A Pilot School-Based Healthy Eating and Physical Activity Intervention Improves Diet, Food Knowledge, and Self-Efficacy for Native Canadian Children[1,2]

Brit I. Saksvig,[3] Joel Gittelsohn,* Stewart B. Harris,† Anthony J. G. Hanley,** Tom W. Valente,‡ and Bernard Zinman**

*Department of Kinesiology, University of Maryland, Baltimore, MD; *Center for Human Nutrition, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD; †Thames Valley Family Practice Research Unit, University of Western Ontario, London, ON, Canada; **Leadership Sinai Centre for Diabetes, Mt. Sinai Hospital, Toronto, ON, Canada; and ‡School of Medicine University of Southern California, Alhambra, CA*

ABSTRACT The Sandy Lake school-based diabetes prevention program is a culturally appropriate intervention for Ojibway-Cree students in the 3rd, 4th, and 5th grades. This paper reports the results of the program in changing dietary intake behaviors and related psychosocial factors. Physical activity results are not included. The study was a pretest/post-test, single-sample design conducted during the 1998–1999 school year. A total of 122 students completed all 4 measurements (anthropometry, 24-h dietary recall, and 2 questionnaires), at baseline and follow-up. There were significant increases ($P < 0.0001$) in dietary intention, dietary preference, knowledge, and dietary self-efficacy, and in the curriculum knowledge scale between baseline and follow-up. Intervention exposure was significantly associated with being in the highest category for knowledge about foods that were low in dietary fat [Medium Exposure odds ratio (OR): 3.4; $P < 0.05$; High Exposure OR: 6.4; $P < 0.05$], being in the highest category for dietary self-efficacy (Medium Exposure OR: 3.7; $P < 0.05$; High Exposure OR: 3.9; $P < 0.1$), being in the highest category for knowledge about curriculum concepts (Medium Exposure OR: 3.4; $P < 0.05$; High Exposure OR: 9.4: $P < 0.01$), and for having met the age + 5 g dietary fiber intake/d (Medium Exposure OR: 2.9; $P < 0.1$; High Exposure OR: 11.0; $P < 0.01$). Exposure to the intervention was not associated with dietary intent or the percentage of energy from dietary fat. This program was associated with improved knowledge and the psychosocial factors related to healthy eating and dietary fiber intake of students in a remote First Nations community. J. Nutr. 135: 2392–2398, 2005.

KEY WORDS: • *school-based intervention* • *Native American* • *Canadian Native children* • *diabetes* • *health promotion*

Type 2 diabetes is a serious health problem in many North American Indian communities in which the prevalence of diabetes among adults ranges from 8 to 49.5% (1,2) and is now a major health problem for Native North American children. The reported prevalence of Type II diabetes was 50.9/1000 among Pima 15- to 19-y-old youth, 4.5 for all U.S. American Indians, and 2.3 for Cree and Ojibway Indians in Manitoba, Canada (3,4).

Factors associated with the high prevalence of diabetes in Native North American populations include diets high in fat and low in dietary fiber intakes (5), low levels of physical activity (6), genetic predisposition (1,2), and obesity (2,4,7,8). Among Native North American children, the reported prevalence of overweight and obesity ranges from 21 to 64% (9–14), compared with 12–14% of U.S. children (15).

There is a need for culturally appropriate health promotion programs for the prevention of diabetes and its primary risk factor, obesity, among Native North American children to prevent chronic disease in the future. There have been a few such programs developed for Native North American children (16) and suburban Mohawk children (17), but there has yet to be a program specifically for Native North American children from remote northern communities.

Sandy Lake (Ne gaaw saga' igan) is a Native North American reserve located ~2000 km northwest of Toronto, ON, Canada. The community is isolated and for most of the year is accessible only by air (18). There are ~1821 band members living in Sandy Lake. The languages spoken in the community are Oji-cree, which is part of the Algonquin (Cree) family of Amerindian languages (19), and English.

The Sandy Lake Health and Diabetes Project (SLHDP)[4]

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[3] To whom correspondence should be addressed.
E-mail: bsaksvig@umd.edu.

[4] Abbreviations used: CATCH, Child and Adolescent Trial for Cardiovascular Health; SCT, social cognitive theory; SLHDP, Sandy Lake Health and Diabetes Project.

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found an age-adjusted prevalence of diabetes of 26% among adults (1). Obesity was significantly associated with diabetes in the 18- to 49-y-old age group for both men and women, 36% of adults had a BMI between 25 and 30 kg/m^2 (overweight), and 36% had a BMI $\geq$ 30 kg/m^2 (obese) (1). Obesity and overweight were also prevalent among children. Compared with the data of the 3rd National Health and Nutrition Examination Survey, 27% of boys and 34% of girls were at or above the 85th percentile for BMI (12). Low dietary fiber and high protein intakes were associated with increased prevalence of newly diagnosed diabetes (5). Low dietary fiber intake was associated with overweight among children (12).

Before the school-centered trial described here, SLHDP developed a number of community-based diabetes prevention strategies to modify the risk factors for diabetes in Sandy Lake among adults (20). The school-based healthy eating and physical activity intervention program was developed for the children of the community.

The goal of the school-based program was to demonstrate that after 1 y, a culturally appropriate school-based intervention would increase the students' knowledge, skills, and self-efficacy and positively change behaviors related to diet and physical activity. This paper describes the effect of the intervention on the knowledge and psychosocial factors related to healthy eating and the effect of the intervention on dietary fiber intake and the percentage of energy from dietary fat.

SUBJECTS AND METHODS

The Sandy Lake Diabetes Prevention intervention

Theoretical framework. The Sandy Lake school-based diabetes prevention intervention combined an ecological (21) model and social cognitive theory (SCT) approaches (22,23). Native North American learning styles were incorporated; these included learning through observation and practice, storytelling, cooperative learning, intergenerational learning, role modeling, emphasis on tradition, and the use of humor (24,25).

The school-based intervention included 4 components that were developed using formative research conducted with both children and adults by the SLHDP (20). Targeted foods were selected on the basis of a review of data collected by the SLHDP and the Northern store to identify the foods that were the greatest sources of fat, sugar, and energy (e.g., soda, potato chips, canned meat, and white bread). More detail about the Sandy Lake school-based diabetes prevention program can be found at www.sandylakediabetes.com.

Curriculum component. The Sandy Lake Diabetes Prevention Curriculum was the main feature of the school intervention and focused on knowledge and skills development related to healthy eating, physical activity, and diabetes education. The curriculum was created by the main author using multiple resources, primarily the CATCH curriculum (26) and the Kahnawake Schools Diabetes Prevention curriculum (27). Cultural adaptations were made to the curriculum and included foods and physical activities from the community. Cultural traditions such as feasts and learning from elders were incorporated. A key adaptation was to use storytelling as a way to introduce the main concepts of the health education lessons. The stories follow the activities of Missy and Buddy Daaybway as they learn about the importance of living a healthy lifestyle to prevent diabetes from an older family relative. The main author is working on a separate paper detailing the development of the intervention and the cultural adaptations that were made. The Sandy Lake curriculum was taught to all students in the 3rd, 4th, and 5th grades during the 1998–1999 school year and included 16 weekly, 45-min teacher-led lessons.

Family component. The family component informed parents and family members about the healthy eating and physical activity messages their children were learning in school. Strategies included messages on the SLHDP's weekly community radio show (topics included encouraging parents to turn off the TV and how to prepare healthy lunches and snacks for their children), information booths during parent-teacher nights, and letters sent home with students.

Peer component. The peer component provided opportunities for peers to act as role models. The first activity included a children's video cooking club, created in the summer of 1998, which showcased the preparation of healthy snacks by local children. Another activity was a "Diabetes Kids" radio show that aired 3 times on the weekly youth radio program.

Environmental component. To create a supportive school environment for healthful eating, the Sandy Lake Board of Education and the principals, with help from the SLHDP staff, developed a school-wide policy banning high-fat and high-sugar snack foods in the schools.

School meal. A healthy school lunch program, sponsored by the SLHDP and the Northern Store, was first developed and pretested to provide students with a low-cost, low-fat, low-sugar lunch alternative. At the end of the trial period, school and community leaders determined that a healthy breakfast snack program would be more sustainable. The breakfast snack program offered to each kindergarten to 5th grade student included a glass of 1% milk, fruit (e.g., apple), cheese, and a rice cake.

Design

The study design was a pretest/post-test, single sample design conducted during the 1998–1999 school year in grades 3, 4, and 5 of the Thomas Fiddler Memorial School in Sandy Lake, Ontario. Impact assessments were made to determine intervention effects on psychosocial and behavioral measures. Impact was assessed by dose-response to intervention components using an exposure scale. Limited process evaluation measures were conducted to assess adherence to the curriculum. Anthropometric measurements were assessed to provide information on the students' baseline and follow-up body composition status. Assessments were conducted before the start of the curriculum and within 1–2 wk after the last lesson of the curriculum.

Signed informed consent was obtained from participants' parents or guardians; assent was provided by study children. The study was approved by the Sandy Lake First Nation Band Council, The Johns Hopkins University Bloomberg School of Public Health, and the University of Toronto Ethics Review Committee.

Measures

Anthropometric status. Anthropometric measurements were conducted in the spring of 1998 and 1999. Height was measured to the nearest 0.1 cm using the Infant/Child/Adult Height Measuring Board™ (Shorr Productions). Weight was measured to the nearest 0.1 kg using an electronic weighing scale (Tanita TBF-305 Body Fat Analyzer™; Tanita). The percentage of body fat was estimated by bioelectrical impedance using the Tanita TBF-305 (26).

Dietary intake. A 24-h dietary recall was conducted with each student pre- and postintervention; the recalls were conducted over a 3-wk period with representation of all weekdays (27). Measurements were conducted in the spring of both 1998 and 1999. Students were trained to use a nonquantitative 1-d food diary to track the foods and drinks they consumed during the recall period to assist recall. This food record method was previously validated with children as young as 8 y old (28). Plastic food models and 2-dimensional models were used to assist students in recalling types and quantities of food and beverages during the interview. Interviewers followed a standardized interview format and were trained to probe for details about the foods and beverages that were consumed, such as the brand name, amounts, ingredients, and cooking method. Information about added fats and sugars was also collected.

Psychosocial factors. A health knowledge and behavior questionnaire was administered in the fall of 1998 and again in spring 1999 with students in the 3rd, 4th, and 5th grades. The questionnaire was developed from the CATCH Health Behaviors Questionnaire (29) and the Kahnawake Schools Diabetes Prevention Program classroom questionnaire (17) to measure change in psychosocial constructs and self-reported behaviors related to diet, physical activity, and knowledge about diabetes. Questions were adapted from these questionnaires to make them culturally and geographically relevant to this population based upon extensive formative research conducted in the community with teachers, parents, and community leaders. Questions measured dietary intention (29), dietary fat knowledge (30), behavioral capabilities (label reading skills), dietary self-efficacy (29), and outcome expectancies (food preferences) (31). A set of questions measured concepts the students learned from the lessons related to knowledge and perceptions about diet, physical activity, and diabetes. General questions assessed items such as grade, sex, languages spoken in the home (Oji-Cree/English/other), and ability to speak Oji-Cree.

Parent questionnaire. The parent/guardian questionnaire assessed family characteristics and the influence of parent/guardian knowledge, perceptions, behavior, and exposure to the intervention. Parents and guardians completed the questionnaire in the fall of 1998 and again in spring of 1999.

Data analysis

Scale development. Factor analysis was conducted with the dietary fat knowledge, dietary intention, dietary preference, and dietary self-efficacy scales to determine the final scale using the scree plot. The individual scale items were identified as having loaded at ≥0.34 on the retained principal component overall or at follow-up only. The final variables were then summed to create each scale. Coefficient α reliability estimates (32) were computed for each scale to measure internal consistency. The dietary fat knowledge scale consisted of 10 questions ($\alpha = 0.62$). The curriculum knowledge scale included 8 items ($\alpha = 0.73$). The dietary intention scale included 6 items ($\alpha = 0.61$), and 6 items comprised the dietary preference scale ($\alpha = 0.55$). The dietary self-efficacy scale included 9 items ($\alpha = 0.68$).

Exposure score. A set of 25 questions measured exposure to specific images and concepts addressed in the curriculum. Questions measured assisted recall of curriculum lesson images such as the food poster characters, the story characters, and the intervention/curriculum logo. Students were asked "Which pictures have you seen before?" and to circle all they had seen. Another set of questions assessed recall and comprehension of curriculum terms such as *Dasokeesheka Meechimun* ("everyday foods"), *Esch-com Meechimun* ("sometimes foods"), and *Wau-wau-kha-wee-win* activities (physical activities that make you feel one or more of the body cues). The last set of questions asked about exposure to other intervention activities, such as the diabetes kids radio show. The questions were all recoded as 0,1 (correct/incorrect or yes/no) with "don't know" responses coded as "0."

Factor analysis was conducted and 3 subscales were identified. The first subscale measured recall of the main curriculum images (*Daaybway* story characters and program logo) and included 4 questions ($\alpha = 0.70$). The second exposure subscale assessed comprehension of curriculum terminology (i.e., *Esch-com Meechimun* and *Wau-wau-kha-wee-win* activities) and included 5 items ($\alpha = 0.64$). The third subscale measured exposure to other intervention images and activities and included 5 items ($\alpha = 0.6$).

Parent-guardian healthy food purchases scale. To assess usual food purchases, parents were asked 7 forced-choice questions about what they usually buy, with a low-fat, low-sugar, high-fiber option paired with a high-fat, high-sugar, low-fiber option. Factor analysis was conducted and 5 of the 7 variables loaded on the same factor. These 5 variables were then summed to measure what types of foods parents usually buy ($\alpha = 0.71$). A high score on the scale indicates the purchase of foods that are lower in fat or sugar and higher in fiber.

Dietary data. Data collected from the 24-h recalls were entered into Food Processor version 7.5 (The Food Processor®, Nutrition Analysis Software from ESHA Research). Nutritional information for 6 traditional foods (soups: duck, rabbit, and moose; moose stew, and cooked moose and rabbit) was added to this software's database from an earlier study in Sandy Lake (5). Standard local recipes for bannock, tomato macaroni soup, and deli foods such as cheese sticks and cheese nachos were analyzed in Food Processor, and the nutrition information was added to the database. Daily nutrient intakes reported by Food Processor for each subject were imported into STATA® for statistical analysis.

Statistical analysis

Data collected from the student and parent questionnaires were entered twice into Epi Info, Version 6 and then transferred into STATA for statistical analysis. Descriptive statistics (means ± SD, minimum and maximum values, coefficient α) were computed for each of the scales. For the dietary intake and anthropometric data, the means ± SD were calculated.

Obesity was classified as being at or above the 95th percentile for age- and sex-specific BMI percentiles from the revised CDC growth charts (33).

Baseline and follow-up scores were compared using the paired *t* tests for normally distributed variables and the Wilcoxon matched-pairs signed-ranks test for nonparametric variables. Differences within sex and obesity status were tested for each variable. Change scores, computed by subtracting the baseline score from the follow-up score, were created to assess differences between subgroups.

Logistic regression was conducted to determine the effect of exposure to the intervention on dietary fat knowledge, curriculum knowledge, dietary self-efficacy, dietary intent, and dietary fiber intake using a lagged analysis, which uses the follow-up score as the dependent variable and controls for the baseline score.

The outcome variables for dietary fat knowledge, dietary intent, and dietary self-efficacy were coded as 0,1 because they were positively skewed. Follow-up dietary fat knowledge, dietary intent, and dietary self-efficacy were coded as 0 "Low" and 1 "High." The curriculum knowledge scale was normally distributed at follow-up, but was transformed into a dichotomous variable for consistency.

Follow-up dietary fiber intake was coded as 0,1 on the basis of the public health recommendation that children > 2 y old consume their age + 5 g/d of dietary fiber (34), with students who had fiber intakes less than their age + 5 g/d of fiber intake coded as "0," and students who met or exceeded the recommendation coded as "1."

The intervention exposure variable used in the models was a combined intervention exposure variable, created by adding the 3 exposure variables together and categorizing them as 0 "Low," 1 "Medium," and 2 "High."

The final logistic regression models were selected based on goodness of fit and theoretical importance and included the baseline outcome score (lagged variable), sex, grade level, baseline obesity status, ability to speak Oji-Cree, parent/guardian education level, and parental purchase of low-fat, high-fiber foods. Parental diabetes status, parent participation in the SLHDP home visit intervention, and family size were explored as possible confounders, but were removed from the analysis when their presence made no difference to the models.

RESULTS

Participation. A total of 122 of 138 eligible students (88%) completed all 4 measurements at baseline and follow-up (anthropometry, 24-h dietary recall, in-class questionnaire, individual questionnaire). Students' ages ranged from 7 to 14 y.

Of the participants, 45% were girls; 84% belonged to the Sandy Lake Band and the remaining 16% belonged to First Nations bands from surrounding communities. The students were in the 3rd (40%), 4th (37%), and 5th grades (23%); 19% of students reported being able to speak Oji-Cree and 41% reported being able to speak and understand only English.

At baseline, 106 parents completed the parent questionnaire for 134 students; 3 parents declined to participate in the study. Of parents/guardians who completed the questionnaire, 89% were women, 31% had participated in the SLHDP home visit program, and 29% had diabetes.

Anthropometry. At baseline, 31% percent of both boys and girls were at or above the 95th BMI percentile. Mean BMI

TABLE 1

Anthropometric and dietary intake variables at baseline and follow-up among Sandy Lake school children[1]

	Baseline	Follow-up	Difference[2]
Anthropometry			
BMI,[3] *kg/m²*	20.5 ± 4.3	21.5 ± 4.8***	0.95 ± 1.3
Body fat,[3] %	29.8 ± 10.7	31.0 ± 10.8***	1.18 ± 4.0
Dietary intake			
Energy intake,[4] *kJ/d*	9552 ± 4763	9580 ± 3996	27.7 ± 6102
Total fat,[4] *g/d*	86.4 ± 51.4	83.3 ± 45.1	−3.0 ± 65.6
Total fat,[3] % *energy*	33.8 ± 7.9	31.9 ± 8.3*	−2.0 ± 11.6
Carbohydrates,[3] *g/d*	308 ± 155	314 ± 137	5.1 ± 204
Carbohydrates,[3] *% energy*	54.5 ± 10.0	55.4 ± 10.5	0.91 ± 15.0
Total protein,[4] *g/d*	71.7 ± 44.4	77.1 ± 33.9	5.4 ± 57.1
Protein,[4] *% energy*	12.5 ± 4.0	13.8 ± 4.6	1.3 ± 6.1
Total fiber,[4] *g/d*	11.6 ± 8.0	13.4 ± 8.0	1.8 ± 11.1

[1] Values are means ± SD, n = 122. Asterisks indicate a difference from baseline: * $P < 0.05$; *** $P < 0.001$.
[2] Follow-up value − baseline value.
[3] Paired t test.
[4] Wilcoxon matched-pairs signed-rank test.

and percentage of body fat both increased significantly between the spring of 1998 and 1999 (**Table 1**). Students who were obese at baseline had a greater mean change in BMI than students who were not ($P < 0.05$).

Dietary intake. The percentage of energy from total fat was reduced at follow-up (Table 1); it decreased for boys (34% vs. 31%; $P < 0.05$), but not for girls (34% vs. 33%; $P < 0.2$). There were no other differences between baseline and follow-up by sex or baseline obesity status; change scores also were not affected.

Psychosocial scales. All scales increased significantly between baseline and follow-up (**Table 2**). Knowledge about foods low and high in dietary fat increased for girls (5.5 vs. 7.0; $P < 0.001$) and boys (5.2 vs. 7.1; $P < 0.001$) and for students who were obese at baseline (5.9 vs. 7.6; $P < 0.001$) and not obese at baseline (5.0 vs. 6.7; $P < 0.001$). The curriculum knowledge scale increased for girls (2.8 vs. 4.4; $P < 0.001$) and for boys (2.9 vs. 4.6; $P < 0.001$), for students who were obese at baseline (3.4 vs. 4.6; $P < 0.001$), and for students who were not obese at baseline (2.6 vs. 4.5; $P < 0.001$).

Dietary intention changed for girls (3.9 vs. 4.7; $P < 0.001$) and boys (3.2 vs. 3.7; $P < 0.01$), and for students who were not obese at baseline (3.5 vs. 4.2; $P < 0.001$). The dietary preference scale changed between baseline and follow-up for girls (2.9 vs. 3.6; $P < 0.003$) and boys (2.2 vs. 2.9; $P < 0.002$) and for students who were not obese at baseline (2.3 vs. 3.2; $P < 0.001$). Dietary self-efficacy changed significantly for girls (18.6 vs. 20.4; $P < 0.05$) and boys (17.4 vs. 19.2; $P < 0.05$) and for students who were obese at baseline (17.7 vs. 20.4; $P < 0.01$).

The change scores were then analyzed by sex and baseline obesity status (data not shown). Boys and girls did not differ in the amount of change for any of the scales between baseline and follow-up. There were some differences in the change scores between obese and nonobese students, with nonobese students showing greater change for dietary intent (0.86 vs. 0.17; $P < 0.05$).

Intervention exposure. Most of the students (94%) recalled seeing the main curriculum images (**Table 3**); 43% recalled concepts promoted in the lessons for making healthy food choices and being physically active, and 50% of students recalled secondary images used in the curriculum lessons that were not part of the main lesson format and said they had heard the "diabetes kids" on the radio.

Impact analysis. Exposure to the intervention was significantly and positively associated with being in the highest category for dietary fat knowledge, having a high score on the curriculum knowledge scale, and having a higher score for dietary self-efficacy at follow-up (**Table 4**). There appeared to be a dose effect with each exposure level. Dietary intention was not predicted by exposure. Intervention exposure was significantly associated with meeting the daily dietary fiber recommendation of age + 5 g/d.

DISCUSSION

The results of this study of 7- to 14-y-old First Nation students provide evidence that increased exposure to a culturally adapted 1-y school-based intervention with environmental components is associated with an increase in knowledge about foods low in fat, overall health knowledge, dietary self-efficacy, and with meeting the dietary fiber intake recommendation of age + 5 g/d for children > 2 y old.

Dietary intake. Dietary fiber intake was proposed to be protective against obesity (35), and one of the recommendations for dietary fiber intake for children > 2 y old is to increase dietary fiber intake to an amount equal to or greater than their age + 5 g/d to achieve intakes of 25–35 g/d after age 20 y (34). This study showed that increased exposure to the intervention was significantly associated with meeting the age + 5 g/d dietary fiber recommendation among children between the ages of 7 and 14 y. Environmental changes that were part of the program appear to have had an effect on meeting this recommendation. A comparison analysis with the change score for fiber intake and participation in the breakfast snack program and the change in dietary fiber intake and exposure to the intervention showed significantly higher increases in dietary fiber intake by exposure. The breakfast snack program, an environmental level strategy to provide students with healthy food choices, was an almost guaranteed daily source of fruit for students from kindergarten through the 5th grade. Each class received a crate of apples or other fruit at the

TABLE 2

Dietary fat knowledge, dietary intent, dietary preference, dietary self-efficacy, and curriculum knowledge at baseline and follow-up among Sandy Lake school children[1]

	Score			
Scale	Range	Baseline	Follow-up	Change[2]
Dietary fat knowledge	0–10	5.3 ± 2.3	7.1 ± 2.5***	1.7 ± 2.7
Dietary intent	0–6	3.5 ± 1.5	4.2 ± 1.6***	0.67 ± 1.8
Dietary preference	0–6	2.5 ± 1.5	3.2 ± 1.7***	0.70 ± 1.9
Dietary self-efficacy	0–27	17.9 ± 5.4	19.6 ± 5.4**	1.7 ± 6.4
Curriculum knowledge	0–8	2.9 ± 2.3	4.5 ± 2.4***	1.4 ± 2.0

[1] Values are means ± SD, n = 122. Asterisks indicate a difference from baseline: * $P < 0.01$; *** $P < 0.001$. All tests are paired t tests.
[2] Follow-up score − baseline score.

TABLE 3

Intervention exposure variables at follow-up among Sandy Lake school children[1]

Exposure scale	Range[2]	Boys (n = 67)	Girls (n = 55)	All children (n = 122)
			%	
Exposure to main curriculum images	0–4	95.9 ± 15.4	93.2 ± 17.6	94.6 ± 16.5
Recall of curriculum terms	0–5	47.5 ± 34.4	38.2 ± 28.3	43.3 ± 32.0
Recall and exposure to secondary curriculum images and radio show	0–5	46.3 ± 24.7	53.8 ± 24.6	49.6 ± 24.8

[1] Values are means ± SD.
[2] Range refers to the lowest and highest scores on the scale.

start of the week. Students were often allowed to eat >1 apple during the day. In addition, the cooking club videos used in the intervention featured students making and enjoying snacks that included vegetables and fruit.

The likelihood of meeting or exceeding the recommended dietary fiber intake was associated with a higher score by parents or guardians on the purchase of healthy foods (lower in fat, lower in sugar, and higher in fiber) score. An analysis of the baseline and follow-up parent purchase of healthy food scales indicates a significant increase in mean purchase of foods lower in fat, lower in sugar, and higher in fiber. These findings suggest that the intervention affected the home environment in addition to the school environment.

This is a very positive finding for school-based studies targeting modifiable dietary intake risk factors for diabetes

TABLE 4

Multiple logistic regression of the follow-up psychosocial scales and dietary fiber intake, demographic characteristics, and intervention exposure among Sandy Lake school children

	Outcomes at 1-y follow-up				
	Dietary fat knowledge	Knowledge scale	Dietary self-efficacy (Low/High)[1] Odds ratio	Dietary intent	Dietary fiber intake
Independent variable					
Intervention exposure					
Medium	3.40*	3.44*	3.70*	1.35	2.89
High	6.40*	9.37**	3.87	0.64	11.04**
Student characteristics					
Female	0.62	1.72	1.75	2.40*	2.06
Grade level					
4th	5.66**	0.68	0.27*	0.53	—[2]
5th	5.56*	2.79	1.87	0.35	—
Obese at baseline, *yes*	1.43	0.48	4.46**	0.87	0.82
Language					
Understands some spoken Oji-Cree	1.02	1.71	0.65	1.58	0.14**
Speaks and understands Oji-Cree	1.58	1.31	1.12	1.17	0.60
Parent/Guardian characteristics					
Education, *y*					
9–10	1.23	1.87	1.00	1.19	0.94
≥11	0.66	2.00	0.90	3.48	1.87
Usual purchase of healthy food choices	0.85	0.90	0.85	1.06	1.38
Dependent variable at baseline[3]	1.27*	1.67***	1.0	1.69**	0.88[4]
Other variables					
Follow-up energy intake, *kJ*					
Second quantile	—	—	—	—	4.89*
Third quantile	—	—	—	—	25.58***
Age at baseline, *y*	—	—	—	—	0.34**
Ate breakfast snack at follow-up, *yes*	—	—	—	—	2.16
Pseudo R^2	0.21**	0.28***	0.19**	0.19**	0.48***

[1] Each scale is coded as "Low" and "High" scores. For dietary fiber intake, "Low" refers to being under the age + 5 g/d of fiber intake; "High" refers to being at or above the age + 5 g/d of dietary fiber intake.
[2] Grade level was not used in this analysis because none of the grade 5 students met or exceeded the recommendation for age + 5 g/d of fiber intake.
[3] The lagged variable is the baseline variable for each dependent variable.
[4] Baseline fiber intake adjusted for energy intake. * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

prevention. A previous study among adults in this community found significant associations between low dietary fiber intake and newly diagnosed diabetes, independent of age, sex, and BMI (36). We found one other school-based study that demonstrated a significant difference between intervention and controls in dietary fiber intake based on 24-h dietary recalls (6.3 g/4184 kJ vs. 5.6 g/4184 kJ) (37).

In this study, the decrease in the percentage of energy from dietary fat was not associated with our intervention exposure variable; however, it decreased significantly between testing periods in this study (34% vs. 32%). There was no difference in the percentage of energy from saturated fat or energy intake between the 2 time periods. The change in dietary fat intake may be due to environmental changes occurring in the school and at home that the intervention exposure variable did not capture. This is something that can be explored further in future studies. A 2-point drop in the percentage of energy from fat is important for obesity prevention. The current U.S. dietary guideline is for a diet that contains ≤30% of energy from dietary fat (38). In our study, 32% of students met this recommendation at baseline, and 41% met the recommendation at follow-up. Diets with a high percentage of energy from fat are associated with obesity (39) and may be lower in other nutrients such as fiber (35). Diets high in fat were shown to lead to greater fatness even at low levels of energy intake (40).

Psychosocial constructs. Exposure to the intervention was significantly associated with children being more knowledgeable about foods low in fat, and having higher scores on the dietary self-efficacy and curriculum knowledge scales. Self-efficacy was shown to be a consistent predictor of behavior across a variety of health domains, including weight loss and diet (41). Those with high self-efficacy are more likely to initiate challenging behaviors (42,43). Those with greater self-efficacy also construe the enactment of healthy behaviors as being within their volitional control, a major determinant of behavior change (44). Further, self-efficacy was found to be an important moderator of the relation between knowledge and behavior (45). Dietary intention, however, was not significantly associated with the exposure variables.

The *Daaybway* stories provided a vehicle for locally recognizable and accepted role-models who were learning about and practicing the new behaviors being promoted in the curriculum and through other intervention components. Students also demonstrated a high recognition (94%) of the *Daaybway* characters at follow-up.

This study did not find any reduction in obesity in the children. Mean BMI and the percentage of body fat increased during the intervention period. Changes in obesity indices such as the percentage of body fat and BMI are difficult to demonstrate in school-based programs in which all students are considered "at risk." A 1-y intervention period with a population-wide focus may not be long enough to have a noticeable effect on these variables, especially considering that school-based programs of longer duration have not demonstrated an effect (46,47).

The positive results of this study are encouraging given the limitations. A key limitation was lack of a control group, which may have led to testing effects. In this study, a representative control group was not feasible due to geographic, resource, and personnel constraints and because the reserves in the Sioux Lookout Zone are diverse in terms of both resources and culture. To strengthen the design, the intervention was a full-coverage panel design in which all students in the 3rd, 4th, and 5th grades participated during an 8-mo time period (48,49). The time-frame for the intervention was 1 school year, which helped to control for maturation. Selectivity bias was controlled for because all possible participants received the program.

Another limitation was the use of a single 24-h dietary recall (pre- and post-), to assess change in diet among study children. Time, resource limitations, and respondent burden concerns prevented us from conducting multiple dietary recalls. Given the variability likely to emerge from use of a single recall, it is encouraging that positive dietary change was seen in the children. Future trials are planned using this curriculum and will assess diet in a manner intended to obtain more precise and reliable estimates.

A limitation of the school program itself was the lack of a strong physical activity component in the intervention. Brief classroom physical activity breaks were a part of the school program, but they were never implemented primarily because the training for activity breaks was very brief and teachers were not reinforced by the project team to fully incorporate them into classroom activities. The Kahnawake school-based intervention demonstrated increased physical fitness 2 y after the program ended but fitness returned to baseline levels 1 y later (47).

The Sandy Lake school-based intervention was implemented in a small (population = 2000) remote First Nations community in Northern Canada. This community is different from First Nations communities in Southern as well as Eastern and Western Canada. However, results are likely generalizable to other remote First Nations communities. In fact, the First Nations and Inuit Health Branch, the Health Canada arm overseeing the health care services of First Nations peoples in Canada, requested the curriculum for their health education materials in other First Nations communities.

In addition, the Sandy Lake diabetes prevention curriculum used the CATCH curriculum as a model and was able to demonstrate similar results. The other intervention strategies are also generalizable, particularly the use of local radio stations in First Nations communities, a primary mode of communication within and among communities throughout Canada. A healthy school breakfast snack program is another viable strategy because the Northern Store is currently in many of the remote communities, and funding is available from many sources. We also learned that a committee was formed to address such a program for another group of communities in the Sioux Lookout Zone. Overall, the cost of the school-based program and burden to teachers was very low. The greatest cost would be in funding a local person or persons to coordinate the different components.

In conclusion, the Sandy Lake First Nations Diabetes Promotion Program was significantly associated with increased knowledge, dietary self-efficacy, and dietary improvements. The curriculum is still being taught in Sandy Lake and the program is currently being evaluated within a broader school and community-based intervention study among 7 First Nation reserves in Ontario. This is evidence that culturally adapted materials can be an effective means of reaching North American Indian children and modifying risk factors related to diabetes and obesity.

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