

---

# Overweight in First Nations Children: *Prevalence, Implications, and Solutions*

---

Noreen D. Willows, PhD,  
Department of Agricultural, Food, and Nutritional Science,  
University of Alberta

## Abstract

Obesity is a condition of excessive body fat to an extent that health may be compromised. Overweight children have high weight for their height and may be at risk for obesity and its complications. In Canada, children are classified as obese or overweight based on their body mass index (BMI), which is the ratio of a child's weight to height. A child with a high BMI typically has excess body fat and is referred to as obese. Although national survey data is lacking, the available evidence suggests that Aboriginal children and youth living in Canada have a high rate of overweight and obesity. Childhood obesity is associated with health problems such as type 2 diabetes, high blood pressure, high levels of fat and insulin in the blood, joint problems, gallstones, and breathing problems when sleeping. Considering the high rate of type 2 diabetes in Aboriginal communities, the health risks associated with obesity in childhood may be high for Aboriginal children. National surveys are required to interpret the extent of the problem in Canada. However, the available evidence suggests a need for programs to prevent obesity in children in Aboriginal communities. The development of programs requires a better understanding of the biological, community-level, cultural, and social contributions to obesity in children. Community-based research that examines the factors associated with obesity in Aboriginal children (e.g., characteristics of the mother, activity level, dietary intake, and body fat); looks at cultural perceptions, attitudes, and knowledge about overweight children; and identifies community barriers to the adoption of healthy lifestyles is required.

## Key Words

Children, obesity, program planning, community-based research, Native American, diabetes, First Nations children

## INTRODUCTION

Obesity is a condition of excessive body fat to an extent that health may be compromised. Overweight children have high weight for their height and may be at risk for obesity and its complications. Many definitions of obesity and overweight have been used in the past. Some researchers in the past have included obese children within the overweight category while other researchers have excluded obese children from the category of overweight. For these reasons, direct comparison of the rates of overweight and obesity from different studies should be made with caution. Hopefully, the 2000 release of pediatric growth charts that allow the terms overweight and obesity to be defined will resolve this problem.

Direct measures of body fat are not practical for clinical or community practice. For this reason, body mass

index (BMI), which correlates well with body fat, is now widely used to define overweight and obesity. BMI is the ratio of weight in kilograms to the square of height in metres. Pediatric growth charts that provide BMI reference values for children are available online at <http://www.cdc.gov/growthcharts>. Growth charts compare a child's BMI to that of other children using percentiles. The child's BMI percentile is in relation to other children of the same age and sex. The 50th percentile is the average BMI value for age. If a child's BMI is the 95th percentile that means the child's BMI is greater than or equal to the BMI measurements of 95 per cent of children that age. The remaining five per cent of children that age have a BMI that is greater than that child's. In Canada, a child with a BMI between the 85th and 95th percentile is considered overweight and a child with a BMI at or above the 95th percentile is considered obese.

In Canada and the United States, there is a high rate of overweight and obesity in boys and girls.<sup>1</sup> There are noticeable differences in obesity rates among racial-ethnic groups. The reasons for these differences are unclear, but are likely the result of economic, social, and cultural factors that directly or indirectly affect the distribution of body weight in a population. In both Canada and the United States, the rate of overweight and obesity is considered to be higher in Aboriginal children than in the non-Aboriginal population (see Table 1). However, there have been limited surveys of these conditions in Aboriginal children in Canada.

Given the negative affects of obesity on health, the prevention of excess body fat that might lead to obesity must begin as early in life as possible. Programs for the prevention of obesity in Aboriginal children must be implemented. To be effective, prevention programs must not focus solely on changes in individual behavioural patterns. They must also focus on eliminating environmental barriers to healthy food choices and active lifestyles.<sup>2</sup>

The intent of this paper is to provide a review of the research published since 1990 on the rate of overweight and obesity and associated risk factors in Aboriginal children living in Canada and the United States. This paper also outlines areas of research that are required to develop effective interventions against obesity in children in Aboriginal communities.

## RESEARCH RELATED TO OVERWEIGHT AND OBESITY IN FIRST NATIONS CHILDREN

### Cree of James Bay, Quebec

The Cree of northern Quebec, whose population numbers 14,000, live in nine rural or remote communities. Historically, the James Bay Cree were hunters, fishers, and trappers. Since the late 1970s, the lifestyle of the people has changed dramatically with a noticeable decrease in physical activity and a change in diet to one that is largely market food. In 2002, 15 per cent of the population over 20 years had type 2 diabetes compared with 4.7 per cent of the population of Quebec. Diabetes has been diagnosed in youth.<sup>3</sup> Obesity in children is a serious health problem. The rates of obesity has increased during the 1990s (see Table 1).<sup>4</sup> In the early 1990s, it was found that overweight children participated less in physical activity and consumed fewer servings of milk products and fruits and vegetables than their normal-weight peers. Total energy intake from food was not evaluated.<sup>5</sup> Overweight is observed early in childhood in this population with

the majority of preschool children being overweight or obese.<sup>6</sup> Cree children living in the region 60 years ago had healthy body weights with only two per cent being obese.<sup>7</sup> Due to geographic and cultural isolation, the James Bay Cree are a relatively genetically-stable population. This suggests that the increase in body weight reflects dramatic environmental alterations and, perhaps, an increase in biological risk factors for childhood obesity.

### Mohawk of Kahnawake, Quebec

Kahnawake is an urban Mohawk community near Montreal. The traditional diet consisted of corn, beans, and squash supplemented by foods acquired through fishing, hunting, and gathering. In contrast, the current diet is predominantly market food. There is a high rate of type 2 diabetes and associated disease in adults in Kahnawake. For this reason, a school-based diabetes prevention program was started in 1994.<sup>8</sup> Since the start of the program, there has been intense study of weight in children. The prevalence of overweight children is high (see Table 1).<sup>9</sup> Because Mohawk children carry excess abdominal fat, the health risk of overweight is potentially heightened.<sup>10</sup> Television viewing is related to body fat in these children and children obtain a high percentage of food energy from sugar.<sup>11</sup>

### Oji-Cree in Sandy Lake, Ontario

Sandy Lake First Nation is an isolated community in the boreal forest region of central Canada. The traditional hunting and gathering lifestyle of the inhabitants has been altered dramatically over the last few decades, comparable to the Cree of James Bay, Quebec. Likely due to this transition in lifestyle, illness

---

## EDITOR'S NOTE

Body Mass Index is the ratio of weight in kilograms to the square height in metres.

A BMI of 18.5 or under is considered underweight.

A BMI of 18.5 to 24.9 is considered normal.

A BMI of 25 to 29.9 is considered overweight.

A BMI of 30 or more is considered obese.<sup>i</sup>

---

- i. "Canadian Guidelines for Body Weight Classification in Adults," (Ottawa: Health Canada, Office of Nutrition Policy and Promotion, 2003) available at [http://www.hc-sc.gc.ca/hpfb-dgpsa/onpp-bppn/qa\\_public\\_e.html](http://www.hc-sc.gc.ca/hpfb-dgpsa/onpp-bppn/qa_public_e.html) (accessed Feb. 8, 2005).

due to obesity and type 2 diabetes in adults is common.<sup>12</sup> Children are overweight (see Table 1) with the rate being highest in preschool children (45.2 per cent in girls aged two to five years old). In those aged 10 to 19 years, overweight children watched more television, had a lower fitness level, and ate less fibre than children who were not overweight.<sup>13</sup>

### Anishnabai Temagami First Nation, Ontario

The Anishnabai Temagami First Nation located four hours north of Toronto is home to more than 200 permanent residents. Residents trace their history back 6,000 years in the area. A descriptive study showed that the rate of obesity was high among 38 Anishnabai youth ages five to 19 years (see Table 1). When data was compared against residents of European ancestry living in a nearby town, Anishnabai youth had a greater rate of obesity and subcutaneous (under the skin) fat and fat around the waist.<sup>14</sup> Factors associated with obesity were not studied.

### The United States

National surveys of Native American schoolchildren in the United States indicate that many are overweight or obese.<sup>15</sup> Studies of specific tribes show high rates of overweight among Navajo, Pueblo, Sioux, Pima, and Winnegabo or Omaha children (see Table 1).<sup>16</sup> High body fat contributes to overweight.<sup>17</sup> Obesity begins early in life considering the high rate of obesity reported in American Indian preschool children (see Table 1).<sup>18</sup> A study comparing the activity levels of Pima children (average age of 10 years) and their non-Native American counterparts found that Pima children spent significantly less time doing sport leisure activities and more time watching television.<sup>19</sup> A study of Cherokee teenagers found no association between body measurements and energy intake or dietary patterns. Although it appears that overeating did not contribute to obesity, levels of physical activity were not assessed.<sup>20</sup> Research of Navajo adolescents found heavier youth had lower energy intakes than leaner youth. Physical activity levels were not assessed.<sup>21</sup>

Table 1a: Prevalence of Overweight and Obese First Nations Schoolchildren and Youth in Canada Compared with the General Population of Children<sup>i</sup>

	Overweight (%)	Obese (%)
General Population of Children <sup>ii</sup>	about 30	about 10
First Nations and Inuit Regional Health Survey (late 1990s) <sup>iii</sup>	6 (boys), 7 (girls)	
Cree in Northern Quebec (early 1990s) <sup>iv</sup>	38	9 (boys), 24 (girls)
Cree in Northern Quebec (late 1990s) <sup>v</sup>	24	35
Mohawk of Kahnawake, Quebec <sup>vi</sup>	29.5 (boys), 32.8 (girls)	
Oji-Cree in Sandy Lake, Northern Ontario <sup>vii</sup>	27.7 (boys), 33.7 (girls)	
Anishnabai Temagami First Nation, Ontario <sup>viii</sup>		29

- i. The reference standards for defining overweight and obese differ among studies. Some studies include obese children within the overweight category while other studies exclude obese children from the category of overweight. Therefore, direct comparison of the prevalence rates of overweight and obesity should be made with caution.
- ii. M.S. Tremblay and J.D. Willms, "Secular Trends in the Body Mass Index of Canadian Children," *Canadian Medical Association Journal*, Vol. 163, No. 11 (2000) p. 1429-33.
- iii. H. MacMillan et al., *Children's Health: Chapter 1: First Nations and Inuit Regional Health Survey* (Ottawa: First Nations and Inuit Regional Health Survey National Steering Committee, 1999). This information is based on reports from parents from select First Nations reserves across Canada and Inuit communities in Labrador. It did not include children from Alberta, the territories, or some areas of Quebec (James Bay Cree, Nunavik Inuit and Mohawk communities).
- iv. L. Bernard et al., "Overweight in Cree Schoolchildren and Adolescents Associated with Diet, Low Physical Activity, and High Television Viewing," *Journal of the American Dietetic Association*, Vol. 95, No. 7 (1995) p. 800-2.
- v. I. Ngnie Teta, *Secular Trends in the Physical Growth of Cree Children*, (Cree Board of Health and Social Services of James Bay, 2002).
- vi. M. Trifonopoulos, *Anthropometry and Diet of Mohawk Schoolchildren in Kahnawake*, master's thesis (Montreal: McGill University, 1995).
- vii. A.J. Hanley et al., "Overweight Among Children and Adolescents in a Native Canadian Community: Prevalence and Associated Factors," *American Journal of Clinical Nutrition*, Vol. 71, No. 3 (2000) p. 693-700.
- viii. P.T. Katzmarzyk and R.M. Malina, "Obesity and Relative Subcutaneous Fat Distribution Among Canadians of First Nation and European Ancestry," *International Journal of Obesity and Related Metabolic Disorders*, Vol. 22, No. 11 (1998) p. 1127-31.

## CONSEQUENCES OF OBESITY ON HEALTH AND WELL-BEING OF ABORIGINAL CHILDREN

### Psychosocial Concerns

Obese children can have poor self-esteem and feel bad about their bodies.<sup>22</sup> Until recently, little attention

has been paid to the weight perceptions and weight control practices of Aboriginal youth. Most of the available studies show a high rate of eating disorders.<sup>23</sup> Two national surveys of weight control practices and weight perceptions in American Indian youth showed many adolescents to have weight dissatisfaction, low body pride, and weight concerns.<sup>24</sup> Overweight youth were less likely than nonover-

Table 1b: Prevalence of Overweight and Obese First Nations Schoolchildren and Youth in the United States Compared with the General Population of Children<sup>i</sup>

	Overweight (%)	Obese (%)
General Population of Children <sup>x</sup>		10-15
National surveys <sup>x</sup>	25-39	9-11
American Indian and Alaska Native Preschool children <sup>xi</sup>		12 - 19
Navajo (late 1980s) <sup>xii</sup>	25 (boys), 33 (girls)	
Navajo (early 1990s) <sup>xiii</sup>	35 (boys), 40 (girls)	
Navajo (mid 1990s) <sup>xiv</sup>	41	15 (boys), 21 (girls)
Pueblo <sup>xv</sup>	40.4	
Sioux <sup>xvi</sup>	32.1 (boys), 30.6 (girls)	3.6 (boys), 6.1 (girls)
Pima <sup>xvii</sup>	74.6 (boys), 78.3 (girls)	44.1 (boys), 51.8 (girls)
Winnegabo and Omaha <sup>xviii</sup>	32.7 (boys), 34.4 (girls)	16.4 (boys), 13.4 (girls)
New Mexico Indian <sup>xix</sup>	35.5 (boys), 33.3 (girls)	
Predominantly Anishinaabe (Ojibwe) <sup>xx</sup>	21.3 (boys), 22.5 (girls)	48 (boys), 35 (girls)

- ix. R.P. Troiano et al., "Overweight Prevalence and Trends for Children and Adolescents: The National Health and Nutrition Examination Surveys, 1963 to 1991," *Archives of Pediatrics and Adolescent Medicine*, Vol. 149, No. 10 (1995) p. 1085-91.
- x. M.Y. Jackson, "Height, Weight, and Body Mass Index of American Indian Schoolchildren, 1990-1991," *Journal of the American Dietetic Association*, 93 (1993) p. 1136-40; B.A. Broussard et al., "Prevalence of Obesity in American Indians and Alaska Natives," *American Journal of Clinical Nutrition*, Vol. 53, Suppl 6 (1991) p. 1535S-42S; and D. Neumark-Sztainer et al., "Psychosocial Concerns and Weight Control Behaviors Among Overweight and Nonoverweight Native American Adolescents," *Journal of the American Dietetic Association*, Vol. 97, No. 6 (1997) p. 598-604.
- xi. Broussard et al., "Prevalence of Obesity in American Indians and Alaska Natives," 1991; M.M. Gallaher et al., "Obesity Among Mescalero Preschool Children. Association with Maternal Obesity and Birth Weight," *American Journal of Diseases of Children*, Vol. 145, No. 11 (1991) p. 1262-5; F.R. Hauck et al., "Trends in Anthropometric Measurements Among Mescalero Apache Indian Preschool Children. 1968 through 1988," *American Journal of Diseases of Children*, Vol. 146, No. 10 (1992) p. 1194-8; and Centers for Disease Control and Prevention, *Pediatric Nutrition Surveillance System Annual Report, 1994* (Atlanta, Georgia: Maternal and Child Health Branch, Division of Nutrition, Centers for Disease Control and Prevention 1996).
- xii. T.J. Gilbert et al., "Obesity Among Navajo Adolescents: Relationship to Dietary Intake and Blood Pressure," *American Journal of Diseases of Children*, Vol. 146, No. 3 (1992) p. 289-95.
- xiii. J.C. Eisenmann et al., "Growth and Overweight of Navajo Youth: Secular Changes from 1955 to 1997," *International Journal of Obesity and Related Metabolic Disorders*, Vol. 24, No. 2 (February 2000) p. 211-218.
- xiv. Eisenmann et al., "Growth and Overweight of Navajo Youth: Secular Changes from 1955 to 1997," 2000.
- xv. S. Davis et al., "Primary Prevention of Obesity in American Indian Children," *Annals of the New York Academy of Sciences*, Vol. 699 (1993) p. 167-80.
- xvi. Broussard et al., "Prevalence of Obesity in American Indians and Alaska Natives," 1991.
- xvii. Broussard et al., "Prevalence of Obesity in American Indians and Alaska Natives," 1991.
- xviii. Broussard et al., "Prevalence of Obesity in American Indians and Alaska Natives," 1991.
- xix. S.M. Davis and L.C. Lambert, "Body Image and Weight Concerns Among Southwestern American Indian Preadolescent Schoolchildren," *Ethnography of Disease*, Vol. 10, No. 2 (2000) p. 184-194.
- xx. K. Rinderknecht and C. Smith, "Body-image perceptions among urban Native American youth," *Obesity Research*, Vol. 10, No. 5 (2002) p. 315-327.

weight youth to engage in health-promoting behaviours and were more likely to perceive their health as poor.<sup>25</sup> In Canada, the limited evidence shows body size dissatisfaction in First Nation youth.<sup>26</sup>

### Physiological Concerns

Childhood obesity causes high blood pressure, high levels of fat and insulin in the blood, increased blood clotting, joint problems, gallstones, and breathing problems (apnea) while asleep.<sup>27</sup> Factors associated with heart disease have been identified in obese children as young as five years of age.<sup>28</sup> Aboriginal children can have poor health when overweight. Among Navajo adolescents, 10 per cent of boys and six per cent of girls were found to have high blood pressure. Overweight children had higher blood pressure.<sup>29</sup> For Plains Indian children from Oklahoma, the heaviest children had higher triglyceride (blood fat) levels and poorer cholesterol levels than children who weighed less.<sup>30</sup> Obesity is related to type 2 diabetes in First Nations adults.<sup>31</sup> Because obese children have greater risk than normal weight children to become obese adults, obese children will likely have increased risk of diseases such as type 2 diabetes when they grow older.<sup>32</sup> Mohawk children tend to carry their weight around their upper body, which is associated with greater risk of type 2 diabetes among adults.<sup>33</sup> The longer the length of time a person is obese, the more likely they are to get type 2 diabetes. For this reason, obese youth are at risk for developing the disease.<sup>34</sup> Until recently, type 2 diabetes was thought to be almost exclusively an adult disease. However, it has dramatically increased among First Nations children as young as four years of age.<sup>35</sup> Data from Pima children show risk factors for heart disease and diabetic complications in children with type 2 diabetes.<sup>36</sup> Up to 10 per cent of First Nations children with type 2 diabetes develop

kidney disease requiring dialysis.<sup>37</sup> Although genetics likely contributes to children getting diabetes, lifestyle factors that lead to obesity are believed to be more relevant.<sup>38</sup>

### LIMITATIONS OF THE KNOWLEDGE ON OBESITY IN FIRST NATIONS CHILDREN

There are several limitations of the knowledge on obesity in Aboriginal children (Table 2). In Canada, there is no national survey data on the body weight of Aboriginal children. Although the First Nations and Inuit Regional Health Survey reported on childhood overweight, these data are based on reports from parents from select First Nations reserves across Canada and Inuit communities in Labrador. It did not include children from Alberta, the territories, or some areas of Quebec (James Bay Cree, Nunavik Inuit and Mohawk communities).<sup>39</sup> Knowledge on the rate of overweight and obese children is restricted to a few intensely studied communities. If the results from these communities are typical of the Aboriginal population as a whole, then obesity in Aboriginal youth, as in non-Aboriginal youth, is a great public health concern. Despite reports of obesity in Aboriginal children associated with type 2 diabetes and risk factors for heart disease, there are only a few studies examining the causes of obesity.

There is little, quality data on the dietary and physical activity patterns of Aboriginal children as it relates to body weight despite evidence for obesity at young ages. Information on the social and environmental causes of obesity in children is even more limited. The poor success rate of adult obesity treatment programs points to the need for the development of obesity prevention programs targeted toward Aboriginal children.<sup>40</sup> Given the limitations of

**Table 2: Limitations of the Knowledge on Obesity in Aboriginal Children in Canada**

- National surveys of body weight are limited
- Studies of preschool-age children are scarce despite evidence for high body weight in this age group
- Dietary patterns of children are not known
- Physical activity patterns of children are not known
- Social and cultural values towards obesity are not well understood
- Community-level barriers to activity and healthy eating are not well documented
- Maternal contribution (maternal diabetes and overweight) are not well studied
- Early childhood factors that may contribute to overweight, such as bottle-feeding and infant feeding practices, are not well studied

the knowledge on obesity in Aboriginal children, it is not clear what form these interventions should take.

### **Dietary and Physical Activity Contributions to Obesity**

To develop relevant nutrition education interventions for obesity, it is important to describe the diet of a population. However, few studies in Canada exist that describe the diet of Aboriginal children. Analysis of food use is an important aspect of this process because it is more practical in education to focus on specific foods and dietary patterns than on nutrients.<sup>41</sup>

The lack of data on physical activity in Aboriginal youth is an important consideration because physical activity has the potential to protect against obesity through maintenance of energy balance. Presently, knowledge of the factors that influence physical activity in Aboriginal children is limited. Confidence in ability to perform a physical activity; beliefs; and social values related to physical activity, involvement in community-based physical activity organizations, access to equipment at home, and parental physical activity have all been associated with, or predictive of, physical activity in children.<sup>42</sup> Knowing the factors that influence physical activity in obese youth is important for designing effective intervention strategies.<sup>43</sup>

### **Maternal and Early Childhood Contributions to Obesity**

As documented for the Pima of Arizona and Oklahoma Indians, factors associated with overweight childhood can be related to the mother's obesity and diabetes.<sup>44</sup> There are an extremely small number of studies in Canada looking at these factors as they relate to child growth. In the James Bay area of Quebec, Cree children who were bottle-fed had greater body weight than breast-fed children. Also, the body weight of the mother during pregnancy is a predictor of the birth weight of the baby.<sup>45</sup> One study in Canada found that breast-feeding was associated with reduced risk of type 2 diabetes among Aboriginal children.<sup>46</sup>

### **Community Contributions to Obesity**

The environment makes it easy or difficult to adopt healthy behaviours.<sup>47</sup> However, there is little information about community factors contributing to obesity in Aboriginal populations. If communities in which

Aboriginal children live cause obesity, then understanding, measuring, and altering the environment is critical to reducing the rate of obesity. The environment is not just the physical environment such as the layout of communities, but also the environment of economic and social organization and cultural values. For example, environmental causes of type 2 diabetes in Mi'kmaq communities in Cape Breton have been identified as dependence upon market food and lack of access to traditional food.<sup>48</sup> Similarly, in Cree communities in northern Quebec, traditional food is recognized as health-promoting, but the lack of access to this food forces many people to consume less-nutritious market food.<sup>49</sup>

### **Social and Cultural Contributions to Obesity**

Not all cultures see obesity as a health problem.<sup>50</sup> Even if concern about excess weight and awareness of health related risks of being overweight are known by a given culture, there may be little social motivation to support sustained weight loss efforts.<sup>51</sup> Diabetes and obesity research in Aboriginal communities must therefore move beyond examining energy intake and physical activity. It must examine the economic, social, and cultural context of obesity.<sup>52</sup> An understanding of how a culture thinks about obesity is essential for a better understanding of the impact obesity has on psychosocial concerns and weight control behaviours.<sup>53</sup> For example, for the Cree of northern Quebec, obesity may not be seen as a problem.<sup>54</sup> Similarly, for the Ojibway-Cree in northern Ontario, diabetes is not always seen as a serious health problem and diet and lack of exercise are not always understood to be causes of obesity.<sup>55</sup> The Ojibway-Cree have been reported to prefer larger body sizes; therefore, individuals in this culture might not be motivated to lose weight. Older people prefer larger body sizes perhaps because of associations between thinness and infectious diseases and tuberculosis.<sup>56</sup> Adopting obesity prevention practices faces barriers including the belief that fat in food is nourishing and healthy and that carrying extra weight is a sign of health and strength.<sup>57</sup>

## **OBESITY PREVENTION PROGRAMS ARE REQUIRED IN ABORIGINAL COMMUNITIES**

Because eating and physical activity habits are formed in childhood and may be carried into adulthood, prevention programs that encourage increased

physical activity and healthy eating habits targeted towards children need to be developed and tested. Program planners interested in developing obesity prevention programs in Aboriginal communities must better understand the causes of obesity before developing interventions. Effective programs to prevent children from becoming overweight must have respect for, and sensitivity to, language and cultural issues. Program planners must ensure that the program agrees with community culture and values. It is important to identify the local belief systems and language by which people label and interpret health problems before developing interventions. Documentation of the local perspectives of health and obesity will permit use of appropriate language for discussing obesity and its associated health risks and will contribute towards effective health promotion programs. A needs assessment can evaluate the community in terms of its health and nutritional status and its needs with respect to health, nutrition, and physical activity.<sup>58</sup> To be most effective, interventions must be developed with full participation of the communities. Examples of obesity prevention programs in Canada that follow a participatory model include the Kahnawake Schools Diabetes Prevention Project (KSDPP)<sup>59</sup> and the Sandy Lake Health and Diabetes Project.<sup>60</sup> In the United States, participatory obesity prevention programs include Pathways, a multisite obesity-prevention study in American Indian school children living on reservations<sup>61</sup> and the Zuni Diabetes Prevention Program.<sup>62</sup> Evaluation of the success of these programs to prevent obesity is limited or not yet available.

In Canada, KSDPP was started in 1994 in the Mohawk community of Kahnawake near Montreal. It was the first primary prevention program for type 2 diabetes in a First Nations community in Canada. This elementary school-based program has a strong community health promotion focus. The aim of the intervention has been the development of a health education curriculum for children. It teaches about diabetes and its complications and about healthy eating and healthy food choices. The intervention is reinforced by community activities to encourage healthy food choices and physical activity. Healthy breakfasts are offered at school and a school policy allows children to bring only healthy lunches and snacks to school. At the community level, a community garden was developed and healthy eating promoted at community events, through radio shows, and in articles written in the local paper. Community canteens were persuaded to include healthy food choices and fewer unhealthy

ones.<sup>63</sup> An evaluation of the diet of school children four years after the start of KSDPP found that children were not eating healthier.<sup>64</sup> Children were not asked specifically about how or why they made food choices. However, given the complexity of food choices in the environment, it was felt that the intervention likely did not provide children with enough information to help them in all the choices they make on their own. Evaluation of KSDPP is ongoing.

## CONCLUSION

Data from the Canadian Census shows that Aboriginal children represent 5.6 per cent of all children in Canada. Children aged 14 and under represent one-third (33.2 per cent) of the Aboriginal population, far higher than the corresponding share of 19 per cent in the non-Aboriginal population.<sup>65</sup> The Census counted 315,685 Aboriginal children aged 14 and under in 2001. Based on current research, up to one-third of these children might be at risk for obesity. The illness and disease expected to result from childhood obesity might be devastating unless preventative measures are taken.

Aboriginal communities require childhood obesity prevention interventions that are based on an understanding of the local risk factors for obesity and that have sensitivity to language and cultural issues. The identification of factors that support and reinforce healthy eating and physical activity at multiple levels of influence is crucial. The determinants that are the most relevant and easiest to change should form the basis for interventions. Individual behaviours must be understood within the context of social, cultural, economic, and physical environments that both support and hinder health behaviours. For this reason, interventions need to focus on both individual behaviour change and environmental change. It is the combination of factors acting together that promotes or prevents healthy eating and physical activity, and in turn healthy weight. Given the multiple and interconnected influences on weight, strategies focused at multiple levels are more likely to be effective than strategies focused at a single level. Policy initiatives to help create and sustain supportive environments are essential to make it easier for children and their families to make healthy choices. At the community level, there is the need for policies to ensure the provision of healthy food at a reasonable price and to ensure opportunities for physical activity.

Better information on the rate of obesity in Aboriginal children in Canada is particularly pertinent so

Aboriginal health organizations can respond to community health needs. The ability to establish baseline data and benchmarks will allow communities to monitor and evaluate the effectiveness of programs designed to decrease obesity rates. The situation may be remedied by the recent establishment of a number of institutes, organizations, and initiatives to improve the state of knowledge of the health of Aboriginal Peoples. The Institute of Aboriginal Peoples' Health whose mandate is to address the special health needs of Aboriginal Peoples in Canada was created as part of the Canadian Institutes of Health Research.<sup>66</sup> The National Aboriginal Health Organization, an Aboriginal-designed and -controlled body created in 2000, works to influence and advance the health and well-being of Aboriginal Peoples through knowledge-based strategies. Both these organizations should support community-based research initiatives to address the issue of obesity rates and its causal factors in Aboriginal children and the development of obesity prevention programs.

## ENDNOTES

1. M.S. Tremblay and J. D. Willms, "Secular Trends in the Body Mass Index of Canadian Children," *Canadian Medical Association Journal*, Vol. 163, No. 11 (2000) p. 1429-1433; and R.P. Troiano et al., "Overweight Prevalence and Trends for Children and Adolescents: The National Health and Nutrition Examination Surveys, 1963 to 1991," *Archives of Pediatrics and Adolescent Medicine*, Vol. 149, No. 10 (1995) p. 1085-1091.
2. M. Nestle M and M.F. Jacobson, "Halting the Obesity Epidemic: A Public Health Policy Approach," *Public Health Reports*, Vol. 115, No. 1 (2000) p. 12-24.
3. Cree Board of Health and Social Services of James Bay, Diabetes Registry, Annual Diabetes Update: Eeyou Istchee (2002).
4. L. Bernard et al., "Overweight in Cree Schoolchildren and Adolescents Associated with Diet, Low Physical Activity, and High Television Viewing," *Journal of the American Dietetic Association*, Vol. 95, No. 7 (1995) p. 800-802; and I. Ngnie Teta, Secular Trends in the Physical Growth of Cree Children (Cree Board of Health and Social Services of James Bay, 2002).
5. Bernard et al., "Overweight in Cree Schoolchildren and Adolescents," 1995.
6. N.D. Willows, "Obesity: A threat to the Health of James Bay Cree Children," *The Shift*, Vol. 5, No. 2 (Winter 2003) p. 3-4 available at [http://www.chps.ualberta.ca/publications/shift.htm#volume5\\_issue2](http://www.chps.ualberta.ca/publications/shift.htm#volume5_issue2) (accessed Aug. 9, 2004); and N.D. Willows, "The Sociocultural and Biological Reasons for the Weight of Cree Children," *Research Update: Alberta Centre for Active Living*, Vol. 10, No. 2 (2003) available at <http://www.centre4activeliving.ca/Research/ResearchUpdate/2003/March.htm> (accessed Aug. 9, 2004)
7. Ngnie Teta, "Secular trends in the physical growth of Cree children," 2002.
8. R. Montour, "KSDPP receives \$2.5 million grant: Diabetes program has gained national recognition of its work in Kahnawake," *Eastern Door*, Vol. 10, No. 7 (March 9, 2001).
9. M. Trifonopoulos, Anthropometry and Diet of Mohawk Schoolchildren in Kahnawake, master's thesis (Montreal: McGill University, 1995).
10. L. Potvin et al., "Anthropometric Characteristics of Mohawk Children Aged 6 to 11 Years: A Population Perspective," *Journal of the American Dietetic Association*, Vol. 99, No. 8 (1999) p. 955-961.
11. O.K. Horn et al., "Correlates and Predictors of Adiposity Among Mohawk Children," *Preventive Medicine*, Vol. 33, No. 4 (2001) p. 274-281; and M. Trifonopoulos, H.V. Kuhnlein, and O. Receveur, "Analysis of 24-Hour Recalls of 164 Fourth- to Sixth-Grade Mohawk Children in Kahnawake," *Journal of the American Dietetic Association*, Vol. 98, No. 7 (1998) p. 814-816.
12. S.B. Harris et al., "The Prevalence of NIDDM and Associated Risk Factors in Native Canadians," *Diabetes Care*, Vol. 20, No. 2 (1997) p. 185-187.
13. A.J. Hanley et al., "Overweight Among Children and Adolescents in a Native Canadian Community: Prevalence and Associated Factors," *American Journal of Clinical Nutrition*, Vol. 71, No. 3 (2000) p. 693-700.
14. P.T. Katzmarzyk and R.M. Malina, "Obesity and Relative Subcutaneous Fat Distribution Among Canadians of First Nation and European ancestry," *International Journal of Obesity and Related Metabolic Disorders*, Vol. 22, No. 11 (1998) p. 1127-1131.
15. M.Y. Jackson, "Height, Weight, and Body Mass Index of American Indian Schoolchildren, 1990-1991," *Journal of the American Dietetic Association*, Vol. 93, No. 10 (1993), p. 1136-1140; B.A. Broussard et al., "Prevalence of Obesity in American Indians and Alaska Natives," *American Journal of Clinical Nutrition*, Vol. 53, Suppl. 6 (1991) p. 1535S-1542S; and D. Neumark-Sztainer et al., "Psychosocial Concerns and Weight Control Behaviors Among Overweight and Nonoverweight Native American Adolescents," *Journal of the American Dietetic Association*, Vol. 97, No. 6 (1997) p. 598-604.
16. Broussard et al., "Prevalence of Obesity in American Indians and Alaska Natives," 1991; D. Neumark-Sztainer et al., "Psychosocial Concerns and Weight Control Behaviors Among Overweight and Nonoverweight Native American Adolescents," 1997; T.J. Gilbert, "Obesity Among Navajo Adolescents: Relationship to Dietary Intake and Blood Pressure," *American Journal of Diseases of Children*, Vol. 146, No. 3 (1992) p. 289-295; and S. Davis, "Primary Prevention of Obesity in American Indian children," *Annals of the New York Academy of Sciences*, Vol. 699 (1993) p. 167-180.
17. T.G. Lohman et al., "Body Composition Assessment in American Indian Children," *American Journal of Clinical Nutrition*, Vol. 69, Suppl. 4 (1999) p. 764S-766S.
18. Broussard et al., "Prevalence of Obesity in American Indians and Alaska Natives," 1991; M.M. Gallaher et al., "Obesity Among Mescalero Preschool Children: Association with Maternal Obesity and Birth Weight," *American Journal of Diseases of Children*, Vol. 145, No. 11 (1991) p. 1262-1265; F.R. Hauck et al., "Trends in Anthropometric Measurements Among Mescalero Apache Indian Preschool Children, 1968 through 1988," *American Journal of Diseases of Children*, Vol. 146, No. 10 (1992) p. 1194-1198; and Centers for Disease Control and Prevention, Pediatric Nutrition Surveillance System Annual Report, 1994 (Maternal and Child Health Branch, Division of Nutrition, Atlanta, Centers for Disease Control and Prevention, 1996).

19. A.M. Fontvieille, A. Kriska, and E. Ravussin, "Decreased Physical Activity in Pima Indian Compared with Caucasian Children, *International Journal of Obesity and Related Metabolic Disorders*, Vol. 17, No. 8 (1993) p. 445-452.
20. M. Story et al., "Anthropometric Measurements and Dietary Intakes of Cherokee Indian Teenagers in North Carolina," *Journal of the American Dietetic Association*, Vol. 86, No. 11 (1986) p. 1555-1560.
21. Gilbert et al., "Obesity Among Navajo Adolescents," 1992.
22. W.H. Dietz, "Health Consequences of Obesity in Youth: Childhood Predictors of Adult Disease," *Pediatrics*, Vol. 101, No. 3 Pt 2 (1998) p. 518-525.
23. G. Marchessault, "Weight Perceptions and Practices in Native Youth," *Healthy Weight Journal*, Vol. 13, No. 5 (1999) p. 71-73, 79.
24. Neumark-Sztainer et al., "Psychosocial Concerns and Weight Control Behaviors Among Overweight and Nonoverweight Native American Adolescents," 1997; and M. Story, "Weight Perceptions and Weight Control Practices in American Indian and Alaska Native Adolescents: A National Survey," *Archives of Pediatrics and Adolescent Medicine*, Vol. 148, No. 6 (1994) p. 567-571.
25. Neumark-Sztainer et al., "Psychosocial Concerns and Weight Control Behaviors Among Overweight and Nonoverweight Native American Adolescents," 1997.
26. Marchessault, "Weight Perceptions and Practices in Native Youth," 1999.
27. D.S. Freedman et al., "The Relation of Overweight to Cardiovascular Risk Factors Among Children and Adolescents: The Bogalusa Heart Study," *Pediatrics*, Vol. 103, No. 6 Pt 2 (1999) p. 1175-1182; M.A. Ferguson et al., "Fat Distribution and Hemostatic Measures in Obese Children," *American Journal of Clinical Nutrition*, Vol. 67, No. 6 (1998) p. 1136-1140; P. Tounian et al., "Presence of Increased Stiffness of the Common Carotid Artery and Endothelial Dysfunction in Severely Obese Children: A Prospective Study," *Lancet*, Vol. 358, No. 9291 (2001) p. 1400-1404; E.S. Ford et al., "C-Reactive Protein and Body Mass Index in Children: Findings from the Third National Health and Nutrition Examination Survey, 1988-1994," *Journal of Pediatrics*, Vol. 138, No. 4 (2001) p. 486-492; and R.S. Strauss and W.S. Browner, "Risk for Obstructive Sleep Apnea," *Annals of Internal Medicine*, Vol. 132, No. 9 (2000) p. 758-759.
28. Freedman et al., "The Relation of Overweight to Cardiovascular Risk Factors Among Children and Adolescents," 1999; and D. Young-Hyman et al., "Evaluation of the Insulin Resistance Syndrome in 5- to 10-year-old Overweight/Obese African-American Children," *Diabetes Care*, Vol. 24, No. 8 (2001) p. 1359-1364.
29. Gilbert et al., "Obesity Among Navajo Adolescents," 1992.
30. P.R. Blackett et al., "Lipoprotein Changes in Relation to Body Mass Index in Native American Adolescents," *Pediatric Research*, Vol. 40, No. 1 (1996) p. 77-81.
31. T.K. Young et al., "Type 2 Diabetes Mellitus in Canada's First Nations: Status of an Epidemic in Progress," *Canadian Medical Association Journal*, Vol. 163, No. 5 (2000) p. 561-566; W.C. Knowler et al., "Diabetes Mellitus in the Pima Indians: Incidence, Risk Factors and Pathogenesis," *Diabetes-Metabolism Reviews*, Vol. 6, No. 1 (1990) p. 1-27; W.C. Knowler et al., "Diabetes Incidence in Pima Indians: Contributions of Obesity and Parental Diabetes," *American Journal of Epidemiology*, Vol. 113, No. 2 (1981) p. 144-156; M.F. Saad et al., "The Natural History of Impaired Glucose Tolerance in the Pima Indians," *New England Journal of Medicine*, Vol. 319, No. 23 (1988) p. 1500-1506; and T.K. Young and G. Sevenhuysen, "Obesity in Northern Canadian Indians: Patterns, Determinants, and Consequences," *American Journal of Clinical Nutrition*, Vol. 49, No. 5 (1989) p. 786-793.
32. A. Must and R.S. Strauss, "Risks and Consequences of Childhood and Adolescent Obesity," *International Journal of Obesity and Related Metabolic Disorders*, Vol. 23, Suppl 2 (1999) p. S2-11; D. Neumark-Sztainer, "The Weight Dilemma: A Range of Philosophical Perspectives," *International Journal of Obesity and Related Metabolic Disorders*, Vol. 23, Suppl. 2 (1999) p. S31-S37; A. Must et al., "Long-Term Morbidity and Mortality of Overweight Adolescents: A Follow-up of the Harvard Growth Study of 1922 to 1935," *New England Journal of Medicine*, Vol. 327, No. 19 (1992) p. 1350-1355; and D.J. Gunnell et al., "Childhood Obesity and Adult Cardiovascular Mortality: A 57-y Follow-Up Study Based on the Boyd Orr Cohort," *American Journal of Clinical Nutrition*, Vol. 67, No. 6 (1998) p. 1111-1118.
33. Potvin et al., "Anthropometric Characteristics of Mohawk Children Aged 6 to 11 years," 1999; and M.I. Goran et al., "Energy Expenditure and Body Fat Distribution in Mohawk Children," *Pediatrics*, Vol. 95, No. 1 (1995) p. 89-95.
34. J.E. Everhart et al., "Duration of Obesity Increases the Incidence of NIDDM," *Diabetes*, Vol. 41, No. 2 (1992) p. 235-240.
35. A. Fagot-Campagna et al., "Type 2 Diabetes Among North American Children and Adolescents: An Epidemiologic Review and a Public Health Perspective," *Journal of Pediatrics*, Vol. 136, No. 5 (2000) p. 664-672; H.J. Dean, R.L. Mundy, and M. Moffatt, "Non-Insulin-Dependent Diabetes Mellitus in Indian Children in Manitoba," *Canadian Medical Association Journal*, Vol. 147, No. 1 (1992) p. 52-57; H. Dean, "Diagnostic Criteria for Non-Insulin-Dependent Diabetes in Youth (NIDDM-Y)," *Clinical Pediatrics*, Vol. 37, No. 2 (1998) p. 67-71; and S.B. Harris, B.A. Perkins, and E. Whalen-Brough, "Non-Insulin-Dependent Diabetes Mellitus Among First Nations Children: New Entity Among First Nations People of North Western Ontario," *Canadian Family Physician*, Vol. 42 (1996) p. 869-876.
36. A. Fagot-Campagna, W.C. Knowler, and D.J. Pettitt, "Type 2 Diabetes in Pima Indian Children: Cardiovascular Risk Factors at Diagnosis and 10 Years Later," *Diabetes*, Vol. 47, Suppl. 1 (1998) p. A155.
37. H. Dean and B. Flett, "Natural History of Type 2 Diabetes Diagnosed in Childhood: Long-Term Follow-Up in Young Adult Years," *Diabetes*, Vol. 51 (2002) p. A24.
38. D.S. Ludwig and C.B. Ebbeling, "Type 2 Diabetes Mellitus in Children: Primary Care and Public Health Considerations," *Journal of the American Medical Association*, Vol. 286, No. 12 (2001) p. 1427-1430; and D.R. McCance et al., "Glucose, Insulin Concentrations and Obesity in Childhood and Adolescence as Predictors of NIDDM," *Diabetologia*, Vol. 37, No. 6 (1994) p. 617-623.
39. H. MacMillan et al., "Children's Health: Chapter 1: First Nations and Inuit Regional Health Survey," (Ottawa: First Nations and Inuit Regional Health Survey National Steering Committee, 1999).
40. M. Story et al., "The Epidemic of Obesity in American Indian Communities and the Need for Childhood Obesity-Prevention Programs," *American Journal of Clinical Nutrition*, Vol. 69, Suppl. 4 (1999) p. 747S-754S.
41. Trifonopoulos, Kuhnlein, and Receveur, "Analysis of 24-Hour Recalls of 164 Fourth- to Sixth-grade Mohawk Children in Kahnawake," 1998.

42. S.G. Trost et al., "Physical Activity and Determinants of Physical Activity in Obese and Non-Obese Children," *International Journal of Obesity and Related Metabolic Disorders*, Vol. 25, No. 6 (2001) p. 822-829.
43. T. Baranowski, C. Anderson, and C. Carmack, "Mediating Variable Framework in Physical Activity Interventions: How are we doing? How might we do better?" *American Journal of Preventive Medicine*, Vol. 15, No. 4 (1998) p. 266-297.
44. W.C. Knowler et al., "Diabetes Incidence in Pima Indians: Contributions of Obesity and Parental Diabetes," *American Journal of Epidemiology*, Vol. 113, No. 2 (1981) p. 144-156; and E.T. Lee et al., "Diabetes, Parental Diabetes, and Obesity in Oklahoma Indians," *Diabetes Care*, Vol. 8, No. 2 (1985) p. 107-113.
45. N.D. Willows, R.A. Bell, and J. Laverdiere, *Infant Feeding Practices and Maternal Glycemic Status Each Modify Infant Weight Gain* (Vancouver: Canadian Diabetes Association/Canadian Society of Endocrinology and Metabolism Conference Proceeding, 2002).
46. T.K. Young et al., "Type 2 Diabetes Mellitus in Children: Prenatal and Early Infancy Risk Factors Among Native Canadians," *Archives of Pediatrics and Adolescent Medicine*, Vol. 156, No. 7 (2002) p. 651-655.
47. L.W. Green, L. Richard, and L. Potvin, "Ecological Foundations of Health Promotion," *American Journal of Health Promotion*, Vol. 10, No. 4 (1996) p. 270-281; and L. Richard et al., "Assessment of the Integration of the Ecological Approach in Health Promotion Programs," *American Journal of Health Promotion*, Vol. 10, No. 4 (1996) p. 318-328.
48. K.R. Travers, "Using Qualitative Research to Understand the Socio-Cultural Origins of Diabetes Among Cape Breton Mi'kmaq," *Chronic Diseases in Canada*, Vol. 16, No. 4 (1995) p. 140-143.
49. P. Boston et al., "Using Participatory Action Research to Understand the Meanings Aboriginal Canadians Attribute to the Rising Incidence of Diabetes," *Chronic Diseases in Canada*, Vol. 18, No. 1 (1997) p. 5-12.
50. S.K. Kumanyika, "Special Issues Regarding Obesity in Minority Populations," *Annals of Internal Medicine*, Vol. 119, No. 7 Pt 2 (1993) p. 650-654.
51. S.P. Davis, L. Northington, and K. Kolar, "Cultural Considerations for Treatment of Childhood Obesity," *Journal of Cultural Diversity*, Vol. 7, No. 4 (2000) p. 128-132.
52. K.M. Flegal, "The Obesity Epidemic in Children and Adults: Current Evidence and Research Issues," *Medicine and Science in Sports and Exercise*, Vol. 31, Suppl. 11 (1999) p. S509-S514; H.J. Dean, "Dancing with Many Different Ghosts: Treatment of Youth with Type 2 Diabetes," *Diabetes Care*, Vol. 25, No. 1 (2002) p. 237-238; and T.K. Young, "Sociocultural and Behavioural Determinants of Obesity Among Inuit in the Central Canadian Arctic," *Social Science and Medicine*, Vol. 43, No. 11 (1996) p. 1665-1671.
53. Neumark-Sztainer et al., "Psychosocial Concerns and Weight Control Behaviors Among Overweight and Nonoverweight Native American Adolescents," 1997; Kumanyika, "Special Issues Regarding Obesity in Minority Populations," 1993; and Davis, Northington, and Kolar, "Cultural Considerations for Treatment of Childhood Obesity," 2000.
54. N. Adelson, *Being Alive Well: Health and the Politics of Cree Well-Being* (Toronto: University of Toronto Press, 2000).
55. J. Gittelsohn et al., "Body Image Concepts Differ by Age and Sex in an Ojibway-Cree Community in Canada," *Journal of Nutrition*, Vol. 126, No. 12 (1996) p. 2990-3000.
56. Gittelsohn et al., "Body Image Concepts Differ by Age and Sex in an Ojibway-Cree Community in Canada," 1996.
57. Boston et al., "Using Participatory Action Research to Understand the Meanings Aboriginal Canadians Attribute to the Rising Incidence of Diabetes," 1997.
58. N.S. Scrimshaw and G.R. Gleeson, *Rapid Assessment Procedures—Qualitative Methodologies for Planning and Evaluation of Health Related Programmes* (Boston, MA: International Nutrition Foundation for Developing Countries, 1992; J. Gittelsohn Rapid Assessment Procedures (RAP)—Ethnographic Methods to Investigate Women's Health (Boston, MA: International Nutrition Foundation, 1998); and J. Gittelsohn et al., "Developing Diabetes Interventions in an Ojibway-Cree Community in Northern Ontario: Linking Qualitative and Quantitative Data," *Chronic Diseases in Canada*, Vol. 16, No. 4 (1995) p. 157-164.
59. A.C. Macaulay et al., "Participatory Research Maximises Community and Lay Involvement," *British Medical Journal*, Vol. 319, No. 7212 (1999) p. 774-778; A.C. Macaulay et al., "Primary Prevention of Type 2 Diabetes in First Nations: Experiences of the Kahnawake Schools Diabetes Prevention Project," *Canadian Journal of Diabetes Care*, Vol. 22, No. 3 (1998) p. 44-49; and A.C. Macaulay et al., "The Kahnawake Schools Diabetes Prevention Project: Intervention, Evaluation, and Baseline Results of a Diabetes Primary Prevention Program with a Native Community in Canada," *Preventive Medicine*, Vol. 26, No. 6 (1997) p. 779-790.
60. Gittelsohn et al., "Developing Diabetes Interventions in an Ojibway-Cree Community in Northern Ontario," 1995; S.B. Harris, "What works? Success Stories in Type 2 Diabetes Mellitus," *Diabetic Medicine*, Vol. 15, Suppl 4 (1998) p. S20-S23; A.J. Hanley et al., "The Sandy Lake Health and Diabetes Project: Design, Methods and Lessons Learned," *Chronic Diseases in Canada*, Vol. 16, No. 4 (1995) p. 149-156; and J. Gittelsohn et al., "Use of Ethnographic Methods for Applied Research on Diabetes Among the Ojibway-Cree in Northern Ontario," *Health Education Quarterly*, Vol. 23, No. 3 (1996) p. 365-382.
61. S.M. Davis et al., "Pathways: A Culturally Appropriate Obesity-Prevention Program for American Indian Schoolchildren," *American Journal of Clinical Nutrition*, Vol. 69, Suppl. 4 (1999) p. 796S-802S; J.L. Thompson et al., "Patterns of Physical Activity Among American Indian Children: an Assessment of Barriers and Support," *Journal of Community Health*, Vol. 26, No. 6 (2001) p. 423-445; and J. Gittelsohn et al., "Multisite Formative Assessment for the Pathways Study to Prevent Obesity in American Indian Schoolchildren," *American Journal of Clinical Nutrition*, Vol. 69, Suppl. 4 (1999) p. 767S-772S.
62. N.L. Teufel and C.K. Ritenbaugh, "Development of a Primary Prevention Program: Insight Gained in the Zuni Diabetes Prevention Program," *Clinical Pediatrics*, Vol. 37, No. 2 (1998) p. 131-141.
63. Macaulay et al., "Participatory Research Maximises Community and Lay Involvement. North American Primary Care Research Group," 1999; Macaulay et al., "Primary Prevention of Type 2 Diabetes in First Nations: Experiences of the Kahnawake Schools Diabetes Prevention Project," 1998; and Macaulay et al., "The Kahnawake Schools Diabetes Prevention Project: Intervention, Evaluation, and Baseline Results of a Diabetes Primary Prevention Program with a Native Community in Canada," 1997.
64. Trifonopoulos, Kuhnlein, and Receveur, "Analysis of 24-Hour Recalls of 164 Fourth- to Sixth-Grade Mohawk Children in Kahnawake," 1998.

