

NIN Review

National Institute of Nutrition

No. 32 2002

Preventing Type 2 Diabetes – A National Priority

Part I – Incidence and prevalence of diabetes and contributing lifestyle trends

D iabetes is a significant and growing public health concern affecting over 2 million (1 in 13) Canadians.^{1,2} This chronic disorder has been estimated to cost the Canadian economy at least US\$9 billion annually for the treatment of people with diabetes and its complications, including lost productivity due to diabetes-related illness and premature death.³ This document provides an overview of the diabetes situation in Canada, focusing on the incidence and prevalence of diabetes and contributing lifestyle trends such as inactivity and overweight.

Diabetes Takes a Toll

In 1996, there were 5,447 deaths (2,701 men; 2,746 women) for which diabetes was considered the underlying cause. This ranks diabetes as the seventh leading cause of death in Canada.⁴ The actual number of deaths for which diabetes was a contributing factor is likely five times higher according to more recent Canadian studies.³ The reason is that people with diabetes usually die from complications associated with diabetes, such as ischemic heart disease, and it is these complications that are usually coded as the underlying cause of death.³

Diabetes contributes to other life-threatening and debilitating complications, notably blindness, end-stage kidney disease, nerve damage, heart attack and stroke, and amputation.¹ Individuals with diabetes can have medical costs two to five times higher than those of a person without diabetes due to more frequent medical visits, more supplies and medication, and the higher likelihood of being admitted to a nursing home.²

Projections of diabetes mortality trends into the year 2016 show an exponential increase in the number of diabetes-related deaths in men and a more linear increase among women (Figure 1). Changing demographics associated with the aging of the population

NIN Review No. 33, 2002, “Preventing Type 2 Diabetes – A National Priority, Part II” will describe a target group that may benefit most from diabetes prevention strategies: adults 35 to 55 years of age, with a Body Mass Index (BMI) of 25 to 29.9, who are physically active less than 30 minutes per day. The document will discuss their changing physiology, eating and activity patterns, and obstacles and barriers to healthy eating and active living.

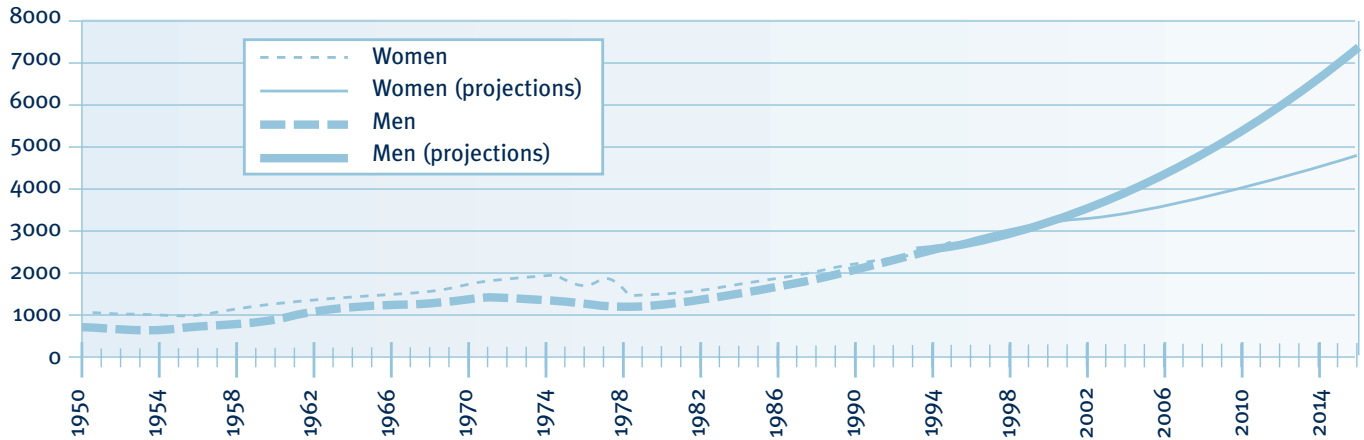
account for some of the increase. However, age-specific rates of diabetes for men are also increasing, resulting in the greater rates of increase in male deaths. Unless measures are taken to address the alarming mortality trend through prevention and control of diabetes, it may continue to rise unchecked.⁵

Types of Diabetes

About 90% of Canadians with diabetes have type 2 diabetes (formerly referred to as adult-onset, or non-insulin-dependent). This type of diabetes occurs when the pancreas does not produce enough insulin or when the body does not effectively use the insulin that is produced.⁶ Type 2 diabetes is typically diagnosed around 45 years of age but can occur earlier. There are now children with marked obesity being diagnosed with type 2 diabetes.⁷



Figure 1: Number of Diabetes Deaths (1950–1995) and Projections to Year 2016 by Gender in Canada⁵



Approximately 10% of Canadians with diabetes have type 1 diabetes. This type of diabetes is usually diagnosed in children and occurs when the pancreas is unable to produce insulin.⁶

A third type of diabetes, gestational diabetes, is a temporary condition that occurs during pregnancy. It affects 2% to 4% of all pregnancies and can increase the risk of developing diabetes later in life for both mother and child.⁶

Who Is at Risk?

People of an advanced age or with a family history of diabetes have a higher risk of developing type 2 diabetes.⁸ Ethnicity can also increase the risk of type 2 diabetes. Among First Nations people, the prevalence of diabetes is three to five times the national average.⁹ People of Latin American, African, Asian and Hispanic descent living in North America also have a higher incidence of diabetes. Risk levels for these groups are between two and six times higher than for Canadians of Caucasian origin.⁸ However, other risk factors—such as excessive overweight, unhealthy eating habits and physical inactivity—are preventable.

Why Is Diabetes on the Rise?

Lifestyle factors, including a healthy diet, weight control and exercise, are strongly linked to the prevention and management of type 2 diabetes. However, current trends indicate that Canadians are not doing very well in terms of controlling their weight and keeping active.

Trends in Obesity

As in other developed nations, Canada is seeing an increase in the percentage of its population considered overweight and obese. Since 1985, the proportion of the Canadian population 20 to 64 years of age considered to be overweight has increased steadily. Canada's 1990 Health Promotion Survey showed that between 1985 and 1990 the prevalence of overweight (BMI >27) among those 18 years of age or older rose from 19% to 27% in men and from 14% to 18% in women.¹⁰

Using the more stringent International Standard to define overweight (BMI >25), data from the 1998/99 National Population Health Survey (NPHS) indicate that half of the Canadian population is overweight or obese.¹¹ The likelihood of being overweight or obese varies with gender and age. More men (61%) than women (39%) are considered overweight or obese; this trend is similar in all adult age categories (Table 1). The likelihood of obesity peaks at 18% among those aged 45 to 64 years and falls to ~15% among seniors 65 years of age or older.¹² The 25–34 age category for men and the 45–54 age category for women appear to be critical periods for increasing weight.

It should be noted that data from the NPHS are based on self-reported weights, which are thought to seriously underestimate obesity prevalence.¹³ According to measured data from earlier Canadian Heart Health Surveys (1986–1992), 57% of men and 48% of women were overweight (BMI >25).¹⁰

The Canadian Heart Health Surveys also indicated that approximately 45% of Canadians (54% of men; 37% of women) were abdominally obese (Table 2).¹⁰ Abdominal (central) obesity, which increases with age, is associated with increased risk of cardiovascular disease (CVD) and type 2 diabetes.

Canadian children, like adults, are becoming progressively overweight. This is a key public health concern as more overweight children will lead to more obese adults and a greater burden of diseases related to excess weight, including type 2 diabetes. The prevalence of overweight (>85th percentile) among 7- to 13-year-old children increased from 15% in 1981 to 28.8% in 1996 among boys, and from 15% to 23.6% among girls during the same time period.¹⁵ The prevalence of obesity (>95th percentile) also rose in children of the same age over that period, from 5% to 13.5% among boys and from 5% to 11.8% among girls.¹⁵ Data from the 1981 Canada Fitness Survey were used to establish the criteria for being overweight or obese, based on BMI for age.¹⁵

In Canada, substantial interprovincial variations exist in the proportion of the population classified as overweight (BMI 25–29.9). According to the 1998/99 NPHS, the Atlantic and Prairie provinces had the highest percentage of overweight people: Prince Edward Island (43.5%), Newfoundland (40.7%), New Brunswick (38.6%), Nova Scotia (37%), Saskatchewan (40.9%) and Manitoba (39%). The prevalence of overweight was lower in Ontario (36.8%) and Alberta (34.5%), and lowest in British Columbia (33.7%) and Quebec (32.5%).¹¹

Analysis of BMI in relation to household income revealed that a significantly higher proportion of men than women were overweight or obese at all income levels. In addition, while the proportion of women who were overweight fell as household income level increased, the opposite was true for men.¹²

Implications: *The progressive increase in weight and development of abdominal obesity that occur with aging need to be considered as part of an overall prevention strategy. Environmental, social and economic factors need to be considered further in terms of how they impact eating and activity behaviours leading to obesity.*

The Obesity–Diabetes Link

The total direct cost of obesity (BMI ≥27) in Canada in 1997 was estimated to be >\$1.8 billion or 2.4% of

Table 1: BMI–International Standard for Canadians 20–64 years of age, 1998/99¹¹

	Underweight BMI <18.5 (%)	Acceptable Weight BMI 18.5–24.9 (%)	Overweight BMI 25–29.9 (%)	Obese BMI ≥30 (%)
Total 20–64 years	2.1	46.8	35.5	14.6
Men	0.8	38.0	45.5	15.1
Women	3.5	55.7	25.2	14.1
20–24 years	4.7	66.3	22.3	5.7
Men	0.8	60.9	31.3	5.9
Women	8.4	72.0	12.9	5.4
25–34 years	3.2	51.6	32.1	12.3
Men	1.2	43.5	42.7	12.2
Women	5.3	59.9	21.2	12.4
35–44 years	1.5	47.4	35.7	14.6
Men	0.0	35.2	48.1	16.0
Women	2.8	60.0	22.9	13.3
45–54 years	1.6	38.9	40.0	18.2
Men	0.0	30.6	48.9	18.8
Women	2.0	46.8	31.4	17.5
55–64 years	0.0	36.4	42.5	19.0
Men	0.0	29.8	49.9	18.6
Women	0.0	43.0	35.1	19.3

Notes: BMI = weight (kg) ÷ height (m) squared

BMI is to be used for those aged 20 to 64 years, excluding pregnant women and persons <0.914 m or >2.108 m in height.

Percentages for those not stating body mass were not included in this chart (range 0%–5%).

health care expenditures.¹⁶ The three largest contributors to that cost were hypertension (\$656.6 million), type 2 diabetes (\$423.2 million) and CVD (\$346.0 million).¹⁶

The association between diabetes and obesity is supported in the literature indicating that obesity is an independent risk factor for diabetes.³ Body weight and body weight change are important predictors of the likelihood of developing type 2 diabetes, with odds ratios rising to >40-fold in men and >90-fold in women who are seriously obese and 8-fold in people who are mildly overweight.¹⁷

Obesity, particularly central obesity, is a key component of the Metabolic Syndrome—a cluster of abnormalities associated with increased risk of developing type 2 diabetes and CVD. Obesity is also



Table 2: Central Obesity Based on Measured Data from the Canadian Heart Health Surveys (1986–1992)¹⁰

	Mean Waist Circumference (cm)	Central Obesity* (%)
Men		
18–24 years	82.8	10
25–34	87.1	21
35–44	92.5	39
45–54	94.5	53
55–64	97.3	61
65–74	97.9	61
Women		
18–24 years	73.2	21
25–34	74.5	25
35–44	77.9	34
45–54	81.7	50
55–64	86.4	64
65–74	84.8	66

*Waist circumference: men ≥ 94 cm (~37 in.); women ≥ 80 cm (~32 in.)¹⁴

associated with hypertension, hyperlipidemia and hyperinsulinaemia,¹⁸ all of which are components of the syndrome. Other risk factors include impaired glucose tolerance or diabetes and/or insulin resistance, raised plasma triglycerides and/or low HDL-cholesterol, and microalbuminuria.¹⁹ Vigorous early management of the syndrome may have a significant impact on the prevention of both diabetes and CVD.¹⁹ A study of a representative sample of US adults (NHANES III, 1988–1994) indicated that the metabolic syndrome was highly prevalent, especially as age increased.²⁰ For example, the prevalence increased from 6.7% among participants 20 to 29 years of age to 43.5% in those 60 to 69.²⁰

The tendency for gradual weight gain with increasing age was described earlier. Even modest gains in weight can produce adverse metabolic effects (including increased risk of CVD, hypertension and type 2 diabetes) in susceptible persons, such as those with a predisposition to central obesity.²¹ Central obesity is associated with an increased incidence of CVD and type 2 diabetes.^{22–26} A weight loss of just 10% of body weight in people who are overweight has been shown to lower blood pressure and blood levels of triglycerides, HDL-cholesterol and insulin.²⁷ A weight loss of ~10% is also associated with a reduction of ~35%

in abdominal fat, with a corresponding ~25% decrease in subcutaneous fat. This remains true, independent of the treatment used.²⁸

Although losing weight improves metabolic risk factors in overweight people in the short run, it is unclear whether this effect is lasting. Improvements in long-term weight loss have so far lagged behind improvements in short-term weight loss. Overweight people may initiate weight control efforts and, with professional assistance, are quite able to persist and lose weight for several months. However, many people who succeed at weight loss do not maintain the behaviour changes that helped them lose weight. Interventions tested so far have shown that extending the length of treatment and placing greater emphasis on exercise can at least delay weight regain.²⁹

Implications: To reduce the risk of obesity-related health problems in adulthood, it is clearly important to work on preventing weight gain in childhood and beyond. For those people who are already at risk of health problems because of their weight, avoiding further weight gain is a key prevention strategy. Physical activity can play a key role in preventing weight gain.

Canadians Are Not Active Enough

Canadian adults are more active now than they were 20 years ago; however, the majority (61%) are still considered insufficiently active for optimal health benefits.³⁰ Inactivity is defined as an energy expenditure of <3 kcal/kg/day, which is equivalent to walking ~1 hour every day.³⁰ More women than men are inactive, and inactivity increases with age (Table 3).

In 1998/99, activity levels varied with income. People in the highest household income group were most likely to be vigorously active in their leisure time (walk for 1 hour, bicycle for 45 minutes, or jog for 20 minutes). Within each household income level, a significantly higher percentage of men than women were vigorously active during their leisure time.¹²

Over half (57%) of children and youth 5 to 17 years of age are not active enough for optimal growth and development (energy expenditure of ≥ 8 kcal/kg/day, roughly equivalent to 1/2 hour of marital arts plus walking for a total of ≥ 1 hour throughout the day).³⁰ Similar to the trend among adults, girls are less active than boys: only 38% of girls compared with 48% of boys are considered active enough for optimal health benefits.³⁰

In addition, the activity level and time spent on physical activity by children declines with age. For example, 44% of girls 5 to 12 years of age vs. 30% of adolescent girls and 53% of boys 5 to 12 years of age vs. 40% of adolescent boys are considered sufficiently active to achieve health benefits.³⁰ Data reported by parents indicate that preschool children spend about

Table 3: Trends in Physical Inactivity Among Canadians Since 1981^{30,31}

	2000	1999	1981
Total ≥18 years	61%	64%	79%
Men	54	59	76
Women	67	68	83
18–24 years	43	48	70
Men	33	36	67
Women	53	60	74
25–44 years	59	64	81
Men	53	61	76
Women	66	67	85
45–64 years	67	68	83
Men	63	67	83
Women	71	69	84
≥65 years	73	73	81
Men	66	65	76
Women	78	78	85

29 hours in physically active play each week.³⁰ Children 5 to 12 years of age spend an average of 16.5 hours a week being physically active, with 9.6 of those hours spent being active at home.³⁰ Adolescents 13 to 17 years of age spend an average of almost 14 hours a week on being physically active, with about 3 hours a week spent being active at home.³⁰ Children spend just as much time watching television as being active. In the fall of 1999, the average hours per week of television viewing was 15.5 for children in the 2–11 and 12–17 age groups.³² This does not include time spent in other passive pursuits such as computer use or video games, which also contribute to inactivity.

Implications: Strategies to increase levels of physical activity in both adults and children are urgently needed and will go a long way in preventing inactivity-related diseases, particularly type 2 diabetes.

The Physical Inactivity–Diabetes Link

As noted earlier, two thirds of Canadians are physically inactive. Being physically inactive is a risk factor for several chronic diseases, particularly type 2 diabetes, CVD, stroke, hypertension, osteoporosis, and breast and colon cancer.³³ The total direct cost of physical inactivity in Canada in 1999 was estimated to be ~\$2.1 billion or 2.5% of health care expenditures, based on estimates from prospective longitudinal studies.³³ The authors hypothesized that 33% of deaths from CVD, colon cancer and type 2 diabetes could be prevented by eliminating

physical inactivity.³³ Also, reducing the prevalence of physical inactivity by 10% has the potential to reduce direct health care expenditures by \$150 million a year.³³

Epidemiological studies using cross-sectional data consistently report that physically active people are less likely to develop type 2 diabetes compared to those who are sedentary.³⁴ In a study involving 70,102 female nurses over an 8-year period, 1,419 cases of type 2 diabetes were confirmed. Investigators found the risk of type 2 diabetes was about 20% lower among those women who reported walking ~1 hour per week and 25% lower for those walking ≥3 hours per week.³⁵

In a prospective cohort study, 1,263 men (50±10 years of age) with type 2 diabetes were studied during an average follow-up period of 12 years. Data were adjusted for age, baseline CVD, fasting plasma glucose level, high blood cholesterol level, overweight, current smoking, hypertension and parental history of CVD. Men in the low cardiorespiratory-fitness group had an adjusted risk for all-cause mortality of 2.1 (95% confidence interval [CI], 1.5 to 2.9) compared with fit men. Men who reported being physically inactive had an adjusted risk for mortality that was 1.7-fold (95% CI, 1.2-fold to 2.3-fold) higher than that in men who reported being physically active. The researchers found that low cardiorespiratory fitness and physical inactivity were independent predictors of all-cause mortality in men with type 2 diabetes. They concluded that physicians should encourage patients with type 2 diabetes to participate both in regular physical activity and in activity to improve cardiorespiratory fitness.³⁶

In a population-based prospective study, 8,633 non-diabetic men (of whom 7,511 did not have impaired fasting glucose) were followed for about 6 years. Of the total, 149 patients developed type 2 diabetes and 593 developed impaired fasting glucose—low cardiorespiratory fitness was associated with increased risk of developing these conditions. A sedentary lifestyle may contribute to the progression from normal fasting glucose to impaired fasting glucose and diabetes. Risk for type 2 diabetes was elevated in older people and in those with higher BMIs, blood pressure and triglyceride levels and a parental history of diabetes.³⁷

Regular exercise has been shown to improve control of lipid abnormalities, diabetes, hypertension and obesity, with the greatest benefits realized by sedentary people who begin to exercise.³⁸

Being unfit may be more risky than being overweight. A study of 21,856 men of varying body sizes found that unfit, lean men (BMI <25) had twice the risk of mortality from all causes than fit, overweight men (BMI ≥27.8).³⁹ The most consistent difference in risk of



developing type 2 diabetes occurs between people who are sedentary versus those who are involved in some form of physical activity.⁴⁰ Physical activity levels need to be considered to be just as important as BMIs for developing preventive strategies to reduce risk of type 2 diabetes.³⁹

Implications: *The evidence suggests that being fit is more beneficial than being of healthy weight and that people who are sedentary would benefit the most from any public health effort to prevent type 2 diabetes.*

Environmental and Lifestyle Influences

As reported earlier, overweight and obesity have been increasing at an alarming rate in Canada since the 1980s. However, the major changes in eating behaviour or activity level sufficient to account for the recent rapid increase in obesity have not been identified. Many articles have attempted to delineate the causes of obesity and prevention strategies, with particular emphasis on excessive dietary fat and declining energy expenditure.

Dietary fat has often been named the culprit for weight gain; however, numerous articles suggest that diets high in fat do not appear to be the primary cause of the high prevalence of excess body fat in our society.^{21,41-46} For example, fat intake has declined about 10% as a percentage of energy over the past 25 years in Canada while energy intakes appear to have declined slightly, except for females 40 to 64 years of age whose energy intakes on average have increased marginally (Table 4).⁴⁷

However, both energy and fat intakes may be under-reported in dietary surveys.^{43,48,49} At this point in time, there is no conclusive evidence that when energy intake levels are constant dietary fat intake promotes the development of obesity.⁴⁵

Other causes for the dramatic increase in the prevalence of obesity over the past few decades need to be considered, particularly the role of energy expenditure.

Energy expenditure is widely believed to have decreased substantially in the last three decades and is often blamed for the increase in obesity.⁵⁰

As noted earlier, the level of physical activity in Canada has increased somewhat over the past two decades but is still insufficient for health benefits (Table 3). Sixty-one percent of Canadians are active less than the equivalent of walking ~1 hour/day.³⁰ *Canada's Physical Activity Guide to Healthy Active Living* recommends working up to 60 minutes of activity each day.⁵¹

The three possibilities of increased energy intake, decreased energy expenditure and increased energy storage must be considered as possible pathogenic mechanisms through which the genes or environmental factors may operate.⁴⁴

Weight gain can be partly a result of the effects of modernization and technology, which have substantially reduced energy expenditure in all aspects of life. Spending more time in front of computers and televisions contributes to an increasingly sedentary lifestyle. Labour-saving devices and remote controls have led to decreased energy expenditure both at home and at work. Vehicle use has increased and is preferred over walking or cycling even for short trips. People are also becoming more passive in their choice of entertainment.⁵²

The contribution of a diminished energy expenditure to the current obesity epidemic is determined by the decrease in the level of habitual physical activity associated with activities of daily living and the increased time spent in sedentary activities. It is not associated with decreases in resting metabolic rate or in dietary-induced thermogenesis. There is no indication of a downward secular trend for these two components of daily energy expenditure.⁵³

The decline in daily energy expenditure has not been matched by an equivalent reduction in energy intake. The current obesity epidemic may be due to an environment that promotes excessive food intake and discourages

Table 4: Comparison of Food Habits Data 1997/98 to Nutrition Canada 1970⁴⁷

	Age and Gender Category							
	20-39 Years				40-64 Years			
	Men		Women		Men		Women	
Year	1970	1997/98	1970	1997/98	1970	1997/98	1970	1997/98
Energy intake (kcal)	3378	2921	2002	1871	2675	2467	1727	1751
%Energy from fat	41.0	29.4	40.0	29.2	39.7	30.3	39.1	29.3

physical activity. It has been argued that although humans have evolved excellent physiological mechanisms to defend against weight loss, they have only weak mechanisms to defend against body weight gain when food is abundant.⁴³

Implications: *The imbalance between energy required for activities of daily living and work, and energy consumed is a key factor in the growing prevalence of obesity in Canada in both adults and children. Public health efforts that focus on helping consumers keep their energy intakes and expenditures in balance should help curtail further weight gain and prevent obesity and its negative impact, including development of diabetes. Increased physical activity may be the strategy of choice.*

Summary

This article provides an overview of the diabetes situation in Canada. As the data indicate, there is a serious concern about the increasing prevalence of obesity and insufficient physical activity among Canadians. Weight gain (leading to obesity) and inactivity both increase with advancing age and increase the risk of developing type 2 diabetes. Adults in the prime of their lives (45 to 64 years of age) are particularly at increased risk of type 2 diabetes because of their weight and activity levels. Healthy weight and active living strategies to reach children and adults before they attain this age are required in order to have any impact on decreasing the incidence of type 2 diabetes and other health concerns related to obesity and inactive lifestyles.

Acknowledgements

This review was written for NIN by **Lynn Roblin**, M.Sc., RD, Nutrition Consultant. It is Part I of a summary of a larger literature review entitled, *The Changing Physiology, Eating and Activity Patterns, and Obstacles and Barriers to Healthy Eating and Active Living in Canadians 35–55 Years of Age*. The literature review was prepared for “Food and Fitness in Focus”, a joint project of the National Institute of Nutrition in conjunction with the Canadian Fitness and Lifestyle Research Institute, Dietitians of Canada, and ParticipACTION. That 3-year project is funded under the Canadian Diabetes Strategy—Prevention and Promotion Contribution Program, Health Canada.

NIN gratefully acknowledges the contributions of:

- the **NIN Scientific Advisory Council**;
- the **NIN Communications Advisory Council**; and
- the advisory committee appointed for the “Food and Fitness in Focus” project: **Louise Aubrey**, Office of Nutrition Policy and Promotion, Health Canada; **Heidi Bates**, representing Dietitians of Canada;

Cora Lynn Craig, Canadian Fitness and Lifestyle Research Institute; **Philippe Dussault**, Fitness and Active Living Unit, Health Canada; **Mary Flynn**, Calgary Regional Health Authority; **Anne Kennedy**, National Institute of Nutrition; **Linda McCargar**, Department of Agricultural, Food and Nutritional Science, University of Alberta; **Robert Ross**, School of Physical and Health Education, Queen’s University; **Art Salmon**, ParticipACTION; and **Stefa Katamay** and **Ellen Lakusiak**, Project Managers.

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