest difference in health care utilization was for emergency department (ED) encounters, where Status Aboriginal people with DM were 2.6 to 3.3 times more likely to visit an emergency room than their counterparts from the general population (Figure 11.25).

Figure 11.25 **Age-Specific Average Number of Emergency Department Encounters for the Population with Diabetes, among the Status Aboriginal and General Populations, 2009**



The Status Aboriginal diabetes population had more hospital days on average compared to the general diabetes population with the largest differences in the 35-49 year old and 50-64 year old age groups (Figure 11.26). The ratio between the Status Aboriginal and the general diabetes populations was the smallest at 1.5 in the youngest and oldest age groups.

Figure 11.26 **Age-Specific Average Number of Hospital Days for the Population with Diabetes, among the Status Aboriginal and General Populations, 2009**




ED encounters and hospital days were more common in the Status Aboriginal population than in the general population, compared by health zone (Figures 11.27 and 11.28). Status Aboriginal people with diabetes were more likely to visit an ED compared to the general population with diabetes with encounters highest in the rural zones of Central and North (Figure 11.27). The pattern was different for days spent in hospital (Figure 11.28). Status Aboriginal people with diabetes from the Calgary and Central zones had the highest average number of hospital days. The fewest average number of hospital days were among those living in the South or North zones. Overall, Status Aboriginal with diabetes had 1.5 to 2.8 times the number of days in hospital compared to the general population with diabetes (Figure 11.28).

Figure 11.27 **Age-Adjusted Average Number of Emergency Department Encounters for the Population with Diabetes, among the Status Aboriginal and General Populations, by Zone, 2009**

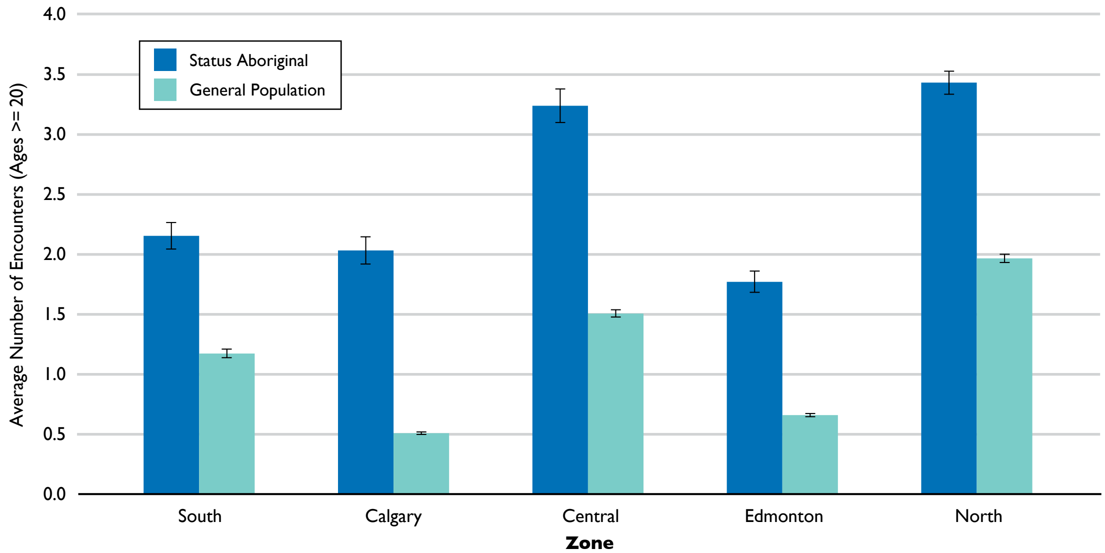
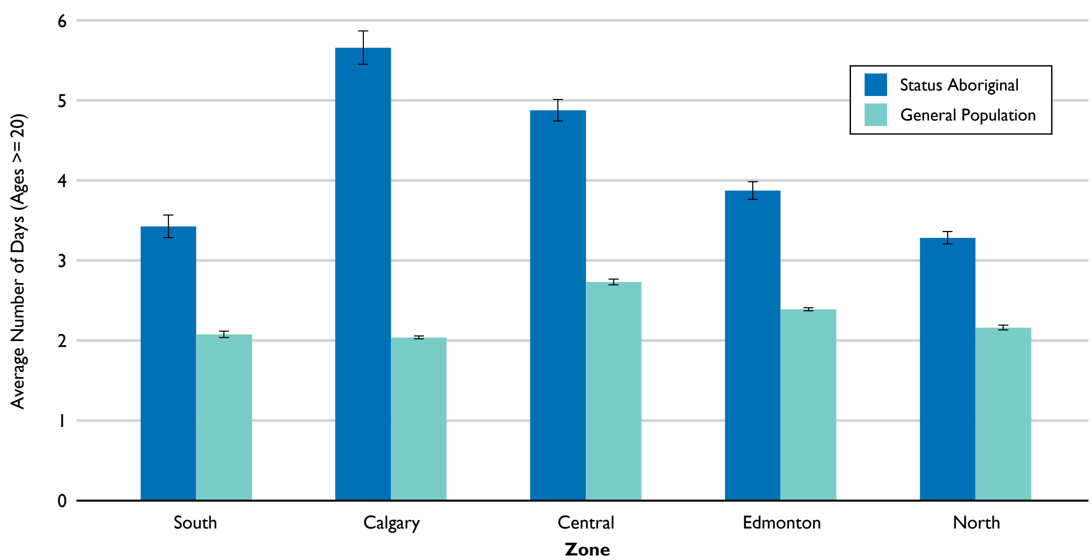



Figure 11.28 **Age-Adjusted Average Number of Hospital Days for the Population with Diabetes, among the Status Aboriginal and General Populations, by Zone, 2009**



A Status Aboriginal person with diabetes was more likely to visit an ED compared to a Status Aboriginal person without diabetes with the highest number of encounters in the Central and North zones (Figure 11.29). In Status Aboriginals with diabetes, the highest average number of hospital days were in those living in Calgary zone; but in those without diabetes, the highest numbers were found in Edmonton zone (Figure 11.30). Calgary and Central zones had the highest average number of hospital days among Status Aboriginals with diabetes, and the North zone had the lowest.

Figure 11.29 **Age-Adjusted Average Number of Emergency Department Encounters for the Status Aboriginal Population, by Zone, 2009**

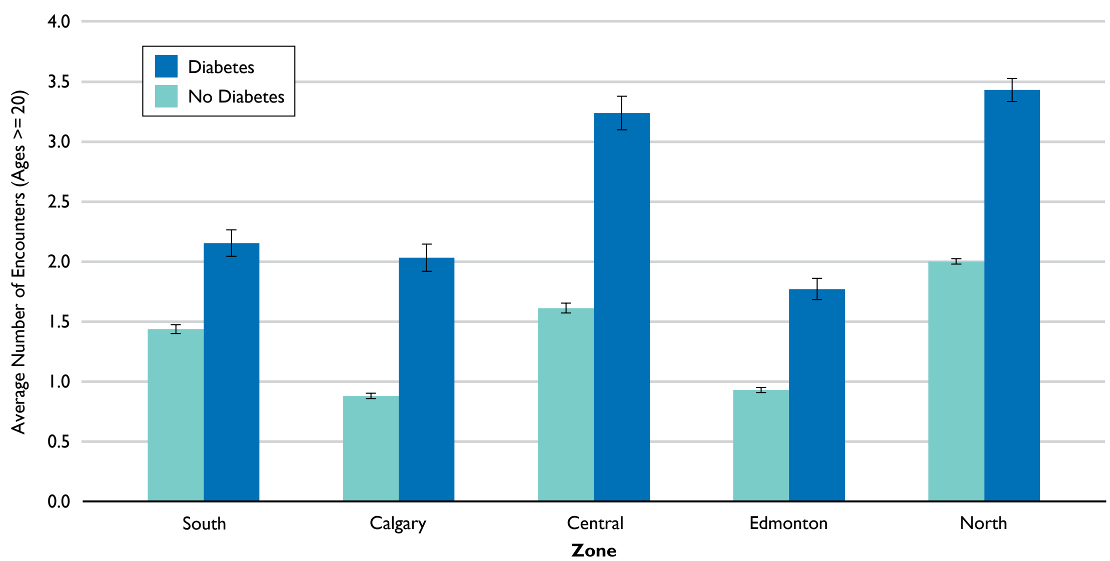
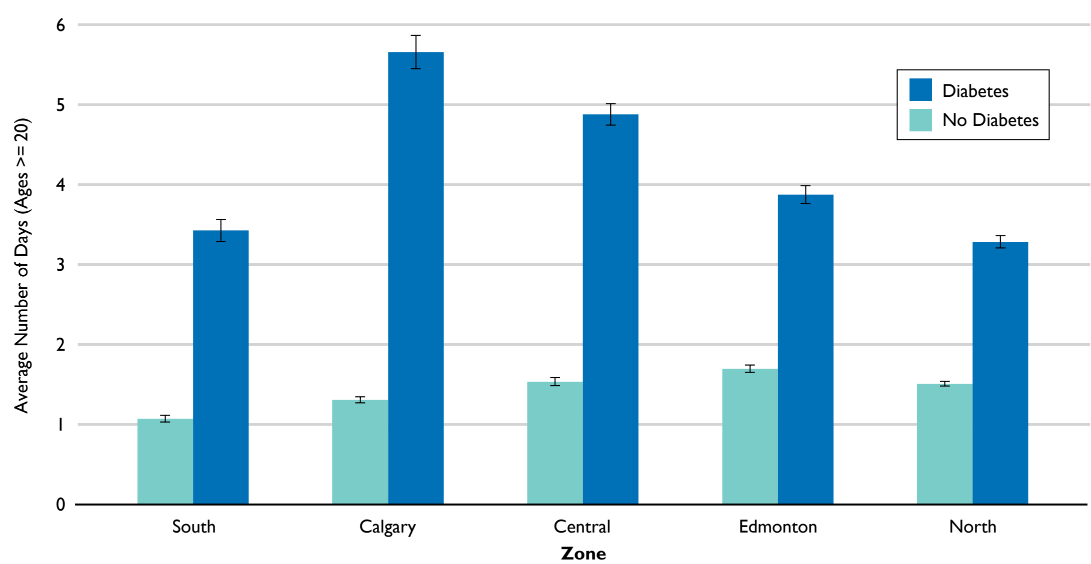



Figure 11.30 **Age-Adjusted Average Number of Hospital Days for the Status Aboriginal Population, by Zone, 2009**



## DISCUSSION

Consistent with national survey data and a few studies based on primary data collection in Canada (including the James Bay Cree of Quebec and the Sandy Lake Oji-Cree of Ontario),[5,7,12-15] incidence and prevalence rates of DM for Status Aboriginals are disproportionately higher than the general population in Alberta. However, the observed differences by ethnicity appear to be less in Alberta than those from other provinces where the NDSS definition was also applied using administrative data.[13,16,17] Furthermore, Status Aboriginals experience DM at an earlier age compared to the general population, a finding also supported by previous work in Canada.[2,7]

Our results suggest that the disproportionate increase of DM prevalence among Status Aboriginal people in Alberta may be reaching a plateau, as incidence increased at a slower rate over the past 15 years in Status Aboriginals compared to the general population.[18] This finding must be taken with caution, as amendments to the Indian Act in 1985 are potentially increasing the Status Aboriginal denominator (Bill C-31) and, conversely, some descendants of Status Aboriginal persons (who still have Aboriginal ancestry) are losing their Status through the “three generations” rule.[19] There is no data describing how much of a demographic change has occurred, making it impossible to discern the impact on the current DM rates. Alternatively, increased awareness and prevention of diabetes amongst the Status Aboriginal population in Alberta, through federally funded activities such as the Aboriginal Diabetes Initiative, SLICK,[20] and the provincially funded MDSi,[21] may have played a role in prevention and the subsequent slowed rise in DM rates among Status Aboriginal people.

The higher prevalence rates among Status Aboriginal females compared to males parallels previous reports.[2,3] These sex differences are contrary to the general Canadian population, where DM rates are slightly higher for males.[22] In the current analysis, however, incidence among Status Aboriginal males is rising at a higher rate compared to females, suggesting that the Status Aboriginal population is becoming more similar to the general population. Even so, young childbearing aged women had concerning DM prevalence rates, almost three times as high as the general population. It is probable that some Status Aboriginal women in these age groups had gestational diabetes, which puts them at risk of subsequent development of DM.[23,24]

The increasing prevalence and incidence in the under-20-year-old Status Aboriginal population is alarming and supports the suggestion that DM is occurring in younger age groups in Aboriginal communities.[5,25] According to the First Nations and Inuit Regional Health Survey, the majority (53%) of those with DM in Aboriginal communities are 40 years of age and younger.[3] The continued rise of obesity in Aboriginal youth is likely the primary driving force of increasing type 2 diabetes rates in the younger population.[2]

Very little information is available with respect to mortality and DM among Canadian Aboriginal people. Our findings of higher mortality rates among Status Aboriginal people with DM is consistent with reports from British Columbia administrative vital statistics that showed Status Aboriginal males and females with DM had mortality rates 1.5 and 2.2 times higher than the general population with DM, respectively.[26] However, administrative data from Ontario showed mortality rates among First Nations people with DM decreased dramatically from 1994-1999, and, in fact, were lower than mortality rates of the non-First Nations population with DM in 1999.[13] Although there were marked improvements in mortality for Status Aboriginals with DM over time in the current analysis, overall rates were still significantly higher than the general population in 2009.

Consistent with a similar report on health care utilization in Alberta[27] and results from other provinces,[28,29] we found Status Aboriginal people with DM were much more likely to have more days in the hospital per year, and were more likely to visit a GP or ED than the general population with DM. This may be explained, in part, by findings that have shown Canadian Aboriginal people with DM experience related complications more frequently than other populations.[30-34] Although health care utilization is greater, it appears to be largely driven by use of acute care services. Thus, the quality of care and follow-up may, in fact, be suboptimal for many Status Aboriginal people with DM as cultural barriers, geographical barriers and physician/nursing retention/shortage problems in rural communities have been shown to compromise care.[1,6,35]

The DM incidence and prevalence rates among the Status Aboriginal population, based on DM defined from administrative data, are likely an underestimate for a variety of reasons. First, a limitation of this definition is the inability to detect undiagnosed diabetes, which is common in Canadian Aboriginal communities. The James Bay Cree and Sandy Lake Oji-Cree communities reported undiagnosed diabetes rates of 2.5% and 10.7%, respectively.[1,12] Second, many Aboriginal people are uncomfortable in the Western cultural medical environments, even when they do receive diagnostic services; therefore, they may not return for care. In addition, medical care in remote Aboriginal communities is often provided by nurse practitioners, including care for DM. Only claims for DM related visits submitted by physicians are included in the administrative data and contribute to the definition of DM used in this *Atlas*. Hence, estimates of DM are likely underestimated.

Similar with other provinces in Canada, rates of DM incidence and prevalence in Alberta are twice as high among Status Aboriginal people compared to the general population. However, this trend may be slower as DM incidence appears to be increasing at a slower rate among the Status Aboriginal population compared to the general population.

## References

1. Adelson N. The embodiment of inequity: Health disparities in Aboriginal Canada. Can J Public Health 2005;96(Suppl 2):S45-61.
2. Young TK, Reading J, Elias B, O'Neil JD. Type 2 diabetes mellitus in Canada's First Nations: status of an epidemic in progress. CMAJ 2000;163(5):561-6.
3. National Steering Committee for the First Nations and Inuit Regional Health Survey. Final report. 1999. Available from: www.hc-sc.gc.ca/fnihdgspni/fnihb/aboriginalhealth/reports_summaries/regional_survey.pdf.
4. First Nations Centre, National Aboriginal Health Organization First Nations regional longitudinal health survey 2002/03. Results for adults, youth and children living in First Nations communities. 2005. Available from: www.naho.ca/firstnations/english/documents/RHS2002-03TechnicalReport_001.pdf.
5. Harris SB, Zinman B, Hanley A, Gittlesohn J, Hegele R, Connelly PW, et al. The impact of diabetes on cardiovascular risk factors and outcomes in a Native Canadian population. Diabetes Res Clin Pract 2002;55(2):165-73.
6. Oster RT, Virani S, Strong D, Shade S, Toth EL. Diabetes care and health status of First Nations individuals with type 2 diabetes in Alberta. Can Family Physician 2009;55(4):386-93.
7. Dean HJ, Mundy RL, Moffatt M. Non-insulin-dependent diabetes mellitus in Indian children in Manitoba. CMAJ 1992;147:52-7.
8. Hegele RA, Cao H, Harris SB, Zinman B, Hanley AJ, Anderson CM. Gender, obesity, hepatic nuclear factor-1alpha G319S and the age-of-onset of type 2 diabetes in Canadian Oji-Cree. Int J Obes Relat Metab Disord 2000;24:1062-4.
9. Hegele RA, Bartlett LC. Genetics, environment and type 2 diabetes in the Oji-Cree population of Northern Ontario. Can J Diabetes 2003;27(3):256-61.
10. Historical Trends - Registered Indian Population Alberta Region 1982-2005. First Nations and Northern Statistics Section, data from Indian Registry, 1982-2005 as at December 31st ñ Indian and Northern Affairs Canada, 2006. Available from: www.ainc-inac.gc.ca/pr/sts/htrip/ht-ab_e.pdf.
11. 2001 Census - Analysis Groups - Métis. Statistics Canada - Ministry of Industry, 2003. Available from: www12.statcan.ca/english/census01/products/analytic/companion/abor/pdf/96F0030XIE200107.pdf.
12. Dannenbaum D, Verronneau M, Torrie J. Comprehensive computerized diabetes registry-serving the Cree of Eeyou Istchee (Eastern James Bay). Can Fam Physician 1999;45:364-70.
13. Shah BR, Anand S, Zinman B, Duong-Hua M. Diabetes and First Nations people. In: Hux JE, Booth GL, Slaughter PM, Laupacis A, editors. Diabetes in Ontario: an ICES practice atlas. Institute for Clinical Evaluative Sciences; 2003:13.231-48.
14. Pollex RL, Khan HM, Connelly PW, Young TK, Hegele RA. The metabolic syndrome in Inuit. Diabetes Care 2004;27:1517-18.
15. Young TK. Contributions to chronic disease prevention and control: studies among the Kivalliq Inuit since 1990. International Journal of Circumpolar Health. 2003;62:323-30.
16. Dyck R, Osgood N, Lin TH, Gao A, Stang MR. Epidemiology of diabetes mellitus among First Nations and non-First Nations adults. CMAJ 2010 Feb;182(3):249-56.
17. Green C, Blanchard JF, Young TK, Griffith J. The epidemiology of diabetes in the Manitoba-registered First Nation population: current patterns and comparative trends. Diabetes Care 2003 Jul;26(7):1993-8.
18. Oster RT, Johnson JA, Hemmelgarn BR, King M, Balko SU, Svenson LW, et al. Recent epidemiologic trends of diabetes mellitus among status Aboriginal adults. CMAJ, 2011 July 25;Epub ahead of print.
19. Registered Indian demography-population, household and family projections, 2004-2029. Indian and Northern Affairs Canada. Available from: http://www.ainc-inac.gc.ca/ai/rs/pubs/re/rgd/rgd-eng.asp.
20. Oster RT, Shade S, Strong D, Toth EL. Improvements in indicators of diabetes-related health status among first nations individuals enrolled in a community-driven diabetes complications mobile screening program in Alberta, Canada. Can J Public Health 2010 Sep-Oct;101(5):410-4.
21. Ralph-Campbell K, Oster RT, Connor T, Toth EL. Emerging Longitudinal Trends in Health Indicators for Rural Residents Participating in a Diabetes and Cardiovascular Screening Program in Northern Alberta, Canada. Int J Family Med Volume 2011(2011), Article ID 596475, 6 pages.
22. Statistics Canada. Diabetic care in Canada: results from selected provinces, 2005. Available from: http://www.statcan.ca/bsol c/english/bsolc?catno=82-621-X20060029224.
23. Mohamed N, Dooley J. Gestational diabetes and subsequent development of NIDDM in aboriginal women of northwestern Ontario. Int J Circumpolar Health 1998;57(Suppl 1):355-8.
24. Ben-Haroush A, Yogev Y, Hod M. Epidemiology of gestational diabetes mellitus and its association with type 2 diabetes. Diabetic Medicine 2004:21(2):103-13.
25. Dean HJ, Young TK, Flett B, Wood-Steiman P. Screening for type-2 diabetes in Aboriginal children in northern Canada. Lancet 1998;352(9139):1523-4.

26. Jin A, Martin AD, Sarin C. Diabetes in the First Nations population of British Columbia, Canada. Part 1. Mortality. Int J Circumpolar Health 2002;61(3):251-3.
27. Cardinal JC, Schopflocher DP, Svenson LW, Morrison KB, Laing L. First Nations in Alberta: a focus on health service use. Edmonton: Alberta Health and Wellness. 2004.
28. Jin A, Martin JD, Sarin C. Diabetes mellitus in the First Nations population of British Columbia, Canada. Part 2. Hospital morbidity. Int J Circumpolar Health 2002;61(3):254-9.
29. Manitoba Health (Epidemiology and Diabetes Units). Epidemiology of diabetes in First Nations. Winnipeg: Manitoba Health. 1997.
30. Berinstein Dm, Stahn RM, Welty TK, Leonardson GR, Herlihy JJ. The prevalence of diabetic retinopathy and associated risk factors among Sioux Indians. Diabetes Care 1997;20(5):757-9.
31. Dyck RF, Tan L. Rates and outcomes of diabetic end-stage renal disease among registered Native people in Saskatchewan. CMAJ 1994;150(2):203-8.
32. Molitch ME, DeFronzo RA, Franz MJ, Keane WF, Mogensen CE, Parving HH, et al. Nephropathy in diabetes. Diabetes Care 2004;27(Suppl 1):S79-83.
33. Zhang Y, Lee ET, Devereux RB, Yeh J, Best LG, Fabsitz RR, et al. Prehypertension, diabetes, and cardiovascular disease risk in a population-based sample: the strong heart study. Hypertension 2006;47(3):410-4.
34. Macaulay AC, Montour LT, Adleson N. Prevalence of diabetic and atherosclerotic complications among Mohawk Indians of Kahnawake, PQ. CMAJ 1988;139(3):221-4.
35. MacDonald CA. Physician retention in rural Alberta: an update of pockets of good news (1994). Rural Physician Action Plan. 2002.

Chapter 12

# Gestational Diabetes in Alberta

Padma Kaul
Jeffrey A. Johnson
Edmund A. Ryan
Constance L. Chik

# CHAPTER 12

# GESTATIONAL DIABETES IN ALBERTA

## KEY MESSAGES

- Rates of gestational diabetes mellitus have increased by 50% in the past decade.
- Rates of GDM are substantially higher in women over the age of 35 years.
- Aboriginal women have greater rates of GDM compared to the general population.

## BACKGROUND

Gestational Diabetes Mellitus (GDM) is defined as glucose intolerance first recognized during pregnancy, typically found in the second or third trimesters. Although it is generally a temporary condition and resolves post partum, it is an established risk factor for the subsequent development of type 2 diabetes. It is estimated that women with GDM have a 50 – 60% risk of developing diabetes mellitus (DM) within 15 years of the index pregnancy; nearly tenfold the risk in the general population.[1-3] Thus GDM is a valuable marker of a high-risk status for future DM and all its attendant risks in terms of complications.

Much of the current research on the prevalence and incidence of GDM has focused on specific groups such as Status Aboriginal populations or patients enrolled in private insurance-based health maintenance organizations.[4-11] Evidence from these studies suggests that GDM rates have increased over time. The increase in GDM has important population health implications. The presence of GDM is of potential prognostic importance for the onset of vascular abnormalities and therefore offers a unique opportunity to develop strategies to defer or prevent the onset of chronic disease or vascular abnormalities in a population that is most at risk.

The primary objective of this chapter is to examine trends in the incidence of GDM in Alberta between 1998 and 2009. We will also compare GDM rates across specific age categories and between the Status Aboriginal and the general population.

This is the first time that the ADSS has included the surveillance of GDM. In order to assess the accuracy of the algorithm used to identify GDM cases from administrative databases, we sought an independent source to estimate GDM prevalence. The Alberta Perinatal Health Program (APHP) is a clinical registry focused on the perinatal health of infants and their mothers, healthy or at risk, in the context of their families and communities.[12] In Alberta, pregnancies are generally screened for GDM between 24 and 28 weeks of gestation. The presence of GDM is routinely captured in the APHP database. The ADSS and the APHP therefore provide independent means for GDM surveillance in Alberta. A secondary objective of this chapter was to compare the incidence of GDM in the ADSS data against that observed in the APHP data.

## METHODS

Data from the Alberta Health and Wellness Discharge Abstract Database (DAD) and Physician Claims databases were utilized for these analyses. The DAD records information including dates, diagnoses and procedures on all admissions to any acute care facility in Alberta. The Physicians Claims database captures demographic, diagnostic, and procedural information for all physician visits completed in an inpatient or outpatient environment.

GDM cases were identified as follows: women between the ages of 10 and 54 with an incident diagnosis of DM in any DAD diagnosis field or as a primary diagnosis in the Physician Claims database between 1998 and 2009 were identified. The time period between 120 days prior to and 180 days following the DM diagnosis was examined for the presence of any hospital gynecology/obstetric codes (see appendix for a list of codes). Patients with a gynecology/obstetric code during this time period were considered to have GDM.

The number of GDM cases was calculated for each year for the time period 1998–2009. This number was then divided by the number of women (aged 10 to 54 years) who had an in-hospital live birth in the province to arrive at the crude GDM rate. Women who had a home birth or a still-birth were not included in the denominator. Similar methodology was used to calculate the age-specific GDM rates for the year 2009. GDM rates among Status Aboriginal patients were compared with those among the general population.

For the second objective, the annual number of GDM cases based on the ADSS algorithm was compared to the annual number of GDM cases identified in the APHP registry. APHP numbers were only available until the year 2007 at the time this Atlas was published.

## FINDINGS

In the 12 years of observation, the absolute number of cases of GDM has doubled, from 710 cases in 1998 to 1,420 cases in 2009 (Figure 12.1). Correspondingly, population rates of GDM have increased from 2% to approximately 3% during the same time period (Figure 12.2).

Figure 12.1 **Gestational Diabetes Cases, 1998-2009**

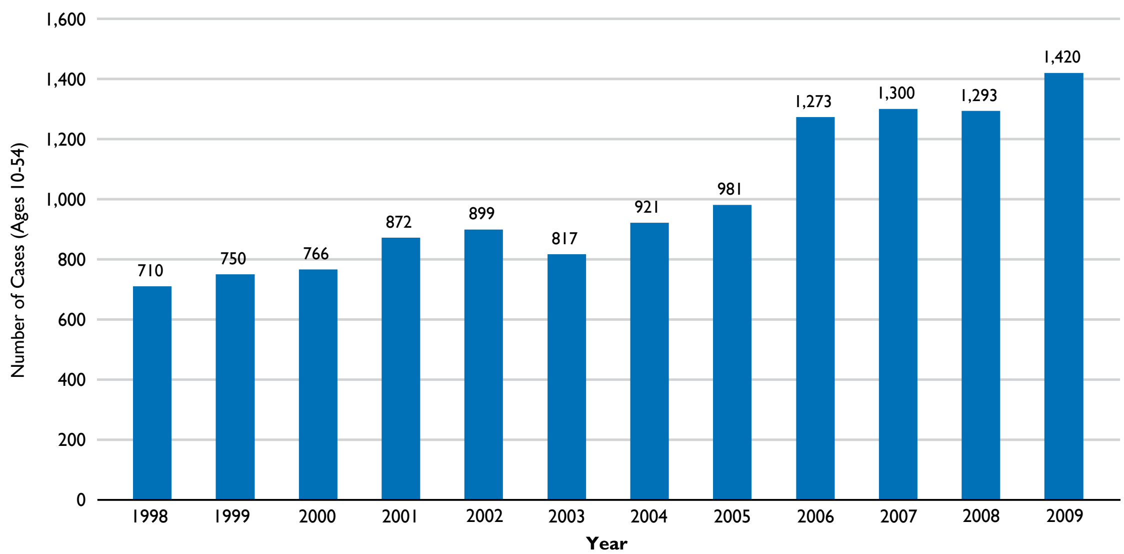
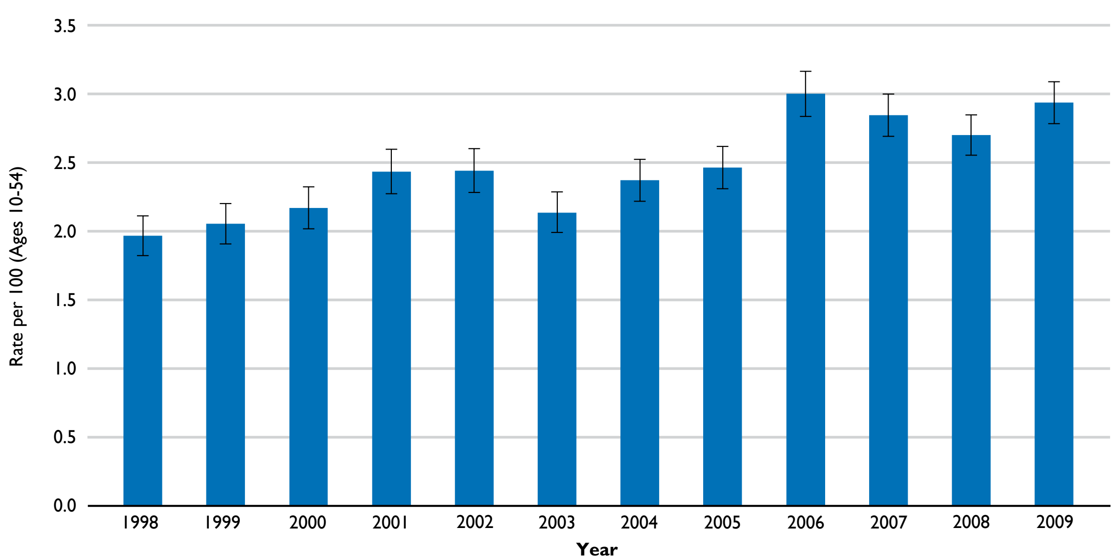
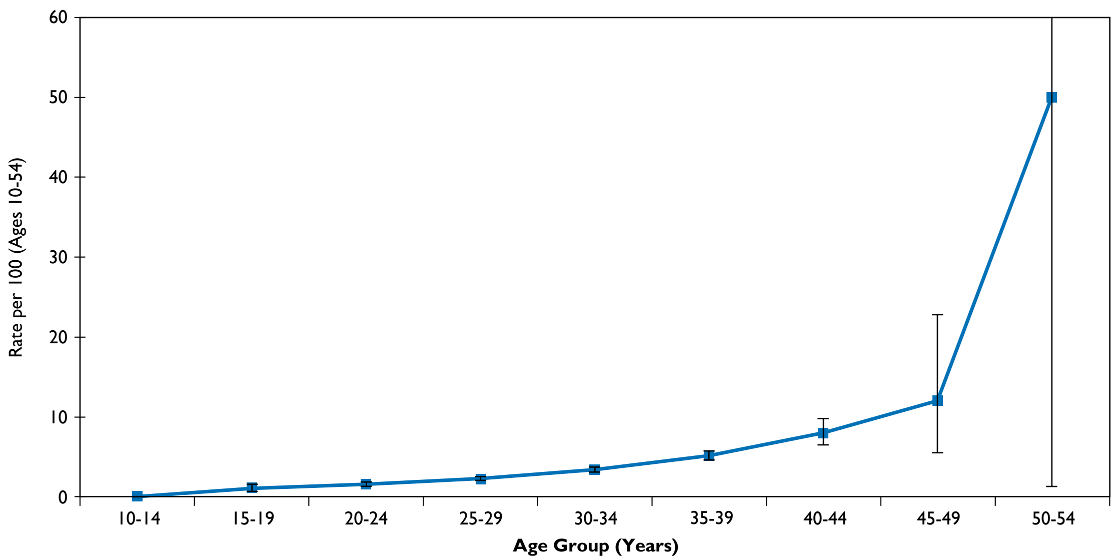



Figure 12.2 **Crude Gestational Diabetes Rates, 1998-2009**



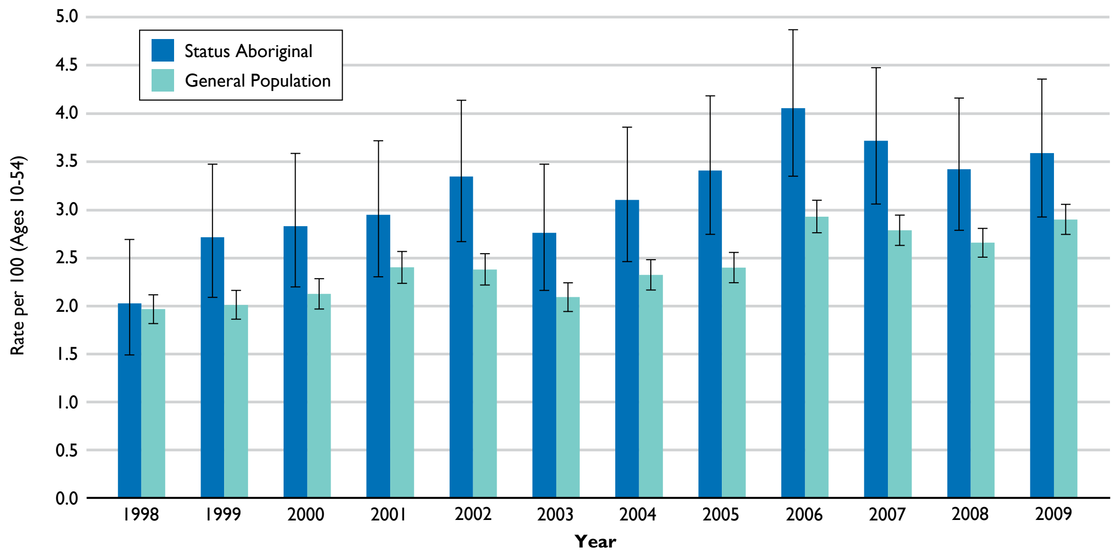
The number of GDM cases is substantially higher with increasing maternal age (Figure 12.3). The GDM rate was less than 5% among women under the age of 35 years and over 10% among women with ages between 45 and 49 years. The GDM rate was highest among women aged over 50 years (50%); however the relatively small number of GDM cases in this age group results in the very wide confidence intervals.

Figure 12.3 **Age-Specific Gestational Diabetes Rates, 2009**



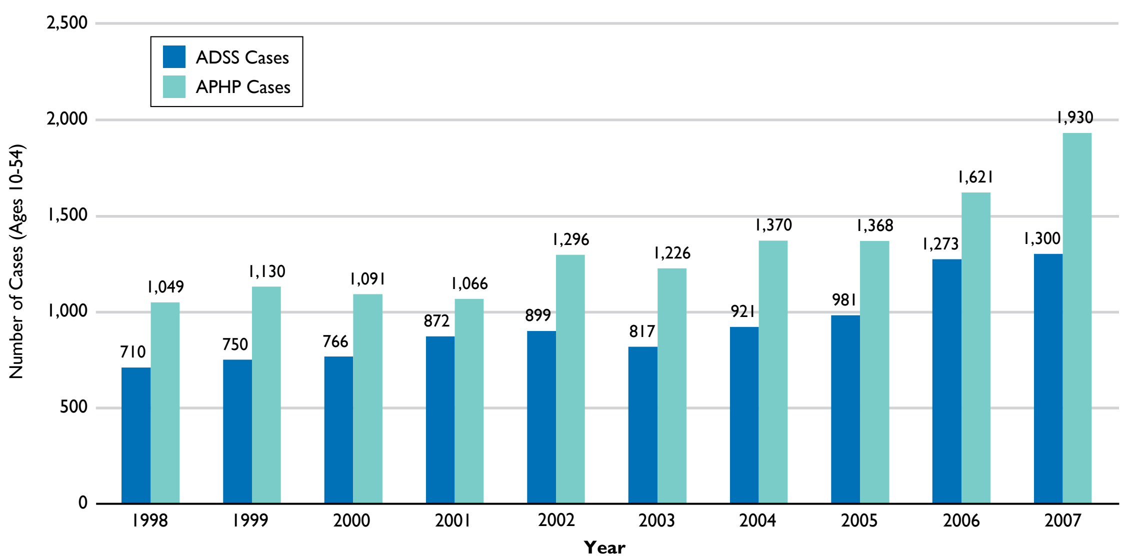

GDM rates among the Status Aboriginal population and the general populations are presented in Figure 12.4. The rates of GDM were consistently higher among Status Aboriginal women compared with women in the general population for the entire time period of study.

Figure 12.4 **Crude Gestational Diabetes Rates, Among Status Aboriginal and General Populations, 1998-2009**




A comparison of the number of GDM cases identified in the ADSS and the APHP clinical registry is presented in Figure 12.5. In general, the trends over time of GDM cases appear similar in both databases. However, the annual number of GDM cases in APHP appears to be consistently higher than the number identified in the ADSS data.

Figure 12.5 **ADSS vs APHP Gestational Diabetes Cases, 1998-2007**



## DISCUSSION

This is the first time that the ADSS is identifying pregnant women with GDM. Consistent with prior studies examining trends of GDM prevalence,[4-11] the rate of GDM has increased by 50%, from 2% to 3%, over the past decade. Given the general increase in birth rate, this represents a doubling of cases of GDM identified: from 710 cases in 1998 to 1,420 cases in 2009. The reasons for the increase in GDM rates are likely multi-factorial, such as increasing maternal age and obesity, and require further study. An examination of age-specific GDM rates found a substantial increase in the incidence of GDM among women older than 35 years of age.

We found GDM rates to be higher among Status Aboriginal patients compared with rates in the general population. These findings are consistent with those reported previously. Among Pima Indians, a population with the highest rates of type 2 diabetes in the world, GDM has been identified as the factor most responsible for the increase in the prevalence of diabetes in both adults and children over the last 30 years.[4-5]

The availability of data on GDM cases from an independent provincial data registry offered us a unique opportunity to assess the accuracy of the algorithm used to identify GDM cases within the ADSS. Although the overall trend in GDM cases was similar in the two databases, the annual number of GDM cases was slightly higher in the APHP database relative to the ADSS numbers. The different estimates from the same population suggest a need to examine potential reasons for the discrepancies, such as billing or coding practices.

## APPENDIX

**Gynecology/obstetric codes**

### Discharge Abstract Database

ICD-9 (641-676, V27)

ICD-10-CA (01, 021-95, 098, 099, Z37)

## References

1. Kjos SL, Buchanan TA. Gestational diabetes mellitus. N Engl J Med 1999;341:1749–1756.
2. Ryan EA: What is Gestational Diabetes? In *Evidenced-Based Diabetes Care*. 1st ed. Gerstein HC, Haynes RB, Eds. Hamilton, BC Decker Inc., 2001;164-183.
3. Lauenborg J, Mathiesen E, Hansen T, Glumer C, Jorgensen T, Borch-Johnsen K, Hornnes P, Pedersen O, Damm P. The prevalence of the metabolic syndrome in a Danish population of women with previous gestational diabetes mellitus is three-fold higher than in the general population. J Clin Endocrinol Metab 2005;90:4004-4010.
4. Dabelea D, Hanson RL, Bennett PH, Roumain J, Knowler WC, Pettitt DJ. Increasing prevalence of type II diabetes in American Indian children. Diabetologia 1998;41:904–910.
5. Knowler WC, Bennett PH, Hamman RF, Miller M. Diabetes incidence and prevalence in Pima Indians: a 19-fold greater incidence than in Rochester, Minnesota. Am J Epidemiol 1978;108:497–505.
6. Dabelea D, Snell-Bergeon JK, Hartsfield CL, Bischoff KJ, , Hamman RF, McDuffie RS. Increasing prevalence of gestational diabetes mellitus (GDM) over time and by birth cohort. Diabetes Care 2005;28:579–584.
7. Mahroos S Al, Nagalla DS, Yousif W, Sanad H. A population-based screening for gestational diabetes mellitus in non-diabetic women in Bahrain. Ann Saudi Med 2005;25:129-133.
8. Murgia C, Berria R, Minerba L, Malloci B, Daniele C, Zedda P, Ciccotto MG, Sulis S, Murenu M, Tiddia F, Manai M, Melis GB: Gestational diabetes mellitus in Sardinia: results from an early, universal screening procedure. Diabetes Care 2006;29:1713-1714.
9. Thorpe LE, Berger D, Ellis JA, Bettegowda VR, Brown G, Matte T, Bassett M, Frieden TR: Trends and racial/ethnic disparities in gestational diabetes among pregnant women in New York City, 1990-2001. Am J Public Health 2005;95:1536-1539.
10. Murphy NJ, Bulkow LR, Schraer CD, Lanier AP: Prevalence of diabetes mellitus in pregnancy among Yup'ik Eskimos, 1987-1988. Diabetes Care 1993;16:315-317.
11. Tanir HM, Sener T, Gurer H, Kaya M: A ten-year gestational diabetes mellitus cohort at a university clinic of the mid-Anatolian region of Turkey. Clin Exp Obstet Gynecol 2005;32:241-244.
12. The Alberta Perinatal Health Program. Available from: www.aphp.ca

# Chapter 13

# Key Findings and Policy Options

ADSS

Alberta Diabetes Surveillance System

# CHAPTER 13

# KEY FINDINGS AND POLICY OPTIONS

## SUMMARY

The *Alberta Diabetes Atlas* 2011 presents a clear picture of the burden that diabetes continues to place on Albertans, with over 1,600 new cases identified each month. About 6%, or 1 in 17 people in Alberta are living with diabetes. An aging population will further drive the increasing prevalence over the coming years.

While it appears that *rates* of some complications and comorbidities are stabilizing or even decreasing for people with diabetes in Alberta, the real burden is the actual *number* of people with these conditions. In most cases, the actual number of people with diabetes who developed complications or comorbidities has increased over the past decade, signaling the increasing demand for health care resources for diabetes and related conditions over the next decade.

In this chapter we have attempted to make this *Alberta Diabetes Atlas* 2011 more useful to you, the reader. We identified what we feel are several important *key findings* in interpreting the evidence presented in the *Atlas*, and linked these with potential *policy options* to consider in managing these observed patterns. We do not see these as the only options, or the final word on what must be done, but rather the beginning of a dialogue amongst stakeholders on how to best deal with the serious and growing problem of diabetes and related conditions in Alberta.

All of the findings in this *Alberta Diabetes Atlas* 2011 offer substantial evidence for the need to enhance primary prevention and management efforts in order to stem the tidal wave we are experiencing due to comorbidities and complications as a result of diabetes. This will require substantial investment now to reduce the health care burden and improve the health of Albertans for decades to come.

The 2011 *Alberta Diabetes Atlas* is more comprehensive than the 2009 version, with the addition of two new chapters related to Laboratory Data and Gestational Diabetes. These enhancements, along with others that were made in the previous *Atlas* version, were recommendations made from the ADSS Steering Committee and other stakeholders. As a reader, you are an important stakeholder, and we encourage you to engage in discussion with other stakeholders including patients and the public, health care professionals, managers, policy-makers and researchers. We encourage this dialogue as we continue to enhance the ADSS, to include more information on patterns of health care delivery and health outcomes for people with diabetes, and to improve our ability to interpret and disseminate our findings.

## KEY FINDINGS

1. **The prevalence and incidence of diabetes are increasing in Alberta, and especially among older adults who are at risk of type 2 diabetes.**

### Policy Options

- Enhance investment in diabetes prevention efforts across all ages.
- Institute an intensive public education program aimed at lifestyle modification to decrease the risk factors for developing diabetes, most importantly obesity and physical inactivity.

2. **The incidence of diabetes is also growing amongst children and adolescents in Alberta. The incidence rates are increasing in all ages, with the fastest growing rates for the younger children. These trends suggest we are seeing increasing rates of both type 1 and type 2 diabetes.**

### Policy Options

- Ensure adequate service and support for children living with type 1 diabetes and their families.
- Strengthen efforts to improve health and health behaviours of children and adolescents to reduce overweight and obesity, and therefore prevent further increases in type 2 diabetes.
- Ensure equal access to diabetes education and support services through all areas of the province.

3. **People with diabetes have a markedly increased chance of having a heart attack or stroke, requiring dialysis, going blind or having a lower limb amputation, compared to people without diabetes. Some success has been achieved in reducing heart disease and strokes in recent years. The chance of developing these complications can be further reduced with more aggressive control of risk factors, such as blood pressure, cholesterol and blood sugar. Still, reports from Alberta and other provinces suggest sub-optimal use of evidence-based therapies to reduce these risks.**

### Policy Options

- Actively disseminate evidence-based guidelines about optimal medication use in people with diabetes, especially to general practitioners.
- Establish risk factor modification clinics throughout the province, aimed at people with diabetes. Appropriately trained teams of allied health professionals, including nurses, pharmacists and dieticians, could coordinate these services.
- Regularly monitor the trends in the number and rates of complications over time, and use this information to plan services for the future.
- Consider financial barriers to individuals for the use of evidence-based medications aimed at improving risk, given that people with diabetes are often on many of these medications at the same time.

4. **People with diabetes are not obtaining the recommended number of laboratory tests such as A1C, LDL and ACR, particularly in the younger age groups.**

### Policy Options

- Continue the surveillance of important laboratory tests for people with diabetes including frequency of testing and actual test results.
- Increase awareness of the importance of obtaining the recommended amount of laboratory tests to both patients and providers.
- Closely monitor those who are not at target laboratory values and ensure they are properly treated to prevent the onset or delay the progression of complications associated with diabetes.

5. **The majority of medical care for people with diabetes is from general practitioners. Still, people with diabetes see medical specialists 3 times more often than people without diabetes.**

### Policy Options

- Enhance investments in strategies to improve quality of care by primary health care providers.
- Ensure that there is a sufficient number of primary care providers in Alberta.
- Enhance access to allied health professional primary care providers, particularly in rural and non-metro health zones.
- Regularly monitor the trends of the number and type of complications of diabetes, and use this information to plan for access to specialized services in the future, such as dialysis and specialized cardiac procedures.

6. **Mental illness, including depression and psychoses, is much more common in people with diabetes, and has been increasing in prevalence over the last 15 years.**

### Policy Options

- Enhance screening for complications in both populations: screening for diabetes in people with mental illness and for mental illness in people with diabetes.
- Enhanced screening will likely result in a greater number of people with depressive diagnoses. We therefore need to also enhance access to allied mental health care, particularly in the primary care environment.
- Implement and evaluate a pay-for-performance framework for improving outcomes in patients with diabetes and depression.

7. **People with diabetes living in non-metro health zones have lower rates of specialists care visits and higher use of hospital and emergency departments for acute and chronic complications of diabetes.**

### Policy Options

- Ensure an adequate supply of primary care providers and access to all diabetes services in all areas of Alberta.
- Consider access to allied health professional primary care providers in rural and non-metro health zones, such as nurses, pharmacists and dieticians.
- Regularly monitor the trends in the number and type of complications of diabetes and use this information to plan for access to specialized services in the future, such as dialysis and specialized cardiac procedures.

8. **Screening for diabetic eye disease is an important strategy in preventing blindness. Despite this strong evidence, the frequency of eye examinations by experienced eye care professionals is lower than suggested by practice guidelines.**

### Policy Options

- Increase awareness of the need for regular eye examinations by actively disseminating the guidelines to both patients and providers.
- Enhance surveillance to include care provided by all eye care professionals, including optometrists.
- Consider increased use of teleophthalmology to enhance access for required eye examinations in non-metro health zones, with particular attention to the North zone.

9. **The prevalence of diabetes is twice as high in the Status Aboriginal population compared to the rest of the population in Alberta.**

### Policy Options

- Target culturally appropriate preventive and therapeutic interventions to Status Aboriginal people and communities, ensuring access to a full range of necessary services.
- Work with Status Aboriginal peoples and communities to better understand the impact of diabetes and related conditions, and enhance ongoing surveillance programs in Status Aboriginal populations.
- Work with Métis Nations in Alberta to develop a strategy to include this segment of the Aboriginal population in the ADSS as well as conduct surveillance of other health conditions.

**10. The number of women who are affected by gestational diabetes (GDM) is increasing over time, placing these women and their offspring at risk for future development of diabetes.**

### Policy Options

- Continue surveillance of GDM and follow these women and their offspring forward in time to monitor any development of diabetes.
- Increase awareness of maternal health prior to and during pregnancy with regards to the importance of maintaining a healthy lifestyle.
- Aim to lower the risk of developing diabetes for women and their offspring who have been affected by GDM.

**11. While the ADSS provides important new information about diabetes and related conditions, there are several limitations in our full understanding of the care and outcomes for people with diabetes in Alberta.**

### Policy Options

- Surveillance should be expanded to include information about risk factors, such as smoking, obesity, physical inactivity, high blood pressure and high cholesterol, and should be linked with information on use of prescription medication, health services and long-term outcomes.
- Surveillance should be expanded to include other special populations (e.g. people with physical or mental disabilities) and other comorbid conditions (e.g. cancer, infectious diseases).
- The number and location of diabetes clinics and information about workload and outcomes associated with these clinics needs to be collected and shared on a regular basis.
- Reliable information on socioeconomic status and lifestyle behaviours is lacking at present and should be made available through the linkages of administrative data with other sources, including clinical and patient-reported outcomes data.

## RESEARCH IMPLICATIONS

Surveillance activities such as the ADSS provide a general overview of the burden of diabetes and its associated health conditions, with a population-based perspective. After seeing the general picture from a bird's eye view, there are many questions generated about what underlies these observed trends. Clinical and health policy research questions are often stimulated by health surveillance activities, such as the information presented in this *Alberta Diabetes Atlas* 2011. Discussions among ADSS contributors have raised a number of important questions that should be addressed through more in-depth investigation:

- Are there differences in health care utilization by socioeconomic status throughout Alberta (across and within health zones)?
- Have recently established primary care networks led to improved care and outcomes for people with diabetes?
- Do health zones with higher rates of eye examinations or eye disease procedures have lower rates of blindness?
- Is there a better way to define mental illnesses using the administrative databases?
- How many Albertans will be living with diabetes in the next 10 years?
- Has increased coverage for visits to optometrists by AHW since October of 2007 led to improved access to eye care specialists and better rates of eye examinations?
- How does the ADSS method of capturing diabetes cases compare with the clinical registries in Alberta, such as from the PCNs or for GDM?

These questions, and many others, can be addressed with data from the same administrative databases as used in the ADSS, possibly linked with other valuable data sources in Alberta. Answers to these questions can help to improve the quality of care for people with diabetes and the efficiency of health care delivery in Alberta. Information from the ADSS is intended to spur such research activities to achieve these goals.

# GLOSSARY

**A1C**
See Glycated (Glycosylated) Hemoglobin

**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 Ischemic Stroke (AIS)**
A sudden loss of brain function(s) due to disturbance in the blood supply to the brain caused by the formation or presence of a blood clot within a blood vessel or an embolus (an abnormal particle; e.g. air bubble).

**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 (e.g. 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.

**Alberta Physician Claims Data**
A dataset that contains information from when physicians submit claims for reimbursement for services provided. Three diagnostic codes are included in addition to other information.

**Alternative Relationship Plan (ARP)**
Formerly known as Alternate Payment Plans (APPs), the ARP is an agreement developed in 2003 between Alberta Health and Wellness, the Alberta Medical Association and the Regional Health Authorities. The ARP is a voluntary reimbursement plan designed to provide physicians with fair and equitable payment while promoting best practices, high standards of care and providing patient satisfaction.

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

**Ambulatory Care Classification System (ACCS)**
Facility-based ambulatory care information developed in 1998. Contains data for same-day surgery, day procedures, diagnoses and emergency department visits. This database was used when reporting emergency department encounters for different conditions in this *Atlas*.

**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.

**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.

**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 20-25 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 Canadian 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.

### Cataract
Opacity of the lens or capsule of the eye, causing impairment of vision or blindness.

### Cellulitis
A bacterial infection of the deepest layer of the skin when bacteria enters the body through a break in the skin. Usually only the top layer of the skin is infected which resolves with proper care. But with cellulitis, the deep skin tissues become red, hot, irritated and painful.

### Comorbid Conditions or Illnesses (also called Comorbidity)
A set of medical conditions present in an individual, other than the condition of primary interest.

### Confidence Interval
An indication of the precision of a population value; wider intervals indicate lesser precision while narrower intervals indicate greater precision.

### 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.

### 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.

### Diabetes Mellitus (DM)
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.

### 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 Peripheral Neuropathy (DPN)
DPN is peripheral nerve damage caused by diabetes, usually causing numbness and weakness.

### Diabetic Retinopathy (DR)
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).

**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 (also see 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).

**Discharge Abstract Database (Inpatient Hospital Data)**
Administrative data from hospitals. Hospitals prepare a discharge summary containing information retrieved from patient charts (for those patients assigned to an inpatient bed). These data contain clinical information (diagnoses and procedures), which is sent by all provinces to CIHI.

**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.

**Epiretinal Membrane**
A thin membrane that is often located over the macula that can reduce vision. It is most commonly composed of residual cortical vitreous with associated inflammatory cells.

**Euglycemia**
Normal concentration of glucose in the blood. Also called normoglycemia.

**Fee-For-Service**
The reimbursement scheme by which the Alberta Health and Wellness 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.

**First Nations**
A term of ethnicity used in Canada. It refers to Indigenous of North America located in what is now Canada, and their descendants, who are not Inuit or Métis.

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

**Glaucoma**
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 (A1C)**
A laboratory test that reflects the average glucose level in the blood over a two to three month period.

**Glycemic Control**
The level of blood sugar control obtained. Recommended targets in the 2003 CDA Guidelines include a fasting blood sugar of 4.0–7.0 mmol/L, a blood sugar 2 hours after meals of 5.0–10.0 mmol/L, and a glycated hemoglobin (A1C) that is ≤ 7% in order to reduce the risk of microvascular and macrovascular complications.

**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 (HRQL)**
Measures various components of well-being including physical, mental, emotional, and social functioning.

**Heart Failure (HF)**
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.

**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.

**Hemorrhagic Stroke**
Stroke caused by the rupture of a blood vessel with bleeding into the tissue of the brain. For example, an intracerebral hemorrhage or a subarachnoid hemorrhage.

**Hyperglycemia**
Abnormally high blood sugar level.

**Hyperglycemic Emergencies**
Diabetic ketoacidosis or hyperosmolar nonketotic coma.

**Hyperlipidemia**
A general term for high concentrations of lipids or fat substances (e.g., cholesterol) in the blood.

**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.

**Hypertension**
Elevated blood pressure.

**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)**
A condition in which fasting blood glucose levels are above normal (between 6.1 and 6.9 mmol/L according to the 2003 CDA guidelines), but not yet within the diabetic range (>7.0 mmol/L).

**Impaired Glucose Tolerance (IGT)**
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, in a specified population.

**International Classification of Diseases (ICD)**
Derived from ICD-9-CM and ICD-10-CA, 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 CIHI.

**Intracerebral Hemorrhage (ICH)**
A stroke caused when a defective artery in the brain bursts, flooding the surrounding tissue with blood.

**Intra-Ocular Pressure (IOP)**
Increased fluid pressure in the eye.

**Intravitreal Anti-Vascluar Endothelial Growth Factor Injection**
One of two medications (bevacizumab or ranibizumab) that are injected into the eye. These two medications are utilized to reduce new blood vessel growth or leakage from the retina.

**Intravitreal Medication Injection**
Injection of medication into the vitreous cavity of the eye.

**Intravitreal Triamcinolone Injection**
A steroid that is injected into the vitreous cavity to reduce macular edema. It is associated with a high risk of increased intraocular pressure post injection

**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.

**Length of Stay (LOS)**
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.

**Low-Density Lipoprotein (LDL)**
Is considered the most important form of cholesterol in determining risk of heart disease.

**Lower Limb Amputation**
Surgical amputation of the leg, foot or toe.

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

**Macular Hole**
Full thickness hole in the retina most commonly found in women older than 60 years of age. It is treated with vitrectomy, membrane peeling and gas injection.

**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 diabetes.

**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.

**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.

**Neovascular Glaucoma**
A secondary mixed-mechanism glaucoma due to the growth of neovascular tissue across the trabecular meshwork. This results in elevated intraocular pressure, which, if untreated, will lead to characteristic glaucomatous optic neuropathy with associated visual field defects.

**Nephropathy**
Any disease of the kidney.

**Normotension**
normal blood pressure.

**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.

**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.

**Peripheral Arterial Disease (PAD)**
Narrowing of the arteries in the feet, legs, abdomen, pelvis, arms, or neck. PAD 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 PAD 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.

**Pharmacotherapy**
The treatment of disease using drugs.

**Pre-Diabetes**
Impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) are commonly referred to as pre-diabetes.

**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.

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

**Resource Intensity Weight (RIW)**
This value indicates the expected relationships of costs between patient types. RIW is a value of each case compared to the average case, which has been assigned a value of 1.

**Retinal (Eye) 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 an experienced health professional. In this *Atlas*, we report on eye examinations by ophthalmologists.

**Retinal Laser Treatment (Retinal Photocoagulation)**
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.

**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.

**Rhegmatogenous Retinal Detachment**
A detachment of the retina due to a tear or hole. This is often treated with vitrectomy, laser and gas injection.

**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.

**Skin and Soft Tissue Infections**
Includes foot ulcers and other localized infections.

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

**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 who do not have the disease/condition; a test with low false-positive rate is specific.

**Statins**
Synthetically-derived cholesterol-lowering agents

**Status Aboriginal**
Aboriginals are the descendants of the original inhabitants of North America. The Canadian Constitution recognizes three groups of Aboriginal people – Indians, Métis and Inuit. A Status Aboriginal or a Status Indian is a person who is registered as an Indian under the Indian Act.

For the purposes of this *Atlas*, any individual in Alberta with a Status Aboriginal identifier (First Nations or Inuit) was classified as "Status Aboriginal" with all other individuals classified as the "general population."

**Stroke**
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).

**Subarachnoid Hemorrhage (SAH)**
A sudden bleeding into the subarachnoid space (space within the spinal column that contains the spinal fluid).

**Transient Ischemic Attack (TIA)**
A brief episode of cerebral ischemia (deficient supply of blood to the brain) that is usually characterized by temporary blurring of vision, slurring of speech, numbness, paralysis, or syncope and that is often predictive of a serious stroke.

**Ulcer/Ulceration**
A break in the skin or a deep sore. Ulcers can become infected and lead to serious problems such as gangrene and amputation.

**Unstable Angina (UA)**
A change in the usual pattern of angina. 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.

**Urine Albumin to Creatinine ratio (ACR)**
An important measure of renal function.

**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 hemorrhage.

## References


1. Last JM. A dictionary of epidemiology. 2nd ed. Toronto: Oxford University Press; 1988.
2. Wyngaarden JB, Smith LH, editors. Cecil textbook of medicine. 18th ed. Toronto: WB Saunders; 1988.
3. Tang TA, Secic M. How to report statistics in medicine. Annotated guidelines for authors, editors, and reviewers. Philadelphia: American College of Physicians; 1997.
4. Dawson-Suanders B, Trapp RG. Basic and clinical biostatistics. Norwalk (CT): Appleton and Lang; 1990.
5. Hennekens CH, Buring JE. Epidemiology and medicine. Mayrent SL, editor. Boston: Little, Brown and Company; 1987.
6. Institute for Clinical Evaluative Sciences. Diabetes in Ontario: an ICES practice atlas. Ontario: Institute for Clinical Evaluative Sciences; 2003.
7. Indian and Northern Affairs Canada, Aboriginal Peoples and Communities: Terminology. 2009 [cited 2009 Aug 10]. Available from: http://www.ainc-inac.gc.ca.login.ezproxy.library.ualberta.ca/ap/tln-eng.asp.
8. MedlinePlus: medical dictionary. 2009 [cited 2009 Aug 10]. Available from: http://www.nlm.nih.gov.login.ezproxy.library.ualberta.ca/medlineplus/mplusdictionary.html.
9. Connolly A, Feldmann E, Hanley Dea. American Stroke Association: updated guidelines advise new treatments for brain hemorrhage. 2009 [cited 2009 Aug 10]. Available from: http://www.strokeassociation.org/presenter.jhtml?identifier=3047356.
10. Canadian Institute for Health Information. DAD resource intensity weight and expected length of stay 2008. 2009 [cited 2009 Aug 11]. Available from: http://secure.cihi.ca.login.ezproxy.library.ualberta.ca/cihiweb/dispPage.jsp?cw_page=bl_dad_11aug2008_e.
11. Government of Alberta: Health and Wellness. Health professional resources Alberta Health and Wellness: resources for health professionals. 2009 [cited 2009 Aug 11]. Available from: http://www.health.alberta.ca.login.ezproxy.library.ualberta.ca/professionals/alternate-relationship-plans.html.
12. Canadian Diabetes Association. Diabetes dictionary. 2005-2009 [cited 2009 Aug 11]. Available from: http://www.diabetes.ca/about-diabetes/what/disctionary.
13. Medline. Cellulitis: MedlinePlus. 2009 [cited 2009 Aug 11]. Available from: http://www.nlm.nih.gov.login.ezproxy.library.ualberta.ca/medlineplus/cellulitis.html.

# ABBREVIATIONS

| | |
|---|---|
| **A1C** | Glycated Hemoglobin |
| **ACR** | Urine Albumin to Creatinine Ratio. |
| **ACS** | Acute Coronary Syndrome |
| **ADSS** | Alberta Diabetes Surveillance System |
| **AHW** | Alberta Health and Wellness |
| **AHS** | Alberta Health Services |
| **AIS** | Acute Ischemic Stroke |
| **AMI** | Acute Myocardial Infarction |
| **APHP** | Alberta Perinatal Health Program |
| **APP** | Alternate Payment Plans |
| **ARP** | Alternate Relationship Plans |
| **ASA** | Aspirin or acetylsalicylic acid |
| **CABG** | Coronary Artery Bypass Graft |
| **CIHI** | Canadian Institute for Health Information |
| **CPWC** | Cost per Weighted Case |
| **CVD** | Cardiovascular Disease |
| **DAD** | Discharge Abstract Database |
| **DM** | Diabetes Mellitus |
| **DPN** | Diabetic Peripheral Neuropathy |
| **DR** | Diabetic Retinopathy |
| **ED** | Emergency Department |
| **ESRD** | End Stage Renal Disease |
| **FFS** | Fee for Service |
| **GDM** | Gestational Diabetes |
| **GP** | General Practitioner |
| **HF** | Heart Failure |
| **HT** | Hypertension |
| **ICD** | International Classification of Diseases |
| **ICD-10-CA** | International Classification of Diseases-10- Canadian Enhancement |
| **ICES** | Institute for Clinical Evaluative Sciences |
| **ICH** | Intracerebral Hemorrhage |
| **IOP** | Intra-ocular Pressure |
| **LDL** | Low-Density Lipoprotein |
| **NDSS** | National Diabetes Surveillance System |
| **PAD** | Peripheral Arterial Disease |
| **PCI** | Percutaneous Coronary Intervention |
| **RIW** | Resource Intensity Weight |
| **SA** | Status Aboriginal |
| **SAH** | Sub-arachnoid Hemorrhage |
| **SES** | Socioeconomic Status |
| **TIA** | Transient Ischemic Attack |