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Prevalence of diabetes mellitus in aboriginal and nonaboriginal people living in the Bella Coola Valley

A retrospective population-based medical chart review found that age, weight, body mass index, and aboriginal ancestry all appear to contribute to the risk of developing type 2 diabetes.

ABSTRACT:

Background: Type 2 diabetes mellitus affects an estimated 4.8% of the Canadian adult population. Diabetes prevalence rates for British Columbia's aboriginal people have been reported as being lower than those reported for other aboriginal groups, and lower than the overall Canadian rate. The purpose of this study was to determine the prevalence rate of diabetes among the aboriginal and nonaboriginal populations living in the Bella Coola Valley. The relationships between age, gender, weight, body mass index and aboriginal status and having diabetes mellitus were also examined.

Methods: Retrospective population-based medical chart review was conducted using the charts of people living in the Bella Coola Valley and having a chart at the Bella Coola Medical Clinic as of September 2001.

Results: After adjustments were made for age, the data revealed the prevalence of type 2 diabetes among aboriginals to be 12.5%. Among nonaboriginals, the prevalence rate was similar to that reported for the general population of Canada (4.8%). It was determined that age, weight, body mass index, and aboriginal status were all significant contributors to the risk of developing type 2 diabetes.

Conclusion: Given the wide variation in prevalence rates observed and reported for aboriginal people residing in British Columbia to date, the findings in this report indicate the need for individual study of different First Nations groups.

Background

According to a report issued by Health Canada in 2002, 4.8% of Canadians, 20 years of age and older, had type 2 diabetes mellitus in 1998–1999.[1] In British Columbia, the prevalence rate is approximately 4.9%.[2] There is considerable agreement among those who study diabetes that the prevalence of the disease is on the rise and will continue to rise if left unchecked. In the United States, the age-adjusted prevalence rate of diabetes has almost

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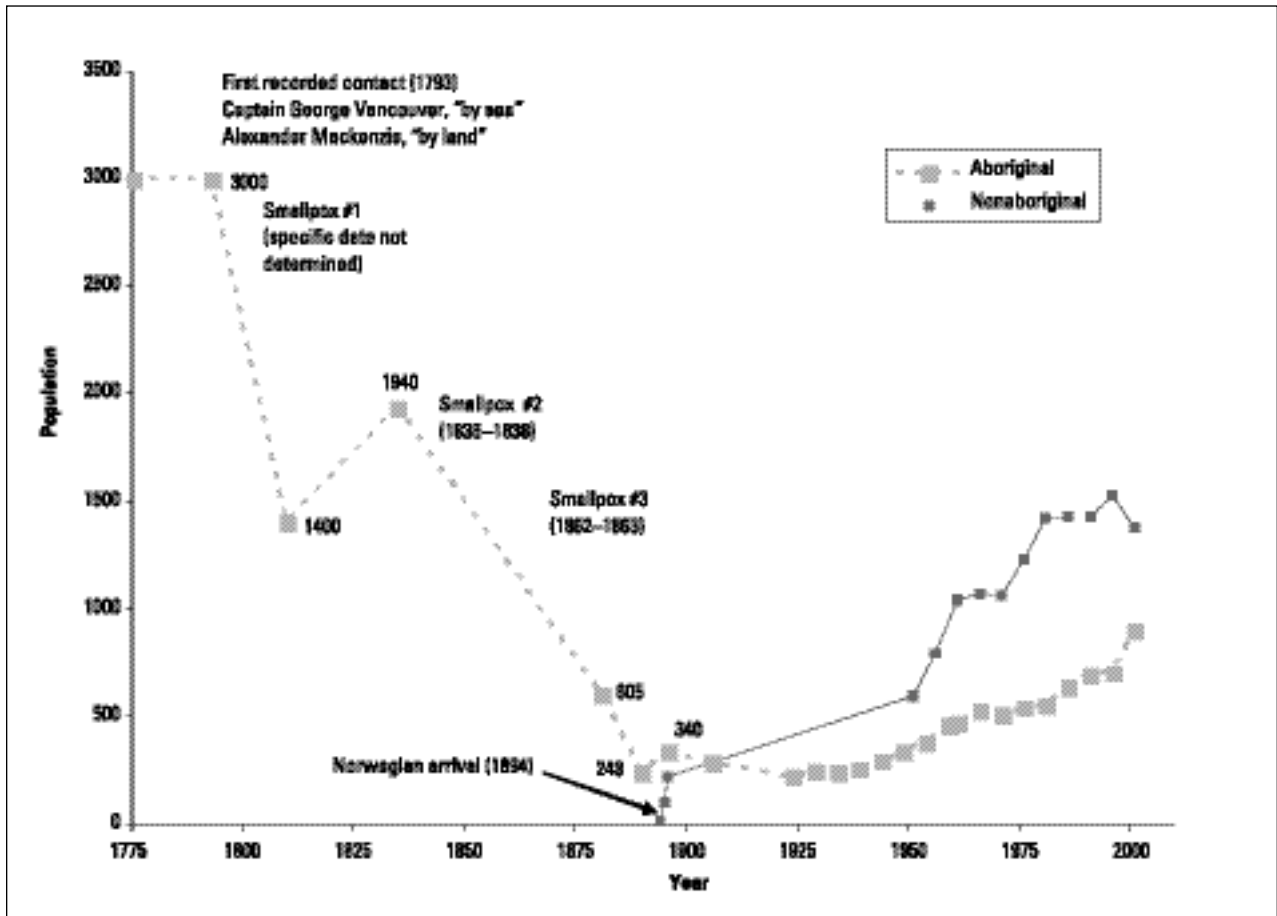
Figure 1. Population trends in Bella Colla Valley.

doubled in 20 years, going from 2.8% in 1980 to 4.5% in 2000.[3] In British Columbia, it is estimated that the prevalence of diabetes will reach 7.1% by the year 2010.[2]

Aboriginal people as a group appear to be at increased risk of developing adult-onset diabetes mellitus. According to a report published by Health Canada, the prevalence rate of diabetes among the First Nations people in Canada is more than double the rate for the general population.[4] While the prevalence rate of diabetes is higher in the aboriginal population overall, it is important to note that there is considerable regional variation.[5-13] A study conducted by Young and col-

leagues showed that the prevalence rates of diabetes in aboriginal populations varied greatly among the provinces and territories, with the Atlantic provinces and Ontario having the highest rates, at 8.7% and 7.6%, respectively, while British Columbia, Yukon, and Northwest Territories had the lowest, at 1.6%, 1.2%, and 0.8%, respectively.[8]

The majority of the studies conducted in Canada on the prevalence of non-insulin-dependent diabetes mellitus have been conducted in eastern Canada, despite the fact that the majority of First Nations tribes live in western Canada. Bella Coola Valley is a rural and remote community located

in the central coast region of British Columbia. According to the 2001 census, 2260 people live in the Bella Coola Valley.[14,15] Bella Coola Valley is part of the traditional territory of the Nuxalk Nation. The Nuxalk people are a tribe of Salish-speaking coastal Indians who now live in the Bella Coola Valley, but formerly lived throughout the surrounding British Columbia central coast area.[16-20] Like most aboriginal tribes living in North America, the Nuxalk were affected by smallpox and other diseases during the 1800s and early 1900s (**Figure 1**).[16,19] According to census information, 44% of Bella Coola's population is of aboriginal ancestry, most of this group being of

Nuxalk descent.[14,15] The majority of these aboriginal people live on the Bella Coola Indian Reserve.

The purpose of this study was to determine (1) the prevalence of diabetes mellitus in both the aboriginal and nonaboriginal populations of Bella Coola, and (2) the relative importance of age, weight, body mass index, and aboriginal ancestry as risk factors for the development of diabetes in this isolated rural population.

We hypothesized that the prevalence of non-insulin-dependent diabetes mellitus would be higher in the aboriginal population than the nonaboriginal population. We also hypothesized that age and weight would be risk factors for the development of diabetes mellitus in this population.

Methods

The United Church Health Services operates a clinic and a hospital in Bella Coola at the same site. There are no other primary care health facilities in the area.[20] Bella Coola Hospital is one of the most isolated health care facilities in British Columbia.[21-23] The closest higher-level hospital is over 6 hours away by road in Williams Lake or 2 hours away by air in Vancouver. The isolation of this community is such that almost everyone who lives in the Bella Coola Valley has either a clinic chart or an emergency room record.

This research project was carried out in a participatory fashion, following the recommendations outlined in a recently published policy statement.[24-28] Prior to collecting data, we obtained letters of support from the Nuxalk Band Council, from the Bella Coola Transitional Health Authority, and from the Central Coast Regional District for a comprehensive study on determinants of health for people living in the Bella Coola Valley. Ethics approval was obtained from research ethics committees at both the University of British Columbia and the University of Northern British Columbia. The results and the manuscript were reviewed and approved for publication by both Nuxalk health professionals and United Church Health Services health professionals.

A retrospective review of all clinic charts was conducted. After excluding clinic charts of people who did not currently live within the Bella Coola Valley, 2377 patients made up the study population—approximately 105% of the May 2001 census estimate (2260) for the valley. According to staff working at the Population Section of BC Stats, Canada Census data typically underreport the true population of a community by approximately 5% because people who are not home or in transition during the time of the census are missed. For this reason we are confident that we captured the entire Bella Coola Valley population for this study. Information collected during the chart review included the subject's address, age, sex, weight, body mass index, aboriginal status, and presence or absence of diabetes.

The presence of diabetes was based on a physician's diagnosis of diabetes, which in turn was based on the 1998 clinical practice guidelines for the management of diabetes in Canada.[29, 30]

The calculation for body mass index (BMI) used was:

$$BMI = \frac{\text{Weight (kg)}}{\text{Height}^2 \text{ (m}^2)}$$

Aboriginal status[31] for each clinic patient was determined using multiple sources: Nuxalk Band lists, a locally available genealogy, clinic chart, and a recent survey.[32,33] It was found that 47% of the people living in the Bella Coola Valley are of aboriginal descent, which is similar to the census estimate of 44%.[14,15]

Data analysis was performed using SPSS software. The crude prevalence rates of diabetes were calculated through simple frequency tables. The age-adjusted prevalence rates were calculated using the direct method of adjustment, with the standard population being a distribution of the aboriginal and nonaboriginal population combined.[34] For the analysis of statistical significance, the dependent variable is diabetic status as a dichotomous variable. The difference in prevalence rates based on gender and aboriginal status were evaluated using Pearson's chi-square. The differences based on age,

While the prevalence rate of diabetes is higher in the aboriginal population overall, it is important to note that there is considerable regional variation.

Table 1. Characteristics of study population.

Characteristic	Aboriginal (%)	Nonaboriginal (%)
Gender		
Male	566 (50.5)	658 (52.3)
Female	554 (49.5)	599 (47.7)
Age (years)		
18-24.9	140 (19.5)	92 (9.1)
25-39.9	254 (35.3)	247 (24.6)
40-44.9	72 (10.0)	113 (11.2)
45-64.9	195 (27.1)	394 (39.2)
≥ 65.0	58 (8.1)	160 (15.9)
Weight (kg)*		
< 60	400 (35.7)	300 (23.9)
60-69	133 (11.9)	197 (15.7)
70-79	157 (14.0)	209 (16.6)
80-89	159 (14.2)	189 (15.0)
90-99	102 (9.1)	122 (9.7)
100-09	64 (5.7)	75 (6.0)
≥ 110	58 (5.2)	57 (4.5)
Body mass index (kg/m²)†		
< 25.0	287 (25.6)	351 (27.9)
25-29.9	165 (14.7)	262 (20.8)
30-34.9	118 (10.5)	127 (10.1)
35-39.9	94 (8.4)	53 (4.2)
≥ 40.0	48 (4.3)	25 (2.0)

* Weight data is missing for 155 (6.5%) of patients (47 [4.2%] aboriginal; 108 [8.6%] nonaboriginal).
†Body mass index data is missing for 847 (35.6%) of patients (408 [36.4%] aboriginal; 439 [34.9%] nonaboriginal).

weight, and body mass index, all continuous variables, were evaluated using analysis of variance (ANOVA). Odds ratios were calculated using logistic regression to determine the predictive power of age, weight, and body mass index. For all of the analyses, significance was set at $P \leq 0.05$.[35] All analyses were conducted on the total adult study population (≥18 years), and for aboriginals and nonaboriginals separately, where appropriate.

Results

The characteristics of the study population, which is divided into aboriginal and nonaboriginal subsets, are summarized in **Table 1** .There is a similar gender distribution in both the aboriginal and nonaboriginal populations, with both populations having a nearly 1:1 ratio of males to females. The nonaboriginal population is substantially older than the aboriginal population, with mean ages of 40.28 ± 21.00 years and 29.09 ± 19.51 years, respectively. The nonaboriginal population also has a higher mean weight than the aboriginal population (70.87 ± 26.31 kg versus 65.77 ± 30.45 kg), but a lower mean body mass index (25.92 ± 6.33 kg/m² versus 27.25 ± 8.02 kg/m²).

Table 2 shows the proportion of Bella Coola Valley patients with a recent blood glucose measurement in their charts. The data are broken down by age and ethnicity. As one would predict, older patients are much more likely to have glucose values in their charts than younger patients.

Table 3 shows the overall crude prevalence of type 2 diabetes was higher in the aboriginal adult population than in the nonaboriginal adult population (10% versus 6%). Given the differences in the age distributions of the aboriginal and nonaboriginal populations, and the important role that age plays in the prevalence of diabetes, it was important to calculate the age-adjusted prevalence rates for each of the populations. The age-adjusted prevalence rates of diabetes for the aboriginal and nonaboriginal populations were 12.5% and 4.8%, respectively. The relationship between aboriginal ancestry and diabetic status was found to be statistically significant (χ^2 = 10.183; $P = 0.001$).

There was no significant relationship found between gender and diabetic status. There was, however, a significant relationship observed between age and diabetic status in both the aboriginal (F = 25.98; $P < 0.001$) and nonaboriginal populations (F = 13.41; $P < 0.001$) for both males and females, as shown in **Figure 2** and **Figure 3** .

Weight was also found to be significantly related to diabetic status (aboriginal: F = 7.70; $P < 0.001$, nonaboriginal: F = 6.34; $P < 0.001$). As seen in **Table 3** , the prevalence rate of diabetes generally increases with increasing weight. With the exception of the 70 kg to 79 kg weight category, the aboriginal population had a higher prevalence rate of type 2 diabetes based on weight, with the difference being most apparent in the greater than 110 kg weight category (31% versus 20%).

Figure 4 illustrates the distribution of prevalence rates of type 2 diabetes in both the aboriginal and nonaboriginal populations based on body mass index. In both the aboriginal and nonaboriginal populations, the prevalence of diabetes increases with higher body mass index values. The rate of

Table 2. Charts with glucose screening results.

Age and ethnicity of chart subject	Total charts reviewed	Percentage with glucose measurement	Percentage of charts with glucose measurement that also include fasting glucose measurement
< 18 years			
Aboriginal	401	18.2% (n = 73)	24.7% (n = 18)
Nonaboriginal	251	10.8% (n = 27)	37.0% (n = 10)
18–29.99 years			
Aboriginal	224	45.5% (n = 102)	47.1% (n = 48)
Nonaboriginal	137	31.4% (n = 43)	55.8% (n = 24)
30–44.99 years			
Aboriginal	242	64.0% (n = 155)	68.4% (n = 106)
Nonaboriginal	315	50.8% (n = 160)	68.1% (n = 109)
45–64.99 years			
Aboriginal	195	77.9% (n = 152)	81.6% (n = 124)
Nonaboriginal	394	67.3% (n = 265)	86.0% (n = 228)
65+ years			
Aboriginal	58	96.6% (n = 56)	87.5% (n = 49)
Nonaboriginal	161	86.3% (n = 139)	82.7% (n = 115)
Total aboriginal	1120	48.0% (n = 538)	64.1% (n = 345)
Total nonaboriginal	1258	50.4% (n = 634)	76.7% (n = 486)
Bella Coola Valley	2378	49.3% (n = 1172)	70.9% (n = 831)
Adult aboriginal	719	64.7% (n = 465)	70.3% (n = 327)
Adult nonaboriginal	1007	60.3% (n = 607)	78.4% (n = 476)
Adult Bella Coola Valley	1726	62.1% (n = 1072)	74.9% (n = 803)

Table 3. Diabetes and demographic variables.

| Characteristic	Adults N = 1725	Diabetics n = 127 (7%)	Test value	*P* value
Gender				
Female	841	58 (7%)		
Male	884	69 (8%)	0.552	0.470
Aboriginal	719	70 (10%)	10.231	0.001
Nonaboriginal	1006	57 (6%)		
Age (years)				
18-24.9	232	0 (0%)	reference	
25-44.9	686	15 (2%)	601.328	0.553
45-64.9	589	68 (12%)	3534.899	0.449
≥ 65.0	218	44 (20%)	6822.426	0.413
Weight (kg)				
< 60	163	2 (1%)	reference	
60-69	283	6 (2%)	2.017	0.383
70-79	345	21 (6%)	5.171	0.027
80-89	334	26 (8%)	7.087	0.008
90-99	220	26 (12%)	10.087	0.002
100-109	137	17 (12%)	13.323	0.001
110-160	113	29 (26%)	28.139	0.000
Body mass index (kg/m²)				
< 25.0	286	6 (2%)	reference	
25-29.9	392	31 (8%)	3.957	0.010
30-34.9	233	29 (12%)	6.255	0.000
35-39.9	139	28 (20%)	13.932	0.000
40-59	71	28 (39%)	28.333	0.000
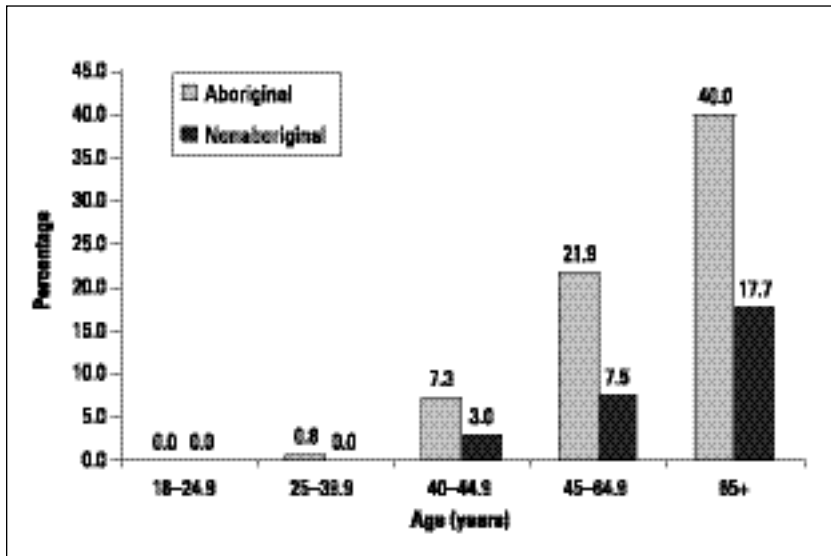
Figure 2. The prevalence of type 2 diabetes in aboriginal and nonaboriginal males based on age.
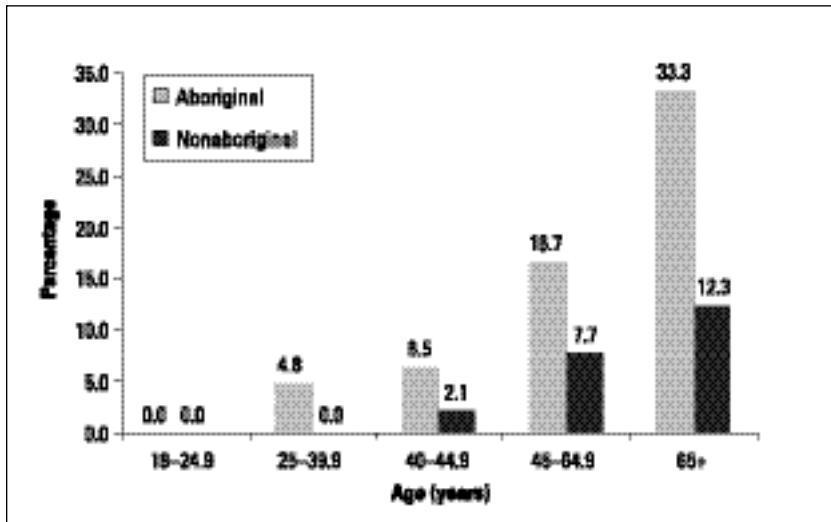

Figure 3. The prevalence of type 2 diabetes in aboriginal and nonaboriginal females based on age.

increase seen is more substantial in the aboriginal population than the nonaboriginal population, with the prevalence rate approximately doubling with each higher body mass index category. The increase seen in the nonaboriginal population is more gradual. Despite these slightly different trends, body mass index is significantly related to diabetic status for both populations (aboriginal: F = 15.3; $P < 0.001$, nonaboriginal: F = 8.02; $P < 0.001$).

The age-adjusted prevalence rate of diabetes among the aboriginal people in Bella Coola is substantially higher than rates previously reported for First Nations groups in British Columbia.[8-10] In the Bella Coola Valley, the crude prevalence of diabetes in the aboriginal population is more than one and a half times that of the nonaboriginal population (10% versus 6%). However, when the differences in the age distribution of the aboriginal and nonaboriginal populations are considered, and the prevalence rates are adjusted, the prevalence of diabetes in the aboriginal population is more than two and a half times that of the nonaboriginal population (12.5% versus 4.8%). The age-adjusted prevalence rate of diabetes for the nonaboriginal population is the same as that reported for the general population of Canada.[1] The finding of a younger age of diabetes onset for aboriginals has been observed in other studies of diabetes and aboriginal populations.[5,11,36]

Since the Bella Coola Valley study population included both aboriginal and nonaboriginal people, it was possible to compare the two groups in terms of their prevalence of diabetes and the relative importance of known risk factors—age, sex, weight, and ethnicity. To the best of our knowledge, this is something that has not been done explicitly before. Two Canadian studies were found that compared aboriginal people to nonaboriginal people with regard to the prevalence of diabetes.[6,7] While both of these studies compared the prevalence rates of diabetes, and other demographic and risk factor variables, neither study specifically examined the relationship between aboriginal ancestry and diabetic status looking for statistical significance. In the Bella Coola Valley study, chi-squared analysis was used to investigate the relationship between aboriginal ancestry and diabetic status. It was determined through this analysis that there is indeed a significant relationship between aboriginal ancestry and diabetic status ($\chi^2 = 10.183$; P

= 0.001).

Since both weight and body mass index values were available for analysis in this study, the relationship between both of these factors and diabetic status was also explored. There was a general trend observed, in both the aboriginal and nonaboriginal populations, of increasing weight and prevalence of diabetes. Analysis of variance revealed that, overall, weight was significantly related to diabetic status in both the aboriginal and nonaboriginal populations. Logistic regression analysis indicated specifically that weight greater than or equal to 70 kg was significantly related to an increased risk of diabetes. The risk of developing diabetes increases substantially with increasing weight, especially at a weight of 110 kg or more (OR = 27.5; 95% CI, 6.4–117.1). In this study, using a body mass index of less than 25 kg/m^2 as the reference, the odds ratios ranged from 4.0 (95% CI, 1.6–9.7) in the 25 to 29.9 kg/m^2 category to 28.1 (95% CI, 11.9–77.6) in the greater than or equal to 40 kg/m^2 category. The results are similar to that reported in a study of the Ojibwa-Cree, where the diabetes odds ratio for a body mass index greater than or equal to 26 kg/m^2 was 4.51 (95% CI, 1.46–6.74) when compared to a body mass index of less than 26 kg/m^2.[37]

Our data suffer from limitations inherent in collecting medical chart information—incomplete information and nonstandardized measurements are common. The sample population was drawn from patients who had been screened for non-insulin-dependent diabetes mellitus. Though there has been a push to screen all adults in this community for non-insulin-dependent diabetes mellitus, this has not been successfully completed yet and the sampling method may therefore have slightly inflated the prevalence rates seen (**Table 2**).
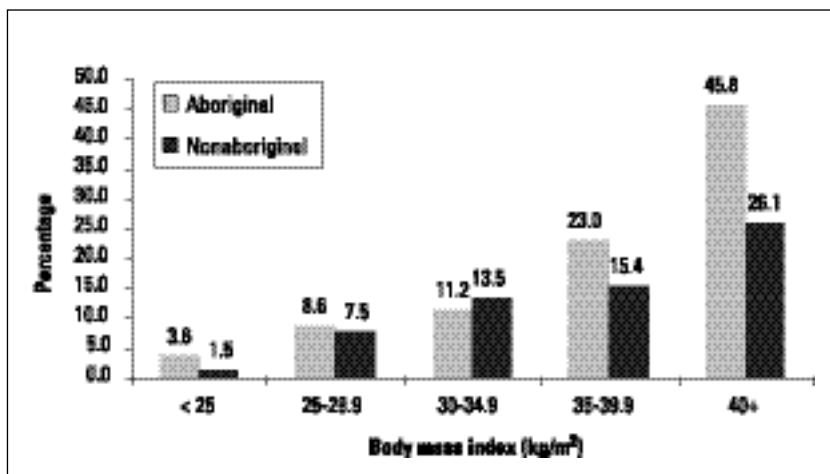

Figure 4. Prevalence rates of type 2 diabetes among aboriginal and nonaboriginal adults based on body mass index (kg/m²).

> **Weight greater than or equal to 70 kg was significantly related to an increased risk of diabetes. The risk of developing diabetes increases substantially with increasing weight, especially at a weight of 110 kg or more.**

After we initiated our chart review in 2001, new clinical practice guidelines for diabetes management in Canada were published. Fortunately, a comparison of the 1998 and 2003 diabetes guidelines reveals identical definitions of diabetes, classifications of diabetes, and plasma glucose values used to diagnose diabetes. The 2003 clinical practice guidelines advocate the age for routine diabetes screening be lowered from 45 years to 40 years, and routine screening is now indicated for people with other kinds of risk factors (e.g., acanthosis nigricans, vascular disease, polycystic ovary syndrome, and schizophrenia). Screening more adults between age 40 and 45 and finding more people with diabetes would not have substantially changed our basic conclusions.

Conclusions

The reported prevalence rates of dia-

betes in British Columbia for aboriginal people are low when compared with rates for other aboriginal groups across Canada, and even lower than the prevalence rate reported for the general population of Canada.[17-19] Our study reveals that at least one First Nations group living in British Columbia—the Nuxalk living in Bella Coola—has diabetes prevalence rates comparable to those reported in eastern Canada. Such findings illustrate the need for individual study of different aboriginal groups. For the purposes of community-level planning for programs and health care resources, province-wide surveys do not provide an accurate picture of the problem of diabetes in aboriginal communities in British Columbia.

Competing interests

None declared.

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