

Physical Activity Levels of Canadian Children and Youth: Current Issues and Recommendations

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ABSTRACT

Physical inactivity and obesity are established risk factors for the development of type 2 diabetes mellitus. Given recent increases in the prevalence of obesity and type 2 diabetes among children and youth in North America, an examination of recommended and current physical activity levels is warranted. In 2002, Health Canada released *Canada's Physical Activity Guide for Children* and *Canada's Physical Activity Guide for Youth*. These guidelines recommend an increase in physical activity levels and a decrease in time spent in sedentary activities for all Canadian children and youth. There is currently no systematic surveillance of physical activity levels in Canadian children and youth, although the Canadian Lifestyle and Fitness Research Institute's (CLFRI's) Physical Activity Monitor (PAM) indicates that approximately two-thirds of children and youth are physically inactive, and there are distinct gender differences in physical activity levels, intensity of physical activity and participation in sports. A high prevalence of physical inactivity in a calorie-rich environment may be a contributing factor in the increasing epidemics of obesity and type 2 diabetes in Canada. Development of a national surveillance strategy is a priority. Where possible, objective measures of physical activity should be incorporated, and survey questions should be harmonized with existing surveys for ease of international comparison.

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RÉSUMÉ

L'inactivité physique et l'obésité sont des facteurs de risque avérés de diabète sucré de type 2. Compte tenu de la hausse récente de la prévalence de l'obésité et du diabète de type 2 chez les enfants et les adolescents nord-américains, il y a lieu d'examiner les niveaux d'activité physique recommandés et réels. En 2002, la Société canadienne de physiologie de l'exercice et Santé Canada ont publié le *Guide d'activité physique canadien pour les enfants* et le *Guide d'activité physique canadien pour les jeunes*. Ces lignes directrices recommandent une augmentation des niveaux d'activité physique et une réduction du temps accordé aux activités sédentaires chez tous les enfants et adolescents canadiens. Il n'existe pas actuellement de surveillance systématique des niveaux d'activité physique des enfants et des adolescents canadiens, mais le Sondage indicateur de l'activité physique de l'Institut canadien de la recherche sur la condition physique et le mode de vie révèle qu'environ les deux tiers des enfants et adolescents sont physiquement inactifs et qu'il existe de nettes différences entre les sexes pour ce qui est des niveaux d'activité physique, de l'intensité de l'activité physique et de la participation aux sports. La prévalence élevée de l'inactivité physique, en association à une alimentation hypercalorique, pourrait être un facteur qui contribue à l'aggravation de l'épidémie d'obésité et de diabète de type 2 au Canada. L'élaboration d'une stratégie de surveillance nationale est une priorité. Autant que possible, des mesures objectives de l'activité physique doivent y être incorporées et les questions du sondage et les questions des sondages actuels doivent être réconciliées pour faciliter la comparaison internationale.

INTRODUCTION

Physical inactivity has been identified as a leading public health concern in developed nations, as low physical activity levels are associated with an increased risk of several chronic diseases, including type 2 diabetes mellitus, coronary artery disease, stroke, hypertension, osteoporosis and certain cancers (1). The 1981 Canada Fitness Survey (CFS) was the first attempt to assess the physical fitness and physical activity levels of an entire nation, and it established Canada as a leader in physical activity surveillance. Although basic surveillance of physical activity levels among adults continues in the form of the Physical Activity Monitor (PAM) series of surveys from the Canadian Fitness and Lifestyle Research Institute (CFLRI) and the National Population Health Survey (NPHS)/Canadian Community Health Survey (CCHS) series, there is currently no adequate national surveillance of physical activity patterns in children and youth.

Coupled with the increasing sedentary nature of the modern Canadian lifestyle and the increasing prevalence of overweight and obesity in Canadian children and youth (2), decreasing physical activity levels may have severe consequences for the incidence of type 2 diabetes and related cardiovascular diseases. Therefore, the primary prevention of obesity and the promotion of lifelong physical activity are priorities. The recent development of *Canada's Physical Activity Guide for Children* and *Canada's Physical Activity Guide for Youth* (3,4) is an important step in recognizing the need for all levels of government to address physical activity levels of children and youth, and the future health of Canadians.

The purpose of this paper is to review the current issues surrounding physical activity levels among children and

youth in Canada. Recent physical activity recommendations will be reviewed and the current knowledge about the physical activity levels of Canadian children and youth will be presented. Finally, potential implications for obesity and health, and specific research recommendations will be discussed.

PHYSICAL ACTIVITY GUIDELINES

The development of guidelines for physical activity levels in children and youth does not have a long history, primarily due to the fact that children and youth have traditionally been more active and presumed to be healthier than adults. An international comparison of current physical activity guidelines is presented in Table 1 (1,3-8). Acknowledging that most of the recommendations for physical activity among children and youth have been based on the effects of physical activity on health in adults, the International Consensus Conference on Physical Activity Guidelines for Adolescents was held in 1993 (9). The outcome of the conference was the recommendation that all adolescents should be physically active as part of their lifestyle every day, and they should also engage in at least 20 minutes of moderate-to-vigorous endurance-type physical activity at least 3 times per week (5).

In 1996, the United States (US) Surgeon General's Report on *Physical Activity and Health* (1) expanded the 1995 physical activity recommendations for adults from the American College of Sports Medicine and Centers for Disease Control and Prevention (10) to include all people over 2 years of age: "All people over the age of 2 years should accumulate at least 30 minutes of endurance-type physical activity, of at least moderate intensity, on most—preferably all—days of the week." Thus, there is no distinction between children and

Table 1. Current physical activity guidelines for children and youth

| Organization | Year | Recommendation |
|--|------|---|
| 1993 Seattle Conference of Pediatric Exercise Scientists (5) | 1993 | Daily physical activity as part of lifestyle, plus vigorous physical activity for at least 20 min/session, 3 times/week |
| US Surgeon General (1) | 1996 | 30 min of moderate physical activity on most, preferably all, days of the week |
| UK Health Education Authority (6) | 1998 | 60 min of at least moderate-intensity physical activity per day, or, for those doing little activity currently, at least 30 min of at least moderate-intensity activity, plus activities to enhance muscular strength, flexibility and bone health at least 2 times/week |
| US National Association for Sport and Physical Education (7) | 1998 | 30–60 min of active play or sustained physical activity on all, or most, days of the week, plus accumulation of >60 min, and up to several hours of activity per day is encouraged |
| Australian Commonwealth Department of Health and Aged Care (8) | 1999 | 30 min of moderate activity on most, preferably all, days of the week, plus vigorous exercise for 30 min/d, 3–4 times/week |
| Health Canada (3,4) | 2002 | Children and youth should increase the time they currently engage in moderate or vigorous physical activity by at least 30 min/d (in periods at least 5–10 min long), progressing to ≥ 90 min more of increasingly vigorous physical activity, plus decrease the time spent doing sedentary activity (television, video games, Internet) by at least 30 min/d, eventually decreasing by ≥ 90 min the amount of time spent daily on these activities |

| Table 2. Canadian surveys of physical activity that include Canadian children and youth as participants | | |
|--|--------------------------|--------------------|
| Survey | Age range (years) | Sample size |
| CFLRI | | |
| 1981 CFS (15) | 7–69 | 23 400 |
| 1988 CSWB (16) | 7–69 | 4200 |
| PAM* | | |
| 1995 (17) | 1–17 ≥18 | 603 2576 |
| 1997 (18) | 1–17 ≥18 | 656 1875 |
| 1998 (19) | 1–17 ≥18 | 1606 4808 |
| 1999 (20) | 1–17 ≥18 | 1375 4369 |
| 2000 (21) | 1–17 ≥18 | 3334 5148 |
| Other surveys | | |
| 1976 Survey of Fitness, Physical Recreation & Sport (22) | ≥14 | 50 816 |
| HPS | | |
| 1985 (23) | ≥15 | 11 181 |
| 1990 (24) | ≥15 | 13 792 |
| 1998 GSS Time Use Survey (25) | ≥15 | 10 749 |
| NPHS | | |
| 1994 (26) | ≥12 | 17 626 |
| 1996 (27) | ≥12 | 81 804 |
| 1998 (28) | ≥12 | 17 244 |
| 2000 CCHS (29) | ≥12 | 130 000 |
| HBSC | | |
| 1990 (30) | 11–15 | 5565 |
| 1994 (30) | 11–15 | 6758 |
| 1998 (30) | 11–15 | 6259 |

*The PAM relies on parental report of physical activity for those <18 years of age.

CCHS = Canadian Community Health Survey

CFLRI = Canadian Fitness and Lifestyle Research Institute

CFS = Canada Fitness Survey

CSWB = Campbell Survey on Well-being in Canada

GSS = General Social Survey

HBSC = Health Behaviour in School-aged Children Survey

HPS = Health Promotion Survey

NPHS = National Population Health Survey

PAM = Physical Activity Monitor

adults in the current US physical activity recommendations. The Australian physical activity recommendations follow the US Surgeon General's Report for adults, with the addition that children and teenagers <18 years of age should routinely add vigorous exercise for 30 minutes per day, 3 to 4 days per week to the basic activity guidelines (8).

Recently, the Health Education Authority in the United Kingdom held a symposium entitled "Young and Active?" from which new recommendations for the physical activity of youth emerged (6). The main recommendations were that all young people should be physically active for at least 60 minutes per day at moderate intensity, and that currently inactive youth should begin by participating in moderate intensity activity for at least 30 minutes per day (6). A secondary recommendation was that ≥ 2 times per week some of the physical activities should help enhance and maintain flexibility, muscular strength and bone health.

Based on the daily physical activity energy expenditure recommendations for adults of approximately $3 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$, Corbin and colleagues have recommended that the minimum activity standard in children be set at $3 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$; however, they also recommend an optimal activity target for children of 6 to $8 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ (11). These recommendations were formalized into a set of guidelines by the US National Association for Sport and Physical Education in 1998, based on minutes of activity rather than energy expenditure (7). The guidelines indicate that elementary school children should engage in 30 to 60 minutes of active play or sustained physical activity on all, or most, days of the week. Furthermore, an accumulation of >60 minutes, and up to several hours, of activity per day is encouraged for elementary school children (7). The rationales for this higher

recommendation for children include: 1) development of motor skills requires substantial practice and effort; 2) lifetime physical activities learned in childhood contribute to active lifestyles later in life; 3) physical activity is positively related to health-related fitness in childhood; 4) given the opportunity, children will choose to be active; and 5) people who are inactive are at increased risk of disease and death in adulthood, and people become less active as they grow older, so establishing a high baseline will be beneficial for future health (11).

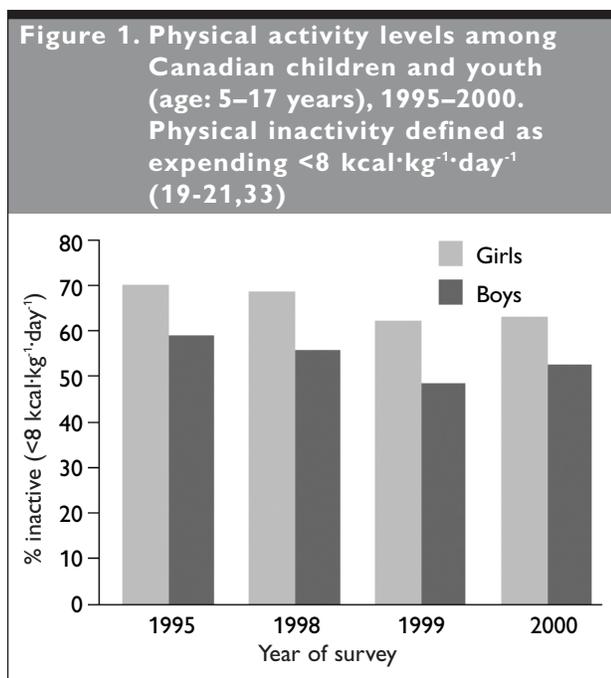
Health Canada recently released *Canada's Physical Activity Guide for Children* and *Canada's Physical Activity Guide for Youth* (3,4). These supplements contain guidelines for physical activity participation among Canadian children and youth. Absent from the Canadian guidelines are concrete numbers; instead, children and youth are advised to increase their physical activity by 30 minutes per day from current levels, in periods of activity that are at least 5 to 10 minutes in duration, and decrease sedentary activities (television viewing, computer or video game use) by 30 minutes per day. Furthermore, these guidelines suggest that this is only a starting point and that in a 5-month plan, children and youth should continue to increase active pursuits (≥ 90 more minutes of mixed moderate and vigorous activities) while decreasing time spent doing those that are inactive (≥ 90 more minutes).

The American Academy of Pediatrics has issued statements supporting the assessment of children's physical activity levels, and emphasizes "active play" as a means of increasing activity levels among children, while warning of the dangers of introducing regimented activity programs at very young ages (12,13). A review by Corbin and colleagues also emphasizes that active play should be encouraged among children and youth (11). Given that certain components of childhood physical activity, such as being forced to exercise or participate, tend to negatively impact adult levels of physical activity (14), the role of promoting fun physical activities that offer enjoyment to children and youth cannot be overemphasized.

PHYSICAL ACTIVITY SURVEYS

Although standardized physical activity surveillance data are not available for Canadian children and youth, comparisons of trends may be compiled from a variety of sources (Table 2) (15-30). The 1981 CFS (31), and its 7-year follow-up, the 1988 Campbell Survey on Well-being in Canada (CSWB) (16) were the first attempts to characterize the physical activity levels of an entire nation. In these surveys, physical activity levels were estimated in participants ≥ 10 years of age using a modification of the Minnesota Leisure-time Physical Activity Questionnaire (31).

The 1985 and 1990 Health Promotion Surveys (HPSs) included limited questions on physical activity, which have been presented in the technical reports (23,24). The retention of the same physical activity questions from 1985 to



1990 allows comparisons to be made between the 2 time points. The 1998 General Social Survey (GSS) on time use also included questions about active and inactive leisure-time pursuits, including participation in sports, on a representative sample of Canadians ≥ 15 years of age (25).

The CFLRI continues to monitor the physical activity levels of children, youth and adults through the PAM (1995, 1997 to 2001), a telephone survey of a series of representative cross-sectional samples of Canadians where the physical activity levels of children (< 18 years of age) are reported by a parent in the household (17-21). The NPHSs (1994, 1996, 1998) include a physical activity component for participants 12 to 18 years of age, as does the 2000/2001 cross-sectional CCHS (26-29). In contrast to the PAM, physical activity levels among subjects 12 to 18 years of age are self-reported in the NPHS and CCHS, not reported by a youth's parent.

Finally, Canada has participated in the World Health Organization's (WHO's) study of Health Behaviour in School-aged Children (HBSC) since 1990 (30). This study is repeated every 4 years cross-sectionally (1990, 1994, 1998), targeting a representative sample of children and youth 11, 13 and 15 years of age. Limited information about frequency and duration of physical activity is available from this survey.

LEVELS OF PHYSICAL ACTIVITY

According to the 1995 PAM, children and youth (age: 1 to 17 years) spent an average of 16 hours per week in physically active play (32). Males spent nearly 20% more time in physically active play than did females, and were more consistently physically active at all ages (32). Examination of PAM data from 1995 to 2000 reveals that between 60% and 70% of females and between 50% and 60% of males 5 to 17 years of age fail to meet the upper guideline recommended by Corbin and colleagues of expending at least $8 \text{ kcal} \cdot \text{kg}^{-1} \cdot \text{day}^{-1}$ (Figure 1) (11,19-21,33).

When physical activity levels outside of school hours are considered, males have consistently higher levels of physical activity than females. Between 50% and 85% of school-aged youth exercise at least 2 times per week outside of school hours, but only between 20% and 50% of them reported exercising at least 4 hours outside of school (30). Between 1990 and 1998, the percentages of both boys and girls who reported exercising at least 2 times per week outside of school hours appeared to decrease.

Given that children and youth spend a significant amount of time in school, the issue of adequate amounts of "active" physical education is of interest. There do not appear to be good data on the actual amounts of "physically active time" that students are exposed to in Canadian schools, and how this amount may vary according to the time of day of the class, age and gender of the instructor. A recent study of a random sample of schools in Ontario, Canada, indicated that the duration of physical education classes increased with grade level from grade 1 through 8, as did the duration of

weekly vigorous physical activity (34). However, there was very little variability in the number of days per week that students received physical education classes (just under 3 days per week) (34). There was, however, a significant drop in the enrolment rates in high school physical education classes between grades 9 (95%) and 12 (45%).

Comparison with other countries

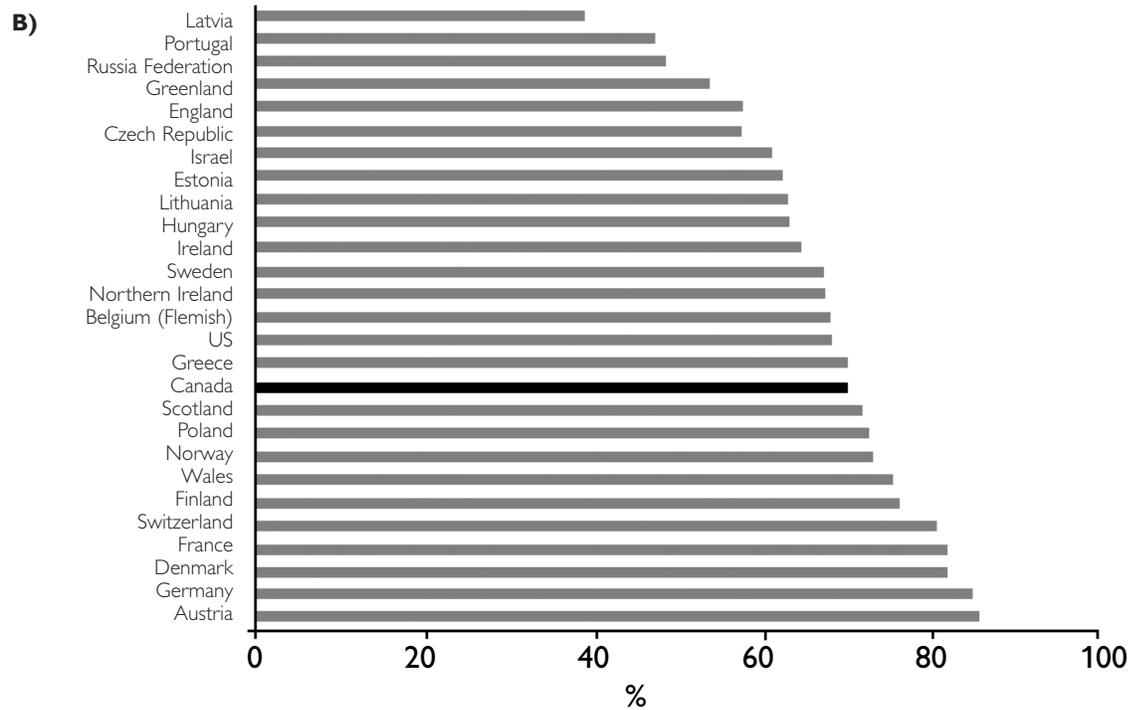
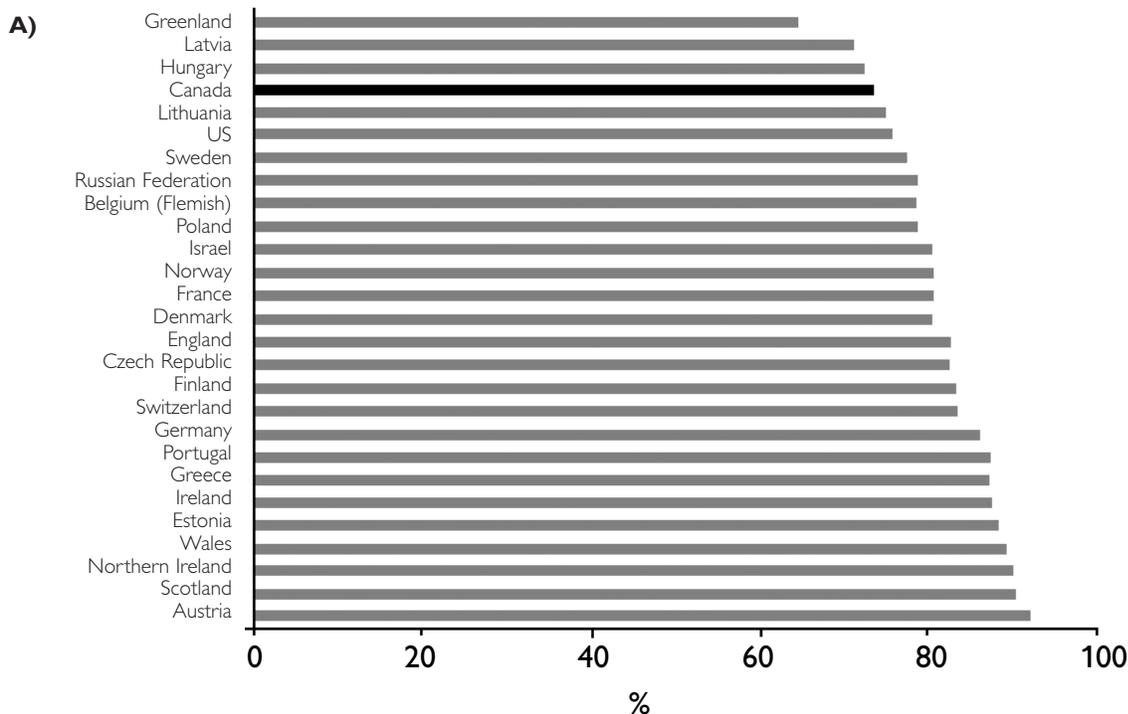
Pate and colleagues recently reviewed the descriptive epidemiology of physical activity among adolescents (35). The authors note that although there have been longstanding concerns about the physical activity levels of children and youth, there have been surprisingly few studies of youth physical activity levels in any country. Recently, Epstein and colleagues published a meta-analysis of heart-rate measured physical activity levels among youth (36). The authors concluded that the majority of youth of all ages attain > 60 minutes per day of low-intensity physical activity and 30 minutes per day of more vigorous physical activity. However, a major limitation to the interpretation of the study results is the non-representativeness of the data. None of the reviewed 26 studies were based on nationally representative samples of youth, as all were small laboratory-based investigations. As such, all of the studies were composed of volunteers, which may bias the results toward higher activity levels.

HBSC is a cross-national (36 participating countries) study conducted in collaboration with WHO (37). The aim of the study is to increase the understanding of health behaviours, health and well-being among young people within a social context. Data from the 1997/1998 HBSC study indicate that although Canadian children (at age 13 years) do not compare well with other countries when one considers the percentages that report exercising ≥ 2 times per week (Figure 2A, Figure 3A), they do much better when comparing the percentages that report exercising ≥ 2 hours per week (Figure 2B, Figure 3B). One conclusion that could be drawn from these comparisons is that Canadian youth are less frequently active, yet they report higher total volumes of physical activity than youth in other countries. It also appears that Canadian youth are much more vigorously active than their peers in the US or England (Figure 4). Pate and colleagues also arrived at this conclusion (35).

Geographic variation

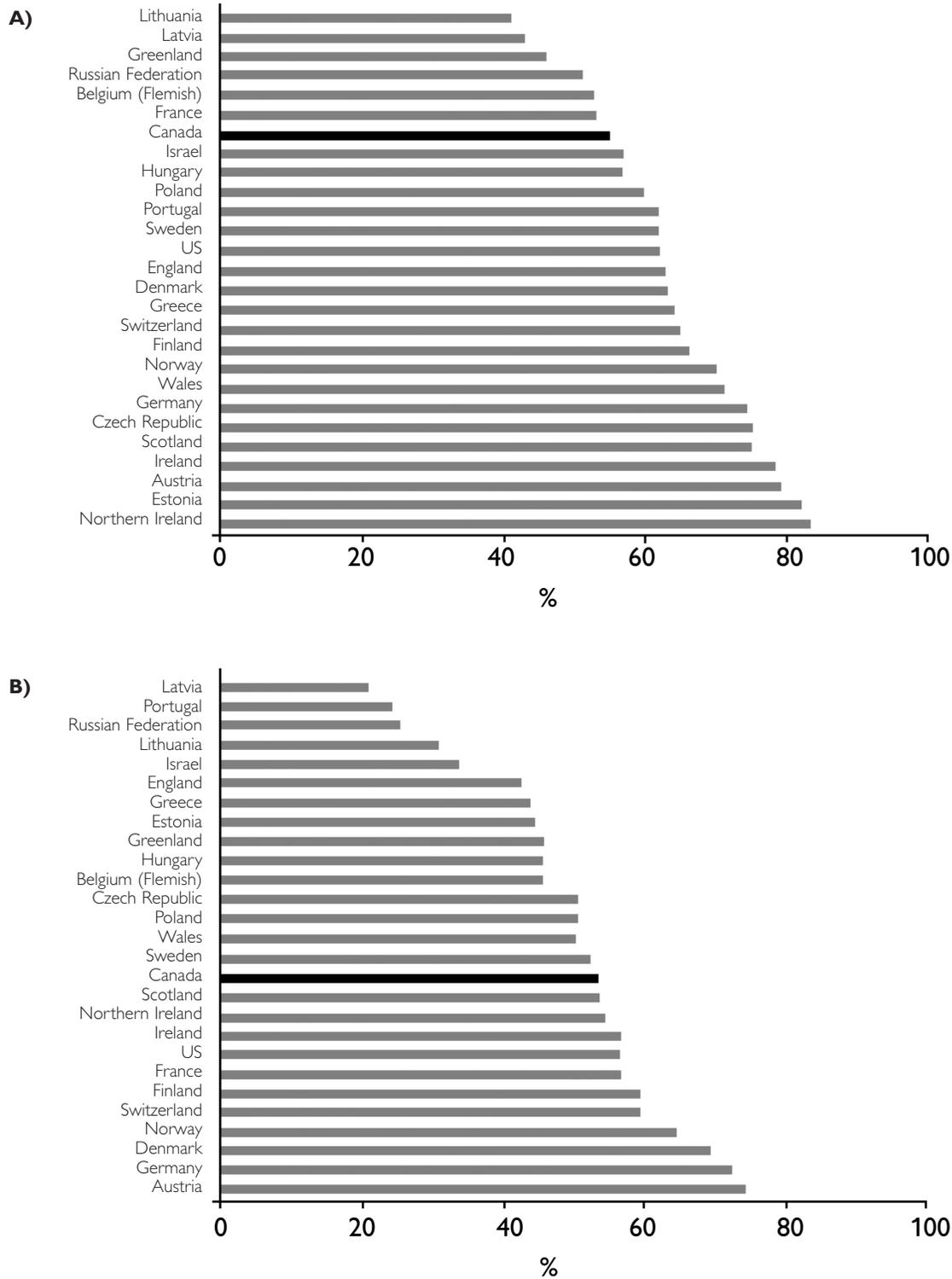
Among adults, there tends to be an east-west gradient in physical activity, where people are more physically active in Western Canada than in the east (38,39). Geographic trends in physical activity levels are difficult to determine for Canadian children and youth due to small sample sizes, even in the national surveys, when data are stratified by province or region. The 1999 PAM shows the east-west trend in children and youth 5 to 17 years of age; however, the magnitude of the trend is small: the prevalence of inactivity decreases from east (57%) to central (55%) to west (51%) (20). Using

Figure 2. Percentages of 13-year-old boys who report A) exercising ≥ 2 times per week and B) exercising ≥ 2 hours per week. From the 1997–1998 HBSC (37). The black line indicates Canada’s position in the ranking



HBSC = Health Behaviour in School-aged Children Survey

Figure 3. Percentages of 13-year-old girls who report A) exercising ≥ 2 times per week and B) exercising ≥ 2 hours per week. From the 1997–1998 HBSC (37). The black line indicates Canada’s position in the ranking



HBSC = Health Behaviour in School-aged Children Survey

data from the NPHS and a threshold of $3 \text{ kcal} \cdot \text{kg}^{-1} \cdot \text{day}^{-1}$, there is an inconsistent pattern of physical inactivity in Canadian children and youth 12 to 19 years of age (Figure 5). However, the level of physical inactivity is consistently high across the country, with each province demonstrating at least a 49% prevalence of physical inactivity, with a national average of 58%.

Gender

There are clear gender differences in levels of participation in physical activity. Data from the 1981 CFS (15), 1988 CSWB (16), 1995 PAM (32), 1985 and 1990 HPSs (23,24), the 1997 Youth Risk Behavior Surveillance System (YRBSS) in the US (40), and the 1998 HBSC survey (37) all demonstrate higher levels of physical activity in boys than in girls at all ages. Boys are also more likely to be vigorously physically active than girls. As well, the level of physical activity tends to decline throughout adolescence, whereas in boys, physical activity levels persist until late adolescence (age: 16 years) and then decline dramatically. Potential gender differences in adolescence yield a number of considerations: children appear to 'play' during the ages of 5 to 12 years, but as they become teenagers, there appears to be a shift toward

specialization and participation in organized sports, where boys are overrepresented (21).

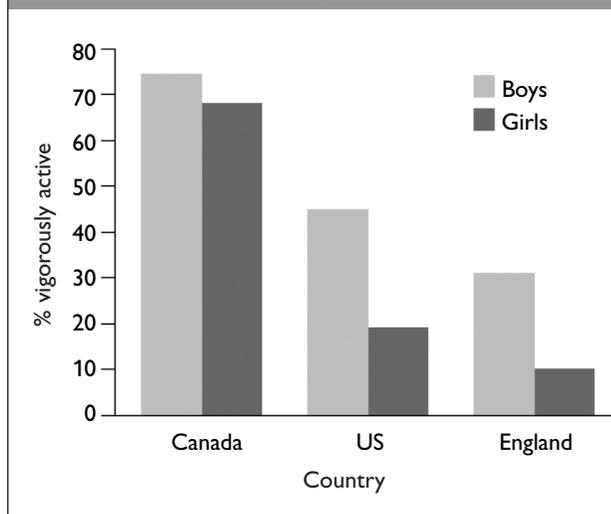
Ethnicity

The epidemic of type 2 diabetes in North American children and adolescents is currently largely confined to high-risk populations such as the Aboriginal peoples, and those of African, Mexican and Asian ancestry (41). Therefore, obtaining data on lifestyle characteristics related to type 2 diabetes, such as physical inactivity and unhealthy eating behaviours, in these groups is an important consideration. Unfortunately, within the context of this review, there are very little, if any, data on the physical activity levels of contemporary ethnic or minority groups in Canada. The lack of data is due primarily to the fact that "ethnicity" is rarely asked on questionnaire surveys. The best evidence of ethnic differences in physical activity among youth in North America comes from the YRBSS in the US (40). According to 1997 data, white youth (grades 9 to 12) were most likely to be vigorously physically active (67%), defined as participating in physical activities that caused sweating and hard breathing for at least 20 minutes on at least 3 days of the preceding week, followed by Hispanics (60%) and African-Americans (54%). Of all the gender-by-ethnic adolescent groups in the US, African-American females are the least likely to be vigorously physically active (41%) (40). Considering that African-American girls have one of the highest prevalences of overweight and obesity in the US, the collection of this information can have clear public health implications.

There is limited published information available about levels of participation in sports among Canadian youth, but this is an increasingly important aspect of physical activity. The most recent statistics are from the 1998 GSS on time use (25). In 1998, 54% of children 5 to 14 years of age living in 1- or 2-parent households participated in regular organized sport activity (42). Almost 48% of these children reported participation in >1 sport over the year (42), with soccer, basketball and swimming listed among the top 5 activities in the 1998 GSS (42) and 1999 PAM (20), indicating that they are among the most popular organized youth sports in Canada.

The only data the authors are aware of that address the issue of ethnicity and participation in sports among adolescents are from the 1997 YRBSS in the US (40). There is a clear ethnic gradient for participation in sports, such that white (55%) > African-American (44%) > Hispanic (40%) for school-sponsored teams, and also white (41%) > African-American (38%) > Hispanic (33%) for teams unaffiliated with the schools (40). A national survey was conducted in England in 1999/2000 on ethnicity and sport among adults (43). Although not directly applicable to children and youth, the results provide some insights into ethnic variation in participation in sports. The primary finding was that the rate of participation in sports among "ethnic minorities" was lower (40%) than the national average (46%) (43).

Figure 4. Percentage of participants who are vigorously physically active at least 3 times per week in 3 national surveys. Data for Canada are from the 1990 HPS (age: 15–19 years), data for the US are from the 1991 YRBSS (age: 17 years), data for England are from the 1990–1991 Allied Dunbar National Fitness Study (age: 16–24 years) (adapted from reference 35)



HPS = Health Promotion Survey

YRBSS = Youth Risk Behavior Surveillance System

IMPLICATIONS FOR THE OBESITY EPIDEMIC AND FUTURE HEALTH

Obesity is a complex, multifactorial disease that results from a chronic energy imbalance, whereby energy intake exceeds expenditure; however, there is no consensus as to whether the current epidemic is primarily the result of excess energy intake or insufficient energy expenditure. In today's calorie-rich environment, decreasing levels of physical activity can have serious implications for the increasing epidemic of childhood obesity, which has been linked to dyslipidemia, diabetes, hypertension and atherosclerosis (44). However, the scientific evidence for a link between physical inactivity and obesity in children is divided. The results from cross-sectional studies are equivocal, as many studies report higher levels of adiposity among sedentary vs. active youth, while others do not (45). The evidence that physical activity influences obesity is encouraging; however, further work is required to determine how the benefits of physical activity can be maximized (46).

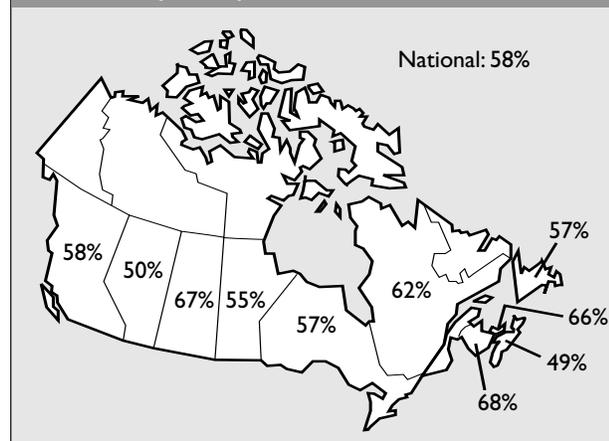
The worldwide incidence of type 2 diabetes has increased dramatically during the last century, and the increases have been attributed primarily to increases in sedentary lifestyles, over-nutrition and obesity (47). It has been hypothesized that type 2 diabetes has arisen as a prominent disease of civilization from a gene-environment interaction whereby a "thrifty genotype" has been rendered "detrimental by progress" (48). Data from the 1996 NPHS suggested that approximately 3.2% of the population ≥ 12 years of age had diabetes, and there are approximately 60 000 new cases of diabetes diagnosed per year (27,49). More recent data from the 1998/1999 National Diabetes Surveillance System indicated that 4.8% of Canadians ≥ 20 years of age had diabetes (50), whereas the 2000 CCHS reported a prevalence of self-reported diabetes of 4.1% for Canadians ≥ 12 years of age (29).

Although attempts have been made to link the recommended levels of physical activity with health outcomes in childhood and adulthood, most of the guidelines are actually based on projections of adult physical activity to health relations backwards into childhood. A recent review by Twisk indicates that there is very little scientific evidence for a particular dose-response relationship or a particular threshold of activity from which physical activity guidelines can be obtained in children, and relationships between physical activity and health indicators in children and youth are complicated by issues of normal growth and maturation (51). It appears that participation in sports by adolescents (age: 13 to 18 years) (52) and physical activity (age: 12 to 15 years) (53) are unable to predict cardiovascular (CV) risk profiles 20 and 10 years into the future, respectively. However, it may be that changes in physical activity or physical fitness are what influence individual CV risk factors (53), and the effects may be short-lived. Therefore, the current recommendations are primarily based on the consensus of experts in the area rather than on true biological thresholds obtained from empirical research.

Hyperinsulinemia is a key component in the metabolic syndrome and is a risk factor for future coronary heart disease (54). Although there is good evidence that exercise training improves insulin sensitivity in adults (55), there is very little information on the relationship between physical activity and glucose metabolism in children and adolescents. Nevertheless, a study in youth without diabetes (age: 10 to 16 years) reported that physical activity was positively correlated with lower fasting insulin and increased insulin sensitivity, suggesting that physical activity may decrease the incidence of type 2 diabetes (56). Furthermore, the ability of physical activity to reduce the progression of impaired glucose tolerance to type 2 diabetes has also been documented in overweight adults (57).

It appears that how a child spends his or her day can contribute significantly to present and future health. According to the Canadian HBSC (age: 11 to 15 years), approximately 20% to 30% of boys and 15% to 25% of girls watch television >4 hours per day (30). There do not appear to be any consistent temporal trends from 1990 to 1998; however, there is a tendency for boys to watch more television than girls. Similarly, there do not appear to be any age-related differences in television viewing time, at least between 11 and 15 years of age. In the 1998 GSS on time use, Canadians ≥ 15 years of age reported spending 0.5 hours per day in "active sports," while they reported spending 2.2 hours per day viewing television (25). These data suggest that, on average, Canadians spend a greater amount of time in 1 popular sedentary behaviour, watching television, than they do in participation in leisure-time physical activity. These findings are in agreement with a recent study that reported that obese children spend 51% more time in sedentary activity compared to their normal-weight peers, and approximately 30% less time being physically active (58).

Figure 5. Current physical inactivity levels in Canadian youth 12–19 years of age. Physical inactivity defined as expending $<3 \text{ kcal} \cdot \text{kg}^{-1} \cdot \text{day}^{-1}$ (28,39)



RECOMMENDATIONS

Throughout this review of physical activity in Canadian children and youth, many limitations and shortcomings of the available Canadian data have been noted. It is obvious that the largest and most pervasive shortcoming is simply the lack of current nationally representative data on the physical activity of Canadian children and youth. There is currently no adequate systematic surveillance of physical activity patterns, making it of primary importance to develop a national surveillance strategy in Canada. It is also apparent that these surveys must be designed to include culturally sensitive language and a variety of activities that have objectively measured metabolic equivalent values that can be associated with a precise activity. Because many health behaviours show ethnic and socioeconomic gradients, the development of a national strategy would allow for the identification of high-risk subgroups (e.g. ethnic or age groups) that should be targeted for intervention, and these groups must be accounted for in the study sample design.

In general, all Canadians should be encouraged to become more physically active to maintain health benefits. A multidisciplinary behavioural approach must be adopted to address a variety of barriers to physical activity in adults as well as children and youth. Specifically, the health benefits of physical activity must continue to be promoted at the community and family levels. Gaps in access to resources (athletic facilities in low socioeconomic communities) should also be addressed, as well as physical activity in schools. A recent review lists several ways in which environments could be modified to facilitate participation in physical activity (59), including modification of existing buildings to encourage the use of stairs; neighbourhoods and urban planners adopting a pedestrian-friendly approach with more green space and easy access to parks and recreation sites; and continued efforts to focus on making neighbourhoods safe and walkable, while promoting bike paths and other forms of active transport.

Recently, the American Heart Association released a scientific statement on Cardiovascular Health in Childhood recommending incorporation of physical activity counselling into all children's regular medical exams to encourage active lifestyles and lifelong physical activity (60). Other general recommendations address the inclusiveness of physical activity programming for children of all physical and mental abilities and emphasize the role of families in physical activity planning. Parents are encouraged to become positive role models and are advised to set time limits on the amount of sedentary activities their children engage in.

It is clear from this review of current physical activity recommendations that they are not based on biological thresholds in the relationship between physical activity and health in children and youth (51). Most of the recommendations are based on current knowledge of the health effects of physical activity in adults, and projection of these beliefs backwards into childhood. Therefore, more research into the dose-

response relationships among indicators of physical activity and several health outcomes in children and youth is required. Given the current state of high levels of physical inactivity, obesity and an increasing prevalence of type 2 diabetes among children and youth, large multicentred intervention trials are warranted in Canada.

In summary, the following 3 recommended actions are required to address the major gaps in physical activity and health research among children and youth: 1) development of a national physical activity surveillance system to collect population level data (linked to other risk factors and disease states); 2) establishment of basic science and clinical evidence to support the development of physical activity guidelines for children and youth; and 3) development of comprehensive interventions to address knowledge (awareness and education), skills and resources (access to facilities and equipment) of individuals, families, communities and healthcare providers to participate in or make recommendations about physical activity.

REFERENCES

1. U.S. Department of Health and Human Services. *Physical Activity and Health: A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion; 1996.
2. Tremblay MS, Willms JD. Secular trends in the body mass index of Canadian children. *CMAJ*. 2000;163:1429-1433.
3. Health Canada. *Canada's Physical Activity Guide for Children*. Ottawa, ON: Health Canada; 2002. Publication H39-611/2002-2E.
4. Health Canada. *Canada's Physical Activity Guide for Youth*. Ottawa, ON: Health Canada; 2002. Publication H39-611/2002-1E.
5. Sallis JF, Patrick K. Physical activity guidelines for adolescents: consensus statement. *Pediatr Exerc Sci*. 1994;6:302-314.
6. Biddle S, Cavill N, Sallis J. Policy framework for young people and health-enhancing physical activity. Biddle S, Sallis J, Cavill N, eds. In: *Young and Active? Young People and Health-enhancing Physical Activity: Evidence and Implications*. London, UK: Health Education Authority; 1998:3-16.
7. Corbin CB, Pangrazi RP. *Physical Activity for Children: A Statement of Guidelines*. Reston, VA: National Association for Sport and Physical Education; 1998.
8. University of Western Australia, Centre for Health Promotion and Research Sydney. *National Physical Activity Guidelines for Australians*. Sydney, Australia: Commonwealth Department of Health and Aged Care; 1999.
9. Sallis JF, Patrick K, Long B. Overview of the international consensus conference on physical activity guidelines for adolescents. *Pediatr Exerc Sci*. 1994;6:299-301.
10. Pate RR, Pratt M, Blair SN, et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA*. 1995;273:402-407.
11. Corbin CB, Pangrazi RP, Welk GJ. *Toward an Understanding of*

- Appropriate Physical Activity Levels for Youth*. President's Council on Physical Fitness and Sports Research Digest; 1994. Series 1, No. 8.
12. American Academy of Pediatrics. Committee on Sports Medicine and Fitness. Fitness, activity, and sports participation in the preschool child. *Pediatrics*. 1992;90:1002-1004.
 13. American Academy of Pediatrics. Committee on Sports Medicine and Fitness and Committee on School Health. Organized sports for children and preadolescents. *Pediatrics*. 2001;107:1459-1462.
 14. Taylor WC, Blair SN, Cummings SS, et al. Childhood and adolescent physical activity patterns and adult physical activity. *Med Sci Sports Exerc*. 1999;31:118-123.
 15. Fitness Canada. *Physical Fitness of Canadian Youth*. Ottawa, ON: Government of Canada; 1985.
 16. Stephens T, Craig CL. *The Well-being of Canadians: Highlights of the 1988 Campbell Survey*. Ottawa, ON: Canadian Fitness and Lifestyle Research Institute; 1990.
 17. Craig CL, Russell SJ, Cameron C, et al. *1997 Physical Activity Benchmarks Report*. Ottawa, ON: Canadian Fitness and Lifestyle Research Institute; 1998.
 18. Craig CL, Russell SJ, Cameron C, et al. *Foundation for Joint Action: Reducing Physical Inactivity*. Ottawa, ON: Canadian Fitness and Lifestyle Research Institute; 1999.
 19. Cameron C, Craig CL, Russell SJ, et al. *Increasing Physical Activity: Creating Effective Communications*. Ottawa, ON: Canadian Fitness and Lifestyle Research Institute; 2000.
 20. Craig CL, Cameron C, Russell SJ, et al. *Increasing Physical Activity: Building a Supportive Recreation and Sport System*. Ottawa, ON: Canadian Fitness and Lifestyle Research Institute; 2001.
 21. Craig CL, Cameron C, Russell SJ, et al. *Increasing Physical Activity: Supporting Children's Participation*. Ottawa, ON: Canadian Fitness and Lifestyle Research Institute; 2001.
 22. Health and Welfare Canada. *Physical Recreation and Sport Survey Codebook*. Ottawa, ON: Statistics Canada; 1976.
 23. Stephens T. Exercise. In: Rootman I, Warren R, Stephens T, et al, eds. *Canada's Health Promotion Survey 1985: Technical Report*. Ottawa, ON: Health and Welfare Canada; 1988:155-168.
 24. Stephens T. Leisure-time physical activity. In: Stephens T, Fowler Graham D, eds. *Canada's Health Promotion Survey 1990: Technical Report*. Ottawa, ON: Minister of Supply and Services Canada; 1993:139-150.
 25. Statistics Canada. *Overview of the Time Use of Canadians in 1998*. Ottawa, ON: Minister of Industry; 1999.
 26. Statistics Canada. 1994–1995 NPHS public use microdata documentation. Ottawa, ON: Ministry of Industry; 1994. Available at: http://prod.library.utoronto.ca/datalib/codebooks/cstdli/nphs/1994_r/nphs.pdf. Accessed July 17, 2003.
 27. Statistics Canada. 1996–1997 NPHS public use microdata documentation. Ottawa, ON: Ministry of Industry; 1997. Available at: <http://prod.library.utoronto.ca/datalib/codebooks/cstdli/nphs/1997/engdoc.pdf>. Accessed July 17, 2003.
 28. Statistics Canada. 1998–1999 NPHS public use microdata files documentation. Ottawa, ON: Ministry of Industry; 1999. Available at: <http://info.library.yorku.ca/depts/lds/docs/nphs/nphs9899guide-all.pdf>. Accessed July 17, 2003.
 29. Statistics Canada. *Health Indicators*. Ottawa, ON: Ministry of Industry; 2002. Publication 82-221-XIE.
 30. King AJ, Boyce WF, King MA. *Trends in the Health of Canadian Youth*. Ottawa, ON: Ministry of Health; 1999.
 31. Shephard RJ. *Fitness of a Nation: Lessons From the Canada Fitness Survey*. New York, NY: Karger; 1986.
 32. Physical activity in children. *Progress in Prevention*. Ottawa, ON: Canadian Fitness and Lifestyle Research Institute; 1996. Bulletin No. 8.
 33. Adherence to youth guidelines. *Progress in Prevention*. Ottawa, ON: Canadian Fitness and Lifestyle Research Institute; 1997. Bulletin No. 13.
 34. Allison KR, Adlaf EM. Structured opportunities for student physical activity in Ontario elementary and secondary schools. *Can J Public Health*. 2000;91:371-375.
 35. Pate RR, Long BJ, Heath G. Descriptive epidemiology of physical activity in adolescents. *Pediatr Exerc Sci*. 1994;6:434-447.
 36. Epstein LH, Paluch RA, Kalakanis LE, et al. How much activity do youth get? A quantitative review of heart-rate measured activity. *Pediatrics*. 2001;108:E44. Available at: <http://www.pediatrics.org/cgi/content/full/108/3/e44>. Accessed September 24, 2003.
 37. Currie C, Hurrelmann K, Settertobulte W, et al. *Health and Health Behaviour Among Young People*. Copenhagen, Denmark: World Health Organization; 2000. Health Policy for Children and Adolescents (HEPCA), WHO Policy Series, No. 1.
 38. McPherson BD, Curtis JE. *Regional and Community Type Differences in the Physical Activity Patterns of Canadian Adults*. Ottawa, ON: Fitness Canada; 1986.
 39. Cameron C, Craig CL, Stephens T, et al. *Increasing Physical Activity: Supporting an Active Workforce*. Ottawa, ON: Canadian Fitness and Lifestyle Research Institute; 2002.
 40. Kann L, Kinchen SA, Williams BI, et al. Youth risk behavior surveillance—United States, 1997. In: *CDC Surveillance Summaries*, August 14, 1998. MMWR. 1998;47(No. SS-3):1-89.
 41. Fagot-Campagna A, Pettitt DJ, Engelgau MM, et al. Type 2 diabetes among North American children and adolescents: an epidemiologic review and a public health perspective. *J Pediatr*. 2000;136:664-672.
 42. Kremarik F. A family affair: children's participation in sports. *Canadian Social Trends*. 2000;Autumn:20-24.
 43. Rowe N, Champion R. *Sports Participation and Ethnicity in England. National Survey 1999/2000: Headline Findings*. London, UK: Sport England; 2000.
 44. Klish WJ. Childhood obesity. *Pediatr Rev*. 1998;19:312-315.
 45. Bar-Or O, Baranowski T. Physical activity, adiposity, and obesity among adolescents. *Pediatr Exerc Sci*. 1994;6:348-360.
 46. Epstein LH, Goldfield GS. Physical activity in the treatment of childhood overweight and obesity: current evidence and research issues. *Med Sci Sports Exerc*. 1999;31(suppl 11):S553-S559.
 47. Zimmet P, Alberti KGMM, Shaw J. Global and societal implications of the diabetes epidemic. *Nature*. 2001;414:782-787.

48. Neel JV. Diabetes mellitus: a "thrifty" genotype rendered detrimental by "progress". *Am J Hum Genet.* 1962;14:353-362.
49. Health Canada. *Diabetes in Canada: National Statistics and Opportunities for Improved Surveillance, Prevention, and Control.* Ottawa, ON: Minister of Public Works and Government Services Canada; 1999.
50. Health Canada. *Diabetes in Canada.* 2nd ed. Ottawa, ON: Centre for Chronic Disease Prevention and Control, Population and Public Health Branch, Health Canada; 2002.
51. Twisk JW. Physical activity guidelines for children and adolescents: a critical review. *Sports Med.* 2001;31:617-627.
52. Lefevre J, Philippaerts R, Delvaux K, et al. Relation between cardiovascular risk factors at adult age, and physical activity during youth and adulthood: the Leuven Longitudinal Study on Lifestyle, Fitness and Health. *Int J Sports Med.* 2002;23(suppl 1):S32-S38.
53. Boreham C, Twisk J, Neville C, et al. Associations between physical fitness and activity patterns during adolescence and cardiovascular risk factors in young adulthood: the Northern Ireland Young Hearts Project. *Int J Sports Med.* 2002;23(suppl 1):S22-S26.
54. Ferrannini E, Haffner SM, Mitchell BD, et al. Hyperinsulinaemia: the key feature of a cardiovascular and metabolic syndrome. *Diabetologia.* 1991;34:416-422.
55. Bjorntorp P. The effects of exercise on plasma insulin. *Int J Sports Med.* 1981;2:125-129.
56. Schmitz KH, Jacobs DR Jr, Hong C-P, et al. Association of physical activity with insulin sensitivity in children. *Int J Obes Relat Metab Disord.* 2002;26:1310-1316.
57. Tuomilehto J, Lindström J, Eriksson JG, et al. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. *N Engl J Med.* 2001;344:1343-1350.
58. Yu CW, Sung RYT, So R, et al. Energy expenditure and physical activity of obese children: cross-sectional study. *Hong Kong Med J.* 2002;8:313-317.
59. Trost SG, Owen N, Bauman AE, et al. Correlates of adults' participation in physical activity: review and update. *Med Sci Sports Exerc.* 2002;34:1996-2001.
60. Williams CL, Hayman LL, Daniels SR, et al. Cardiovascular health in childhood: a statement for health professionals from the Committee on Atherosclerosis, Hypertension, and Obesity in the Young (AHOY) of the Council on Cardiovascular Disease in the Young, American Heart Association. *Circulation.* 2002;106:143-160.