The Prevalence of NIDDM and Associated Risk Factors in Native Canadians

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OBJECTIVE — To determine the true prevalence of impaired glucose tolerance (IGT), NIDDM, and associated risk factors by age and sex in an isolated native community.

RESEARCH DESIGN AND METHODS — A community-wide prevalence survey using a 75-g oral glucose tolerance test (OGTT) was undertaken in the remote native reserve of Sandy Lake, Ontario, Canada. Measurements for obesity included waist-to-hip circumference, BMI, and percentage body fat.

RESULTS — A total of 728 individuals were enrolled, representing a community participation rate of 72%. The overall crude prevalence of NIDDM was 17.2% (18.1% females and 16.0% males) and increased to 26.1% overall (28.0% females and 24.2% males) when age-standardized. The prevalence of IGT was higher in females compared with males (age-standardized prevalence of 19.8 vs. 7.1%, respectively). Females had a higher prevalence of obesity, IGT, and NIDDM occurring at younger ages. Measures of obesity and fasting insulin levels were significantly associated with NIDDM in the 18–49 age-group.

CONCLUSIONS — The prevalence rates of NIDDM in this study population are the highest reported to date in a Canadian native population and among the highest reported in the world. Females appear to be at much higher risk of developing obesity, IGT, and NIDDM and at a younger age. Due to the high prevalence rates of IGT and NIDDM in this young population, there is urgent need to develop culturally appropriate community-based public health intervention programs before the long-term complications of diabetes have a devastating effect on the residents.

Dramatic changes in lifestyle have taken place in native communities across North America over the past 50 years, impacting profoundly on the social, environmental, and health status of native people. This has resulted in a shift in the disease burden with a reduction in morbidity and mortality associated with infectious diseases and starvation and the emergence of chronic diseases such as obesity, diabetes, and cardiovascular disease. NIDDM is now recognized as a major health problem.

Prevalence figures of NIDDM in native communities throughout the world have been reported to be between 4.6 and 49.5% (1). Similar findings have been reported in native communities from Northern Canada (2,3). These recent studies have also supported the hypothesis that the high prevalence of NIDDM in native populations is a consequence of "Westernization" of their lifestyle and the loss of more traditional activities. The result of going from a "hunter-gatherer" existence, characterized by feast or famine and high levels of physical activity, to one of nutrient excess and inactivity has led to significant increases in obesity, a strong predictor of diabetes (1). Few studies have combined a detailed ethnographic assessment with metabolic and anthropometric evaluation to evaluate an entire community at risk comprehensively. To better determine the risk factors and the influence of Euro-American culture on the development of NIDDM in a native community, we initiated the Sandy Lake Health and Diabetes Project (SLHDP). Descriptions of the methodology and results of the ethnographic study are reported elsewhere (4–6). In this study, we report on the data from the metabolic and anthropometric prevalence survey.

RESEARCH DESIGN AND METHODS

— The community identified for the study was Sandy Lake, Ontario, a native Canadian reserve whose demographic, social, and health dynamics, culture, and geographical locale are representative of the native population in Northwest Ontario and whose chief and band council had expressed their desire to carry out such a study. The community consists of ~1,600 Algonquian-speaking Ojibwa-Cree inhabitants of the Canadian subarctic.

A detailed description of the study design and methodology used for the prevalence survey and risk factor assessment, which targeted all permanent residents of the community ≥10 years of age, has been previously published (4). To summarize, after signing the consent form, which was provided in either English or Ojibwa-Cree, a standard 75-g oral glucose tolerance test (OGTT) (Glucodex, Rougier, Chambly, Quebec) after an overnight fast was administered to all participants, except those with previously diagnosed NIDDM (verified by a medical chart review). Fasting and 2-h post–glucose challenge blood samples were taken. A diagnosis of diabetes or impaired glucose tolerance (IGT) was made according to the standard World Health Organization criteria. Anthropometric measurements

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IGT, impaired glucose tolerance; OGTT, oral glucose tolerance test; SLHDP, Sandy Lake Health and Diabetes Project; WHR, waist-to-hip ratio.

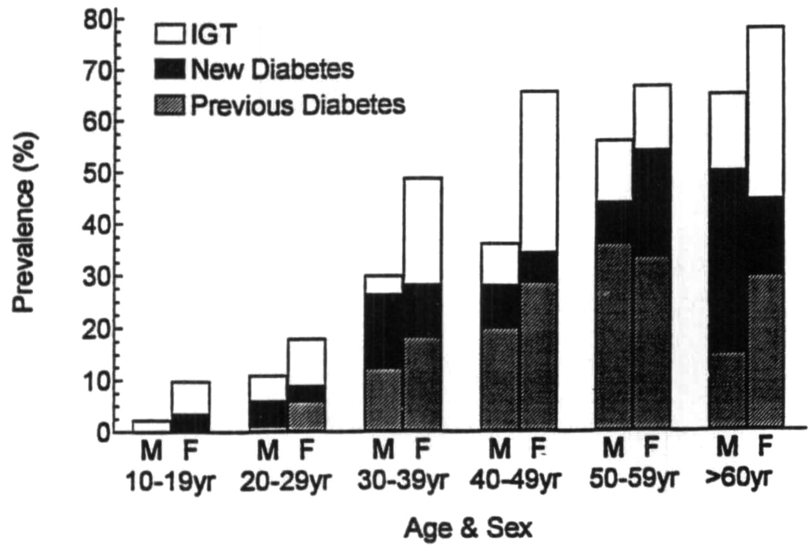

Figure 1—*Crude age- and sex-specific prevalence of IGT, newly diagnosed diabetes, and previously diagnosed diabetes.*

included BMI, waist-to-hip ratio (WHR), and bioelectrical impedance analysis. Obesity was defined as a BMI >27 kg/m^2. Percentage body fat and lean body mass were estimated by bioelectrical impedance analysis, using the Tanita TBF-201 Body Fat Analyzer (Tanita Corporation, Tokyo, Japan) and an equation based on total body water. The reproducibility of percentage body fat estimates was determined using a subsample of the population and resulted in an intraclass correlation coefficient of 0.99 (7). Blood pressure was also measured using a standard methodology that has been previously described (4). Data collection was performed by well-trained local community members who were hired specifically for the project.

Data management and analysis was performed in the Division of Clinical Epidemiology, Samuel Lunenfeld Research Institute, Mount Sinai Hospital, University of Toronto, Canada, on a Digital MicroVax computer, using the SIR database management software for data entry and SAS for data analysis. A 20% sample of the dataset was double-entered to assess the rate of data entry error, which was found to be 0.685%.

The prevalence rates of IGT and NIDDM were calculated by age and sex and adjusted for age using the direct method. Two standard populations were used: the Canadian population from the 1991 census (8) and the World Standard population from King and Rewers (9). The mean values for the measures of obesity were stratified by age and sex. The results were collapsed into two age-groups: 18–49 and ≥50 years of age. Glucose tolerance status was then dichotomized to diabetes versus normal (including IGT). Logistic models were used to investigate the relationships between glucose tolerance status and continuous anthropometric variables.

RESULTS — A total of 728 eligible participants (72%) >10 years of age, whose demographics have been described elsewhere, were enrolled in the study (4). Figure 1 shows the prevalence for IGT and NIDDM by age and sex. The rates for NIDDM increase steadily by age, with the rates consistently higher in females compared with males. The highest rates overall were found in females in the age-group of 50–59 years (54.17%). IGT was found to be much higher in women compared with men and did not appear to follow any age trend. Of those classified with NIDDM, 41% were newly diagnosed. The overall crude prevalence rates of NIDDM and IGT were 17.2% (females 18.1% and males 16.0%) and 10.4% (females 14.2% and males 5.3%), respectively. When adjusted for age, the overall rates increased to 26.1% (28.0% females and 24.2% males) for NIDDM and 13.6% (19.8% females and 7.1% males) for IGT.

Table 1 presents the univariate odds ratios adjusted for age, demonstrating the association between diabetes status and measures of body composition. All measurements for obesity (except percentage body fat in females) were found to be significantly associated with NIDDM in the 18–49 age-group for both males and females. WHR was found to have the strongest association for NIDDM in both males and females, particularly for those <50 years of age. For males and females ≥50 years of age, there were no significant associations between the measures of obesity and NIDDM.

All four anthropometric measurements for obesity were clearly significant and correlated strongly with fasting insulin levels, using Spearman's correlation coefficients for normal and IGT subjects, stratified by sex and adjusted for age (range, 0.42–0.62; $P < 0.0001$).

CONCLUSIONS — The lifestyle changes occurring in the community of Sandy Lake are typical of those being experienced by other native populations throughout the Canadian North. High unemployment, the lack of exercise, and the consumption of a diet high in fat have replaced a traditional nomadic hunter-gatherer existence. Although diabetes and its associated risk factors are thought to be more prevalent in these communities, the magnitude of the prevalence documented in the SLHDP was truly unexpected. Interestingly, the age-adjusted prevalence of IGT was almost three times more common in females (19.8%), compared with males (7.1%). This pattern differs from other published results, using similar survey methods, involving native populations in North America. The Strong Heart Study showed an age standardized prevalence rate of IGT of 16% in females and 15% in males in 13 Native American tribes (10). However, it did not include individuals <45 years of age, where the majority of IGT cases were found in our study. Delisle and Ekoe found a prevalence of IGT of 5% and 6% in two Algonquian communities in Quebec (2). Our findings of distinctly different rates of IGT than previous studies may have several explanations. The primary risk factor for diabetes, namely obesity, was higher in the female subjects and this increased prevalence may have led to more individuals developing IGT. The possible impact of estrogen and other factors that can affect carbohydrate metabolism may have also been important in mediating this sex difference.

Not surprisingly, in those individuals between 18 and 49 years of age, all measures of obesity were highly associated with NIDDM (Table 1). This was particularly

Table 1—*Univariate associations between measures of body composition and NIDDM, age-adjusted, by age-group and sex*

	Unit increase	OR	95% CI	*P* value
Males				
18–49 years (*n* = 183)				
BMI	5 kg/m²	2.39	1.32–4.35	0.00225
WC	10 cm	1.99	1.23–3.21	0.00236
WHR	0.1	6.24	2.34–16.68	0.00004
PBF	10%	2.40	1.08–5.33	0.01854
50+ years (*n* = 45)				
BMI	5 kg/m²	1.43	0.76–2.69	0.25294
WC	10 cm	1.13	0.67–1.90	0.63130
WHR	0.1	0.69	0.26–1.85	0.45426
PBF	10%	0.82	0.37–1.81	0.62205
Females				
18–49 years (*n* = 246)				
BMI	5 kg/m²	1.22	0.90–1.67	0.20156
WC	10 cm	1.39	1.02–1.89	0.03340
WHR	0.1	4.22	2.02–8.82	0.00003
PBF	10%	1.24	0.80–1.90	0.32593
50+ years (*n* = 51)				
BMI	5 kg/m²	1.74	0.93–3.29	0.07034
WC	10 cm	1.63	0.93–2.88	0.07486
WHR	0.1	2.28	0.70–7.46	0.15792
PBF	10%	1.11	0.56–2.22	0.75915

Glucose tolerance status was dichotomized as individuals with normal glucose tolerance and IGT versus those with NIDDM. The results for the 10–17 age-group are not presented because of 0 events in some cells that were estimated using logistic regression. The percentage body fat was measured using bioelectrical impedance analysis. PBF, percentage body fat; OR, odds ratio; WC, waist circumference.

true for WHR, which showed the highest odds ratio in men and women and underscores the important pathophysiological variable of splanchnic fat accumulation. Intriguingly, none of the measures of obesity related to NIDDM prevalence in those ≥50 years of age. This suggests that the expression of the NIDDM phenotype in relationship to anthropomorphic risk factors occurs early in life. In agreement with other studies, insulin resistance, as demonstrated by fasting hyperinsulinemia, was strongly correlated with BMI, waist circumference, WHR, and percentage body fat.

Native populations across North America have experienced a rapid increase in the prevalence of NIDDM over the past two to three decades and present a challenge to health care providers for prevention and management. The SLHDP is currently developing culturally appropriate community-based intervention strategies. The major focus of these strategies will be the primary prevention of diabetes. However, improved metabolic control and regular surveillance for the complications of diabetes will have to be instituted for those already affected by this metabolic disorder.

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