Specific Patterns of Food Consumption and Preparation Are Associated with Diabetes and Obesity in a Native Canadian Community[1,2]

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ABSTRACT We examined the relationship between usual patterns of food intake, fattiness of food preparation and consumption, and diabetes and obesity status in a Native Canadian reserve in northwestern Ontario. Patterns of intake were estimated using a 34-item food frequency instrument. Scales and scores were developed using factor analysis procedures and were tested for reliability using coefficient alpha. Impaired glucose tolerance (IGT) and diabetes status was determined by administering a 75-g glucose tolerance test. A number of the food groups appear to have a protective effect in regard to IGT and diabetes, including vegetables [odds ratio (OR) = 0.41, confidence interval (CI) = 0.18–0.91], breakfast foods (OR = 0.41, CI = 0.18–0.93) and hot meal foods (OR = 0.29, CI = 0.11–0.78). Most of these foods are relatively high in fiber and low in fat. High consumption of junk foods and the bread and butter group was associated with substantial increases in risk for diabetes (OR = 2.40, CI = 1.13–5.10; OR = 2.22, CI = 1.22–4.41, respectively). These foods tend to be high in simple sugars, low in fiber and high in fat. More fatty methods of food preparation are also associated with increased risk for diabetes in this population (OR = 2.58, CI = 1.11–6.02). This information has been incorporated into an ongoing community-based diabetes prevention program in the community. J. Nutr. 128: 541–547, 1998.

KEY WORDS: • *Native Canadians* • *Native Americans* • *diabetes* • *obesity* • *food frequency* • *food preparation* • *diet*

Noninsulin-dependent diabetes mellitus (NIDDM)[4] has emerged as a leading cause of morbidity and mortality in Native American communities throughout North America (Knowler et al. 1981, Long 1978, Szathmary 1986, West 1974). It is apparent that this change reflects profound social, environmental and lifestyle changes. Dietary changes and reduced activity levels, acting on a susceptible genotype, are thought to be at the root of the high diabetes prevalence in Native Americans (Dowse et al. 1991, Knowler et al. 1983, Kriska et al. 1993, Neel 1962).

While most of the work on determining diabetes prevalence and risk factors in Native Americans has been conducted in the United States, in the past decade similar work has been carried out among Native Canadians (Schraer et al. 1988, Szathmary and Holt 1983, Young et al. 1985, 1990, 1992). These studies, most conducted using case registry methods, found diabetes prevalences ranging from 1 to 10%, much lower than that found among Native Americans in the Southwestern United States, for example, where prevalences range from 8 to 40% during the same time period (Carter et al. 1989, Knowler et al. 1990, Sugarman et al. 1990, Sugarman and Percy 1989).

The development of diabetes among Native Canadians follows a somewhat different pattern from that of Native Americans in the United States. The traditional diet in the Northern lifestyle is based mainly on hunting and fishing. The diet is high in protein, moderate in fat, and low in carbohydrates and fiber. There were high energy demands from the extreme cold temperatures and strenuous physical activity of daily living. Seasonal macronutrient shortages and periodic famines resulted from depletion of game (Berkes and Farkas 1978, Ritenbaugh and Goodby 1989). The arrival of fur traders in the late 1700s introduced European foods such as salted meat, flour, oatmeal, sugar, lard and tea. This contact brought about an alteration in subsistence activities, where activities focused heavily on trapping and hunting for trade with the fur traders.

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[4] Abbreviations used: BMI, body mass index; CI, confidence interval; IGT, impaired glucose tolerance; NIDDM, noninsulin-dependent diabetes mellitus; OR, odds ratio.

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Thus, most Native Canadian populations were highly active and retained much of their traditional subsistence patterns until early in this century. Since the 1940s, the increase in permanent settlements has led to a growing dependence on store-bought foods and a decrease in the importance of hunting and fishing (Young 1988a and 1998b). The resulting dietary changes have led to higher energy intakes, especially of fat and refined carbohydrate sources such as soft drinks and snack foods (Harrison and Ritenbaugh 1992).

Dietary change appears to play a major role in the development of NIDDM and its main risk factor, obesity, among indigenous peoples living in the North. The reduction in consumption of the traditional diet appears to play a key role. In particular, among Alaskan Natives, persons who had IGT or NIDDM were significantly more overweight and reported significantly greater consumption of nonindigenous food than others. The Athabascan people, who have twice the rate of NIDDM as the Yup'ik people, consumed more nonindigenous foods and had a lower frequency of indigenous carbohydrate and fat intake (Murphy et al. 1995). Consumption of seal oil and salmon, high in omega-3 fatty acids, appeared to lower the risk of IGT and NIDDM (Adler et al. 1994).

Consumption of store-bought foods also plays a role in the development of obesity and diabetes in Native Canadians. Overweight James Bay Cree schoolchildren and adolescents consumed less milk and fewer fruits and vegetables than those with a lower body mass index (BMI) (Bernard et al. 1995). Ojibway-Cree people with diabetes had a greater intake of proteins and a lower intake of carbohydrates than nondiabetics, resulting in a lower energy intake per unit body weight. This reflected a lower level of physical activity (Young 1985).

The Sandy Lake Health and Diabetes Project was initiated in 1992 to ascertain the prevalence of diabetes in the reserve of Sandy Lake (a remote Ojibwa-Cree community in northwestern Ontario), identify key risk factors, and develop strategies for primary prevention of NIDDM at the community level (Hanley et al. 1995). The prevalence rate of NIDDM in Sandy Lake was found to be 26.1% overall (age-standardized), the highest reported in a Canadian population and the third highest reported in the world (Harris et al. 1997). The diet of the Sandy Lake population is typical of Native American populations undergoing rapid cultural change. Twenty-four–hour dietary recalls revealed that the diet is high in saturated fat (13% of energy intake), high in cholesterol (350 mg/d) and simple sugars (22% of energy intake), low in dietary fiber (11 g/d) and high in glycemic index (Wolever et al. 1997a). Adolescents consumed more simple sugars and less protein than older adults. This was mostly in the form of "junk food" (potato chips, fried potatoes, hamburgers, pizza, soft drinks, etc.). Older adults consumed more traditional foods than adolescents, including bannock (fried bread) and wild game. Sandy Lake, like other Native North American populations affected by diabetes, has a total fat intake similar to the general population in North America, but a lower intake of dietary fiber. The higher incidence of diabetes cannot be attributed to high fat intake alone (Bell 1995, Price 1993, Swinburn et al. 1991, Wolever et al. 1997b).

Dietary fat intake can come from multiple sources. Besides fat contained in the food itself, cooking method (e.g., frying vs. baking), fat added to the food while preparing it or eaten with the food, can all add to total fat intake. While many studies have examined preparation method as a primary determinant of dietary fat intake (Burghardt et al. 1995, Lip et al. 1995, Snyder et al. 1992 and 1994) and a possible risk factor for chronic disease (Kosich 1983), we were unable to find any studies of food preparation methods among Native Americans. Prior to our study, anecdotal reports from Sandy Lake describe the use of high amounts of lard, vegetable shortening or animal fat drippings to fry fish or meat, and to prepare bannock. Yet the relationship between food preparation methods and obesity and diabetes is a large gap in the literature regarding the evolution of the these conditions in Native Americans.

This paper presents the relationship between broad patterns of food intake, preparation and consumption, and obesity and diabetes in a remote Ojibwa-Cree community in northwestern Ontario, Canada. We describe usual patterns of food intake in this population, as well as main methods of food preparation, particularly in terms of the use of added fat. Finally, we show how these dietary patterns are related to body fatness and total glucose intolerance.

MATERIALS AND METHODS

Study design and instruments. Full details of the study research design have been presented elsewhere (Hanley et al. 1995). The study consisted of a cross-sectional diabetes and obesity prevalence survey and risk factor assessment, which targeted all permanent residents of the community ≥10 years of age (721 sampled out of 1018 eligible residents). Participants were given a standard 75-g oral glucose tolerance test (Glucodex, Rougier, Chambly, Quebec) after an overnight fast, except those with previously diagnosed NIDDM (verified by chart review). Fasting and 2-h postglucose challenge blood samples were taken. A diagnosis of diabetes or impaired glucose tolerance was made according to standard World Health Organization criteria. Obesity was defined as BMI > 28 kg/m^2 (for males) or BMI > 26 kg/m^2 (for females) according to the criteria developed by Wellens et al. (1996). Percent body fat was obtained using the Tanita TBF-201 Body Fat Analyzer (Tanita Corporation, Tokyo, Japan).

Survey questionnaires included both individual and household components. We used an individual, three-month food frequency questionnaire to obtain patterns of usual intake of 34 commonly eaten foods, including both traditional foods (moose, duck, fish, etc.) and store-bought foods (tea/coffee, fruits, vegetables, canned meats, etc.). Respondents aged 10 y and older were asked to recall their usual consumption of each food over the past three months using the following categories: more than once per day, once per day, 3–6 times per week, 1–2 times per week, 1–3 times per month, rarely or never. Food frequencies have been used with success to describe patterns of dietary intake among Native Americans in other settings (Murphy et al. 1995).

A component of the household questionnaire was designed to collect information on the use of added fat in food preparation and consumption. For 13 foods, a combination of traditional and store-bought foods [i.e. bannock, moose, beaver, fish, duck, rabbit, pork chops, chicken, beef, french fries, potatoes, Klik (a kind of canned meat) and eggs], the main food preparer was queried on method of preparation (e.g. fried, boiled, baked, etc.), kind of fat used in preparation and the kind of fat eaten on or with the food after preparation.

Scale and score development. Exploratory factor analysis was used to identify underlying patterns of food consumption to reduce the list of 34 foods to a few key groups, such that the foods in each group tend to be consumed together. This method has been applied previously to examine diets based on food frequency results in order to identify dietary patterns (Barker 1990, Gittelsohn et al. 1997, Randall 1990, Schwerin 1982). The principal factor method was used to extract the factors, followed by an oblique (promax) rotation (Hatcher 1994). A combination of scree test (a plot of the eigenvalues of the factors) and assessment of proportion of variance accounted by the factors were utilized to determine the number of factors to be retained for rotation. In interpreting the rotated factor pattern, a selected food was considered to load on a given factor if the factor loading was ≥0.40 for that factor and <0.40 for all other factors. No food item was permitted to load more than one factor; therefore, each scale contains a distinct set of foods. Factor scores for each dietary pattern identified were computed for each participant by multiplying the factor weight of each food included in the pattern by the standardized values of the reported frequency of use and summing

TABLE 1

Description of the adult study population (>20 y) in the Ojibway-Cree community of Sandy Lake, Ontario[1,2]

	Male (n = 210)	Female (n = 268)
Age, *y*	37.4 ± 14.3	37.3 ± 14.2
Height, *cm*	174.7 ± 6.1	161.5 ± 5.5
Weight, *kg*	82.9 ± 15.2	76.0 ± 14.6
Body mass index, *kg/m²*	27.1 ± 4.5	29.1 ± 5.4
Body fat, %	28.0 ± 7.2	45.1 ± 8.7
Diabetes, %	22.9	24.4
Impaired glucose tolerance, %	6.7	18.7
Education, % *none*	10.0	11.2
Education, % *secondary or more*	25.2	18.7
Oji-Cree speaking only, %	5.3	11.6
English speaking only, %	8.2	4.1
Both Oji-Cree and English speaking, %	86.5	84.3

1 Values are means ± SD.
2 n = 478 adults out of total sample of 721.

for those foods. Factors were named based on our understanding of food intake in this setting and from the preliminary ethnographic data.

Factor analysis was also used to develop scales from the household-level questions on fat use in food preparation and consumption. Reliability for all scales was assessed by calculating coefficient alpha (Cronbach 1951). Odds ratios (OR) and 95% confidence intervals (CI) were calculated by logistic regression to estimate the risk of a specific consumption pattern for persons of normal weight relative to obese individuals, and normal glucose tolerance status relative to IGT and/or diabetes (new and previously detected). Additional analyses were run comparing normal individuals and persons with newly diagnosed diabetes, as recent findings had indicated dietary differences between newly and previously diagnosed persons with diabetes based on 24-h recall (Wolever et al. 1997b). However, as only one significant odds ratio was found (out of 70 runs), these findings are discussed, but are not included in the tables.

To improve the meaningfulness of the parameter estimates, most scales were broken down into dichotomous variables classified by quartiles (Q1, Q2, Q3, Q4) although terciles (T1, T2, T3) and simple bi-level (high, low) variables were created when the distribution of the scale or score was skewed. The first quartile (Q1) or lowest grouping was not included in the regression. Therefore, all odds ratios should be interpreted in relation to the first quartile, i.e., the lowest score or intake of the food group/consumption pattern. Odds ratios were adjusted for age and sex. Household data were not obtained for 111 persons, yielding a smaller sample size for analyses using the household food preparation and consumption scales and scores. Statistical analysis was performed using the SAS statistical package (SAS/STST version 6.11, SAS Institute, Cary, NC).

The research project was approved by the University of Toronto Research Ethics Committee.

RESULTS

Demographics. **Table 1** presents demographic and basic body composition information for adults only (≥20 y) in the study sample (n = 478 out of the 721 total sample). As reported elsewhere (Harris et al. 1997), adult women tended to have higher BMI and much higher percentage body fat than men. Almost a quarter of the adult population had diabetes, and many more women then men had impaired glucose tolerance. Adult men tended to be more educated than women and were somewhat more likely to speak English.

The analyses that follow are based on the 721 person study sample. 48.7% (n = 351) of the sample were obese; 9.6% (n = 67) were previously diagnosed diabetics, 7.0% (n = 49) were newly diagnosed diabetics, 10.6% (n = 74) had impaired glucose tolerance, while 72.9% (n = 511) had normal glucose status. Glucose tolerance data were not collected on 20 persons in the sample.

Individual food frequency scales. **Table 2** presents the results of the factor analysis of the individual food frequency results. A series of seven scales were produced from factors with eigenvalues > 1 (for the 34 different foods). The items that loaded into each of the factors were remarkably consistent with our sense of how foods are grouped in the community, and included "vegetables," "junk foods," "bush foods" (foods gathered or hunted from the surrounding area), "breakfast foods," "hot meal foods," "tea foods" and "bread and butter." A higher score indicates that the individual ate foods more frequently from that group than a person with a lower score.

Items in the same scale were highly intercorrelated. Persons who ate a lot of one type of bush food, rabbit for example, were more likely to eat a lot of another bush food, like duck. A number of foods, such as ground beef and wild berries did not fit into any of the scales and were not included in the analyses. The first three scales had acceptable Cronbach's alphas (> 0.60), indicating a good level of consistency in responses from respondents. The remaining four scales ranked only fair with Cronbach's alphas ranging from 0.39 to 0.52. Although the alphas for these four scales are low, we kept them in the analyses because previous work indicated that the foods in these scales contributed a substantial portion of the energy in the diet (Wolever et al. 1997a).

Fattiness of preparation and consumption scales. Scales and scores that were created based on the questions asked about fat used in the preparation and consumption of 13 key foods appear in **Table 3.** Cronbach's alpha was used to select items to include in the three scales that were created (fat used in preparation, fat added for consumption, and combined fat used for preparation and consumption). A higher score on any scale indicates that the respondent reported using fat in the preparation and consumption of more food items. All three final scales have acceptable Cronbach's alphas ranging from 0.61 to 0.72.

A series of simple additive scores were calculated to examine which types of fat are more or less likely to be used in the preparation and consumption of the 13 key foods. In general, lard was much more likely to be reported to be used for the foods, followed by butter, Crisco (vegetable shortening), other fats, margarine, and wild animal fat. In the logistic regression analyses, wild animal fats (mean = 0.02) were not considered due to infrequent use.

Relationships with obesity and diabetes. **Table 4** describes the relationship between the frequency of consumption of different food scales and health status in the study population. More frequent consumption of bush foods was associated with increased risk for obesity, with almost a twofold greater risk in those persons eating bush food at the highest frequency (4th quartile), as compared with those in the lowest quartile.

Several of the food scales showed a protective effect in terms of IGT status. Increased consumption of vegetables (59% reduction in risk, 3rd quartile), breakfast foods (59% reduction in risk, 4th quartile), and lower fat hot meal foods (67% reduction in risk, 2nd quartile; 71% reduction in risk, 4th quartile) were all associated with a reduced risk for impaired glucose tolerance, when compared with the first quartile.

High junk food (storebought foods high in fat and/or simple sugars) consumption was associated with 2.4 times greater risk for having diabetes (both newly and previously diagnosed) in this population. High consumption of foods in the bread and butter group (white bread, bannock and butter/lard) was asso-

TABLE 2

Food group scales created using factor analysis on individual food frequency data (n = 721)

Scale name	Foods in scale	Mean	SD	Range	Cronbach's alpha
Vegetables	Peas Carrots Corn Other vegetables	2.98	1.05	1.41–6.61	0.72
Junk foods	Chips or french fries Chocolate/candy Cookies/cake Pop Klik (canned meat) Canned fruit (in heavy syrup)	4.11	1.29	1.42–8.09	0.66
Bush foods	Rabbit Duck Fish Moose Indian medicine/tea	2.71	0.95	1.46–7.37	0.64
Breakfast foods	Cold cereal Milk Fresh fruit Whole wheat bread	4.56	1.50	1.39–8.08	0.52
Hot meal foods	Hot cereal Home made soup Other potatoes	3.01	0.97	1.02–5.64	0.50
Tea foods	Tea/coffee Carnation milk Margarine	5.43	1.24	1.17–6.99	0.41
Bread and butter	Butter/lard White bread Bannock	5.28	1.09	1.69–6.73	0.39

ciated with greater than twofold risk at the second, third and fourth quartiles, when compared to the first. No significant relationships were observed between any of the food scales when looking at only persons not previously diagnosed with diabetes.

When IGT and positive diabetes status (newly and previously diagnosed) were combined, many of the relationships observed for diabetes and IGT independently are no longer significant. Higher vegetable consumption was associated with reduced risk for diabetes and IGT. High levels of junk food and foods from the bread and butter group were associated with almost a twofold increase in risk for one of the two conditions. When persons with previously diagnosed diabetes were removed from consideration, all of these significant relationships disappear, with the exception that high consumption of hot meal foods was associated with 56% reduction in risk in the combined IGT/new diabetes group.

The relationship between the fattiness of food preparation and consumption, types of fat used and body fatness and glucose intolerance is presented in **Table 5.** No significant associations between any of these variables and obesity was found, nor between the variables and newly diagnosed diabetes. Individuals who were in the highest

TABLE 3

Fattiness of food preparation and consumption scales and scores at the household level (n = 241 households)

Scale/score name	Foods in scale	Mean	SD	Range	Cronbach's alpha
Fat used in preparation	Bannock, moose, fish, duck, rabbit, pork, chicken, beef, fries, potatoes, Klik, eggs	8.17	3.97	0–18	0.61
Fat added for consumption	Moose, beaver, fish, duck, rabbit, pork, chicken, beef, fries, Klik, eggs	0.80	1.22	0–8	0.72
Combined fat preparation and consumption	Bannock, moose, fish, duck, rabbit, pork, chicken, beef, fries, Klik	8.12	4.23	0–22	0.68
Lard	Score[1]	4.15	3.19	0–16	—
Butter	Score[1]	0.86	0.98	0–5	—
Wild animal fat	Score[1]	0.02	0.18	0–2	—
Margarine	Score[1]	0.41	0.68	0–3	—
Vegetable shortening	Score[1]	0.60	1.20	0–6	—
Other fat	Score[1]	0.47	1.16	0–11	—

[1] Scores are simple additive scales which have not been tested for reliability.

TABLE 4

Relationship between individual food group consumption patterns and by individual obesity, impaired glucose tolerance and diabetes status, adjusted odds ratios (95% confidence intervals)[1]

Food group		Nonobese vs. obese (n = 721)	Normal vs. IGT[2] (n = 585)	Normal vs. diabetes (n = 627)	Normal vs. IGT/diabetes (n = 701)
Vegetables	Q2	1.04 (0.66–1.64)	0.74 (0.32–1.72)	0.84 (0.41–1.71)	0.82 (0.45–1.47)
	Q3	0.72 (0.45–1.17)	0.41 (0.18–0.91)[3]	0.52 (0.26–1.06)	0.51 (0.28–0.92)[3]
	Q4	1.01 (0.64–1.58)	0.64 (0.28–1.46)	0.86 (0.42–1.75)	0.79 (0.44–1.41)
Junk foods	Q2	0.91 (0.57–1.44)	0.86 (0.42–1.76)	1.68 (0.91–3.08)	1.27 (0.76–2.12)
	Q3	1.38 (0.86–2.19)	0.70 (0.34–1.44)	1.56 (0.82–2.99)	1.11 (0.65–1.88)
	Q4	1.15 (0.71–1.87)	1.65 (0.68–4.03)	2.40 (1.13–5.10)[3]	1.93 (1.04–3.58)[3]
Bush foods	Q2	1.42 (0.91–2.22)	0.95 (0.43–2.10)	0.69 (0.34–1.41)	0.82 (0.46–1.44)
	Q3	1.70 (1.06–2.72)[3]	0.62 (0.29–1.33)	0.68 (0.33–1.40)	0.69 (0.39–1.21)
	Q4	1.94 (1.22–3.08)[3]	0.70 (0.32–1.54)	0.59 (0.29–1.21)	0.64 (0.36–1.13)
Breakfast foods	Q2	1.00 (0.64–1.56)	0.57 (0.26–1.25)	1.19 (0.62–2.29)	0.92 (0.53–1.59)
	Q3	0.97 (0.61–1.55)	0.51 (0.22–1.17)	0.80 (0.42–1.52)	0.68 (0.39–1.18)
	Q4	1.02 (0.64–1.62)	0.41 (0.18–0.93)[3]	0.83 (0.42–1.65)	0.61 (0.35–1.08)
Hot meal foods	Q2	0.82 (0.52–1.29)	0.33 (0.13–0.87)[3]	1.31 (0.62–2.75)	0.77 (0.43–1.41)
	Q3	0.99 (0.62–1.58)	0.58 (0.21–1.63)	1.17 (0.58–2.38)	0.92 (0.50–1.68)
	Q4	1.29 (0.79–2.10)	0.29 (0.11–0.78)[3]	0.99 (0.48–2.05)	0.63 (0.34–1.15)
Tea foods	Q2	0.76 (0.48–1.20)	1.09 (0.48–2.47)	1.47 (0.73–3.00)	1.32 (0.74–2.37)
	Q3	0.95 (0.61–1.49)	0.62 (0.28–1.34)	0.94 (0.47–1.86)	0.84 (0.48–1.47)
	Q4	0.97 (0.63–1.51)	0.73 (0.34–1.54)	0.89 (0.47–1.66)	0.83 (0.49–1.40)
Bread and butter	Q2	1.10 (0.70–1.73)	1.30 (0.60–2.83)	2.30 (1.19–4.45)[3]	1.70 (0.98–2.93)
	Q3	1.29 (0.83–2.00)	1.39 (0.64–2.99)	2.65 (1.38–5.09)[3]	1.98 (1.16–3.39)[3]
	Q4	0.79 (0.54–1.26)	1.10 (0.50–2.40)	2.22 (1.22–4.41)[3]	1.57 (0.90–2.75)

1 Adjusted for age (years) and sex.
2 Abbreviation used: IGT, impaired glucose tolerance.
3 Significant at $P < 0.05$.

quartile of fat use in food preparation (i.e., report using fat in the preparation of more of the 13 different foods) were over two and a half times more likely to have diabetes (new or previously diagnosed) or impaired glucose tolerance than individuals in the lowest quartile of use of fat in food preparation. A similar pattern was seen for the scale combining fat preparation and fat used in consumption of food. In this case, however, there was a 2.79 times greater

TABLE 5

Relationship between fattiness of household preparation and consumption by individual obesity, impaired glucose tolerance and diabetes status, adjusted odds ratios (95% confidence intervals)[1,2]

Food group		Nonobese vs. obese (n = 610)	Normal vs. IGT[3] (n = 484)	Normal vs. diabetes (n = 533)	Normal vs. IGT/diabetes (n = 593)
Fat used in preparation	Q2	0.65 (0.41–1.02)	1.33 (0.64–2.78)	1.22 (0.66–2.28)	1.34 (0.79–2.26)
	Q3	0.72 (0.43–1.22)	1.33 (0.56–3.15)	0.93 (0.47–1.85)	1.09 (0.60–1.97)
	Q4	0.78 (0.45–1.36)	2.79 (0.98–7.91)	2.58 (1.11–6.02)[4]	2.72 (1.33–5.55)[4]
Fat added for consumption	T2	1.11 (0.71–1.74)	1.20 (0.56–2.55)	1.16 (0.62–2.17)	1.20 (0.70–2.05)
	T3	0.88 (0.56–1.38)	1.21 (0.56–2.61)	1.10 (0.59–2.04)	1.15 (0.68–1.96)
Combined fat preparation & consumption	Q2	0.73 (0.46–1.16)	1.67 (0.79–3.55)	1.07 (0.56–2.03)	1.29 (0.75–2.20)
	Q3	0.82 (0.48–1.39)	2.23 (0.90–5.53)	1.07 (0.52–2.20)	1.42 (0.76–2.63)
	Q4	0.91 (0.54–1.51)	2.79 (1.14–6.79)[4]	1.86 (0.90–3.88)	2.15 (1.16–3.98)[4]
Lard	Q2	0.96 (0.62–1.48)	0.69 (0.33–1.45)	0.88 (0.48–1.59)	0.79 (0.48–1.32)
	Q3	1.18 (0.66–2.11)	0.93 (0.35–2.50)	1.20 (0.53–2.72)	1.12 (0.56–2.25)
	Q4	1.51 (0.92–2.49)	1.65 (0.66–4.14)	2.49 (1.18–5.27)[4]	2.11 (1.12–3.98)[4]
Butter		0.91 (0.63–1.34)	0.82 (0.43–1.59)	0.81 (0.47–1.41)	0.87 (0.55–1.38)
Margarine		0.82 (0.55–1.21)	1.29 (0.64–2.62)	0.68 (0.40–1.14)	0.80 (0.51–1.26)
Vegetable shortening		0.81 (0.54–1.22)	0.85 (0.44–1.65)	0.94 (0.53–1.66)	0.90 (0.56–1.44)

1 Adjusted for age (years) and sex.
2 Total sample size reduced to 610 due to missing household data.
3 Abbreviation used: IGT, impaired glucose tolerance.
4 Significant at $P < 0.05$.

risk for IGT in the highest quartile of fattiness in preparation and consumption of the 13 foods.

Of the different types of fat reportedly used in preparation and added for consumption, only lard showed a significant relationship with individual health status. The most frequent users of lard were over twice as likely to have diabetes or to belong to the combined diabetes/IGT group.

DISCUSSION

Our findings indicate a series of relationships between patterns of dietary intake, fattiness of food preparation and consumption, and body fatness and glucose intolerance status in this community of Native Canadians. The results suggest that, in this setting, a substantial reduction in the risk of diabetes may be obtained by increasing consumption of vegetables, breakfast foods and hot meal foods. Many of the foods in these groups are low in fat relative to other foods available in the community, depending on how they are prepared and consumed. Perhaps more significantly, they are almost all relatively high in fiber. These findings agree with those presented by Wolever et al. (1997b), who found that low dietary fiber intake was associated with diabetes in this population by 24-h recall.

High consumption of junk foods and the bread and butter group was associated with substantial increases in risk for diabetes and impaired glucose tolerance. These foods tend to be high in simple sugars, low in fiber and high in fat.

Method of preparation is also associated with increased risk for diabetes and impaired glucose tolerance in this population. In particular, it appears that choice of cooking method and the addition of fat during the preparation of foods is associated with greater than a twofold risk for higher levels of glucose intolerance. Of the different types of fat, lard is the most commonly used, and was the only type of fat associated with a significant increase in risk. Other types of fat (butter, margarine, etc.) are not as commonly consumed and are not associated with increased risk.

In this setting, then, a substantial reduction in risk of developing diabetes would be obtained by reducing the consumption of high fat/low fiber junk foods and breads. Efforts also need to be made to increase intakes of high fiber/lower fat foods, such as vegetables, fruits, and cereals.

The Sandy Lake Health and Diabetes Project is currently conducting a series of community-based interventions to prevent diabetes in Sandy Lake which use these principles, including home visits that teach community members how to produce a lower fat, higher fiber form of bannock.

Many of the relationships observed in the data do not progress in a linear fashion. In Table 4 for example, one would expect the fourth quartile of vegetable consumption for IGT vs. Normal to have an even greater reduction in risk than the third quartile—instead no significant relationship is observed. These kinds of nonprogressive relationships may be related to the small sample size of some subgroups. In particular, out of our total sample, only 74 were found to have impaired glucose tolerance. Still, it should be noted that the trend in the relationships observed is similar.

The positive association between high consumption of bush foods and risk for obesity in this population is surprising, but explainable. Bush foods are infrequently consumed in this population, since few people go out hunting nowadays. Thus, the consumption of bush foods is not associated with high levels of energy expenditure for most. The main opportunity for most persons to consume bush foods is at community feasts (which occur with great frequency throughout the year), where great efforts are made to serve bush foods as well as a wide variety of other foods. Another social mechanism associated with high bush food intake is being part of a food redistribution network (e.g., having a relative or a close friend who is a successful hunter, or living with an elder, who are commonly given gifts of bush foods). The association between high bush food intake and obesity may reflect greater access of some individuals to high-fat foods in general. Fattiness of food preparation and food consumption in the home is not related to obesity—again perhaps reflecting the importance of feasts.

Another possible explanation is simply that obese individuals in this setting may be actively trying to control their weight through the consumption of bush foods. This hypothesis is weakened however, considering the relatively high acceptability of fatness in this population (Gittelsohn et al. 1996a) and the fact that similar patterns are not seen among people with diabetes, a health problem of much greater salience and concern in this population (Gittelsohn et al. 1996b).

Another perplexing finding is that while relationships are observed between dietary patterns and combined previously diagnosed and newly diagnosed diabetics, no significant associations are observed when newly diagnosed diabetics alone are examined. We might expect that previously diagnosed diabetics would have already begun to alter their dietary patterns and would therefore be less likely to show significant associations between diet and glucose tolerance abnormalities, not the other way around. One possible explanation may have to do again with a small sample size, we found only 49 undiagnosed diabetics in our study. Therefore our study may have lacked power to pull out these associations.

A simple food frequency method that used 34 key foods was useful in identifying the relationship between main dietary patterns and obesity/diabetes status in the community. Our results are comparable to those detected through the more time-consuming use of 24-h recalls in the same population. Borrelli (1990) has observed that a barrier to firmly establishing the relationship between diet and the development of chronic disease is obtaining a valid estimate of habitual pattern and level of food consumption for each individual. We feel that the food frequency method (to obtain usual patterns of intake) in combination with 24-h recalls (to obtain precise estimates of nutrients consumed) were an effective means of determining dietary factors associated with obesity and diabetes status in this population.

In summary, we were able to identify main food groups and patterning in the usual consumption of foods in an Ojibwa-Cree reserve in northern Ontario. We were then able to relate these dietary patterns to obesity and total glucose intolerance in the community. Consumption of foods high in fat and low in dietary fiber is associated with increased risk of diabetes in this population, while consumption of foods low in fat and high in fiber appear to have a protective effect. Methods of food preparation, particularly the use of lard, appear to contribute to the high rate of diabetes found in this community.

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