DIABETES CANADA

Diabetes and Sight Loss Prevention

A Position Statement

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About Diabetes Canada: Diabetes Canada is a national health charity representing close to 11.5 million Canadians living with diabetes or prediabetes. Diabetes Canada leads the fight against diabetes by helping those affected by diabetes live healthy lives, preventing the onset and consequences of diabetes, and discovering a cure. It has a heritage of excellence and leadership, and its co-founder, Dr. Charles Best, along with Dr. Frederick Banting, is credited with the co-discovery of insulin. Diabetes Canada is supported in its efforts by a community-based network of volunteers, employees, health-care professionals, researchers, and partners. By providing education and services, advocating on behalf of people living with diabetes, supporting research, and translating research into practical applications, Diabetes Canada is delivering on its mission. Diabetes Canada will continue to change the world for those affected by diabetes through healthier communities, exceptional care, and high-impact research.

For more information, please visit: www.diabetes.ca

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Position Statement

Diabetes Canada recommends that the **federal** government:

- Adopt a National Diabetes Strategy that includes a campaign on the importance of vision care in the management of diabetes, to raise eye health as a priority on a national platform.
- Develop programs and services to enable screening for and management of diabetic retinopathy. This includes using available data to help identify individuals who are risk for sight loss, assessing approaches to managing diabetic retinopathy, and facilitating access to integrated diabetes care teams that include optometrists and ophthalmologists, who can help delay or prevent sight loss for people with diabetic retinopathy.
- Within a national framework to address diabetes, develop and launch a diabetic retinopathy screening service for everyone and target certain population groups who are vulnerable and/or disproportionately affected, including people residing in northern, rural, and remote regions. Access to screening must be coupled with access to timely treatment.
- Under the auspices of a National Diabetes Strategy, develop a multi-stakeholder coalition comprising people living with diabetes, researchers, clinicians, and organizations that advocate for diabetes and vision-related complications, to address barriers and identify solutions at a national level to support the development of evidence-based policy, foster intergovernmental collaboration within ministries, and develop a national strategy for diabetes-related eye complications.
- Assess the disparities in access to care at a national level, including proximity to health-care services and at-risk populations, to develop strategies to address identified inequalities.
- Establish an interdisciplinary and multi-sectoral research funding strategy, which aims to address the research gaps in diabetes-specific risk factors and indicators, socio-economic implications of diabetes-related eye complications, screening and treatment of diabetes-related eye complications, and effective knowledge translation, to optimize patient outcomes and improve access and delivery of health-care services.
- Invest in continuing education and training for all health-care providers, about the etiology of diabetes, prevention strategies, and advancement in available diabetes and diabetes-related complications, screening, treatment, and management.
- Promote the vision health guidelines on screening, treatment, and management, as outlined in the most current Diabetes Canada *Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada*.

Diabetes Canada recommends that **provincial and territorial** governments:

- Adopt a National Diabetes Strategy that includes a campaign on the importance of vision in the management of diabetes, to raise eye health as a priority on a provincial/territorial platform and, if available, inform people with diabetes of available screening services.
- Develop programs and services to enable screening for and management of diabetic retinopathy. This includes using available data to help identify individuals who are risk for sight loss, assessing

approaches to managing diabetic retinopathy, and facilitating access to integrated diabetes care teams that include optometrists and ophthalmologists, who can help delay or prevent sight loss for people with diabetic retinopathy.
- Establish a collection of information and patient education resources regarding diabetes-related sight loss.
- Evaluate the effectiveness of eye-related information and interventions provided by patient support programs, to ensure adequate access to education and behavioural interventions.
- Promote a patient-driven health-care system that supports effective communication between relevant health-care providers, including the sharing of relevant patient data, to optimize patient outcomes.
- Ensure that clinical settings of health-care providers, which provide care to people living with diabetes, have sufficient patient education information on diabetes-related eye complications. Information should be available in the patient's native language and provided upon both initial diagnosis of diabetes and initial eye exam.
- Assess health-care system barriers to eye exams and define a strategy to ensure that they are available to all people living with diabetes, regardless of age, duration of diabetes, gender, and socioeconomic status.
- Promote the vision health guidelines on screening, treatment, and management, as outlined in the most current Diabetes Canada *Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada*.

Diabetes Canada recommends that **municipal** governments:
- Educate the public by promoting the value of eye examinations to detect and monitor the development and progression of diabetic retinopathy through a multi-stakeholder public health information campaign.
- Establish a hub of information and patient education resources regarding diabetes-related sight loss.
- Evaluate the effectiveness of eye-related information and interventions provided by patient support programs, to ensure adequate access to education on behavioural interventions.
- Promote the vision health guidelines on screening, treatment, and management, as outlined in the most current Diabetes Canada *Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada*.

Diabetes Canada recommends that **health-care providers**:
- Consider diabetic retinopathy prevention and management a population health priority and integrate it into patients' preventive health-care routine.
- Provide diabetic retinopathy screening and treatment, as well as management guidance, as outlined in the most current Diabetes Canada *Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada*.

- Incorporate a vision care professional (optometrist or ophthalmologist) in the health-care team of their patients living with diabetes to ensure optimal patient outcomes.
- Are trained to engage people with diabetes in a proactive dialogue on the importance of eye health and preventive strategies, including adherence to eye exams, as outlined in the *Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada*.
- Inform people living with diabetes of the results of their screening exam, their diagnosis, rationale for treatment modality, and preventive measures, to ensure they are an active participant in their medical care.
- Ensure people with diabetes are equipped with sufficient and suitable information on diabetes vision-related complications and effective screening, treatment, and management. Information should be available in a language they understand and provided upon both initial diagnosis of diabetes and initial eye exam.
- Evaluate the uptake, barriers, and effectiveness of eye-related information in diabetes management programs, to ensure appropriate education on lifestyle and behavioural interventions.

Diabetes Canada recommends that **Canadians** living with diabetes:

- Continue to manage their diabetes to prevent or delay the onset of diabetes-related complications, including blindness.
- Regularly communicate with their team of health-care providers to facilitate adherence to diet, exercise, and medication regimens.
- Get a comprehensive eye exam, as outlined in the *Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada*, as diabetic retinopathy can be undetected without routine screening until irreparable sight loss occurs. Discuss the recommended frequency with your diabetes health-care team and experienced vision care professionals (optometrist or ophthalmologist).

Diabetes Canada will:

- Advocate for a National Diabetes Strategy that includes a campaign on the importance of vision care in the management of diabetes, to raise eye health as a priority on a national platform.
- Call for affordable and timely access to medications, devices, supplies, education, services, and supports that are necessary to achieve optimal diabetes management and prevent the onset of serious complications, including sight loss.
- Call for access to publicly funded services to prevent and treat diabetic retinopathy, including screening, treatment, and management.
- Advocate on behalf of Canadians living with diabetic retinopathy who are denied access to evidence-based treatment, or screening services, due to reimbursement restrictions and/or the inability to pay for life-sustaining services.
- Work with patients and health-care providers to establish information requirements for people with diabetes regarding diabetes-related sight loss and develop appropriate patient education resources on diabetic retinopathy.

Why is Sight Loss Prevention Important to Diabetes Canada?

Diabetes represents one of the greatest public health and health systems challenges in Canada. Diabetes decreases quality and length of life, and is the leading cause of sight loss in this country (1,2). Among the numerous diabetes complications, blindness due to diabetic retinopathy (DR) imposes an enormous burden on public health and has significant clinical implications. Even though substantial progress has been made in understanding the etiology of the disease and increasing access to new screening and treatment modalities, DR remains the most common cause of blindness among working-aged adults, placing an enormous impact on society and the economy (3). Further, in parallel with the increasing prevalence of diabetes and the aging population in Canada, the burden of sight loss attributable to DR is substantial and growing.

The development and progression of sight loss due to DR can be altered by addressing modifiable risk factors, early detection through recommended screening guidelines, and appropriate cost-effective management and treatment. This policy position presents the disease and economic burden of sight loss due to DR, as well as prevention interventions that can be administered by public health, primary health-care systems, and health-care providers.

Methods

A rapid evidence review was conducted to develop this policy position, which is a streamlined alternative to standard systematic reviews to meet the needs of fast-paced evidence-informed decision making and advocacy (4–6).

An experienced medical information specialist developed and tested a search strategy for the PubMed database through an iterative process, in consultation with the review team. The search used a combination of controlled vocabulary (e.g., "diabetic retinopathy", "costs and cost analysis") and keywords (e.g., "retinopathy", "burden"). A geographic filter was applied to identify literature pertaining to Canada, including provincial, territorial, and municipal jurisdictions. There were no date or language restrictions. Further, a grey literature search employed the Grey Matters tool of the Canadian Agency for Drugs and Technologies in Health (CADTH) to identify relevant literature, and searches were also run using Google and Google Scholar with key words such as "diabetic retinopathy," "Canada," and the names of the provinces and territories. Additional studies were identified by reviewing the references of included studies.

One reviewer screened titles and abstracts of all the studies found through the searches to identify those that met the inclusion criteria for full-text evaluation. All studies identified as potentially relevant were retrieved for full-text evaluation. Articles selected for this rapid review met the following criteria: people living with type 1 or type 2 diabetes with a focus on DR-related vision changes or blindness. Further,

studies were restricted by language of publication (only studies published in English or French were eligible) and abstracts and dissertations were excluded. The reviewer categorized included literature by relevant research topic.

Based on the synthesized literature, the present position statement and accompanying recommendations were formulated. This position statement was reviewed by experts in the field including clinicians, researchers, and policymakers.

Diabetes in Canada

Diabetes and prediabetes are conditions that are estimated to affect close to 11.5 million people in Canada in 2021, and cost our health-care system up to $3.95 billion annually in direct health-care costs (7). The total number of people living with diabetes and prediabetes is projected to increase steadily to an estimated 13.6 million in Canada by the year 2030 (7) due to various demographic trends (8–10), including:

- An ageing population;
- Increasing prevalence of risk factors, including overweight and obesity, physical inactivity, and unhealthy eating;
- Increasing rates of immigration from high-risk populations, including Asian and South-Asian countries; and
- Population growth among Indigenous populations (First Nations, Métis, and Inuit), who have 2.5 to 5 times higher rates of diabetes than the non-Indigenous population.

There are three common types of diabetes. Type 1 diabetes occurs when pancreatic beta cells no longer function, leading to insulin deficiency (11). Consequently, glucose builds up in the blood instead of entering the cells to be used as energy (11). Approximately 5-10% of people living with diabetes have type 1 diabetes (11,12). Type 1 diabetes usually develops in childhood or adolescence, but can also develop in adulthood (11). Insulin therapy, is required for the treatment of type 1 diabetes and is life-sustaining (13). Adopting and maintaining healthy behaviours, including adhering to a healthy diet, engaging in physical activity, and consistently monitoring of blood glucose, are a key strategy for preventing and delaying the onset of diabetes complications for people living with type 1 diabetes.

Type 2 diabetes occurs when the body cannot properly use the insulin that is released from the pancreas or does not make enough insulin (11). Consequently, glucose builds up in the blood instead of entering the cells to be used as energy (11). Over 90% of people living with diabetes have type 2 diabetes (11,12). Type 2 diabetes generally develops in adulthood, but children are increasingly affected (11). Various treatment options exist for treating type 2 diabetes including: nutrition guidance and physical activity, glucose lowering medications, and insulin therapy (14). The treatment plan prescribed by a clinician will depend on individual factors, including goals, lifestyle, meal plan, age, and general health (14).

A third type of diabetes, gestational diabetes, is a temporary condition that occurs during pregnancy (11). It affects up to 1% of all pregnancies and increases the risk of developing type 2 diabetes for mother and child in the future (11).

If left untreated or managed poorly, type 1 and type 2 diabetes can result in the development of numerous life-limiting and life-threatening complications (15,16). Diabetes contributes to 30% of strokes, 40% of ischemic heart disease, 50% of kidney failure requiring dialysis, 70% of all nontraumatic leg and foot amputations, sight loss, and reduced sensation in the lower extremities. (9,15,16). Diabetes complications are associated with premature death (17). Working-aged adults (aged 20 to 64 years) with diabetes have a life expectancy five to ten years less than adults of the same age without diabetes (17). However, a recent study reported people living with type 2 diabetes who had five risk-factor variables—including A1C—within target ranges appeared to have little or no excess risks of death (18). By offering better care and support to people affected by diabetes, the opportunity exists to reduce that gap.

Diabetic Retinopathy

DR is the most common microvascular complication among people living with diabetes (16). According to the Diabetes Canada's 2018 *Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada,* DR is defined, diagnosed, and treated based on the extent of retinal vascular disease (19). There are three distinct forms (19):

1. Diabetic macular edema (DME): Diffuse or focal vascular (blood vessel) leakage at the macula (centre of the eye).
2. Non-proliferative DR (NPDR) and proliferative DR (PDR): NPDR is the progressive accumulation of microvascular (small blood vessels) change that includes microaneurysms (small clots), intra-retinal hemorrhage (small bleeds), vascular tortuosity (blood vessel circulation), and vascular malformation (irregular blood vessels). PDR develops from NPDR with the appearance of abnormal vessel growth on the optic disc or retina.
3. Retinal capillary non-perfusion: A form of vascular closure (blood vessel closure) recognized as a potential complication that can cause blindness.

Diabetic retinopathy is the most common cause of legal blindness, which is corrected visual acuity worse than 20/200 in the better eye, in people of working age (19,20). If left undetected and untreated, DR can lead to severe sight loss and irreversible blindness (21). Diabetes is responsible for about 12% of all new cases of blindness and DR is the most common ocular complication of diabetes (22). DR will affect most people living with diabetes at some stage during the course of their lifetime and people living with diabetes are 25 times more likely than the general population to become blind (23). Studies suggest that, if left untreated, 50% of people with PDR become legally blind within 5 years, versus only 5% of people who receive early treatment (24). Currently, at least 500,000 Canadians living with diabetes have some

form of DR (17,25), 100,000 have a vision-threatening form (defined as severe DR, diabetic macular edema, or both) (17), and 6,000 are already blind from the disease (17). Several risk factors are known to contribute to the development or progression of diabetic retinopathy including: longer duration of diabetes, elevated hemoglobin A1c (A1C), increased blood pressure, dyslipidemia, anemia, pregnancy with type 1 diabetes, proteinuria, and severe retinopathy (19,26–28). Effective management and treatment of these factors has been shown to slow the progression of DR (19).

Sight loss due to DR is associated with significant morbidity, including increased falls, hip fractures, and a four-fold increase in mortality (29). The incidence and prevalence of DR will increase as the incidence and prevalence of diabetes increase, presenting important implications for health-care services and expenditures (30,31). It represents a major national and international public health problem (32). However, sight loss due to DR is preventable through better glycaemic management and/or photocoagulation treatments or intravitreal injections (21). Early DR is often asymptomatic; therefore, detection of the disease is either incidental or by deliberate screening (33).

Diabetic Retinopathy in Indigenous Populations

Diabetes has become epidemic in Indigenous communities, where its prevalence is at least three times greater than that of the non-Indigenous population (34). In Canada, 29-40% of Indigenous peoples living with diabetes who were examined revealed some form of DR, with PDR found in 2.5% of people living with sight loss (31). The rates of both NPDR and PDR are higher in the Canadian Indigenous population versus Indigenous populations around the world (31).

DR is a leading cause of blindness in northern, remote, and rural communities in Canada and also accounts for a disproportionate amount of sight loss among other visible minorities (34).Treating blindness resulting from DR is significantly more costly than treating blindness from other causes (35). However, these prevalence estimates are likely underestimated since a major shortcoming is the lack of accurately collected data on blindness among Canada's Indigenous and visible minorities populations (31). Researchers in Saskatchewan found that visual health has been largely ignored, resulting in significant numbers of Indigenous populations in Canada suffering from serious ocular and visual health problems (25). Further, many Indigenous People living in remote communities have significant barriers to accessing health-care and remain undiagnosed for type 2 diabetes and/or DR (25).

Disease Burden of Sight Loss Due to Diabetic Retinopathy

The Likelihood of Developing Sight Loss from Diabetic Retinopathy

The natural progression of DR showed that more than 33% of people living with untreated DR will be defined as legally blind and nearly 30% of these people will develop severe sight loss after 3 years (36).

The Wisconsin Epidemiologic Study of Diabetic Retinopathy (WESDR) through the 1980s found that, for people with type 1 diabetes whose onset was before 30 years of age, at 10, 14, and 25 years follow-up, the cumulative incidence rates of DR were 89.3%, 95.9%, and 97%, respectively (22,37). This study found that, for older adults with type 2 diabetes, duration of diabetes was the major determinant of DR, particularly when people were taking insulin (22).

The Canadian Ophthalmological Society's *Evidence-Based Clinical Practice Guidelines for the Management of Diabetic Retinopathy* noted that, after 10 years, 7% of people with diabetes had DR, rising to 90% after 25 years (10). A 2000-2007 United Kingdom (UK) study of newly-diagnosed people with diabetes found a 9-year cumulative incidence of DR to be approximately 24%, while another UK study of people with type 2 diabetes reported a cumulative DR incidence of 26% at 4 years, 38%–41% at 6 years, and 66% at 10 years (37). Finally, two Canadian studies found that DR will eventually affect almost all people with type 1 diabetes, whereas for people with type 2 diabetes, 60-80% will have DR 15-20 years post-diagnosis and the majority by 30 years (38,39).

Prevalence of Sight Loss in People Living with Diabetes

The prevalence of visual impairment is greater among people living with diabetes compared to people without diabetes. The Canadian Longitudinal Study on Aging (2012-2015 data), found that 8.4% of people with type 1 diabetes were visually impaired versus 8.7% of those with type 2 diabetes and5.3% of participants who did not have diabetes (40). The rates of DR prevalence are high in Canada, varying between 22 and 41% (Table 1) (40–43).

Table 1. Prevalence Rates of Diabetic Retinopathy from Canadian Studies.

Study [First Author (Year of Publication)]	Location	Years	Type of diabetes	DR	Severe DR or PDR	Macular edema
Nathoo (2010) (41)	AB	2005–2007	NR	27.0%	2.3%	2.0% (CS)
Kanjee (2017) (42)	MB	2007–2013	T2DM	25.0%	6.5%	NR
Aljied (2018) (40)	NR	2013–2016	T1DM	40.9%	NR	NR
Felfeli (2019) (43)	TO	2013–2017	Mixed	25.9%	2.5%	4.5%
Felfeli (2019) (43)	BC, AB, SK, MB, QC	NR	NR	22.5%	1.8%	

Abbreviations: Type 2 Diabetes (T2DM); Type 1 Diabetes (T1DM); Type 1 and Type 2 Diabetes (Mixed); Clinically Significant (CS); Diabetic Retinopathy (DR); Not Reported (NR); Proliferative Diabetic Retinopathy (PDR); Manitoba (MB); British Columbia (BC); Alberta (AB); Saskatchewan (SK); Manitoba (MB); Quebec (QC).

Economic Burden of Sight Loss Due to Diabetic Retinopathy

Sight loss and blindness impose a significant social and economic burden on individuals and society. Canadian health economists estimated the financial resources necessary for eye health service planning for people with sight loss, not specific to diabetes (44,45). An annual cost per person with sight loss from all causes was estimated to be $25,390 in 2020 Canadian dollars; adding loss of well-being increased the annual cost per person to $41,047 in 2020 Canadian dollars (44,45). DR was determined to generate the fifth highest overall cost at $250 million in 2020 Canadian dollars (44,45).

Two primary studies in Canada referred to the costs of sight loss in people with diabetes (2,23,35). An older study from Nova Scotia (1993-1996) analyzed the cost-of-illness of ophthalmic and related services which totalled $10.5 million over 3 years ($16.3 million in 2020 Canadian dollars), including direct and indirect ophthalmic care (23). The percentage breakdown of ophthalmologic costs for people with diabetes in Nova Scotia is presented in Table 2 (23).

Table 2. Percentage breakdown of ophthalmologic costs for people with diabetes in Nova Scotia (1993-1996) (23).

Percentage of cost	**Cost category**				
	Direct Costs for ophthalmologic services	Indirect Costs (i.e., lost productivity)	Rehabilitation services*	Disability payments	Lost wages due to disability payments
100.00%	13.46%	48.22%	2.38%	9.32%	26.62%

*Rehabilitation services include talking books, reorientation, and mobility training.

Another group estimated a general Canadian health system cost of $3,000 per year in 2007 Canadian Dollars ($3,600 in 2020 Canadian Dollars) for treatment of severe sight loss/blindness secondary to diabetes, this being higher than the equivalent sight loss from causes not related to diabetes (2,35). Table 3 provides the average annual health-care cost by year since experiencing blindness for the cohort with diabetes and the unmatched cohort without diabetes (2). The excess cost of blindness for people with diabetes by year since experiencing the event is also shown (2).

Table 3. Average annual per person health-care cost of blindness in Ontario in 2007 (2).

Diabetes status	**Sample Size**	**Cost of blindness per year since index event (2007 Canadian Dollars)**				
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Diabetes	2,651	3,890	3,130	2,896	2,787	2,979
Non-diabetes	18,383	2,545	2,068	1,893	1,926	1,776
Excess cost		1,345	1,062	1,003	861	1,203

Prevention of Sight Loss

Prevention of sight loss involves activities aimed at reducing the onset of DR in people living with diabetes (46,47). Strategies include improved awareness and knowledge of DR and risk factor reduction through healthy behaviour modifications, and pharmacological interventions for the management and treatment of diabetes and screening to detect the onset of DR (47).

Diabetic Retinopathy Screening

DR screening is a cost-effective aspect of type 1 and type 2 diabetes management (19,47–49). Diabetes Canada's guidelines make specific recommendations for screening intervals based on the age and type of diabetes. (19).

DR screening is an effective preventive strategy that promptly identifies people with diabetes at risk of developing DR or vision-threatening DR at a relatively low cost compared to the government-funded disability programs that would be provided to people who lose their sight in the absence of a screening program (19,47–49). Screening adherence is associated with better visual outcomes, while low screening compliance is associated with lost opportunities in preventing sight loss attributable to DR (19,47–49).

Diabetic Retinopathy Screening Rates

Although expert clinical guidelines recommend when to start DR screening with respect to a diagnosis of diabetes, as well as appropriate DR screening intervals (19,31), population-based studies consistently show sub-optimal levels of DR screening between 35.6%–67.4% (Table 4) (43,50–53). Low rates of adherence to screening guidelines are attributed to: limited accessibility to eye care professionals, socioeconomic and geographic challenges, restricted mobility associated with poor health, and lack of awareness and knowledge (43).

A population-based study in Toronto, Ontario, found that DR screening was inadequate for all people following diabetes diagnosis, but recent immigrants were even less likely to be screened than long-time residents (51). Despite universal access to physician services, only 50.5% of all individuals with newly-diagnosed type 2 diabetes received DR screening within the first year, and recent immigrants were markedly less likely to be screened (37.5%) (51). A 5% increase in Ontario's DR screening rate and treatment, especially among younger adults, could avert blindness in more than 100 Ontarians per year (52). In Alberta, between 2000-2004, the proportion of people with diabetes who had an eye examination within 3 years of a diagnosis of diabetes fell to 55% from 60% (53). Since there had been a doubling in the actual number of examinations provided by ophthalmologists for people living with diabetes over a 13-year period, the authors suggest that the decline in DR screening rates was related to diabetes rates growing faster than availability of doctors to screen for DR (53).

A study based in Southern Ontario sought to assess whether patient education and tele-retina screening among high-risk people with DR could achieve increased rates of compliance (50). During screening, a 12-slide basic DR presentation was presented by an eye-care professional, which described: risk factors, how diabetes can impact the eye, why sight loss might take place, possible treatment options, and the importance of regular annual screening (50). Following the intervention, annual screening increased from 36% to 51% for people living with diabetes (50).

Table 4. Diabetic retinopathy screening rates in Canada.

Study [First Author (Year of Publication)]	Location	Study Year(s)	Diabetic Retinopathy Screening Rates
Felfeli (2019) (43)	Toronto, Ontario	2011-2013	• 63% of the Toronto population with diabetes
Moinul (2018) (50)	Southern Ontario	2014-2016	• 67.4% of people with diabetes had ever been screened; after education, the rate of annual screening increased from 35.6% to 50.5%
Lovshin (2017) (51)	Toronto, Ontario	1996-2013	• 37.5% of recent immigrants with diabetes • 50.5% of long-time residents with diabetes
Zwarenstein (2014) (52)	Ontario	Not Stated	• 43% of people ages 30-49 years with diabetes • 50% of people ages 50-64 years with diabetes
Rudnisky (2011) (53)	Alberta	2000-2004	• 55% of the Alberta population with diabetes

Benefits of Increased Diabetic Retinopathy Screening

Current DR screening rates range from 35.6%–67.4%, indicating that a significant proportion of people with diabetes who should be screened regularly are not (43,50–53). Further, although funding for optometrist eye exams for people with diabetes of any age is publicly funded in Ontario (54), this is not true in all provinces, including Prince Edward Island (PEI) (55). This is a significant gap in access to care, in terms of potential benefits in sight-years preserved and expenditures averted (55–59).

A cost-utility analysis in Prince Edward Island found that extending publicly-insured services to include eye examinations for people with diabetes was estimated to increase the number of screening tests by 2,221 per year (55). Further, the model showed that, over 30 years, extending public coverage of eye exams to people with diabetes aged 45 and older was associated with incrementally higher costs (~$2.2 million) but improved quality-adjusted life years ($1,337/QALY gained), versus usual care —government-

insured examinations by general practitioners plus ophthalmologists—which resulted in an incremental cost-effectiveness ratio (ICER) of $1668/QALY gained (55).

A vision screening program for seven Cree communities in Western James Bay (11,000 people) compared the cost-effectiveness of screening via a portable retinal camera (i.e. camera system) versus the existing program with specialists flying to the largest town every 6 months (i.e. specialist system) (56). DM prevalence was estimated at 6% (650 individuals) with type 2 diabetes accounting for 99% of cases (56). From the perspective of cost to the health-care system, the camera program was preferable to the specialist-based program (Table 5) (56). Generalizing results to the entire Ontario First Nations population, the authors calculated that the camera system could allow most isolated First Nations People with diabetes to be screened for 5 years for approximately $1.2 million (56).

Overall, the systematic screening for DR is cost-effective in terms of sight-years preserved versus no screening; and digital photography with telemedicine has the potential to deliver cost-effective, accessible screening to rural, remote, northern, and hard-to-reach populations (56,57). However, variations in compliance rates, age of onset of diabetes, glycemic management, and screening sensitivities will influence the cost-effectiveness of a nation-wide DR screening program (57) Notably, screening is only an effective intervention if paired with access to care services.

Table 5. Results from a Cree Community Screening Study (56).

Outcome	Camera System	Specialist System	No Screening
Years of sight lost over 10 years	93	105	161
Years of sight saved over 10 years	67	56	0
Cost of screening per year of sight saved	$3,900	$9,800	NA
QALYs saved	17.4	14.6	NA
Cost per QALY	$15,000	$37,000	NA

Abbreviations: NA (Not Applicable); QALYs (quality-adjusted life years).

Strategies to Increase Diabetic Retinopathy Screening Rates

Interventions to increase DR screening rates can be delivered at a patient, provider, or health system level (60,61). Interventions aimed at improving the general quality of diabetes care work as well as those specifically aimed at improving screening for DR (60,61). Strategies to increase DR screening should be tailored to local needs, as there is great diversity across Canada (60–65). Further, these strategies should target certain population groups who are vulnerable and/or disproportionately affected by diabetes including (60–65):

- Individuals who are low or non-attendees, especially those with multiple missed appointments.

- Working-aged people, people with mental health issues, vulnerable groups including those living in areas of high social deprivation, belonging to a high risk racial and/or ethnic group, with special needs, under the age of 40 years old, longer duration of diabetes, and people with multiple conditions and thus competing demands on their time.

Population-level strategies that are effective in increasing screening rates include:

1. Increased awareness of DR among people with diabetes. Health-care providers should seek to educate people with diabetes about the importance of DR screening as part of diabetes self-care, highlight the asymptomatic nature of DR and emphasize the potential consequences if DR is left unchecked, and explain the procedure including the safety and the benefits of early detection (61,64).
2. Improved health-care provider and practice performance, such as improved adherence to recommendations, improved flexibility of practices (e.g., set up local screening facilities, improve accessibility and transportation, have flexible appointments, and integrate services), and reduced negligence of provider practices.
3. Improved health-care system infrastructure and processes (60–64). Effective health-care system infrastructure and processes include: improved access to health-care; the implementation of computer-based registration and/or reminder systems; collaboration among local organizations that improve access to retinal screening; and the development of a community-based health-care system, which ensures social and cultural compatibility between care recipients and health-care providers (61,62,64). Finally, there is a need to improve communication between health-care providers by integrating ophthalmology into diabetes clinics and/or developing infrastructure to incorporate screening results into diabetes care providers' clinical notes.

Awareness and Knowledge of Diabetic Retinopathy

According to the recommended health-care guidelines, lack of awareness of developing DR is one of the major barriers facing people living with diabetes who are at risk of DR (66). The DR Barometer study—surveyed health-care providers from 41 countries found that the most substantial barrier to eye health was a person with diabetes's lack of knowledge and/or awareness of eye complications (67). The DR Barometer study indicated that there was a significant proportion of respondents who reported being unaware that sight loss could be a complication of diabetes, or had been unaware until they faced vision issues themselves (67).

Evidence suggests that the relationship between the care recipient and the health-care provider is critical in achieving optimal patient outcomes. The DR Barometer Study also found that in clinical settings, there is a general lack of relevant information on diabetes, potential eye complications, and the importance of DR screening (67–69). Limited access to patient education is a serious challenge in improving patient outcomes related to DR, as education is an essential tool for improving the management of diabetes and related complications (67–69). Improved education, knowledge, and awareness about diabetes-related

eye complications and preventive interventions can help people living with diabetes prevent and delay the onset of DR and live healthier lives (67–69). Therefore, ensuring a patient's health literacy as it relates to the management of their diabetes, in conjunction with preventive interventions to delay the onset of complications, is paramount to achieving optimal health outcomes (67–69).

Reducing the Risk of Sight Loss

Targeting modifiable risk factors, including regular physical activity, healthy eating, and maintaining a healthy body weight, helps improve health outcomes associated with diabetes management (70). Optimal diabetes management is key for preventing the development and progression of life-threatening complications, including DR (15,16).

Higher physical activity rates and lower rates of sedentary behaviour are associated with a lower prevalence of DR, while sedentary behaviour has been shown to increase the risk of DR (71–74). One study demonstrated the link after controlling for age, rural residence, education, triglycerides and low-density lipoproteins and higher blood concentrations of high-density lipoproteins, higher systolic blood pressure, lower body mass index, and lower depression score (71).

Maintaining glucose levels within target range reduces the risk of DR, and adherence to the Mediterranean diet enriched with olive oil was associated with a decreased risk of incident DR through its effects on glycemic management (75). The Mediterranean diet, which is also associated with a reduced risk of type 2 diabetes, emphasizes the consumption of fruits and vegetables, beans and pulses, low-sodium foods, plant-based proteins, and lean meats such as fish (15,76). Further, in alignment with the evidence on the Mediterranean diet, high fruit, vegetable, and oily fish intake have been observed to confer strong protective effects on the development of DR (75,77). Overall, nutritional strategies can help reduce the risk of developing DR by helping to preserve the normal physiology, structure, and functions of the retina (27).

A healthy body weight can help prevent or effectively manage diabetes; improve blood sugar, blood pressure, and blood lipids (fats); and reduce the risk of complications such as DR (15). Obesity or high BMI are correlated with escalating DR, since obesity increases inflammatory markers (27,78). A cohort study found that obesity in people with type 1 diabetes is associated with clinically significant DR and macrovascular disease (79). Furthermore, obesity increases the risk of hyperlipidemia and hypertension, which are among the major risk factors of DR (27).

Diabetes Management and DR

Maintaining glucose levels within target range is a key strategy for preventing and delaying the onset of vascular complications, including DR (80). Glucose management is complex and requires a combination of efforts at the individual, health-care provider, and health system level (80).

From the individual perspective, strategies for effective glucose management include, but are not limited to, a healthy eating, engaging in physical activity, consistently self-monitoring of blood glucose, and adhering to medication regimens (80). Even though optimal use of medications is known to delay the onset of complications, approximately 58% of people with diabetes cannot or do not adhere to their medication regimen (81). From the health-care provider perspective, strategies to improve adherence consist of modifying medication regimens in a timely manner if management goals are not achieved; coordinating communication and care among the diverse health-care provider team members; and equipping the individual with all the knowledge and tools needed to effectively self-manage their condition (80).

Several studies have identified barriers and facilitators for effective diabetes management. Facilitators include trust in health-care providers, communication with health-care providers, a support system, use of culturally-appropriate exercise and dietary management, personal understanding of their medical condition, and adequate self-management (82–85). Barriers include lack of knowledge and misconceptions about the condition, information overload, anxiety and uncertainty about how best to manage diabetes, time commitments, lack of active support groups, and lack of cultural adaptation to diabetes management (82–85).

Delaying Progression of DR

Activities aimed at reducing the progression of DR in those with existing DR encompasses (46,47):

- Continuing to monitor, manage, and treat risk factors, which includes achieving optimal blood glucose and blood pressure levels (19). Optimizing glycemic management, targeting an A1C ≤7%, has been shown to slow the development and progression of diabetic retinopathy (19). Blood pressure control is an important component of risk factor modification in diabetes and reduces the risk of DR progression (19).
- Performing regular screening to monitor the progression of mild DR to vision-threatening stages (19). Screening for DR should be performed by an experienced vision care professional (optometrist or ophthalmologist), either in person or through interpretation of retinal photographs (19).
- Following the evidence-based guidelines for managing DR as outlined in the 2018 *Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada* (19).

In people who experience sight loss due to DR, treatment modalities consist of pharmacological intervention, laser therapy, and vitreoretinal surgery (19).

Conclusion

The burden and impact of sight loss due to DR are high in Canada and are expected to remain substantial in parallel with the increasing prevalence of diabetes. Early detection of DR by screening is variable across Canada, is not readily accessible in rural, remote, and northern regions, and access to treatment by eye care professionals is unequal based on where you live. Further, adherence to or uptake of DR screening is low-to-moderate across Canada.

Prevention strategies need to be at the forefront of preventing and/or delaying the onset of sight loss due to DR. A shift in focus from delaying progression of DR to prevention strategies is needed to target a larger portion of the population. The effective implementation of prevention strategies has the potential to significantly reduce the burden of sight loss due to DR.

Technical Glossary

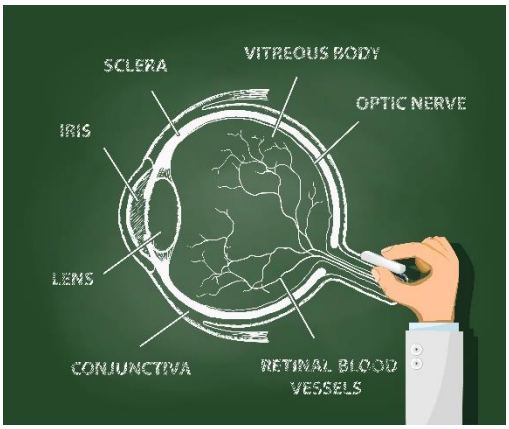

Image credit: Trifonenko; source: iStock

Intraretinal hemorrhage: A small blood vessel bleed in the retina.
Intravitreal: The clear, colourless, transparent gel that fills the eyeball, behind the lens of the eyeball.
Intravitreal injections: Injection of medication into the vitreous of the eyeball (see vitreous).
Macula: A small, yellowish area lying slightly off-centre to the centre of the retina. It is made up mostly of cones and plays a key role in vision.
Microaneurysms: Small blood clots.
Microvascular: Small blood vessels.
Non-clearing vitreous bleeding: Bleeding in the eye that does not spontaneously resolve and requires treatment, impairs vision.
Photocoagulation treatments: Laser treatments to the eye to stop bleeding from blood vessels which can impair vision.
Proteinuria: Elevated levels of protein in the urine, commonly associated with diabetes and kidney disease.
Retina: Thin lining at the back of the eyeball, important for vision.
Vascular: Blood vessel.
that can easily bleed and can impair vision.
Vascular malformation: Irregular blood vessels that can leak fluid and/or bleed and can impair vision.

Vascular tortuosity: Twisted or distorted blood vessels that can leak fluid and/or bleed and can impair vision.
Vitreoretinal: Relating to the vitreous and the retina (see retina and vitreous).
Vitreoretinal traction: The vitreous gel has an abnormally strong adhesion to the retina, causing pulling, and can impair vision.
Vitreous: The clear gel that fills the space between the lens and the retina of the eyeball.

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