

# Improvements in Indicators of Diabetes-related Health Status Among First Nations Individuals Enrolled in a Community-driven Diabetes Complications Mobile Screening Program in Alberta, Canada

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## ABSTRACT

**Objective:** The goal of Screening for Limb, I-Eye, Cardiovascular, and Kidney complications of diabetes (SLICK) is to reduce the burden of diabetes among Alberta First Nations individuals. By analyzing the longitudinal results of SLICK over a six-year time span, our purpose was to examine both baseline diabetes-related health status and whether subsequent improvements occurred.

**Methods:** Diabetes complications screening, diabetes education, and community-based care were provided by mobile clinics which traveled to 43 Alberta First Nations communities biannually. Body mass index (BMI), waist circumference, hemoglobin A1c (HbA1c), total cholesterol and blood pressure, as well as the presence of foot and kidney abnormalities were assessed among 2,102 unique subjects with diabetes. Mean values of diabetes health indicators at baseline and subsequent visits for returning subjects were compared. Secular trends were sought by examining trends in mean baseline health indicators per year.

**Results:** High baseline rates of obesity, poor HbA1c concentrations, hypercholesterolemia, hypertension, foot abnormalities and kidney damage were observed. Significant improvements in BMI, blood pressure, total cholesterol and HbA1c concentrations were identified ( $p < 0.01$ ) in returning subjects. Similarly, significant decreasing secular trends in total cholesterol and HbA1c concentrations were observed ( $p < 0.01$ ). At baseline, females had a higher prevalence of obesity and abnormal waist circumference ( $p < 0.05$ ); however, males had more inadequate HbA1c concentrations ( $> 8.4\%$ ), hypercholesterolemia, hypertension, foot abnormalities and kidney damage ( $p < 0.05$ ).

**Discussion:** Despite worrisome baseline clinical characteristics, diabetes-related health appears to be improving modestly in Alberta First Nations individuals.

**Key words:** Aboriginal; North American; type 2 diabetes mellitus; mobile screening; rural communities

La traduction du résumé se trouve à la fin de l'article.

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As with many Aboriginal populations worldwide, there has been a rapid emergence of type 2 diabetes among First Nations populations.<sup>1,2</sup> Aboriginal prevalence rates of diabetes and its complications are reportedly 2-5 times higher than those of the general Canadian population.<sup>2-6</sup> The problem is expected to worsen dramatically with the increasing prevalence of obesity, metabolic syndrome and type 2 diabetes in First Nations youth.<sup>3</sup> In response, several community-based, primary and secondary diabetes prevention and/or screening projects have been successfully implemented in many Canadian First Nations communities.<sup>7-10</sup> Reported longitudinal results of such projects are scarce and have shown only limited effectiveness with respect to health outcomes.<sup>8,10</sup> However, modest health improvements among Aboriginals have been shown in longitudinal diabetes projects in Australia and the US.<sup>11-13</sup>

The Screening for Limb, I-Eye, Cardiovascular, and Kidney complications of diabetes (SLICK) project is an ongoing community-driven diabetes complications mobile screening program. This descriptive paper sought to report indicators of diabetes health status at baseline and over time among SLICK participants over a six-year time span from December 2001 to June 2007.

## METHODS

SLICK travelled to 43 Alberta First Nations communities twice a year to provide diabetes complications screening, diabetes education, and community-based care starting in 2001. Rationale and

methods have been reported elsewhere.<sup>9,14</sup> Briefly, two mobile clinics were equipped with portable lab technology and staffed by qualified health care personnel who were either First Nations (Cree-speaking where possible) or had Aboriginal-specific training. Local community health representatives and home-care nurses, and/or personal care attendants collaborated within each First Nation community by assisting with each visit. Significant initial funding to SLICK was provided by the Canadian Health Infrastructure Partnership Program (CHIPP) to University of Alberta researchers, who ran the program in collaboration with the First Nations and Health Canada. SLICK was approved by the University of Alberta Health Research Ethics Board. The project direction transitioned from the University of Alberta to Health Canada in 2005.

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**Conflict of Interest:** None to declare.

**Table 1.** Baseline Characteristics of SLICK Subjects (total n = 2102)

	Male	Female
Age	54.0 ± 13.9	53.4 ± 14.6
Age at diagnosis (years)	45.9 ± 13.5	44.3 ± 14.0
Duration of diabetes (years)	<b>7.9 ± 8.1*</b>	<b>9.2 ± 9.0*</b>
BMI (kg/m <sup>2</sup> )	32.5 ± 6.1	33.7 ± 7.1
% Overweight	<b>30.5%* (27.2-33.8)</b>	<b>23.3%* (21.0-25.6)</b>
% Obese	<b>62.8%* (59.4-66.2)</b>	<b>68.4%* (65.9-70.9)</b>
Waist circumference (cm)	110.1 ± 14.4	110.7 ± 14.8
% Abnormal NCEP	<b>70.8%* (67.6-74.0)</b>	<b>94.1%* (92.8-95.4)</b>
HbA1c (%)	8.0 ± 2.0	7.8 ± 1.9
% Poor	62.4% (59.0-65.8)	59.0% (56.3-61.7)
% Inadequate	<b>38.1%* (35.0-41.8)</b>	<b>33.2%* (30.7-35.8)</b>
Total cholesterol (mmol/L)	5.1 ± 1.2	5.1 ± 1.2
% Hypercholesterolemia	<b>46.3%* (43.3-49.3)</b>	<b>43.0%* (39.2-46.8)</b>
Systolic blood pressure (mmHg)	<b>133.2 ± 17.9*</b>	<b>128.7 ± 18.0*</b>
Diastolic blood pressure (mmHg)	<b>80.0 ± 11.0*</b>	<b>75.7 ± 10.3*</b>
Mean arterial pressure (mmHg)	<b>97.6 ± 11.7*</b>	<b>93.4 ± 11.3*</b>
% Hypertensive	<b>70.3%* (67.1-73.5)</b>	<b>57.3%* (54.6-60.0)</b>
Foot risk category		
% with no abnormality (0)	<b>63.0%* (59.5-66.5)</b>	<b>71.3%* (68.7-73.9)</b>
% at high risk (3)	7.7% (5.8-9.7)	5.2% (4.0-6.5)
% High ACR	<b>49.0%* (45.0-53.0)</b>	<b>29.2%* (26.2-32.3)</b>
% Overt proteinuria	<b>14.1%* (11.5-16.7)</b>	<b>10.1%* (8.2-12.0)</b>
% Taking insulin	20.9% (18.0-23.8)	20.1% (17.9-22.3)
% Taking oral agents	65.3% (61.9-68.7)	63.6% (61.0-66.2)

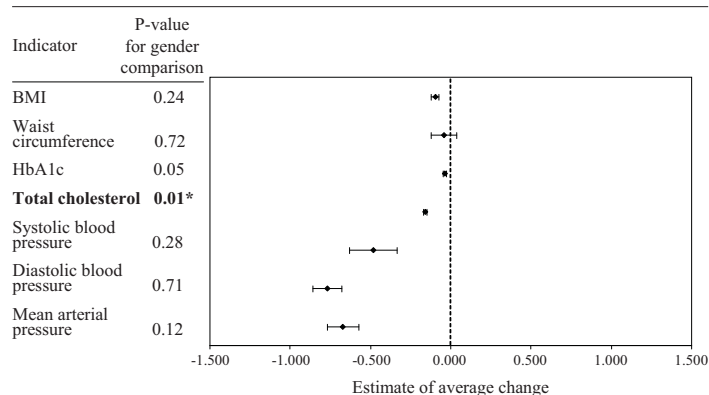
Values are means (± SD) or prevalence (95% confidence intervals).

\* Significant difference between genders (p<0.05).

Indicators of diabetes-related health status that were measured included height and weight (for the calculation of body mass index; BMI), waist circumference, hemoglobin A1c (HbA1c), total and fractionated cholesterol, triglycerides, blood pressure, foot abnormalities (peripheral neuropathy) and kidney damage (proteinuria or microalbuminuria). Each diabetes indicator analyzed was drawn from the recent Canadian consensus for the standardized evaluation of quality improvement interventions in type 2 diabetes.<sup>15</sup>

Subjects were volunteers with known diabetes and enrolled through either referral by community health care workers or self-referral in response to advertising. Diabetes was confirmed by medications, chart review, or infrequently, nurse history. The vast majority of subjects had type 2 diabetes (approximately 99%). Adult subjects (18 years or older) were considered overweight if BMI was 25-29.9 and obese if BMI was ≥30.<sup>16</sup> Children were classified as overweight or obese if BMI was between the 85<sup>th</sup>-95<sup>th</sup> percentile or ≥ the 95<sup>th</sup> percentile, respectively.<sup>17</sup> Given that there are no established definitions for abnormal waist circumference in Aboriginals, the National Cholesterol Education Program (NCEP) cutoffs (males >102 cm, females >88 cm<sup>16</sup>) were utilized for adults. Children were considered to have abnormal waist circumferences if ≥ the 90<sup>th</sup> percentile.<sup>18</sup> HbA1c was used to assess glucose control according to both the 1998 and 2003 Canadian Clinical Practice Guidelines (CPGs) cutoffs: "inadequate glucose control" (>8.4%) and "poor glucose control" (>7%), respectively.<sup>19,20</sup> We used cutoffs for hypercholesterolemia and hypertension of >5.2 mmol/L (total cholesterol) and >130/80, respectively.<sup>20</sup> Children were considered hypertensive if ≥ the 95<sup>th</sup> percentile.<sup>21</sup> HbA1c and lipid concentrations were determined using the Bayer DCA2000®+ and the Cholestech L.D.X™ portable analyzers, respectively.

The presence of foot abnormalities (peripheral neuropathy) were determined by use of a microfilament wire, and World Health Organization foot grades (0 = no abnormality; 1 = sensory loss, low risk; 2 = sensory loss and presence/history of deformity, moderate risk; 3 = presence/history of plantar ulcer, high risk) were applied.<sup>22</sup> Kidney damage was defined as either overt proteinuria (urine dip-

**Figure 1.** Trends for diabetes indicators of returning SLICK subjects over time (N=1218)

Values are estimates for the average change in indicators per year with 95% confidence intervals.

\* Decreased more in females compared to males

stick >100 mg/dl) or microalbuminuria (microalbumin/creatinine ratio (ACR) >2.0 for males, >2.8 for females). Dipstick was used to screen all participants and ACR was measured (via Bayer DCA2000®+) only on those who were dipstick negative.

Mean baseline indicators of diabetes-related health were calculated and compared between genders. Also, mean baseline and subsequent indicators were compared for individuals over time, and clinical parameters at baseline visits, per year, were also examined, looking for a secular trend. Compared to baseline subjects, the longitudinal group (those with more than one visit) differed only in age (53.6 and 56.3 years, respectively) and duration of diabetes (8.8 and 10.5 years, respectively). Statistical analyses were done with SAS 9.1 (SAS Institute Inc, Cary, NC) and SPSS 17.0 (SPSS Inc, Chicago, IL). Results were considered significant if p<0.05. Standard deviations and 95% confidence intervals were determined for mean and prevalence values accordingly. Gender comparisons were conducted using chi-square tests for categorical variables. For continuous variables, we used a logistic regression model, where the variables included covariates. For the longitudinal analysis, univariate general linear mixed effect models with random client effect and fixed time (year) effect were used for continuous outcome variables and gender comparisons. Longitudinal analyses for baseline clinical parameters per year were adjusted for duration of diabetes. Categorical variables were not analyzed longitudinally due to the unbalanced nature of the data.

## RESULTS

From 2001 to 2007, 2,102 unique subjects with known diabetes were screened and a total of 4,978 visits were completed, corresponding to approximately 62% of cases in Alberta's First Nations population on-reserve.<sup>2,23</sup> The mean and median number of visits per subject were 2.2 and 2, respectively. For returning subjects, the mean and median time span between visits were 441 and 351 days, respectively. Subjects ranged from 9 to 94 years of age, the mean being 54 years. The majority of subjects (62.5%) were female.

The mean duration of diabetes was 9 years, with females having a significantly longer mean duration than males (p<0.05; Table 1). We identified high baseline rates of overweight and obesity (91.8%), abnormal waist circumference (85%), poor and inadequate glucose control (60% and 35%), hypercholesterolemia (44.1%),

**Table 2.** Diabetes Indicators of New Unique SLICK Subjects Over Time Adjusted for Duration of Diabetes

	2001/02	2003	2004	2005	2006	2007	Overall F (p-value)	Gender-specific F (p-value)
BMI (kg/m <sup>2</sup> ) (n=1879)	33.1 ± 0.2 (n=757)	32.8 ± 0.3 (n=376)	33.4 ± 0.4 (n=320)	33.6 ± 0.5 (n=167)	33.7 ± 0.5 (n=157)	33.4 ± 0.7 (n=102)	0.72 (p=0.61)	0.25 (p=0.94)
Waist circumference (cm) (n=1860)	111.4 ± 0.5 (n=754)	108.9 ± 0.7 (n=372)	110.5 ± 0.8 (n=318)	109.9 ± 1.1 (n=164)	109.9 ± 1.2 (n=155)	110.2 ± 1.9 (n=97)	1.60 (p=0.16)	0.57 (p=0.73)
HbA1c (%) (n=1902)	8.0 ± 0.0 (n=768)	7.5 ± 0.0 (n=378)	7.3 ± 0.0 (n=320)	7.5 ± 0.0 (n=171)	7.3 ± 0.0 (n=161)	7.2 ± 0.0 (n=104)	8.92 (P<0.01)	1.12 (p=0.22)
Total cholesterol (mmol/L) (n=1913)	5.4 ± 0.1 (n=771)	5.0 ± 0.1 (n=380)	4.9 ± 0.1 (n=322)	4.6 ± 0.1 (n=172)	4.8 ± 0.1 (n=163)	4.7 ± 0.1 (n=106)	18.48 (P<0.01)	1.46 (p=0.20)
Systolic blood pressure (mmHg) (n=1893)	131.6 ± 0.7 (n=769)	129.9 ± 0.9 (n=372)	130.6 ± 1.0 (n=318)	129.0 ± 1.4 (n=170)	129.5 ± 1.4 (n=161)	127.5 ± 1.8 (n=103)	1.52 (p=0.18)	1.75 (p=0.12)
Diastolic blood pressure (mmHg) (n=1893)	77.3 ± 0.4 (n=769)	76.7 ± 0.6 (n=372)	77.1 ± 0.6 (n=318)	77.5 ± 0.8 (n=170)	78.0 ± 0.9 (n=161)	76.8 ± 1.1 (n=103)	0.42 (p=0.83)	0.49 (p=0.79)
Mean arterial pressure (mmHg) (n=1893)	95.4 ± 0.4 (n=769)	94.4 ± 0.6 (n=372)	94.9 ± 0.7 (n=318)	94.7 ± 0.9 (n=170)	95.1 ± 0.9 (n=161)	93.7 ± 1.1 (n=103)	0.68 (p=0.64)	0.94 (p=0.45)

Values are means ± SD.

hypertension (62.3%), foot abnormalities (32%) and kidney damage (37% with elevated ACR, 11.8% with proteinuria). The proportion of overweight subjects was higher among males ( $p<0.05$ ); however obesity ( $p<0.05$ ) and abnormal waist circumference ( $p<0.05$ ) were more prevalent among females. The proportion with inadequate HbA1c concentrations was higher for males ( $p<0.05$ ). Hypercholesterolemia, hypertension, foot abnormalities, abnormally high ACR, and proteinuria were more prevalent among males than females ( $p<0.05$ ).

Figure 1 displays the trends over time for selected diabetes indicators in returning subjects enrolled in the SLICK program. Significant improvements in BMI, blood pressure, mean arterial pressure, total cholesterol and HbA1c concentrations were detected in returning subjects ( $p<0.01$ ). No gender differences were apparent for returning subjects, with the exception of total cholesterol, which improved to a greater extent among returning females compared to males ( $p<0.05$ ).

When baseline data for new unique subjects coming to SLICK were compared over time (adjusted for duration of diabetes), significant improvements were observed for average total cholesterol and HbA1c concentrations as yearly trends for these parameters declined over the six-year time span ( $p<0.01$ ; Table 2). In other words, new subjects coming to SLICK had more favourable total cholesterol and HbA1c concentrations compared to prior unique subjects, suggesting secular improvements. For new unique subjects, no gender differences were observed in the change over time in diabetes indicators.

## DISCUSSION

We observed improvements in several indicators of diabetes-related health status among First Nations individuals with diabetes living on-reserve in Alberta between 2001 and 2007. Significant improvements in BMI, blood pressure, total cholesterol and HbA1c concentrations were shown in those followed over time. Additionally, decreasing secular trends in total cholesterol and HbA1c concentrations were identified. These results are encouraging given the poor baseline results.

Our reported poor baseline diabetes health status of First Nations is consistent with recent studies of Canadian Aboriginals. Roughly

40% of First Nations individuals in Alberta with diabetes had HbA1c concentrations below the CPGs target ( $<7%$ ), compared to 45% and 37% in First Nations populations of Eeyou Istchee (Quebec<sup>4</sup>) and Sandy Lake (Ontario<sup>7</sup>), respectively. Additionally, the detected high prevalence rates of overweight/obesity, abnormal waist circumference, hypercholesterolemia, hypertension and kidney damage are similar in other Aboriginal populations in North America and Australia, and are considerably higher than in non-Aboriginal populations.<sup>4-7,11,12,24</sup>

Providing modest improvements in BMI, HbA1c, blood pressure and cholesterol concentrations leads to considerable reductions in diabetes complications risk,<sup>25,26</sup> thus our reported decreases in diabetes-related measures seen over time can be viewed as progress. It is also favourable that additional outcomes that did not improve over time (waist circumference, risk of foot abnormalities, kidney damage/proteinuria) at least did not worsen. Various longitudinal diabetes projects in Australia and the US<sup>11-13</sup> have shown similar modest improvements in HbA1c concentrations, cholesterol and blood pressure in Aboriginals with and without diabetes. However in British Columbia, a two-year community-based diabetes prevention and control project utilizing behavioural and environmental change was found to be ineffective in improving diabetes indicators among First Nations individuals with or at risk for diabetes.<sup>8</sup> Also, a community-based diabetes prevention project in Quebec did not lead to sustained improvements in risk factors over 8 years among First Nations children.<sup>10</sup>

The secular data support results from cross-sectional studies of administrative data in both Canada and the US.<sup>4,13,24</sup> Dannenbaum et al.<sup>4</sup> showed that the proportion of Eeyou Istchee First Nations individuals with diabetes achieving HbA1c concentrations  $<7%$  significantly improved from 2002 to 2005. Significant improvements in HbA1c and cholesterol concentrations, as well as in blood pressure, have also been shown in American Indians and Alaska Natives with diabetes from 1995 to 2001.<sup>13,24</sup>

In the present study, subjects were educated about appropriate screening recommendations and the SLICK program itself. Subjects received a copy of their screening test results, were individually informed of the implications of the results, and were given recom-

mentations regarding the need for follow-up with primary care providers. Part of SLICK's community care provision is to increase accessibility to and quality and quantity of diabetes screening services for rural First Nations people who may not have access to care. However, whether or not the improvements observed for returning subjects over time in the current study are the result of the SLICK project cannot be determined, as no control group was included. It is also probable that various other factors had an impact, particularly the updated Canadian CPGs,<sup>20</sup> improved diabetes treatments and care from other health providers, and non-SLICK activities of the federally funded Aboriginal Diabetes Initiative. These factors likely had an even more pronounced effect on secular trends observed for new subjects per year.

Gender differences in diabetes complications rates described in other populations have been contradictory.<sup>27-29</sup> Our results suggest that First Nations males may be at a higher risk for diabetes-related complications than females, despite having endured a shorter duration of the disease on average. The prevalence of inadequate HbA1c concentrations, hypercholesterolemia, hypertension, foot abnormalities and kidney damage were significantly higher among male subjects. It could be speculated that these are the results of males seeking care less often. Interestingly, however, although greater reductions in total cholesterol were observed for returning females compared to males, we did not observe any other differences between males and females regarding changes in diabetes indicators over time in both new subjects per year and returning subjects.

In addition to the lack of a control group, the findings are also limited as data regarding anti-hypertensive and lipid-lowering medications were not always reliably collected, thus the prevalences of hypertension and lipid abnormalities are likely underestimated. Also, subjects were not randomly selected and therefore were not necessarily a representative sample; the study probably (and anecdotally) included both those likely to be more health-conscious and some who had very poor care. Population-based studies examined prospectively are needed. Nevertheless, SLICK improves access to diabetes care and provides important community-based information. It should also be noted that SLICK only captures on-reserve individuals; caution must be used when extrapolating results to the diabetes health of off-reserve individuals.

Despite high baseline rates of obesity, poor HbA1c concentrations, hypercholesterolemia, hypertension, foot abnormalities and kidney damage, on-reserve Alberta First Nations subjects with diabetes followed over time showed improvements in BMI, blood pressure, total cholesterol and HbA1c concentrations. Moreover, decreasing secular trends in total cholesterol and HbA1c concentrations were observed. While these observations are encouraging, efforts such as SLICK and other community-based diabetes initiatives will need to be sustained and possibly expanded in order for improvements to be continued.

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### RÉSUMÉ

**Objectifs :** Le projet SLICK (dépistage des complications du diabète) vise à réduire le fardeau du diabète chez les Premières nations de l'Alberta. Nous avons examiné l'état de santé de référence des personnes diabétiques et ses améliorations ultérieures en analysant les résultats longitudinaux du projet sur six ans.

**Méthode :** Le dépistage des complications, la sensibilisation au diabète et les soins communautaires ont été assurés par des unités sanitaires mobiles qui ont visité deux fois l'an 43 communautés des Premières nations de l'Alberta. L'indice de masse corporelle (IMC), le périmètre ombilical, l'hémoglobine A1c (HbA1c), le cholestérol total, la pression artérielle et la présence d'anomalies du pied et des reins ont été évalués

chez 2102 sujets diabétiques. Nous avons comparé les valeurs moyennes des indicateurs pendant la visite de référence et les visites ultérieures des sujets de retour, et déterminé les tendances à long terme d'après l'évolution moyenne annuelle des indicateurs de base.

**Résultats :** Des niveaux d'obésité élevés, des concentrations excédentaires en HbA1c, de l'hypercholestérolémie, de l'hypertension artérielle, des anomalies du pied et des insuffisances rénales ont été observés au départ. Chez les sujets de retour, des améliorations significatives ( $p < 0,01$ ) de l'IMC, de la pression artérielle, du cholestérol total et des concentrations en HbA1c ont été détectées. À long terme, il y a eu des baisses significatives ( $p < 0,01$ ) du cholestérol total et des concentrations en HbA1c. À la base, les femmes affichaient une prévalence accrue d'obésité et de périmètre ombilical anormal ( $p < 0,05$ ). Cependant, les concentrations excédentaires en HbA1c ( $> 8,4\%$ ), l'hypercholestérolémie, l'hypertension, les anomalies du pied et l'insuffisance rénale étaient plus présentes chez les hommes ( $p < 0,05$ ).

**Discussion :** Malgré un profil clinique de base inquiétant, l'état de santé lié au diabète semble s'améliorer modérément chez les Premières nations de l'Alberta.

**Mots clés :** Indiens d'Amérique nord; diabète de type 2; dépistage mobile; population rurale



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