

## Chapter 4

# Diabetes and Health Care Utilization in Alberta



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## 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.<sup>(1,2)</sup> 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.<sup>(3)</sup> 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,<sup>(4)</sup> 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.<sup>(2,5)</sup>

## **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.

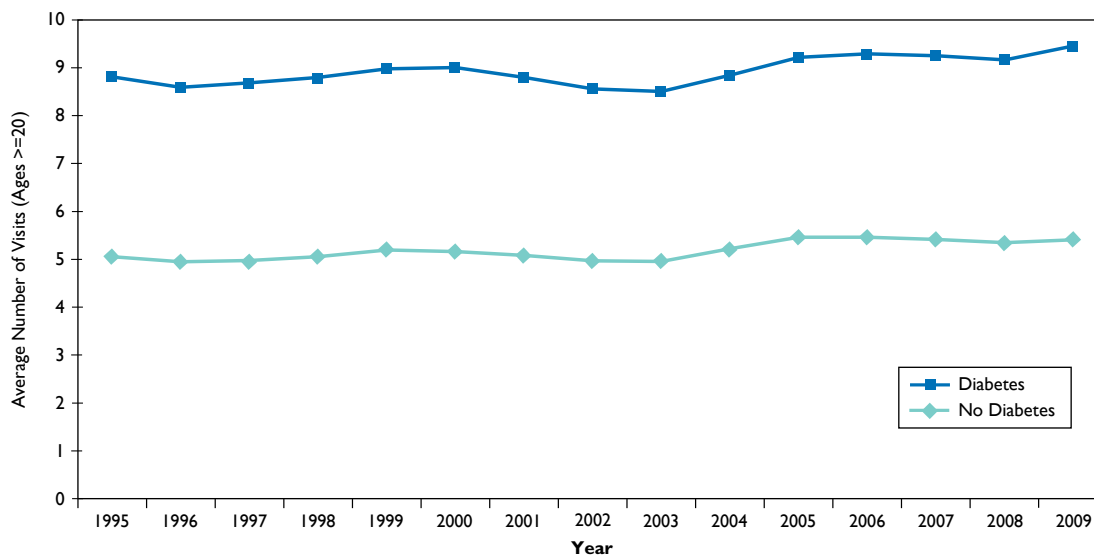
## FINDINGS

### Physician Visits in the Adult Population (Ages $\geq$ 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**

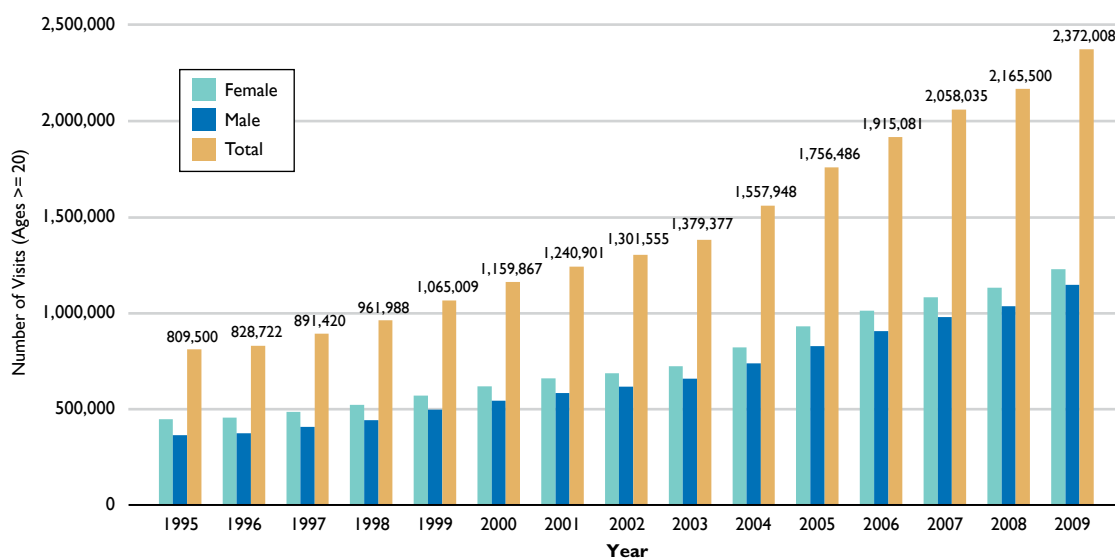


Figure 4.3 Average Number of General Practitioner Visits by Age for Adults, 2009

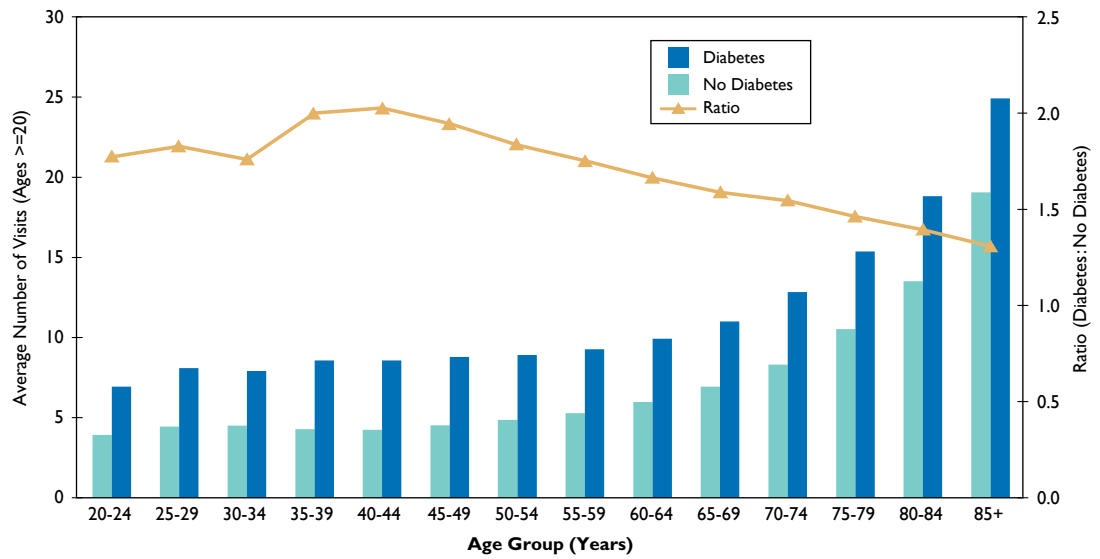
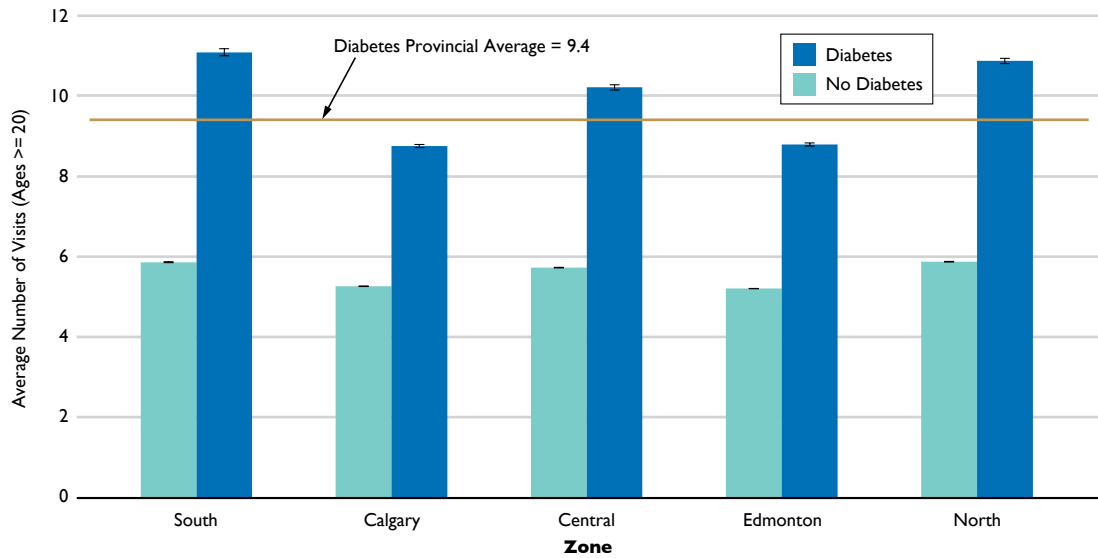


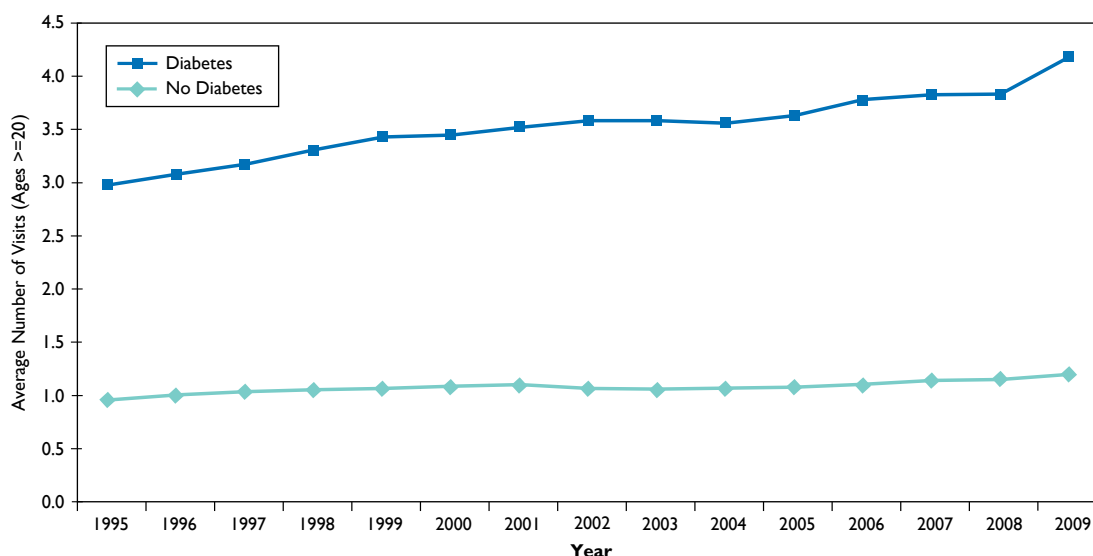
Figure 4.4 Age-Adjusted Average Number of GP Visits for Adults by Zone, 2009



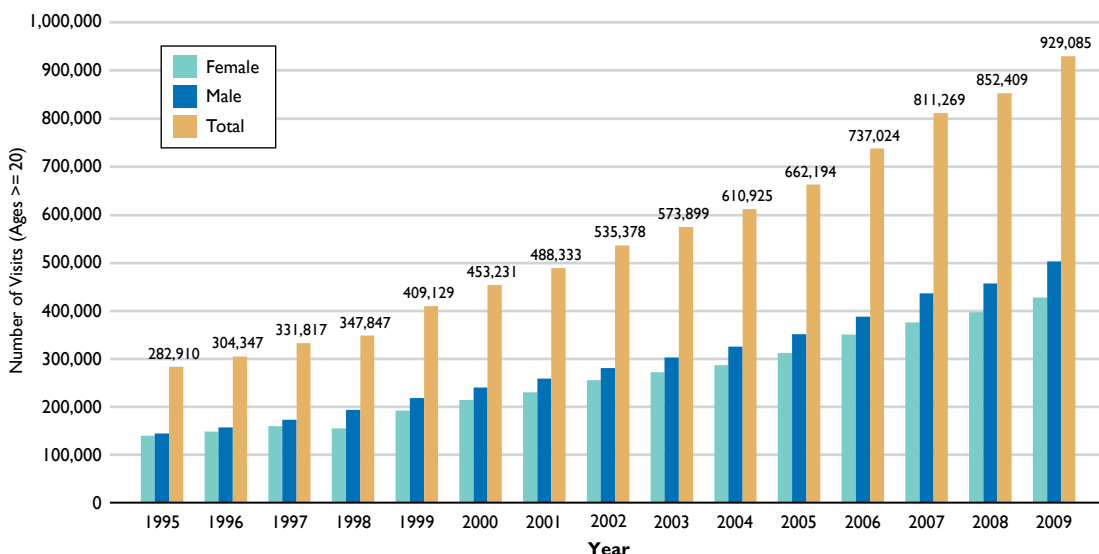
**Specialists Visits**

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**

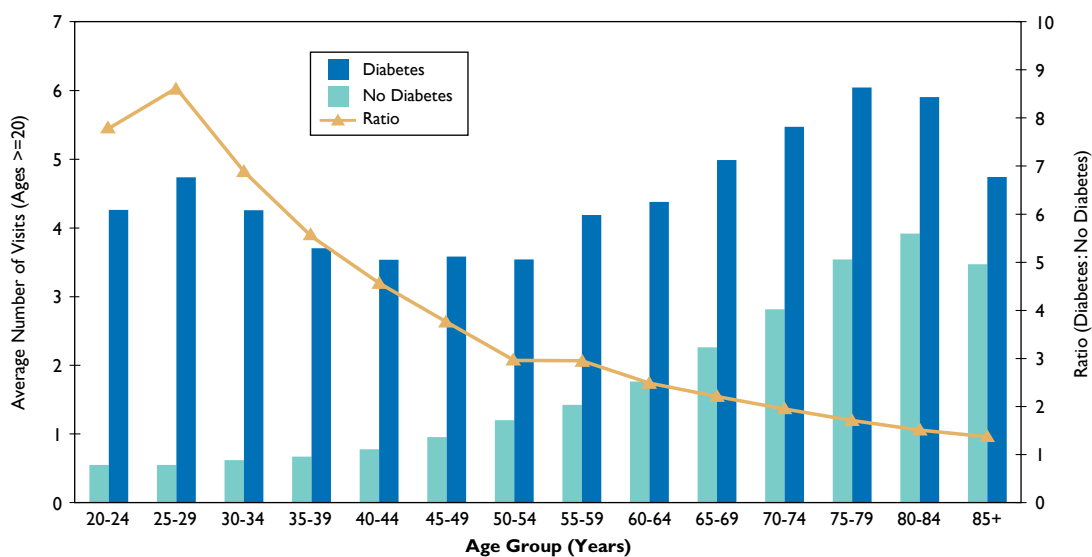


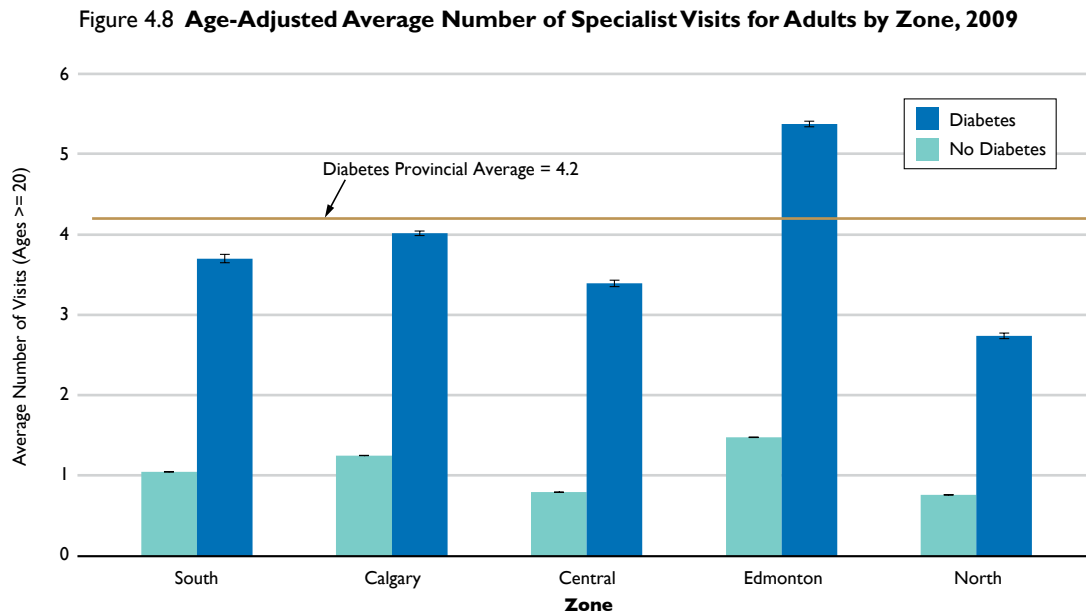
**Figure 4.6 Total Number of Specialist Visits for Adults with Diabetes, 1995-2009**



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

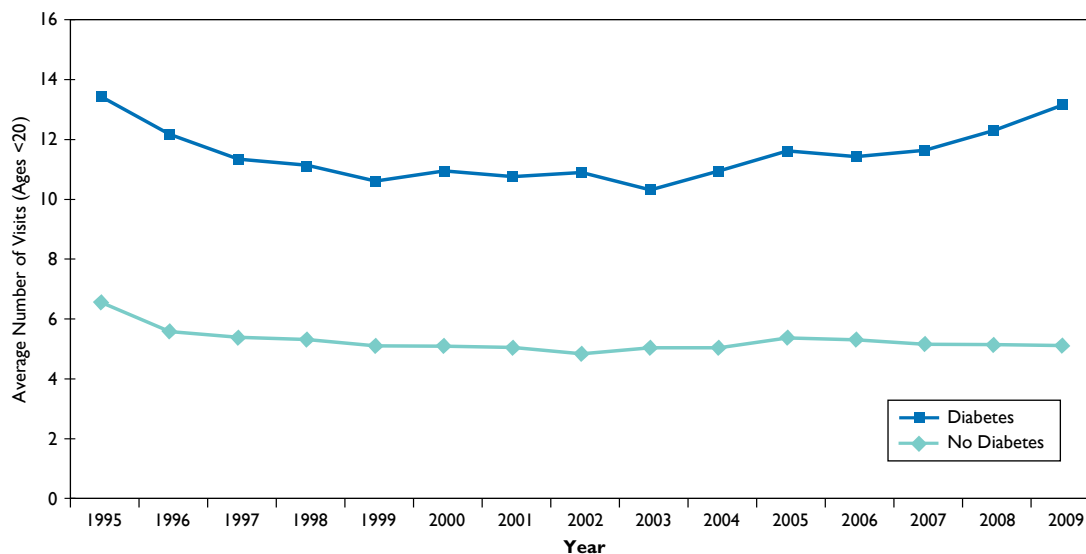




**Physician Visits in Children and Adolescents (Ages < 20 years)**

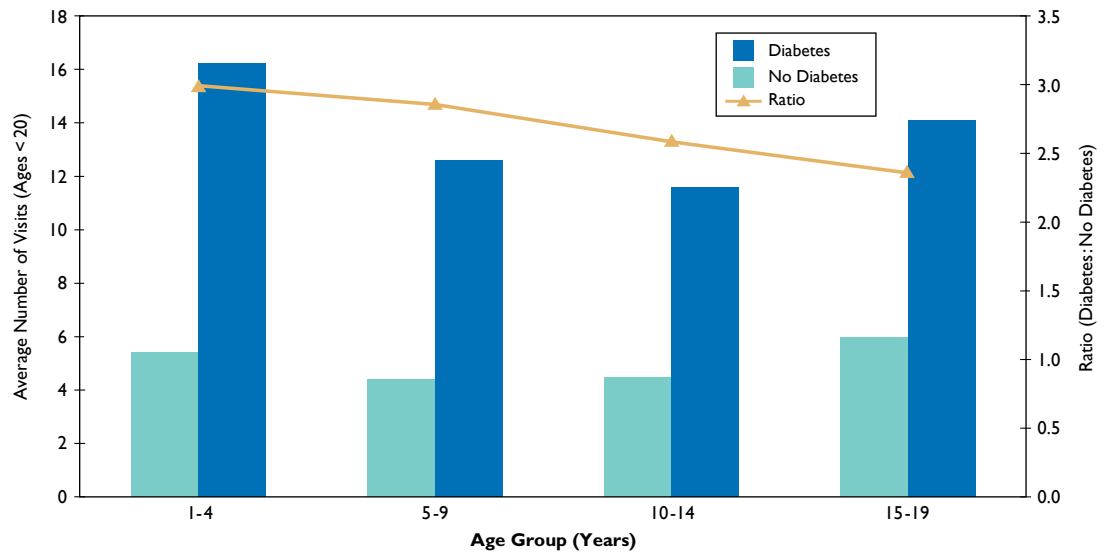
On average, children and adolescents with diabetes visited their physician about 13 times per year in 2009. The non-diabetic children and adolescent population had less than half that amount of visits at about 5 per year (Figure 4.9).

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



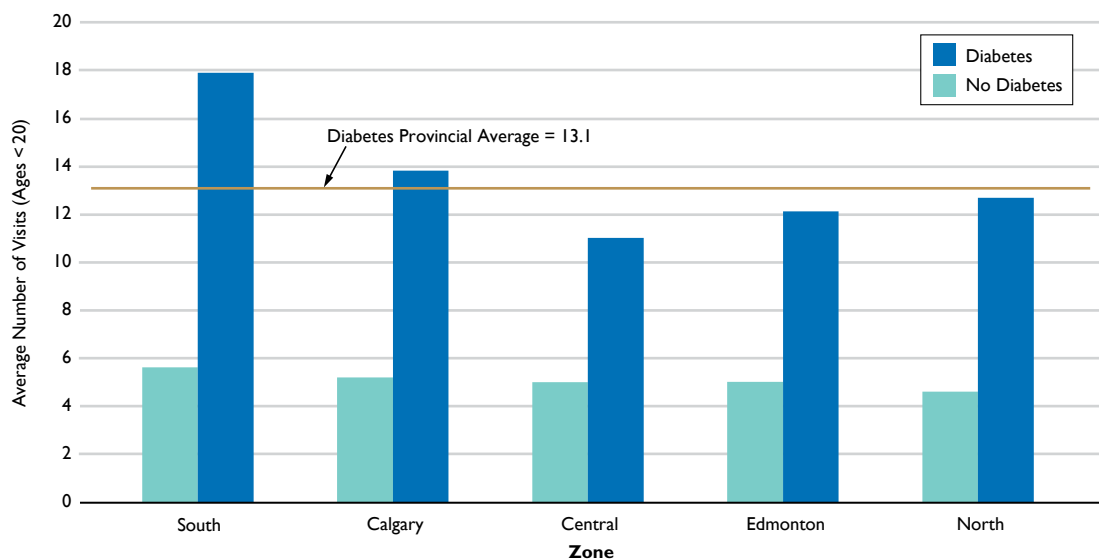
In 2009, the average number of physician visits was the highest among the youngest population (1-4 year olds) at just over 16 visits per year (Figure 4.10). The ratio of average physician visits between children with and without diabetes was the highest for the youngest population.

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 $\geq 20$ 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**

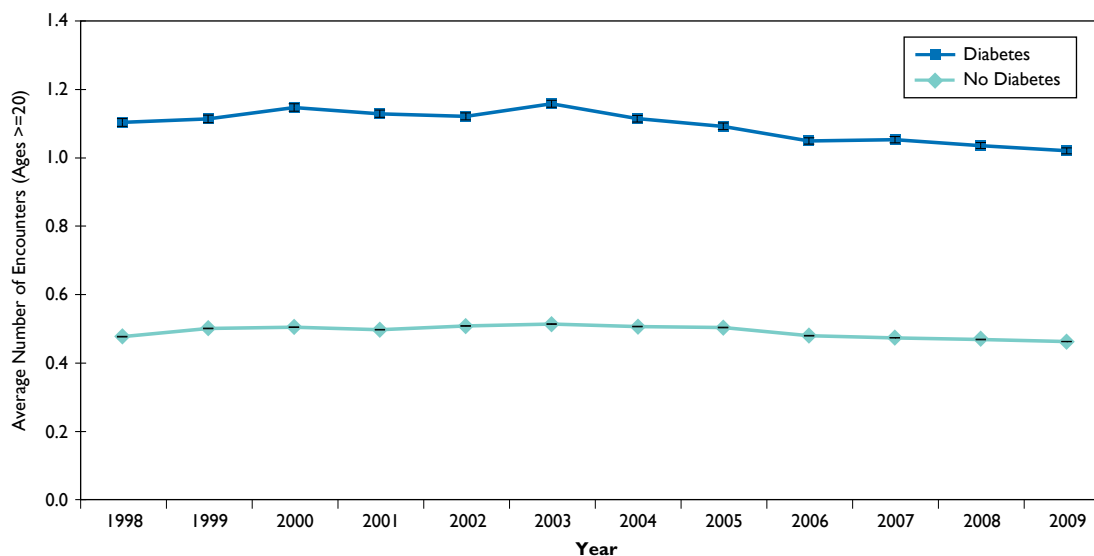


Figure 4.13 Total Number of Emergency Department Encounters for Adults with Diabetes, 1998-2009

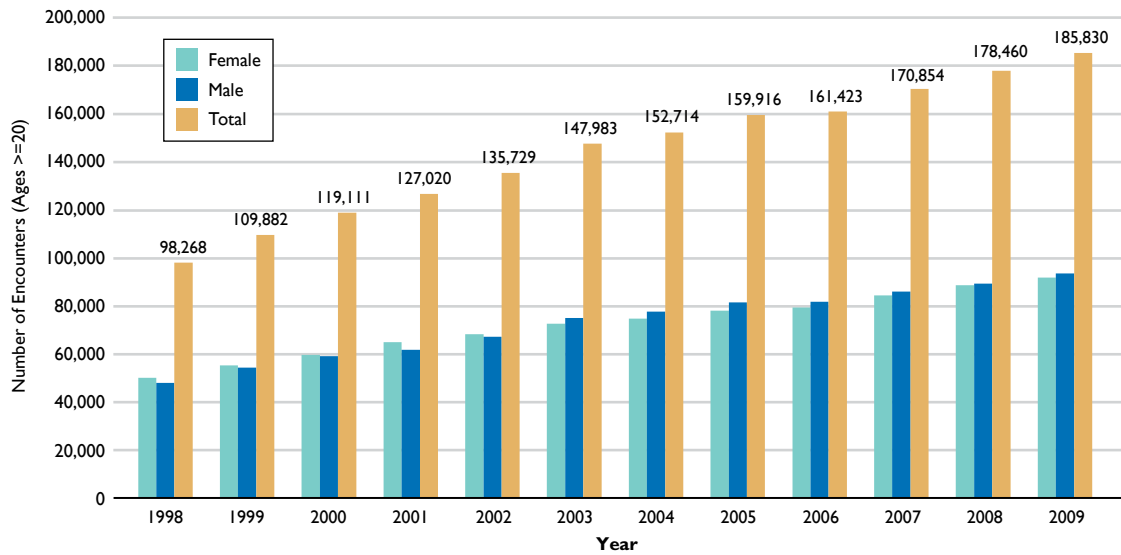
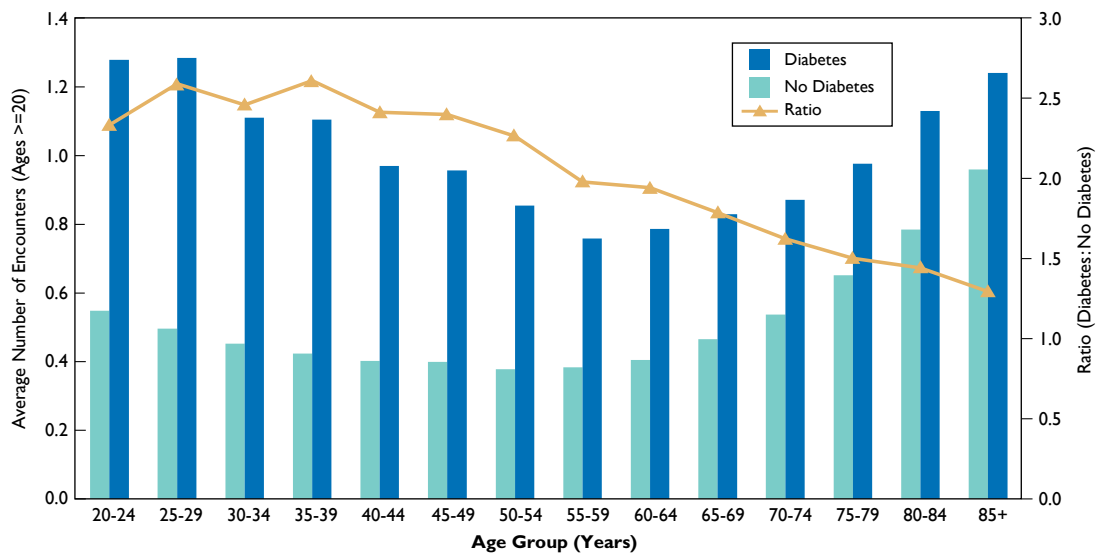
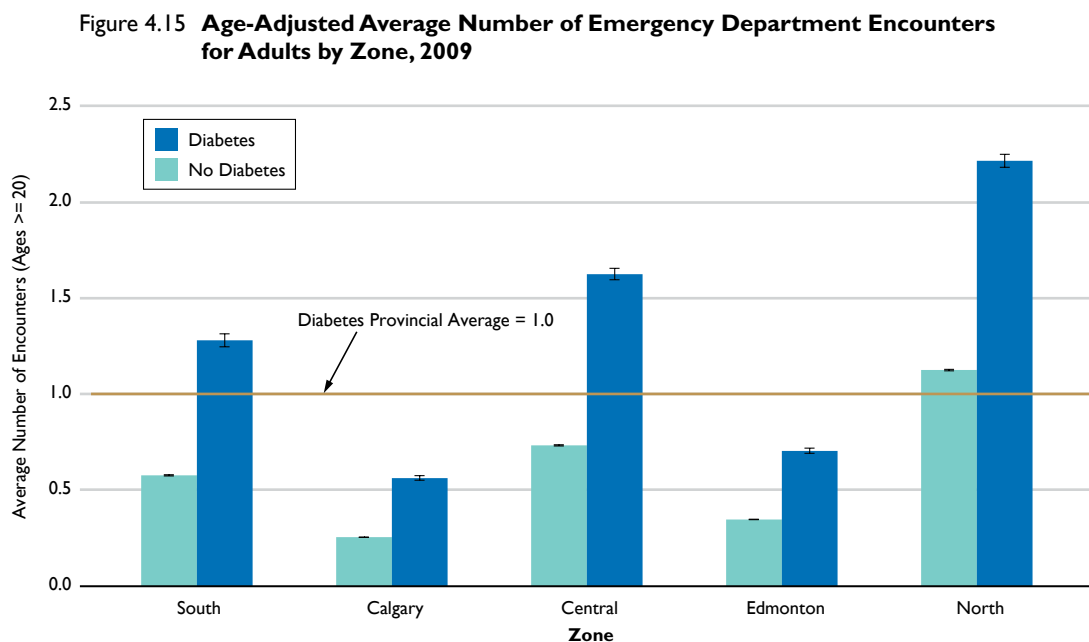


Figure 4.14 Average Number of Emergency Department Encounters by Age for Adults, 2009



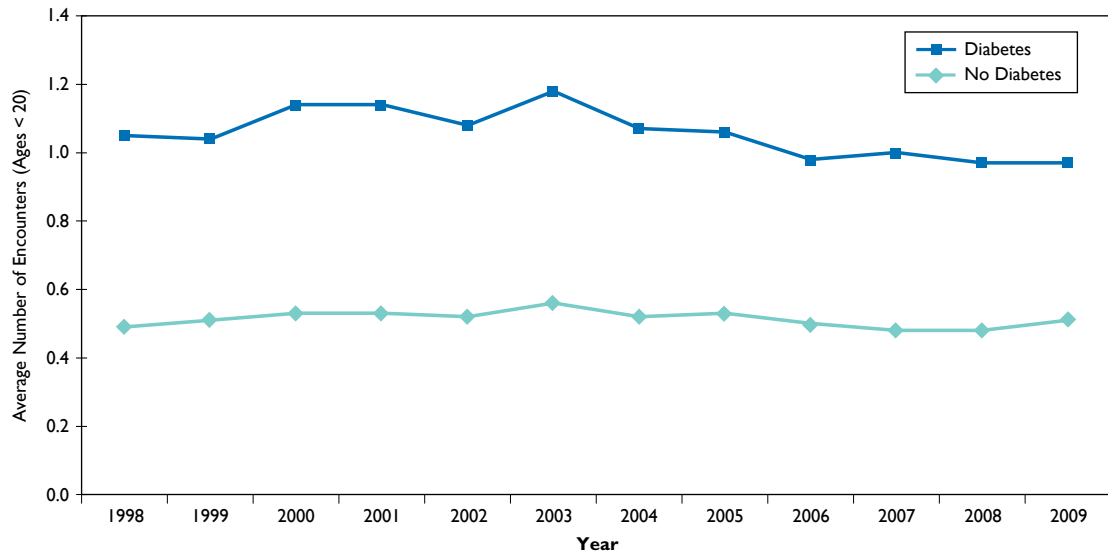
For people with and without diabetes, the average number of ED encounters was highest in the South, Central and North zones and lowest in the Edmonton and Calgary zones (Figure 4.15). However, people with diabetes had twice as many ED encounters compared to people without diabetes in all zones.



#### Children and Adolescents (Ages <20 years)

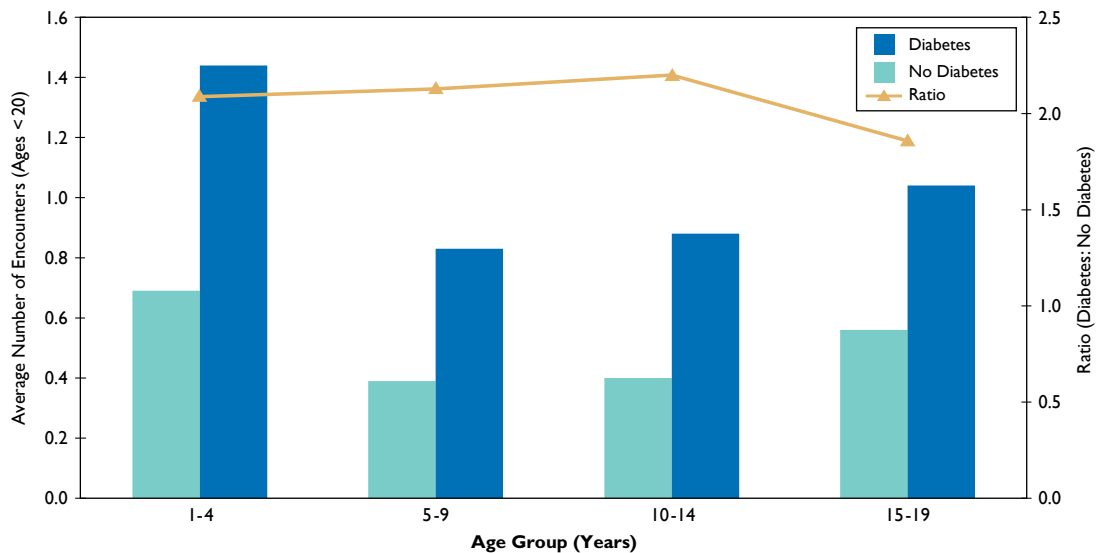
From 1998-2009, the average number of ED encounters remained fairly stable for children and adolescents in absolute magnitude, regardless of their diabetes status. However, the change in relative magnitude over the same time period was more marked with a decrease of 7.6% for ED encounters for children 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



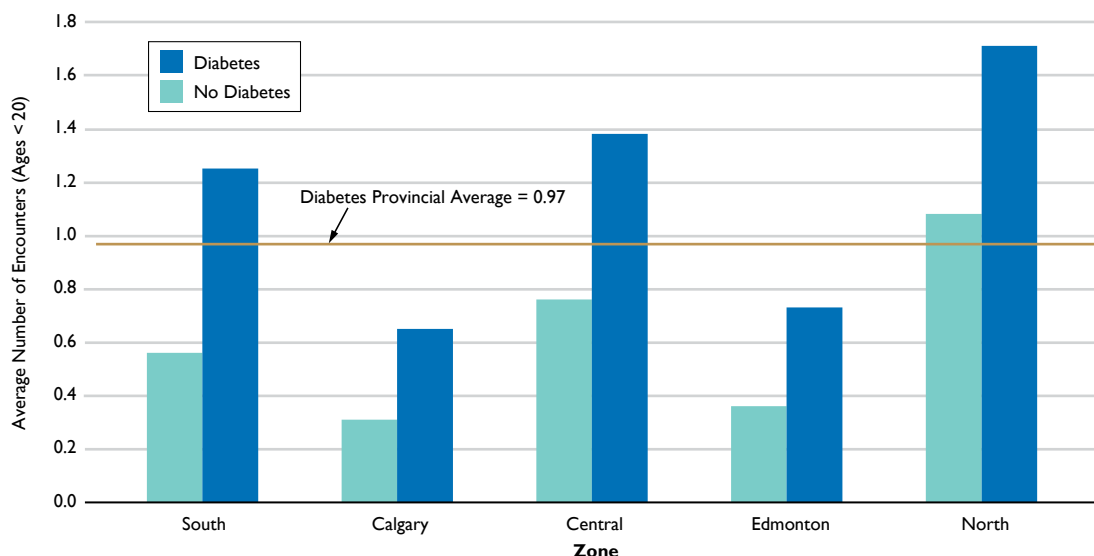
Children aged 1-4 years had the highest average number of ED encounters, regardless of DM status (Figure 4.17). The largest ratio was observed for the 10-14 year old age group, where those with diabetes had over 2.2 times more ED encounters compared to those without diabetes. The older age group (15-19 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 $\geq 20$ 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

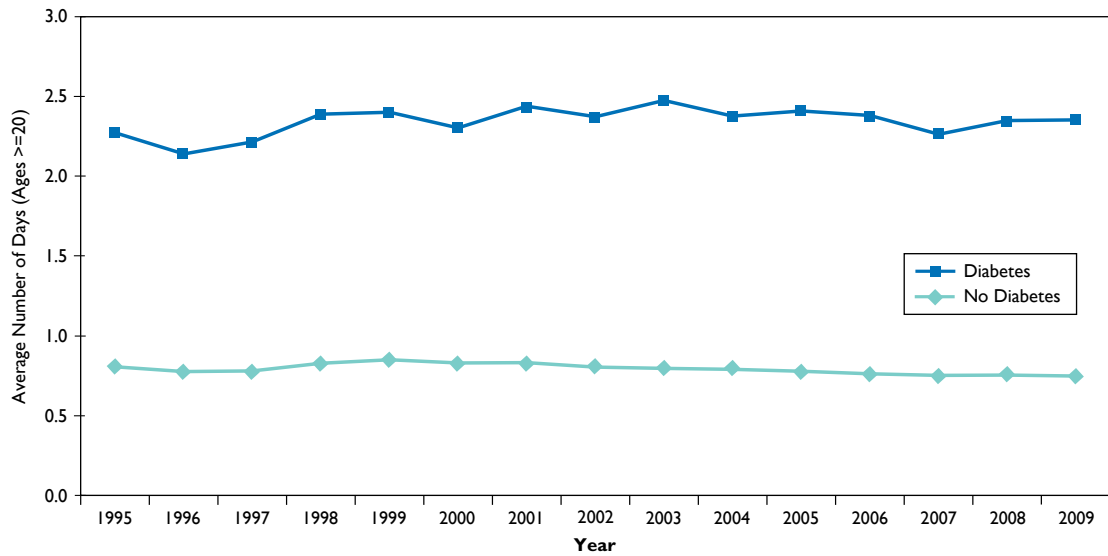
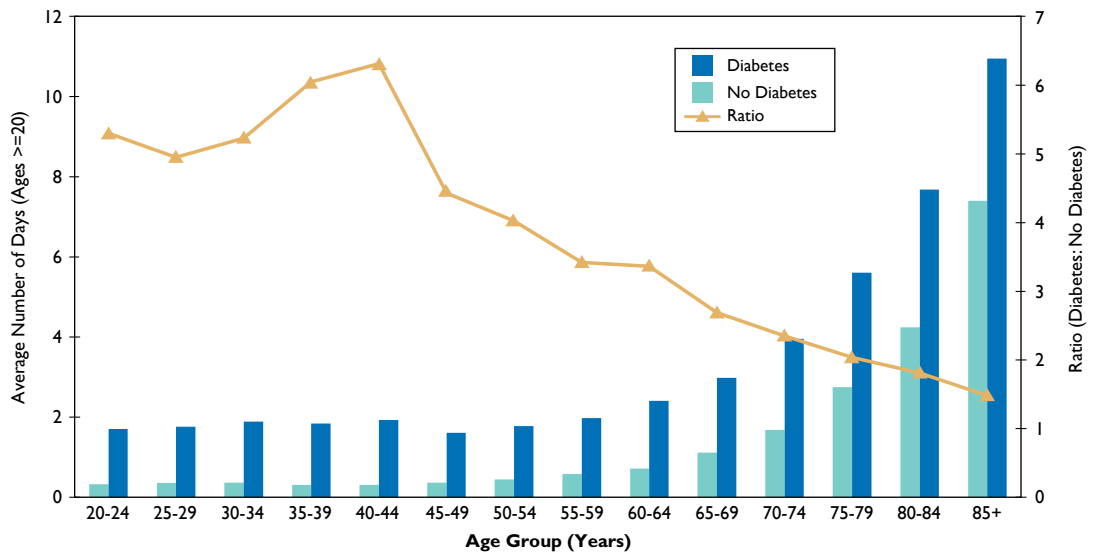
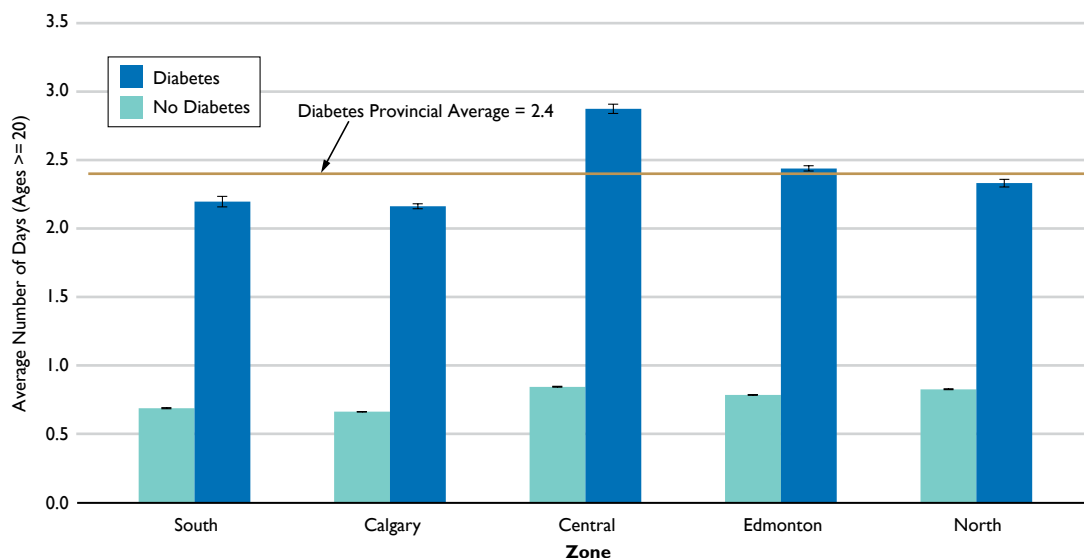


Figure 4.20 Average Number of Hospital Days by Age for Adults, 2009



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

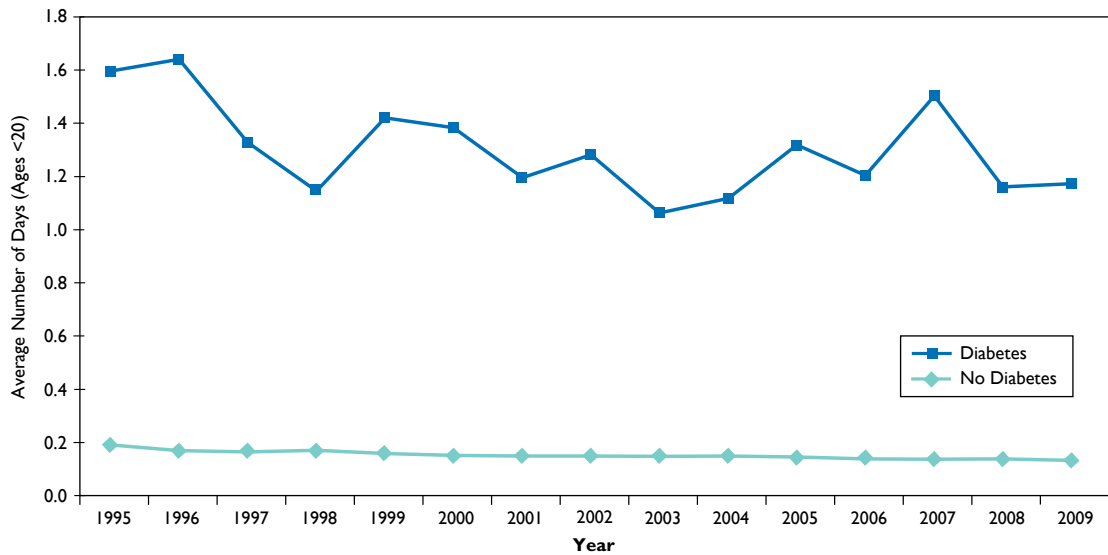
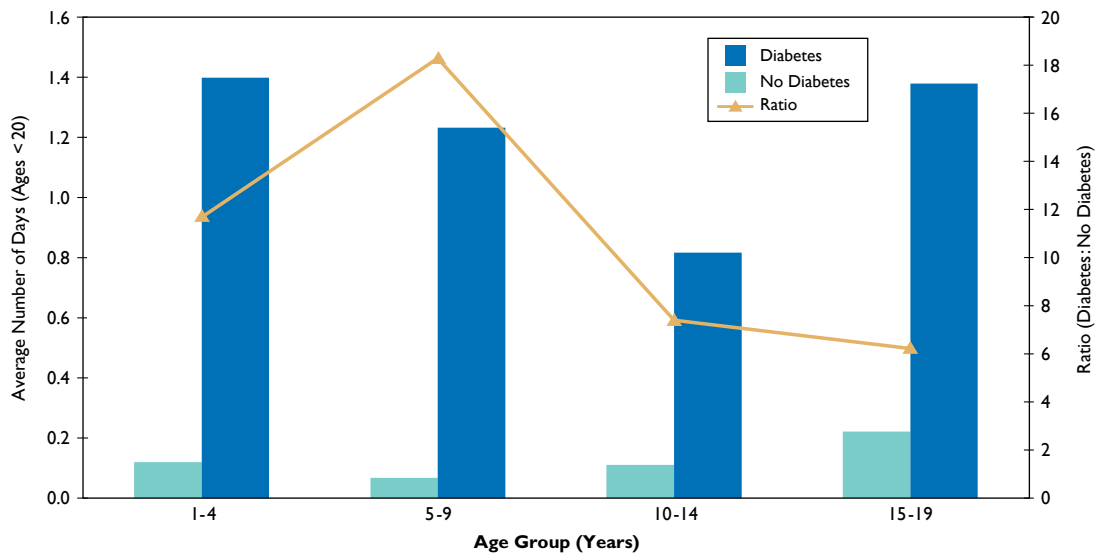
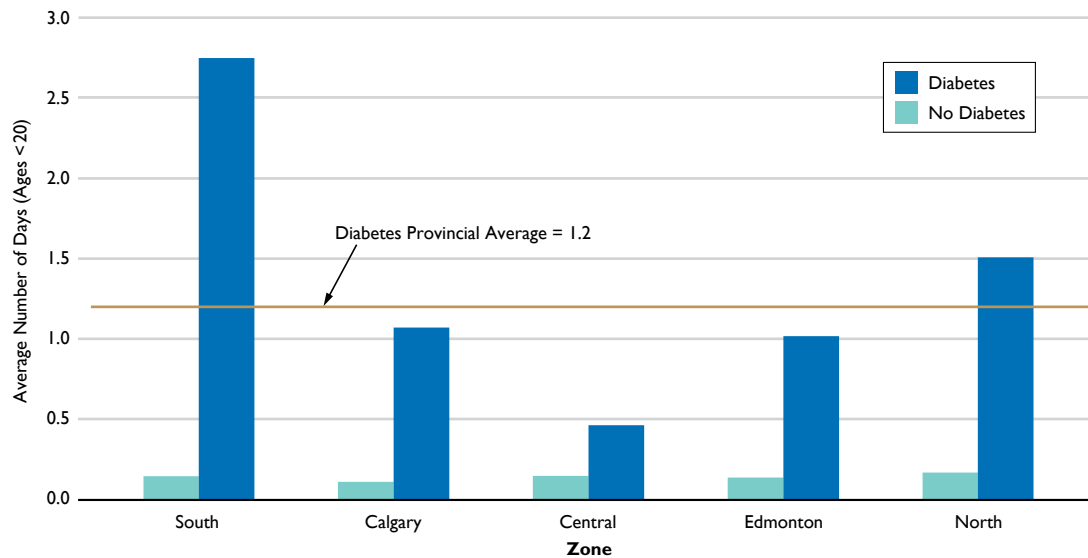


Figure 4.23 Average Number of Hospital Days by Age for Children and Adolescents, 2009



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.<sup>(2,5,6)</sup> 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%.<sup>(7)</sup> 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.<sup>(8,9)</sup> It is generally agreed that the majority of health care for people with diabetes should be provided by GPs.<sup>(4)</sup> 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.<sup>(10)</sup> 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<sup>(11-14)</sup> and other provinces in Canada<sup>(15-18)</sup> 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<sup>(4)</sup> may actually require an increase in utilization of certain health care services to avoid devastating and costly complications down the road.<sup>(6)</sup>

The *Canadian Diabetes Association 2008 Clinical Practice Guidelines* encourage the use of integrated diabetes health care.<sup>(4)</sup> 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.<sup>(19-22)</sup> 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, dietitians, 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.<sup>(6,23)</sup> 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](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(suppl 1);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.

