Diabetes-Induced Eye Disease Among First Nations People in Ontario, Canada: A Longitudinal, Population-Based Cohort Study

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ABSTRACT

Background: First Nations populations in Canada experience a higher incidence of diabetes and diabetes-related complications than other people. To date, little information has been available comparing utilization of preventive eye examinations and the need for interventional care for severe retinopathy among First Nations people and other people.

Methods: In collaboration with the Chiefs of Ontario, we carried out a population-based study to identify cohorts of First Nations and other people with diabetes in Ontario, Canada from 1995 to 2014. Linked databases were used to evaluate eye examination rates and severe DR treatment rates.

Results: Only 49.8% (95% CI: 48.9% - 50.7%) of First Nations people and 53.8% (95% CI: 53.7% - 54.0%) of other people with diabetes received an eye examination in 2014. First Nations people with diabetes developed severe DR at a faster rate than other people with diabetes (Hazard ratio 1.19 [95% CI: 1.02 - 1.38). The gap between First Nations people and other people in the proportion requiring therapy for severe diabetic retinopathy was especially prominent among younger people.

Interpretation: Eye examination rates remain sub-optimal among people with diabetes in Ontario and were lower among First Nations people. This is particularly concerning in light of our other findings showing an increased risk of developing advanced DR and the accelerated rate of DR progression among First Nations people with diabetes.

INTRODUCTION

First Nations people in Canada experience a higher incidence of diabetes and diabetes-related complications than other people.(1-5) The reasons for this are complex and linked to the effects of colonization including persistent material deprivation, multigenerational trauma and long term stress.(6, 7) Among the many deleterious consequences of diabetes, diabetic retinopathy (DR) is the most common and is the leading cause of blindness and vision impairment in working-age adults.(8-10) DR is a progressive disorder and, of the more than 3 million Canadians with diabetes, over 60% will develop DR.(11-15) At advanced stages, DR leads to severe vision loss, which has profound effects on people's lives.(10, 16)

While the risk for developing DR is related to the degree of glycemic control (17, 18), the risk of developing poor vision outcomes due to advanced retinopathy can be reduced through regular eye examinations and early detection.(14, 19) However, ensuring access to regular eye examinations for the growing population with diabetes is challenging and First Nations people may be at higher risk of not receiving screening eye examinations for a number of reasons such as remoteness from care providers and comorbidity, as well as financial and cultural barriers.(1, 2) At advanced stages of retinopathy, interventions are required to prevent further vision loss. Although these treatments can be vision saving, they often indicate a failure of preventive efforts and are associated with poor vision outcomes. To date, little information has been available comparing utilization of eye examinations and the need for interventional care for severe retinopathy among First Nations people and other people. Hence, in collaboration with the Chiefs of Ontario, we carried out a population-based study to compare rates of eye examinations and interventional therapies to treat vision-threatening stages of DR among First Nations people with diabetes and other people with diabetes in Ontario.

METHODS

We conducted a population-based, retrospective cohort study in Ontario, Canada from 1995-2014. Details of the study methods are published elsewhere.(20) Briefly, in each year of the study, people with diabetes in Ontario were identified using the Ontario Diabetes Database, a validated population-based dataset.(21) First Nations people were identified using the Indian Register (IR), which provides information on all Registered/Status First Nations people in Canada, and the remainder of the population was classified as other people in Ontario.(20)

The primary outcomes evaluated were the frequency of eye examinations and advanced DR treatments in each study year. To evaluate eye examinations, we used the Ontario Health Insurance Plan (OHIP) database, which includes information on all visits for eye examinations provided by ophthalmologists, family physicians and optometrists as well as telemedicine care. To assess the development of severe retinopathy, the OHIP database was used to identify procedures employed in the treatment of vision-threatening stages including intravitreal medication injections (e.g. for delivery of vascular endothelial growth factor inhibitors), laser retinal photocoagulation procedures and vitrectomy surgery. Covariates evaluated included age, sex, comorbidity (assessed using the Johns Hopkins Adjusted Diagnosis Groups), rurality (using the Rurality Index for Ontario) and, for First Nations people, living in or outside of a First Nations community. Details of the codes used to identify eye examination visits and procedures are listed in Table S1 (online supplementary material).

To further compare the rates at which First Nations people and other people develop the need for interventions for advanced DR, a Cox proportional hazards model was used to evaluate the time from diagnosis of diabetes to first DR treatment among First Nations people and other people diagnosed with diabetes during the study period, adjusting for age and sex.

In 2004, OHIP policies regarding the coverage of routine eye exams were changed, therefore, the evaluation of eye examination frequency was limited to a ten-year period from 2005-2014. For eye examination data, unadjusted rates were evaluated to reflect adherence to DR care guidelines, which recommend regular eye examinations for people with diabetes irrespective of age and sex.(14) For interventional care outcomes, age and sex standardized rates were calculated in order to adjust for differences both between and within populations over time.

Analyses were conducted using SAS Enterprise Guide version 7.1 (Cary, NC). This project received approvals from the Chiefs of Ontario Data Governance Committee and the Research Ethics Boards of Queen's University and Laurentian University. The report structure follows "reporting of studies conducted using observational routinely-collected data" (RECORD) & "strengthening the reporting of observational studies in epidemiology" (STROBE) guidelines.

RESULTS

First Nations people with diabetes were significantly younger, more likely to be female and less likely to live in urban areas than other people with diabetes included in the study (Table 1).

During the study period, there was sub-optimal utilization of eye examinations among both First Nations people and other people with diabetes, with only about half the population receiving an eye examination within the previous year and only two thirds receiving an eye examination in the previous 2-year period (Figures 1 and S1). For example, only 49.8% (95% CI: 48.9% - 50.7%) of First Nations people and 53.8% (95% CI: 53.7% - 54.0%) of other people with diabetes receiving an eye examination in 2014. Further, First Nations people with diabetes were less likely than other people with diabetes to receive an eye examination (Figures 1 and S1). Encouragingly, the proportion of First Nations people with diabetes who received an eye examination during the previous year increased from 43% to 50% between 2005 and 2014, mirroring a similar increase among other people with diabetes. Eye examination rates were similar for First Nations people with diabetes regardless of whether they lived in or outside a First Nations community (Figure S2). In both populations, younger people were less likely to undergo eye examinations than their older counterparts (Figure S3). Up through the age of 80 years, the proportion of people with diabetes receiving eye examinations increased with age. Beyond 80 years of age the proportion dropped significantly in both population groups.

First Nations people with diabetes were more likely to develop advanced DR requiring treatment, particularly in later study years (Figure 2). There were no significant differences in DR treatment rates in First Nations people stratified by place of residence (living in versus outside a First Nations community) (Figure S4). The differences between First Nations people and other people in the proportion requiring therapy for DR was especially prominent among younger people (Figure 3). For example, in the 30-49 years age group 1.8% of First Nations people required treatment in 2014, compared to 0.9% of other people requiring treatment in the same year.

Finally, in the analysis of time from diabetes diagnosis to first DR treatment, the rate of progression to severe DR requiring therapy was approximately 20% higher among First Nations people with diabetes than among other people with diabetes (hazard ratio: 1.19; 95% confidence interval: 1.02 to 1.38; Figure 4). Overall, approximately 4% of First Nations people with diabetes required therapy for DR within 10 years of diagnosis.

INTERPRETATION

Diabetes is a common disease with serious consequences including the risk of blindness if not carefully managed. As part of a comprehensive, population-based study on diabetes and its consequences in the First Nations population of Ontario, this study compared temporal trends in eye examination frequency, a measure of advanced DR prevention, and DR treatment rates, a measure of eye-related diabetes complications, between First Nations people and other people. We found that preventative eye examination access and uptake is suboptimal among all Ontarians and is worse among First Nations people. Even when the screening interval was set at the upper limit of guideline recommendations, approximately one-third of diabetics from either population group failed to undergo eye examinations. We also found that First Nations people are more likely to require interventions for advanced stages of DR and that this gap has widened recently. Moreover, First Nations people progressed to advanced stages of DR at a faster rate than other people in Ontario leading to strikingly higher need for interventional DR treatment among younger First Nations people.

The current finding of lower than expected eye examination rates is consistent with other First Nations population studies (22, 23) and other population-based surveys.(14, 24, 25) While all people diagnosed with diabetes in Ontario are afforded annual eye examinations under the Ontario Health Insurance Plan (OHIP), impediments to screening, in the overall population and in First Nations populations specifically, have persisted over time. Our finding that First Nations people with diabetes developed advanced stages of DR requiring interventional therapy at a higher rate than other people also parallels findings from previous reports.(1, 5, 23, 26-28) The development of DR can imply inadequate prevention measures, such as infrequent eye screening or inadequate control of glucose, blood pressure and lipids. Other work by our group shows that glycemic control is significantly worse in First Nations people with diabetes regardless of location of residence or rurality, while lipid control is better in First Nations people than in other people in Ontario with diabetes.(29) Previous studies have also shown that programs to support tight control of blood glucose and other risk factors such as blood pressure and lipid profile could reduce progression of DR among First Nations people.(27, 30) Achieving these improvements among those most at risk, however, has proven to be complex and challenging.(27) Our finding that younger First Nations people with diabetes were particularly at risk is concerning and deserves additional study. Furthermore, the finding that people with newly-diagnosed diabetes in the First Nations population require treatment for DR earlier than their non-First Nation counterparts, underlines the importance of enhanced DR screening, risk factor control and additional work to design programs tailored to the unique situations of First Nations people to reduce the onset of DR.(1)

There are several limitations to this study. First, we assumed that visits to care providers for an eye examination would include examination of the retina to evaluate the presence of DR; however, it is not possible to confirm from the data whether a full examination was actually provided. However, given the importance of DR, it is likely that eye examinations for people with diabetes did in fact include screening for DR as indicated. Second, quantification of eye care services was based on fee-for-service claims captured in the public insurance program

(OHIP) and does not include examinations reimbursed solely from private insurance. Although people with diabetes are entitled to have their visits covered through the public insurance program, we cannot exclude the possibility that some visits were not captured. Third, the Ontario Diabetes Database does not distinguish between type 1 and type 2 diabetes, which may differ in proportion among populations. Fourth, potential barriers to care such as travel, missed work, child and elder care duties and cultural barriers were not directly evaluated in our study.(2, 14) Fifth, some people in north-western Ontario may have received care in Manitoba and would not have been captured. This would affect only a small proportion of people and would be unlikely to affect our overall conclusions.

Through the use of a large healthcare administrative data base, our study has added to our understanding of temporal trends in preventive care and management of DR in First Nations people and other people in Ontario. Further analysis is needed to uncover factors that could contribute to our understanding of suboptimal screening rates in both population cohorts, including health care provider availability, the use of telemedicine, financial barriers and clinical factors. Additional study will also be needed to understand both the increased risk of developing advanced DR and the accelerated rate of DR progression in First Nations people with diabetes. This population-based study provides policymakers, healthcare providers and people with diabetes with an enhanced understanding of diabetes and its life-altering complications.

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B. Chiefs of Ontario
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G. Data Access and Responsibility: In accordance with the Personal Health Information Protection Act (PHIPA) of Ontario, the raw administrative data used for statistical analyses in this manuscript may only be accessed by agents of the Institute for Clinical Evaluative Sciences (ICES), a prescribed entity under Section 45 of the Act, for the purposes of conducting research that contributes to the effectiveness, quality, equity and efficiency of health care and health services. Dr. R.J. Campbell is an agent of ICES and had full control over the data definitions and analyses used in this manuscript. Dr. R.J. Campbell had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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Table 1. Demographic characteristics of First Nations people and other people in Ontario with and without diabetes, 2014 [a,b]

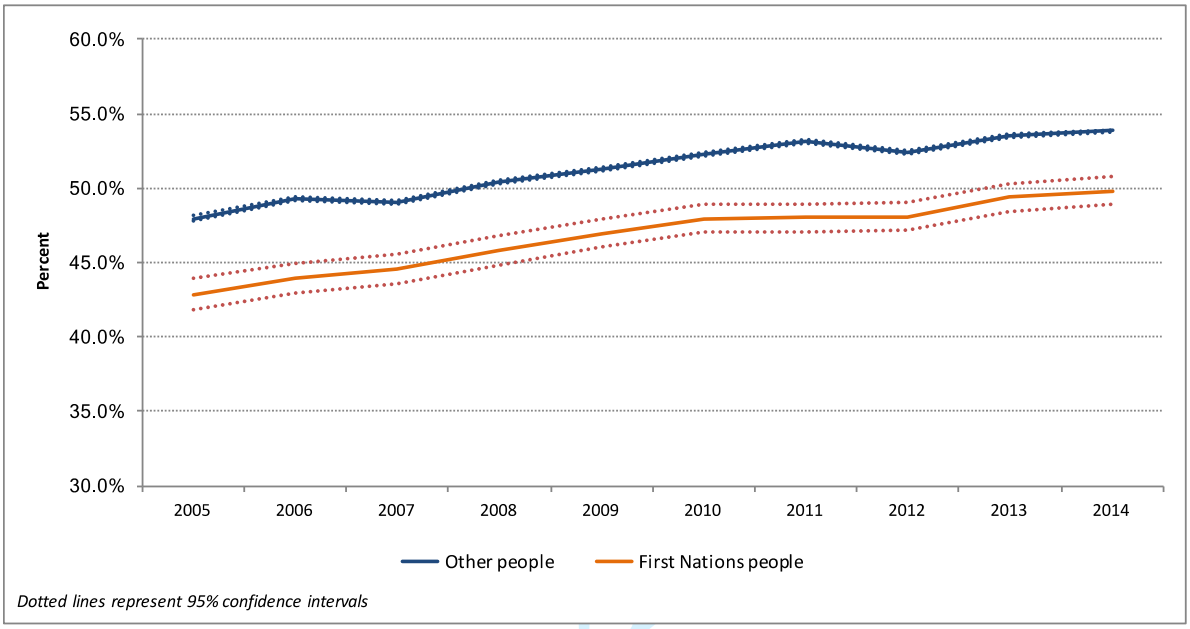
		Other People		First Nations People		First Nations People - In Community		First Nations People - Outside Community	
		with diabetes	overall	with diabetes	overall	with diabetes	overall	with diabetes	overall
Variable	**Value**	*N=1,364,222*	*N=13,454,157*	*N=23,013*	*N=160,578*	*N=8,914*	*N=56,215*	*N=14,098*	*N=104,323*
Sex	Female	655,137 (48.0%)	6,853,014 (50.9%)	12,324 (53.6%)	79,887 (49.7%)	4,649 (52.2%)	26,884 (47.8%)	7,675 (54.4%)	52,982 (50.8%)
	Male	709,085 (52.0%)	6,601,143 (49.1%)	10,689 (46.4%)	80,691 (50.3%)	4,265 (47.8%)	29,331 (52.2%)	6,423 (45.6%)	51,341 (49.2%)
Age	0-19	11,558 (0.8%)	3,026,961 (22.5%)	289 (1.3%)	48,337 (30.1%)	110 (1.2%)	19,154 (34.1%)	179 (1.3%)	29,165 (28.0%)
	20-34	42,554 (3.1%)	2,665,604 (19.8%)	1,615 (7.0%)	40,496 (25.2%)	622 (7.0%)	12,965 (23.1%)	993 (7.0%)	27,525 (26.4%)
	35-49	190,115 (13.9%)	2,821,609 (21.0%)	5,655 (24.6%)	33,500 (20.9%)	2,229 (25.0%)	10,881 (19.4%)	3,426 (24.3%)	22,608 (21.7%)
	50-64	472,041 (34.6%)	2,828,926 (21.0%)	9,239 (40.1%)	26,811 (16.7%)	3,543 (39.7%)	9,095 (16.2%)	5,695 (40.4%)	17,712 (17.0%)
	65-74	337,383 (24.7%)	1,170,125 (8.7%)	4,108 (17.9%)	7,657 (4.8%)	1,597 (17.9%)	2,736 (4.9%)	2,511 (17.8%)	4,921 (4.7%)
	75+	310,571 (22.8%)	940,932 (7.0%)	2,107 (9.2%)	3,777 (2.4%)	813 (9.1%)	1,384 (2.5%)	1,294 (9.2%)	2,392 (2.3%)
Rurality [c]	Urban (0-9)	989,738 (72.5%)	9,829,035 (73.1%)	6,278 (27.3%)	50,852 (31.7%)	97 (1.1%)	622 (1.1%)	6,181 (43.8%)	50,212 (48.1%)
	Sub-urban (10-39)	262,088 (19.2%)	2,580,133 (19.2%)	4,588 (19.9%)	31,742 (19.8%)	1,192 (13.4%)	6,563 (11.7%)	3,395 (24.1%)	25,174 (24.1%)
	Rural (40+)	103,251 (7.6%)	958,797 (7.1%)	3,865 (16.8%)	25,822 (16.1%)	1,149 (12.9%)	7,328 (13.0%)	2,716 (19.3%)	18,487 (17.7%)
	Missing	9,145 (0.7%)	86,192 (0.6%)	8,282 (36.0%)	52,162 (32.5%)	6,476 (72.6%)	41,702 (74.2%)	1,806 (12.8%)	10,450 (10.0%)

[a] Data presented as number (%)

[b] Within each variable, percentages add to 100% by column

[c] Rurality Index of Ontario

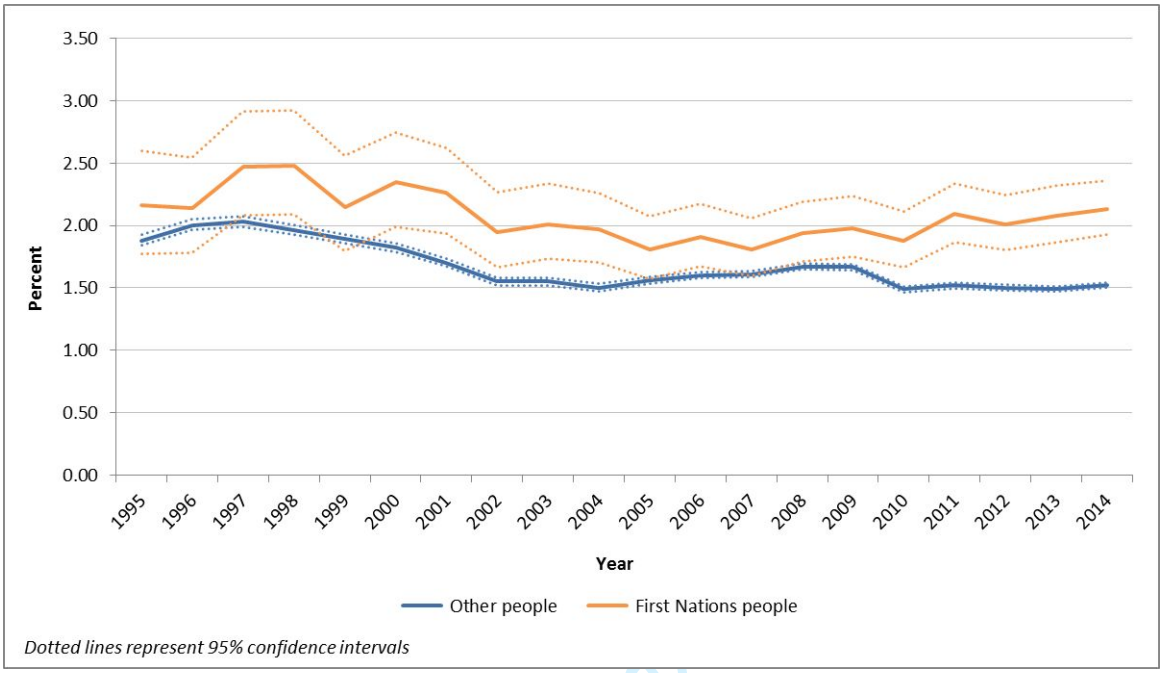
Figure 1 Proportion of individuals with diabetes receiving an eye examination, among First Nations people and other people in Ontario, 2005–2014*



Dashed lines represent 95% confidence intervals.

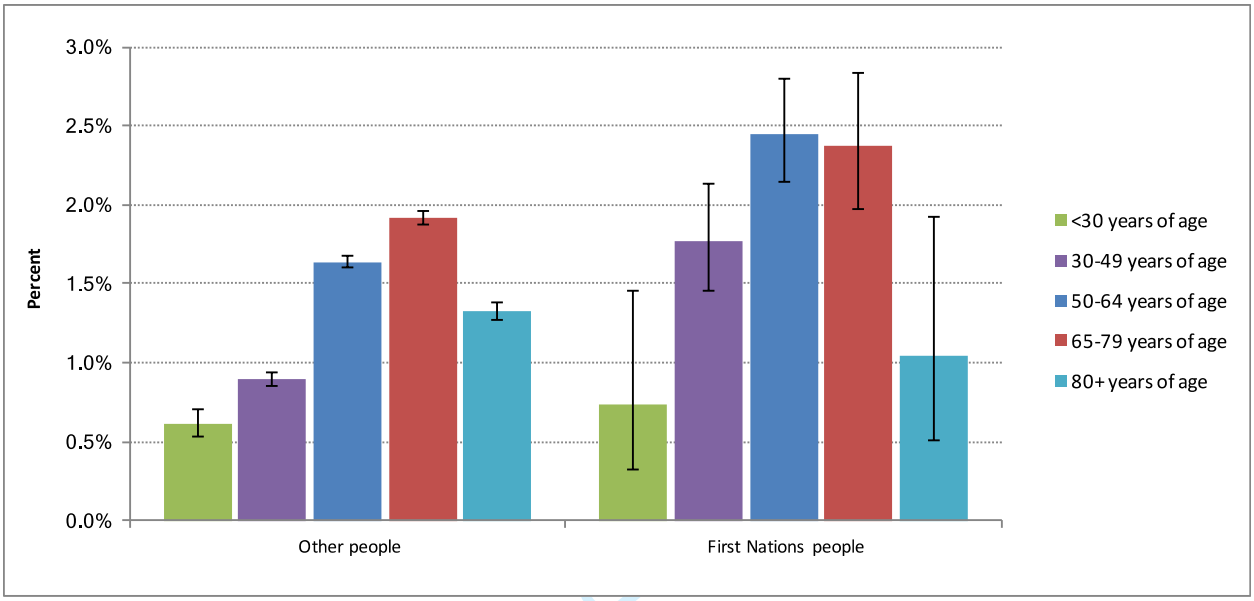
* Because OHIP funding of eye examinations changed in 2004, the baseline year was set at 2005 to provide data consistency.

Figure 2 Age and sex-adjusted proportion of individuals with diabetes receiving any treatment for diabetic retinopathy, among First Nations people and other people in Ontario, 1995–2014



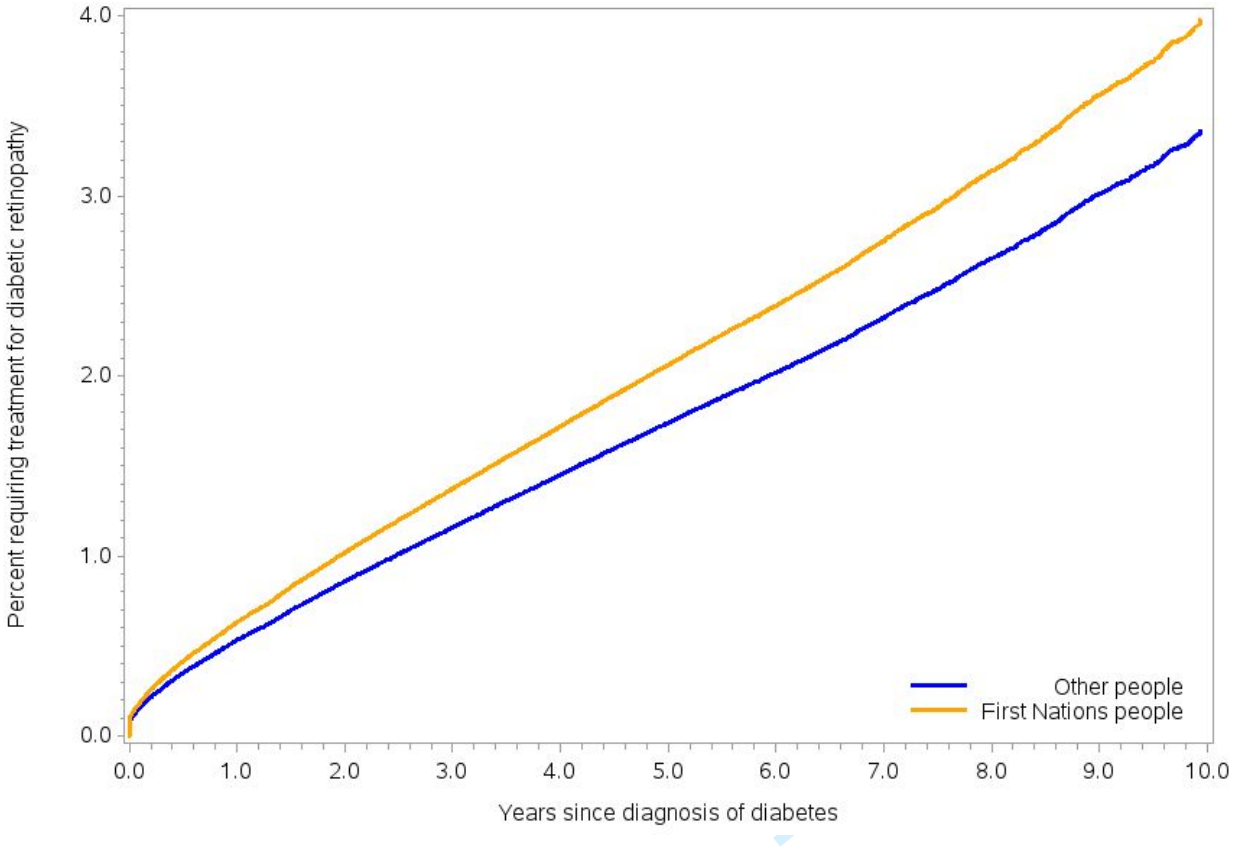
Dashed lines represent 95% confidence interval.

Figure 3 Proportion of individuals with diabetes receiving therapy for diabetic retinopathy, among First Nations people and other people in Ontario, by age group, 2014



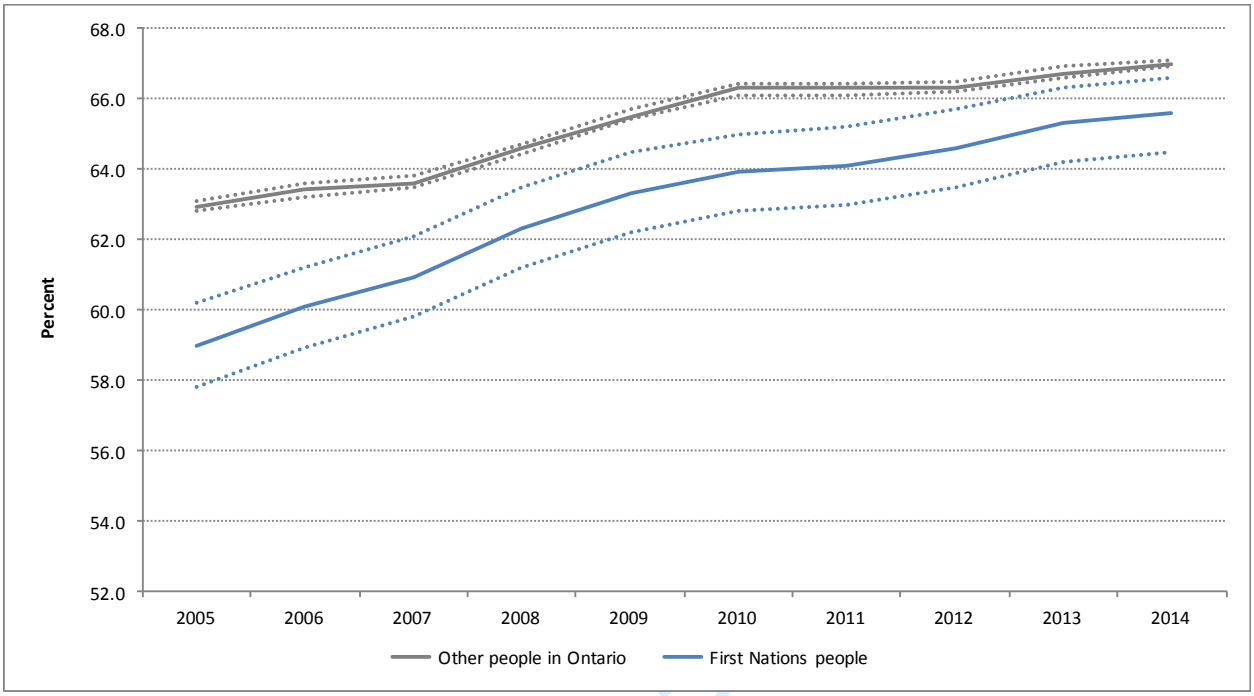
Error bars represent 95% confidence intervals.

Figure 4 Age- and sex-adjusted proportion of First Nations people and other people with diabetes undergoing treatment for diabetic retinopathy by time since diabetes diagnosis, 1995–2014*



*Includes intravitreal injection procedure, laser photocoagulation and vitrectomy.

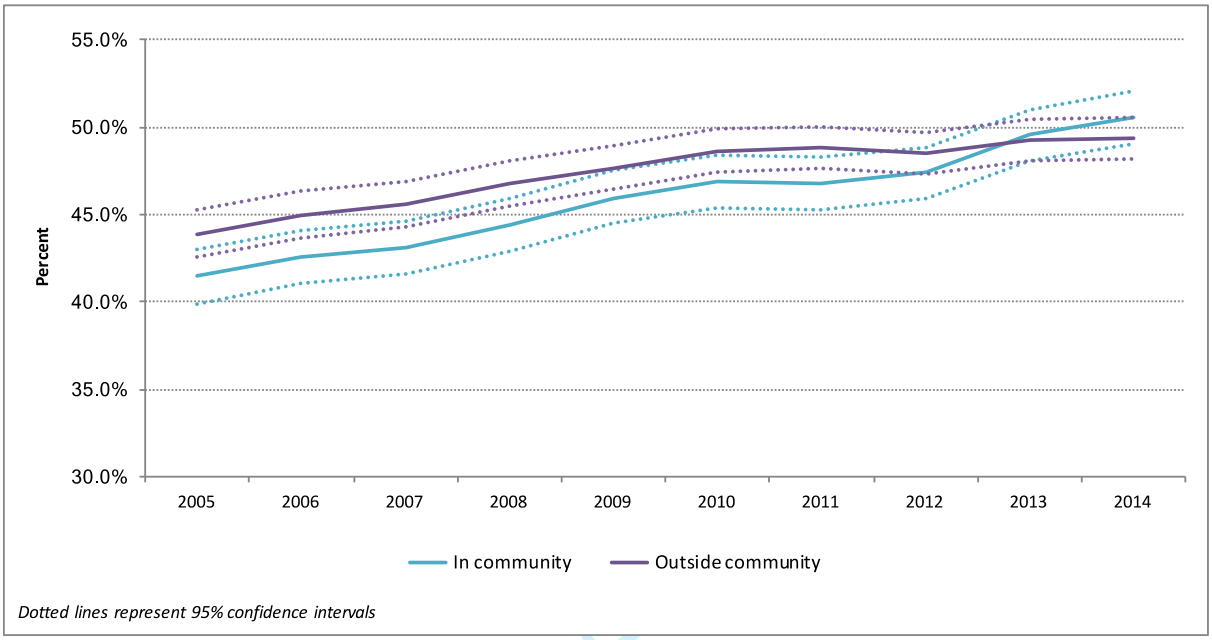
Figure S1 Proportion of individuals with diabetes receiving an eye examination in the previous 2-years, among First Nations people and other people in Ontario, 2005–2014*



Dashed lines represent 95% confidence intervals.

* Because OHIP funding of eye examinations changed in 2004, the baseline year was set at 2005 to provide data consistency.

Figure S2 Proportion of individuals with diabetes receiving an eye examination, among First Nations people living in and outside of First Nations communities in Ontario, 2005–2014*



Dashed lines represent 95% confidence interval.

* Because OHIP funding of eye examinations changed in 2004, the baseline year was set at 2005 to provide data consistency.

Figure S3 Percentage of First Nations people with diabetes and other people with diabetes receiving an eye examination by age, 2014.

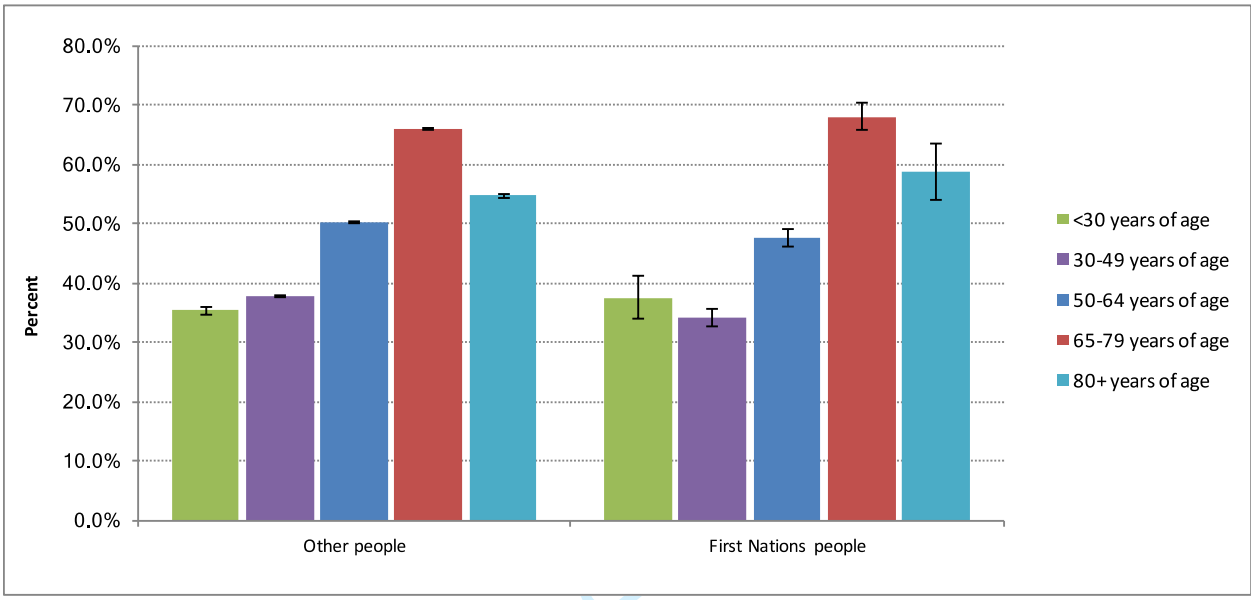
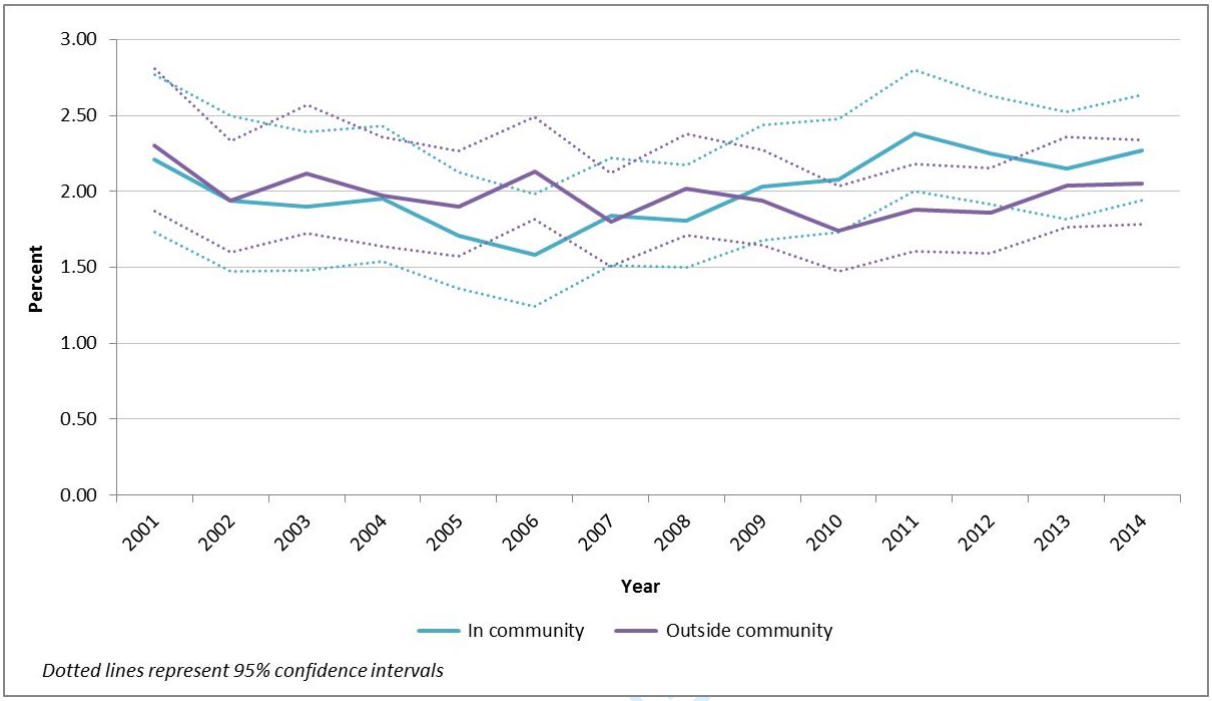


Figure S4 Proportion of individuals with diabetes receiving any treatment for diabetic retinopathy, among First Nations people living in and outside of First Nations communities in Ontario, 2001–2014



Dashed lines represent 95% confidence interval.