ORIGINAL RESEARCH ARTICLE

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Increasing rates of diabetes amongst status Aboriginal youth in Alberta, Canada

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Objectives. To track and compare trends in diabetes rates from 1995 to 2007 for Status Aboriginal and general population youth.
Study design. Longitudinal observational research study (quantitative) using provincial administrative data.
Methods. De-identified data was obtained from Alberta Health and Wellness administrative databases for Status Aboriginal (First Nations and Inuit people with Treaty status) and general population youth (<20 years). Diabetes cases were identified using the National Diabetes Surveillance System algorithm. Crude annual diabetes prevalence and incidence rates were calculated. The likelihood of being a prevalent case and incident case of diabetes for the 2 populations was compared for the year 2007. Average Annual Percent Changes (AAPC) in prevalence and incidence from 1995 to 2007 were determined and compared between the 2 groups to examine trends over time.
Results. While the prevalence of diabetes was higher in the general population in 1995, by 2007 there were no between group differences, reflected in the significantly higher AAPC of 6.98 for Status Aboriginal youth. Status Aboriginal males had a lower diabetes risk in 1995 compared with females, and experienced a greater increase in prevalence over the 13 years (AAPC 9.18) so that by 2007 their rates were equivalent to those of the females. Differences in diabetes incidence trends were only observed among male youth, where increases in incidence were greater for Status Aboriginal (AAPC 11.65) compared to general population males (AAPC 4.62) ($p = 0.03$).
Conclusion. Youth-onset diabetes is an increasing problem in Alberta, especially among young Status Aboriginal males.

Keywords: *indigenous population*; *Canada*; *epidemiology*; *youth*; *diabetes mellitus*

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For the Aboriginal peoples of Canada (First Nations, Inuit and Métis) type 2 diabetes persists as a major public health problem (1). Although rates of type 2 diabetes are increasing among Inuit and Métis populations (2,3), First Nations in particular suffer rates that are at least 2 times higher than the population at large (1,4,5). Compared to urban populations, the prevalence of diabetes appears to be higher among rural Aboriginal populations (6), and approximately 50% of Aboriginal individuals still reside in rural areas (7). Perhaps more alarming are reports of increasing obesity and emerging type 2 diabetes in Aboriginal youth, which will only further perpetuate the impact of diabetes (4,8–10). Those with early-onset type 2 diabetes experience a longer duration of disease and thus have an increased risk of developing complications (11). Moreover, it has been suggested that an increase in type 2 diabetes among female youth of childbearing age will promote future diabetes among offspring whom are exposed to maternal diabetes in utero (12).

The epidemiology of diabetes in Aboriginal youth has been explored primarily in the province of Manitoba (10), and not in Alberta. Because of considerable differences in First Nations across the country, it is of interest to describe local trends. Moreover, despite the well known increased burden of diabetes among First Nations adults

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(1,4,5), studies comparing diabetes trends in youth according to ethnicity are scarce. Herein we report incidence and prevalence of diagnosed diabetes among Status Aboriginal (First Nations) and the general population youth of Alberta between 1995 and 2007 from Alberta Diabetes Surveillance System (ADSS) administrative data.

Methods

ADSS obtained de-identified data for the entire population of Alberta from Alberta Health and Wellness administrative databases (discharge abstract database, Alberta physician claims data, ambulatory care classification system and vital statistics). Data on the adult (over 20 years) population has been reported elsewhere (5). The present analysis focused on Albertan youth <20 years of age. Status Aboriginal individuals are 'flagged' in the databases and were defined as any Alberta inhabitant registered under the federal Indian Act and entitled to Treaty status with the Canadian Government. The Status Aboriginal identifier captures First Nations and Inuit peoples both on- and off-reserve with Treaty status, but not Métis individuals or Aboriginal individuals without Treaty status who are included in the general population comparison group. Alberta law requires that all residents and dependants register with the Alberta Health Care Insurance plan, thus the Alberta Central Stakeholder registry functioned as a denominator.

Diabetes cases were identified by applying the National Diabetes Surveillance System (NDSS) algorithm (13), which has recently been validated for the determination of pediatric diabetes rates (14). The NDSS methodology of identifying has been validated in non-Aboriginal populations that include persons of varying geographical locations (15,16), and also within an Aboriginal community in Alberta (17). The algorithm requires an individual to have either 2 physician visits or 1 hospitalization for diabetes (ICD-9 codes starting with 250 and ICD-10 codes E10–E14) within 2 years to be labelled as case of diabetes (13). In contrast to the NDSS case definition, pregnant women that may have had gestational diabetes were not excluded in the current analysis due to the elevated risk of subsequent diabetes (18). Also, since the numbers of diabetes cases are small among this population, only crude, unadjusted rates are provided.

Statistical analysis

For both populations, crude annual diabetes prevalence and incidence rates were calculated. The denominators were based on the health insurance registry (which provincial law requires all residents and dependants to register) for the entire population as of June 30 in each year. The first year in which an individual met the criteria for diabetes (with no diabetes claims in the preceding 2 years) was considered an incident year, and considered a prevalent case in subsequent years. Prevalence was determined using the following group-specific formula: total number of youth with diabetes in the calendar year/ the total population for the calendar year. Incidence was determined using the following formula: total number of youth with a diabetes incident date for in calendar year/ (total population count for calendar year)–(prevalent diabetes cases)+(incident diabetes cases). Odds ratios (OR) and 95% confidence intervals were calculated and used to compare the likelihood of being a prevalent case and incident case of diabetes for the 2 populations in 2007. OR 95% confidence intervals that did not include the null value of 1.00 were considered statistically significant with a 5% error. To examine trends over time, Average Annual Percent Changes (AAPC) in prevalence and incidence from 1995 to 2007 were determined and compared using Joinpoint version 3.4.2 (Rockville, MD) for crude values. The AAPC provides a relative summary measure of the trend over a prespecified fixed interval. The AAPC is commonly used in the literature examining longitudinal trends. Technical details about the AAPC can be found in Clegg et al. (19). Tests of parallelism were then performed to determine if trends over time differed by group or sex. P-values of <0.05 were considered statistically significant.

Results

Based on Alberta Health and Wellness administrative databases, 853,733 youth (51.2% male) were living in the province as of 2007, of which 50,930 were Status Aboriginal (51.2% male). Among these youth a total of 2,589 prevalent diabetes cases were apparent in 2007, with 140 cases occurring amongst Status Aboriginal youth. The 2007 crude prevalence rate of diabetes was 0.27 and 0.31% in the Status Aboriginal and general population youth populations respectively (Fig. 1, Table I). Incidence was 0.59 per 1,000 for Status Aboriginal and 0.49 per 1,000 for general population. No discernible differences were seen in diabetes prevalence or incidence with respect to group or sex in 2007 (Fig. 1, Table I).

Crude rates of both diabetes prevalence and incidence increased in Status Aboriginal and general population youth over the observation period (Fig. 1, Table II). However, prevalence grew to a greater extent among Status Aboriginal youth (AAPC 6.98) compared to those in the general population (AAPC 3.93; $p < 0.01$), with Status Aboriginal males experiencing the largest increase in diabetes prevalence (AAPC 9.18). Ethnic differences in diabetes incidence trends were only observed among the male population, which saw a significantly larger rise in incidence for Status Aboriginal (AAPC 11.65) compared to general population males (AAPC 4.62; $p < 0.01$). Male youth, regardless of group, experienced greater

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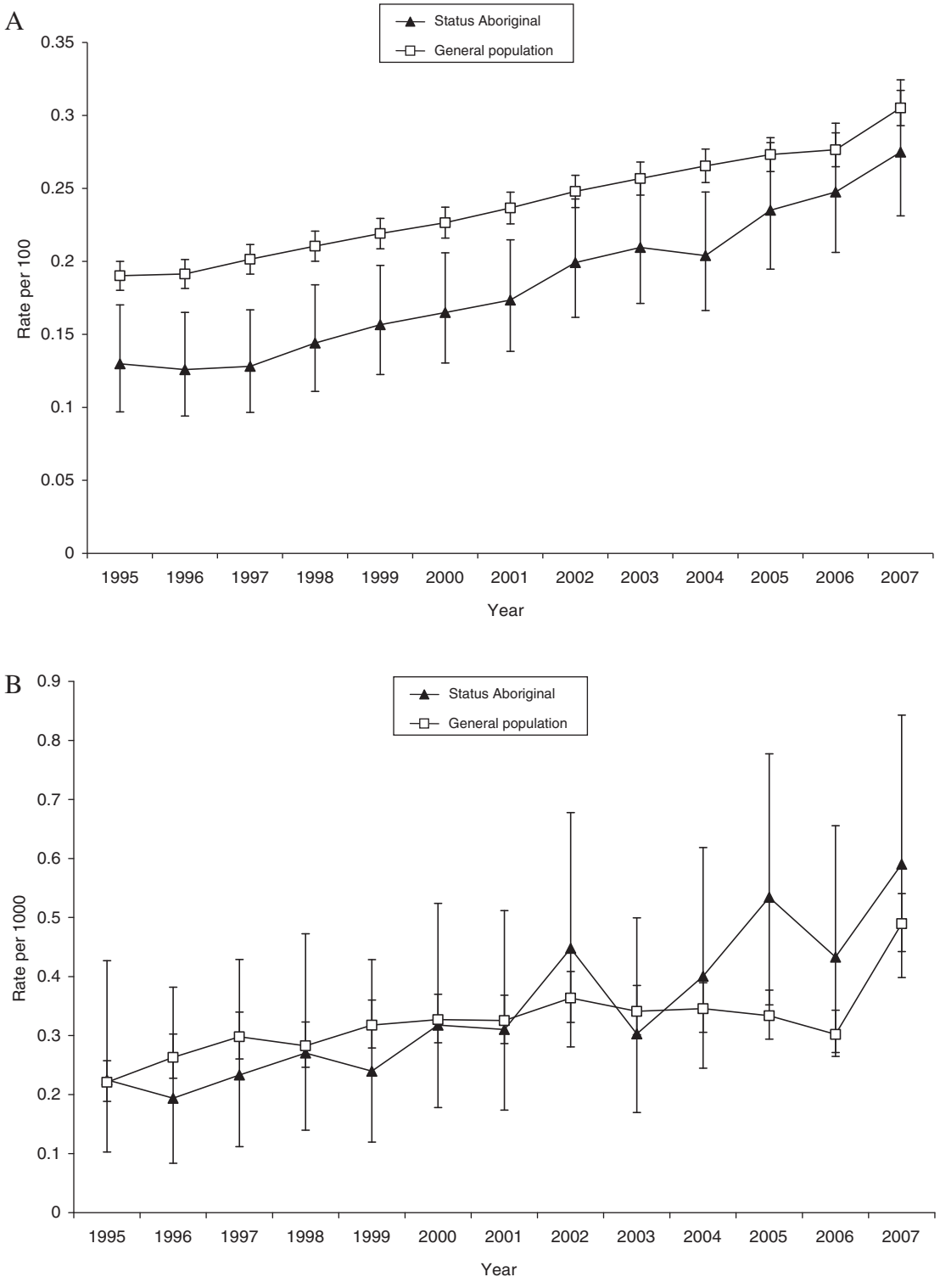

Fig 1. Crude rates of diabetes among Status Aboriginal and general population youth in Alberta, 1995–2007 (ADSS). A = Prevalence; B = Incidence.

increases in both prevalence and incidence over time than that of respective female youth (Table II). Age-specific crude prevalence and incidence of diabetes by group are shown in Fig. 2.

Discussion

Paralleling adult populations, diabetes among youth is increasing worldwide (20). While type 1 diabetes remains the majority of cases in youth, type 2 diabetes (a disease

Table I. Crude diabetes prevalence and incidence among Status Aboriginal and general population youth, 2007

	Status Aboriginal	General population	Odds ratio (95% CI)
Prevalence rate per 100 (numerator/denominator)			
Combined	0.27 (140/50930)	0.31 (2449/802803)	0.90 (0.76, 1.07)
Females	0.31 (76/24861)	0.30 (1170/391526)	1.02 (0.81, 1.29)
Males	0.25 (64/26069)	0.31 (1279/411277)	0.79 (0.61, 1.01)
Incidence rate per 1000 (numerator/denominator)			
Combined	0.59 (30/50820)	0.49 (392/800746)	1.21 (0.83, 1.75)
Female	0.56 (14/24799)	0.49 (192/390548)	1.15 (0.67, 1.98)
Males	0.61 (16/26021)	0.49 (200/410198)	1.26 (0.76, 2.10)

typically regarded as an adult phenomenon) is becoming progressively more common in children and adolescents (20). We report that youth-onset diabetes is an increasing problem in Alberta, especially among Status Aboriginals.

Though our results are in line with international data showing increasing trends (20,21), they contradict the recent NDSS reports (12,22), which found diabetes prevalence and incidence rates remained stable at 0.3 and 0.4 (per 1,000) respectfully among general population youth between 2001–2006. This suggests that increases in diabetes among Canadian youth vary geographically and require investigation. It is possible that differences in ethnicities and/or socioeconomic parameters contribute to these differences.

Among Indigenous populations especially, including American Indian/Alaskan Natives, Australian Aborigines, the Maori of New Zealand, and Canadian Aboriginals, youth-onset diabetes is increasingly being identified (14,23–27). In Canada, longitudinal trends of diabetes in Aboriginal youth had previously only been explored in Manitoba. Dean and colleagues (10) showed the crude type 2 diabetes incidence rate rose to 0.55/1,000 (for ages 0–19) in 2001. Similarly, crude diabetes incidence increased from 0.22 per 1,000 to 0.59 per 1,000 over a 12 year time span in the current analysis. The observed accelerated increase in diabetes among Status Aboriginal youth is consistent with reports of a decrease in the age of diagnosis of diabetes among Aboriginal adults. In Saskatchewan type 2 diabetes incidence was highest among Status Aboriginal adults aged 40–49, while most new diabetes cases among the general population were in those >70 years of age (4). Also, as indicated by the First Nations and Inuit Regional Health Survey, the majority (53%) of those with diabetes in Aboriginal communities were <40 years of age (28).

Compared to general population, diabetes grew approximately twice as much among Status Aboriginal youth. Ethnic comparisons have remained largely unexplored in youth, despite numerous studies documenting the divergence in diabetes epidemiology in adult populations. In the beginning of ADSS observation 1995, incidence and prevalence of diabetes were distinctly higher among general population. By 2007 however, Status Aboriginal youth have 'caught up' to the point where no detectable differences were apparent, likely (as mentioned above) due to type 2 diabetes. Reinforcing this notion, a recent national surveillance study amongst practicing physicians found the incidence of type 2

Table II. Ethnicity comparisons of AAPC (Average annual percent change) in diabetes prevalence and incidence among Status Aboriginal and general population youth, 1995–2007

	AAPC Status Aboriginal (95% CI)	AAPC General population (95% CI)
Prevalence		
Combined	6.98*† (6.26–7.70)	3.93* (3.65–4.21)
Female	5.70*†§ (4.75–6.66)	3.70*§ (3.42–3.98)
Male	9.18*† (7.78–10.60)	4.15* (3.83–4.47)
Incidence		
Combined	8.92* (6.22–11.69)	4.01* (1.90–6.16)
Female	6.18*§ (2.59–9.90)	3.36*§ (0.42–6.38)
Male	11.65*† (6.14–17.44)	4.62* (2.90–6.36)

*$p < 0.05$ for AAPC.
†$p < 0.05$ for AAPC ethnicity comparison.
§$p < 0.05$ for AAPC sex comparison.

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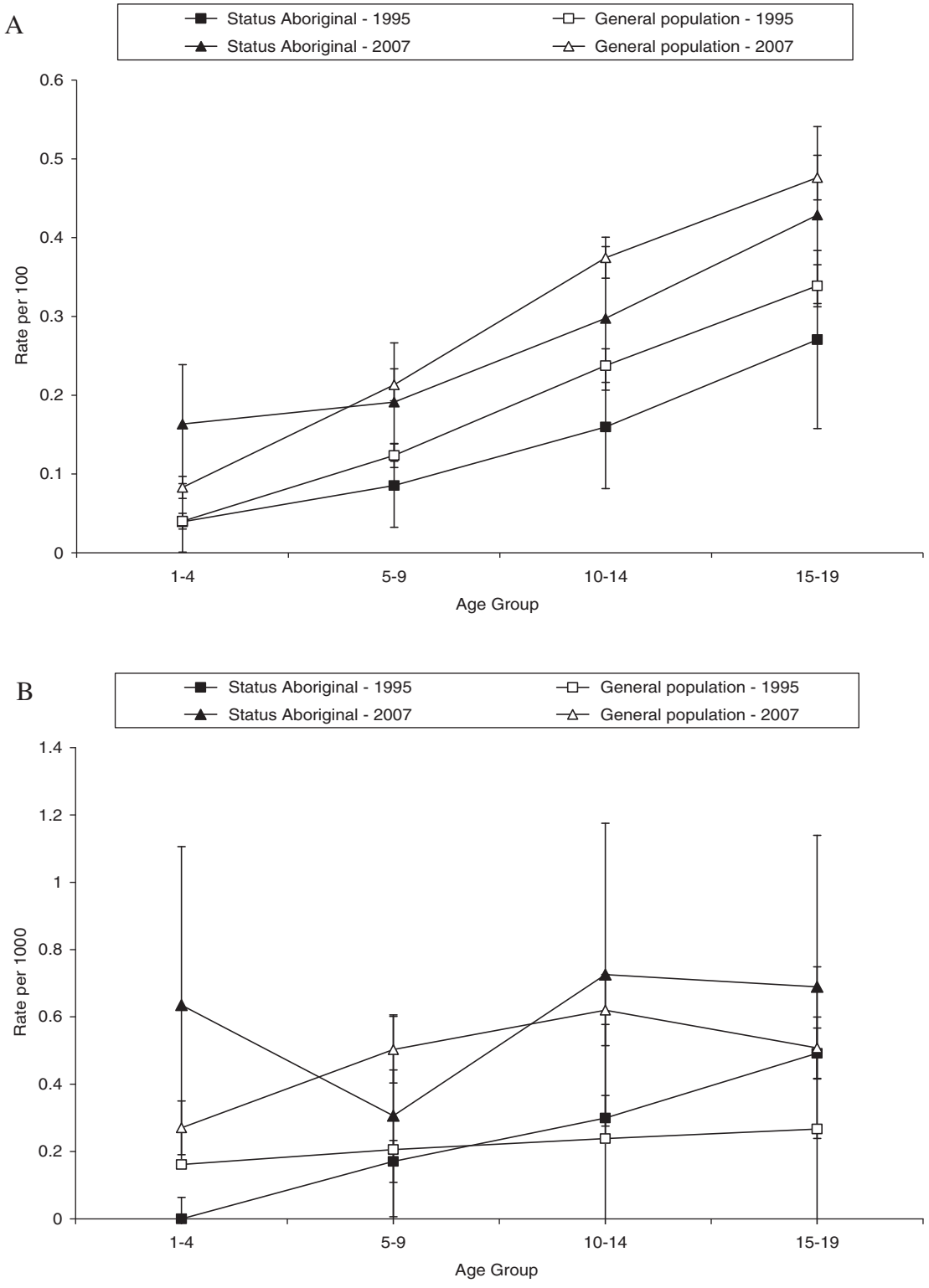

Fig 2. Age specific crude rates of diabetes among Status Aboriginal and general population youth, 1995 and 2007. A = Prevalence; B = Incidence.

diabetes among Aboriginal children (0.23/1,000) was strikingly 46-fold higher than Caucasian children (0.005/1,000) over a 24 month period (29).

We observed an increased rise of diabetes among young Status Aboriginal males, confirming earlier studies. Sex ratios of prevalence and incidence (female: male)

of approximately 4:1 and 2:1 in 1995 decreased to 1:1 and 1:1 respectively in 2007. Additionally, the AAPC in prevalence was highest amongst Status Aboriginal males (AAPC 9.18) compared to females (AAPC 5.70). Over a 15 year time period in Manitoba, the early predominance of youth diabetes cases among Aboriginal females (8-fold compared to males) disappeared by 2001 (10). From 1990 to 1998, American Indian and Alaskan Native young males also experienced relative increases in diabetes prevalence almost double that of their female counterparts (30). Similarly, the gap in diabetes prevalence between adult Status Aboriginal females and males is also diminishing (4,5). Reasons for the accelerated rise of diabetes among Status Aboriginal males have not been explored, but may be due in-part to escalating childhood overweight and obesity (31) with a possible gender-based lag in the obesity epidemic where it may have occurred earlier in time amongst females.

In countries with universal healthcare, administrative data have become common and invaluable sources for the population-based surveillance of many chronic diseases. NDSS methodology has been validated in adults and youth, and is a standard for diabetes monitoring at the population level (16,18,32,33). For instance, Guttmann et al. (33) recently found the NDSS algorithm in youth (0–19 years of age) in Ontario was associated with 100% sensitivity and 94% specificity. Using a similar algorithm (4 physician claims over a 2-year period), diabetes prevalence rose from 0.18 to 0.24 and incidence (per 1,000) increased from 0.25 to 0.32 among Ontarian youth between 1994 and 2003 (32). In support, general population youth in the current study experienced nearly identical increases in prevalence and incidence between 1995 and 2003: 0.19 to 0.25 and 0.22 to 0.32 (per 1,000) respectively, with rates progressively increasing until the end of the study period in 2007.

Our analyses are subject to several limitations. We are unable to distinguish the type of diabetes in our administrative data. However, our clinical experience suggest that the majority of the diabetes in Aboriginal youth is type 2 diabetes, whereas in the non-Aboriginal population it is heavily dominated by type 1 diabetes. Moreover, rates of type 1 diabetes are much lower among American Indian and Canadian Aboriginal youth compared to the general population historically (34). Future research aimed at describing the contribution of both type 1 and type 2 diabetes to the observed trends is warranted. Possible gestational diabetes cases were included and may have inflated rates in Status Aboriginal as gestational diabetes has been shown to be more common in adult Aboriginal populations (35). It is possible that increased awareness and screening in youth may have contributed to the observed increases, however for various projects (http//:www.braiddm.ca) we have screened 799 youth at risk (mostly Aboriginal) in rural Alberta since 2001 and have found only 3 (0.4%) of those had undiagnosed diabetes (unpublished). By contrast, the rates of undiagnosed diabetes are approximately 4% in at risk adults. Thus, it appears that diabetes in youth is not often asymptomatic, and therefore is less likely to be detected by increased awareness and screening. Our results cannot be generalized to non-registered Aboriginal or Métis youth, whom could not be identified and were included in the general population group. Also, due to the small number of diabetes cases in youth, age-standardized prevalence and incidence rates were not calculated and only crude rates were reported. Lastly, amendments to the Indian Act in 1985 are possibly increasing the Status Aboriginal denominator (Bill C-31) and likewise some descendants of Status Aboriginal people are losing their Status through the "three generations" rule (36). Taken together, prudence is needed when interpreting the observed epidemiological findings.

In conclusion, diabetes prevalence and incidence has increased among all Alberta youth from 1995 to 2007. Status Aboriginal youth, males in particular, experienced a disproportionate growth in diabetes. If unabated, increasing diabetes in youth will likely only further perpetuate the diabetes epidemic in the Status Aboriginal population. Type 2 diabetes is typically the 'tip of the iceberg' as it is often preceded by several co-morbidities (obesity, hypertension, metabolic syndrome, pre-diabetes, etc), rendering its increased diagnosis in youth a potential public health crisis.

Conflict of interest and funding

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