REVIEW / SYNTHÈSE

Physical activity of Aboriginal people in Canada[1]

T. Kue Young and Peter T. Katzmarzyk

Abstract: This paper summarizes available information on patterns of physical activity, their determinants and consequences, and the results of various interventions designed to increase the physical activity of Aboriginal peoples in Canada and the United States. There is a paucity of national data on this issue for Aboriginal peoples. The most recent data, from the First Nations Regional Longitudinal Health Survey of 2002–2003, indicate that 21% of adults (27% of men, 15% of women) were engaging in at least 30 min of moderate to vigorous physical activity on 4 d/week or more. The present paper highlights the unique challenges this group faces, underlining the need to integrate collective knowledge regarding how much physical activity is required for Aboriginal Canadians, and how this activity should be accomplished, to promote and maintain health. Efforts are currently underway to tailor Canada's physical activity guide for First Nations, Inuit, and Métis. Future research among Aboriginal groups should examine the minimal and optimal levels of physical activity required to achieve health benefits.

Key words: physical activity, Aboriginal people, intervention programs.

Résumé : Cet article présente un bilan des pratiques de l'activité physique, des facteurs et des conséquences de même que des effets de plusieurs interventions menées pour accroître la pratique de l'activité physique chez les Aborigènes du Canada et des États-Unis. Peu d'études nationales ont été menées à propos de la pratique de l'activité physique chez les peuples aborigènes. Les données les plus récentes proviennent de l'Enquête régionale longitudinale sur la santé des Premières Nations (2002–2003) : 21 % des adultes (hommes, 27 %, femmes, 15 %) font en une journée au moins 30 min d'activité physique d'intensité modérée à vigoureuse, et ce, 4 jours ou plus par semaine. Cet article indique les défis particuliers auxquels les Aborigènes sont confrontés et souligne le besoin pour cette population de s'approprier le savoir collectif à propos de la quantité d'activité physique à pratiquer et des modalités à suivre pour la promotion et le maintien de la santé. En ce moment, des individus travaillent à adapter le guide d'activité physique aux Premières Nations, aux Inuits et aux Métis. Les prochaines études devraient porter sur les niveaux, minimal et optimal, de pratique de l'activité physique chez ces populations afin qu'elles en retirent les bienfaits au plan de la santé.

Mots-clés : activité physique, peuple aborigène, programmes d'intervention.

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Introduction

The Canadian Constitution defines three groups of Aboriginal people — First Nations, Inuit, and Métis. According to the 2001 census, approximately 1.3 million Canadians reported having Aboriginal origins, of which 73% were First Nations, 20% Métis, and 4% Inuit; the remainder were those with multiple Aboriginal origins (Statistics Canada 2003*a*). The health of Aboriginal people has undergone substantial changes in the past half-century, with an increasing burden of diabetes, cardiovascular disease, and other chronic diseases as causes of mortality and morbidity (Waldram et al. 2006; Young 1994). As physical inactivity is a well recognized risk factor for these emerging health problems (US Department of Health and Human Services 1996; Warburton et al. 2007), estimating and understanding its prevalence, distribution, and determinants among Aboriginal people are of major importance to the health care system.

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Many Aboriginal people, particularly elders, recall times when most activities of daily living such as the procurement of food and fuel were physically demanding. With the change to a more sedentary lifestyle, the opportunities for sustained, vigorous, physical activity are much diminished in most communities. The consequences for health are already immense and in the absence of effective intervention strategies are likely to increase further with time.

Despite a large volume of data on the status and determinants of health among Aboriginal people in Canada, relatively little is known about their patterns and levels of physical activity; factors that are associated with its development; and evidence of effective interventions to promote physical activity in this population. Longitudinal observations are particularly lacking, with the exception of the work of Roy Shephard's research team in Igloolik (in present-day Nunavut) over a 20 year span from 1970–1990, which documented declining physical fitness among the Inuit as a result of acculturation (for example, see Rode and Shephard 1994*a*, 1994*b*).

This paper reviews available epidemiological data on physical activity among Aboriginal groups in Canada, examining how findings differ from those for other segments of the Canadian population. It discusses methodological issues related to monitoring physical activity in the Aboriginal population, and considers whether Canada's physical activity guide can and should be adapted to improve physical activity in Aboriginal people within the broader context of chronic disease prevention and health promotion.

Sources of data

There are two major sources of data on the health status of Aboriginal peoples: large-scale national or regional surveys involving few and relatively crude interview questions on aspects of physical activity, and research studies conducted in single or small groups of communities, usually employing more intensive and sophisticated methods.

Although there have been many large, national health surveys since the 1970s, most have specifically excluded people living in the northern territories and those living on reserves. Among national surveys that do provide data on Aboriginal people, there are three basic categories:

(1) National surveys that deliberately sampled, or did not deliberately exclude, First Nations reserves and (or) the North (hereafter referring to the Yukon, Northwest Territories, and Nunavut, where Aboriginal people account for approximately 25%, 51%, and 85% of the total population, respectively (Statistics Canada 2003*a*)).

(2) National surveys that sampled some Aboriginal people as provincial or territorial residents, identified under variables such as "ethnicity" (with categories for "North American Indians", "Métis", and "Inuit") and (or) "race" (with a category for "Aboriginal peoples of North America"). Such surveys also deliberately excluded First Nations reserves, and can provide information only on Aboriginal people living off-reserve and in urban areas.

(3) National surveys that specifically targeted Aboriginal people.

National surveys that deliberately sampled, or did not deliberately exclude, First Nations reserves and (or) the North

The Nutrition Canada Survey, conducted during 1970–1972, had a separate First Nations sample selected from 29 reserves across Canada and an Inuit sample from 4 communities in the Northwest Territories. This survey provided a wealth of health and nutritional data collected through interviews, anthropometry, and laboratory tests; surprisingly, however, it included no data whatsoever on physical activity (Nutrition Canada 1975*a*, 1975*b*).

Canada's Health Promotion Survey of 1985 did cover physical activity. Although it excluded First Nations reserves, it sampled residents of the North. The proportion of Aboriginal respondents who engaged in physical activity (at least 15 min/day, 3 times/week) was lower than in non-Aboriginal respondents. Such a measure, however, may not be culturally appropriate for the Northwest Territories, where a substantial proportion of Aboriginal people still live "off the land," and there is little need for gratuitous exercise (Imrie and Warren 1988).

The Health and Activity Limitation Survey of 1986, which provided a national perspective on the prevalence of disabilities, did sample the territories and First Nations. As the focus was on activity limitation, it provided no data on the levels and categories of physical activity per se (Statistics Canada 1990).

National surveys that sampled some Aboriginal people as provincial or territorial residents, identified under variables such as "ethnicity"

The National Population Health Survey (NPHS) has been conducted every two years since 1994–1995, and it includes a longitudinal cohort. Based on self-reported ethnicity, the first wave of the NPHS in 1994–1995 included 28 Inuit, 855 Métis, and 1821 First Nation participants. The Canadian Community Health Survey (CCHS) is a cross-sectional survey that has been conducted every two years since 2000–2001, with special supplements covering topics such as mental health and nutrition in intervening years. The sample of Aboriginal participants varies from year to year, but the 2000–2001 survey included 4216 First Nations, 1497 Métis, and 827 Inuit. Because of the small number of Aboriginal respondents, sub-national analyses may yield unstable estimates; however, precision can be increased by combining data from two or more cycles of the same survey. One study adopting this approach compared physical activity levels across different ethnic groups in Canada, using data from the 2000–2001 and 2003 CCHS. The results demonstrated that Aboriginal adults had a prevalence of moderate physical activity that was similar to people of European ancestry, and higher than that of many visible minority groups (Bryan et al. 2006).

Figure 1 shows the prevalence of "moderately active" and "active" categories among Aboriginal and non-Aboriginal people nationally, in urban areas and rural areas in the provinces, and in the North. There was little difference between the two groups, with the exception of the North, where the prevalence of "active" and "moderately active" individuals was lower in aboriginal than in non-aboriginal people. It is likely that many non-aboriginal people who

Fig. 1. Proportions of physically active and moderately active adults by Aboriginal status in the Canadian population. Source: CCHS 2000–2001, as reported in Tjepkema (2002). Categories are based on daily energy expenditures estimated from various reported activities engaged in during leisure time: "active" ≥ 12.5 kJ·kg^{-1}·d^{-1}; "moderately active" 6.25–12.4 kJ·kg^{-1}·d^{-1}.

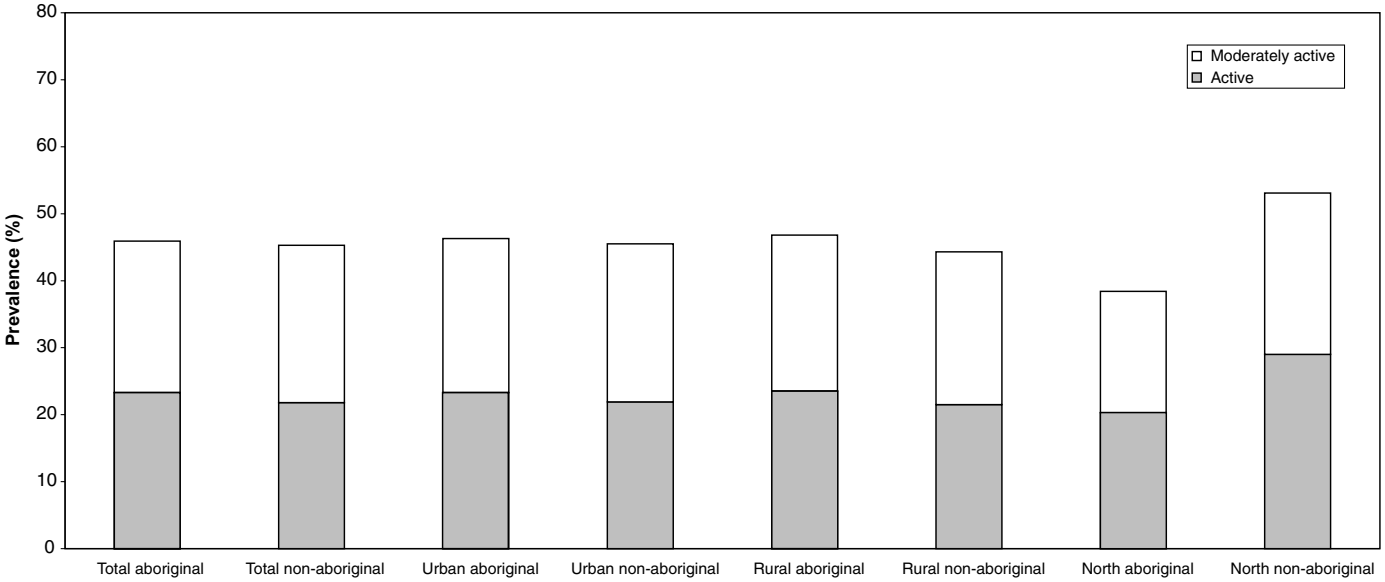


Table 1. Prevalence of physical inactivity in northern Canada.

	Prevalence (%)			
	Canada	Yukon	NWT	Nunavut
Both sexes	48.0	40.2	46.8	56.4
Males	45.1	38.0	45.1	54.5
Females	50.9	42.3	48.7	58.4

Note: Data derived from the combined CCHS 2003 and 2005. Physical inactivity is defined as energy expenditure of less than 6.25 kJ·kg^{-1}·d^{-1}.

chose to move to the North are attracted to outdoor recreation and are therefore physically active.

Within the North, the prevalence of leisure-time inactivity was highest in Nunavut (56%), compared with 47% in the Northwest Territories and 40% in the Yukon (Table 1). In the latter two territories, values were close to or lower than the Canadian national average of 48%. Women in general tended to be more physically inactive than men.

National surveys that specifically targeted Aboriginal people

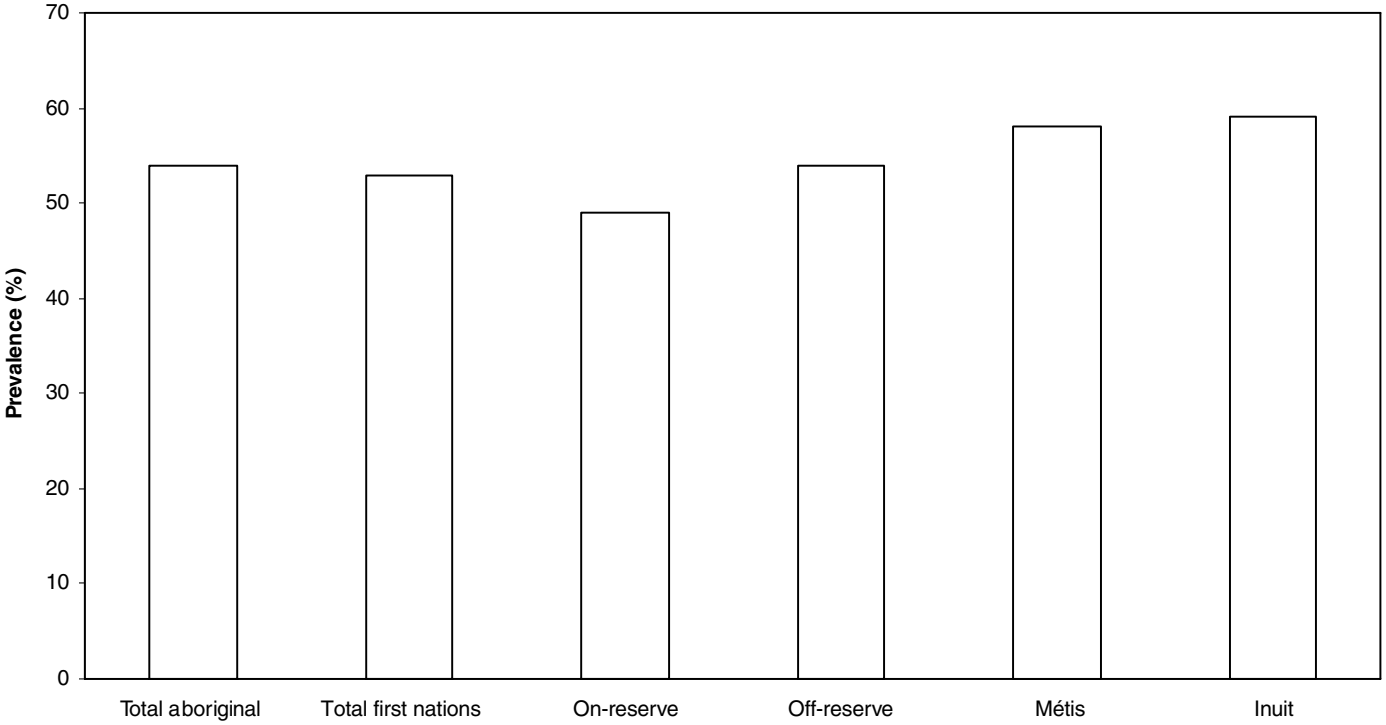
The Aboriginal Peoples Survey (APS), conducted in 1991, contained one question on participation in leisure-time physical activity ("Do you participate in any sports, games, dance, or recreation which involve physical activity?") and one question on the type of recreation facilities used. As a "post-censal" survey, it was conducted by Statistics Canada shortly after the 1991 census, and it used census data in selecting its sample. The target population of the APS comprised all individuals in the 1991 census who reported Aboriginal origins and (or) those who were a Registered Indian under the Indian Act. The 78 reserves or settlements (an estimated 38 000 individuals) that did not take part in the 1991 census were therefore not included in the APS. Further attrition occurred subsequently, with an additional 195 communities (about 22 000 inhabitants) refusing to take part in the APS (Statistics Canada 1993).

Figure 2 compares the proportion of different categories of Aboriginal adults who participated in the APS. The Inuit, the majority of whom live in the North, reported the highest levels of physical activity. There is thus some discrepancy between the APS data and the CCHS data presented in Fig. 1.

In 2001, Statistics Canada conducted another Aboriginal Peoples Survey (APS-2), which included 123 First Nations reserves, 53 Inuit communities, 8 Métis settlements, 35 other communities with a high Aboriginal population, and 9 urban areas. There were no items related to physical activity in the "adult core" or the Arctic supplement, but relevant questions were included in the children and youth survey (ages 0–14 y) and the Métis supplement. Among Aboriginal children aged 6–14 y, living in non-reserve areas, 71% participated in sports activities at least once per week (Statistics Canada 2004). Statistics Canada cautioned against generalizing the on-reserve data in APS-2 to the on-reserve population nationally. The First Nation participation was especially poor; fewer than 15% of the communities that participated in the 2001 census also participated in APS-2 — the survey thus represented only 44% of the Aboriginal identity population. The census itself also failed to achieve full enumeration, with some 30 reserves "incompletely enumerated" (Statistics Canada 2003*b*).

The First Nations and Inuit Regional Health Survey is a First Nation and Inuit controlled health interview survey, conducted in 9 regions (British Columbia, Alberta, Saskatchewan, Manitoba, Quebec, Nova Scotia, New Brunswick, and Labrador) during 1997. Although each region designed its own survey questions, a set of national core questions was included in each regional survey. The national total of respondents was 9870. No physical activity questions were included in the national core of the survey, only queries on activity limitations.

Fig. 2. Proportion of Aboriginal adults who participated in leisure-time activity. Source: APS 1991 (Statistics Canada 1993).



A second cycle of this survey, now called the First Nations Regional Longitudinal Health Survey (RHS) was coordinated by the National Aboriginal Health Organization (NAHO) in 2002–2003. RHS consisted of 3 national surveys from 238 communities (10 962 adults ≥18 y, 4983 youth aged 12–17 y, and 6657 children aged 0–11 y) using computer-assisted survey techniques. A longitudinal design planned repeated surveys of the initial cohort in future years. NAHO was assisted by the Canadian Fitness and Lifestyle Research Institute in the design and analysis of the self-reported physical activity component. One report on various aspects of health has been released to date (NAHO 2005).

Overall, 21% of adults (27% of men, 15% of women) were categorized as engaging in sufficient physical activity, i.e., they reported at least 30 min of moderate to vigorous activity (that resulted in "an increase in heart rate and breathing") on 4 d/week or more days. Relative to their peers, adults who were sufficiently active were more likely to be in excellent general health, to eat a nutritious and balanced diet always or almost always, and to enjoy social support with a balance of "mind, spirit, heart, and body" (NAHO 2005).

In the United States, information on physical activity among both Native and non-Native Americans is available from the Behavioural Risk Factor Surveillance System (BRFSS), a telephone interview survey conducted annually in all states. Figure 3 shows the prevalence of physical inactivity in Alaska, here defined as someone who did not engage in any leisure-time physical activity other than their regular job in the past month, categorized by age, sex, ethnicity, education, and income.

The various national health surveys conducted by Statistics Canada are accessible for detailed analyses by researchers through regional data centres across the country (Statistics Canada 2007). Much can still be learned about patterns of physical activity and their correlates among Aboriginal people in Canada. Further research should be directed at understanding levels of physical activity and their correlates among Aboriginal Canadians.

Regional studies

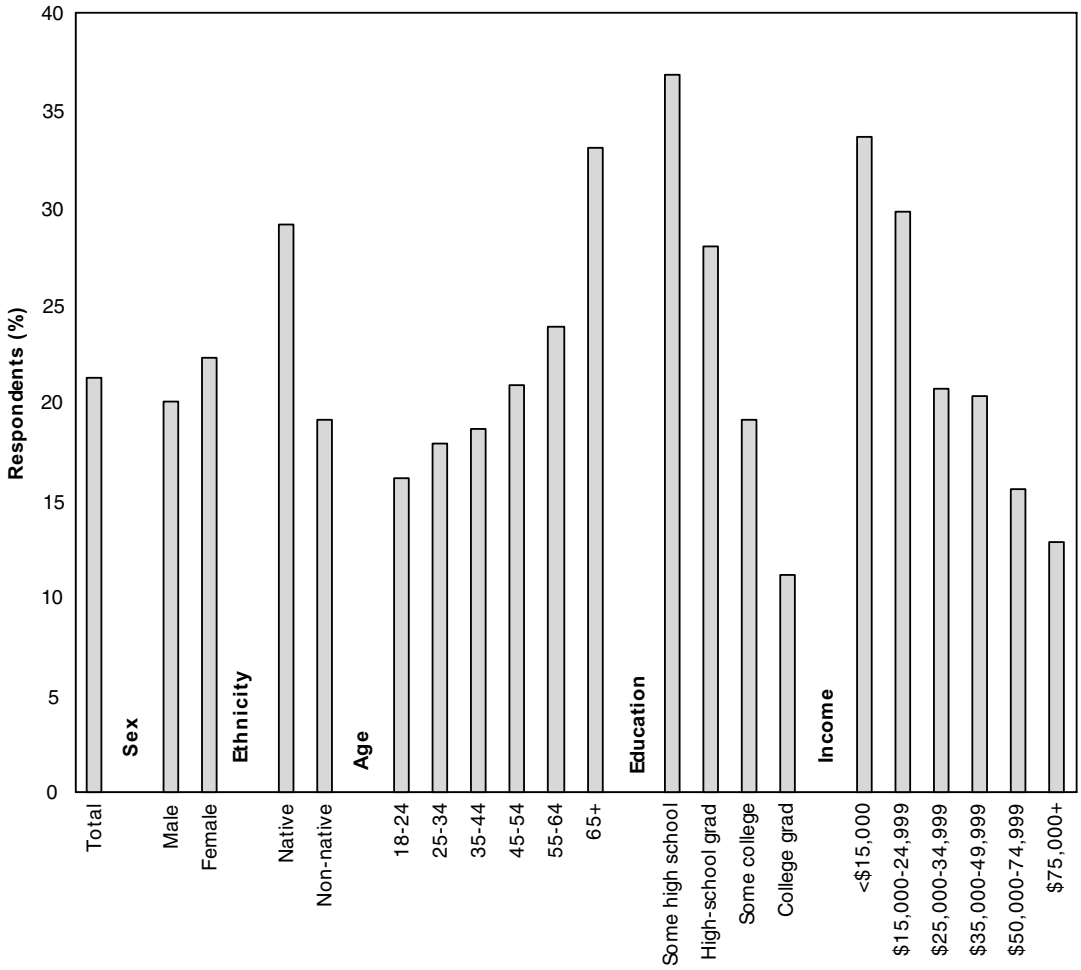
Published scientific studies involving single or clusters of communities offer another source of information on physical activity among Aboriginal people. A PubMed search on the key words "physical activity" combined with different designations of Aboriginal people in Canada and the United States (First Nations, Native Americans, Aboriginal, Inuit, North American Indians, etc.) during the period 1995–2006 yielded approximately 70 papers. These papers emanated from a substantially smaller number of separate studies, a selection of which is presented in Table 2. The listing is not intended to be exhaustive, but it reflects the geographical and methodological diversity (or lack thereof).

Patterns and correlates of physical activity

The prevalence of variously defined categories of physical activity among Canadian Aboriginal people nationally is shown in Figs. 1 and 2. Additional data from local and regional studies, in both Canada and the United States, are summarized in Table 2. Table 2 also provides summary measures of associations between physical activity and other variables. Whether these variables are determinants or consequences of physical activity is often difficult to determine, as the great majority of studies are cross-sectional.

One narrative review on the determinants of physical activity among Aboriginal adults collected 28 quantitative, 4

Fig. 3. Prevalence of leisure-time physical inactivity in Alaska. Source: Alaska Department of Health and Social Services. Behavioral Risk Factor Surveillance Annual Reports for 2002–2003 and 2004–2005. Data were aggregated for the four years 2002–2005.



qualitative, and 3 intervention studies in Canada and the United States during 1990–2005. It identified age, gender, and social support as the most important factors associated with physical activity. Other potential factors such as socioeconomic status, perceived healthy body mass, and the existence of facilities, programs, and community infrastructure were not found consistently across studies (Coble and Rhodes 2006).

Intervention studies: selected examples

A few intervention studies, most of which were directed at the prevention of diabetes and (or) obesity, have been described, evaluated, and reported in the scientific literature. Examples from both Canada and the United States are presented here.

Canadian studies

The Mohawk community of Kahnawake in suburban Montreal has been the site of a community-based program for the primary prevention of diabetes since the mid 1990s (the Kahnawake Schools Diabetes Prevention Project (KSDPP); Macaulay et al. 1997; Potvin et al. 2003). The intervention included a school nutrition and healthy lifestyle education program, community-wide events, and environmental changes such as the building of a recreation path to promote walking and running. In their "deconstruction", Lévesque et al. (2005) characterized the intervention as a complex package with multitarget, multisetting strategies implemented through dynamic exchanges between a diversity of community partners. A pre–post intervention comparison of cross-sectional surveys of grades 2–4 children between 1994 and 1998 shows an increase in the proportion of children engaged in >30 min/d of physical activity, and a decrease in the amount of TV watching, but no change in BMI or diet (Adams et al. 2005). Further follow-up to 2002 showed that the gains in physical activity and fitness were not maintained, although at this point dietary patterns had improved (Paradis et al. 2005).

The Sandy Lake Health and Diabetes Project was initiated in a remote, air-accessible Oji-Cree community in northwestern Ontario, also in the mid 1990s. Baseline studies on the prevalence and correlates of both physical activity and fitness are summarized in Table 2 (Kriska et al. 2001; Hanley et al. 2000; Liu et al. 2006). As part of the study planning, extensive ethnographic research on health beliefs, attitudes, and perceptions relating to diet and physical activity was undertaken (Gittelsohn et al. 1996). The intervention was three-pronged — community-wide activities (media promotion, walking, home visits), school health curriculum de-

velopment (for grades 3–5), and the stores program (food labelling and in-store education). An evaluation of the school program using a pre–post single-sample design during 1998 and 1999 showed improved nutritional knowledge and dietary fibre intake (Saksvig et al. 2005). Data specific to physical activity have yet to be reported.

An intervention that focussed on gestational diabetes was conducted among four Cree communities on the James Bay coast in northern Québec during 1995–1997. About 100 pregnant women were each monitored during the control and intervention periods. The intervention consisted of individually based diet and physical activity counselling. A pre–post evaluation failed to demonstrate any difference in diet, plasma glucose, birth weight or maternal weight gain between women in the intervention and control groups (Gray-Donald et al. 2000).

A prenatal exercise program among urban Aboriginal people in Saskatoon also focussed on preventing gestational diabetes. The intervention comprised water aerobics and walking. Over 2 years, 90% of participants reported improved fitness and increased self-esteem (Klomp et al. 2003).

US studies

Broussard et al. (1995) reviewed two formative school-based programs in the southwest United States. These studies indicated that Native communities were receptive to school-based interventions, and that such interventions were able to slow the rate of excess weight gain and improve physical fitness.

The Pathways Study was a 3-year randomized, school-based intervention for the primary prevention of obesity among American Indian children. It was implemented in 41 schools involving over 1700 grade 3–5 children from 7 tribes in Arizona, New Mexico, and South Dakota. It included a health-promotion curriculum, a physical education program, a school meal program, and a family involvement component (see Davis et al. (1999) for an overview of the study design and related papers on the Pathways study in volume 69, supplement 4, of the American Journal of Clinical Nutrition). One evaluation of the project showed no difference between intervention and control schools in terms of physical activity levels (as measured by a motion sensor), although a reduction in fat intake was observed (Caballero et al. 2003).

Among the Zuni in the southwestern United States, a high-school-based diabetes prevention program included an educational component targeted at reducing soft drink consumption and a youth-oriented fitness centre (program). At baseline, Zuni youths (n = 72) had higher plasma glucose and insulin levels than a peer group of Anglo-Americans. Values in both groups showed a steady decline throughout the study period, and by year 3, data for Zuni males were comparable to those of the Anglo-Americans, although Zuni females still had higher readings (Ritenbaugh et al. 2003).

The Pima prospective cohort study began in the 1970s, and is world renowned for its scientific contributions to the understanding of the epidemiology and mechanisms of diabetes. An entire tribe in Arizona was tested periodically for diabetes and related metabolic factors; rather belatedly it also implemented and evaluated preventive programs. In one study, 95 obese normo-glycemic adults aged 25–54 y were randomized to two groups: "Pima Action" (consisting of structured physical activity and nutritionaal interventions) and "Pima Pride" (consisting of unstructured activities emphasizing Pima history and culture). After 12 months of intervention, both groups reported increased levels of physical activity, but body mass index (BMI), blood pressure, and plasma glucose and insulin increased in Action members, whereas waist circumference decreased in Pride members. The researchers concluded that for the Pimas, a less-direct and less-structured but more participatory approach could be more acceptable and effective (Narayan et al. 1998).

A pilot study of Alaska Native women was conducted by the Southcentral Foundation in 2000–2001, as part of the WISEWOMAN study, a randomized controlled heart disease prevention program. The intervention consisted of 12 weekly, 2 h educational sessions taught by a multidisciplinary team (nutritionist, exercise specialist, health educator, and traditional wellness coordinator). At 12 weeks, significant improvements were noted in moderate walking and physical activity self-efficacy. Substantial movement from the contemplation and preparation stages to the action stage was also observed with respect to physical activity and heart-healthy eating (Witmer et al. 2004).

With funding from the Centers for Disease Control and Prevention, the Eastern Band of Cherokees in rural North Carolina developed the Cherokee Choices program in 1999. The intervention comprised elementary school mentoring, worksite wellness programs for adults, and church-based health promotion activities. The school policy was altered to promote physical activity. Consequences of the program included an increased interest among school staff in attending fitness classes, and the meeting of dietary and physical activity goals by workplace program participants (Bachar et al. 2006).

A 6-week exercise class was directed at older Native Americans aged 55–75 y living in an urban area in Oklahoma. Post-intervention, participants improved their self-perceived physical and emotional health, as well as their personal appearance. They also showed gains in objective measures of health such as mean systolic blood pressure and respiratory rate (Kochevar et al. 2001).

Methodological caveat

In most studies of physical activity among Aboriginal populations, measurement of physical activity has been based on adaptations of leisure-time physical activity questionnaires designed for non-indigenous populations. The focus on leisure-time physical activity, rather than total activity, may be less useful in Aboriginal populations, where leisure-time and occupation-time are not necessarily clearly separated, and organized sports are not always available. Commonly used tools for the measurement of physical activity do not necessarily assess culturally based forms of physical activity and they may underestimate activities spent in domestic care. Women tend to engage in lower-intensity activities, such as walking, child care, and housework — all of which are relatively more difficult to assess and less reproducible than the high-intensity activities found with many organised sports. This reinforces the need to validate

Table 2. Summary of studies in Aboriginal people of Canada and United States providing data on prevalence and correlates of physical activity.

Population/location	Study year	Study design	Age/sex groups	Physical activity measure	Results	Reference
Canada						
Mohawk: Kahnawake QC, Tyendinaga, ON	1994–1996	Prospective cohort	103 girls, 95 boys grades 1–4	Run/walk fitness test, Q on past-week PA, TV watching, self-efficacy	In girls, excessive TV and low PA predicted follow-up sub-scapular skinfold thickness	Horn et al. (2001)
Oji-Cree: Sandy Lake, ON	1993–1995	Cross-sectional	242 youths aged 10–19 y	Q on past year PA (leisure and occupational), TV viewing; fitness $VO_{2\ max}$ from step test	TV ≥5 h/d vs. ≤2 h/d (OR for obesity 2.5); 4th/1st quartile of $VO_{2\ max}$ (OR 0.13)	Hanley et al. (2000)
			530 adults ≥18 y		Reduced fasting insulin associated with increased PA and with increased fitness in men, adj for age, BMI, %body fat, waist, and fasting glucose	Kriska et al. (2001)
			360 adults ≥18 y		Reduced odds of metabolic syndrome associated with PA in men (OR 0.96); and fitness in men (OR 0.16) and women (OR 0.34)	Liu et al. (2006)
James Bay Cree: QC	1992	Cross-sectional	144 children in grades 4–5, 8–9	Q on PA freq and TV viewing; active = 30+ min resulting in sweat or out-of-breath	Mean 13 h/week of TV/video games; 2.7 times/week active; overweight less active and watch more TV than non-overweight	Bernard et al. (1995)
Ojibwa: Christian Island, ON	2000	Cross-sectional	101 children, kindergarten to grade 8	Fitnessgram (aerobic capacity, abdominal/ upper body/trunk strength and flexibility)	Various age groups fell below healthy fitness zones	Smith et al. (2002)
Inuit: 8 communities in Kivalliq region, NU	1990–1991	Cross-sectional	434 adults ≥18 y	Q on PA (2 items)	PA not independently associated with various obesity measures	Young (1996)
United States						
National sample, 36 states (BRFSS)	1997–2000	Cross-sectional (multiple years aggregated)	7862 NA adults ≥18 y	Q on LTPA previous month	Prevalence of no LTPA 33% among NA (cf. 28% other races); M > F; highest in east, lowest in northern plains	Denny et al. (2003)
Yupik and Athabaskans: 15 villages, AK	1987–1988	Cross-sectional	666 adults ≥40 y	Scores based on Q on participation in traditional and mechanized activities	Moderate PA (OR 0.7) and high PA (OR 0.2) associated with reduced DM or IGT, adj for age, BMI and sex	Adler et al. (1996)
			1124 adults ≥20 y		Hypertension associated with mechanized activities	Murphy et al. (1997)

Table 2 (*continued*).

Population/location	Study year	Study design	Age/sex groups	Physical activity measure	Results	Reference
National sample, multi-ethnic (Women's Determinants Study)	1996–1997	Cross-sectional	738 NA women ≥40 y	Q on PA: LTPA = regularly active if 5+ times/week, ≥30 min; vigorous if ≥3 times/week, ≥20 min; occupational and household = active if ≥300 min/week; also composite index	49% NA had no LTPA but 74% active on composite index; compared to Whites, 1.7 times more likely to have no LTPA, but also 1.5 and 1.3 times more likely to be active on occupational and household	Brownson et al. (2000)
				Physical activity social support (PASS) score;	54% NA had high PASS, > Black and White but < Hispanic; High PASS assoc with 4 measures of PA	Eyler et al. (1999)
				5-item scale for stages of exercise adoption	Too tired, bad health and lacks energy barriers at various stages	Heesch et al. (2000)
Pima tribe: AZ (Pima Study)	1990s	Cross-sectional	88 children aged 5 y	Q on number of activities (ACT) and hours per week; TEE from doubly labelled water; RMR from indirect calorimetry; PAL = TEE/RMREEACT energy expended from PA = (TEE – (RMR+ 0.1×TEE))	Maternal diabetic status not associated with PA measures of off-psirng	Salbe et al. (1998)
		Prospective cohort	90 children aged 5 y at baseline; 5 y follow-up		An increase in ACT (but not PAL) associated with increase in insulin sensitivity (partial $r = 0.22$) independent of gain in weight or adiposity	Bunt et al. (2003)
			138 children aged 5 y		At age 5 and 10, obesity associated with decreased sports and increased TV; but association with decreased PAL seen at age 10 only	Salbe et al. (2002)
		Cross-sectional	30 adults aged 18–71 y		Weight-adj indices of PA negatively correlated with %body fat	De Groot and Van Staveren (1995)
		Prospective cohort	92 adults		Baseline energy expenditure due to PA not associated with change in body weight	Tataranni et al. (2003)
			1728 adults aged 15–59 y; 6 y follow-up	Q on past year PA (MET–h/week)	LTPA associated with reduced incidence of diabetes in women adj for age and BMI (hazard ratio 0.74)	Kriska et al. (2003)
		Cross-sectional	580 adults aged 15–59 y	Q on past year PA and locus of control (LOC)	Internal LOC associated with more PA than external LOC, adj for age and BMI	Gregg et al. (1996)

Table 2 (*continued*).

Population/location	Study year	Study design	Age/sex groups	Physical activity measure	Results	Reference
Lakota: 2 reservations, SD	1990s	Cross-sectional	219 adults	Q on PA ≥3 times/week	Women less mod/strenuous PA than men; barriers to exercise: lack of child care, time, safety concerns	Harnack et al. (1999)
3 Chippewa and Menominee communities: MN and WI (Intertribal Heart Project)	1992–1994	Cross-sectional	843 women and 501 men, ≥25 y	Q on leisure-time, occupational, transport, and household PA past year	No LTPA in 33% (F) and 21% (M); but 90% walked 20+ minutes per workday; median 3 h (M) and 10 h (F) of household activity; age, poor self-rated health and smoking associated with inactivity in men	Fischer et al. (1999)
Mohawk: St.Regis, NY	1980s?	Cross-sectional	28 Mohawk children aged 4–7 y	TEE by doubly labelled water; REE by indirect calorimetry	TEE higher in Mohawk compared to Whites, independent of fat free mass and sex	Goran et al. (1995)
Urban NA (mostly Chippewa): MN	1990s	Cross-sectional	155 youths aged 5–18 y	Q on PA, TV viewing, Presidential Physical Fitness (PPF) tests	59% sedentary; BMI correlated with PA, fitness and TV viewing	Gray and Smith (2003)
Tri-ethnic sample: including Pueblo and Navajo reservations in NM (Cultural Activity Participation Study)	1990s	Cross-sectional	46 NA women ≥40 y	8 d PA records; PA intensity as MET–min/d	Increase in 30 min of moderate intensity PA associated with lower fasting insulin level, adj for age, education, obesity, and cardiorespiratory fitness	Irwin et al. (2000)
				MET–min/day from 8 d PA records and max treadmill time	Lipoprotein (a) levels not associated with any PA variables	Drowatzky et al. (2001)
		Qualitative (interviews)	26 NA women	Explored context, enablers and constraints of walking		Henderson and Ainsworth (2000)
		Cross-sectional	127 NA women ≥40 y	8 d PA records; pedometer	NA more time walking than Blacks or Whites; 42% from household, 24% transportation and 22% occupation; steps/day higher with higher education, lower age and BMI	Whitt et al. (2004)
41 schools from 7 tribes in AZ, NM, SD (Pathways Study)	1997	Cross-sectional (baseline data of intervention trial)	1441 grade 2 and 3 children	3-item PA self-efficacy Q	No difference between obese and normal weight children regarding PA self-efficacy	Story et al. (2001)
	1997–2000	Prospective cohort	454 grade 2 children	Average vector magnitude (AVM) from accelerometer	Higher AVM counts associated with decrease in %body fat in normal weight children; among overweight children, high AVM associated with increase in BMI, fat mass and fat-free mass but not %body fat	Stevens et al. (2004)

Table 2 (*concluded*).

Population/location	Study year	Study design	Age/sex groups	Physical activity measure	Results	Reference
NA (mostly Navajo and Pueblo): NM, AZ, and other southwest states	2001–2002	Cross-sectional	350 women aged 20–50	Q on PA; personal, social and environmental factors	55% moderate/vigorous PA; factors associated with being active: not married, good self-rated health, high self-efficacy, knew others who exercise, saw people who exercise, attended religious services	Thompson et al. (2003)
NA: from 13 tribes in AZ, OK, ND, SD (Strong Heart Study)	1989–1992	Cross-sectional	1846 men and 2703 women aged 45–74	Q on PA	PA levels in Dakotas and OK similar to USA but AZ much lower; PA associated with apo AI adj for covariates	Yurgalevitch et al. (1998)

Note: Adj, adjusted (statistically in multivariate modeling); AK, Alaska; AZ, Arizona; BMI, body mass index; BRFSS, Behavioral Risk Factors Surveillance System; DM, diabetes mellitus; Freq, frequency; LTPA, leisure-time physical activity; NA, Native American; OK, Oklahoma; ON, Ontario; OR, Odds ratio; Q, questionnaire; QC, Québec; IGT, impaired glucose tolerance; MET, metabolic equivalent; MN, Minnesota; NC, North Carolina; ND, North Dakota; NM, New Mexico; NY, New York; PA, physical activity; RMR, resting metabolic rate; SD, South Dakota; TEE, total energy expenditure; WI, Wisconsin.

existing measurement tools, or develop new tools for use in Aboriginal populations.

A few efforts have been made to modify and validate physical activity questionnaires for use in Aboriginal populations. A version of the Modifiable Activity Questionnaire (MAQ) (originally designed for the Pima Study) was used in the Sandy Lake study. The MAQ was designed for easy modification to maximize its feasibility and appropriateness in a variety of minority populations (Kriska et al. 1990). It assesses current, past-week, and past-year occupational and leisure activities, as well as extreme levels of inactivity resulting from disability. For Sandy Lake, the qualitative research (Gittelsohn et al. 1996) identified leisure and occupational activities specific to the community, and incorporated them into the questionnaire.

In Greenland, the International Physical Activity Questionnaire (IPAQ) was modified and translated into Greenlandic. It was validated against combined heart rate and accelerometer measurements. The questionnaire scores showed a high correlation with physiological measurements, both for low- and for higher-intensity activities (M. Jørgensen, National Institute of Public Health, Copenhagen, Denmark, personal communication).

More research is required to develop and validate tools for the assessment of physical activity in Aboriginal groups. There is a need for objective monitoring of physical activity — both for surveillance purposes and for the evaluation of population interventions.

A physical activity guide for Aboriginal people?

In 2006, the First Nations and Inuit Health Branch of Health Canada (FNIHB) contracted a commercial polling firm to survey Aboriginal people on their awareness, attitudes, and behaviours relevant to chronic diseases, nutrition, and physical activity. A total representative sample of 700 First Nations living on-reserve and 204 Inuit aged 18 y and older were surveyed. About 1 in 4 respondents claimed to be familiar with Canada's physical activity guide, although few kept a copy in their homes. Among First Nations respondents, those with better education and better self-rated health were more likely to be aware of the guide. Knowledge of the guide showed no association with body mass or physical activity level. Among the Inuit, awareness was similar across different subgroups (Environics Research Group 2006).

Another commercial consultant firm conducted in-depth interviews with ''intermediaries'' (i.e., health, education, and recreation professionals working in Aboriginal communities) on their views on the existing guide, its acceptability, and usefulness. The consensus that emerged supported the tailoring of the guide to ensure maximum use and effectiveness in Aboriginal communities. Adaptations were needed, especially the inclusion of traditional Aboriginal activities and community events, and taking into account cultural and environmental differences between different regions (Phoenix Strategic Perspectives Inc 2006).

Although a separate guide for Aboriginal groups may be preferred from a communications standpoint, it is evident from the literature review that there is as yet no scientific

evidence to justify creating different physical activity recommendations for this group. We lack descriptive data that is valid, reliable, comprehensive, and representative of major regions and cultural groups across the country. We need more studies to identify determinants of and barriers to physical activity in a variety of environmental and cultural contexts. We need scientifically rigorous research to investigate gene–behaviour–environment interactions in the development of chronic diseases that may be unique to Aboriginal people. We also need formal evaluations of intervention programs that have been launched under the Aboriginal Diabetes Initiative (many are poorly described, and even fewer have been evaluated). Such basic background research is a prerequisite to the development of evidence-based physical activity guidelines for a specific population, and as yet we do not have this information. However, the process that has been initiated by CSEP with funding support from Health Canada and the Public Health Agency of Canada, of which this supplement is the first product, is an important step. The inclusion of a section on Aboriginal people recognizes their important health needs, the tremendous disparities in health status, and the urgent need for the promotion of physical activity as components of a broader strategy to abort the emerging epidemic ofchronic disease.

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