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Food-related behavior, physical activity, and dietary intake in First Nations[1] – a population at high risk for diabetes

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Objective. To describe determinants of diet-related behavior and physical activity in First Nations for development of culturally appropriate diabetes prevention programs.

Design. Cross-sectional 24-hour dietary recalls ($n = 129$), random household risk factor surveys of primary food preparers/shoppers ($n = 133$), and accelerometry ($n = 81$) were assessed in First Nations adults.

Setting. Nine Anishinaabe (Ojibwe and Oji-Cree) First Nations in northwestern Ontario, Canada.

Results. Descriptive statistics (mean, SD, range) were calculated for all outcomes (dietary intake, psychosocial determinants of diabetes risk factors, dietary behaviors, physical activity, and body mass index, BMI) and *t*-tests were performed to examine differences in means between remote and semi-remote communities. Regression models adjusting for sociodemographic factors were also fit for the outcome measures. Respondents reported high-energy intake (2676 and 2060 kcal/day for men and women, respectively) and acquired higher fat/higher sugar/lower fiber foods up to 30 times more often than healthier alternatives. Over 80% of respondents were overweight or obese ($BMI > 25\ kg/m^2$) with no significant difference between remote and semi-remote communities. Employment and having diabetes or impaired glucose tolerance were positively associated with BMI. Food intention scores were positively associated with healthy food acquisition scores. Younger respondents in semi-remote communities were more likely to have higher knowledge scores. Food intention scores were predicted by outcome expectations; outcome expectations by self-efficacy.

Conclusions. Diabetes prevention programs for First Nations should focus on improving physical activity and dietary intake by targeting specific risk group needs. Food knowledge, self-efficacy, outcome expectations, and intention are important factors in understanding those needs.

Keywords: First Nations; diabetes prevention; diet; nutrition; physical activity; obesity; psychosocial factors

Introduction

Indigenous peoples across the globe suffer from increasingly high prevalence of Type 2 diabetes. In northwestern Ontario, the third highest prevalence of diabetes (26%

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age-adjusted) in the world was recorded in Sandy Lake First Nation (Harris *et al.* 1997). The prevalence of diabetes in other First Nations across Canada is three to five times that of the general population (Young *et al.* 2000). Additionally, First Nations have disproportionately high rates of complications from diabetes such as end-stage renal disease and cardiovascular disease (Dyck and Tan 1994, Harris *et al.* 2002).

Modification of diet and physical activity has been shown to be an effective way to prevent diabetes in diverse populations (Tuomilehto *et al.* 2001, Knowler *et al.* 2002). In First Nations genetic factors (Hegele *et al.* 2003) and sociopolitical contexts (Frohlich *et al.* 2006) have been suggested as contributors to their increased risk for diabetes. First Nations also have a higher prevalence of overweight, obesity, and diabetes than the general Canadian population but there are limited data on differences in risk factors such as diet and physical activity between First Nations and the general population (Coble and Rhodes 2006). Most of the studies of dietary quality in First Nations have been on children in only a few groups (Receveur *et al.* 1997, deGonzague *et al.* 1999, Jimenez *et al.* 2003, Nakano *et al.* 2005) and no published studies have objectively measured physical activity in First Nations adults using more sophisticated methods such as accelerometry (Coble and Rhodes 2006). Limited studies have explored the psychosocial and environmental determinants of dietary behavior (Willows 2005) despite the fact that lifestyles in First Nations communities have undergone dramatic changes in the past 50 years. Hence there is a clear need to build a scientific knowledge base on dietary and physical activity determinants in First Nations.

In order to develop and evaluate an effective multiinstitutional intervention to reduce risk for diabetes, we sought to investigate diet, physical activity, and associated factors in First Nations. The theoretical framework for the intervention was based on Social Cognitive Theory (SCT), which posits that human functioning is a product of the interaction of individual factors, behavior, and environment. Our baseline measures were related to specific individual and environmental factors and behaviors to be targeted by the intervention. They were based on results of formative research and measures used by the authors in other similar intervention studies.

Here, we present data from in nine northwestern Ontario First Nations to address the following research questions:

- What are the main dietary risk factors for diabetes in this population?
- What are the main food preparation and acquisition patterns that could be modified to reduce risk of diabetes?
- What factors are associated with diet-related behaviors and their psychosocial determinants?
- What factors are associated with physical activity levels and body mass index (BMI)?

Answers to these questions can be used to develop more effective diabetes prevention programs for this high-risk population.

Methods

Study design

Twenty-four-hour dietary recalls were collected in eight First Nations in 2003 and 2004 as part of formative research for development of (Zhiiwaapenewin Akino'maagewin:

Teaching to Prevent Diabetes (ZATPD), an intervention to reduce risk factors for diabetes. In 2005, a risk factors survey and accelerometry were conducted as part of the baseline evaluation in seven First Nations that were a part of the ZATPD study. Respondents were from a total of nine different First Nations.

Study setting

Eight of the First Nations included were potential sites for Zhiiwapenewin Akino'maagewin: Teaching to Prevent Diabetes (ZATPD). The ninth First Nation was Sandy Lake, where the investigators have conducted previous related research. Communities were recruited on the basis of their expressions of interest or through referral by a local healthcare professional. All were Anishinaabe (Ojibway and Oji-Cree) First Nations in northwestern Ontario. These communities share some cultural and linguistic similarities, but vary in size, remoteness, and dependence on off-reserve services. The four remote communities are accessible only by air except for several weeks in the winter if weather permits building of a temporary ice road, while the remaining five semi-remote communities have year round road access to towns within a one-hour drive. The semi-remote communities only have convenience stores on the reserve, while the remote communities have one or more medium-sized grocery stores on the reserve. The remote communities have indoor ice arenas and the semi-remote communities have community gymnasiums but only one of the nine has adequately paved roads and excluding Sandy Lake, none of the communities has walking trails. Remote communities are staffed by nursing stations with visits by physicians and other specialists dependent on population size. In semi-remote communities visits by community health nurses and nurse practitioners are routine but many health services are accessed in the nearest town.

Sampling procedures

Data from two different sample populations are presented here. The first is a non-random sample of individuals from eight First Nations who completed 24 dietary recalls. The second is a stratified (by First Nation community) random sample of households from seven First Nations who completed the risk factors survey. A subset of these households were asked to participate in the accelerometry measurement. Six First Nations were included in both the dietary recall and risk factors survey samples and three participated in only one of the samples.

Twenty-four-hour dietary recall

A total of 129 dietary recalls were collected. Seven recalls were excluded from analyses due to unusually high intake ($>$5000 kcal/day) (Sharma *et al.* 2007). Only four recalls were conducted in Sandy Lake First Nation (on reserve population of 2057) because it was not a site for the proposed intervention. The remaining First Nations had on reserve populations ranging from 151 to 1125, and at least 14 recalls were collected in each community. In half of the communities individuals were randomly sampled from band membership lists,[1] in the other half a purposive sample maximizing variation in age, gender, and income was obtained. Only 8% of people contacted refused or were unable to complete the recall. Data were collected on both weekdays and weekends.

Risk factors survey

Six of the First Nations represented in the 24-hour dietary recall sample participated in the intervention study and baseline evaluation, in addition to one new community. The total number of households in each First Nation ranged from 32 to 247. We randomly selected 200 households across the seven communities at baseline (after weighting for reserve size) and attempted to contact the primary food shopper/preparer in each household. Due to ineligible respondents (pregnancy, birth in past six months, not living in community, $n=14$) and refusals, we added 50 households to the sample. Our final response rate for eligible respondents was 56% ($n=133$).

Accelerometry

Half of the overall random sample for the risk factors survey was asked to participate in the accelerometry measurements. Some of the respondents from the random sample agreed to wear the accelerometers, but we were later unable to complete the risk factors survey. Eighty-five respondents were given accelerometers, and only four were excluded due to insufficient data (less than three complete days).

Survey procedures

All research was approved by the Ethics Review Board of University of Western Ontario (UWO) and the Committee for Human Research at Johns Hopkins Bloomberg School of Public Health (JHSPH). Informed consent was obtained from all participants. Statistical analyses were conducted at JHSPH using Stata (StataCorp 2001). Interviews were conducted in English except for a few cases when a translator conducted the interview in Ojibwa or Oji-Cree.

Twenty-four-hour dietary recalls

Data were collected by two of the investigators either in respondents' homes or at community offices. Respondents were asked to recall all foods eaten in the past 24 hours and responses were recorded on paper forms. Data were entered into Nutribase Clinical Nutrition Manager (Cybersoft 2001) for nutrient analyses conducted at University of Hawai'i. A detailed description of procedures is provided elsewhere (Sharma *et al.* 2007).

Risk factors survey and accelerometry

Six community members were trained and certified to conduct the survey. Where local data collectors were unavailable, three staff members from UWO and JHSPH conducted surveys. Data collectors contacted respondents to schedule interviews in the band office or the respondent's home. Participants were asked questions about sociodemographics, diabetes history, food purchasing and preparation habits, and psychosocial determinants of diabetes risk factors. They were measured in duplicate for height, weight, and body composition using a stadiometer (Invicta Plastics, UK) and scale/bioimpedance analyzer (Tanita UM-206). Reported height and weight were taken if the respondent preferred not to be measured ($n=8$). Respondents selected to participate in physical activity assessment using Actical accelerometers (Minimitter, Respironics, Inc., Eugene, OR) were instructed to wear the accelerometer for at least three days including both weekend and weekdays.

Participants were allowed to remove the accelerometer for bathing but recommended to wear it even while sleeping. Responses including accelerometer numbers were recorded on paper forms and entered into a MS Access database at UWO. Ten percent of forms were entered twice to check for data entry errors.

Scale design and data analysis

A series of measures was developed to evaluate targeted food-related behaviors and their hypothesized psychosocial predictors based on SCT (Bandura 1986) and the planned intervention program. Intention, a component of the Theory of Reasoned Behavior (Ajzen and Fishbein 1980) was added based on its predictive value in a similar intervention study (Gittelsohn *et al.* 2006). Internal consistency of scales was assessed using Cronbach's alpha.

Food knowledge

Food knowledge was the average number of correct responses to five questions that asked about healthier food choices. The mean score was 0.6 (SD = 0.2, $\alpha = 0.42$).

Healthy food self-efficacy

Healthy food self-efficacy was the average score across six Likert-type items that assessed how easy (scored as 1) or difficult (scored as 4) it would be to perform a series of behaviors (e.g., How easy or difficult would it be for you to use cooking spray instead of oil or margarine to make eggs?). Scores ranged from 1.5 to 4 and the mean score was 3.3 (SD = 0.5, $\alpha = 0.56$) but distribution was heavily skewed toward high self-efficacy so the variable was transformed to categories of low (2.3%), medium (70.7%) and high (27.1%) self-efficacy.

Healthy food outcome expectations

Healthy food outcome expectations was the average score across six Likert-type questions that asked how helpful (using a five-point scale) they thought a series of behaviors would be in keeping them healthy. The mean score was 4.1 (SD = 0.7, $\alpha = 0.80$). The distribution was skewed so the variable was transformed into two categories of medium or high outcome expectations as there were no scores in the low category. High outcome expectations were reported by 63.9% of respondents.

Healthy food intentions

Healthy food intentions was the average of responses to six items. Respondents were asked how often (using a five-point Likert scale) they intended to perform a series of behaviors in the next month. Scores ranged from 1.7 to 4.7 and the mean score was 3.2 (SD = 0.6, $\alpha = 0.59$).

Healthy food acquisition frequency

Healthy food acquisition frequency was the additive scale that included 25 healthier food choices to be promoted by the ZATPD program. We refer to food acquisition instead of food purchasing because many people fish or hunt in addition to purchasing food from stores. Respondents were asked to report how many times in the past 30 days they had purchased each food. Scores ranged from 3 to 126 with a mean score of 38.3 (SD = 23.9, $\alpha = 0.70$). The distribution of scores was skewed, so for the regression analysis the square root of the score was used.

Healthy preparation of food

Healthy preparation of food represented the healthfulness of preparations of seven commonly consumed foods: ground beef, chicken, pork, fish, venison/moose, potatoes, and eggs. Respondents reported the three primary methods of preparing these foods. Methods were categorized on a scale of healthfulness ranging from −1 (least healthy) to 2 (most healthy) detailed in a previous study (Gittelsohn *et al.* 2006). Total scores for each food were calculated by weighting each method: first (60%), second (30%), and third (10%) and summing into a single score. Scores for all seven foods were then summed to produce the overall healthy preparation of food score. Scores ranged from −2.6 to 5.4 with a mean of 1.0 (SD = 1.7, $\alpha = 0.45$).

Physical activity

Physical activity was measured using accelerometry. Accelerometry data obtained using the Actical accelerometer (Minimitter, Respironics, Inc. Eugene, OR) measured total activity counts and minutes spent in sedentary, light, moderate, and vigorous activity in a subsample of respondents.

Material style of life

Respondents were asked whether or not anyone in the household owned a series of common items (television, vehicle, computer). Scores were added giving a possible minimum of 0 and maximum of 18. This scale was used as an indicator of socioeconomic status because of variation in salaries and cost of living across regions. Scores ranged from 1 to 18 with a mean of 10.9 (SD = 3.7, $\alpha = 0.80$).

In addition, for the risk factors survey models we included several control variables hypothesized to have an influence on outcomes. These included location of community (remote vs. semi-remote), sex, age, educational status (an ordinal variable ranking highest level of education achieved), employment (whether the respondent had earned any wages or salary in the previous year), DM/IGT (self-reported diagnosis of either diabetes or impaired glucose tolerance/impaired fasting glucose). Only age, sex, and location were available as control variables in the 24-hour recall analyses. Rank-sum tests, *t*-tests, and Spearman correlations as well as simple regressions were performed to examine associations between pairs of variables. Logistic, linear, and ordered logistic regression models were fit depending on the outcome variable. Standardized coefficients are reported to allow comparison of the relative influence of control variables. Both random effects multilevel models and cluster robust estimation of standard errors were tested to adjust for potential clustering within communities. The results were similar, so results of the robust estimations are presented as this method best represents the survey design and the limited number of clusters and individuals within each cluster reduces the ability of the multilevel model to produce significantly different results. We examined interaction of factors such as knowledge and self-efficacy but did not find any significant interactions.

Results

Twenty-four-hour dietary recalls

Dietary risk factors

The final sample used in the dietary analysis was 64.1% female with overall mean ages of 42 and 44 years for men and women, respectively. Both male and female respondents reported high fat and sugar and low fiber intake compared to dietary reference intakes (Otten *et al.* 2006) regardless of the remoteness of their residence (Table 1). Total energy intake was significantly different across age and sex ($p < 0.002$) and it was marginally significant across location ($p < 0.09$). After adjusting for remoteness and sex, age and gender were still significantly associated with energy intake (kcal/day) ($p < 0.03$). Table 2 shows the nutrients (% of calories from protein and sugar) that were significantly associated with age, sex, or remote location. We also examined vitamins A, B_{12}, C, D, and E, fiber, calcium, percentage of calories from fat and energy but found no significant associations. All of the top 10 most frequently reported foods were store-bought foods.

Risk factors survey

Table 3 shows the survey sample characteristics by region. Nearly one half of the sample (47.7%) was obese (BMI >30 kg/m^2) and an additional 32.6% were overweight (BMI >25 kg/m^2), with no significant difference between remote and semi-remote regions. Twenty-seven percent of respondents reported having diabetes, and another 3% reported having been diagnosed with impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) but not diabetes. There were significantly more people in semi-remote communities who had completed grade 12 or equivalent education compared to in remote communities (63.1% vs. 39.5% respectively, $p < 0.007$).

Table 1. Nutrient intake by sex and residence

	All sites (mean ± SD)		Remote (mean ± SD)		Semi-remote (mean ± SD)	
	M	F	M	F	M	F
Total number (n)	47	75	22	38	25	37
Age (years)	42 ± 14	44 ± 17	42 ± 16	47 ± 19	43 ± 13	41 ± 14
Energy (kcal)	2676 ± 1012	2060 ± 985	2459 ± 1047	1950 ± 983	2867 ± 961	2172 ± 974
Fat (g)	106 ± 56	79 ± 53	96 ± 58	74 ± 50	115 ± 53	84 ± 55
Saturated fat (g)	35 ± 20	24 ± 19	32 ± 22	23 ± 17	38 ± 19	26 ± 21
Protein (g)	109 ± 45	76 ± 38	110 ± 42	81 ± 39	109 ± 49	71 ± 37
Carbohydrate (g)	328 ± 134	268 ± 134	296 ± 123	245 ± 142	356 ± 140	291 ± 122
Sugar (g)	138 ± 87	109 ± 81	128 ± 86	92 ± 75	146 ± 89	127 ± 83
Dietary fiber (g)	16 ± 12	13 ± 8	15 ± 15	12 ± 8	17 ± 8	14 ± 8
Percentage (%) of energy from total fat	34 ± 10	32 ± 10	33 ± 9	32 ± 11	35 ± 10	32 ± 10

Note: Recommended intake for fat, sugar and fiber in adults: Fat, 20–35% of total energy; added sugars, <25% of total energy; fiber, 38 g/day (men 19–50 years old); 25 g/day (women 19–50 years old).

Table 2. Determinants of nutrient intake ($n = 122$, remote = 60, semi-remote = 62)

R^2	Percentage (%) of kcal from protein		Sugar (g)	
	0.215		0.159	
	β^a	p-Value	β^a	p-Value
Age	2.552	0.043	−2.460	0.049
Gender	2.761	0.033	0.066	0.949
Remote	3.120	0.021	−1.349	0.226
Total kcal	−3.302	0.016	4.242	0.005

[a]Standardized betas.

Patterns of food acquisition and food preparation

Higher fat/higher sugar/lower fiber foods were for the most part acquired more frequently than healthier alternatives. For instance, in the past 30 days respondents reported getting: 2% milk 3.4 times vs. 1% or skim milk 0.5 times, regular soda 6.4 times vs. diet soda 3.3 times, sugar 1.2 times vs. sugar substitutes 0.5 times, and butter or margarine 1.8 times vs. lower fat spreads 0.2 times. Supermarkets or local grocery stores were the primary source of food. In remote communities, 54% of respondents supplemented store foods by hunting or fishing while only 5% in semi-remote communities did. In addition, 28% of respondents in remote communities ordered food that was flown in or purchased food that was brought into their community when they flew out to town.

Table 4 shows the primary method of preparation for seven foods. There was no significant difference across sites. Pan-frying was the most common method of preparation for fish and eggs. Boiling, or baking or microwaving with added fat were the most common ways of preparing potatoes, chicken, and deer/moose. A third of respondents drained their ground beef and 16% also rinsed it before serving. Cooking spray was used very rarely.

Determinants of food-related behavioral outcomes

Table 5 shows the results of regression analyses for healthy food purchasing and healthiness of food preparation. Older respondents with higher intention scores who had earned income in the past year and were living in larger households in remote communities were significantly more likely to have higher healthy food acquistion scores. Women were significantly more likely to use healthier methods of food preparation. Older people and

Table 3. Risk factor survey respondent characteristics ($n = 133$, remote = 76, semi-remote = 57).

	Total	Remote	Semi-remote
Female (%)	78.2	82.9	71.9
Age in years [mean (SD)][a]	42.1 (12.3)	41.1 (12.5)	43.4 (11.9)
BMI [mean (SD)][b]	30.3 (6.0)	30.8 (5.8)	29.6 (6.4)
Living with partner (%)	59.4	56.6	63.2
Household members [mean (SD)]	4.1 (2.1)	4.4 (2.3)	3.8 (1.9)
With > = grade 12 or equivalent (%)	49.6	39.5*	63.2*

[a]Based on $n = 132$ (remote, $n = 75$, semi-remote = 57).
[b]Based on $n = 130$ (remote, $n = 75$, semi-remote = 55).
*$p = 0.005$.

Table 4. Main methods of food preparation for seven key foods in past 30 days, row% ($n = 133$)

Food	Deep fried	Pan-fried	Pan-fried and drained	Drained and rinsed	Cooking spray	Grilled	Boiled and drained	Cooked without added fat	Cooked with added fat, other	Did not cook
Ground beef	1	17	33	16	0	4	11	1	13	5
Chicken	2	6	1	0	0	3	14	23	44	8
Pork	1	21	1	0	0	5	10	26	17	20
Fish	12	51	0	0	0	0	9	1	5	22
Deer/Moose	2	23	1	1	0	1	4	2	27	41
Potatoes	3	7	0	0	0	1	65	11	9	4
Eggs	2	73	0	0	2	0	14	0	6	3

Table 5. Determinants of healthy food acquisition and preparation methods ($n = 132$)

	Healthy foods getting score*		Healthiness of cooking methods score	
	0.3135		0.1632	
	β	p-Value	β	p-Value
Remote	5.153	0.002	−2.267	0.064
Sex	a	a	−6.355	0.001
Age	2.754	0.033	2.384	0.054
Education	a	a	1.248	0.259
Working	3.098	0.021	*	*
MSL	a	a	a	a
DM/IGT	a	a	1.776	0.126
Household size	6.277	0.001	a	a
Food intentions	3.174	0.019	a	a

[a]Square root of score was used because of non-normality.

people in remote communities were also more likely to use healthier methods, although the association did not reach statistical significance.

Determinants of food-related psychosocial factors

It would be expected that as knowledge increases, self-efficacy and outcome expectations would increase, leading to increased intentions, and finally to increase practice of a behavior. Table 6 shows the results of regression analyses for predictors of food knowledge, outcome expectation, and intentions. Significant models were not able to be fit for self-efficacy. Older age and living in a remote community were the only statistically significant

Table 6. Determinants of psychosocial factors relating to food choice ($n = 132$)

	Food knowledge score		Food outcome expectations scale		Food intentions scale	
	0.1801		0.2497		0.1669	
	β^a	p-Value	Odds ratio	p-Value	β^a	p-Value
Sex	b	b	b	b	−5.249	0.002
Age	−4.698	0.003	0.981	0.230	b	b
Education	1.125	0.303	1.209	0.280	−1.467	0.193
Employment	1.411	0.208	3.029	0.095	−0.824	0.441
DM/IGT	0.705	0.507	b	b	−0.653	0.537
MSL	b	b	b	b	b	b
Remote community	−6.262	0.001	0.642	0.471	−1.534	0.176
Food knowledge	b	b	b	b	b	b
Food self-efficacy	b	b	2.906	0.003	b	b
Food outcome expectation	b	b	b	b	8.540	0.000

[a]Standardized betas.
[b]Not included because of high intercorrelations or poor fit in the model as a predictor.

Table 7. Physical activity as measured by accelerometry ($n = 81$, semi-remote = 44, remote = 37)

	Total (Mean ± SD)	Semi-remote (Mean ± SD)	Remote (Mean ± SD)
Sedentary PA (min/day)	856 ± 119	856 ± 138	856 ± 95
Light PA (min/day)	322 ± 64	320 ± 71	324 ± 54
Moderate PA (min/day)	262 ± 87	264 ± 90	260 ± 86
Vigorous PA (min/day)	1 ± 2	1 ± 2	0 ± 1
Total daily activity (counts/day)	252,729 ± 98,853	257,565 ± 102,510	246,977 ± 95,401

predictors of healthier food knowledge after adjusting for education, employment, and diabetes status. Self-efficacy was positively associated with outcome expectation after adjusting for age, education, employment, and living in a remote community. Being female and outcome expectation were positively associated with intention score after adjusting for education, employment, diabetes status, and living in a remote community.

Determinants of physical activity

Table 7 shows the accelerometry results by region based on 24-hour days. There were no statistically significant differences between remote and non-remote communities in mean minutes of physical activity or total activity counts. Two-thirds of respondents recorded no vigorous activity at all, although respondents averaged over four hours a day of moderate activity (using cutpoints of 350–1200 counts per minute). Over five hours per day of light activity was recorded, and including sleep time, time spent in sedentary activity averaged more than 14.5 hours. When fitting regression models to determine associations with different levels of physical activity, none of the models was statistically significant.

Determinants of body mass index (BMI)

Having DM or IGT, and being employed were significantly associated ($p < 0.05$) with increased BMI (Table 8). Age showed a trend for significance ($p = 0.09$).

Discussion

Modification of diet and physical activity have been shown to be effective in prevention of diabetes (Tuomilehto *et al.* 2001). Our results show that our First Nations sample has a high prevalence of poor diet and inactivity. The dietary data showed high intake of fat and

Table 8. Determinants of body mass index ($n = 132$)

R^2	0.1413	
	β^{a}	p-Value
Age	2.031	0.089
Employment	2.958	0.025
MSL	1.919	0.103
DM/IGT	2.654	0.038
Food intentions	1.146	0.295

[a]Standardized betas.

sugar and low intake of fiber (Table 1) compared to recommended levels (Otten *et al.* 2006). In our risk factors survey we found correspondingly frequent purchasing of non-nutrient dense high fat, high sugar, and low fiber foods and frequent frying of fish, which is also consistent with food habits observed in other studies of Native North Americans (Gittelsohn *et al.* 1998, Archer *et al.* 2002, Gittelsohn *et al.* 2006). Although there were a few single fathers, most of the male respondents were older men living alone, which might explain their lower scores for healthiness of food preparation. In formative research, we found men generally less concerned with health than most women. Many healthcare providers suggested that younger people had limited self-efficacy for food preparation in part because it was becoming less common for traditional knowledge to be passed down as family structures had changed. Multigenerational households are becoming less common, especially in semi-remote areas, decreasing the passing down of healthier traditional food preparation to youth through role-modeling and observation.

Living in a remote community significantly affected frequency of purchasing healthier food options, although in the opposite direction than anticipated. One reason might be that in remote communities, stores are on reserve, making it easy to go to the store daily. Our measure did not include quantity purchased so that the total volume of healthier foods might be less even though the frequency was greater. Location of residence was also associated with purchasing patterns in a similar study in Baltimore (Suratkar *et al.* 2007) reinforcing that environmental factors may be important in determining diet. As in the Baltimore and Apache Healthy Stores studies (Gittelsohn *et al.* 2006, Suratkar *et al.* 2007) higher intention scores were also associated with healthy food purchasing frequency supporting the theory that intention predicts behavior (Ajzen and Fishbein 1980).

Scores for psychosocial factors were moderate except for outcome expectations which were very high. This suggests that although respondents perceived greater benefits from healthy foods, they did not feel efficacious in engaging in healthy behaviors. As the SCT framework would predict, higher outcome expectations were associated with higher intentions to perform healthy behaviors. Given the previously discussed decreased role-modeling opportunities, intervention strategies may target healthier food preparation and acquisition. By providing skill-based activities for community members to learn and practice healthier behaviors they can increase their self-efficacy and directly observe positive outcomes that may increase their intention to perform healthy behaviors. Activities would need to be tailored to each community based on the differences observed between remote and semi-remote First Nations.

There are few studies of accelerometry in general adult populations with which to compare our data although the most recent National Health and Nutrition Examination Survey (NHANES) survey has added seven-day accelerometry to its measures. Studies of self-reported physical activity from the Centers for Disease Control (CDC) using data from the 2001 and 2003 Behavioral Risk Factor Surveillance System show that approximately 46% of the general population meets the recommended amount of physical activity (MMWR 2005). Thus, less than half of US adults spend 30 or more minutes in moderate-to-vigorous physical activity (MVPA) as indicated by whether they reported moderate-intensity activity on five or more days per week, including activities such as brisk walking, bicycling, gardening, etc. In our accelerometry data, 100% of respondents met this minimum recommended physical activity level of 30 or more minutes a day of MVPA. However, it must be noted that the accelerometry findings may be misleading when using the predefined cutpoints from the manufacturer. The cutpoints used in the analysis software consider 350–1200 activity counts/minute to be moderate activity, which would include activities such as light cleaning. This is in marked contrast to the CDC definition of 'moderate' activity as brisk walking and bicycling. In our sample, the level of activity from the accelerometer that might be equivalent to the CDC self-report definition of moderate amounts might actually be activity counts at the high end of 'moderate' and closer to the 'vigorous' level. In these First Nations, there was virtually no vigorous activity as measured by the manufacturer cutpoint of >1200 activity counts per minute. Overall, the largest portion of the day for our participants was spent in inactivity. These may be an effect of the high prevalence of obesity, which can make it more difficult to engage in vigorous physical activity. Although the use of objectively measured physical activity eliminates the problems that may arise in cultural understandings of terms such as 'leisure activity' that are commonly used in self-assessment tools (Coble and Rhodes 2006), validation of the accelerometers for appropriate cutpoints for Native populations may need to be explored further. We found no significant predictors of physical activity, but this may be in part due to our small sample size, and future investigation of psychosocial predictors among First Nations and American Indians is warranted.

A much greater proportion of this sample was obese (47.7%) or overweight (32.6%) than the general Canadian population which has rates of 23.1% as obese and 36.1% as overweight (Tjepkema 2005). Our sample also had a higher prevalence of obesity than the 36.6% found in the national First Nations Regional Longitudinal Health Survey (NAHO 2005), although that study was based on self-report. Obesity is a known risk factor for diabetes, so it is not surprising to see that people reporting having diabetes were more likely to have greater BMI. Most employment in First Nations is by the band, such that employed respondents are likely to be sitting in an office for long periods of time which may be a contributor to their increased likelihood of greater BMI. Although some research has shown and inverse association between income and obesity (Drewnowski and Specter 2004), in remote First Nations settings virtually all people are low income whether or not they are employed, but employed individuals are more likely to travel off reserve frequently and eat out in restaurants where there are limited healthy options while unemployed people may suffer from more food insecurity.

There are limited data on diet and physical activity in First Nations or American Indians making it difficult to compare our population to other Native populations although previous research on the prevalence of Type 2 diabetes suggests that there is considerable variability across different communities (Young *et al.* 2000). Our data suggest higher prevalence of risk factors such as obesity and poor diet in this population than in the general population, which may be a contributor to the high prevalence of diabetes observed. Our previous research in these communities describes a number of environmental factors that may contribute to this, such as lack safe places to exercise, limited access to healthier foods, and lack of social support for improving food preparation skills (Ho *et al.* 2006).

The small size of our sample limited the statistical power in our analyses so that we were unable to fit models for some variables. The low internal consistency of some of the scales may be a limitation in their utility as general SCT measures, but the primary purpose of the measures was to evaluate specific behaviors targeted in intervention activities. In cross-sectional surveys there are limits to the conclusions we can draw about some observed associations such as whether knowledge predicts diabetes status or vice versa. This is especially true given our low response rate and the non-random sample for the 24-hour dietary recalls. We also appreciate that the recall method only captures one day's intake allowing for a risk of random associations or lack of association. However, the primary purpose of the recalls was not for description of nutrient intake but for identification of foods to be included in a quantitative food frequency questionnaire

(FFQ). We subsequently collected FFQs from a random sample that will provide long-term dietary intake in terms of food, nutrient and food group intakes over a 30-day period. These specific dietary results likely have limited generalizability to First Nations in sub-artic boreal forest regions of Canada. They do demonstrate the importance of descriptive research for the development of interventions tailored to communities due to the variability across broad ethnic categorizations such as First Nations or American Indians.

Conclusions

Given the scarcity of data on adult First Nations diet and physical activity patterns, this small study provides important information that is essential to developing effective programs for diabetes prevention in this high-risk population. Effective strategies are needed to improve diet and physical activity level and reduce obesity in First Nations. Increasing knowledge and outcome expectations about healthier food preparation and selection could help reduce fat and sugar intake as well as increase fiber intake. Special attention should be paid to including men and youth as targets for behavior change. In addition, environmental barriers should be considered when designing interventions.

Note

1. The populations of First Nations communities are referred to as 'bands'. Official membership in a band accords an individual the benefits of government recognition of his/her aboriginal 'status', such as health care and treaty payments.

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