Conquering Childhood Inactivity: Is the Answer in the Past?

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ABSTRACT

TREMBLAY, M. S., J. D. BARNES, J. L. COPELAND, and D. W. ESLIGER. Conquering Childhood Inactivity: Is the Answer in the Past? *Med. Sci. Sports Exerc.*, Vol. 37, No. 7, pp. 1187–1194, 2005. **Purpose:** The primary purpose of this study was to compare the health-related physical fitness and physical activity behaviors of Old Order Mennonite children to both rural and urban-dwelling children living a contemporary Canadian lifestyle. **Methods:** A cross-sectional study design was used to compare the physical fitness and physical activity characteristics of three groups of children between the ages of 8–13 yr. A total of 124 Old Order Mennonite children (OOM) from Ontario, Canada, were compared with contemporary living children from urban (USK, $N = 110$) and rural (RSK, $N = 165$) Saskatchewan, Canada. Fitness was assessed using measures of height, weight, triceps skinfold, grip strength, push-ups, partial curl-ups, and aerobic fitness. Physical activity levels were directly measured for seven consecutive days using a MTI Actigraph accelerometer model 7164. **Results:** After controlling for maturational age, analyses revealed that OOM children had a smaller triceps skinfold than USK children ($P < 0.01$), a greater aerobic fitness score than RSK children ($P < 0.05$), and greater grip strength than both RSK and USK children ($P < 0.001$). The OOM children also accumulated more minutes of MVPA per day than RSK or USK groups ($P < 0.001$). **Conclusion:** This research demonstrates that OOM children tend to be leaner, stronger and more active than urban and rural dwelling children living a contemporary Canadian lifestyle despite having no physical education, no institutionalized sport, and low socioeconomic status. These findings support the notion that that contemporary living may facilitate a decline in fitness and physical activity among some Canadian children. **Key Words:** FITNESS, ACCELEROMETRY, CHILDREN, ADOLESCENTS, OLD ORDER MENNONITE, PHYSICAL ACTIVITY

The World Health Organization (WHO) International Obesity Task Force estimated that 30–45 million children worldwide are obese and approximately 155 million are overweight (18). These alarming figures illustrate the public health consequence of the rapid westernization, urbanization, and mechanization of modern society. Potential strategies to achieve population caloric balance must target caloric intake (diet) and/or energy expenditure (physical activity). In a growing child, restricting food intake is generally discouraged because of the need for essential nutrients for normal growth and development, and because of the risk of prompting eating disorders. On a population basis, modifications to physical activity behavior are generally considered to be the best alternative because they can facilitate energy balance, avoid risks associated with nutritional imbalances, and provide multiple health benefits above and beyond achieving an energy balance or deficit (19,37).

For perhaps the first time in our evolution, an entire generation of children has the opportunity, or perhaps the misfortune, of living a completely sedentary lifestyle. Multimedia-based, inactive behaviors appear to progressively displace the potentially active leisure time of our children. Most daily chores are completed by automated technology, and automobiles have replaced active modes of transportation. The minimal movement required for contemporary living may be insufficient to provide the health protection that was inherent in the lifestyle of previous generations. This pattern of hypokinetic behavior may accelerate the development of chronic diseases including cardiovascular disease, metabolic disease, osteoporosis, and some cancers (37). Despite comprehensive efforts by various groups around the world (24,27,36), we do not know how much physical activity children require for the promotion of health and fitness. In a comprehensive review, Twisk (36) concluded that there is a paucity of evidence supporting any particular threshold value for physical activity.

One way to begin to determine appropriate physical activity guidelines would be to quantify activity behaviors

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TABLE 1. Comparison of lifestyle characteristics between Old Order Mennonites (OOM) and mainstream Canadian children (MCC) in the early 1900s and today.

Variable	MCC (Early 1900s)	OOM (Today)	MCC (Today)
Education	School frequently left early for work	Grades 1–8 followed by 2 yr of apprenticing	Grades 1–12+ among the majority
Housing	No electricity or piped water in rural areas	Electricity and piped water among the majority	Electricity and piped water among the majority
Recreation	Cycling, horseback riding, swimming, and walking	Auctions, barn raisings, family games, singing, and swimming	Cycling, jogging, swimming, television viewing, and video games
Technology	No computers or televisions	No computers or televisions	Computers and televisions among the majority
Transportation	Bicycles and horse-drawn vehicles	Bicycles and horse-drawn vehicles	Bicycles and motorized vehicles

from previous generations before the manifestation of the current "obesity epidemic." Unfortunately, these "historical" data are not available or are based on incomplete subjective information (10). Ideally, if we could compare the typical activity pattern of today's children to that of children from previous generations with much different lifestyles, we would have some empirical evidence upon which we could assess changes over time and base physical activity recommendations.

The Old Order Mennonites in southwestern Ontario, Canada, are a religious group who originated from the Anabaptist movement of 16th century Europe and relocated to Canada between 1800 and 1830 (20). The distinguishing feature of Mennonite culture is their steady resistance to social and technological changes (25), resulting in the preservation of daily behaviors representative of a traditional agrarian lifestyle, one somewhat representative of life in Canada three to four generations ago (1,8,9,15,28) (Table 1).

Examining the fitness and daily activity patterns of the Old Order Mennonites, where the lifestyle of previous generations has been somewhat preserved, provides us with a glimpse of the past. The purpose of this study was to compare the health-related physical fitness and physical activity behaviors of Old Order Mennonite children to both rural and urban-dwelling children living a contemporary Canadian lifestyle. It was hypothesized that Old Order Mennonite children would be more fit and more active.

METHODS

Subjects

A cross-sectional study design was used to compare the physical fitness and physical activity characteristics of three groups of children ($N = 399$) between the ages of 8 and 13 yr. A target sample size of 150 (75 males and females) per group was set to accommodate 80% power to detect a 15% difference in means at an alpha level of 0.05, while allowing for as much as 20% attrition. A final sample of 124 Old Order Mennonite (OOM) children from southwestern Ontario, Canada was obtained and compared to contemporary living children from urban (USK, $N = 110$) and rural (RSK, $N = 165$) Saskatchewan, Canada. Data from the 2001 Canadian Community Health Survey (3) indicated no significant difference in physical activity behavior between these areas of Canada (30) suggesting these were comparable regions of Canada for the purposes of this study.

A directory of all Old Order Mennonite families in southwestern Ontario was used to generate a list of families with 9- to 12-yr-old children. Using a random number generator, 150 children were selected from this list and invited by mail to participate in this research. An additional 150 children were randomly selected as data collection proceeded. The final response rate was calculated to be 41%. The OOM children were tested in their home. The sample of mainstream contemporary children was obtained through the school system, and testing was completed in the school. Schools were selected based on their location and approval from the District School Board, and all schools within a selected District were invited to participate in the study. Three rural schools (community population < 5000) and one urban school (community population $> 200{,}000$) volunteered. All students in grades 4–7 at these schools were invited to participate in the testing, and the final response rate was calculated to be 59% for the RSK sample and 62% for the USK sample.

Details of the study procedures were explained to all children and their parents and also to the teachers and principals of the RSK and USK samples. Each child completed a Physical Activity Readiness Questionnaire (31) and gave written assent. Parental consent was also obtained. All procedures were approved by the Institutional Research Ethics Board. All data collection for this study took place September to December 2002.

Measurement of health-related physical fitness.

Fitness was assessed on each participant individually using measures of height, weight, triceps skinfold, grip strength, push-ups, partial curl-ups, and aerobic fitness (progressive step test to 85% of age-predicted maximum heart rate) according to the procedures of the Canadian Physical Activity, Fitness and Lifestyle Appraisal (CPAFLA) (5). CPAFLA measures of waist circumference, trunk skinfolds, and sit-and-reach flexibility were unobtainable or determined to be invalid due to the restrictive traditional clothing of the Mennonite children and were excluded from subsequent analysis. Measures of resting blood pressure and heart rate were used for screening purposes according to the CPAFLA (5). Maturational age was calculated from estimated peak height velocity based on methods by Mirwald et al. (22). The maturational age calculation includes measures of chronological age, body mass, standing height, sitting height, and leg length. All measurements were performed by university trained Professional Fitness and Lifestyle Consultants certified as advanced fitness appraisers by the Canadian Society for Exercise Physiology. Testing was done

individually in the home (for the OOM) or in a vacant room at school (for RSK and USK).

Measurement of physical activity.

Physical activity levels were directly measured for seven consecutive days using a MTI Actigraph accelerometer model 7164 (MTI) (Manufacturing Technologies Inc., Fort Walton Beach, FL). The MTI is a uniaxial accelerometer that detects vertical acceleration in the magnitude of 0.05–2.00 *g* with a frequency response of 0.25–2.50 Hz (35). All accelerometers were calibrated on a hydraulic shaker plate at varying accelerations and frequencies before use in the study. Only accelerometers with intra- and inter-accelerometer reliability coefficients greater than 0.8 were used. Participants wore the MTI over the right hip using a waist mounted nylon belt. The participants were asked to record the times the monitor was attached and removed each day for the purpose of distinguishing between activity time and sleeping time. Upon completion of the data collection, the data were electronically downloaded into a file, which contained minute-by-minute movement counts for each child. After data were scanned for spurious measures, sleep time was determined from the log sheets and activity counts were added to the data file for unworn daytime periods for which the activity was included on the log sheet (using MET-count conversion values published by Trost et al. (34)). Subsequently, the average daily activity counts and number of minutes of light (<3 METs), moderate (3–5.99 METs), vigorous (6–8.99 METs), and very vigorous (9+ METs) activity was determined from the activity counts (34) for the week and each day individually. It should be noted that despite their ability to provide temporal assessments of physical activity intensity, there are inherent limitations when using accelerometers to assess free-living physical activity (39). When each participant returned the accelerometer, the Physical Activity Questionnaire for Older Children (PAQ-C) was completed (16). A composite score (range 1–5) was calculated as the mean score of the first nine items on the questionnaire.

Data analyses.

The normality of the data was assessed by calculating skewness and kurtosis statistics. The data were considered within the limits of a normal distribution if the dividend of the skewness and kurtosis statistics and their respective standard errors did not exceed ± 2.0. If the data for a given variable were not normally distributed, one of two steps was taken: either a log transformation (base 10) was performed or the outliers were identified (± 3 standard deviations from the mean) and removed. Log transformations were performed for push-ups and minutes of vigorous physical activity per day. Outliers were removed from the data for the following variables: sitting height, body mass index (BMI), handgrip strength, and activity counts per minute.

To determine whether physical fitness was different between groups an ANCOVA was performed with group and gender as the main effects and maturational age as the covariate. A multivariate ANCOVA was used to detect group differences in physical activity variables. Tukey *post hoc* testing was performed when necessary to determine where significant differences occurred. Statistical significance was set at $P < 0.05$, and all analyses were performed using SPSS v. 11.0 software (SPSS Inc., Chicago, IL).

RESULTS

Subjects.

Using unadjusted data the OOM children were chronologically and maturationally older than the other groups ($P < 0.01$). Although 9- to 12-yr-old children were targeted in this study, the use of entire classrooms in the RSK and USK groups resulted in the inclusion of some 8- and 13-yr-olds such that the average age of these groups was less than that of the OOM group. Accordingly, maturational age was included as a covariate in all analyses. When analyses were performed using maturational age as a covariate, most group differences disappear (Table 2) although the USK children were taller than the RSK ($P < 0.05$) and OOM ($P < 0.01$) children. As might be expected, after adjusting for maturational age, boys are taller and heavier than girls. (Note: Although not reported here, analyses were replicated using chronological age as the covariate instead of maturational age, with very similar group results for fitness and physical activity. When chronological age was used as a covariate, many significant gender effects emerge as would be expected given the significant difference in maturational age between boys and girls (Table 2)). There were no significant differences in BMI between groups.

Health-related physical fitness.

The assessment of health-related physical fitness revealed several noteworthy differences between OOM and mainstream contemporary children. The mean triceps skinfold values are shown in Figure 1. There was a significant main effect for group with OOM children having a smaller skinfold than USK children ($P < 0.01$) and a trend for a smaller skinfold than the RSK children ($P = 0.07$). There was no significant gender effect but there was a significant group × gender interaction ($P < 0.05$), indicating a significantly greater within-group gender effect in the RSK group compared to the other groups.

As shown in Figure 2, both OOM and USK children had a significantly greater aerobic fitness score than the RSK children ($P < 0.05$), and there was also a gender effect with boys scoring better than girls ($P < 0.001$). Handgrip strength, shown in Figure 3, was greater in the OOM children than either RSK ($P < 0.001$) or USK ($P < 0.001$). There was a gender difference for handgrip strength (boys stronger than girls; $P < 0.001$) and a significant group × gender interaction ($P < 0.01$). The interaction effect is caused by the different gender effect in the RSK group (no gender difference) compared with the other groups. The OOM group performed fewer push-ups (9.6 ± 8.1 repetitions) than the RSK (11.9 ± 9.8) and USK (12.9 ± 9.1)

TABLE 2. Characteristics of study participants; mean (SD) and range.

Variable	OOM Boys		OOM Girls		USK Boys		USK Girls		RSK Boys		RSK Girls	
N	67		57		52		58		75		90	
Chronological age (yr)	11.5 (1.25)	9.1 to 13.8	11.7 (1.27)	9.3 to 13.7	11.2 (1.20)	8.8 to 13.2	11.0 (1.06)	8.9 to 12.9	10.8 (1.22)	8.8 to 12.9	11.1 (1.17)	9.0 to 13.2
Maturational age (yr from PHV)	−1.9 (1.0)	−3.8 to 0.5	−0.19 (1.1)	−2.7 to 1.6	−2.4 (1.0)	−6.6 to −0.4	−0.83 (1.0)	−2.8 to 1.5	−2.4 (0.94)	−4.5 to −0.7	−0.64 (1.1)	−3.0 to 1.5
Standing height (cm)#	148.5 (9.4)	124.5 to 174.5	149.7 (9.2)	129.0 to 165.0	146.9 (10.8)*	122.0 to 172.0	146.5 (9.9)*	126.0 to 166.0	145.3 (9.6)	123.5 to 163.5	147.3 (10.3)	125.0 to 169.0
Sitting height (cm)	77.4 (4.3)	65.5 to 86.5	78.0 (5.0)	68.5 to 87.5	74.8 (4.7)	64.5 to 85.5	75.3 (5.0)	65.5 to 87.5	76.7 (4.5)	66.0 to 88.5	79.1 (7.0)	68.5 to 111.5
Weight (kg)#	43.9 (9.0)	23.5 to 66.2	45.0 (11.1)	26.8 to 70.3	42.0 (10.8)	22.0 to 67.8	41.5 (9.6)	26.0 to 67.4	39.5 (9.1)	21.4 to 68.5	43.0 (10.5)	23.0 to 69.5
BMI ($kg·m^{-2}$)	19.8 (2.8)	13.2 to 25.3	19.8 (3.2)	14.1 to 26.7	19.1 (3.0)	14.5 to 26.5	19.1 (2.7)	13.8 to 25.8	18.5 (2.8)	13.5 to 28.1	19.5 (3.1)	11.9 to 28.3

BMI, body mass index; PHV, peak height velocity. * Taller than RSK ($P < 0.05$) and OOM ($P < 0.01$), after adjustment for maturational age; # boys greater than girls ($P < 0.01$), after adjustment for biological age.

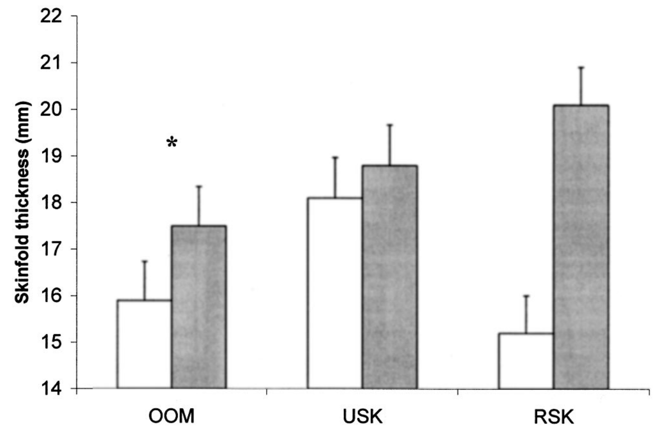

FIGURE 1—Mean triceps skinfold thickness (± standard error) of Old Order Mennonite children (OOM, *N* = 124), urban Saskatchewan children (USK, *N* = 110), and rural Saskatchewan children (RSK, *N* = 164). *White bars* are boys, *shaded bars* are girls. *OOM less than USK (*P* < 0.01) and trend for OOM less than RSK (*P* = 0.07).

groups ($P < 0.05$). There were no group differences for the partial curl-ups (OOM = 15.1 ± 8.8; RSK = 15.7 ± 8.9; USK = 15.2 ± 8.4), but there was a gender effect (boys performed more repetitions than girls; $P < 0.01$).

Physical activity.

There were no significant group differences in self-reported physical activity from the PAQ-C (Table 3). The absence of any correlation between the directly measured indicator of physical activity (counts·min^{-1}) and the physical activity reported on the PAQ-C by the OOM children suggest that the instrument is not culturally sensitive to their lifestyle. However, the direct monitoring of physical activity revealed that the OOM group had greater average accelerometer activity counts per minute than the RSK group ($P < 0.05$) (Table 3). The accelerometer results also revealed a significant gender difference with boys having greater average counts per minute than girls ($P < 0.01$) (Table 3). Figure 4 illustrates that OOM children accumu-

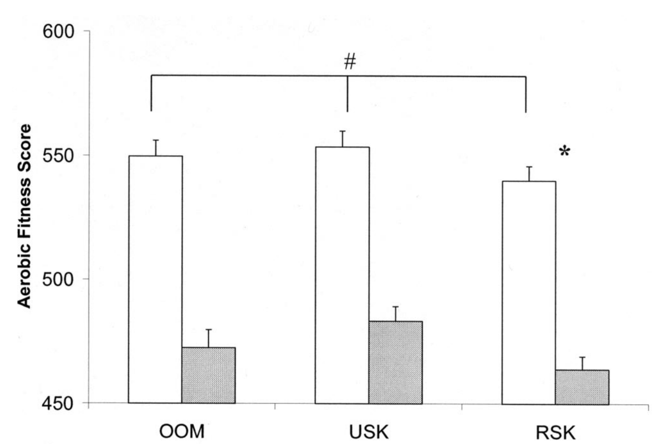

FIGURE 2—Mean aerobic fitness score (± standard error) of Old Order Mennonite children (OOM, *N* = 124), urban Saskatchewan children (USK, *N* = 108), and rural Saskatchewan children (RSK, *N* = 162). *White bars* are boys, *shaded bars* are girls. * RSK lower than OOM and USK (*P*< 0.05); # boys greater than girls (*P*< 0.001).

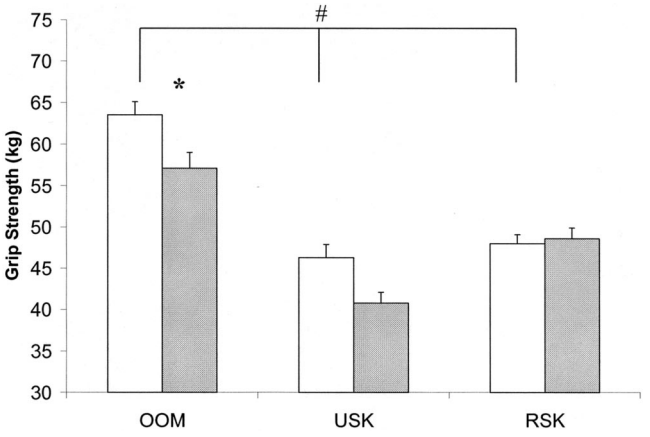

FIGURE 3—Mean grip strength (± standard error) of Old Order Mennonite children (OOM, $N = 124$), urban Saskatchewan children (USK, $N = 110$), and rural Saskatchewan children (RSK, $N = 164$). *White bars* are boys, *shaded bars* are girls. * OOM greater than USK and RSK ($P < 0.001$); # boys greater than girls ($P < 0.001$).

lated more minutes of moderate and vigorous activity per day (MVPA) than either the RSK ($P < 0.001$) or USK ($P < 0.001$) groups. There were no significant gender differences for minutes of moderate and vigorous activity per day after adjusting for differences in maturational age. Figure 5 illustrates that nearly all children in this study met or exceeded the physical activity guidelines set by different groups (6,13,14,24,27) and summarized in Table 4.

DISCUSSION

This study was designed to assess how social change (progressive impact of labor saving technology and sedentary multimedia recreational opportunities) has influenced physical activity behavior and fitness in children. The experimental model employed in this study allowed us a glimpse of the past, perhaps comparable to life three to four generations ago. Though the Old Order Mennonites differ from other Canadians who live a more contemporary lifestyle in many ways, perhaps the most striking is their daily behavior in the absence of most modern conveniences. With a cross-sectional comparison, we have demonstrated that a traditional way of life may reduce chronic disease risk factors (obesity, low fitness, physical inactivity). This information can assist in determining key strategies to address the determinants of the top preventable diseases affecting the health of Canadians.

Approximately 30% of the participants in this sample were overweight using the international sex-specific cut-points established by Cole et al. (7). This prevalence is similar to that reported by Tremblay et al. (32) on a nationally representative sample of 7- to 13-yr-old Canadian children, suggesting that this sample was not morphologically different than other Canadian children. Although there were no significant differences in BMI between groups, the OOM children did have a smaller triceps skinfold, which suggests the OOM children were slightly leaner after adjusting for maturational age differences. The triceps skinfold results in girls suggest a gradient with OOM < USK < RSK. This gradient is consistent with our hypothesis that OOM children are more habitually active than children living a contemporary lifestyle and recent evidence demonstrating that rural dwelling female high school students have higher prevalences of obesity than urban dwelling peers (26). The OOM children had greater grip strength than both the RSK and USK groups; however, they performed fewer push-ups. The OOM children were completely unfamiliar with the push-up test, likely due to the lack of institutionalized physical education in the Mennonite school system. Therefore, the apparent contradiction between grip strength results and push-up results may be attributed to a learning effect. In other words, contemporary Canadian children may be more "practiced" in performing push-ups, than OOM children, for whom this was a very foreign movement. The aerobic fitness score was higher in OOM children than RSK children but there was no difference between OOM and USK.

Collectively, these results suggest that children who live a lifestyle somewhat representative of previous generations (OOM) are leaner and stronger than children living a contemporary Canadian lifestyle. Furthermore, OOM and USK children are more and more aerobically fit than RSK children. The apparent fitness advantage of the OOM children may be caused by their lifestyle-related physical activity (e.g., farm chores, active commuting). We found that OOM girls and boys attained over 2.0 and nearly 3.0 h of MVPA per day, respectively. Using the same accelerometer and cut-points, Campagna et al. (4) assessed several hundred children from Nova Scotia, Canada and reported 183 and 166 min of MVPA for boys and girls from grade 3, and 79 and 63 min of MVPA for boys and girls from grade 7, respectively. Though not perfectly comparable because of age differences, the results of Campagna et al. compare favorably to those reported in this study. In contrast, Santos et al. (29) and Mota et al. (23) reported 1.0 and 1.5 h of MVPA per day in Portuguese girls and boys of similar age to the present study. This substantial difference may be the result of cultural differences or underlying sampling differences. Alternatively, these differences may provide support for our belief that our sample of contemporary children was biased towards more active children. The recommendations

TABLE 3. Physical activity characteristics; mean (SD)

Variable	OOM		USK		RSK	
	Boys	Girls	Boys	Girls	Boys	Girls
Average activity (counts·min^{-1})	647 (124)*#	534 (97)	646 (179)#	523 (114)	594 (158)#	513 (136)
PAQ-C score	3.0 (0.6)	3.1 (0.6)	3.1 (0.6)	2.9 (0.7)	3.1 (0.7)	2.9 (0.7)
Correlation	$r = 0.02$, $P = 0.80$		$r = 0.23$, $P < 0.05$		$r = 0.39$, $P < 0.001$	

* Greater than RSK, $P < 0.05$; # greater than girls, $P < 0.01$. PAQ-C, Physical Activity Questionnaire for Older Children.

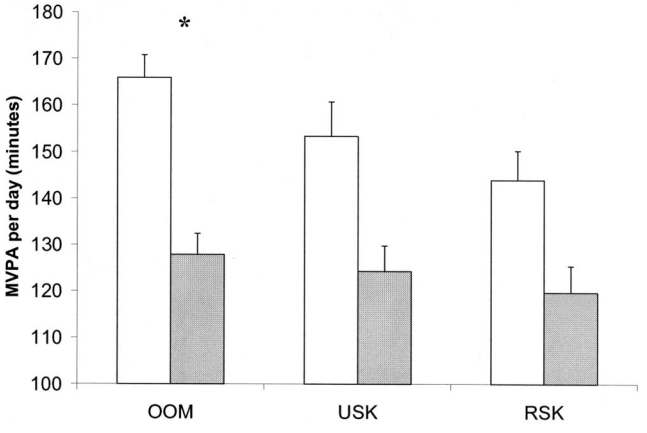

FIGURE 4— Mean minutes per day of moderate and vigorous physical activity (MVPA) (± standard error) of Old Order Mennonite children (OOM, $N = 120$), urban Saskatchewan children (USK, $N = 94$), and rural Saskatchewan children (RSK, $N = 137$). *White bars* are boys, *shaded bars* are girls; * OOM greater than USK and RSK ($P < 0.001$).

of various international guidelines for physical activity range from 20 to 90 min of accumulated physical activity every day (6,13,14,24,27). As shown in Figure 5 nearly all children in this study, from all groups, met these guidelines and most exceeded them. This is consistent with the findings of Epstein et al. (11), whose meta-analysis on directly measured physical activity based on heart rate data showed that across many studies virtually all children met the physical activity guidelines. Because temporal trend information continues to demonstrate an increase in childhood obesity (32,40), it is clear that the guidelines are insufficient for the current energy intake of Canadian children.

There were expected gender differences in physical fitness and activity. Boys had greater grip strength, better aerobic fitness, and did more partial curl-ups than girls. Although boys had greater average activity counts per minute than girls, there was no significant gender effect for minutes of moderate and vigorous activity per day after adjusting for differences in maturational age. It is interesting to note that the group difference in physical activity is much more dramatic in the boys (see Fig. 4). This may be explained by gender-specific chores performed by the Mennonites; boys tend to work at farming-related tasks whereas girls tend to do more sedentary activities such as sewing and

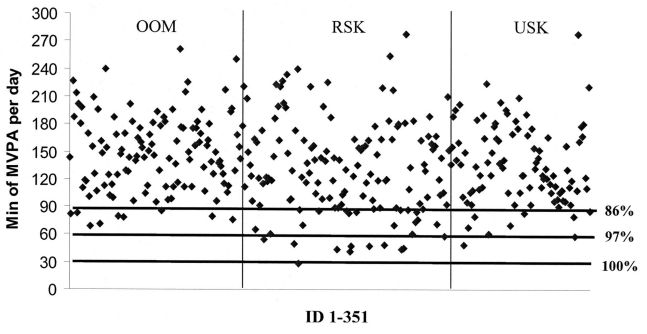

FIGURE 5—Proportion of children meeting common international physical activity guidelines for accumulated daily physical activity. MVPA, moderate and vigorous physical activity.

TABLE 4. Physical activity guidelines for children and youth.

Organization and Reference	Guideline
Consensus Meeting (27)	Active daily + 3 × 20 min of MVPA·wk^{-1}
Health Canada (13,14)	Increase activity by 30–90 min·wk^{-1}decrease inactivity by 30–90 min·wk^{-1}
Health Education Authority (24)	60 min MPA·d^{-1}, 30 min MPA·d^{-1} if inactive, strength and flexibility activities 2× wk^{-1}
National Association for Sport and Physical Education (6)	60 min·d^{-1} from three or more bouts of activity

MVPA, moderate and vigorous physical activity; MPA, moderate physical activity.

cooking. However, even when girls were analyzed separately, OOM girls still had significantly greater MVPA than USK or RSK girls.

On average, the OOM children accumulated 12 and 18 more minutes MVPA (3+ METs) per day, respectively, compared with the urban and rural contemporary children. To put this in perspective, at this rate the OOM children would accumulate 5475 additional minutes of MVPA per year, which, if all else were equal, would translate into a caloric difference of approximately 15,000 kcal per year, or over 40 pounds of fat per person per decade! These results provide evidence to support the speculation that the health-related physical fitness and habitual physical activity of contemporary Canadian children has declined over the last few generations and may offer insight to the rising obesity epidemic.

To our knowledge, this is the first study to compare the physical activity and fitness of a sample of children from an Old Order Mennonite community to children living a contemporary Western lifestyle. Previous studies have examined the diet, health-related physical fitness, activity, and mortality among adults in Old Order Mennonite communities and similar Old Order Amish communities (12,17,21). Glick et al. (12) examined men and women from an Old Order Mennonite community in Yates County, NY. They demonstrated that despite a similar diet to that of the overall U.S. population, Old Order Mennonite men were leaner (based on BMI) and exhibited lower serum cholesterol and blood pressure levels compared with men from the overall U.S. population. The authors suggested that higher levels of physical activity in the Old Order Mennonite population explained the observed differences in coronary heart disease risk factors among Old Order Mennonite men. In support of this theory, Bassett et al. (2) reported that Amish adults living a traditional agrarian lifestyle had extremely high levels of physical activity (as measured by pedometers) and a low prevalence of obesity.

One limitation to this study was the poor response rate of the Mennonite children and the inability to randomly select children from the rural and urban schools. The Old Order Mennonite population is a very homogeneous religiocultural group with little exposure to contemporary societal ideals of fitness and body image; therefore, we believe there was a minimal risk of selection bias in that group of children. Indeed, we were advised by community leaders that the families most resistant to technological or societal change were the most likely to disregard requests for involvement.

In contrast, the self-identifying process required to select participating schools from contemporary society almost surely resulted in schools participating that were very supportive of physical activity. The schools involved had won awards for physical education programs and inter-school sports programs. We believe it is possible that the volunteer participants from the urban and rural contemporary schools were more fit and active than the general population. We are confident that, if anything, these ″limitations″ work to disprove our hypothesis and therefore strengthen our findings.

It has been shown that socioeconomic status is inversely related to risk of overweight (40) and physical inactivity (33). However, the present results demonstrate that Old Order Mennonite children tend to be more active and more physically fit than children living a contemporary lifestyle despite having very low socio-economic status and no physical education or institutionalized sport. Conventional intervention strategies forwarded to combat the childhood obesity epidemic tend to focus on purposeful activity approaches (increased physical education, increased green space, increased sport opportunities) (38). This study demonstrates that lifestyle-embedded physical activity also has potential to assist in getting children more active.

Implications for the future.

Efforts to establish physical activity guidelines for children and youth have been hindered by a relative absence of empirical evidence upon which to base any guidelines. Although cause and effect relationships cannot be determined from this study, these findings suggest that contemporary living has resulted in a decline in fitness and physical activity among Canadian children, that traditional behavior patterns that include substantial lifestyle-embedded physical activity provide nonsport, nonphysical education opportunities for physical activity interventions to alleviate the childhood obesity epidemic, and that most physical activity guidelines for children and youth appear insufficient to achieve important health and fitness outcomes. The approach taken in Canada's Physical Activity Guide for Children and Youth (13,14) may be closer to what is required (90-min increase in physical activity *and* a 90-min decrease in sedentary behavior).

Future research is needed to understand how children accumulate physical activity, how children should accumulate physical activity, and what the relationships are among different physical activity patterns and health outcomes. Prospective longitudinal research is required to investigate the dose–response relationship between physical activity level during childhood and long-term health outcomes and how *changes* in physical activity level during childhood affect short- and long-term health outcomes and quality of life. Further exploration is required to understand these relationships if changes in physical activity levels occur at different ages, among different ethnic and cultural groups, and between sexes. This information is required to produce evidence-based, health-related physical activity guidelines for children and youth.

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