Chapter 9

Diabetes and Eye Disease in Alberta

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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.

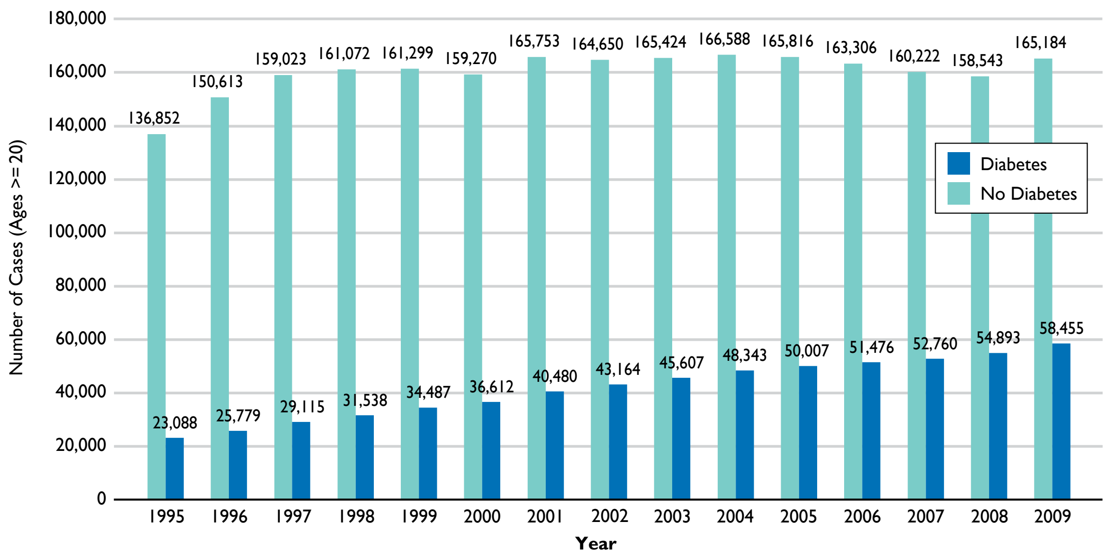
Persons with incident and prevalent diabetes were identified as described in the “Background and Methods” chapter. As with other rates in the *Atlas*, direct standardization to age- and sex-adjusted rates of eye examinations and procedures was performed using the Alberta population according to the 2006 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

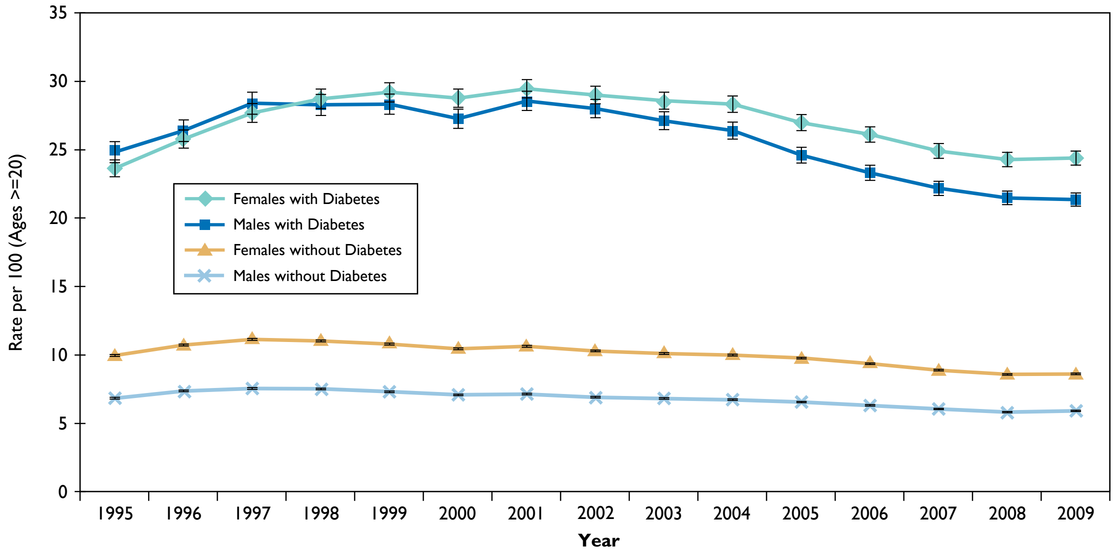
Between 1995-2009 there was more than a doubling of the number of people with diabetes who had an eye examination over the 15-year interval (23,088 to 58,455) (Figure 9.1). When considered as the proportion of patients seen by an ophthalmologist, the number of people with diabetes steadily increased 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**



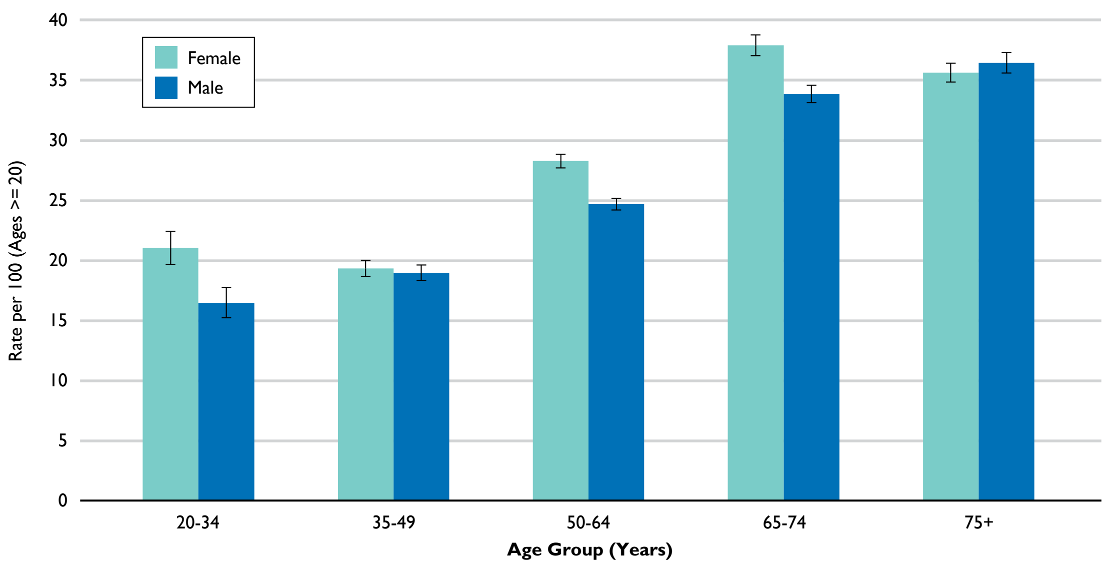
Even after adjusting for age, people with diabetes are about 3 times more likely to have an eye examination in comparison to people without diabetes (Figure 9.2). Since 1995, women are more likely to have an eye examination by an ophthalmologist than men. Overall, the rate of diabetic eye examinations 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**



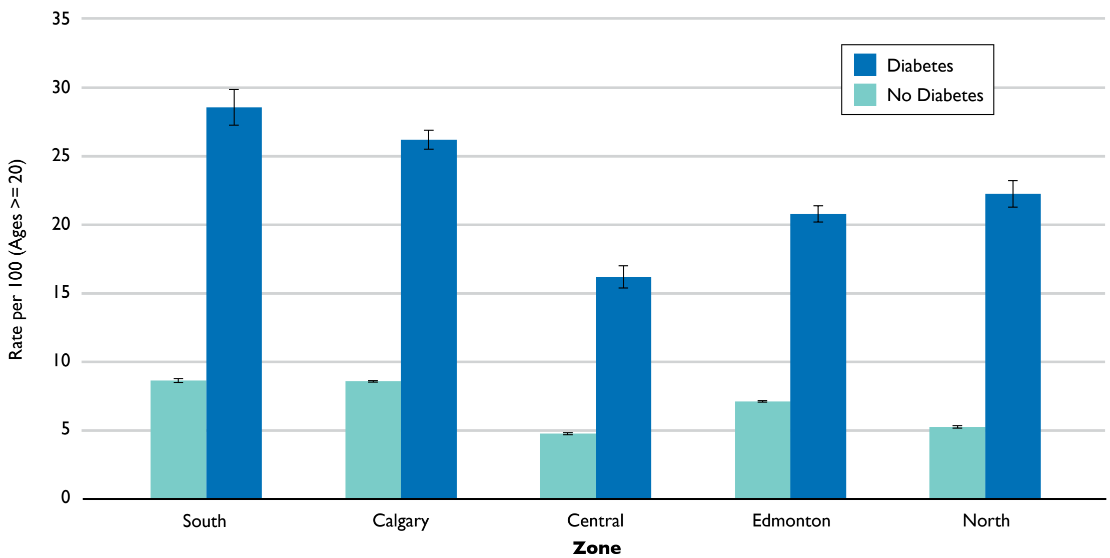
Older people, irrespective of diabetes status, continue to have higher rates of eye examinations (Figure 9.3), perhaps because the prevalence of most ophthalmic conditions increases with age. Similarly, because most diabetic ocular complications are associated with duration of disease, older patients 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**



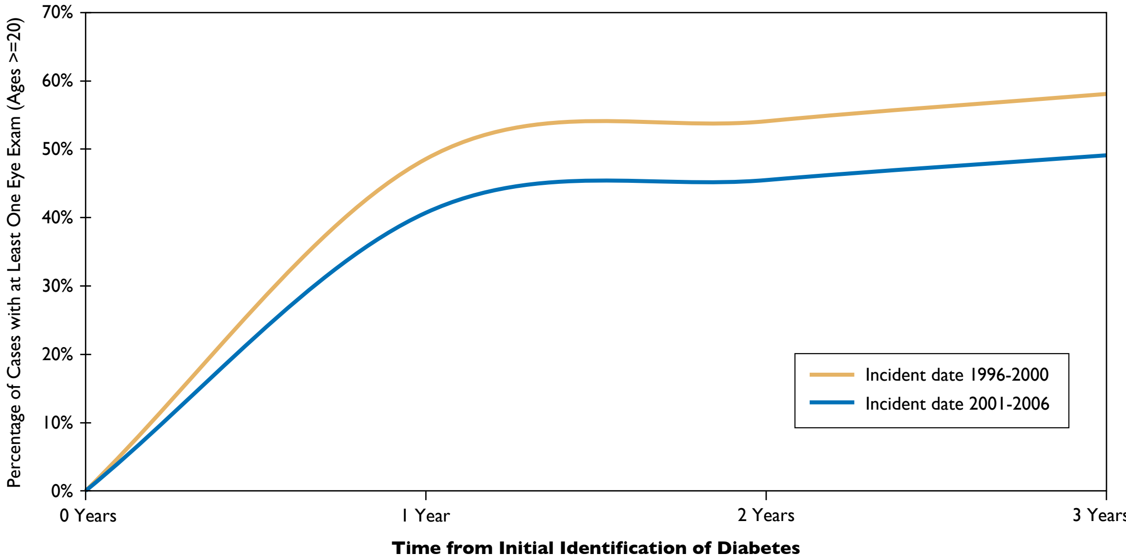
After adjusting for age, the rate of eye examinations varies between health zones. In the South zone, 29% of those with diabetes are examined by an ophthalmologist, compared to only 16% in the Central zone (Figure 9.4). In every health zone, diabetes is associated with much higher rates of eye examinations.

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



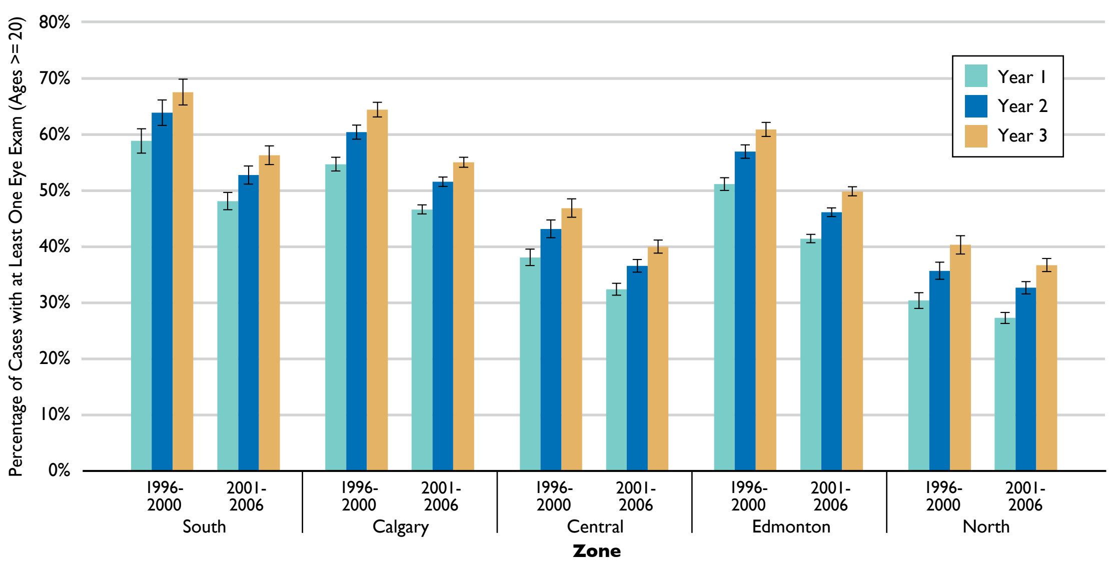
In Alberta, the incidence of an eye examination by an ophthalmologist within 3 years of identification of diabetes continues to be low. For the time period 1996-2000, about 58% of people were assessed by an ophthalmologist within 3 years of diagnosis; however, this decreased to only 49% for the period 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**

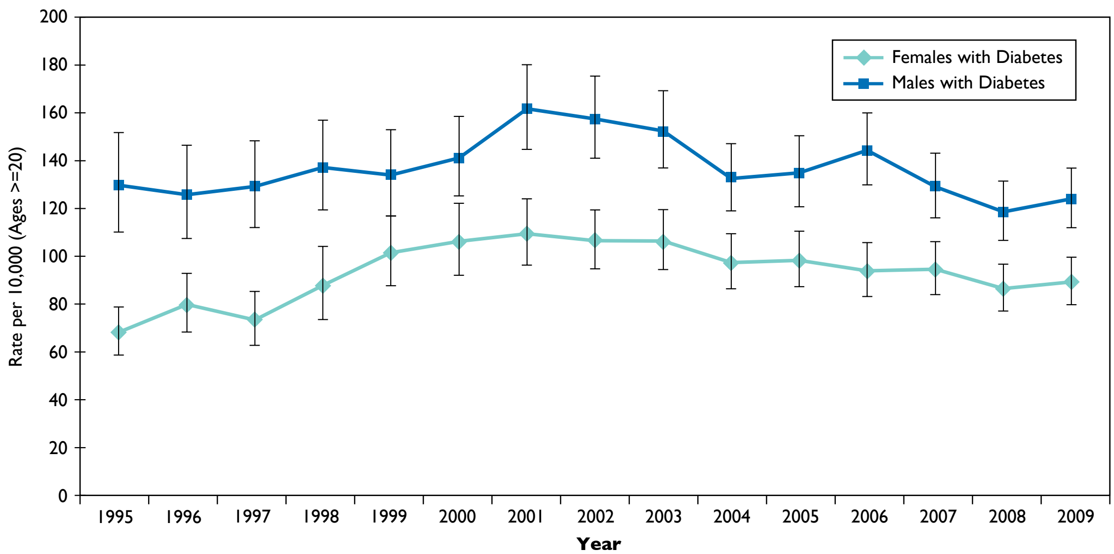
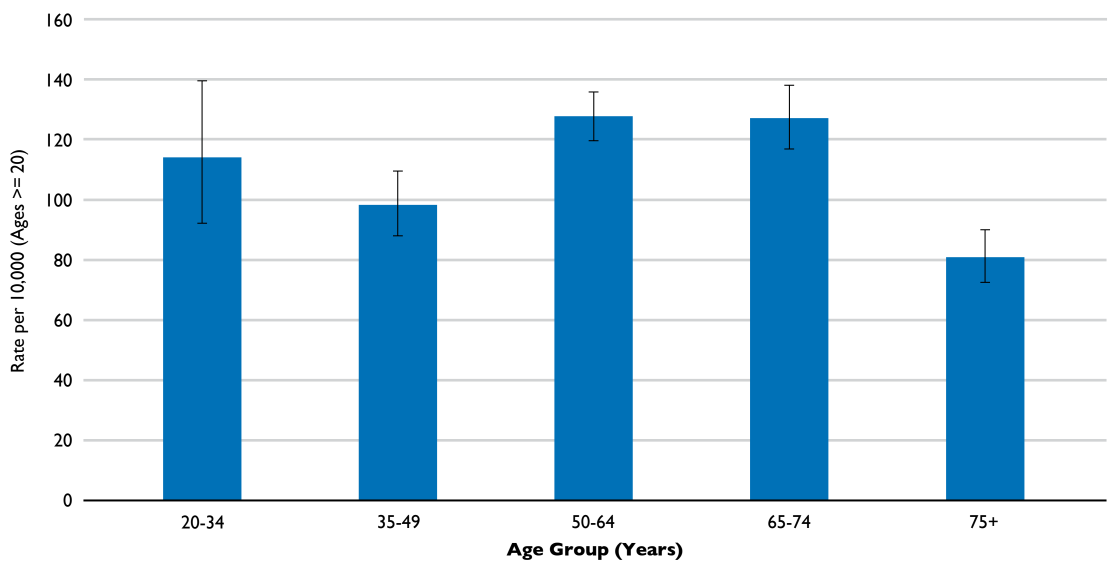
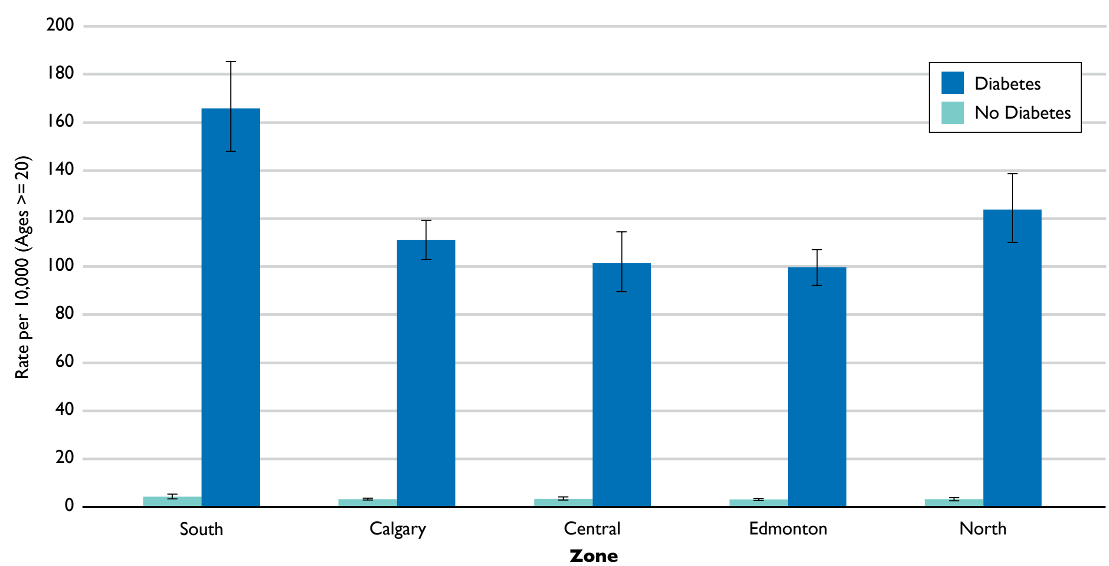


Figure 9.8 **Age-Specific Rates of People with Diabetes who had at least one Retinal Laser Treatment, 2009**



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).

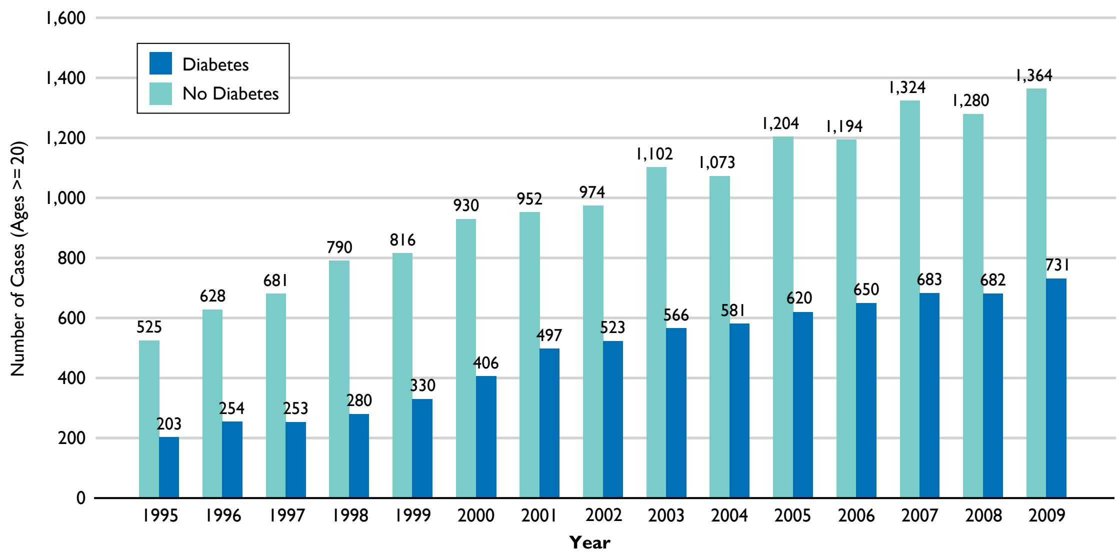
Figure 9.9 **Crude Rates of People who had at least one Retinal Laser Treatment by Zone, 2009**



Vitrectomy Surgery

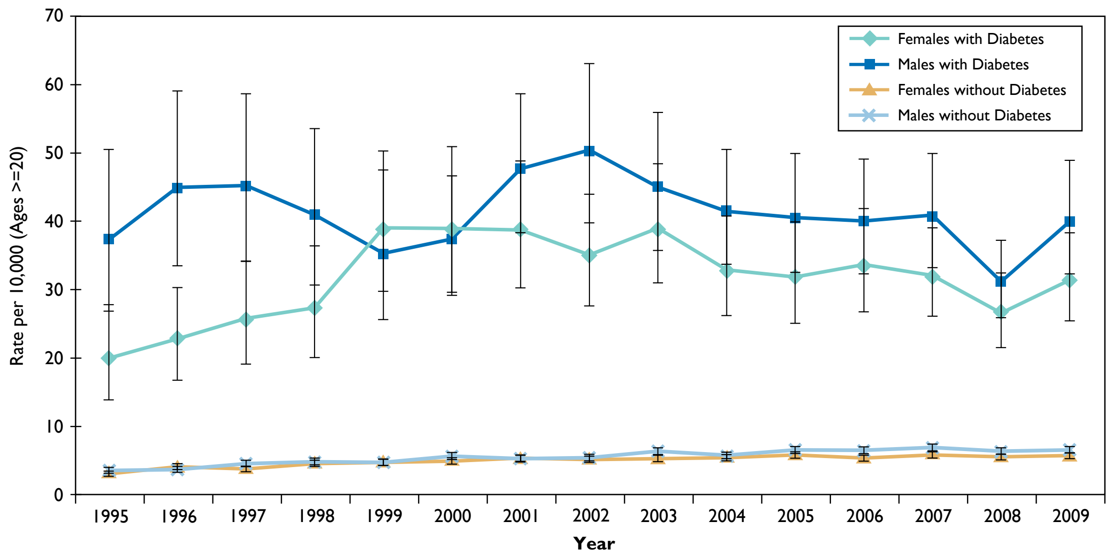
Vitrectomy is a surgical procedure that is used to treat advanced DR, as well as other forms of eye disease. When performed, it suggests that other less invasive treatment options have failed. The number of vitrectomies performed overall is steadily increasing (Figure 9.10). This increase might be explained 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**



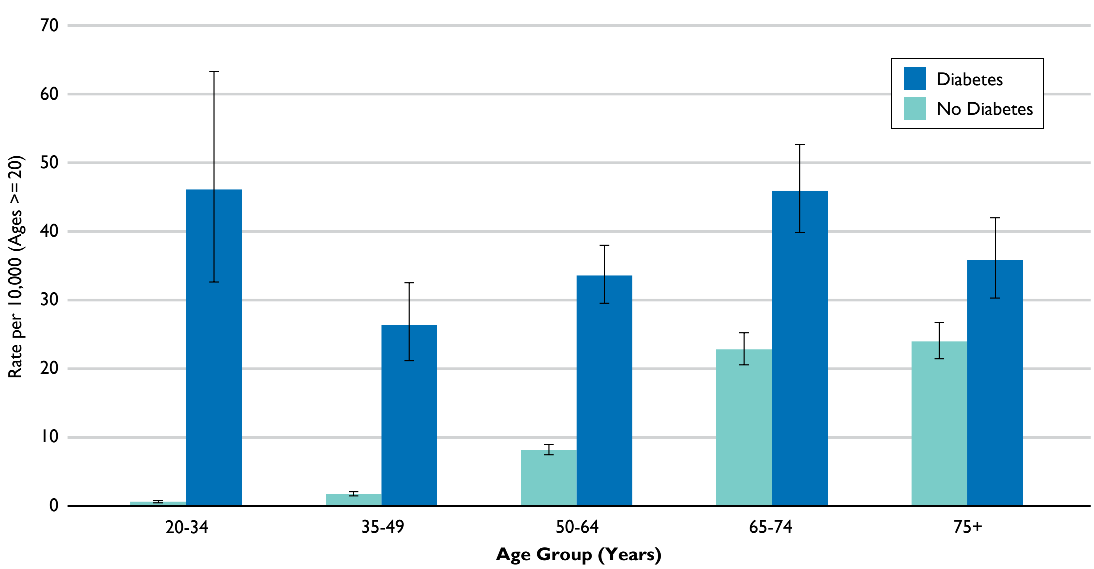
Within the diabetic population, men tend to have higher rates of vitrectomy compared to women, but this gap narrowed in recent years (Figure 9.11). Given that men also have higher photocoagulation rates, the most likely explanation for this would be more severe disease. These sex differences in vitrectomy 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**

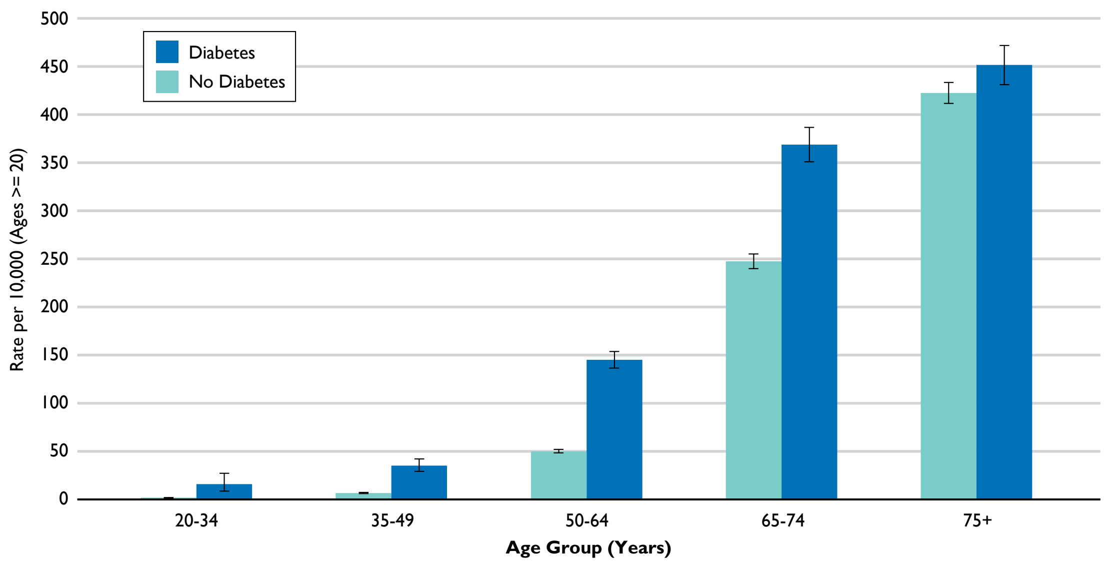
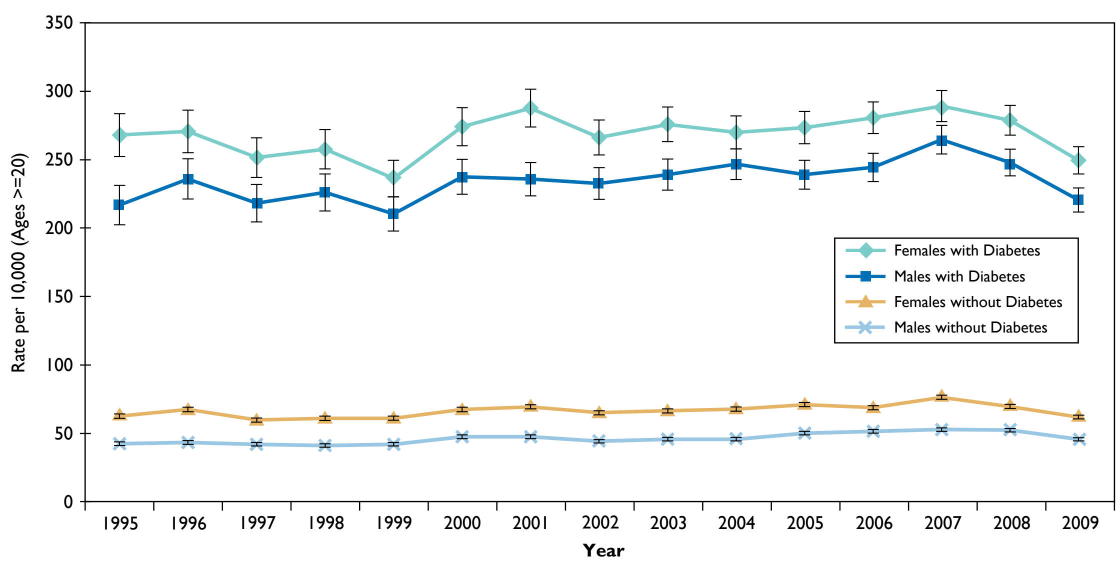
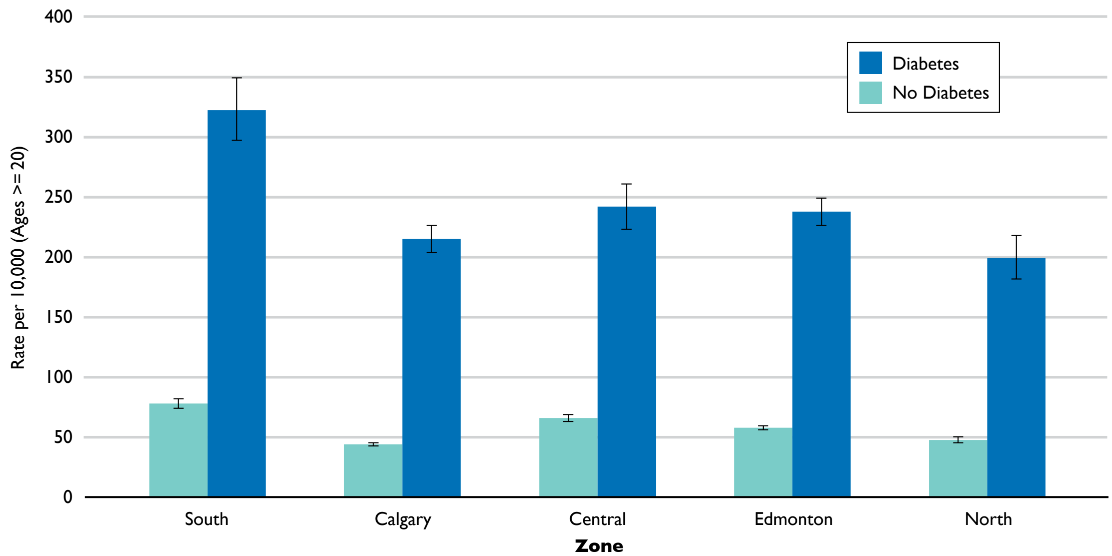


Figure 9.14 **Crude Rates of People who had at least one Cataract Surgery, 1995-2009**



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**

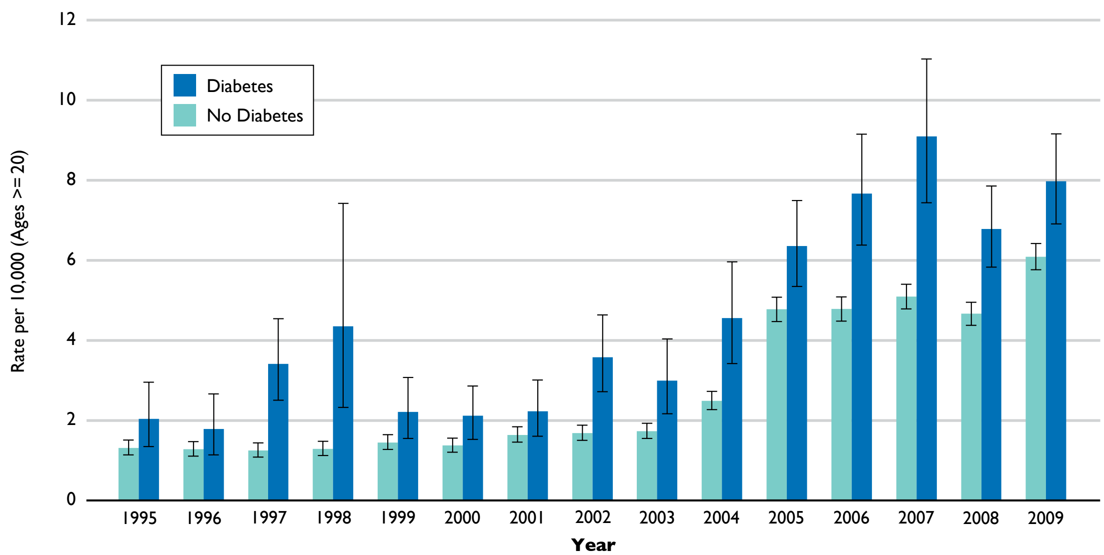
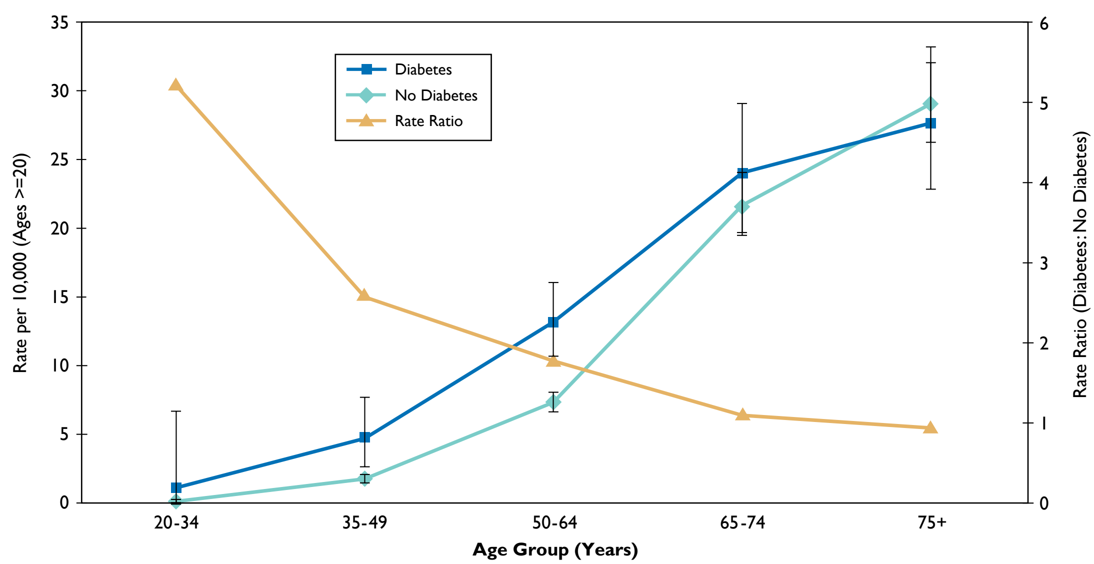
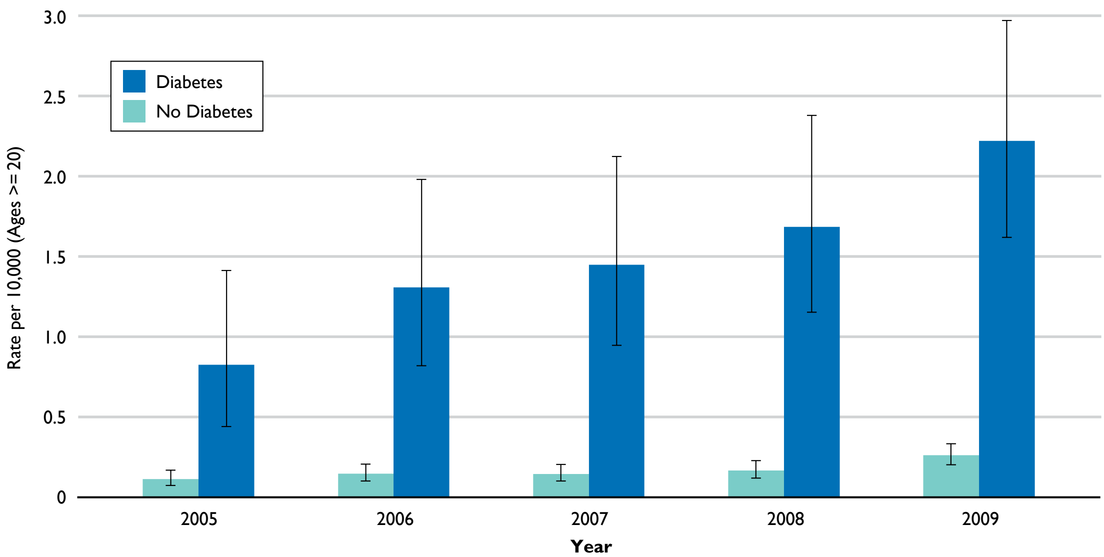


Figure 9.17 **Age-Specific Rates of People who had at least one Laser Treatment for Glaucoma, 2009**



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**

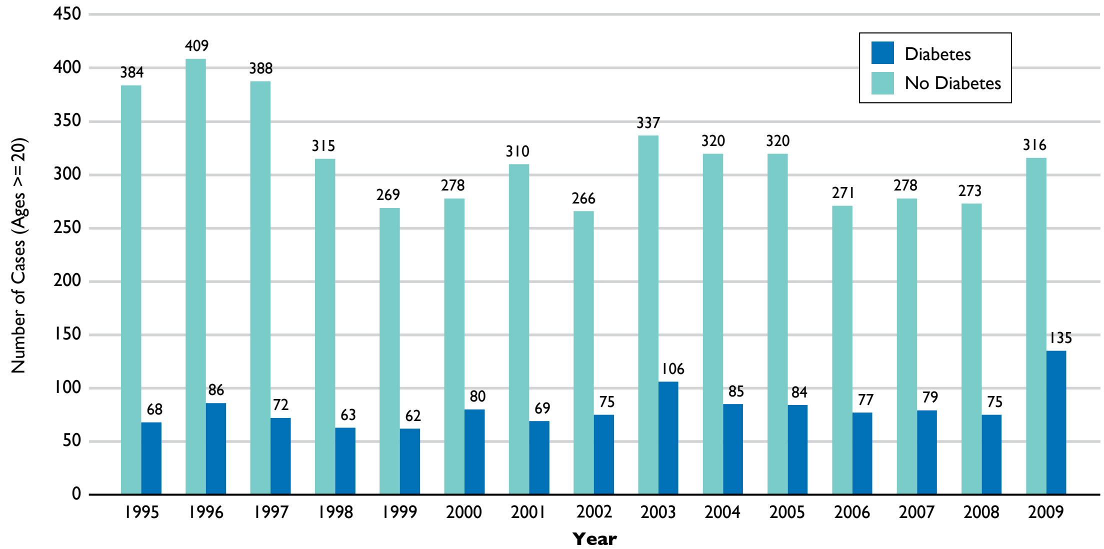


Figure 9.20 **Age-Adjusted Rates of People who had at least one Glaucoma Surgery, 1995-2009**

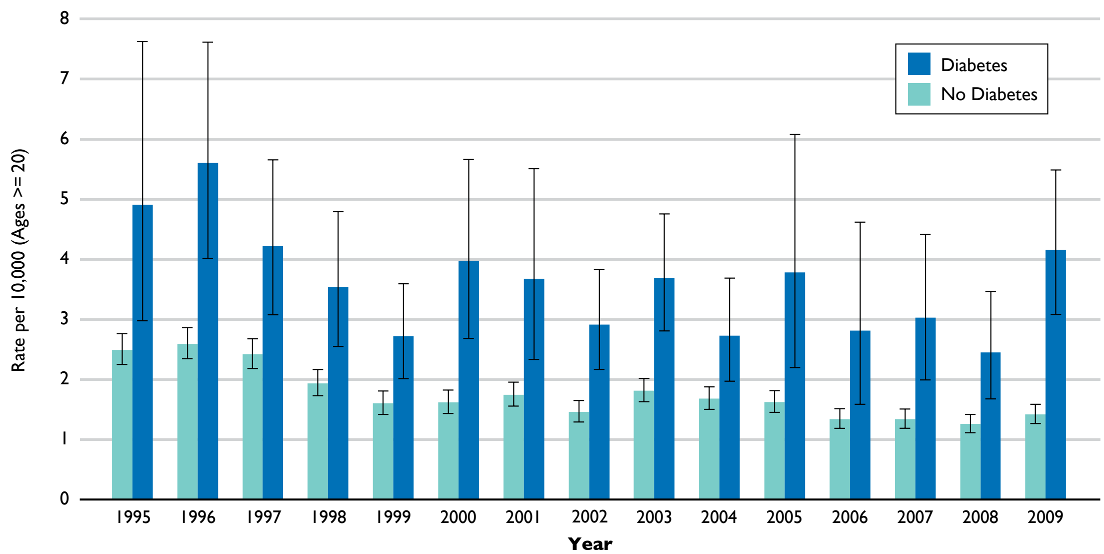
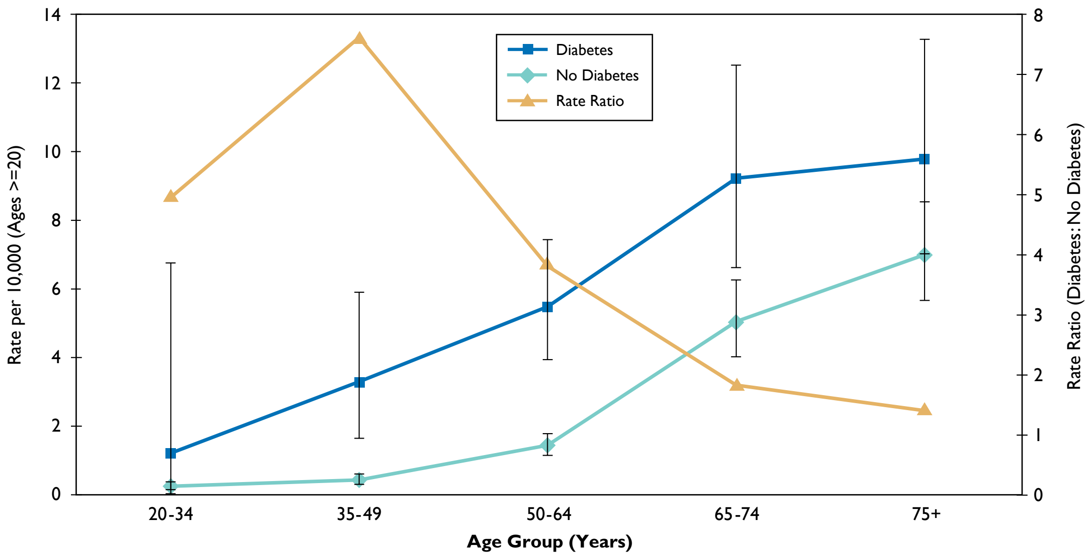
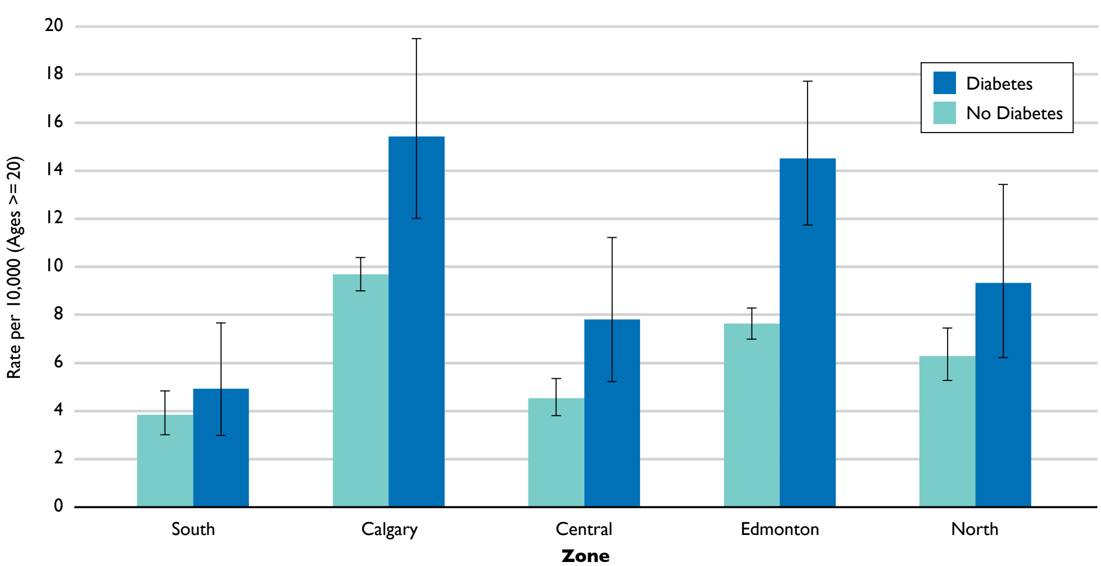


Figure 9.21 **Age-Specific Rates of People who had at least one Glaucoma Surgery, 2009**



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

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