COMPARING HEALTH-RELATED PHYSICAL FITNESS AND ACTIVTY BETWEEN OLD ORDER MENNONITE CHILDREN IN ONTARIO AND RURAL CHILDREN IN SASKATCHEWAN

A Thesis Submitted to the College of Graduate Studies and Research
In Partial Fulfillment of the Requirements for the Degree of Master of Science
In the College of Kinesiology
University of Saskatchewan
Saskatoon

Joel David Barnes

PERMISSION TO USE

By presenting this thesis in partial fulfillment of the requirements for the Degree of Master of Science in the College of Kinesiology at the University of Saskatchewan, I grant the Libraries of this University permission to make the thesis freely available for inspection. In addition, permission to copy this thesis for scholarly purposes—in whole or in part—may be granted by the professors who supervised my thesis work or, in their absence, by the Dean of the College of Kinesiology where my thesis work was undertaken.

Any copying, publishing, or use of this thesis for financial gain without my prior written consent is forbidden. It is also understood that due recognition will be given to me, Joel David Barnes, and to the University of Saskatchewan for any scholarly use made of this thesis.

Requests for permission to copy or make other uses of this thesis should be addressed to:

Dean of the College of Kinesiology
University of Saskatchewan
87 Campus Drive
Saskatoon, Saskatchewan
Canada
S7N 5B2

ABSTRACT

Temporal trend research in some components of health-related physical fitness and activity among young people is lacking. However, the increasing prevalence of overweight and obesity in young people over the last couple decades has created speculation of secular deterioration in health-related physical fitness and activity. In an effort to address the speculation, this research project compared health-related physical fitness and activity between two groups of children: Old Order Mennonite children in southwestern Ontario (n = 124; aged 9.1 to 13.8 years), who live an agrarian lifestyle which does not include motorized transportation, computer use, or television viewing and rural children in central Saskatchewan (n = 165; aged 8.8 to 13.2 years), who live a contemporary Canadian lifestyle. The Canadian Physical Activity, Fitness, and Lifestyle Appraisal (CPAFLA) was used to measure health-related physical fitness. The CPAFLA is a battery of tests measuring anthropometry (standing height, body mass, skinfolds, and waist girth), cardiorespiratory endurance (step test), and musculoskeletal fitness (handgrip strength, push-ups, partial curl-ups, and trunk forward flexion). Physical activity was measured on seven consecutive days using the Model AM7164 activity monitor. The Physical Activity Questionnaire for Older Children (PAQ-C) was also employed. The PAQ-C is a guided, self-administered seven-day recall questionnaire, which assesses general levels of physical activity in schoolchildren of grades four to eight during the school year. With biological age as a covariate, univariate and multivariate analyses of covariance were used to compare health-related physical fitness and activity between groups respectively. Old Order Mennonite children evinced greater mean handgrip strength ($p < 0.0001$) and rural Saskatchewan children demonstrated greater mean trunk forward flexion ($p < 0.001$). However, there were no significant differences between groups in the other health-related physical fitness variables. Old Order Mennonite children had significantly greater mean activity counts·min^{-1} ($p < 0.001$), mean activity counts·day^{-1} ($p < 0.0001$), and mean minutes of moderate physical activity·day^{-1} ($p < 0.0001$). Collectively, these results suggest that Old Order Mennonite children have greater static strength and are more physically active than rural Saskatchewan children. Assuming that Old Order Mennonite children represent Canadian children from previous generations, these results may lend support to secular deterioration in some aspects of health-related physical fitness and activity among Canadian children.

ACKNOWLEDGMENTS

I thank my supervisor, Dr. Mark Tremblay, for his guidance. He encouraged me to problem solve in a creative way, but this independence was not left to its own devices; it was cultivated in the garden of expectation. The fruit of the labor was (dare I say?) an innovative research project, personal growth, and a contribution to the ever-growing body of knowledge in Pediatric Exercise Science. In this way, my experience as a graduate student over the past two years was the best it could have been and I shan't trade it for anything.

To my thesis committee in alphabetical order, Drs. Adam Baxter-Jones, Karen Chad, and Kent Kowalski, I offer my gratitude. Though the meetings were painful betimes, they were a means to an end. Like the ancient proverb says, "As iron sharpens iron, so one man sharpens another." (Proverbs 27.17) I also thank Dr. Bruce Reeder of the Department of Community Health and Epidemiology for agreeing to the role of external examiner at my thesis defense.

Dale Esliger should be awarded a medal of courage for accepting what, at first, seemed to be M:I-3. I think most potential "agents" for this data collection assignment would have promptly declined the invite had they been told the mission would include 12,000 kilometers traveled, 79 Old Order Mennonite farms visited, and 124 CPAFLAs administered—all in the space of six weeks no less! But, then again, there were no other candidates. So perhaps Dale should just be given credit for stoically accepting his own fate. At any rate, he showcased that elusive concept coined as "heart."

Dr. Jennifer Copeland's task was no less arduous having to coordinate physical fitness and activity measurements on 275 children from four different schools in the City of Saskatoon and surrounding area. Thank you!

In a similar vein, I thank Dr. Louise Humbert for establishing contact with the participating schools in this research project. Apart from her expertise, the selection of schoolchildren from urban and rural Saskatchewan would have been far more difficult if not impossible.

The assistance of Victor Wiebe and Sam Steiner was deeply appreciated. With their help, we were able to make initial contact with the Old Order Mennonite communities in southwestern Ontario.

I also mention Levi Frey. Without his mediating role in our behalf, this research project would not have been accepted among the Old Order Mennonites. Gratitude is expressed for his crucial cooperation, not to mention the host of questions that he answered over the telephone and in person, sans (any apparent) resentment. The delightful Sunday afternoon dinner with his family in October 2002 also merits acknowledgment.

Randy Bye's work in scouting out a place for Dale and me to stay while in Mount Forest, Ontario, did not go unnoticed. Thank you!

I also thank Kylie Bilz and Clark Mundt for their help in data collection. Krista Friesen deserves special mention for her perseverance in the reduction of the activity monitor output after data collection was completed.

Lastly, I acknowledge the Canadian Population Health Initiative of the Canadian Institute for Health Information. This research project would never have grown wings and taken flight without their financial support.

Joel Barnes

November 21, 2003

DEDICATION

To Roddie Duguay, my high school math teacher

Whose passion for learning was a communicable disease

And who encouraged me to pursue the University.

Your influence is recognized.

I do not know what I may appear to the world, but to myself
I seem to have been only like a boy playing on the seashore,
And diverting myself in now and then finding a smoother pebble
Or a prettier shell than ordinary, while the great ocean of truth
Lay all undiscovered before me.

Sir Isaac Newton

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BMI	Body mass index
CAC	Canadian children
CI	Confidence interval
CPAFLA	Canadian Physical Activity, Fitness, and Lifestyle Appraisal
G	9.80665 $m \cdot sec^{-2}$; a unit of stress measurement for bodies undergoing acceleration
Hz	Hertz; a unit of measurement that represents the frequency of a periodic phenomenon in one second
IOTF	International Obesity Task Force
kcal	Calories
kJ	Kilojoules
M	Mean
mCAFT	Modified Canadian Aerobic Fitness Test
MET	Metabolic equivalent
$mg \cdot dL^{-1}$	Milligrams per deciliter
mmHg	Millimeters of Mercury
nd	No date of publication given
NCHS	National Center for Health Statistics
NHANES	National Health and Nutrition Examination Survey
NHES	National Health Examination Survey
OB	Obesity
OOM	Old Order Mennonite children
OW	Overweight
PAQ-C	Physical Activity Questionnaire for Older Children
PAR-Q	Physical Activity Readiness Questionnaire

PHV	Peak height velocity
RSK	Rural Saskatchewan children
SE	Standard error
UA	Uniaxial, or single axis, accelerometer

LIST OF APPENDICES

CHAPTER ONE

1.1 INTRODUCTION

The purpose of this research project was to compare health-related physical fitness and activity between Old Order Mennonite children in southwestern Ontario and rural children in central Saskatchewan. Full justification for this research project can be found in Section 1.2. What follows here is a summary of that argumentation.

The Old Order Mennonites in southwestern Ontario are a religious group, who originated from the Anabaptist movement of 16th century Europe (Martin, 2003; Rensberger, 2003). During the 1700s, they immigrated to the United States for relief from religious persecution (Horst, 2000). Due to a lack of available land, some of the agrarian Mennonites eventually relocated to Upper Canada between 1800 and 1830 (Horst, 2000).

In those pioneer days, the Old Order Mennonite mode of living was similar to the lifestyle in mainstream society (Peters, 2003). However, in the late 19th century the Old Order Mennonites in southwestern Ontario began to resist lifestyle-related change facilitated by modern theology and technological innovation, which they viewed as incompatible with the Old Order Mennonite philosophy of life (Peters, 2003).

Contemporary Old Order Mennonites in southwestern Ontario retain the unique mode of living that began to develop more than 100 years ago: They live an agrarian lifestyle which does not include motorized transportation, computer use, or television viewing (Peters, 2003; Horst, 2000). Because the educational, recreational, technological, and locomotive aspects of the contemporary Old Order Mennonite lifestyle bear close resemblance to the traditional, more rural lifestyle seen in Canada 100 years ago (Baldwin and Baldwin, 2000; Craats, 2000; Horst, 2000; Salomons, 2000) and differ markedly from the mode of living in Canadian mainstream society today, it is argued that contemporary Old Order Mennonite children in southwestern Ontario represent Canadian children between 50 and 100 years ago.

There are at least two reasons for comparing health-related physical fitness between Old Order Mennonite children in southwestern Ontario and rural children in central Saskatchewan: First, no study examining health-related physical fitness among Old Order Mennonite populations has ever involved children (Glick et al., 1998; Michel et al., 1993; Fuchs et al., 1990; Levinson et al., 1989; Hamman et al., 1980). Second, assuming that Old Order Mennonite children represent Canadian children between 50 and 100 years ago, a comparison with contemporary children in Canada would provide a much-needed model of temporal trend analysis, that is, an estimation of change in health-related physical fitness over time.

Though temporal trend estimates in body composition among young people suggest deterioration over time as evidenced by the increasing prevalence of overweight and obesity in developed (Kautiainen et al., 2002; Ogden et al., 2002; Tremblay et al., 2002; Berg et al., 2001; Chinn and Rona, 2001; Ogden et al., 1997) and developing countries (Luo and Hu, 2002; Chu, 2001), temporal trends in other components of young people's health-related physical fitness are less certain due to disparate results and/or a paucity of data (Blair, 1992), thus demonstrating the need for a model of temporal trend analysis. For example, findings from studies measuring cardiorespiratory endurance in young people directly (gas analysis) have generally failed to show any temporal trends over the last 60 years (Eisenmann and Malina, 2002). However, field-based studies suggest that young people have experienced deterioration in cardiorespiratory endurance over the last 20 years (Tomkinson et al., 2003; Westerstahl et al., 2003; Dawson et al., 2001; Hamlin et al., 2001; Dollman et al., 1999).

A similar scenario exists with the musculoskeletal fitness component of health-related physical fitness: Disparate results impede any conclusions about temporal trends in young people (Tomkinson et al., 2003; Westerstahl et al., 2003; Hamlin et al., 2001; Dollman et al., 1999; Corbin and Pangrazi, 1992).

The need to study health-related physical fitness in young people and determine temporal trends is further demonstrated by what is currently known about one component of health-related physical fitness: The health consequences of poor body composition. Overweight children are at substantially increased risk of developing chronic diseases and metabolic disorders compared to normal weight children (Freedman et al., 1999). Obese children and adolescents have poor serum lipid levels as well as varying degrees of glucose intolerance, which predispose them to cardiovascular disease in adulthood (Dietz, 1998). Given these ramifications of poor health-related physical fitness in young people, attention should be directed toward understanding its status among young people and in which direction health-related physical fitness is moving over time so as to prioritize the different areas of public health in young people.

Comparing physical activity between Old Order Mennonite children in southwestern Ontario and rural children in central Saskatchewan can be justified on the same ground as health-related physical fitness: Assuming that Old Order Mennonite children represent Canadian children between 50 and 100 years ago, a comparison of this nature would provide a model of temporal trend analysis in physical activity. The need for this analysis is evidenced by the fact that the few studies attempting to estimate temporal trends in physical activity among young people (Eisenmann et al., 2003; Lowry et al., 2001; Tremblay et al., 1996) have been hampered by a paucity of data (Durnin, 1992).

There are at least two applications of temporal trend analysis in physical activity among young people: First, temporal trend estimates may help clarify the role of physical activity in the current obesity epidemic. It is generally agreed that adiposity is fundamentally about positive energy balance (Jebb and Moore, 1999; World Health Organization, 1998). If it could be demonstrated that physical activity in young people has declined commensurate with the secular deterioration in body composition, a strong argument could be formulated for decreased physical activity and increased sedentariness as causal factors in the obesity epidemic. Indeed, a number of acculturation studies provide limited support for this hypothesis (Prista et al., 2003; Rode and Shephard, 1995; 1994a; 1994b; 1993; Shephard and Rode, 1992; Rode and Shephard, 1985; 1984a; 1984b; 1984c; 1973; 1971). Second, an understanding of temporal trends in physical activity among young people may help establish more evidenced-based activity guidelines, which are currently lacking (Haskell, 1996). The fact that the majority of young people are meeting the current recommendations (Epstein et al., 2001) despite deteriorating body composition in the population at large would seem to confirm that physical activity guidelines are not sufficiently supported by the literature. Ideally, physical activity guidelines would be based on doses of activity linked to conditions and outcomes associated with health (Caspersen et al., 1998). Though this research project cannot establish such a link, the demonstration of secular deterioration in health-related physical fitness and activity among young people over the last 50 to 100 years while controlling for the potential confounders of growth and development may be good reason for recommending the amount of activity received prior to the decline: It is believed that the number of children and adolescents of that era plagued by the ostensible health consequences of hypokinetic-related conditions was much smaller than what it is today.

1.2 REVIEW OF THE LITERATURE

1.2.1 Old Order Mennonites of Southwestern Ontario

The Old Order Mennonites in southwestern Ontario are a religious group, who originated from the Anabaptist movement of 16th century Europe (Martin, 2003; Rensberger, 2003; refer to Figure 1.1). They broke off from their Protestant peers over theological differences, which included their affirmation of believer's baptism, non-resistance, and separation of church and state (Peters, 2003; Rensberger, 2003; Horst, 2000). Consequently, the Old Order Mennonites suffered persecution and fled to southwestern Germany for relief (Horst, 2000). In the 18th century, they immigrated to the United States with the help of a Quaker named William Penn (Horst, 2000). However, the lack of available land for the agrarian Mennonites forced some of them to relocate (Martin, 2003) and, between 1800 and 1830, Old Order Mennonites settled in Upper Canada (Horst, 2000).

In those pioneer days, the Old Order Mennonites lived like their neighbors (Peters, 2003). However, between 1872 and 1913 industrialization and "a more evangelical and individualistic understanding of one's relationship with God" (Peters, 2003) led to the development of a mode of living among the Old Order Mennonites, which deviated from mainstream society (Peters, 2003). The Old Order Mennonites began to resist lifestyle-related change facilitated by modern theology and technological innovation, which they viewed as incompatible with humility, separation from the world, and a proper simplicity of life (Horst, 2000).

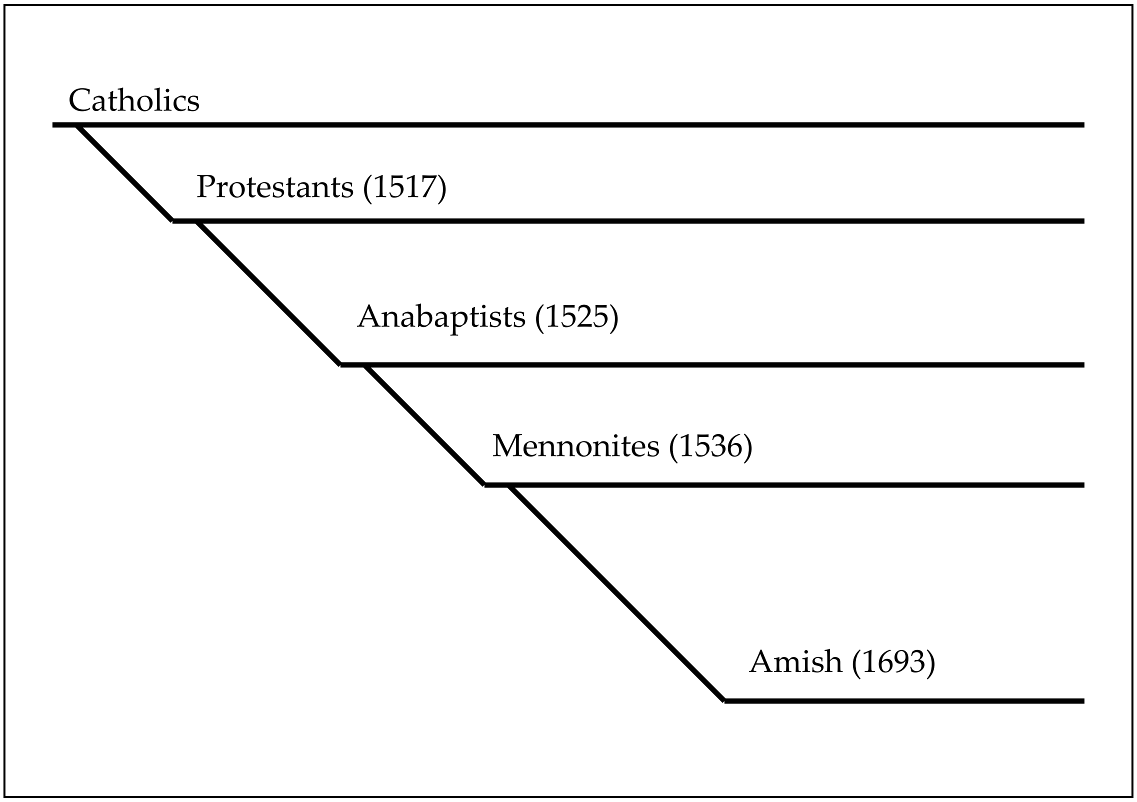

Figure 1.1 Origin of the Old Order Mennonites in southwestern Ontario (modified from Rensberger, 2003, by permission of Alpha Books: 375 Hudson Street, New York, New York, United States).

Contemporary Old Order Mennonites in southwestern Ontario retain the unique mode of living that began to develop among their group in the late 19th century: They live an agrarian lifestyle which does not include motorized transportation, computer use, or television viewing (Peters, 2003; Horst, 2000). Put simply, the Old Order Mennonites in southwestern Ontario experience change facilitated by technological innovation at a rate slower than what is seen in mainstream society (Peters, 2003). This is coherent with one of their life philosophies: "New, bigger, and faster are not necessarily better." (Peters, 2003; also Horst, 2000; refer to Appendix A for a summary of the Old Order Mennonite life philosophy) Indeed, the largest split among the Old Order

Mennonites in southwestern Ontario occurred in 1939 because of a "step into modernity" (Peters, 2003). Some did not think the adoption of the automobile and telephone would be detrimental to their religious and community life; others strongly disagreed (Peters, 2003).

Based on their unique lifestyle, it is hereafter argued that Old Order Mennonite children in southwestern Ontario represent the traditional, more rural way of life seen in Canada between 50 and 100 years ago when many modern technological innovations were not available. Table 1.1 provides support for this proposition. From the table, it is clear that the educational, recreational, technological, and locomotive aspects of the Old Order Mennonite lifestyle bear closer resemblance to the lifestyle seen in Canada 100 years ago and differ markedly from the current mode of living in Canadian mainstream society (Baldwin and Baldwin, 2000; Craats, 2000; Horst, 2000; Salomons, 2000; Cragg et al., 1999; Fretz, 1978).

Table 1.1 Comparison of lifestyles between Canadian children in the early 1900s and contemporary Old Order Mennonite and Canadian children.

Variable	CAC (early 1900s)	OOM (today)	CAC (today)
Diet	Sweets and unprocessed foods	Sweets and unprocessed foods	Many not meeting Canada's Food Guide to Healthy Eating
Education	School frequently left early for work	Grades 1-8 followed by 2 years 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

(CAC: Canadian children; OOM: Old Order Mennonite children; sources for this table include Baldwin and Baldwin, 2000; Craats, 2000; Horst, 2000; Salomons, 2000; Cragg et al., 1999; Fretz, 1978)

There are at least two reasons for comparing health-related physical fitness between Old Order Mennonite children in southwestern Ontario and rural children in central Saskatchewan: First, because no study examining health-related physical fitness in Old Order Mennonite populations has ever involved children. Second, assuming that Old Order Mennonite children represent Canadian children between 50 and 100 years ago, a comparison with contemporary children in Canada would provide a much-needed model of temporal trend analysis, that is, an estimation of change in health-related physical fitness over time. These rationales are developed further in the next section.

1.2.2 Old Order Mennonite Studies

Diet, health-related physical fitness, activity, and mortality among Old Order Mennonite communities (and similar Old Order Amish communities) in the United States have been observed and, in some cases, compared to the general population over the past several years (Glick et al., 1998; Michel et al., 1993; Fuchs et al., 1990; Levinson et al., 1989; Hamman et al., 1980). From these studies, researchers have found favorable health profiles and mortality rates in Old Order Mennonite adults (and similar Old Order Amish populations). They attribute this, in part, to cultural practices among Old Order Mennonites, which likely include high levels of physical activity due to a restriction on technological innovation that competes with opportunities for physical activity (Glick et al., 1998; Levinson et al., 1989).

To my knowledge, no study like the ones described above has used a sample of Old Order Mennonite children. Yet comparing health-related physical fitness between Old Order Mennonite children and their rural counterparts from mainstream society in Canada may provide a model of temporal trend analysis spanning the last 50 to 100 years. A research project of this nature may help in estimating change in health-related physical fitness over time. The following review of the literature, which has attempted to estimate change in health-related physical fitness among young people over time, will demonstrate the need for a model of temporal trend analysis in selected components of young people's health-related physical fitness.

1.2.3 Health-Related Physical Fitness of Young People

Physical fitness has been variously described (Bar-Or and Malina, 1995; Gutin et al., 1992). The current consensus of scholarly opinion defines physical fitness as "a set of attributes that people have or achieve that relates to the ability to perform physical activity." (U.S. Department of Health and Human Services, 1996) Physical fitness subsists in skill- and health-related dimensions. Bouchard et al. (1997) define the latter as "those components of fitness that relate to the health status of the individual and that may be influenced by regular physical activity." The components of health-related physical fitness include body composition, cardiorespiratory endurance or aerobic fitness, and musculoskeletal fitness (Nieman, 1998; Malina and Bouchard, 1995; Corbin and Pangrazi, 1992).

In the last 25 to 30 years, scientists have shifted their attention from skill- to health-related dimensions of young people's physical fitness (Gledhill, 2001; Pate et al., 1998; U.S. Department of Health and Human Services, 1996; Bar-Or and Malina, 1995). With this increased emphasis on health-related physical fitness has come the criticism from the lay media and some health scientists that "children are less fit now than they were a generation or two ago." (Quoted in Bar-Or and Malina, 1995; refer also to Aaron and Laporte, 1997) A considerable amount of temporal trend research in some components of health-related physical fitness has recently been published to address this speculation.

1.2.3.1 Temporal Trends in Body Composition

Table 1.2 summarizes studies, which have reported the prevalence of overweight and obesity in young people of different nationalities as well as estimated change over time.

Table 1.2 Prevalence and temporal trend estimates of overweight and obesity in young people.

Authors	Sample	Measure	Cutoffs	Results
Kautiainen et al., 2002	n = 64,147 12- to 18-year-old Finnish adolescents	BMI (based on self-report)	International centiles proposed by IOTF	OW: Increased from 7.2-16.7% and 4.0-9.8% in boys and girls respectively across age (1977-99) OB: Increased from 1.1-2.7% and 0.4-1.4% in boys and girls respectively across age (1977-99)
Luo and Hu, 2002	n = 692 2- to 6-year-old Chinese children	BMI (based on direct measures)	International centiles proposed by IOTF	OW: Increased from 14.6-28.6% across age and sex (1989-97) OB: Increased from 1.5-12.6% across age and sex (1989-97)
Ogden et al., 2002	n = 4,722 0- to 19-year-old American infants, children, and adolescents	BMI (based on direct measures)	2000 Centers for Disease Control and Prevention growth charts	OW: Increased from 7.2-10.4%, 11.3-15.3%, and 10.5-15.5% in 2- to 5-, 6- to 11-, and 12- to 19-year-olds respectively across sex and race (1988/94-1999/2000)

(BMI: Body mass index; IOTF: International Obesity Task Force; OW: Overweight; OB: Obesity)

Table 1.2—continued

Authors	Sample	Measure	Cutoffs	Results
Tremblay et al., 2002	n > 9,156 7- to 13-year-old Canadian children and adolescents	BMI (based on direct measures and parental-report)	International centiles proposed by IOTF	OW: Increased from 11-33% and 13-27% in boys and girls respectively across age (1981-96) OB: Increased from 2-10% and 2-9% in boys and girls respectively across age (1981-96)
Berg et al., 2001	n = 12,173 9-, 12-, 15-, and 18-year-old Swedish young people	BMI (based on self-report)	1990 BMI index reference curves for the United Kingdom	OW: 4.8-12.3% across age and sex OB: 3.9-8.9% across age and sex
Bundred et al., 2001	n = 28,768 2- to 4-year-old British children	BMI (based on direct measures)	1990 BMI index reference curves for the United Kingdom	OW: Increased from 14.7-23.6% across age and sex (1989-98) OB: Increased from 5.4-9.2% across age and sex (1989-98)

(BMI: Body mass index; IOTF: International Obesity Task Force; OW: Overweight; OB: Obesity)

Table 1.2—continued

Authors	Sample	Measure	Cutoffs	Results
Chinn and Rona, 2001	n = 30,391 4- to 6-, 7- to 8-, and 9- to 11-year-old English and Scottish children	BMI (based on direct measures)	International centiles developed by IOTF	OW: Increased from 5.9-9.5% and 9.3-13.5% in boys and girls respectively across age (1984-94) OB: 1.9 and 2.9% of boys and girls respectively across age
Chu, 2001	n = 1,366 12- to 15-year-old Taiwanese adolescents	BMI (based on direct measures)	> 120% ideal body mass of unstated reference strata	OB: Increased from 12.4-16.4% and 10.1-11.1% in boys and girls respectively across age (1980-94)
Magarey et al., 2001	n = 11,454 2- to 18-year-old Australian children and adolescents	BMI (based on direct measures)	International centiles developed by IOTF	OW: 15.0 and 15.8% of boys and girls respectively across age OB: 4.5 and 5.3% of boys and girls respectively across age

(BMI: Body mass index; IOTF: International Obesity Task Force; OW: Overweight; OB: Obesity)

Table 1.2—continued

Authors	Sample	Measure	Cutoffs	Results
Strauss and Pollack, 2001	n = 8,270 4- to 12-year-old American children and adolescents	BMI (based on direct measures)	2000 Centers for Disease Control and Prevention growth charts	OW: 21.5, 21.8, and 12.3% of African Americans, Hispanics, and Whites respectively across age and sex
Eisenmann et al., 2000	n = 526 6- to 12-year-old Navajo children and adolescents (Arizona, United States)	BMI (based on direct measures)	NHANES 1 dataset-referenced centiles	OW: 15 and 21% of boys and girls respectively across age *Body mass increased from 1.5-3.0 kg·decade^{-1} across age and sex (1955-97)
Hanley et al., 2000	n = 445 2- to 19-year-old Canadian, Aboriginal youth	BMI (based on direct measures)	NHANES 3 dataset-referenced centiles	OW: 27.7 and 33.7% of boys and girls respectively across age

(BMI: Body mass index; OW: Overweight; NHANES: National Health and Nutrition Examination Survey)

Table 1.2—continued

Authors	Sample	Measure	Cutoffs	Results
Tremblay and Willms, 2000	n > 12,504 7- to 19-year-old Canadian children and adolescents	BMI (based on direct measures and parental-report)	1981 Canada Fitness Survey dataset-referenced centiles	OW: Increased from 15.0-35.4% and 15.0-29.2% in boys and girls respectively across age (1981-96) OB: Increased from 5.0-16.6% and 5.0-14.6% in boys and girls respectively across age (1981-96)
Troiano and Flegal, 1998	n = 5,707 6- to 17-year-old American children and adolescents	BMI (based on direct measures)	NHES 1 and 3 dataset-referenced centiles	OW: 11.0% across age, sex, and race
Ogden et al., 1997	n = 7,784 0- to 6-year-old American infants and children	BMI (based on direct measures)	1979 NCHS growth charts for the United States	OW: Increased from 5.8-10.0+% in 4- to 5-year-olds across sex and race (1971/74-1988/94)

(BMI: Body mass index; OW: Overweight; OB: Obesity; NHES: National Health Examination Survey; NCHS: National Center for Health Statistics)

A few observations can be made from Table 1.2: First, the prevalence and temporal trend estimates of overweight and obesity vary by age, sex, and race (e.g. Strauss and Pollack, 2001). Further differences may reflect variation in sampling techniques, reference datasets, anthropometric measures (e.g. directly measured vs. parental-reported height and body mass), and definitions of overweight and obesity (Ball and McCargar, 2003). To eliminate some of this ambiguity and to enhance inter-study comparisons, the International Obesity Task Force of the World Health Organization proposed age- and sex-specific cutoffs for overweight and obesity in young people (Cole et al., 2000). These body mass index centiles were developed from six national datasets and pass through health-related cutoffs in adulthood (25 and 30 $kg \cdot m^{-2}$). Five of the 15 studies in Table 1.2 used these new international standards to arrive at their definition of overweight and obesity (Kautiainen et al., 2002; Luo and Hu, 2002; Tremblay et al., 2002; Chinn and Rona, 2001; Magarey et al., 2001). The prevalence and temporal trend estimates of overweight were similar.

Second, a substantial proportion of young people demonstrated unfavorable body composition regardless of the definition of overweight and obesity applied. The majority of studies in Table 1.2 reported an overweight prevalence of 10% or higher across age and sex. This was true of young people in developed (Ogden et al., 2002; Tremblay and Willms, 2000) and developing countries (Luo and Hu, 2002; Chu, 2001). The deterioration in body composition was exacerbated in Aboriginal children and adolescents. Hanley et al. (2000) found 27.7 and 33.7% of Sandy Lake First Nation (Ontario, Canada) boys and girls overweight respectively when body mass index was referenced to the dataset of National Health and Nutrition Examination Survey 3 (greater than or equal to age- and sex-specific 85th centiles). When overweight was defined as a body mass index greater than or equal to age- and sex-specific 95th centiles of the dataset of National Health and Nutrition Examination Survey 1, Eisenmann et al. (2000) reported prevalence estimates of 15 and 21% in Navajo (Arizona, United States) boys and girls respectively.

Third, change in the prevalence of overweight and obesity over time reveals a secular deterioration in body composition. Tremblay et al. (2002) found increases as high as fivefold in 7- to 13-year-old Canadian children and adolescents between 1981 and 1996. The risk appears to increase across Canadian provinces from west to east (Willms et al., 2003). Kautiainen et al. (2002) reported twofold increases in overweight among Finnish adolescents between 1977 and 1999. Others reported the same temporal trends over similar time periods in American (Ogden et al., 2002; Ogden et al., 1997) and British young people (Berg et al., 2001; Bundred et al., 2001; Chinn and Rona, 2001).

1.2.3.2 Temporal Trends in Cardiorespiratory Endurance

Though health-related physical fitness is not a unitary concept, which can be defined by a single measurement, (Eisenmann and Malina, 2002) the second component of health-related physical fitness—cardiorespiratory endurance—is often considered an index of overall physical fitness (Cooley and McNaughton, 1999). Also known as aerobic fitness, cardiorespiratory endurance is "the ability of the circulatory and respiratory systems to supply oxygen during sustained physical activity." (U.S. Department of Health and Human Services, 1996) When measured directly, the aerobic fitness of American young people generally appears to have changed little since the 1930s and 1940s though there are some exceptions (Armstrong and Van Mechelen, 1998; Rowland, 1996; Bar-Or and Malina, 1995).

Eisenmann and Malina (2002) reviewed 43 studies between the 1930s and 1990s, which delineated the aerobic fitness of American boys. Direct measurement (gas analysis) was used in all studies. Eisenmann and Malina found no decline in the aerobic fitness of 6- to 18-year-old boys since 1938. Thirty-two studies between the 1960s and 1990s were also reviewed, which measured the aerobic fitness of American girls. Aerobic fitness was stable in 6- to 14-year-old girls since the 1960s. However, the oldest group of girls (15- to 19-year-olds) experienced a 20% reduction in aerobic fitness between the 1970s and 1990s. Their mean relative peak oxygen consumption declined from 41.6 to 33.4 $ml \cdot kg^{-1} \cdot min^{-1}$.

Whether young people are aerobically fit has been controversial in the past (Morrow, Jr., 1992) and remains so. Contrary to the results of Eisenmann and Malina (2002), for example, Table 1.3 presents field-based studies, which have found secular deterioration in cardiorespiratory endurance among young people.

Table 1.3 Temporal trend estimates of aerobic fitness in young people from field-based studies.

Authors	Sample	Measure	Results
Tomkinson et al., 2003	n = 18,631 12- to 15-year-old Australian adolescents	20-m shuttle run	0.4-0.8% decline in laps·year^{-1} across age and sex (1995-2000)
Westerstahl et al., 2003	n = 1,010 16-year-old Swedish adolescents	Run/walk test (distance covered in 9 min)	3 and 4% decline in distance covered by boys and girls respectively (1974-95)
Dawson et al., 2001	n = 5,579 10- to 14-year-old New Zealand children and adolescents	550-m run	23.6 and 27.0 sec time increase in boys and girls respectively across age (1991-2000)
Hamlin et al., 2001	n = 423 6- to 12-year-old New Zealand children and adolescents	550-m run	18.0 and 30.1 sec time increase in 10- and 12-year-old children respectively across sex (1984-2000)
Dollman et al., 1999	n = 1,463 10- to 11-year-old Australian children and adolescents	1.6-km run/walk test	38.0-48.5 sec time increase across age and sex (1985-97)

The majority of studies in Table 1.3 represent Australian and Swedish populations. Figure 1.2 illustrates temporal trend estimates of aerobic fitness (from field-based studies) in samples of similar-aged young people (6- to 17-year-olds) from other countries.

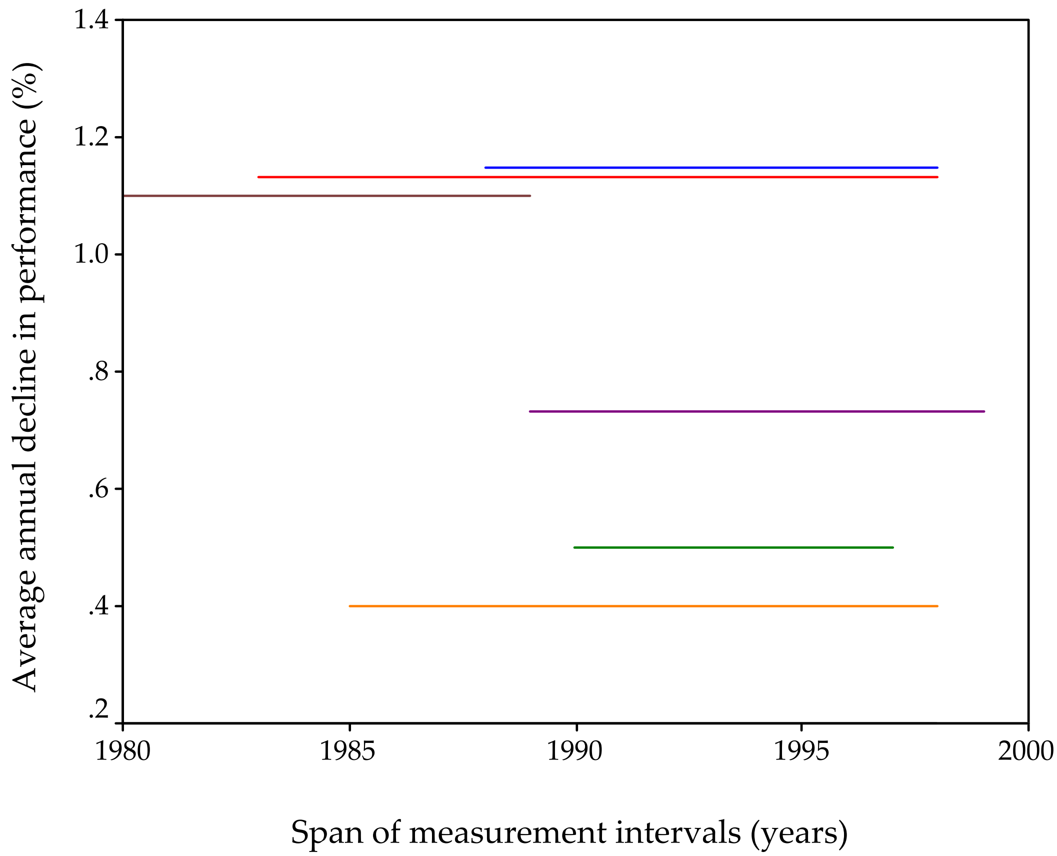

Figure 1.2 Temporal trend estimates of aerobic fitness in young people over the past 20 years from field-based studies. (From top to bottom: Korean study 1, Korean study 2, American study, Polish study, Belgium study, and Japanese study; modified from Tomkinson et al., 2003, by permission of Minerva Medica: Torino, Italy)

The horizontal lines in Figure 1.2 represent the measurement intervals for each study. Their position along the ordinate illustrates average annual percentage decline in performance. The aerobic fitness tests varied across study but involved some type of distance run/walk with time as the outcome variable (Tomkinson et al., 2003). To demonstrate the meaningfulness of a one percent average annual decline in performance, consider the following example: A sample of young people had a mean performance time of 134 seconds on the 550-meter run in 1985, and a second sample had a corresponding time of 155 seconds in 2000. The 21-second deterioration over 15 years would equal an average annual decline in performance of one percent ([[155-134] / 15] / 134 x 100%).

Though the results in Table 1.3 and Figure 1.2 suggest secular deterioration in cardiorespiratory endurance among young people in developed countries, criticism has been raised against the proxy measures of aerobic fitness used in these field-based studies. Eisenmann and Malina (2002) asserted that many of the changes observed in distance runs over time are simply artifacts of field-based testing. Motivation, effort, practice, and environmental conditions have been cited as confounding variables (Dollman et al., 1999). While it is true that direct measurement of oxygen consumption is preferable, even studies of this nature have their problems, which include sampling limitations (small and unrepresentative numbers), time constraints, financial expense, and measurement variation due to difficulties in determining peak oxygen consumption in young people (Eisenmann and Malina, 2002; Cooley and McNaughton, 1999).

The status of aerobic fitness in young people, not to mention temporal trends, is uncertain. Better data are needed for elucidation. Yet given the ostensible clarity of the literature on secular deterioration in body composition among young people, it is difficult to refrain from assuming a similar scenario in aerobic fitness due to the positive relationship between body composition and cardiorespiratory endurance in young people (Westerstahl et al., 2003; Mota et al., 2002a).

1.2.3.3 Temporal Trends in Musculoskeletal Fitness

At present it is also difficult to determine temporal trends in musculoskeletal fitness owing to the fact that few fitness tests have been studied over time with the exception of pull-ups and the flexed arm hang (Corbin and Pangrazi, 1992). To add to this uncertainty, emerging studies have reported disparate results.

Corbin and Pangrazi (1992) analyzed data from the National School Population Fitness Surveys. They conducted inter-year comparisons (1975-85) on musculoskeletal test items performed by boys and girls, which included the 50-yard dash, the standing long jump, pull-ups (boys), and the flexed arm hang (girls). Corbin and Pangrazi (1992) found few statistically significant differences between years within sex. They concluded that the musculoskeletal fitness of American boys and girls had changed little in the years between 1975 and 1985.

In contrast, Tomkinson et al. (2003) reported time increases in the 40-meter sprint performance among 12- to 15-year-old Australian adolescents between 1995 and 2000. Dollman et al. (1999) also found time increases in the 50-meter sprint among 10- and 11-year-old Australian children between 1985 and 1997. Secular deterioration and/or no change over time have also been reported in curl-ups, standing broad jump, and sit-and-reach performances of children and adolescents from different countries (Westerstahl et al., 2003; Hamlin et al., 2002; Dollman et al., 1999).

Put simply, there is a paucity of data which is limiting a clear and decisive statement about temporal trends in musculoskeletal fitness among young people. A remark by Steven Blair (1992) a few years ago to this effect remains applicable today. He said:

> We do not have much good data on which to base a conclusion regarding changes in physical fitness in American children and youth over the past several decades. The limited data that are available suggest that there has been no major change.

In conclusion, temporal trend estimates of body composition in young people from developed and developing countries seem to be in agreement: Prevalence estimates of overweight and obesity are on the rise. However, changes in cardiorespiratory endurance and musculoskeletal fitness among young people over time are less certain. The primary reason for this uncertainty is a paucity of good data. Hence, there is sufficient reason to undertake a research project, which will provide new health-related physical fitness data as well as a model of temporal trend analysis.

The need to study health-related physical fitness in young people and determine temporal trends is further demonstrated by what is currently known about one component of health-related physical fitness: The health consequences of poor body composition. In the following section, risk factors for cardiovascular disease are documented in overweight and obese young people. Given these possible ramifications of poor body composition, attention should be directed toward understanding the status of health-related physical fitness in young people and in which direction it is moving over time so as to prioritize the different areas of public health in young people.

1.2.4 Health Consequences of Poor Body Composition in Young People

As stated previously, much about the cardiorespiratory endurance and musculoskeletal fitness of young people remains to be elucidated. However, body composition in young people and its relation to health have been established. Dietz (1998) reviewed studies, which have documented some of the adverse effects of obesity in children and adolescents. He cited elevated serum low-density lipoprotein and triglyceride levels, low serum high-density lipoprotein levels, and glucose intolerance (manifest in the occurrence of type 2 diabetes)—risk factors for cardiovascular disease in adulthood—as the characteristic pattern in obese young people.

Freedman et al. (1999) analyzed data from the Bogalusa Heart Study collected between 1973 and 1994 in Louisiana, United States. Overweight was defined as a body mass index greater than age- and sex-specific 95th centiles of aggregated datasets (Health Examination Surveys 2 and 3, and National Health and Nutrition Examination Surveys 1, 2, and 3). The sample consisted of 5,477 schoolchildren aged 5 to 17 years. Eleven percent was classified as overweight. Based on this dichotomy, the risk of overweight children and adolescents acquiring cardiovascular disease risk factors was determined. Risk factors included elevated systolic and diastolic blood pressures (greater than age-, sex-, and race-specific 95th centiles from regression models), elevated cholesterol levels (a total cholesterol greater than 200 $mg \cdot dL^{-1}$, low-density lipoproteins greater than 130 $mg \cdot dL^{-1}$, and triglycerides greater than or equal to 130 $mg \cdot dL^{-1}$), low high-density lipoproteins (less than 35 $mg \cdot dL^{-1}$), and elevated fasting insulin levels (greater than or equal to age-, sex-, and race-specific 95th centiles). Table 1.4 presents odds ratios for these cardiovascular disease risk factors.

Table 1.4 Odds ratios of overweight schoolchildren from the Bogalusa Heart Study (1973-94) acquiring cardiovascular disease risk factors compared to normal weight schoolchildren across age, sex, and race.

Cardiovascular disease risk factor	Odds ratio (95% CI)
Systolic blood pressure	4.5 (3.5-5.8)
Diastolic blood pressure	2.4 (1.8-3.0)
Low-density lipoproteins	3.0 (2.4-3.6)
Triglycerides	7.1 (5.8-8.6)
Total cholesterol	2.4 (2.0-3.0)
High-density lipoproteins	3.4 (2.8-4.2)
Fasting insulin	12.6 (10.0-16.0)

(CI: Confidence interval)

The results from Table 1.4 indicate that overweight children and adolescents are at substantially increased risk of developing several chronic diseases, which include cardiovascular and metabolic disorders. Of particular interest is the odds ratio of 12.6 for fasting insulin. This implies a link between overweight and type 2 diabetes. Indeed, others have observed an increasing prevalence of type 2 diabetes in children and adolescents commensurate with the temporal trends in overweight and obesity (Hypponen et al., 2000; Pinhas-Hamiel et al., 1996). A tenfold increase in the incidence of type 2 diabetes in children between 1982 and 1994 has been reported (Pinhas-Hamiel et al., 1996).

Similar to overweight and obesity, a high prevalence and increasing temporal trend in type 2 diabetes is specially marked among Aboriginal adults and young people in North America (Fagot-Campagna et al., 2000; Young et al., 2000; Harris et al., 1997; Pioro et al., 1996; Brassard et al., 1993; Delisle et al., 1993).

1.2.5 Physical Activity of Young People

Comparing physical activity between Old Order Mennonite children in southwestern Ontario and rural children in central Saskatchewan can be justified on the same ground as health-related physical fitness: Assuming that Old Order Mennonite children represent Canadian children between 50 and 100 years, a comparison of this nature would provide a model of temporal trend analysis in physical activity. As demonstrated in this section, data for temporal trend analysis in physical activity among young people do not exist, thus demonstrating the need for a model of temporal trend analysis.

Like health-related physical fitness, physical activity can be variously described. Physical activity has been expressed in terms of energy expenditure, the amount of work performed, units of movement, or as a numerical score derived from a questionnaire (Montoye et al., 1996). The broadest definition of physical activity is any "bodily movement that is produced by the contraction of skeletal muscle and that substantially increases energy expenditure." (U.S. Department of Health and Human Services, 1996) The four dimensions of physical activity are frequency, intensity, time, and purpose (Montoye et al., 1996). Different instruments have been implemented to measure one or more of these components of physical activity, such as questionnaires, diaries, heart rate monitors, motion sensors, direct observation, doubly labeled water, and indirect calorimetry (Rowland, 1996). All have their strengths and weaknesses. The following subsection reviews those studies, which have attempted to estimate temporal trends in various dimensions of physical activity among young people using these different instruments.

1.2.5.1 Temporal Trends

A few studies attempting to document temporal trends in the physical activity of young people have emerged recently. Eisenmann et al. (2003) examined the leisure-time activity of 12- to 19-year-old Canadian adolescents using data from five national surveys between 1981 and 1998. The proportion of 12- to 14-year-old boys meeting the recommended activity level of 12.6 $kJ \cdot kg^{-1} \cdot day^{-1}$ decreased from 64 to 44% between 1988 and 1998. Though relatively stable patterns were observed in other age groups of both sexes between 1981 and 1998, as many as 80 and 90% of boys and girls respectively were not meeting the recommended level of physical activity during the last year of measurement.

Lowry et al. (2001) analyzed temporal trends in American high school students' participation in physical education classes. They used data from the Youth Risk Behavior Surveys conducted in 1991, 1993, 1995, and 1997. Lowry et al. (2001) reported secular deterioration in those who were physically active for more than 20 $minutes \cdot day^{-1}$ in physical education classes: The proportion dropped from 34 to 22% between 1991 and 1997.

Tremblay et al. (1996) reported a 60% reduction in full-time equivalent physical education specialist positions in elementary schools across New Brunswick, Canada, between 1991/2 and 1994/5. This indicates secular deterioration in the quality of physical education offered as well as a secular decline in the quantity of time spent in physical education-related activity by students.

Durnin (1992) examined the energy intake of 14- and 15-year-old adolescents from the United Kingdom between the 1930s and 1980s. Energy intake was estimated from diet analyses and expressed in $kcal \cdot day^{-1}$. Durnin

(1992) noticed that energy intake declined from 3,065 to 2,490 and from 2,640 to 1,880 kcal·day^{-1} in boys and girls respectively across age between the 1930s and 1980s. Assuming a positive relationship between energy intake and activity, he interpreted this decline as deterioration in physical activity.

Despite the efforts being made, limitations in the methods of measuring physical activity make it difficult to quantify changes in physical activity over time (Tremblay et al., 2001; Trost, 2001; Tremblay et al., 1996; Bar-Or and Malina, 1995). A further complication is the paucity of data (Troiano and Flegal, 1998; Freedson and Rowland, 1992; Stephens, 1987). Durnin (1992) has stated the problem accurately. He said:

> The problem about attempting a scientific discussion of "physical activity levels—past and present" is that factual information is limited. Data which are valid generally, and which will tell us how active people were 20, 50 or 100 years ago, what sort of activity they indulged in, how it was influenced by socio-economic class or by age, and how this has altered at the present day, do not exist.

1.2.6 Applications of Temporal Trend Analysis in Physical Activity

The message in Table 1.2 is unequivocal: The proportion of young people with excess body mass at a given age is high and on the rise. Some relate this phenomenon to earlier maturation (Adair and Gordon-Larsen, 2001; Kaplowitz et al., 2001; Dietz, 1998a; Bar-Or and Malina, 1995) while others believe genetics will eventually explain the causative mechanism(s) (Baranowski et al., 2000). However, there are three strong arguments against both proposals: Time, parallel trends in adults, and the global nature of the obesity epidemic. The relatively short period over which the pandemic has become manifest—approximately two decades (Ball and McCargar, 2003; Hill et al., 2003; Office of the Surgeon General, 2001; Olds and Harten, 2001)—in people of all ages and nationalities would seem to emphasize the importance of environmental and behavioral mechanisms as explanative of the phenomenon (Hill et al., 2003; Baranowski et al., 2000; Hill and Melanson, 1999; World Health Organization, 1998). Indeed, adiposity is fundamentally about energy balance (Jebb and Moore, 1999; World Health Organization, 1998). Given this principle, increased body mass among young people may relate to decreased physical activity, increased sedentariness, and poor dietary practices (Ball and McCargar, 2003).

1.2.6.1 Understanding the Etiology of the Obesity Epidemic

One application of temporal trend analysis in physical activity among young people, therefore, may be its ability to help clarify the role of physical activity in the current obesity epidemic. It is generally agreed that adiposity is fundamentally about positive energy balance (Jebb and Moore, 1999; World Health Organization, 1998). If it could be shown that physical activity in young people has declined commensurate with the secular deterioration in body composition, a strong argument could be formulated for decreased physical activity and increased sedentariness as causal factors in the obesity epidemic. Indeed, a number of acculturation studies provide limited support for this hypothesis.

1.2.6.1.1 Acculturation Studies

Prista et al. (2003) examined the influence of socioeconomic changes on the somatic growth, health-related physical fitness, and activity of 8- to 15-year-old children and adolescents from Mozambique between 1992 and 1999. During this period, a transition was made from war to peace in the country. Two cross-sectional samples of 593 and 1,811 children were compared between 1992 and 1999 respectively. Somatic growth variables (standing height and body mass) increased significantly during the seven-year interval. Conversely, aspects of health-related physical fitness (aerobic fitness and flexibility) and activity (assessed by questionnaire) decreased. The authors concluded that socioeconomic changes (e.g. increased wealth and sedentariness) were contributory to the observed differences.

In explaining the deteriorating health-related physical fitness in Australian adolescents between 1995 and 2000, Tomkinson et al. (2003) cited sedentariness as the explanation with technological innovation (e.g. motorized vehicles, television) being the main facilitator. This speculation was based on the following statistics: (1) A sixfold decrease in the number of persons per non-commercial car (12.5 to 2.0) between 1947-8 and 1991-2, (2) A twofold increase in television ownership per head of the population between the 1960s and 1990s, and (3) 80% of households owning a videocassette recorder in 1994 (Australian Bureau of Statistics, 2001 cited by Tomkinson et al., 2003).

Dollman et al. (1999) also attributed temporal trends in health-related physical fitness among young people to sociocultural transitions. They claimed that the widening range of physically inactive leisure pursuits (e.g. computer games) was the primary cause of increasing sedentariness.

Drs. Roy Shephard and Andris Rode have contributed a great deal of research to the impact of acculturation on sedentariness and, subsequently, health-related physical fitness and activity in young people from circumpolar populations in Canada (1995; 1994a; 1994b; 1993; 1985; 1984a; 1984b; 1984c; 1973; 1971; Shephard and Rode, 1992). In 1970/1, the body composition, cardiorespiratory endurance, and muscular strength of 9- to 19-year-old Inuit children and adolescents from Igloolik, Northwest Territories (now Nunavut), Canada, were measured. Compared to Caucasians from urban Canada, the Eskimos demonstrated superior values in all three variables across age and sex

(Rode and Shephard, 1973; 1971). The authors suggested high levels of physical activity as contributory to the observed differences.

Ten years later, Rode and Shephard (1984a; 1984b; 1984c) performed identical measurements on Inuit young people from the same community. During that span, the community acculturated toward the more sedentary, mainstream culture in Canada. Snowmobile ownership increased ninefold and, by 1981, hunting was done recreationally instead of for survival. Additionally, machinery was used to clear snow from the streets and 50 households (population of the community was 719) owned televisions (Rode and Shephard, 1984a; 1984c).

According to Rode and Shephard (1984c), Inuit young people experienced an increase in body mass and subcutaneous fat, and a decrease in predicted maximal oxygen uptake and knee extension strength between 1971 and 1981. They attributed the deterioration to decreased physical activity and increased sedentariness.

In 1989-90, Rode and Shephard (1993) compared body composition, cardiorespiratory endurance, and strength variables between 13- to 39-year-old Eskimos from Igloolik, Nunavut, Canada, who were physically active and those who were not. Rode and Shephard (1993) reported the active group as successful in sustaining thin skinfolds and high levels of aerobic fitness, which characterized the 1970/1 sample.

Many studies have examined the relationship between television viewing and body composition in children and adolescents in an attempt to explore the role of decreased physical activity and increased sedentariness in the modern obesity epidemic. Though some studies have not found a strong association between television viewing and adiposity (Katzmarzyk et al., 1998; DuRant et al., 1996; DuRant et al., 1994; Robinson et al., 1993) and have discouraged the use of television viewing as a marker of sedentariness in young people (Marshall et al., 2003), other studies have reported a positive relationship (Lowry et al., 2002; Crespo et al., 2001; Hernández et al., 1999; Andersen et al., 1998). Proctor et al. (2003) followed 106 4-year-old American children prospectively for seven years. They found that 11-year-old children who had watched three hours of television or more per day (assessed by parental report) had the greatest increase in body fat as measured by skinfolds.

The studies summarized in this subsection suggest a link between decreased habitual physical activity/increased sedentariness and decreased health-related physical fitness, particularly body composition. However, the majority of results are descriptive in nature and, therefore, do not allow for definitive conclusions about causal mechanisms (Jebb and Moore, 1999). Perhaps the greatest limitation of all is the lack of control for growth and development in these studies. Malina and Bouchard (1991) have demonstrated the growth- and maturational-associated variation in young people's health-related physical fitness and activity. Without controlling these variables, it is difficult to conclude with certainty whether secular deterioration in body composition among young people is due to systematic change in physical activity, sedentariness, diet, growth, and/or maturation.

1.2.6.2 Contributing to Evidenced-Based Activity Guidelines

A second application of temporal trend analysis in physical activity among young people may be its ability to help establish more evidence-based activity guidelines, which currently are lacking. Due to the difficulty of establishing a physical activity-health link in young people (Welk et al., 2000), recommendations detailing how much activity children and adolescents should receive have been lacking (Pate et al., 1998). Yet, numerous guidelines have recently been proposed if for no other reason than to evoke a desire for physical activity in youth that may persist into adulthood (Pate et al., 1998). Table 1.5 summarizes existing physical activity recommendations for young people in Canada, the United Kingdom, and the United States.

Table 1.5 Physical activity guidelines for children and adolescents.

Sources	Country	Frequency	Intensity	Duration
Health Canada, 2002a; 2002b	Children and adolescents in Canada	Daily increase	Moderate	30-90 min beyond what one currently receives, accumulated in at least 5- and 10-min continuous bouts
Cavill et al., 2001; Pate et al., 1998	Children and adolescents in the United Kingdom	Daily	Moderate at least	60 min accumulated
Corbin et al., 1994	Children in the United States	Daily	Moderate-vigorous	60 min distributed in 3 or more bouts*
Sallis and Patrick, 1994	Adolescents in the United States	3 times· $week^{-1}$	Moderate-vigorous	Continuous bouts of 20 min or more

* The Optimal Functioning Standard of the Children's Lifetime Physical Activity Model

The physical activity guidelines for Canadian children and adolescents differ from other recommendations in that they do not state a base dose. Rather, they call for the attainment of 30 minutes of moderate to vigorous physical activity·day^{-1} above that which an individual already receives. The goal is to reach an increase of 90 minutes·day^{-1} (beyond what one already receives) in five months (Health Canada, 2002a; 2002b).

1.2.6.2.1 Are the Recommendations Being Met?

Epstein et al. (2001) reviewed 26 studies, which measured physical activity in 3- to 17-year-olds using heart rate telemetry. Young people across age and sex received more than 60 minutes of light physical activity·day^{-1}. Additionally, they received 30 minutes of daily moderate to vigorous physical activity (defined as greater than 50% heart rate reserve). Others have reported similar findings using measurements of physical activity that include heart rate telemetry, accelerometry, and surveys (Gavarry et al., 2003; Klentrou et al., 2003; Santos et al., 2003; Trost et al., 2003; Mota et al., 2002b; Pate et al., 2002; Trost et al., 2002; Sleap and Tolfrey, 2001; Kelly, 2000; Ross, 2000; Pratt et al., 1999; Armstrong and Van Mechelen, 1998; Health Education Authority, 1997; Pate et al., 1994; Simons-Morton et al., 1990). However, concern has been raised with respect to the proportion of young people who are physically inactive, especially in survey studies (Tudor-Locke et al., 2003; Cameron et al., 2001; Hussey et al., 2001; Craig et al., 2000; Heath et al., 1994)

Despite various definitions of, and assessment options for, physical activity, the literature cited above suggests that the majority of young people in Canada, the United Kingdom, and the United States are active for more than one hour each day, frequently accumulating 20 to 30 minutes of physical activity at a moderate intensity or higher. Thus, young people seem to be meeting the established physical activity guidelines.

The incongruence between unhealthy body mass (and/or dietary practice) and acceptable physical activity levels in large proportions of young people intimates the lack of evidence-based activity guidelines. Indeed, Haskell (1996) pointed out the fact that issues related to activity recommendations are "based as much on concept or assumption as on well-established scientific fact." Pate et al. (1998) also expressed "glaring deficiencies" in the body of knowledge used to develop physical activity guidelines in young people.

The need for activity interventions and evidence-based recommendations for young people in Canada is particularly marked in 9- to 12-year-olds. Recently, the Heart and Stroke Foundation of Canada (2002) reported that "[T]he current lifestyles of tweens—kids aged 9 to 12—could put them in the fast lane for developing heart disease and stroke as early as their 30s". Naturally, children of this age are a vulnerable population because of their inability to make informed, health-related choices on their own (Hill et al., 2003).

Ideally, physical activity guidelines would be based on doses of activity linked to conditions and outcomes associated with health (Caspersen et al., 1998). However, physical activity epidemiology research is still in its infancy stage (Caspersen et al., 1998).

Though this research project cannot establish a physical activity-health link in young people, the demonstration of secular deterioration in health-related physical fitness and activity among young people over the last 50 to 100 years while controlling biological age may be good reason for recommending the amount of activity received prior to the decline: It is believed that the number of children and adolescents of that era plagued by the ostensible health consequences of hypokinetic-related conditions was much smaller than what it is today. For example, the obesity and type 2 diabetes epidemics have emerged only in the last 10 or 20 years (Ball and McCargar, 2003; Brosnan et al., 2001).

1.3 SUMMARY

Comparing health-related physical fitness and activity between Old Order Mennonite children in southwestern Ontario and rural children in central Saskatchewan is justified along two lines: First, because of the uniqueness of the sample. To my knowledge, no study examining health-related physical fitness and activity among Old Order Mennonite populations has ever involved children. Second, because of the uniqueness of the comparison, which may serve as a model of temporal trend analysis in health-related physical fitness and activity due to the marked lifestyle differences between Old Order Mennonite and rural Saskatchewan children. Currently, temporal trend analyses in health-related physical fitness and activity among young people are severely limited due to a paucity of good data. Two possible applications of temporal trend research in physical activity among young people may be: (1) A clearer understanding of the role of physical activity/sedentariness as a causal factor in the obesity epidemic, and (2) The development of a more empirical basis for physical activity guidelines for young people.

1.4 STATEMENT OF THE PROBLEM

1.4.1 Purpose

The aim of this research project was to compare health-related physical fitness and activity between Old Order Mennonite children in southwestern Ontario and rural children in central Saskatchewan, both groups aged 9 to 12 years.

1.4.2 Hypotheses

There were two hypotheses in this research project: First, that Old Order Mennonite children would be more physically fit in health-related components than rural children in central Saskatchewan. Second, that Old Order Mennonite children would be more physically active than rural Saskatchewan children.

1.5 ASSUMPTIONS

There were five fundamental assumptions to this research project: First, that Old Order Mennonite children represent children in Canada between 50 and 100 years ago. The justification for this assumption has been presented in Section 1.2. Second, that elements of rural life in Saskatchewan children (e.g. degree of social isolation, availability and variety of outdoor play spaces; Dollman et al., 2002) impact their physical activity in a way similar to the influence of rural life on physical activity in Old Order Mennonite children. Third, that Old Order Mennonite and rural Saskatchewan children are comparable on seasonal variation within their respective geographical settings, that is to say, there are no marked differences in weather conditions between Ontario and Saskatchewan during the fall season (when data collection was conducted) that would hinder physical activity, such as snowfall. Fourth, that the Canadian Physical Activity, Fitness, and Lifestyle Appraisal is a reliable and valid protocol for the measurement of health-related physical fitness in 9- to 12-year-old children. Fifth, that the Model AM7164 activity monitor and Physical Activity Questionnaire for Older Children are reliable and valid instruments for measuring physical activity in 9- to 12-year-old children.

1.6 LIMITATIONS

The Old Order Mennonites in southwestern Ontario practice strict endogamy (Fretz, 1978). Therefore, genetics may have a singular influence on health-related physical fitness in Old Order Mennonite children, which cannot be controlled. Additionally, the energy intake of the samples was not accounted for in this research project due to the limited budget. This lack of control introduces a confounding factor owing to the fact that diet likely contributes to health-related physical fitness, particularly body composition (Harnack et al., 2000).

A poor response rate from the Old Order Mennonite children (refer to Chapter 2) and the inability to randomly select children from schools in rural Saskatchewan were threats to the representative nature of the samples in this research project. However, because the Old Order Mennonite population is such a homogenous religocultural group, there was perhaps less chance of selection bias with the Old Order Mennonite children. Conversely, the rural Saskatchewan participants may have been more physically fit and active compared to the population from whence they came due to self-selection and the more heterogeneous nature of their population.

CHAPTER TWO

2.1 DESIGN

The research problems were addressed using a static group comparison known as the ex post facto, or causal comparative, design (Thomas and Nelson, 2001). In an ex post facto design, the cause(s) of group differences is assumed despite the lack of an experimental design, which includes an intervention, treatment and control groups, pre- and post-tests, etc. In this research project, health-related physical fitness and activity characteristics were compared between Old Order Mennonite and rural Saskatchewan children, who presumably differed on lifestyle-related physical activity (the "treatment" variable).

2.2 ETHICS

In February 2002, permission to undertake this research project was directed to the Behavioural Research Ethics Board (telephone: 306-966-2084) of the University of Saskatchewan. On March 8, 2002, approval was granted from the said committee (Appendix B).

2.3 PARTICIPANTS

2.3.1 Determination of Sample Size

Two items were considered when deciding on the size of the sample for this research project: Statistical power and feasibility. A sample size was desired, which could detect potential differences in physical activity between two groups. But a sample size just large enough for statistical significance was sought so the research project could be carried out in the confines of a reasonable budget.

In a previous study (Ekelund et al., 2001), the physical activity of 26 9-year-old Danish children (15 boys and 11 girls) was measured using activity monitors identical to the ones in this research project. Activity counts·min^{-1} were 636 ± 98 and 698 ± 174 (mean ± standard deviation) in boys and girls respectively. These results were used in sample size calculations for this research project. For example, to determine the number of boys necessary for the detection of real differences in physical activity between two groups 95% of the time, the following assumptions were made: (1) A power coefficient of 0.80, (2) A 15% difference in mean activity counts·min^{-1} between groups is biologically meaningful, (3) Intra-group standard deviations of 98 activity counts·min^{-1}, and (4) The use of two-tailed, independent-samples *t* tests to detect statistical differences at an alpha level of 0.05. Under these conditions, a sample size of 24 boys per group was required to correctly reject a false null hypothesis when group means for activity counts·min^{-1} differed by 94 (15%) or more. The same calculation was applied to girls. However, assumption (3) corresponded to the standard deviation reported by Ekelund et al. (2001) for mean activity counts·min^{-1} in girls. Sixty-one participants per group were requisite. In view of these results, the aim was to recruit 75 boys and 75 girls per group for a total of 300 children. The target age was 9 to 12 years in keeping with the rationale for this research project as posited in Chapter 1.

2.3.2 Old Order Mennonite Children

To establish contact with the Old Order Mennonite communities in southwestern Ontario—the only region of Canada that this population of approximately 5,800 cohabits (Peters, 2003)—a letter was sent to Isaac Horst, which delineated the intentions of this research project. Mr. Horst is a prolific writer from Ontario who has written numerous books on the Old Order Mennonite tradition. He notified one of the advisory committee members responsible for supervising all Old Order Mennonite parochial schools across southwestern Ontario. A telephone call was received from this individual shortly thereafter. He suggested that contact with the Old Order Mennonite children be made by family instead of by school due to the fact that not everyone would be receptive to the research project. This advice was taken and 150 children were randomly selected by family from a prescreened list. These children were mailed an envelope that contained information about the research project should they desire to participate. The package included a consent form (Appendix C) and the Physical Activity Readiness Questionnaire (Canadian Society for Exercise Physiology, 1999; refer to Appendix D).

To randomly select children from all Old Order Mennonite families in southwestern Ontario, their most recent directory, Families of the Old Order Mennonite Church in Ontario, (Weber, 1998) was obtained and consulted. More than 300 Old Order Mennonite families with 9- to 12-year-old children were identified, placed on a list, and represented numerically. (The total population in this age range was 483 children.) Prior to random selection of the families, this list was sent to the advisory committee member mentioned above who then promptly eliminated 24 families (36 children) whom he thought would be disinterested in this research project or whose child/ren would be unable to participate due to a physical handicap. An algorithm available at <www.randomizer.org> was used to generate random numbers for selection of a sample of 150 children from the remaining families.

As completed consent forms and questionnaires were returned by mail, data were collected in the Waterloo and Wellington counties of southwestern Ontario. Two researchers traveled to participant farms with portable equipment.

A room in the house, usually the kitchen or living room, was provided for set up and testing.

After a couple weeks of data collection, a follow-up letter was sent to the families who had not responded to the initial mail-out. Due to the poor response, two more random samples and an additional 150 children were contacted by mail and invited to participate. Though the final response rate was low (43% [79 / 182] and 41% [124 / 300] by family and participant respectively), no discernable pattern of non-participation in relation to health-related physical fitness and/or activity is thought to have influenced the validity of the sample's random nature. In fact, there is evidence to suggest the non-respondents simply did not want a "spotlight" on their lifestyle (refer to Peters, 2003). For example, an email message was received from an American researcher writing a book about monastic cultures in North American, who had attempted to penetrate the Old Order Mennonite communities in southwestern Ontario. She said:

> While ending a visit with a Mennonite family near St. Jacobs last week, I was told that your department had approached this family and others with a survey concerning the lifestyle of Mennonite children. The family told me that they declined the survey, stating they didn't want a spotlight on their life. (Personal communication, 2002)

Furthermore, an Old Order Mennonite parent wrote:

> I received your letter and being it is voluntary, I will decline from giving permission to have my child tested…It should be no secret that if children walk to school instead of ride, they will be in better shape…As far as technology is concerned, I think the world would be better off with less. (Personal communication, 2002)

Some form of follow-up with the non-respondents (e.g. height and body mass measurements) would have been ideal. In this way, they could have been compared to the respondents. However, because we were outsiders and dealing with a sensitive population, it was speculated that follow-up would be unsuccessful. The non-respondents would be no more open to correspondence of this nature than to the research project itself. Furthermore, there was a chance that follow-up would jeopardize our current and future relations with the Old Order Mennonite communities. Therefore, contact with the non-respondents was decided against. Overall, health-related physical fitness and activity data were collected on 124 Old Order Mennonite children (79 families), who ranged in age from 9.1 to 13.8 years.

2.3.3 Rural Saskatchewan Children

Seldom do researchers provide a definition of "rural." Some have suggested this ambiguity as the cause of conflicting results between international studies, which have compared the physical fitness characteristics of urban and rural samples (Dollman et al., 2002). To avoid this problem, the term "rural" as used in this research project denotes any population outside a major city, which is defined as a population concentration greater than 20,000 persons (Dollman et al., 2002).

For convenience and maximum acceptance, rural Saskatchewan children were contacted and tested at school. Schools were considered for recruitment based on their distance from the University of Saskatchewan, receptivity to past research projects, representation of the population, and approval from the governing school board. For example, schools northwest of Saskatoon were not considered for selection because of the Mennonite background of many of the children there. Applying these criteria, schools east of Saskatoon were invited to participate in this research project.

The Director of the Saskatoon East School Division was contacted. He sent out a call for all interested schools and teachers. Schools in Clavet, Colonsay, and Hanley were the first to respond. Clavet and Colonsay are located approximately 20 and 55 kilometers southeast of Saskatoon respectively. Hanley is located 60 kilometers south of Saskatoon. Each of the three towns has a population less than 5,000. Figure 2.1 illustrates their geographical location in relation to Saskatoon.

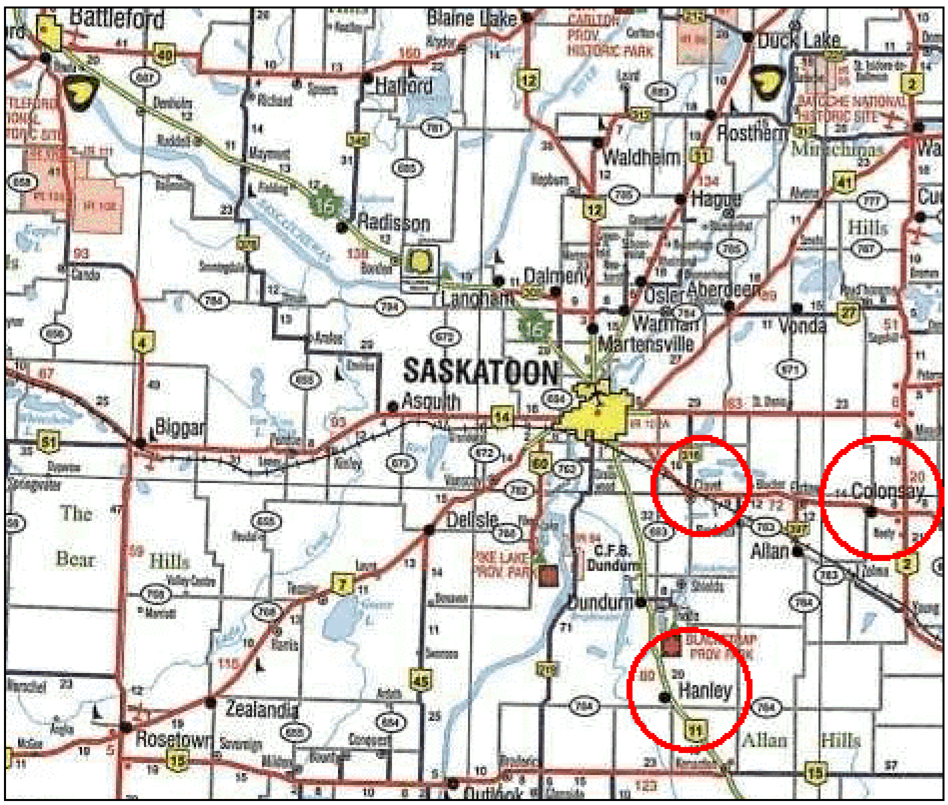

Figure 2.1 Map of Clavet, Colonsay, and Hanley in relation to Saskatoon (modified by permission of Uncommon Sense: Practical Solutions: Yorkton, Saskatchewan, Canada).

Meetings were held with the school principals to disseminate information about this research project. There were additional briefings with the teachers whose students were eligible for participation (grades four to seven). Consent forms and Physical Activity Readiness Questionnaires were delivered to the teachers. The teachers then handed them out for their students to take home to their parents to sign and return if interested. In each of the three schools, a room was provided in which testing could be conducted by a team of researchers. One hundred sixty-five 8.8- to 13.2-year-old schoolchildren from rural Saskatchewan participated in this research project.

Table 2.1 Summary of samples and sampling techniques.

	Old Order Mennonites	Rural Saskatchewan children		
Sample size	124	82	42	41
County or town	Waterloo, Wellington	Clavet	Colonsay	Hanley
Sampling technique	Randomized by family from a prescreened list	Self-selected		

2.4 DATA COLLECTION

The entire data collection was staggered by group. The Old Order Mennonite children were tested between September and October 2002. The rural Saskatchewan children participated during the months of November and early December 2002. Complete testing required eight days of each participant's time: Forty-five minutes to one hour for performance of the health-related physical fitness tests and seven days for wearing of the activity monitor. After returning his or her monitor, each participant completed a seven-day physical activity recall questionnaire. Figure 2.2 illustrates the sequence for data collection.

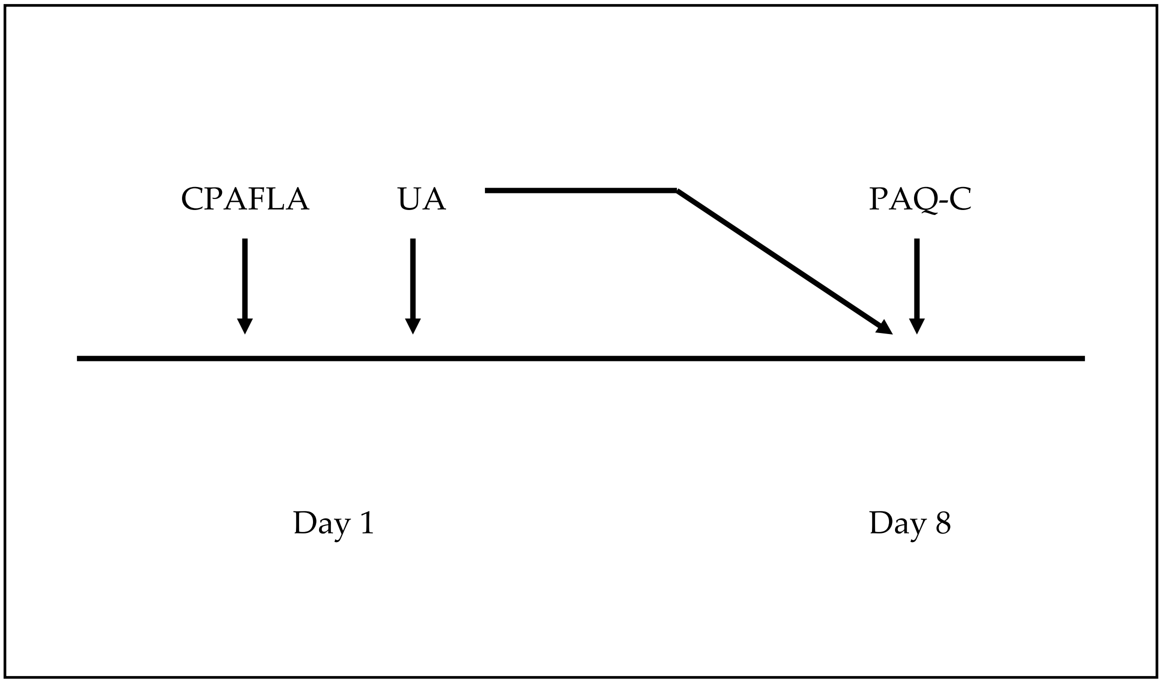

Figure 2.2 Temporal sequence for data collection (CPAFLA: Canadian Physical Activity, Fitness, and Lifestyle Appraisal; UA: Uniaxial accelerometer; PAQ-C: Physical Activity Questionnaire for Older Children).

All health-related physical fitness measurements were collected in accordance with the Canadian Physical Activity, Fitness, and Lifestyle Appraisal (Canadian Society for Exercise Physiology, 1999). This battery of tests is the current protocol used in Canada "to provide a simple, safe, and standardized approach to assessing the major components of fitness in apparently healthy individuals" (Canadian Society for Exercise Physiology, 1999). The majority of researchers in this research project were accredited as Certified Fitness Consultants or Professional Fitness and Lifestyle Consultants through the Canadian Fitness Appraisal Certification and Accreditation program operated by the Canadian Society for Exercise Physiology (Tremblay et al., 2001). Moreover, the researchers had considerable experience with the Canadian Physical Activity, Fitness, and Lifestyle Appraisal prior to this research project. The less experienced researchers were instructed on the protocol prior to testing and then closely supervised during data collection. Because the testing equipment was frequently transported to different sites, daily calibrations were conducted to ensure accuracy of measurement.

2.4.1 Screening

By law any participant who may be exposed to physical, psychological, or social injury must give informed consent prior to participation (Nieman, 1999). Therefore, each participant in this research project was required to produce a completed consent form (Appendix C), which included a parent/guardian signature as well his or her own. Completion of the Physical Activity Readiness Questionnaire (PAR-Q; refer to Appendix D) was also requisite. The purpose of the PAR-Q is to identify any individual, who requires medical clearance from a physician prior to the performance of physical fitness tests. Any affirmative response(s) results in exclusion from tests requiring physical exertion. None of the participants in this research project were excluded based on these procedures.

Each participant was observed for signs of illness, persistent coughing, and lower-extremity swelling. Additionally, a resting heart rate slower than 100 beats·min^{-1} as well as resting systolic and diastolic blood pressure readings less than 144 and 94 mmHg respectively were necessary conditions for participation (Canadian Society for Exercise Physiology, 1999).

With the participant sitting quietly, heart rate was measured in one of two ways: Taking a 15-second count at the radial pulse of his or her left arm and multiplying that number by four, or using a Polar PC5 heart rate monitor (Polar

Electro Inc.: Port Washington, New York, United States). To screen for blood pressure, the participant's left arm was held at an angle of 10 to 45^0 in relation to his or her trunk. A pediatric-sized blood pressure cuff (Almedic AL 14-2200 aneroid sphygmomanometer; Almedic: St. Laurent, Québec, Canada) was wrapped comfortably around the participant's arm. Once his or her brachial artery was identified by palpation at the antecubital space, an Almedic AL 10-1800 stethoscope (Almedic: St. Laurent, Québec, Canada) was placed over the artery and the cuff was rapidly inflated to 20 or 30 mmHg above the radial palpatory pressure. The cuff pressure was then released at a rate of approximately two $mmHg \cdot sec^{-1}$. Systolic and diastolic blood pressures were recorded from the gauge at the first and fourth Korotkoff sounds respectively. To reduce inflated blood pressure readings resulting from anxiety, the researchers took time to explain the procedure and answer any questions from the participant prior to measurement.

2.4.2 Chronological and Biological Age

Each participant's birth date was obtained from the consent form. Chronological age was expressed in decimal years. Biological age was expressed in the same unit but in relation to years from peak height velocity. A value of -2.5 would represent two years and six months from peak height velocity. Years from peak height velocity is the most commonly used index of somatic maturity in longitudinal studies (Thompson et al., 2003; Malina and Bouchard, 1991). Though this research project was a cross-sectional study, age from peak height velocity was predicted using sex-specific regression equations developed by Mirwald et al. (2002). Equations 2.1 and 2.2 are for boys and girls respectively:

Maturational age (boys) = -9.236 + 0.0002708 x leg length (cm) x sitting height (cm) – 0.001663 x leg length + 0.007216 x age (decimal years) x sitting height + 0.02292 x [body mass (kg) / standing height (cm)] (2.1)

Maturational age (girls) = -9.376 + 0.0001882 x leg length (cm) x sitting height (cm) + 0.0022 x age (decimal years) x leg length + 0.005841 x age x sitting height – 0.002658 x age x body mass (kg) + 0.07693 x [body mass / standing height (cm)] (2.2)

2.4.3 Anthropometry

Standing and sitting heights as well as body mass were measured using a Health O Meter 402KL balance beam scale (Health O Meter Inc.: Bridgeview, Illinois, United States). The attached height rod served as a stadiometer. In light clothing and without footwear each participant was instructed to stand erect and hang his or her hands at the side. Standing as tall as possible and looking straight ahead, the participant was asked to take a deep breath at which point a height measurement was taken to the nearest 0.5 cm. The same procedure was followed for sitting height, the difference being that the participant sat on a stool. Leg length was calculated as the difference between standing and sitting heights after adjusting for the height of the stool. A participant with standing and sitting heights of 145.5 and 77.5 cm respectively would have a calculated leg length of 68.0 cm.

With the participant standing erect on the balance beam scale, body mass was measured to the nearest 0.1 kg. Body mass index was expressed as the dividend of the participant's body mass in kg and his or her height in m^2.

To determine waist girth, a Gulick CM22C measuring tape (MicroFit Inc.: Mountain View, California, United States) was placed around the participant's trunk at the level of noticeable waist narrowing. At the end of a normal expiration, the tape was read to the nearest 0.5 cm. In the Old Order Mennonite boys and rural Saskatchewan children, waist girth was measured at the surface of the skin. To accommodate the traditional apparel of the Old Order Mennonite girls (dress and apron), measurements were taken over the dress.

The triceps skinfold was raised midway between the shoulder (tip of the acromion process) and elbow (tip of the olecranon process) on the right arm. Each participant stood erect with his or her right arm bent at an angle of 90^0. Using Harpenden C136 skinfold calipers (British Indicators: West Sussex, England), the triceps skinfold was measured to the nearest 0.2 mm. Duplicate measurements were taken and a third was required if the first two readings deviated by more than 0.4 mm. The mean of the two closest measurements was then calculated and recorded as the true value.

2.4.4 Cardiovascular Endurance Index

The Modified Canadian Aerobic Fitness Test provides an index of aerobic fitness (Canadian Society for Exercise Physiology, 1999). This progressive, submaximal step test has eight sex-specific stages, each three minutes in duration. Equipment included an FS2 staircase of two steps with a combined height of 40.6 cm (FitSystems Inc.: Calgary, Alberta, Canada) and a Polar PC5 heart rate monitor (Polar Electro Inc.: Port Washington, New York, United States) to record the participant's heart rate during the test. Male and female participants started the test at stages four and three respectively. Because the stages were sex-specific, boys and girls began stepping at an identical cadence of 66 footsteps·min^{-1}. This intensity is equivalent to 65 or 70% of the average aerobic power expected of an individual 10 years older (Canadian Society for Exercise Physiology, 1999).

Cadence was maintained during each stage by playing an audio compact disc in a compact disc player. The compact disc was specially designed for the

Modified Canadian Aerobic Fitness Test (Canadian Society for Exercise Physiology, 1999). It contained rhythmic background music and an instructor who, for the duration of each stage, said: "Up-2-3! Down-2-3!" This command reflects the two-stair stepping pattern required of each participant.

Some parents of the Old Order Mennonite children preferred not to use the compact disc player during the step test. Personal reasons were cited for this decision. In this situation, the researchers instructed the participant(s) for the duration of the test on proper cadence using a metronome.

The step test was explained and demonstrated to each participant and s/he was allowed to practice on the steps a couple times. Then the participant began the step test with both feet flat on the floor. Stepping to the beat of the music, s/he raised one foot (either the right or left) onto the first step and then the second foot onto the second step. The first foot was raised to the level of the second foot so that the participant was standing level with both feet flat on the top step. This procedure was repeated as s/he worked his or her way back down to the floor. During the test, the researchers observed the participant to ensure safety and that s/he was keeping rhythm with the music. The participant was corrected if s/he did not maintain an upright posture, was not placing his or her entire foot on the step, or was not fully extending his or her knees on the top step.

Following the completion of the first stage (stages four and three for boys and girls respectively), the participant's heart rate was observed. If it was below 85% of his or her age-predicted maximum heart rate (220 – age), the participant prepared for the next three-minute stage, which was set to a faster cadence. For those male participants who reached stages seven and eight, the staircase was turned around to evoke a one-stair stepping pattern. The command from the instructor's voice on the audio compact disc was: "Up-2! Down-2!" The same procedure was applied to the female participants who reached stage eight. Further details about stages and cadences are available in the Canadian Physical Activity, Fitness, and Lifestyle Appraisal Manual (Canadian Society for Exercise Physiology, 1999).

If the participant's heart rate exceeded the age-predicted cutoff at the end of a given stage, the test was terminated. As a cool-down, each participant was instructed to walk around the testing room and drink water. Blood pressure readings were taken between 2.0 and 2.5 minutes and between 3.5 and 4.0 minutes post-exercise to ensure normal recovery. A heart rate measurement was also taken between 4.0 and 4.5 minutes. If the participant's heart rate was faster than 100 beats·min^{-1} and/or systolic and diastolic blood pressure readings were greater than 145 and 95 mmHg respectively, s/he was instructed to sit quietly and relax. The researchers continued to monitor the participant until his or her heart rate and blood pressure approximated pre-exercise values.

Aerobic fitness scores were derived from an equation that required the participant's chronological age, body mass, and oxygen cost for the last completed stage of the Modified Canadian Aerobic Fitness Test as listed in the Canadian Physical Activity, Fitness, and Lifestyle Appraisal Manual (Equation 2.3). This equation was developed from regression models that were validated against maximal treadmill tests and which demonstrated R^2 values as high as 0.77 on maximal oxygen uptake data in 15- to 69-year-old Canadians (Gledhill, 2002; Weller et al., 1995; 1993; 1992). The aerobic fitness scores are used to assess aerobic fitness.

Aerobic fitness score = 10 x [17.2 + [1.29 x oxygen cost for last completed stage] – [0.09 x body mass (kg)] – [0.18 x chronological age (decimal years)]] (2.3)

2.4.5 Musculoskeletal Fitness Tests

Musculoskeletal fitness consists of muscular strength, muscular endurance, and flexibility (Nieman, 1998). The Canadian Physical Activity, Fitness, and Lifestyle Appraisal assesses these dimensions with the following tests: Handgrip strength, push-ups, trunk forward flexion, partial curl-ups, and the vertical jump. These tests are indices of muscular strength, power, endurance, and flexibility at the hip joint (Canadian Society for Exercise Physiology, 1999). The vertical jump test was not included in this research project due to difficulties with its measurement in the field. Table 2.2 describes procedures for the musculoskeletal fitness tests.

Table 2.2 Protocol for musculoskeletal fitness tests of the Canadian Physical Activity, Fitness, and Lifestyle Appraisal.

Test	Procedures
Handgrip strength	(1) The participant grasps the handgrip dynamometer firmly. The second joint of his or her fingers is fitted snugly under the handle. The dynamometer is held in line with the participant's forearm at his or her thigh and away from the body.
	(2) The participant squeezes the dynamometer vigorously while exhaling to prevent buildup of intra-thoracic pressure.
	(3) Each hand is measured alternately to the nearest kg with two trials per hand. The greatest force output per hand is summed to yield a combined score.
Push-ups	(1) The participant begins by lying on his or her stomach on a flat surface. The legs are together and his or her hands are pointing forward under the shoulders.
	(2) The participant pushes upward by fully extending his or her elbows and using the toes as a pivot. (For girls, the knees serve as the fulcrum.) The body is kept in a straight line and the participant's back is flat.
	(3) The participant returns to the starting position and makes contact with the floor using his or her chin, but without the stomach or thighs touching. As many repetitions are performed as possible.

Table 2.2—continued

Test	Procedures
Trunk forward flexion	(1) The participant performs two sets of the modified hurdle stretch per leg as a warm-up. S/he then begins the test with his or her knees fully extended and the soles of the feet flat against the flexometer without wearing footwear. The inner border of each foot is placed two cm from the scale.
	(2) The participant bends at his or her hip and reaches forward slowly, pushing the block as far along the scale as possible using the fingertips. S/he makes sure to keep his or her knees fully extended, the arms evenly stretched, and the palms down. If the knees flex as judged by the researcher, the trial is not counted.
	(3) The point of maximum flexion is held for two seconds. The participant performs two sets and the best trial is recorded as the true score in cm.
Partial curl-ups	(1) The participant begins in the supine position on a mat. His or her head is resting on the surface, arms are at the side and parallel to the trunk with the palms touching the mat. The tips of the participant's middle fingers are in contact with the first ridge on the mat indicative of the zero-cm mark.
	(2) The participant's knees are bent at an angle of 90^0, confirmed using a plastic goniometer. His or her heels are in contact with the mat. Footwear is worn during this test and anchoring of the feet is not permitted. A metronome is set to a cadence of 50 $\text{beats} \cdot \text{min}^{-1}$ and placed near the participant's ear.

Table 2.2—continued

Test	Procedures
Partial curl-ups	(3) On the first beat, the participant curls his or her upper spine slowly until the tips of the middle fingers come in contact with the second ridge on the mat (10-cm mark). On the second beat, s/he returns to the starting position with his or her head and shoulder blades touching the mat. Each participant is encouraged to perform as many repetitions as possible. After 25 repetitions, the test is terminated.

Care was taken by the researchers to carefully explain the purpose of the tests to each participant and to demonstrate proper execution prior to any attempts. For the push-up and partial curl-up tests, two consecutive repetitions deemed as poor by the researchers resulted in termination of the tests. Other reasons for disqualification included undue discomfort to the participant.

2.4.6 Physical Activity Assessment

2.4.6.1 Activity Monitor

Following the health-related physical fitness test battery, each participant was given a Model AM7164 activity monitor (MTI Health Services Division: Fort Walton Beach, Florida, United States) to wear for seven days. The Model AM7164 activity monitor (Figure 2.3) is a single axis accelerometer (also identified in the literature as "CSA" and "MTI"), which measures and records time-dependent accelerations of a body in the vertical plane ranging from 0.05 to 2.00 Gs. It has dimensions of 4.1 (length) by 1.5 (width) by 5.1 (height) cm and weighs 42.5 g (Schneider, nd). Frequencies of acceleration less than 0.25 and greater than 2.50 Hz are minimized so as to reduce the motion recorded from other sources not reflective of true human movement. For example, if a participant wore the activity monitor while traveling in an automobile, the vibrations recorded from the motorized vehicle would be minimal. For technical details about the model AM7164 activity monitor, refer to the Activity Monitor Operator's Manual (Schneider, nd).

Figure 2.3 Model AM7164 activity monitor with nylon belt (photo: Joel Barnes).

The Model AM7164 activity monitor has been compared to criterion measures of physical activity among young people (e.g. heart rate telemetry, observation, oxygen uptake) in laboratory- and field-based settings to provide estimates of concurrent validity. Pearson product moment correlation coefficients ranging from 0.39 to 0.87 have been reported in the literature (Coe and Pivarnik, 2001; Ekelund et al., 2001; Ott et al., 2000; Louie et al., 1999; Eston et al., 1998; Trost et al., 1998; Janz et al., 1994). Given the aim of this research project to assess the frequency, intensity, and duration dimensions of physical activity in children, accelerometry is the objective method of choice as opposed to heart rate telemetry and pedometry (Bassett, Jr., 2000). Heart rate as a measure of physical activity is influenced by emotional and environmental influences, and varies with age, level of physical fitness, and mode of exercise, thus affecting the heart rate/oxygen uptake relationship and consequent extrapolations to activity (Bassett, Jr., 2000). Pedometers provide no information about the frequency, intensity, and duration of physical activity and lack the ability to store data (Trost, 2001; Bassett, Jr., 2000).

Each participant was instructed on how to wear the activity monitor. The device was mounted on his or her right hip with a nylon belt and worn for seven consecutive days. The seven-day protocol provides a reliable estimate of usual physical activity in young people (Trost et al., 2000b; refer to Matthews et al., 2002). It was permissible for the activity monitor to be taken off for activities that involved water (e.g. bathing, swimming), high-impact sports (e.g. football, hockey), and/or sleep. However, on and off times were recorded by each participant on a log sheet provided to him or her.

To initialize the activity monitors for data collection, RIU256k software 2.26 (MTI Health Services Division: Fort Walton Beach, Florida, United States), was installed on a Toshiba Satellite 2400-S252 PS240U-02S4H3 PC Notebook (Toshiba of Canada Limited: Markham, Ontario, Canada) having Microsoft Windows XP Professional operating system (Microsoft Canada Co.: Mississauga, Ontario, Canada). A reader interface unit was connected to the laptop by a terminal-to-reader interface cable and wall transformer power supply (MTI Health Services Division: Fort Walton Beach, Florida, United States). Initialization commands were transferred from the reader interface unit to the activity monitor via coded infrared light. The same procedure was used for data retrieval.

The activity monitor output for a given participant was a series of numbers stored in a data file, which reflected his or her intensity of physical activity for a given period of time or epoch (Trost, 2001). For example, if participants A and B scored 786 and 1,344 respectively over a 30-second epoch, then participant B's physical activity was more intense than participant A's was. The epochs can range from single seconds to several minutes but most researchers use one-minute epochs (Schneider, nd). In this research project, the activity monitors were set to one-minute epochs, enabling them to gather data on 22 consecutive days (Schneider, nd).

Once all the activity monitor output was collected and stored, procedures were taken to reduce the data so the following variables could be expressed in relation to participant waking hours (means of 13.7 and 13.3 in Old Order Mennonite and rural Saskatchewan children respectively): Mean activity $counts \cdot min^{-1}$, mean activity $counts \cdot day^{-1}$, mean minutes of moderate physical $activity \cdot day^{-1}$, and minutes of vigorous physical $activity \cdot day^{-1}$. Moderate and vigorous activities were defined as age- and activity-specific $counts \cdot min^{-1}$ equal to intensities of 3.00 to 5.99 and greater than or equal to 6.00 METs respectively (Pate et al., 2002; Ainsworth et al., 2000). All activity variables were calculated with a macro developed by Dale Esliger using Microsoft Excel (Microsoft Canada Co.: Mississauga, Ontario, Canada).

In the event that a participant did not wear the activity monitor for a length of time as specified on his or her log sheet (water or high-impact activities, etc.) appropriate activity counts were supplemented. Two steps were required to accomplish this. First, an intensity for the activity was established in METs using the compendium of physical activities by Ainsworth et al. (2000). Second, this intensity was converted to counts·min^{-1} using the age-specific regression equation (Equation 2.4; refer to Appendix E) developed by Freedson et al. (1997). For further information on the cleaning procedures, consult the activity monitor data reduction protocol (Appendix F).

$$\text{Activity counts}\cdot\text{min}^{-1} = \text{METs} - 2.757 + [0.08957 \times \text{chronological age (decimal years)}] / 0.0015 - [0.000038 \times \text{chronological age}] \quad (2.4)$$

To determine whether the activity monitor data reduction protocol was reliable, inter-rater reliability testing was conducted. Two researchers cleaned the same 25 activity monitor output files, which had been randomly selected from the dataset of the Old Order Mennonite and rural Saskatchewan children. Pearson product moment correlations were calculated using the Statistical Package for Social Scientists 11.0 for Windows (SPSS Inc.: Chicago, Illinois, United States). The correlation coefficient between raters for activity counts·day^{-1} was 0.94 ($p < 0.001$). This suggests high inter-rater agreement and a reliable protocol. The coefficients were lower when activity counts·min^{-1} and minutes of moderate physical activity were compared (0.93 and 0.91, respectively), but they were still greater than 0.90. However, these results should be interpreted with caution. When the activity monitor output for the Old Order Mennonite children was compared separately, the correlation coefficients between raters were 1.00 ($p < 0.001$) for activity counts·min^{-1}, counts·day^{-1}, and minutes of moderate physical activity·day^{-1}. However, inter-rater results for the activity monitor output of the Saskatchewan children were Pearson product moment correlations of 0.92 ($p <$

0.001), 0.87 ($p < 0.001$), and 0.91 ($p < 0.001$) for activity counts·min^{-1}, counts·day^{-1}, and minutes of moderate physical activity·day^{-1} respectively. The reason for this disparity was due to the fact that the Old Order Mennonite children seldom took the activity monitors off during the day. Therefore, minimal judgment was required when reducing the activity monitor output. However, the same did not hold true for the rural Saskatchewan children. Considerable off time required a fair amount of supplemented activity counts, which meant substantial rater judgment. Thus, while the activity monitor data reduction protocol was reliable, the inter-rater reliability varied somewhat depending on the extent of rater judgment.

Seventy-seven Model AM7164 activity monitors were available for this research project. Prior to use in the field, the intra- and inter-instrument reliabilities were assessed. All 77 activity monitors were firmly secured to a hydraulic shaker plate (Figure 2.4) provided by the College of Engineering at the University of Saskatchewan. Five trials of force varying by acceleration and frequency were then applied to the activity monitors. Each trial was five minutes in duration. The measuring frequency of the activity monitors was set at a one-minute epoch. Table 2.3 provides a summary of the different experimental conditions and inter-instrument reliability results.

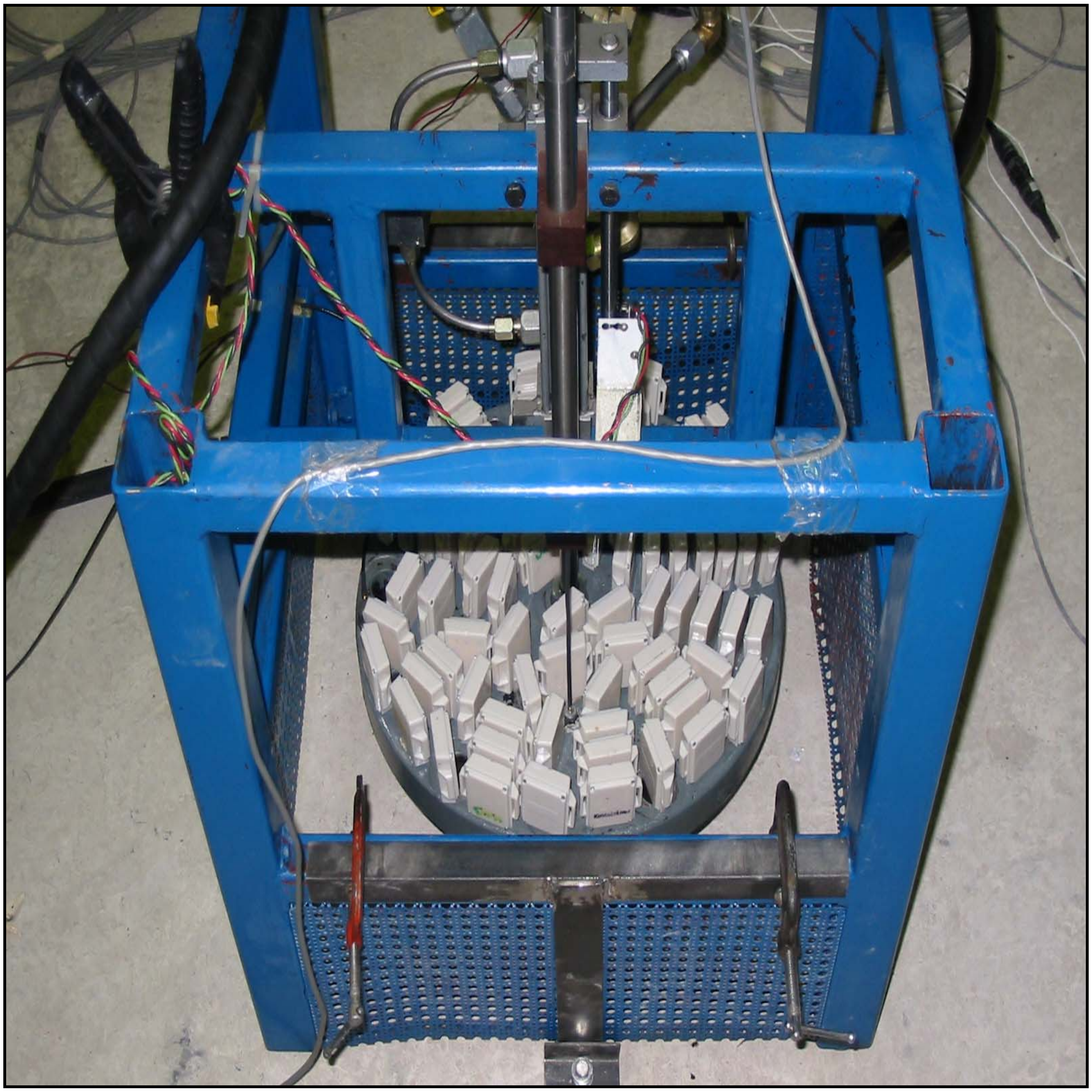

Figure 2.4 Hydraulic shaker plate used for reliability testing of the Model AM7164 activity monitors (photo: Joel Barnes).

Table 2.3 Inter-instrument reliability of 77 model AM7164 activity monitors by five-minute trials of varying acceleration and frequency.

Variable	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
Acceleration (G)	0.50	0.50	0.50	1.00	1.25
Frequency (Hz)	1.5	2.0	2.5	2.0	2.5
Activity counts·min^{-1}	3,558	2,448	1,279	5,952	6,250
Standard deviation	141	116	90	211	265
Standard error of the mean	16	14	11	25	31
Coefficient of variation (%)	*3.96	*4.74	*7.02	*3.55	*4.24
Correlation coefficient	*0.995	*0.868	*0.803	*0.973	*0.865

* $p < 0.05$ (G: G-force; Hz: Hertz)

Because the displacement capacity of the hydraulic shaker plate was limited, the range of accelerations was narrow (0.50 to 1.25 Gs). Nevertheless, the Pearson product moment correlation coefficients ranged from 0.803 to 0.995, indicative of good inter-instrument reliability. Though not reported, the intra-instrument correlation coefficients were even higher. Two of the activity monitors malfunctioned during the testing and were promptly returned to the manufacturer.

Others have also reported that the model AM7164 activity monitor is a precise tool for measuring changes in acceleration in laboratory settings (Metcalf et al., 2002). However, a call is now being made for unit-specific calibration prior to use, or statistical adjustment, because of an ostensible systematic bias and acceleration-specific differences between units (Brage et al., 2003).

Overall, activity monitor output was available for 120 Old Order Mennonite children (100% adherence). During the last week of data collection with these children, an additional four participated in the Canadian Physical Activity, Fitness, and Lifestyle Appraisal. However, time for wearing of the activity monitor was not available. Activity monitor output was also received from 137 rural Saskatchewan children (83% adherence).

2.4.6.2 Recall Questionnaire

When each participant returned his or her activity monitor, the Physical Activity Questionnaire for Older Children (Crocker et al., 1997; Kowalski et al., 1997; refer to Appendix G) was completed. This guided, self-administered seven-day recall questionnaire assesses general levels of physical activity in schoolchildren from grades four to eight during the school year (Kowalski et al., 1997). There are 10 items on the Physical Activity Questionnaire for Older Children (PAQ-C). Apart from items one and 10, questions are rated on a five-point scale. Higher scores reflect greater volumes of physical activity.

Crocker et al. (1997) reported test-retest reliability for the PAQ-C as ranging from 0.75 to 0.82 when expressed as Pearson product moment correlations for 9- to 14-year-old boys and girls respectively. Kowalski et al. (1997) found the PAQ-C to have a moderate validity correlation coefficient (r = 0.39) when compared to the Caltrac motion sensor in similar-aged children.

The PAQ-C took each participant between 10 and 20 minutes to complete. The researchers explained any questions the participant experienced difficulty with. A composite score was calculated as the mean score of the first nine items on the questionnaire. The score ranged from one to five. One hundred twenty Old Order Mennonite children and 151 rural Saskatchewan children completed the questionnaire. One Old Order Mennonite participant's questionnaire was lost, lowering that total to 119.

2.5 STATISTICAL 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 so long as 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. Both procedures are frequently used to normalize data (Vincent, 1999).

Log transformations were performed for push-ups and minutes of vigorous physical activity·day^{-1}. Outliers were removed from the data for the following variables in both groups: Sitting height, body mass index, handgrip strength, activity counts·min^{-1}, and activity counts·day^{-1}.

Comparisons were carried out using independent-samples *t* tests (chronological and biological age), univariate analyses of covariance (health-related physical fitness variables), and a multivariate analysis of covariance (physical activity variables). Univariate analyses of covariance were used with the health-related physical fitness variables because of the low interrelatedness between them. A multivariate analysis of covariance was used with the physical activity variables for the opposite reason: Because of high interrelatedness between variables. For all analyses of covariance, group and sex were the main effects. Unless stated otherwise, alpha levels were set at 0.05.

An analysis of covariance, whether univariate or multivariate, is a convenient way of equating groups statistically on factors or covariates, which may influence the dependent variable(s) (Vincent, 1999). Biological age was included as a covariate in the analyses of covariance in this research project for two reasons: First, because of its known influence on health-related physical fitness and activity (Thompson et al., 2003; Trost et al., 2002; Malina and Bouchard, 1991; Sallis et al., 2000a). Second, because of its moderate (0.30 to 0.59) to moderately high (0.60 to 0.84) relationship with selected variables in the dataset, determined using Pearson product moment correlations. In other words, biological age covaries with the dependent variables. Bonferroni adjustments were made for multiple comparisons to protect against type 1 errors (Vincent, 1999). All statistical analyses were performed using the Statistical Package for Social Scientists 11.0 for Windows (SPSS Inc.: Chicago, Illinois, United States).

Assumptions to the statistical analyses used, which were not tested for, include: Normal distribution of the variables of interest in the respective populations from whence the samples were taken, random selection of samples from the population, and homogeneity of variance between groups on the variables of interest (Vincent, 1999).

CHAPTER THREE

3.1 CHRONOLOGICAL AND BIOLOGICAL AGE COMPARISONS

The age variables in this research project were chronological and biological age. Tables 3.1, 3.2, and 3.3 summarize these variables in the format, mean ± standard deviation, and include the results of independent-samples *t* tests.

Table 3.1 Comparison of chronological and biological age between Old Order Mennonite and rural Saskatchewan children (mean ± standard deviation).

Variable	OOM	RSK	*t* ratio	*p* value
Sample size	124	165	—	—
Chronological age (years)	*11.6 ± 1.26	11.0 ± 1.20	3.995	0.0001
Biological age (years from PHV)	-1.1 ± 1.36	-1.4 ± 1.38	1.857	0.064

(OOM: Old Order Mennonite children; RSK: Rural Saskatchewan children; PHV: Peak height velocity)

* Significant after Bonferroni adjustment for multiple comparisons ($p < 0.025$)

Table 3.2 Comparison of chronological and biological age between Old Order Mennonite and rural Saskatchewan boys (mean ± standard deviation).

Variable	OOM	RSK	*t* ratio	*p* value
Sample size	67	75	—	—
Chronological age (years)	*11.5 ± 1.25	10.8 ± 1.22	3.102	0.002
Biological age (years from PHV)	*-1.9 ± 0.99	-2.4 ± 0.94	3.017	0.003

(OOM: Old Order Mennonite children; RSK: Rural Saskatchewan children; PHV: Peak height velocity)

* Significant after Bonferroni adjustment for multiple comparisons ($p < 0.025$)

Table 3.3 Comparison of chronological and biological age between Old Order Mennonite and rural Saskatchewan girls (mean ± standard deviation).

Variable	OOM	RSK	*t* ratio	*p* value
Sample size	57	90	—	—
Chronological age (years)	*11.7 ± 1.27	11.1 ± 1.17	2.775	0.006
Biological age (years from PHV)	*-0.2 ± 1.13	-0.6 ± 1.14	2.298	0.023

(OOM: Old Order Mennonite children; RSK: Rural Saskatchewan children; PHV: Peak height velocity)

* Significant after Bonferroni adjustment for multiple comparisons ($p < 0.025$)

Bonferroni adjustments were performed to protect against type 1 error. This required the single-test alpha level ($p = 0.05$) to be divided by the number of t tests (two). The dividend was an alpha level of 0.025, which was necessary for statistical significance.

When age was expressed chronologically, Old Order Mennonite children were approximately 0.5 years older than rural Saskatchewan children (11.6 vs. 11.0 years). Biological age was significantly different when groups were compared by sex: Old Order Mennonite boys and girls were approximately 0.5 years nearer peak height velocity than their rural Saskatchewan counterparts.

3.2 HEALTH-RELATED PHYSICAL FITNESS COMPARISONS

The health-related physical fitness variables included standing and sitting heights, body mass, waist girth, triceps skinfold, body mass index, the Modified Canadian Aerobic Fitness Test score, handgrip strength (both hands combined), push-ups, trunk forward flexion, and partial curl-ups. Tables 3.5 and 3.6 relate the differences in these variables between groups and sex respectively. The screening variables, heart and blood pressure, are also included. Data are in the form mean ± standard error. The means in normal type font are adjusted for biological age while the means in bold type font remain unadjusted. The number of participants differed by variable due to missing data.

Due to the nature of the partial curl-ups, that is, termination of the test once 25 repetitions were performed, the corresponding data did not meet the assumptions of normality. Therefore, partial curl-ups were analyzed non-parametrically using a Mann-Whitney U test. Table 3.4 summarizes the results, which were not significant.

Table 3.4 Comparison of partial curl-ups between groups: Results of Mann-Whitney U Test.

Variable	OOM	RSK
Mean rank	139.6	148.2
Sum of ranks	17309.5	24306.5
Mann-Whitney U	9559.5	—
Z score	-0.886	—
p value	0.376	—

(OOM: Old Order Mennonite children; RSK: Rural Saskatchewan children)

Table 3.5 Comparison of health-related physical fitness between Old Order Mennonite and rural Saskatchewan children (biological age-adjusted mean ± standard error with non-adjusted mean ± standard deviation on the next row in bold type font) with group as main effect.

Variable	OOM	RSK	*F* ratio	*p* value	R^2
Heart rate (beats·min^{-1})	90 ± 1.2	86 ± 1.0	6.224	0.013	0.022
	90 ± 11.8	**87 ± 13.6**			
Systolic blood pressure (mmHg)	*121 ± 0.9	111 ± 0.8	55.586	0.0001	0.165
	121 ± 10.5	**111 ± 11.0**			
Diastolic blood pressure (mmHg)	*79 ± 0.7	73 ± 0.6	41.501	0.0001	0.128
	79 ± 7.6	**73 ± 7.7**			
Standing height (cm)	147.2 ± 0.45	148.0 ± 0.40	1.898	0.169	0.007
	149.1 ± 9.25	**146.4 ± 10.02**			
Sitting height (cm)	*76.8 ± 0.24	78.2 ± 0.21	17.876	0.0001	0.060
	77.7 ± 4.61	**78.0 ± 6.14**			
Body mass (kg)	42.8 ± 0.60	42.7 ± 0.52	0.017	0.898	0.0001
	44.4 ± 10.03	**41.4 ± 10.04**			
Waist girth (cm)	67.2 ± 0.56	65.6 ± 0.49	5.056	0.025	0.018
	68.0 ± 6.79	**65.1 ± 7.27**			
Triceps skinfold (mm)	16.4 ± 0.63	17.8 ± 0.55	2.881	0.091	0.010
	16.6 ± 6.78	**17.9 ± 7.66**			

(OOM: Old Order Mennonite children; RSK: Rural Saskatchewan children)

* Significant after Bonferroni adjustment for multiple comparisons ($p < 0.0038$)

Table 3.5—continued

Variable	OOM	RSK	*F* ratio	*p* value	R^2
Body mass index (kg·m^{-2})	19.5 ± 0.24	19.1 ± 0.21	1.832	0.177	0.007
	19.8 ± 2.99	**19.1 ± 2.99**			
mCAFT (aerobic fitness score)	514 ± 4.6	499 ± 4.0	5.393	0.021	0.019
	514 ± 65.7	**498 ± 62.5**			
Handgrip strength (kg)	*58 ± 0.8	50 ± 0.7	66.147	0.0001	0.191
	61 ± 13.9	**48 ± 11.1**			
Push-ups (log transformation)	0.94 ± 0.030	1.05 ± 0.027	6.712	0.010	0.027
(reps)	**10 ± 8.0**	**12 ± 9.8**			
Trunk forward flexion (cm)	*26.7 ± 0.63	29.5 ± 0.55	10.908	0.001	0.037
	26.5 ± 6.66	**29.8 ± 7.78**			

(OOM: Old Order Mennonite children; RSK: Rural Saskatchewan children; mCAFT: Modified Canadian Aerobic Fitness Test)

* Significant after Bonferroni adjustment for multiple comparisons ($p < 0.0038$)

Table 3.6 Comparison of health-related physical fitness between children (biological age-adjusted mean ± standard error with non-adjusted mean ± standard deviation on the next row in bold type font) with sex as main effect.

Variable	Boys	Girls	*F* ratio	*p* value	R^2
Heart rate (beats·min^{-1})	86 ± 1.3	91 ± 1.3	4.863	0.028	0.017
	88 ± 12.7	**89 ± 13.2**			
Systolic blood pressure (mmHg)	118 ± 1.0	114 ± 1.0	4.641	0.032	0.016
	115 ± 10.7	**116 ± 13.1**			
Diastolic blood pressure (mmHg)	77 ± 0.7	75 ± 0.7	2.110	0.147	0.007
	75 ± 7.7	**76 ± 8.9**			
Standing height (cm)	*153.7 ± 0.48	141.5 ± 0.49	251.940	0.0001	0.472
	146.8 ± 9.58	**148.3 ± 9.93**			
Sitting height (cm)	*80.3 ± 0.26	74.7 ± 0.27	179.606	0.0001	0.392
	77.0 ± 4.43	**78.7 ± 6.32**			
Body mass (kg)	*47.7 ± 0.64	37.8 ± 0.65	94.320	0.0001	0.251
	41.6 ± 9.32	**43.8 ± 10.77**			
Waist girth (cm)	*68.3 ± 0.60	64.5 ± 0.60	15.863	0.0001	0.053
	65.5 ± 6.99	**67.1 ± 7.34**			
Triceps skinfold (mm)	16.5 ± 0.68	17.8 ± 0.68	1.399	0.238	0.005
	15.5 ± 6.91	**19.1 ± 7.27**			

* Significant after Bonferroni adjustment for multiple comparisons ($p < 0.0038$)

Table 3.6—continued

Variable	Boys	Girls	*F* ratio	*p* value	R^2
Body mass index ($kg \cdot m^{-2}$)	*20.0 ± 0.26	18.6 ± 0.26	10.250	0.002	0.0350
	19.1 ± 2.86	**19.6 ± 3.13**			
mCAFT (aerobic fitness score)	*535 ± 4.9	478 ± 4.9	53.407	0.0001	0.1600
	545 ± 51.0	**467 ± 51.8**			
Handgrip strength (kg)	*63 ± 0.8	46 ± 0.9	160.308	0.0001	0.3630
	55 ± 13.5	**52 ± 13.9**			
Push-ups (log transformation)	0.93 ± 0.034	1.06 ± 0.032	5.977	0.015	0.2400
(reps)	**8 ± 7.4**	**13 ± 9.9**			
Trunk forward flexion (cm)	*25.6 ± 0.67	30.7 ± 0.68	22.621	0.0001	0.0740
	25.7 ± 6.85	**31.0 ± 7.15**			

(mCAFT: Modified Canadian Aerobic Fitness Test)

* Significant after Bonferroni adjustment for multiple comparisons ($p < 0.0038$)

Bonferroni adjustments were performed to protect against type 1 error during the health-related physical fitness comparisons. This required the single-test alpha level (p = 0.05) to be divided by the number of univariate tests (13). The dividend was an alpha level of 0.0038, which was necessary for statistical significance.

There were statistically significant differences in systolic and diastolic blood pressure readings between groups. Old Order Mennonite children had consistently higher values. Between-sex comparisons were not significant.

The body composition variables (body mass, waist girth, triceps skinfold, and body mass index) showed no difference between groups. However, boys had greater body mass, waist girth, and body mass index than girls when comparisons were adjusted for biological age.

Boys performed significantly better on the Modified Canadian Aerobic Fitness Test and in handgrip strength than girls. However, girls outperformed boys on the trunk forward flexion test.

3.3 PHYSICAL ACTIVITY COMPARISONS

Physical activity variables included activity counts·min^{-1}, activity counts·day^{-1}, minutes of moderate physical activity·day^{-1}, minutes of vigorous physical activity·day^{-1}, and the Physical Activity Questionnaire for Older Children (PAQ-C) score. Because these variables are closely related (the first four were taken from each participant on the same instrument over the same interval), a multivariate analysis of covariance was used to detect statistical differences (Tables 3.7 and 3.8). The alpha level was set at 0.05.

Table 3.7 Comparison of physical activity between Old Order Mennonite and rural Saskatchewan children (biological age-adjusted mean ± standard error with non-adjusted mean ± standard deviation on the next row in bold type font) with group as main effect.

Variable	OOM	RSK	*F* ratio	*p* value	R^2
Activity counts·min^{-1}	*592 ± 11.4	540 ± 11.0	10.558	0.001	0.042
	596 ± 125.9	**549 ± 151.3**			
Activity counts·day^{-1}	*483,637 ± 9,172.0	426,651 ± 8,877.2	19.360	0.0001	0.075
	487,865 ± 102,363.2	**433,773 ± 122,691.3**			
Moderate physical activity (min·day^{-1})	*139 ± 3.0	112 ± 2.9	38.764	0.0001	0.139
	136 ± 36.9	**118 ± 45.5**			
Vigorous physical activity (log transformation)	1.02 ± 0.033	0.92 ± 0.031	0.120	0.730	0.0001
(min·day^{-1})	**13 ± 7.6**	**13 ± 11.4**			
PAQ-C (score)	3.06 ± 0.059	3.04 ± 0.057	0.060	0.807	0.0001
	3.05 ± 0.565	**3.00 ± 0.687**			

(OOM: Old Order Mennonite children; RSK: Rural Saskatchewan children; PAQ-C: Physical Activity Questionnaire for Older Children)

* $p < 0.05$

Table 3.8 Comparison of physical activity between children (biological age-adjusted mean ± standard error with non-adjusted mean ± standard deviation on the next row in bold type font) with sex as main effect.

Variable	Boys	Girls	*F* ratio	*p* value	R^2
Activity counts·min^{-1}	*590 ± 13.0	542 ± 12.9	5.436	0.021	0.022
	621 ± 143.6	**522 ± 121.2**			
Activity counts·day^{-1}	*479,039 ± 10,460.3	431,249 ± 10,380.6	8.268	0.004	0.033
	500,185 ± 115,745.2	**418,194 ± 102,621.2**			
Moderate physical activity (min·day^{-1})	121 ± 3.4	130 ± 3.4	2.741	0.099	0.011
	140 ± 41.4	**113 ± 39.4**			
Vigorous physical activity (log transformation)	1.00 ± 0.037	0.95 ± 0.037	0.897	0.345	0.004
(min·day^{-1})	**15 ± 10.2**	**10 ± 8.7**			
PAQ-C (score)	3.09 ± 0.067	3.00 ± 0.067	0.686	0.408	0.003
	3.09 ± 0.636	**2.96 ± 0.631**			

(PAQ-C: Physical Activity Questionnaire for Older Children)

* $p < 0.05$

Old Order Mennonite children were more physically active when accelerometry was reduced to activity counts·min^{-1}, activity counts·day^{-1}, and minutes of moderate physical activity·day^{-1}. However, no statistically significant differences were found in minutes of vigorous physical activity·day^{-1}.

Noticeable by their absence were any differences in PAQ-C composite scores between groups. In view of the accelerometry results, this suggests poor concurrent validity. Figures 3.1 and 3.2 illustrate the relationship between mean activity counts·day^{-1} and mean PAQ-C composite scores in Old Order Mennonite (r = -0.02; p = 0.80) and rural Saskatchewan children (r = 0.39; p < 0.001) respectively.

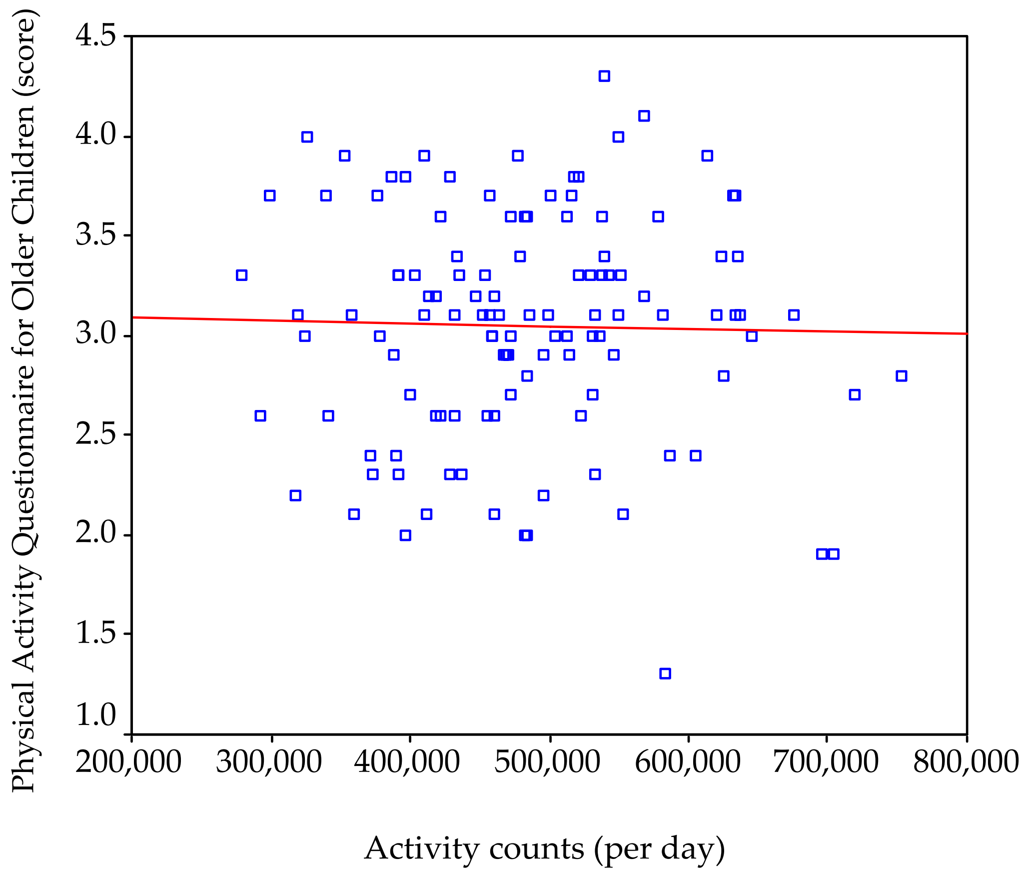

Figure 3.1 Plot of mean activity counts·day^{-1} against mean Physical Activity Questionnaire for Older Children scores in Old Order Mennonite children (r = -0.02; p = 0.80).

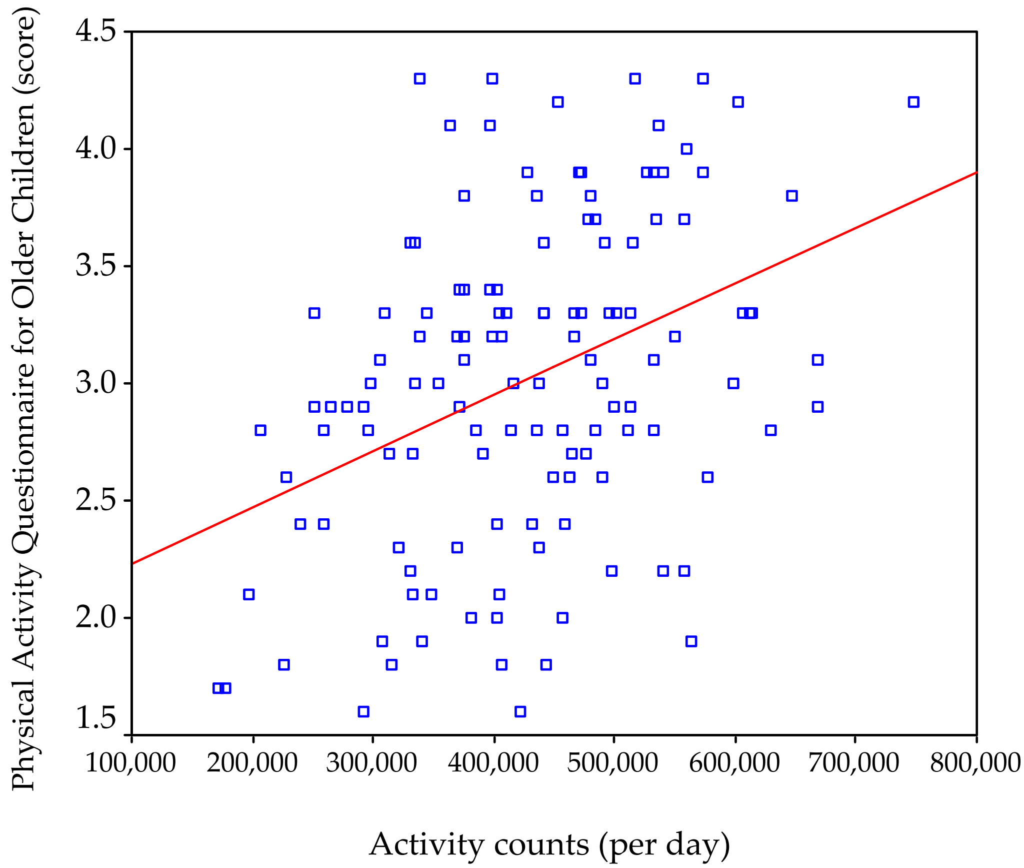

Figure 3.2 Plot of mean activity counts·day^{-1} against mean Physical Activity Questionnaire for Older Children scores in rural Saskatchewan children (r = 0.39; $p < 0.001$).

CHAPTER FOUR

The objective of this research project was to compare health-related physical fitness and activity between two groups of 9- to 12-year-olds: Old Order Mennonite children in southwestern Ontario and rural children in central Saskatchewan.

4.1 HYPOTHESIS ONE

Under the assumption that the Old Order Mennonite way of life reflects many aspects of the lifestyle in Canadian mainstream society between 50 and 100 years ago, it was predicted that Old Order Mennonite children would demonstrate greater health-related physical fitness possibly because of their lifestyle, which may provide more opportunities for physical activity and, subsequently, the development of physical fitness than the lifestyle of rural children in central Saskatchewan, which is believed to be more sedentary.

4.1.1 Screening Variables

The screening variables in this research project included heart rate and blood pressure measurements in the seated position. Only the latter measure was significantly different between groups.

Normative heart rates in the seated position are between 70 and 80 beats·min^{-1} for tweens (Malina and Bouchard, 1991). Therefore, the elevated values of 90 ± 1.0 and 86 ± 1.0 beats·min^{-1} in Old Order Mennonite and rural Saskatchewan children respectively are bothersome. However, these results may be indicative of emotional state rather than heart functionality or cardiovascular health. Despite all attempts to relax them prior to testing, many of the participants appeared nervous—particularly the Old Order Mennonite children. When the researchers arrived to test them, some of the Old Order Mennonite children were called from their chores in the barn. In such cases, heart rate would have been elevated as a result of physical exertion and, therefore, invalidated as a resting value.

Though seated blood pressure measurements (systolic and diastolic) were greater in Old Order Mennonite children, the readings would be considered healthy for both groups (less than 126 and 82 mmHg for systolic and diastolic blood pressures respectively) according to the Report of the Second Task Force on Blood Pressure Control in Children (National Institute of Health, 1987 cited by Bouziotas et al., 2001). Guerro et al. (2002) reported similar systolic blood pressures in 8- to 13-year-old Portuguese boys and girls (118 ± 10.8 and 118 ± 11.8 mmHg respectively), who demonstrated a similar body mass index (19.3 ± 8.2 and 19.1 ± 7.4 $kg \cdot m^{-2}$ respectively) to the Old Order Mennonite and rural Saskatchewan children in this research project. However, the diastolic blood pressures in this research project were elevated when compared to the data of Guerro et al. (2002). Perhaps the argumentation advanced for the elevated resting heart rates applies here: Anxiety and/or physical exertion may have negated the true nature of the measurements so they were no longer resting values. Additionally, if multiple blood pressure measurements would have been taken, the mean values on subsequent readings would likely have been lower due to a reduction in emotional status among the participants, especially among the Old Order Mennonite children.

It is known that heavier and/or taller children tend to exhibit higher blood pressure when compared to lighter and/or shorter children (Guerro et al., 2002). The lack of statistical significance in body mass and standing height between groups in this research project would seem to rule out that explanation.

Alternate causes for variation in blood pressure in children and adolescents include genetics and socioeconomic status (Reddy, 1998; Malina and Bouchard, 1991). Given that Old Order Mennonites practice strict endogamy (Fretz, 1978) and may be of a lower socioeconomic status than the majority of Canadians (Horst, 2000), these explanations may be valid. However, caution is advised in interpreting these variables due to the role they served in this research project, which was to screen the participants. The variables were not taken in a rigorously controlled environment.

4.1.2 Body Composition

Body composition measurements (body mass, waist girth, triceps skinfold, body mass index) yielded non-significant results. Though Old Order Mennonite children were expected to be leaner possibly because of their activity-enhanced lifestyle, this was not observed. In fact, a greater proportion of Old Order Mennonite children (31%) than rural Saskatchewan children (25%) were overweight and/or obese when body mass index was compared to age- and sex-specific cutoffs developed by the International Obesity Task Force of the World Health Organization (Cole et al., 2000). These prevalence estimates are similar to those reported by Tremblay et al. (2002) in nationally representative samples of 7- to 13-year-old Canadian children.

The lack of statistical significance in body composition variables between groups may be partially explained by the inherent problems common to skinfold measurements and body mass index in small samples. For example, the triceps skinfold is one of the most commonly used sites for assessment of subcutaneous fat distribution in growth studies (Malina and Bouchard, 1991). Unfortunately, intra- and inter-individual reliability of skinfold measurements are difficult to establish with reliability decreasing as body fat increases for a given individual (Dietz and Robinson, 1998).

Like the triceps skinfold, body mass index is one of the most frequently used indices of body composition (Daniels et al., 1997). However, body mass index is limited because of its derivation from body dimensions. Ideally, the definition of body composition should be based on body fat (Tyrrell et al., 2001; Cole et al., 2000). Additionally, body mass index has been found to have variable sensitivity, that is, limited utility in detecting those who are at increased risk for overweight (Malina and Katzmarzyk, 1999). Nevertheless, in field-based settings and epidemiological studies, skinfolds and body mass index are preferable because of their simplicity of computation and low cost (Curtin et al., 1997).

In explaining the lack of differences in body composition between groups, it should be observed that the difference in physical activity between groups (8.7% when mean activity counts·min^{-1} were compared) may not have been biologically meaningful and, therefore, inefficacious in eliciting a more lean body mass among Old Order Mennonite children. Indeed, when determining sample sizes for this research project, we assumed that nothing less than a 15% difference in physical activity as assessed by accelerometry would be biologically meaningful (refer to Chapter 1).

Another confounding factor is diet as stated in Chapter 1. Perhaps the benefits of lifestyle-related physical activity on body composition in Old Order Mennonite children were masked by a high-fat diet. For example, Glick et al. (1998) administered a 60-item food frequency questionnaire to 250 Old Order Mennonite adults in Yates County, New York, United States. They found that Old Order Mennonites consumed a diet high in total fat, saturated fat, and cholesterol. Others have reported similar findings (Michel et al., 1993). However, the likely explanation for the non-significance of the body composition variables in this research project was no real difference.

4.1.3 Cardiorespiratory Endurance

Despite their poorer blood pressure profile when compared to rural Saskatchewan children, Old Order Mennonite children did not demonstrate a significantly inferior aerobic fitness score on the Modified Canadian Aerobic Fitness Test. It has been noted previously that blood pressure is weakly associated with cardiorespiratory fitness in children and adolescents across age and sex (Guerra et al., 2002; Bazzano et al., 1992; Armstrong et al., 1991), thus resolving the ostensible incongruence between a non-significant difference in aerobic fitness despite a relatively poorer blood pressure profile among Old Order Mennonite children.

Numerous scientists have speculated that decreased physical activity and increased sedentariness have been major contributors to the secular deterioration across aerobic fitness observed in field-based studies involving young people (Tomkinson et al., 2003; Westerstahl et al., 2003; Dawson et al., 2001; Dollman et al., 1999; Rode and Shephard, 1993). Previously, Sunnegårdh and Bratteby (1987) reported correlation coefficients of 0.41 and 0.48 between daily activity scores assessed by questionnaire/interview and maximum oxygen uptake via a maximal cycle ergometer test and gas analysis in 101, 8- to 13-year-old Swedish children and adolescents. Atomi et al. (1986) found an even higher correlation coefficient of 0.74 between physical activity assessed by heart rate telemetry (greater than or equal to 60% of maximum oxygen uptake) and maximum oxygen uptake via a maximal treadmill test and gas analysis in 11 9- to 10-year-old Japanese boys. They concluded that the "volume (intensity and duration) of daily physical activity above [a heart rate] corresponding to 60% VO_{2max} in preadolescent children might contribute to increase [sic] aerobic power."

Raudsepp and Jürimäe (1996) reported a moderate correlation (r = 0.41) between moderate to vigorous physical activity as assessed by a 7-day recall questionnaire and aerobic fitness estimated using a 20-meter endurance shuttle run in 10- to 11-year-old Estonian girls. More recently, Loftin et al. (1998) compared moderate to vigorous physical activity assessed by heart rate telemetry to peak oxygen uptake via a maximal treadmill test and gas analysis in 32 elementary and high school girls. They reported zero-order correlation coefficients ranging from 0.05 to 0.34. In this research project, Pearson product moment correlations for aerobic fitness scores and activity counts·min^{-1} were 0.33 and 0.34 (p < 0.05) in Old Order Mennonite and rural Saskatchewan children respectively. However, these moderate correlations do not suggest that physical activity differences in the magnitude of 9% between groups are contributory to differences in aerobic fitness.

In a review of the extant literature, Morrow, Jr. and Freedson (1994) concluded that physical activity and aerobic fitness typically demonstrate a low correlation (0.16 to 0.17) in children and adolescents. However, their conclusion could be challenged on the grounds that the physical activity measurements (e.g. interview, questionnaire) and aerobic fitness methodologies (e.g. maximal tests, submaximal tests, field-based tests) were far too diverse and/or limited to merit comparison. Morrow, Jr. and Freedson (1994) themselves admitted that further research investigating the association between physical activity and aerobic fitness in children was needed.

4.1.4 Musculoskeletal Fitness

4.1.4.1 Static Strength

Handgrip strength is a measure of static strength, that is, the force exerted against an external load which is unaccompanied by a change in muscle length (Malina and Bouchard, 1991). Static strength increases linearly in boys until the age of 13 or 14 years when it accelerates as a result of increased lean body mass (Beunen et al., 2003; Malina and Bouchard, 1991). The increase in static strength continues until 16 or 17 years in girls without the spike manifest in boys (Beunen et al., 2003; Malina and Bouchard, 1991). Figure 4.1 is a plot of maturity-adjusted mean handgrip strength (combined score of both hands in kg) against chronological age in years between Old Order Mennonite and rural Saskatchewan children. (The lines were smoothed using spline adjustments.) Figure 4.1 illustrates the increase in static strength across age in both groups and the better performance of the Old Order Mennonite children.

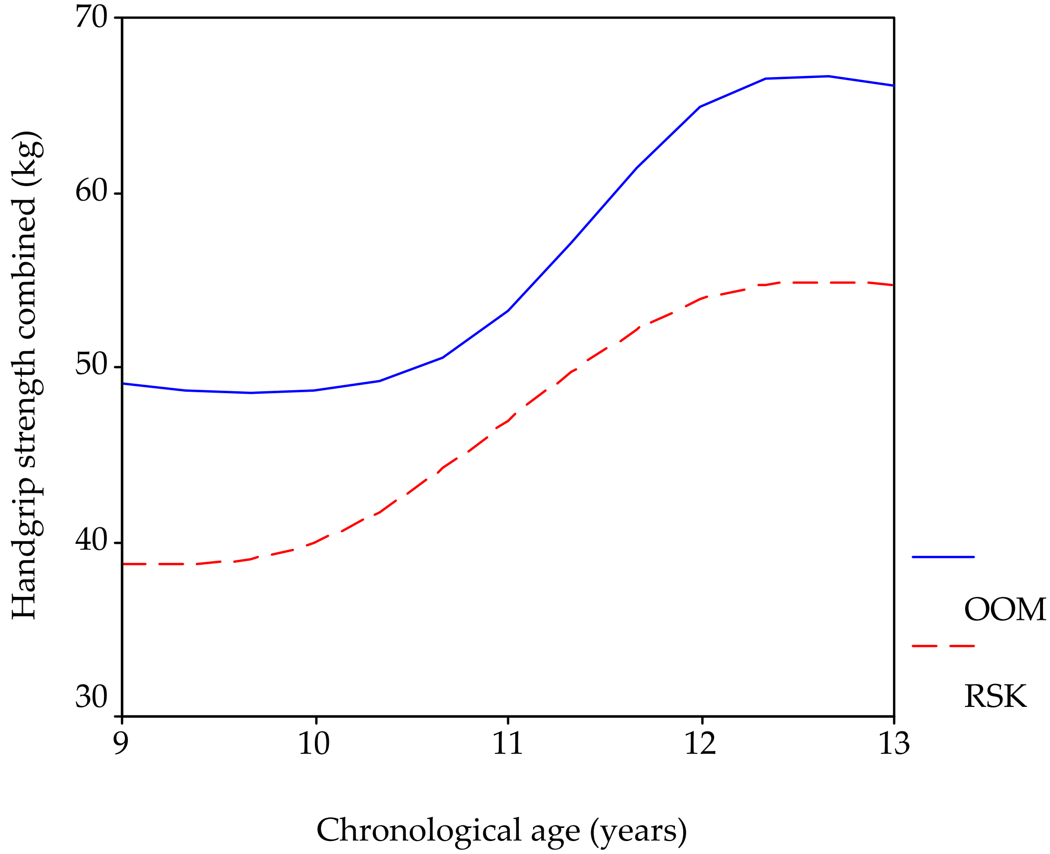

Figure 4.1 Plot of biological age-adjusted mean handgrip strength (right and left hands combined) against chronological age in Old Order Mennonite and rural Saskatchewan children (OOM: Old Order Mennonite children; RSK: Rural Saskatchewan children).

Given that handgrip strength serves as an index of upper body strength (Canadian Society for Exercise Physiology, 1999), Old Order Mennonite children may have exhibited greater upper body strength than rural Saskatchewan children. These differences persisted between groups when handgrip strength was expressed relative to body mass (1.4 ± 0.25 vs. 1.2 ± 0.20 $kg{\cdot}kg^{-1}$ of body mass). Based on Canadian musculoskeletal fitness norms (Payne et al., 2000), which are only available for 15- to 69-year-olds, the handgrip strength of Old Order Mennonite girls matches that of 15- to 19-year-old girls in Canada (56 ±

2.0 kg). However, Old Order Mennonite boys are far from reaching the norms for 15- to 19-year-old boys (94 ± 2.0 kg). This sex difference can likely be explained by the earlier maturation in girls (Malina and Bouchard, 1991) and the nonlinear strength gains in boys of 14 years and older, commensurate with accelerated increases in lean mass as previously described. Based on data published by Malina and Bouchard (1991), rural Saskatchewan children had normative handgrip strength. Old Order Mennonite children demonstrated above average values.

One explanation for the observed difference in static strength may be the agrarian lifestyle of Old Order Mennonites. From a young age children perform farm chores (e.g. feeding animals, hay bailing), which may improve their strength (Horst, 2000). This accords with the general consensus that prepubescent children can experience relative gains in muscular strength from training as much as pubescent children and adolescents can (Bar-Or and Malina, 1995).

Genetic variations between groups may also be explanative of the observed difference in handgrip strength. Beunen et al. (2003) measured the static strength of 105 Belgium twin pairs as they aged from 10 to 18 years. The arm pull test was employed on a semi-annual basis. Using path models and intra-pair correlations on the data, Beunen et al. (2003) reported static strength in children and adolescents as having a "moderate to moderately strong" genetic influence. Because of their reproductive isolation (Rensberger, 2003; Fretz, 1978), it is likely that genetic influences on static strength in Old Order Mennonite children differ significantly from other populations like rural Saskatchewan children and, thereby, introduce a confounding factor.

4.1.4.2 Dynamic Strength and Muscular Endurance

High levels of muscular strength and endurance offer numerous benefits to an individual's quality of life (e.g. bone health, mobility, decreased fracture risk), psychological well-being, and mortality, which vary across age and sex (Warburton et al., 2001). Push-ups and partial curl-ups provide information about muscular strength and endurance (Canadian Society for Exercise Physiology, 1999). There was no statistically significant difference in push-ups or partial curl-ups between Old Order Mennonite and rural Saskatchewan children. This is difficult to interpret because of the better performance of the Old Order Mennonite children on the handgrip test. One explanation for the discrepancy is that Old Order Mennonite children were not familiar with push-ups. Old Order Mennonite young people in southwestern Ontario do not have physical education as part of their school curriculum. Consequently, they may not have learned how to perform push-ups as the rural Saskatchewan children probably have. The researchers noted this general inexperience when they tested the Old Order Mennonite children. However, this may not be incompatible with the better performance of the Old Order Mennonite children on the handgrip strength test if, in fact, that test demonstrated a lifestyle-related adaptation in the Old Order Mennonite children as previously described rather than providing a pure index of upper body strength.

4.1.4.3 Flexibility

The trunk forward flexion test, also known as the v-tie reach or sit-and-reach (Corbin and Pangrazi, 1992), determines range of motion in the hip joint (Albert et al., 2001). It also assesses flexibility of the lower back and upper thigh (Malina and Bouchard, 1991). Old Order Mennonite children were observed to be less flexible than rural Saskatchewan children.

Part of the difference between groups may be explained by clothing. The researchers noted that the Old Order Mennonite children tended to wear tight, restrictive clothing. Rural Saskatchewan children, on the other hand, wore “relaxed fit” clothing more in keeping with the current styles in mainstream society in Canada.

Compared to other trunk forward flexion data from Australia (Dawson et al., 2001) and the United States (Reiff et al., 1986), Old Order Mennonite and rural Saskatchewan children fair well (Figure 4.2).

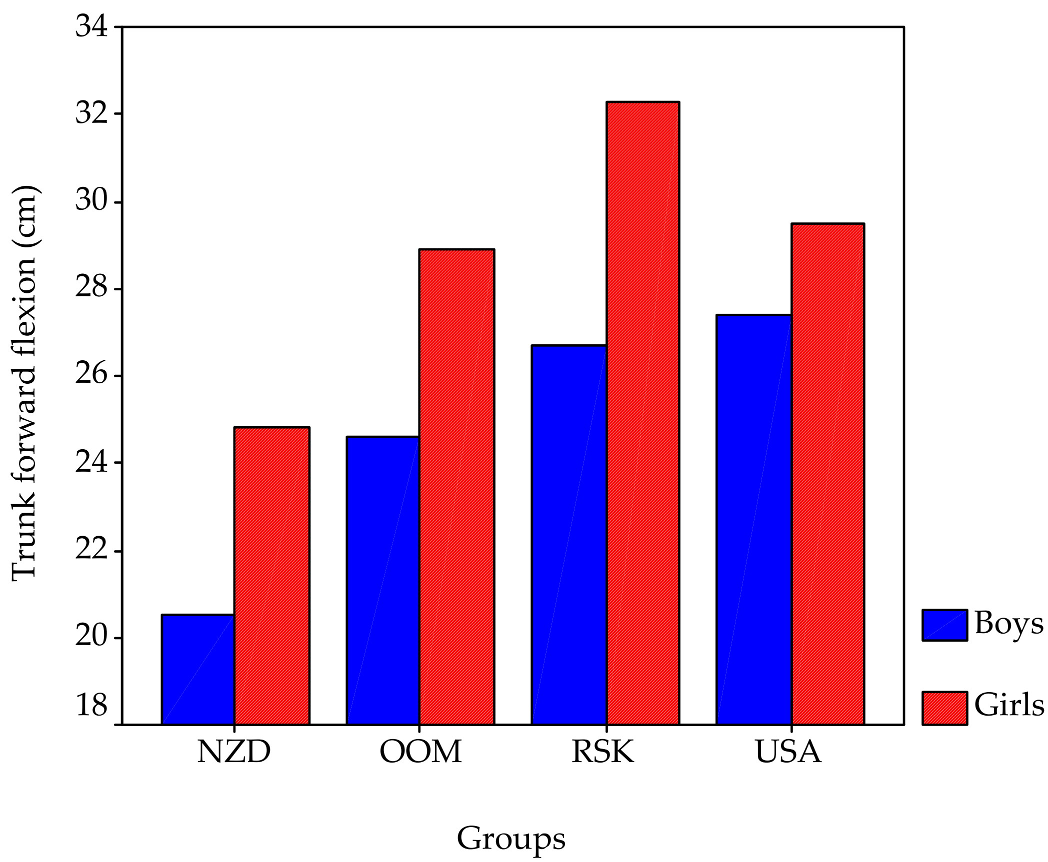

Figure 4.2 Trunk forward flexion scores in samples of 9- to 14-year-old boys and girls (NZD: New Zealand children, Dawson et al., 2001; OOM: Old Order Mennonites; RSK: Rural Saskatchewan children; USA: American children; Reiff et al., 1986).

Old Order Mennonite and rural Saskatchewan children had greater trunk forward flexion scores than New Zealand children and adolescents across sex. However, Old Order Mennonite and rural Saskatchewan boys performed poorer than American boys from the 1985 National School Population Fitness Survey. Old Order Mennonite and American girls had similar scores while rural Saskatchewan girls demonstrated superior performance.

4.2 HYPOTHESIS TWO

According to the second hypothesis, Old Order Mennonite children would demonstrate superior physical activity for reasons related to their lifestyle as stated previously.

4.2.1 Physical Activity

4.2.1.1 Accelerometry

Old Order Mennonite children received 152 ± 3.5 (biological age-adjusted mean ± standard error) minutes of moderate to vigorous physical activity·day^{-1} (greater than or equal to 3.0 METs), which was significantly more than the 126 ± 3.3 minutes that rural Saskatchewan children received each day. Table 4.1 summarizes the studies that have reported mean activity counts·min^{-1}, mean minutes of moderate physical activity·day^{-1}, and mean minutes of vigorous physical activity·day^{-1} in similar-aged children and adolescents using the same activity monitor that was employed in this research project.

Table 4.1 Mean activity counts·min^{-1} and mean minutes of moderate to vigorous physical activity·day^{-1} in children and adolescents as assessed by accelerometry.

Authors	Sample	BMI (kg·m^{-2})	Protocol	Results
Santos et al., 2003	n = 157 8- to 15-year-old Portuguese children and adolescents	Boys: 20.1 Girls: 20.0	3 consecutive school days of monitoring	MVPA: 87 and 66 min per day in boys and girls respectively across age
Mota et al., 2002b	n = 118 8- to 15-year-old and non-obese Portuguese children and adolescents	Boys: 18.7 Girls: 19.1	3 consecutive school days of monitoring	CMIN: 617 and 537 in boys and girls respectively across age
				MVPA: 88 and 69 min per day in boys and girls respectively across age
Mota et al., 2002c	n = 109 8- to 16-year-old Portuguese children and adolescents	Boys: 20.3 Girls: 20.5	3 consecutive school days of monitoring	CMIN: 624 and 523 in boys and girls respectively across age

(BMI: Body mass index; MVPA: Moderate to vigorous physical activity; CMIN: Activity counts·min^{-1})

Table 4.1—continued

Authors	Sample	BMI (kg·m^{-2})	Protocol	Results
Ekelund et al., 2001	n = 26, 9-year-old Danish children	Boys: 16.8 Girls: 19.2	14 consecutive days of monitoring during the school year	CMIN: 626 and 689 in boys and girls respectively
Janz et al., 1995	n = 30, 7- to 15-year-old American children and adolescents	N/A	6 consecutive days of monitoring during summer vacation	CMIN: 155 and 104 in boys and girls respectively across age
Janz, 1994	n = 31, 7- to 15-year old American children and adolescents	N/A	3 consecutive days of monitoring during the school year	CMIN: 147 across age and sex

(BMI: Body mass index; N/A: Not available; CMIN: Activity counts·min^{-1})

Despite the various measurement protocols used, Old Order Mennonite and rural Saskatchewan children had mean activity counts·min^{-1} similar to those reported by others in Table 4.1 (Mota et al., 2002b; Ekelund et al., 2001). However, values were much greater than those reported by Janz et al. (1995) and Janz (1994). This may be explained in that the latter two studies employed different data reduction techniques; or perhaps the participants were simply less physically active. Neither Janz et al. (1995) or Janz (1994) reported the physical characteristics of their participants. This adds to the difficulty in interpreting the low activity counts·min^{-1}. For example, their participants may have been exceedingly heavy, possibly contributing to low activity. Additionally, sleep time may not have been accounted for prior to analysis, which would have diluted mean activity counts·min^{-1}.

Where the results in this research project differ from previous studies is in mean minutes of moderate to vigorous physical activity·day^{-1}. Using similar data reduction procedures to those employed in this research project, Santos et al. (2003) and Mota et al. (2002b) reported near 1.5 and 1.0 hour(s) of moderate to vigorous physical activity·day^{-1} in boys and girls respectively. However, Old Order Mennonite boys and girls attained near 3.0 and over 2.0 hours of moderate to vigorous physical activity·day^{-1} respectively. Though significantly less than what Old Order Mennonite children received, rural Saskatchewan boys and girls also received high amounts of moderate to vigorous physical activity·day^{-1} (144 ± 49.3 and 120 ± 49.4 min·day^{-1} respectively).

Though the mean activity counts·min^{-1} in this research project were similar to other studies, mean minutes of moderate to vigorous physical activity·day^{-1} were quantitatively different—even when similar data reduction protocols were followed. This may be explained by variability in the datasets. Welk et al. (2000) stated that activity patterns in children tend to be positively skewed. Therefore, physical activity values (e.g. activity counts·min^{-1}) may be biased by a few participants performing high amounts of physical activity or by many participants receiving little activity. The coefficients of variation (standard deviation / mean) in the studies from Table 4.1 ranged from 35 to 44%. These statistics reflect large inter-individual variability in activity habits (Welk et al., 2000). Though the moderate to vigorous physical activity·day^{-1} variable in this dataset was normally distributed (refer to the operational definition at the end of Chapter 2), the coefficients of variation were 28 and 39% in Old Order Mennonite and rural Saskatchewan children respectively.

If Old Order Mennonite children represent Canadian children between 50 and 100 years ago, then perhaps there has been secular deterioration in physical activity in the quantity of 20 to 30 minutes·day^{-1} at a moderate to vigorous intensity. Though physical activity is not synonymous with energy expenditure (Montoye et al., 1996), the two are strongly associated (Chu, et al., 2003; Eston et al., 1998; Trost et al., 1998). Therefore, it may be that there has been a temporal change in energy expenditure. Canadian children may have shifted toward positive energy balance. This is recognized as the fundamental mechanism of overweight and obesity (World Health Organization, 1998) and may help explain the current epidemic among young people in Canada (Tremblay et al., 2002; Tremblay and Willms, 2000).

As stated in Chapter 1, the majority of children and adolescents are physically active for more than one hour each day, frequently accumulating 20 to 30 minutes of activity at a moderate intensity or higher. In this research project, both groups of children were active for over two hours at the moderate level or higher. Thus, they seem to be meeting the established activity recommendations, which is cogent with previous studies (Epstein et al., 2001; Sallis and Patrick, 1994). However, the increased physical activity in Old Order

Mennonite children may have a protective effect against cardiovascular risk factors such as adiposity and serum lipid levels. Though that was not demonstrated in this research project, research using more precise measurement tools and controlling for confounders (e.g. diet) may lead to further elucidation.

4.2.1.2 Self-Report Questionnaire

The Physical Activity Questionnaire for Older Children (PAQ-C) demonstrated Pearson product moment correlation coefficients of 0.39 with activity counts·min^{-1}, activity counts·day^{-1}, and with daily minutes of moderate to vigorous physical activity in rural Saskatchewan children (p < 0.05). This suggests moderate concurrent validity. Kowalski et al. (1997) reported an identical zero-order correlation between the PAQ-C and output from the Caltrac motion sensor in 89 elementary schoolchildren. However, Pearson product moment correlations between PAQ-C and activity monitor output in Old Order Mennonite children in this research project were negative and near zero.

The lack of higher validity coefficients in rural Saskatchewan children may reflect exaggerated perceptions of time and effort, but the known sporadic nature of children's activity may also be explanative (Welk et al., 2000). The fact that Old Order Mennonite children were more active than rural Saskatchewan children as assessed by accelerometry, but similar on PAQ-C composite scores (3.1 vs. 3.0) suggests underestimation or overestimation of activity on the part of the former or latter group respectively. Overestimation of physical activity is common in children (Shephard, 2003; Welk et al., 2000).

In addition to the reasons already submitted, this lack of validity coefficients may be due to the less developed cognitive ability of children, which is characterized by concrete thinking (Welk et al., 2000). Children view even small amounts of physical activity as significant, demonstrate less interest in continuous activity, and fail to see the health-benefits of activity (Welk et al., 2000). Yet, recalling physical activity is a complex cognitive task (Sallis and Saelens, 2000). For these reasons, self-report measures of activity are considered inappropriate for use in children under 12 years of age (Pate et al., 2002).

Trost et al. (2000a) evaluated the understanding of 127 grade four students in relation to physical activity. The students were divided into three groups: Two treatment groups and a control. The treatment groups received either a verbal explanation or video description of physical activity. Then all three groups completed a 17-item checklist, which assessed their comprehension of physical activity. The treatment groups had significantly higher values, thus demonstrating greater understanding of physical activity. Trost et al. (2000a) concluded that apart from intervention, children have limited understanding of physical activity.

The cultural differences in Old Order Mennonite children may also explain the absence of concurrent validity with the PAQ-C (Shephard, 2003). For accurate measurement of activity, the assessment tool must elicit information about the activities common to the greatest proportion of the study population (Kriska, 2000). Failure of self-report questionnaires to account for this has led to the consistent finding of lower physical activity levels in minority groups compared to their majority counterparts (Kriska, 2000). It is doubtful that the PAQ-C was an adequate measurement tool for Old Order Mennonite children. For example, some of the items asked about the frequency of "walking for exercise" and "aerobics". Old Order Mennonite children simply do not participate in activities of this nature. Instead, they acquire the majority of their physical activity from lifestyle-related pursuits (e.g. farm chores) whereas the PAQ-C seems to assess activity of more institutionalized and recreational forms. Additionally, the Old Order Mennonite premium on humility and denunciation of pride (Peters, 2003; Horst, 2000) may have hindered them from making extreme responses on the PAQ-C.

Overall, the discrepancy between activity monitor output and PAQ-C scores highlights the need of ensuring the cultural relevance of the self-report questionnaire for a given sample. It may also accentuate the utility of self-report questionnaires in assessing the context and types of physical activity (e.g. institutional vs. lifestyle) when used in combination with objective measurement tools (Sallis and Saelens, 2000).

4.3 CONCLUSION

Old Order Mennonite children demonstrated better scores in one aspect of health-related physical fitness (static strength) while rural Saskatchewan children performed better in other aspects of health-related physical fitness (blood pressure, flexibility). The better performance in handgrip strength was attributed, in part, to the agrarian lifestyle of Old Order Mennonite children. Both groups attained more than two hours of daily, moderate to vigorous physical activity. However, Old Order Mennonite children received 20 minutes more each day. These results may indicate secular deterioration in the physical activity of Canadian young people between the last 50 to 100 years if the Old Order Mennonite lifestyle is representative of previous generations. Any clear benefit in health outcomes as a result of greater physical activity was not observed between groups in this research project.

Many challenges remain for temporal trend research in health-related physical fitness among young people in Canada. New and more precise data are required. The same applies for temporal trend research in physical activity. Additionally, how young people accumulate their activity (continuous vs. sporadic bouts) needs to be quantified and whether one pathway is more protective against chronic diseases such as coronary heart disease than the other remains to be determined (Shephard, 2003; Caspersen et al., 1998). All of these research needs may be addressed most adequately by recourse to a longitudinal method of research in which participants are followed prospectively.

LIST OF CITED LITERATURE

1. Aaron, D.J. and Laporte, R.E. (1997). Physical activity, adolescence, and health: An epidemiological perspective. *Exercise and Sport Sciences Reviews*, 25, 391-405.

2. Adair, L.S. and Gordon-Larsen, P. (2001). Maturational timing and overweight prevalence in US adolescent girls. *American Journal of Public Health*, 91, 642-4.

3. Ainsworth, B.E., Haskell, W.L., Whitt, M.C., Irwin, M.L., Swartz, A.M., Strath, S.J., O'Brien, W.L., Bassett, Jr., D.R., Schmitz, K.H., Emplaincourt, P.O., Jacobs, Jr., D.R., and Leon, A.S. (2000). Compendium of physical activities: An update of activity codes and MET intensities. *Medicine and Science in Sports and Exercise*, 32, S498-516.

4. Albert, W.J., Bonneau, J., Stevenson, J.M., and Gledhill, N. (2001). Back fitness and back health assessment considerations for the Canadian Physical Activity, Fitness, and Lifestyle Appraisal. *Canadian Journal of Applied Physiology*, 26, 291-317.

5. Andersen, R.E., Crespo, C.J., Bartlett, S.J., Cheskin, L.J., and Pratt, M. (1998). Relationship of physical activity and television watching with body weight and level of fatness among children. *Journal of the American Medical Association*, 279, 938-42.

6. Armstrong, N. and Van Mechelen, W. (1998). Are young people fit and active? In Biddle, S., Sallis, J., and Cavill, N. (Editors). Young and active? Young people and health-enhancing physical activity—evidence and implications. Health Education Authority: London, England.

7. Armstrong, N., Williams, J., Balding, J., Gentle, P., and Kirby, B. (1991). Cardiopulmonary fitness, physical activity patterns, and selected coronary

risk factor variables in 11- to 16-year-olds. *Pediatric Exercise Science*, 3, 219-28.

8. Atomi, Y., Iwaoka, K., Hatta, H., Miyashita, M., and Yamamoto, Y. (1986). Daily physical activity levels in preadolescent boys related to VO_{2max} and lactate threshold. *European Journal of Applied Physiology*, 55, 156-61.
9. Baldwin, D. and Baldwin, P. (2000). Canada through the decades: The 1920s. Weigel: Calgary, Alberta, Canada.
10. Ball, G.D.C. and McCargar, L.J. (2003). Childhood obesity in Canada: A review of prevalence estimates and risk factors for cardiovascular diseases and type 2 diabetes. *Canadian Journal of Applied Physiology*, 28, 117-40.
11. Baranowski, T., Mendlein, J., Resnicow, K., Frank, E., Weber Cullen, K., and Baranowski, J. (2000). Physical activity and nutrition in children and youth: An overview of obesity prevention. *Preventive Medicine*, 31, S1-10.
12. Baranowski, T., Thompson, W.O., DuRant, R.H., Baranowski, J., Puhl, J. (1993). Observations on physical activity in physical locations: Age, gender, ethnicity, and month effects. *Research Quarterly for Exercise and Sport*, 64, 127-33.
13. Bar-Or, O. and Malina, R.M. (1995). Activity, fitness, and health of children and adolescents. In Cheung, L.W.Y. and Richmond, J.B. (Editors). Child health, nutrition, and physical activity. Human Kinetics: Champaign, Illinois, United States.
14. Bassett, Jr., D.R. (2000). Validity and reliability issues in objective monitoring of physical activity. *Research Quarterly for Exercise and Sport*, 71, 30-6.
15. Bazzano, C., Cunningham, L.N., Varrassi, G., and Falconio, T. (1992). Health related fitness and blood pressure in boys and girls ages 10 to 17 years. *Pediatric Exercise Science*, 4, 128-35.

16. Berg, I.-M., Simonsson, B., Brantefors, B., and Ringqvist, I. (2001). Prevalence of overweight and obesity in children and adolescents in a county in Sweden. *Acta Paediatrica*, 90, 671-6.

17. Beunen, G., Thomis, M., Peeters, M., Maes, H.H., Claessens, A.L., and Vlietinck, R. (2003). Genetics of strength and power characteristics in children and adolescents. *Pediatric Exercise Science*, 15, 128-38.

18. Blair, S.N. (1992). Are American children and youth fit? The need for better data. *Research Quarterly for Exercise and Sport*, 63, 120-3.

19. Bouchard, C., Malina, R.M., and Pérusse, L. (1997). Genetics of fitness and physical performance. Human Kinetics: Champaign, Illinois, United States.

20. Bouziotas, C., Koutedakis, Y., Shiner, R., Pananakakis, Y., Fotopoulou, V., and Gara, S. (2001). The prevalence of selected modifiable coronary heart disease risk factors in 12-year-old Greek boys and girls. *Pediatric Exercise Science*, 13, 173-84.

21. Brage, S., Brage, N., Froberg, K., and Wedderkopp, N. (2003). Reliability and validity of the Computer Science and Applications Model 7164 accelerometer in a mechanical setting. *Measurement in Physical Education and Exercise Science*, 7, 101-19.

22. Brassard, P., Robinson, E., and Lavallée, C. (1993). Prevalence of diabetes mellitus among the James Bay Cree of northern Quebec. *Canadian Medical Association Journal*, 149, 303-7.

23. Brosnan, C.A., Upchurch, S., and Schreiner, B. (2001). Type 2 diabetes in children and adolescents: An emerging disease. *Journal of Pediatric Health Care*, 15, 187-93.

24. Bundred, P., Kitchiner, D., and Buchan, I. (2001). Prevalence of overweight and obese children between 1989 and 1998: Population based series of cross sectional studies. *British Medical Journal*, 322, 1-4.

25. Cameron, C., Craig, C.L., Stephens, T., and Ready, T.A. (2001). 2001 physical activity monitor. URL: <http://www.cflri.ca/pdf/e/2001pam.pdf>

26. Canadian Society for Exercise Physiology (1999). The Canadian Physical Activity, Fitness, and Lifestyle Appraisal (2nd edition). Canadian Society for Exercise Physiology: Ottawa, Ontario, Canada.

27. Caspersen, C.J., Nixon, P.A., and DuRant, R.H. (1998). Physical activity epidemiology applied to children and adolescents. *Exercise and Sport Sciences Reviews*, 26, 341-403.

28. Cavill, N., Biddle, S., and Sallis, J.F. (2001). Health enhancing physical activity for young people: Statement of the United Kingdom Expert Consensus Conference. *Pediatric Exercise Science*, 13, 12-25.

29. Chinn, S. and Rona, R.J. (2001). Prevalence and trends in overweight and obesity in three cross sectional studies of British children, 1974-94. *British Medical Journal*, 322, 24-6.

30. Chu, B.B., Lawson, D., Naughton, G. (2003). Validation of the Computer Science and Applications (CSA) activity monitor as an objective measure of activity energy expenditure in Vietnamese adolescents. *Pediatric Exercise Science*, 15, 56-66.

31. Chu, N.-F. (2001). Prevalence and trends of obesity among school children in Taiwan—the Taipei Children Heart Study. *International Journal of Obesity*, 25, 170-6.

32. Coe, D. and Pivarnik, J.M. (2001). Validation of the CSA accelerometer in adolescent boys during basketball practice. *Pediatric Exercise Science*, 13, 373-9.

33. Cole, T.J., Bellizzi, M.C., Flegal, K.M., and Dietz, W.H. (2000). Establishing a standard definition for child overweight and obesity worldwide: International survey. *British Medical Journal*, 320, 1-6.

34. Cooley, D. and McNaughton, L. (1999). Aerobic fitness of Tasmanian secondary school children using the 20-m shuttle run test. *Perceptual and Motor Skills*, 88, 188-98.

35. Corbin, C.B. and Pangrazi, R.P. (1992). Are American children and youth fit? *Research Quarterly for Exericse and Sport*, 63, 96-106.

36. Corbin, C.B., Pangrazi, R.P., and Welk, G.J. (1994). Toward an understanding of appropriate physical activity levels for youth. *Physical Activity and Fitness Research Digest*, 1, 1-8.

37. Craats, R. (2000). Canada through the decades: The 1910s. Weigel: Calgary, Alberta, Canada.

38. Cragg, S., Cameron, C., Craig, C.L., and Russell, S. (1999). Canada's children and youth: A physical activity profile. URL: <http://www.cflri.ca/pdf/e/98NLSCY.pdf>

39. Craig, C.L., Cameron, C., Russell, S.J., and Beaulieu, A. (2000). 2000 physical activity monitor. URL: < http://www.cflri.ca/pdf/e/2000pam.pdf>

40. Crespo, C.J., Smit, E., Troiano, R.P., Bartlett, S.J., Macera, C.A., and Andersen, R.E. (2001). Television watching, energy intake, and obesity in US children. *Archives of Pediatrics and Adolescent Medicine*, 155, 360-5.

41. Crocker, P.R.E., Bailey, D.A., Faulkner, R.A., Kowalski, K.C., and McGrath, R. (1997). Measuring general levels of physical activity: Preliminary evidence for the Physical Activity Questionnaire for Older Children. *Medicine and Science in Sports and Exercise*, 29, 1344-9.

42. Curtin, F., Morabia, A., Pichard, C., and Slosman, D.O. (1997). Body mass index compared to dual-energy x-ray Absorptiometry: Evidence for a spectrum bias. *Journal of Clinical Epidemiology*, 50, 837-43.

43. Daniels, S.R., Khoury, P.R., and Morrison, J.A. (1997). The utility of body mass index as a measure of body fatness in children and adolescents: Differences by race and gender. *Pediatrics*, 99, 804-7.

44. Dawson, K., Hamlin, M., and Ross, J. (2001). Trends in the health-related physical fitness of 10-14 year old New Zealand children. *Journal of Physical Education New Zealand*, 34, 26-39.

45. Delisle, H.F. and Ekoé, J.-M. (1993). Prevalence of non-insulin-dependent diabetes mellitus impaired glucose tolerance in two Algonquin communities in Quebec. *Canadian Medical Association Journal*, 148, 41-7.

46. Dietz, W.H. (1998). Health consequences of obesity in youth: Childhood predictors of adult disease. *Pediatrics*, 101, 518-25.

47. Dietz, W.H. and Robinson, T.N. (1998). Use of the body mass index (BMI) as a measure of overweight in children and adolescents. *Journal of Pediatrics*, 132, 191-3.

48. Dollman, J., Norton, K., and Tucker, G. (2002). Anthropometry, fitness, and physical activity of urban and rural south Australian children. *Pediatric Exercise Science*, 14, 297-312.

49. Dollman, J., Olds, T., Norton, K., and Stuart, D. (1999) .The evolution of fitness and fatness in 10-11-year-old Australian schoolchildren: Changes in distributional characteristics between 1985 and 1997. *Pediatric Exercise Science*, 11, 108-21.

50. DuRant, R.H., Baranowski, T., Johnson, M., and Thompson, W.O. (1994). The relationship among television watching, physical activity, and body composition of young children. *Pediatrics*, 94, 449-55.

51. DuRant, R.H., Thompson, W.O., Johnson, M., and Baranowski, T. (1996). The relationship among television watching, physical activity, and body composition of 5- or 6-year-old children. *Pediatric Exercise Science*, 8, 15-26.

52. Durnin, J.V.G.A. (1992). Physical activity levels—past and present. In Norgan, N.G. (Editor). Physical activity and health. Cambridge University Press: New York, New York, United States.

53. Eisenmann, J.C., Katzmarzyk, P.T., Arnall, D.A., Kanuho, V., Interpreter, C., and Malina, R.M. (2000). Growth and overweight of Navajo youth: Secular changes from 1955 to 1997. *International Journal of Obesity*, 24, 211-8.

54. Eisenmann, J.C., Katzmarzyk, P.T., and Tremblay, M.S. (2003). Leisure-time physical activity levels among Canadian adolescents, 1981-1996. *Medicine and Science in Sports and Exercise*, 35, S180 (abstract 1001).

55. Eisenmann, J.C. and Malina, R.M. (2002). Secular trend in peak oxygen consumption among United States youth in the 20^{th} century. *American Journal of Human Biology*, 14, 699-706.

56. Ekelund, U., Sjöström, M., Yngve, A., Poortvliet, E., Nilsson, A., Froberg, K., Wedderkopp, N., and Westerterp K. (2001). Physical activity assessed by activity monitor and doubly labeled water in children. *Medicine and Science in Sports and Exercise*, 33, 275-81.

57. Epstein, L.H., Paluch, R.A., Kalakanis, L.E., Goldfield, G.S., Cerny, F.J., and Roemmich, J.N. (2001). How much activity do youth get? A Quantitative review of heart-rate measured activity. *Pediatrics*, 108, e44. URL: <http://www.pediatrics.org/cgi/content/full/108/3/e44>

58. Eston, R.G., Rowlands, A.V., and Ingledew, D.K. (1998). Validity of heart rate, pedometry, and accelerometry for predicting the energy cost of children's activities. *Journal of Applied Physiology*, 84, 362-71.

59. Fagot-Campagna, A., Pettitt, D.J., Engelgau, M.M., Burrows, N.R., Geiss, L.S., Valdez, R., Beckles, G.L.A., Saaddine, J., Gregg, E.W., Williamson, D.F., and Narayan, K.M.V. (2000). Type 2 diabetes among North American

children and adolescents: An epidemiologic review and a public health perspective. *Journal of Pediatrics*, 136, 664-72.

60. Flegal, K.M., Carroll, M.D., Kuczmarski, R.J., and Johnson, C.L. (1998). Overweight and obesity in the United States: Prevalence and trends, 1960-1994. *International Journal of Obesity*, 22, 39-47.

61. Freedman, D.S., Dietz, W.H., Srinivasan, S.R., and Berenson, G.S. (1999). The relation of overweight to cardiovascular risk factors among children and adolescents: The Bogalusa Heart Study. *Pediatrics*, 103, 1175-83.

62. Freedson, P.S. and Rowland, T.W. (1992). Youth activity versus youth fitness: Let's redirect our efforts. *Research Quarterly for Exercise and Sport*, 63, 133-6.

63. Freedson, P.S., Sirard, J., Debold, N., Trost, S., Dowda, M., Pate, R., and Sallis, J. (1997). Calibration of the Computer Science and Applications, Inc. (CSA) accelerometer. *Medicine and Science in Sports and Exercise*, 29, S45.

64. Fretz, J.W. (1978). Work and leisure among Waterloo County Mennonites. *Unpublished*.

65. Fuchs, J.A., Levinson, R.M., Stoddard, R.R., Mullet, M.E., and Jones, D.H. (1990). Health risk factors among the Amish: Results of a survey. *Health Education Quarterly*, 17, 197-211.

66. Gavarry, O., Giacomoni, M., Bernard, T., Seymat, M., and Falgairette, G. (2003). Habitual physical activity in children and adolescents during school and free days. *Medicine and Science in Sports and Exercise*, 35, 525-31.

67. Gledhill, N. (2001). Introduction to the review papers pertaining to components of the Canadian Physical Activity, Fitness, and Lifestyle Appraisal. *Canadian Journal of Applied Physiology*, 26, 157-60.

68. Gledhill, N. (2002). Derivation of the aerobic fitness equation contained in the CPAFLA. *Unpublished*.

69. Glick, M., Michel, A.C., Dorn, J., Horwitz, M., Rosenthal, T., and Trevisan, M. (1998). Dietary cardiovascular risk factors and serum cholesterol in an Old Order Mennonite community. *American Journal of Public Health*, 88, 1202-5.

70. Guerra, S., Ribeiro, J.C., Costa, R., Duarte, J., and Mota, J. (2002). Relationship between cardiorespiratory fitness, body composition, and blood pressure in school children. *Journal of Sports Medicine and Physical Fitness*, 42, 207-13.

71. Gutin, B., Manos, T., and Strong, W. (1992). Defining health and fitness: First step toward establishing children's fitness standards. *Research Quarterly for Exercise and Sport*, 63, 128-32.

72. Hamlin, M.J., Ross, J.J., and Hong, S.-W. (2002). Health related fitness trends in children. *New Zealand Journal of Sports Medicine*, 30, 4-11.

73. Hamman, R.F., Barancik, J.I., and Lilienfeld, A.M. (1981). Patterns of mortality in the Old Order Amish. *American Journal of Epidemiology*, 114, 845-61.

74. Harnack, L.J., Jeffrey, R.W., and Boutelle, K.N. (2000). Temporal trends in energy intake in the United States: An ecologic perspective. *American Journal of Clinical Nutrition*, 71, 1478-84.

75. Harris, S.B., Gittelsohn, J., Hanley, A., Barnie, A., Wolever, T.M.S., Gao, J., Logan, A., and Zinman, B. (1997). The prevalence of NIDDM and associated risk factors in Native Canadians. *Diabetes Care*, 20, 185-7.

76. Haskell, W.L. (1996). Health consequences of physical activity: Understanding and challenges regarding dose-response. *Medicine and Science in Sports and Exercise*, 26, 649-60.

77. Health Canada (2002a). Canada's physical activity guide for children. URL: <http://www.hc-sc.gc.ca/hppb/paguide/pdf/tearsheeten6-9.pdf>

78. Health Canada (2002b). Canada's physical activity guide for youth. URL: <http://www.hc-sc.gc.ca/hppb/paguide/pdf/tearSheetEn.pdf>

79. Health Education Authority (1997). Young people and physical activity: A literature review. Health Education Authority: London, England.

80. Heart and Stoke Foundation of Canada (2002). Report cards on health—tweens could be headed for trouble—February 2002. URL: <http://ww2.heartandstroke.ca/Page.asp?PageID=110&ArticleID=1088&Src=news>

81. Heath, G.W., Pratt, M., Warren, C.W., and Kann, L. (1994). Physical activity patterns in American high school students. *Archives of Pediatrics and Adolescent Medicine*, 148, 1131-6.

82. Hernández, B., Gortmaker, S.L., Colditz, G.A., Peterson, K.E., Laird, N.M., and Parra-Cabrera, S. (1999). Association of obesity with physical activity, television programs, and other forms of video viewing among children in Mexico City. *International Journal of Obesity*, 23, 845-54.

83. Hill, J.O. and Melanson, E.L. (1999). Overview of the determinants of overweight and obesity: Current evidence and research issues. *Medicine and Science in Sports and Exercise*, 31, S515-21.

84. Hill, J.O., Wyatt, H.R., Reed, G.W., and Peters, J.C. (2003). Obesity and the environment: Where do we go from here? *Science*, 299, 853-5.

85. Horst, I.R. (2000). A separate people: An insider's view of Old Order Mennonite customs and traditions. Herald Press: Waterloo, Ontario, Canada.

86. Hussey, J., Gormley, J., and Bell, C. (2001). Physical activity in Dublin children aged 7-9 years. *British Journal of Sports Medicine*, 35, 268-73.

87. Hypponen, E., Virtanen, S.M., Kenward, M.G., Knip, M., and Åkerblom, H.K. (2000). Obesity, increased linear growth, and risk of type 1 diabetes in children. *Diabetes Care*, 23, 1755-60.

88. Janz, K.F. (1994). Validation of the CSA accelerometer for assessing children's physical activity. *Medicine and Science in Sports and Exercise*, 26, 369-75.

89. Janz, K.F., Witt, J., and Mahoney, L.T. (1995). The stability of children's physical activity as measured by accelerometry and self-report. *Medicine and Science in Sports and Exercise*, 27, 1326-32.

90. Jebb, S.A. and Moore, M.S. (1999). Contribution of a sedentary lifestyle and inactivity to the etiology of overweight and obesity: Current evidence and research issues. *Medicine and Science in Sports and Exercise*, 31, S534-41.

91. Kaplowitz, P.B., Slora, E.J., Wasserman, R.C., Pedlow, S.E., and Herman-Giddens, M.E. (2001). Earlier onset of puberty in girls: Relation to increased body mass index and race. *Pediatrics*, 108, 347-53.

92. Katzmarzyk, P.T., Malina, R.M., Song, T.M.K., and Bouchard, C. (1998). Television viewing, physical activity, and health-related fitness of youth in the Québec Family Study. *Journal of Adolescent Health*, 23, 318-25.

93. Kelly, L.E. (2000). Patterns of physical activity in 9-10-year-old American children as measured by heart rate monitoring. *Pediatric Exercise Science*, 12, 101-10.

94. Klentrou, P., Hay, J., and Plyley, M. (2003). Habitual physical activity levels and health outcomes of Ontario youth. *European Journal of Applied Physiology*, 89, 460-5.

95. Kohl, III, H.W., Fulton, J.E., and Caspersen, C.J. (2000). Assessment of physical activity among children and adolescents: A review and synthesis. *Preventive Medicine*, 31, S54-76.

96. Kowalski, K.C., Crocker, P.R.E., and Faulkner, R.A. (1997). Validation of the Physical Activity Questionnaire for Older Children. *Pediatric Exercise Science*, 9, 174-86.

97. Kriska, A. (2000). Ethnic and cultural issues in assessing physical activity. *Research Quarterly for Exercise and Sport*, 71, 47-53.

98. Levinson, R.M., Fuchs, J.A., Stoddard, R.R., Jones, D.H., and Mullet, M. (1989). Behavioral risk factors in an Amish community. *American Journal of Preventive Medicine*, 5, 150-6.

99. Loftin, M., Strikmiller, P., Warren, B., Myers, L., Schroth, L., Pittman, J., Harsha, D., and Sothern, M. (1998). Comparison and relationship of VO_{2peak} and physical activity patterns in elementary and high school females. *Pediatric Exercise Science*, 10, 153-63.

100. Louie, L., Eston, R.G., Rowlands, A.V., Tong, K.K., Ingledew, D.K., and Fu, F.H. (1999). Validity of heart rate, pedometry, and accelerometry for estimating the energy cost of activity in Hong Kong Chinese boys. *Pediatric Exercise Science*, 11, 229-39.

101. Lowry, R., Wechsler, H., Galuska, D.A., Fulton, J.E., and Kann, L. (2002). Television viewing and its associations with overweight, sedentary lifestyle, and insufficient consumption of fruits and vegetables among US high school students: Differences by race, ethnicity, and gender. *Journal of School Health*, 72, 413-21.

102. Lowry, R., Wechsler, H., Kann, L., and Collins, J.L. (2001). Recent trends in participation in physical education among US high school students. *Journal of School Health*, 71, 145-52.

103. Luo, J. and Hu, F.B. (2002). Time trends of obesity in pre-school children in China from 1989 to 1997. *International Journal of Obesity*, 26, 553-8.

104. Malina, R.M. and Bouchard, C. (1991). Growth, maturation, and physical activity. Human Kinetics: Champaign, Illinois, United States.

105. Malina, R.M. and Katzmarzyk, P.T. (1999). Validity of the body mass index as an indicator of the risk and presence of overweight in adolescents. *American Journal of Clinical Nutrition*, 70, 131S-6.

106. Marshall, S.J., Biddle, S.J.H., Murdey, I., Gorely, T., and Cameron, N. (2003). But what are you doing now? Ecological momentary assessment of sedentary behavior among youth. *Medicine and Science in Sports and Exercise*, 35, S180 (abstract 996).

107. Martin, D. (2003). Old Order Mennonites of Ontario: Gelassenheit, discipleship, brotherhood. Pandora Press: Kitchener, Ontario, Canada.

108. Matthews, C.E., Ainsworth, B.E., Thompson, R.W., and Bassett, Jr., D.R. (2002). Sources of variance in daily physical activity levels as measured by an accelerometer. *Medicine and Science in Sports and Exercise*, 34, 1376-81.

109. Metcalf, B.S., Curnow, J.S.H., Evans, C., Voss, L.D., Wilkin, T.J. (2002). Technical reliability of the CSA activity monitor: The EarlyBird study. *Medicine and Science in Sports and Exercise*, 34, 1533-7.

110. Michel, A., Glick, M., Rosenthal, T.C., and Crawford, M. (1993). Cardiovascular risk factor status of an Old Order Mennonite community. *Journal of American Board of Family Practice*, 6, 225-31.

111. Mirwald, R.L., Baxter-Jones, A.D.G., Bailey, D.A., and Beunen, G.P. (2002). An assessment of maturity from anthropometric measurements. *Medicine and Science in Sports and Exercise*, 34, 689-94.

112. Montoye, H.J., Kemper, H.C.G., Saris, W.H.M., and Washburn, R.A. (1996). Measuring physical activity and energy expenditure. Human Kinetics: Champaign, Illinois, United States.

113. Morrow, Jr., J.R. (1992). Are American children and youth fit? Review and commentary. *Research Quarterly for Exercise and Sport*, 63, 95.

114. Morrow, Jr., J.R. and Freedson, P.S. (1994). Relationship between habitual physical activity and aerobic fitness in adolescents. *Pediatric Exercise Science*, 6, 315-29.

115. Mota, J., Guerra, S., Leandro, C., Pinto, A., Ribeiro, J., and Duarte, J. (2002a). Association of maturation, sex, and body fat in cardiorespiratory fitness. *American Journal of Human Biology*, 14, 707-12.

116. Mota, J., Santos, P., Guerra, S., Ribeiro, J.C., and Duarte, J.A. (2002b). Differences of daily physical activity levels of children according to body mass index. *Pediatric Exercise Science*, 14, 442-52.

117. Mota, J., Santos, P., Guerra, S., Ribeiro, J.C., Duarte, J.A., and Sallis, J.F. (2002c). Validation of a physical activity self-report questionnaire in a Portuguese pediatric population. *Pediatric Exercise Science*, 14, 269-76.

118. National Institute of Health (1987). Report of the second task force on blood pressure control in children. *Pediatrics*, 79, 1-25.

119. Nichols, J.F., Morgan, C.G., Chabot, L.E., Sallis, J.F., and Calfras, K.J. (2000). Assessment of physical activity with the Computer Science and Applications, Inc., accelerometer: Laboratory versus field validation. *Research Quarterly for Exercise and Sport*, 71, 36-43.

120. Nieman, D.C. (1998). The exercise-health connection. Human Kinetics: Champaign, Illinois, United States.

121. Nieman, D.C. (1999). Exercise testing and prescription: A health-related approach (4th edition). Mayfield Publishing Company: Toronto, Ontario, Canada.

122. Office of the Surgeon General (2001). Surgeon General's call to action to prevent and decrease overweight and obesity. URL: <http://www.surgeongeneral.gov/topics/obesity/>

123. Ogden, C.L., Troiano, R.P., Briefel, R.R., Kuczmarski, R.J., Flegal, K.M., and Johnson, C.L. (1997). Prevalence of overweight among schoolchildren in the United States, 1971 through 1994. *Pediatrics*, 99, e1. URL: <http://www.pediatrics.org/cgi/content/full/99/4/e1>

124. Olds, T.S. and Harten, N.R. (2001). One hundred years of growth: The evolution of height, mass, and body composition in Australian children, 1899-1999. *Human Biology*, 73, 727-38.

125. Ott, A.E., Pate, R.R., Trost, S.G., Ward, D.S., and Saunders, R. (2000). The use of uniaxial and triaxial accelerometers to measures children's "free play" physical activity. *Pediatric Exercise Science*, 12, 360-70.

126. Pate, R.R., Freedson, P.S., Sallis, J.F., Taylor, W.C., Sirard, J., Trost, S.G., and Dowda, M. (2002). Compliance with physical activity guidelines: Prevalence in a population of children and youth. *Annals of Epidemiology*, 12, 303-8.

127. Pate, R.R., Long, B.J., and Heath, G. (1994). Descriptive epidemiology of physical activity in adolescents. *Pediatric Exercise Science*, 6, 434-47.

128. Pate, R., Trost, S., and Williams, C. (1998). Critique of existing guidelines for physical activity in young people. In Biddle, S., Sallis, J., and Cavill, N. (Editors). Young and active? Young people and health-enhancing physical activity—evidence and implications. Health Education Authority: London, England.

129. Payne, N., Gledhill, N., Katzmarzyk, P.T., Jamnik, V.K., and Keir, J. (2000). Canadian musculoskeletal fitness norms. *Canadian Journal of Applied Physiology*, 25, 430-42.

130. Peters, J. (2003). The plain people: A glimpse at life among the Old Order Mennonites of Ontario. Pandora Press: Kitchener, Ontario, Canada.

131. Pinhas-Hamiel, O., Dolan, L.M., Daniels, S.R., Standiford, D., Khoury, P.R., and Zeitler, P. (1996). Increased incidence of non-insulin-dependent diabetes mellitus among adolescents. *Journal of Pediatrics*, 128, 608-15.

132. Pioro, M.P., Dyck, R.F., and Gillis, D.C. (1996). Diabetes prevalence rates among First Nations adults on Saskatchewan reserves in 1990: Comparison by tribal grouping, geography, and with non-First Nations people. *Canadian Journal of Public Health*, 87, 325-8.

133. Pratt, M., Macera, C.A., and Blanton, C. (1999). Levels of physical activity and inactivity in children and adults in the United States: Current evidence and research issues. *Medicine and Science in Sports and Exercise*, 31, S526-33.

134. Prista, A., Maia, J., Saranga, S., Damasceno, A., Marques, A., and Beunen, G. (2003). Short term changes in growth, physical fitness, and physical activity from time of war to time of peace. *Medicine and Science in Sports and Exercise*, 35, S179 (abstract 994).

135. Raudsepp, L. and Jürimäe, T. (1996). Physical activity, fitness, and adiposity of prepubertal girls. *Pediatric Exercise Science*, 8, 259-67.

136. Reddy, B.N. (1998). Blood pressure and adiposity: A comparative study of socioeconomically diverse groups of Andhra Pradesh, India. *American Journal of Human Biology*, 10, 5-21.

137. Reiff, G.G., Dixon, W.R., Jacoby, D., Ye, G.X., Spain, C.G., and Hunsicker, P.A. (1986). The President's Council on Physical Fitness and Sports 1985: National School Population Fitness Survey. University of Michigan: Ann Arbor, Michigan, United States.

138. Rensberger, S. (2003). The complete idiot's guide to understanding the Amish. Alpha Books: New York, New York, United States.

139. Robinson, T.N., Hammer, L.D., Killen, J.D., Kraemer, H.C., Wilson, D.M., Hayward, C., and Taylor, C.B. (1993). Does television viewing increase obesity and reduce physical activity? Cross-sectional and longitudinal analyses among adolescent girls. *Pediatrics*, 91, 273-80.

140. Rode, A. and Shephard, R.J. (1971). Cardiorespiratory fitness of an Arctic community. *Journal of Applied Physiology*, 31, 519-26.

141. Rode, A. and Shephard, R.J. (1973). Growth, development, and fitness of the Canadian Eskimo. *Medicine and Science in Sports*, 5, 161-9.

142. Rode, A. and Shephard, R.J. (1984a). Growth, development and acculturation—a ten year comparison of Canadian Inuit children. *Human Biology*, 56, 217-30.

143. Rode, A. and Shephard, R.J. (1984b). Lung function in Canadian Inuit: A follow-up study. *Canadian Medical Association Journal*, 131, 741-4.

144. Rode, A. and Shephard, R.J. (1984c). Ten years of "civilization": Fitness of Canadian Inuit. *Journal of Applied Physiology*, 56, 1472-7.

145. Rode, A. and Shephard, R.J. (1985). Lung function of circumpolar residents undergoing acculturation—a ten year follow-up of Canadian Inuit. *Human Biology*, 57, 229-43.

146. Rode, A. and Shephard, R.J. (1993). Acculturation and loss of fitness in the Inuit: The preventive role of active leisure. *Arctic Medical Research*, 52, 107-12.

147. Rode, A. and Shephard, R.J. (1994a). Acculturation and the growth of lung function: Three cross-sectional surveys of an Inuit community. *Respiration*, 61, 187-94.

148. Rode, A. and Shephard, R.J. (1994b). Physiological consequences of acculturation: A 20-year study of fitness in an Inuit community. *European Journal of Applied Physiology*, 69, 516-24.

149. Rode, A. and Shephard, R.J. (1995). Growth and development of physical fitness in Igloolik Inuit and Volochanka nGanasan. *Pediatric Exercise Science*, 7, 432-44.

150. Ross, J.J. (2000). Contemporary patterns and trends in physical activity in New Zealand children and adolescents. *Journal of Physical Education New Zealand*, 33, 99-109.

151. Rowland, T.W. (1996). Developmental exercise physiology. Human Kinetics: Champaign, Illinois, United States.

152. Sallis, J.F. and Patrick, K. (1994). Physical activity guidelines for adolescents: Consensus statement. *Pediatric Exercise Science*, 6, 302-14.

153. Sallis, J.F., Prochaska, J.J., and Taylor, W.C. (2000). A review of correlates of physical activity of children and adolescents. *Medicine and Science in Sports and Exericse*, 32, 963-75.

154. Sallis, J.F. and Saelens, B.E. (2000). Assessment of physical activity by self-report: Status, limitations, and future directions. *Research Quarterly for Exercise and Sport*, 71, 1-14.

155. Salomons, E. (2000). Canada through the decades: The 1900s. Weigel: Calgary, Alberta, Canada.

156. Santos, P., Guerra, S., Ribeiro, J.C., Duarte, J.A., and Mota, J. (2003). Age and gender-related physical activity: A descriptive study in children using accelerometry. *Journal of Sports Medicine and Physical Fitness*, 43, 85-9.

157. Schneider, J. (nd). Activity Monitor Operator's Manual. MTI Health Services Division: Fort Walton Beach, Florida, United States.

158. Shephard, R.J. (2003). Limits to the measurement of habitual physical activity by questionnaires. *British Journal of Sports Medicine*, 37, 197-206.

159. Shephard, R.J. and Rode, A. (1992). Cold, fitness, and the exercise electrocardiogram. *International Journal of Sports Medicine*, 13, S176-8.

160. Simons-Morton, B.G., O'Hara, N.M., Parcel, G.S., and Huang, I.W. (1990). Children's frequency of participation in moderate to vigorous physical activities. *Research Quarterly for Exercise and Sport*, 61, 307-14.

161. Sleap, M. and Tolfrey, K. (2001). Do 9- to 12 yr-old children meet existing physical activity recommendations for health? *Medicine and Science in Sports and Exercise*, 33, 591-6.

162. Stephens, T. (1987). Secular trends in adult physical activity: Exercise boom or bust? *Research Quarterly for Exercise and Sport*, 58, 94-105.

163. Sunnegårdh, J. and Bratteby, L.-E. (1987). Maximal oxygen uptake, anthropometry, and physical activity in a randomly selected sample of 8 and 13 year old children in Sweden. *European Journal of Applied Physiology*, 56, 266-72.

164. Thomas, J.R. and Nelson, J.K. (2001). Research methods in physical activity (4th edition). Human Kinetics: Champaign, Illinois, United States.

165. Thompson, A.M., Baxter-Jones, A.D.G., Mirwald, R.L., and Bailey, D.A. (2003). Comparison of physical activity in male and female children: Does maturation matter? *Medicine and Science in Sports and Exercise*, 35, 1684-90.

166. Tomkinson, G.R., Olds, T.S., and Gulbin, J. (2003). Secular trends in physical performance of Australian children. Evidence from the Talent Search program. *Journal of Sports Medicine and Physical Fitness*, 43, 90-8.

167. Tremblay, M.S., Katzmarzyk, P.T., and Willms, J.D. (2002). Temporal trends in overweight and obesity in Canada, 1981-1996. *International Journal of Obesity*, 26, 538-43.

168. Tremblay, M., Pella, T., and Taylor, K. (1996). The quality and quantity of school-based physical education: A growing concern. *Canadian Health, Physical Education, Recreation, and Dance Journal*, 62, 4-7.

169. Tremblay, M.S., Shephard, R.J., McKenzie, T.L., and Gledhill, N. (2001). Physical activity assessment options within the context of the Canadian Physical Activity, Fitness, and Lifestyle Appraisal. *Canadian Journal of Applied Physiology*, 26, 388-407.

170. Tremblay, M.S. and Willms, J.D. (2000). Secular trends in the body mass index of Canadian children. *Canadian Medical Association Journal*, 163, 1429-33. (Published erratum: *Canadian Medical Association Journal*, 164, 970.)

171. Trost, S.G. (2001). Objective measurement of physical activity in youth: Current issues, future directions. *Exercise and Sport Sciences Reviews*, 29, 32-6.

172. Trost, S.G., Morgan, A.M., Saunders, R., Felton, G., Ward, D.S., and Pate, R.R. (2000a). Children's understanding of the concept of physical activity. *Pediatric Exercise Science*, 12, 293-9.

173. Trost, S.G., Pate, R.R., Freedson, P.S., Sallis, J.F., and Taylor, W.C. (2000b). Using objective physical activity measures with youth: How many days of monitoring are needed? *Medicine and Science in Sports and Exercise*, 32, 426-31.

174. Trost, S.G., Pate, R.R., Sallis, J.F., Freedson, P.S., Taylor, W.C., Dowda, M., and Sirard, J. (2002). Age and gender differences in objectively measured physical activity in youth. *Medicine and Science in Sports and Exercise*, 34, 350-5.

175. Trost, S.G., Sirard, J.R., Dowda, M., Pfeiffer, K.A., and Pate, R.R. (2003). Physical activity in overweight and nonoverweight preschool children. *International Journal of Obesity*, 27, 834-9.

176. Trost, S.G., Ward, D.S., Moorehead, S.M., Watson, P.D., Riner, W., and Burke, J.R. (1998). Validity of the computer science and applications (CSA)

activity monitor in children. *Medicine and Science in Sports and Exercise*, 30, 629-33.

177. Tudor-Locke, C., Ainsworth, B.E., Adair, L.S., and Popkin, B.M. (2003). Physical activity in Filipino youth: The Cebu Longitudinal Health and Nutrition Survey. *International Journal of Obesity*, 27, 181-90.
178. Tyrrell, V.J., Richards, G.E., Hofman, P., Gillies, G.F., Robinson, E., and Cutfield, W.S. (2001). Obesity in Auckland school children: A comparison of the body mass index and percentage body fat as the diagnostic criterion. *International Journal of Obesity*, 25, 164-9.
179. U.S. Department of Health and Human Services (1996). Physical activity and health: A report of the Surgeon General (1st edition). International Medical Publishing, Inc.: McLean, Virginia, United States.
180. Vincent, W.J. (1999). Statistics in kinesiology (2nd edition). Human Kinetics: Champaign, Illinois, United States.
181. Warburton, D.E.R., Gledhill, N., and Quinney, A. (2001). Musculoskeletal fitness and health. *Canadian Journal of Applied Physiology*, 26, 217-37.
182. Weber, E. (1998). Families of the Old Order Mennonite Church in Ontario. Published independently: Heidelberg, Ontario, Canada.
183. Welk, G.J., Corbin, C.B., and Dale, D. (2000). Measurement issues in the assessment of physical activity in children. *Research Quarterly for Exercise and Sport*, 71, 59-73.
184. Weller, I.M.R., Thomas, S.G., Corey, P.N., and Cox, M.H. (1992). Selection of a maximal test protocol to validate the Canadian Aerobic Fitness Test. *Canadian Journal of Sport Sciences*, 17, 114-9.
185. Weller, I.M.R., Thomas, S.G., Corey, P.N., and Cox, M.H. (1993). Prediction of maximal oxygen uptake from a Modified Canadian Aerobic Fitness Test. *Canadian Journal of Applied Physiology*, 18, 175-88.

186. Weller, I.M.R., Thomas, S.G., Gledhill, N., Paterson, D., and Quinney, A. (1995). A study to validate the Canadian Aerobic Fitness Test. *Canadian Journal of Applied Physiology*, 20, 211-21.

187. Westerstahl, M., Barnekow-Bergkvist, M., Hedberg, G., and Jansson, E. (2003). Secular trends in body dimensions and physical fitness among adolescents in Sweden from 1974 to 1995. *Scandinavian Journal of Medicine and Science in Sports*, 13, 128-37.

188. Willms, J.D., Tremblay, M.S., and Katzmarzyk, P.T. (2003). Geographic and demographic variation in the prevalence of overweight Canadian children. *Obesity Research*, 11, 668-73.

189. World Health Organization (1998). Obesity: Preventing and managing the global epidemic. World Health Organization: Geneva, Switzerland.

190. Young, T.K., Reading, J., Elias, B., and O'Neil, J.D. (2000). Type 2 diabetes mellitus in Canada's First Nations: Status of an epidemic in progress. *Canadian Medical Association Journal*, 163, 561-6.

APPENDIX A

SUMMARY OF THE OLD ORDER MENNONITE LIFE PHILOSOPHY

The following list of fundamental, Old Order Mennonite beliefs was compiled by Krayball et al. (2001) in their monograph, On the backroad to heaven, and cited by Peters (2003): (1) The individual is not the primary reality, (2) Communal goals transcend personal ones, (3) The past is as important as the future, (4) Tradition is valued over change, (5) Preservation overshadows progress, (6) New, bigger, and faster are not necessarily better, (7) Personal sacrifice is esteemed over pleasure, (8) Local involvement outweighs national acclaim, (9) Work is more satisfying than consumption, (10) Obedience to authority brings order and unity, (11) Spiritual salvation comes via the grace of community, (12) Friends are more important than status, fame, or wealth, (13) Yielding to community brings meaning, identity, and belonging, and (14) Maintaining the unity of community is the supreme value.

APPENDIX B

ACKNOWLEDGMENT AND APPROVAL OF ETHICS SUBMISSION

Investing in Ideas
U OF S RESEARCH

Research Services

Bonnie Korthuis, Administrative Assistant
University of Saskatchewan
Rm 210 Kirk Hall, 117 Science Place
SASKATOON, SK S7N 5C8 CANADA
Phone: 966-4053 Fax: 966-8597
Email: bonnie.korthuis@usask.ca

MEMORANDUM

To: Dr. Mark Tremblay and J. Barnes
College of Kinesiology

From: Bonnie Korthuis

Date: February 8, 2002

Re: **Verification of Ethics Submission**

This memorandum acknowledges that the application for ethics approval submitted by Joel Barnes and entitled, "Moving Ahead by Looking Back: A Novel Approach for Establishing Physical Activity Guidelines for Children" was received in the ethics office on Friday, February 8, 2002.

B Korthuis

UNIVERSITY OF SASKATCHEWAN
BEHAVIOURAL RESEARCH ETHICS BOARD
http://www.usask.ca/research/ethics.shtml

NAME: M. Tremblay (J. Barnes) **BSC#:** 02-344
College of Kinesiology

DATE: March 8, 2002

The Behavioural Research Ethics Board has reviewed the revisions to the Application for Ethics Approval for your study "Moving Ahead by Looking Back: A Novel Approach for Establishing Physical Activity Guidelines for Children" (02-344).

1. Your study has been APPROVED.

2. Any significant changes to your proposed study should be reported to the Chair for Committee consideration in advance of its implementation.

3. The term of this approval is for 5 years.

4. This approval is valid for five years on the condition that a status report form is submitted annually to the Chair of the Committee. This certificate will automatically be invalidated if a status report form is not received within one month of the anniversary date. Please refer to the website for further instructions: http://www.usask.ca/research/ethics.shtml

I wish you a successful and informative study.

____
Dr. Valerie Thompson, Chair
Behavioural Research Ethics Board

VT/bk

APPENDIX C

CONSENT FORM

Joel David Barnes
University of Saskatchewan
105 Gymnasium Place
Saskatoon, SK S7N 5C2
(306) 651-7061

Dear Parent/Guardian,

Many Canadian children today are physically inactive. One explanation for this phenomenon is technology. Children spend hours playing video games and watching television every day. As a result, obesity in Canadian children is on the rise.

Health Canada has given us a grant so that we can compare physical activity between children aged 9 – 12 years in Saskatchewan with similar-aged children from your community in Ontario. What we expect to find is that children in your community are more physically active than children in Saskatchewan because of lifestyle differences. For example, the lifestyle of children in Saskatchewan is influenced by technology to a greater extent than it is in children from your community.

Since the spring of 2002, we have been in contact with Mr. Levi Frey who lives in your community. We have informed him about our research project. He is in support of the project and he has agreed to let us contact you on an individual basis.

The information from this research project will be useful in our attempt to promote physical activity among Canadian children. It will help us demonstrate the need for children to reduce their use of technology as part of maintaining a physically active lifestyle.

In order for your children to participate in this project, they must be between 9 and 12 years old and willing to complete a fitness test that includes height and weight measurements, push-ups, sit-ups and so on. The fitness test will be done in the house where the children live and should take about 30 minutes for one child to complete. Also, a small device must be worn on one side of the hip for seven days following the fitness test. This device is called an accelerometer and measures physical activity. After seven days when we return for the accelerometer, a questionnaire measuring physical activity must be completed. The questionnaire should take between 10 and 15 minutes to fill out. Next summer, the accelerometer must be worn for an additional seven days followed by the completion of the same physical activity questionnaire.

Each child who participates will receive $10 this fall and $10 again next summer for their participation.

We would appreciate it if you would read and fill out the attached consent form and the PAR-Q questionnaire, and then mail them back to us using the self-addressed stamped envelope enclosed. Your prompt attention to this would be appreciated. The Research Assistants for this project will be moving to Mount Forest in the middle of September and would like to begin the testing as soon as possible. Thank you for you consideration of this request.

We look forward to hearing from you.

Sincerely,

Joel Barnes

College of Kinesiology, University of Saskatchewan
105 Gymnasium Place, Saskatoon SK S7N 5C2 Canada Telephone: (306) 966-6500 Facsimile: (306) 966-6464

Moving Ahead by Looking Back: A Novel Approach for Establishing Physical Activity Guidelines for Children

Parent and Guardian Information and Consent Form

Principal Investigator:

Dr. Mark Tremblay
College of Kinesiology
University of Saskatchewan
(306) 966-6484

Research Assistant:

Joel Barnes
College of Kinesiology
University of Saskatchewan
(306) 242-3961

College of Kinesiology, University of Saskatchewan
105 Gymnasium Place, Saskatoon SK S7N 5C2 Canada Telephone: (306) 966-6500 Facsimile: (306) 966-6464

The purpose of this study is to assess and compare the fitness and physical activity levels of children from an Old Order Mennonite community with a group of children from Saskatchewan sharing a similar rural environment. This will assist in establishing healthy physical activity guidelines by comparing a lifestyle similar to years gone by, with that of today.

In addition to assisting in the establishment of physical activity guidelines for children, you stand to benefit from this research project on a personal level. Each participant will receive the results of the fitness appraisal. These results could help to identify areas where the participant could benefit from additional physical activity. None of these benefits are guaranteed.

The fitness level of participants will be determined using a standard battery of fitness tests. (Blood pressure, heart rate, height, weight, waist girth, triceps skinfold, grip strength, push-ups, sit and reach flexibility, partial curl-ups, and a test of aerobic fitness). These tests are commonly used and produce no risk greater than performing regular physical activity. Normal sensations associated with normal physical exertion such as fatigue, mild nausea, "rubbery" legs, and possible slight dizziness should be expected. Prior to any testing the participants would be required to complete the Physical Activity Readiness Questionnaire (PAR-Q), which serves as a screening tool. This battery of tests has been administered to over a million Canadians without any recorded serious incidents. The investigator has administered or overseen thousands of these test, without incident. The time commitment for this portion of the research project is one hour.

The physical activity level of participants will be determined using a small activity monitor that is worn on a belt for seven consecutive days. Since this will be carried out on two separate occasions, each participant will wear the device for 14 days, but the only inconvenience is putting on and taking off the device. Physical activity will also be assessed by having the participants complete a self-reported physical activity questionnaire. The time commitment involved is between 10 and 15 minutes.

The participants will be identified by an ID number in order to protect their anonymity and right of privacy. No personal information other than age and sex will be recorded. Address information will be collected so that the summary results can be mailed out after the study is complete. All reported data will use ID numbers and in most cases grouped data will be reported.

The findings from this study will be reported in one or more masters theses as well as several research papers and presentations. All participants will be mailed a short summary of the findings with only grouped data presented to preserve anonymity. Upon completion of the individual fitness testing, participants will be given their individual results for their own interest or records.

Your participation in this research project is completely voluntary and should you wish, you may withdraw from participating at any time without fear of reprisal.

If you have any concerns or questions regarding this research project, feel free to contact the principal investigator, Dr. Mark Tremblay (306-966-6484), the research assistant, Joel Barnes (306-242-3961), or the Office of Research Services at the University of Saskatchewan (306-966-4053).

This research project was reviewed and approved on ethical grounds by the University of Saskatchewan Advisory Committee on Ethics in Behavioural Science Research on March 8, 2002.

Moving Ahead by Looking Back: A Novel Approach for Establishing Physical Activity Guidelines for Children

University of Saskatchewan
Parent and Guardian Information and Consent Form

This Parent/Guardian Authorization form is being sent to you to obtain your permission in allowing your child to participate in the research study titled **Moving Ahead by Looking Back: A Novel Approach for Establishing Physical Activity Guidelines for Children**. The testing will be overseen by Dr. Mark Tremblay. For more information contact Dr. Tremblay at (306) 966-6484. Your participation in this project is greatly appreciated.

Parent's Name: ______________________________

Child's Name: ______________________________

School: ______________________________

Home Address: ______________________________

______________________________ Postal Code:____________

Phone:____________ Birthdate: _________

Please identify any medical or health conditions that the researchers should be aware of, including the use of any medications:

____

CONSENT
I acknowledge that:

1. Based on my knowledge there is no medical reason why my child cannot perform the testing
2. My child has completed the PAR-Q and none of the responses were "yes"
3. I have reported any medication that my child is taking
4. The researchers have answered all of my questions
5. I understand the potential risks and benefits of these procedures
6. All of the results will be kept strictly confidential and if used for publication, identities will remain anonymous
7. I recognize that my child's involvement is voluntary and they may discontinue the testing at any time.

Parent's Name:______________ Signature of Parent:_______________ Date: ________

Child's Name:______________ Signature of Child:________________ Date: ________

APPENDIX D

PHYSICAL ACTIVITY READINESS QUESTIONNAIRE

Physical Activity Readiness
Questionnaire - PAR-Q
(revised 1994)

PAR - Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
☐	☐	1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?
☐	☐	2. Do you feel pain in your chest when you do physical activity?
☐	☐	3. In the past month, have you had chest pain when you were not doing physical activity?
☐	☐	4. Do you lose your balance because of dizziness or do you ever lose consciousness?
☐	☐	5. Do you have a bone or joint problem that could be made worse by a change in your physical activity?
☐	☐	6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
☐	☐	7. Do you know of any other reason why you should not do physical activity?

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active — begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal — this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever — wait until you feel better; or
- if you are or may be pregnant — talk to your doctor before you start becoming more active.

Please note: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction.

NAME ______________________________

SIGNATURE ______________________________ DATE ______________________________

SIGNATURE OF PARENT ______________________________ WITNESS ______________________________
or GUARDIAN (for participants under the age of majority)

continued on other side...

Supported by: Health Canada Santé Canada

...continued from other side

PAR - Q & YOU

Physical Activity Readiness Questionnaire - PAR-Q (revised 1994)

We know that being physically active provides benefits for all of us. Not being physically active is recognized by the Heart and Stroke Foundation of Canada as one of the four modifiable primary risk factors for coronary heart disease (along with high blood pressure, high blood cholesterol, and smoking). People are physically active for many reasons — play, work, competition, health, creativity, enjoying the outdoors, being with friends. There are also as many ways of being active as there are reasons. What we choose to do depends on our own abilities and desires. No matter what the reason or type of activity, physical activity can improve our well-being and quality of life. Well-being can also be enhanced by integrating physical activity with enjoyable healthy eating and positive self and body image. Together, all three equal VITALITY. So take a fresh approach to living. Check out the VITALITY tips below!

Active Living:

- accumulate 30 minutes or more of moderate physical activity most days of the week
- take the stairs instead of an elevator
- get off the bus early and walk home
- join friends in a sport activity
- take the dog for a walk with the family
- follow a fitness program

Healthy Eating:

- follow Canada's Food Guide to Healthy Eating
- enjoy a variety of foods
- emphasize cereals, breads, other grain products, vegetables and fruit
- choose lower-fat dairy products, leaner meats and foods prepared with little or no fat
- achieve and maintain a healthy body weight by enjoying regular physical activity and healthy eating
- limit salt, alcohol and caffeine
- don't give up foods you enjoy — aim for moderation and variety

Positive Self and Body Image:

- accept who you are and how you look
- remember, a healthy weight range is one that is realistic for your own body make-up (body fat levels should neither be too high nor too low)
- try a new challenge
- compliment yourself
- reflect positively on your abilities
- laugh a lot

Enjoy eating well, being active and feeling good about yourself. That's VITALITY.

FITNESS AND HEALTH PROFESSIONALS MAY BE INTERESTED IN THE INFORMATION BELOW.

The following companion forms are available for doctors' use by contacting the Canadian Society for Exercise Physiology (address below):

The **Physical Activity Readiness Medical Examination (PARmed-X)** - to be used by doctors with people who answer YES to one or more questions on the PAR-Q.

The **Physical Activity Readiness Medical Examination for Pregnancy (PARmed-X for PREGNANCY)** - to be used by doctors with pregnant patients who wish to become more active.

References:

Arraix, G.A., Wigle, D.T., Mao, Y. (1992). Risk Assessment of Physical Activity and Physical Fitness in the Canada Health Survey Follow-Up Study. **J. Clin. Epidemiol.** 45:4 419-428.

Mottola, M., Wolfe, L.A. (1994). Active Living and Pregnancy, In: A. Quinney, L. Gauvin, T. Wall (eds.), **Toward Active Living: Proceedings of the International Conference on Physical Activity, Fitness and Health**. Champaign, IL: Human Kinetics.

PAR-Q Validation Report, British Columbia Ministry of Health, 1978.

Thomas, S., Reading, J., Shephard, R.J. (1992). Revision of the Physical Activity Readiness Questionnaire (PAR-Q). **Can. J. Spt. Sci.** 17:4 338-345.

***To order multiple printed copies of the PAR-Q**, please contact the*

Canadian Society for Exercise Physiology
185 Somerset St. West, Suite 202
Ottawa, Ontario CANADA K2P 0J2
Tel. (613) 234-3755 FAX: (613) 234-3565

The original PAR-Q was developed by the British Columbia Ministry of Health. It has been revised by an Expert Advisory Committee assembled by the Canadian Society for Exercise Physiology and Fitness Canada (1994).

Disponible en français sous le titre «Questionnaire sur l'aptitude à l'activité physique - Q-AAP (revisé 1994)».

Supported by: Health Canada Santé Canada

APPENDIX E

METABOLIC EQUIVALENTS TO ACTIVITY COUNTS PER MINUTE CONVERSION TABLE FOR 8- TO 13-YEAR-OLDS

Table E.1 Age-specific metabolic equivalents to activity counts·min^{-1} conversion table

	Age (years)					
METs	8	9	10	11	12	13
1.0	0	0	0	0	0	0
1.5	201	226	254	284	316	350
2.0	401	453	508	568	631	700
2.5	602	679	763	851	947	1,049
3.0	802	906	1,017	1,135	1,262	1,399
3.5	1,220	1,338	1,463	1,597	1,741	1,896
4.0	1,638	1,770	1,910	2,059	2,220	2,393
4.5	2,056	2,201	2,356	2,522	2,699	2,890
5.0	2,475	2,633	2,802	2,984	3,178	3,387
5.5	2,893	3,065	3,249	3,446	3,657	3,884
6.0	3,311	3,497	3,695	3,908	4,136	4,381
6.5	3,729	3,928	4,142	4,370	4,615	4,878
7.0	4,147	4,360	4,588	4,832	5,094	5,375
7.5	4,565	4,792	5,035	5,294	5,573	5,872
8.0	4,983	5,224	5,481	5,756	6,052	6,369
8.5	5,401	5,656	5,927	6,218	6,530	6,866
9.0	5,819	6,087	6,374	6,680	7,009	7,363
9.5	6,237	6,519	6,820	7,143	7,488	7,860
10.0	6,655	6,951	7,267	7,605	7,967	8,357
10.5	7,073	7,383	7,713	8,067	8,446	8,854
11.0	7,491	7,814	8,160	8,529	8,925	9,351
11.5	7,909	8,246	8,606	8,991	9,404	9,848
12.0	8,327	8,678	9,052	9,453	9,883	10,345

(METs: Metabolic equivalents)

The multiple regression equation used for these conversions (Freedson et al., 1997) cannot predict activity counts·min^{-1} below 3.0 METs. Therefore, the following steps were taken: First, 1.0 MET (resting metabolic rate) was assumed equal to zero activity counts·min^{-1} across age based on the assumption that resting metabolic rate is associated with no bodily movement (Nichols et al., 2000). Second, activity counts·min^{-1} at 1.5, 2.0, and 2.5 METs were assumed equivalent to 0.25, 0.50, and 0.75 the activity counts·min^{-1} respectively at 3.0 METs across age. On this basis, METs below 3.0 were converted to activity counts·min^{-1}.

APPENDIX F

ACTIVITY MONITOR DATA REDUCTION PROTOCOL

1. 50-50 rule: If the activity monitor was not worn during a physical activity, half the length of the event should be given counts per minute equal to the age-specific metabolic equivalent for the activity (Ainsworth et al., 2000). The other half should be given counts per minute equal to 2.0 metabolic equivalents at the appropriate age.

2. Activity monitor off for physical activities (hockey, swimming, etc.): For all physical activities during which the activity monitor was not worn, the *50-50 rule* should be applied.

3. Activity monitor off without a reason: If the activity monitor was not worn for a period of 3 hours and 59 minutes or less and no reason for the off time was specified, then leave the data values at zero. If the activity monitor was not worn for a period greater than or equal to 4 hours and no reason for the off time was specified, then the data values should be modeled (see the *Modeling rule*). If the activity monitor was not worn for any period of time on a weekend day (except during sleep), apply the *Poor Data rule*.

4. Modeling: Missing weekdays should be modeled after all the other available weekdays. This involves the following: For every minute of the missing weekday, a count value should be applied that is the average of the 4 identical minutes from the other weekdays. When averaging is done using the AVERAGE function in Microsoft Excel, care should be taken to ensure that no asterisks are included.

5. Poor data: Activity monitor output is considered poor when one of the following 2 conditions is observed: Data values are only available for 3 weekdays or are missing for a weekend day. Activity monitor output should automatically be disregarded when the data values are not fitting this protocol or when the data values are not appropriately matching the log sheet as judged by the data cleaner.

6. Self-care activities (bath, shower, etc.): Such activities should be given counts per minute equal to 2.0 metabolic equivalents at the appropriate age.

The following rules apply for poor data:

7. Church: If the activity monitor was not worn on Sunday morning and the reason given was "church", the *One Weekend Day Missing rule* should be applied.

8. One weekend day missing: If the activity monitor was not worn on a weekend day and no reason for the off time was specified, then the appropriate data from the other weekend day should be inserted. If the activity monitor was not worn on a weekend day and a reason for the off time was specified (hockey, swimming, etc.), the *50-50 rule* should be applied.

9. Two weekdays missing: If the activity monitor was not worn for 2 weekdays, model on the other 3 weekdays. This means the 2 days modeled will receive identical data values.

APPENDIX G

PHYSICAL ACTIVITY QUESTIONNAIRE FOR OLDER CHILDREN

Physical Activity Questionnaire for Children (Elementary School)

Name: ____________________ Age:__________ Sex: M______ F______

Grade:_________ Teacher:____________________

We are trying to find out about your level of physical activity from ***the last 7 days*** (in the last week). This includes sports or dance that make you sweat or make your legs feel tired, or games that make you breathe hard, like tag, skipping, running, climbing, and others.

Remember:
There are no right and wrong answers — this is not a test.
Please answer all the questions as honestly and accurately as you can — this is very important.

---

1. Physical activity in your spare time: Have you done any of the following activities in the past 7 days (last week)? If yes, how many times? (Mark only one circle per row.)

	No	1-2	3-4	5-6	7 times or more
Skipping	❍	❍	❍	❍	❍
Rowing/canoeing	❍	❍	❍	❍	❍
In-line skating	❍	❍	❍	❍	❍
Tag	❍	❍	❍	❍	❍
Walking for exercise	❍	❍	❍	❍	❍
Bicycling	❍	❍	❍	❍	❍
Jogging or running	❍	❍	❍	❍	❍
Aerobics	❍	❍	❍	❍	❍
Swimming	❍	❍	❍	❍	❍
Baseball, softball	❍	❍	❍	❍	❍
Dance	❍	❍	❍	❍	❍
Football	❍	❍	❍	❍	❍
Badminton	❍	❍	❍	❍	❍
Skateboarding	❍	❍	❍	❍	❍
Soccer	❍	❍	❍	❍	❍
Street hockey	❍	❍	❍	❍	❍
Volleyball	❍	❍	❍	❍	❍
Floor hockey	❍	❍	❍	❍	❍
Basketball	❍	❍	❍	❍	❍
Ice skating	❍	❍	❍	❍	❍
Cross-country skiing	❍	❍	❍	❍	❍
Ice hockey/ringette	❍	❍	❍	❍	❍
Other:____________________	❍	❍	❍	❍	❍
____________________	❍	❍	❍	❍	❍

2. In the last 7 days, during your physical education (PE) classes, how often were you very active (playing hard, running, jumping, throwing)? (Check one only.)

I don't do PE .... ❍
Hardly ever .... ❍
Sometimes .... ❍
Quite often .... ❍
Always .... ❍

3. In the last 7 days, what did you do most of the time *at recess*? (Check one only.)

Sat down (talking, reading, doing schoolwork)... ❍
Stood around or walked around .... ❍
Ran or played a little bit .... ❍
Ran around and played quite a bit .... ❍
Ran and played hard most of the time .... ❍

4. In the last 7 days, what did you normally do *at lunch* (besides eating lunch)? (Check one only.)

Sat down (talking, reading, doing schoolwork).. ❍
Stood around or walked around .... ❍
Ran or played a little bit .... ❍
Ran around and played quite a bit .... ❍
Ran and played hard most of the time .... ❍

5. In the last 7 days, on how many days *right after school*, did you do sports, dance, or play games in which you were very active? (Check one only.)

None .... ❍
1 time last week .... ❍
2 or 3 times last week .... ❍
4 times last week .... ❍
5 times last week .... ❍

6. In the last 7 days, on how many *evenings* did you do sports, dance, or play games in which you were very active? (Check one only.)

None .... ❍
1 time last week .... ❍
2 or 3 times last week .... ❍
4 or 5 last week .... ❍
6 or 7 times last week .... ❍

7. *On the last weekend*, how many times did you do sports, dance, or play games in which you were very active? (Check one only.)

None .... ❍
1 time .... ❍
2 — 3 times .... ❍
4 — 5 times .... ❍
6 or more times .... ❍

8. Which *one* of the following describes you best for the last 7 days? Read *all five* statements before deciding on the *one* answer that describes you.

A. All or most of my free time was spent doing things that involve little physical effort .... ❍

B. I sometimes (1 — 2 times last week) did physical things in my free time (e.g. played sports, went running, swimming, bike riding, did aerobics) .... ❍

C. I often (3 — 4 times last week) did physical things in my free time .... ❍

D. I quite often (5 — 6 times last week) did physical things in my free time.. ❍

E. I very often (7 or more times last week) did physical things in my free time .... ❍

9. Mark how often you did physical activity (like playing sports, games, doing dance, or any other physical activity) for each day last week.

	None	Little bit	Medium	Often	Very often
Monday	❍	❍	❍	❍	❍
Tuesday	❍	❍	❍	❍	❍
Wednesday	❍	❍	❍	❍	❍
Thursday	❍	❍	❍	❍	❍
Friday	❍	❍	❍	❍	❍
Saturday	❍	❍	❍	❍	❍
Sunday	❍	❍	❍	❍	❍

10. Were you sick last week, or did anything prevent you from doing your normal physical activities? (Check one.)

Yes .... ❍
No .... ❍

If Yes, what prevented you? ______________________________

VITA

Biographical

October 1979	Born in Saint John, New Brunswick, Canada
May 2001	B.Sc.Kin. (First Division) at the University of New Brunswick
November 2003	M.Sc. (Kinesiology) at the University of Saskatchewan

Honors

September 1997	Christina Estey Scholarship
	Hampton High School Bursary
September 1998	Mr. and Mrs. Conrad J. Osman Scholarship
	New Brunswick Achievement Grant
September 1999	Alumni Undergraduate Scholarship
	Canada Student Loan Bursary
	John Aubrey Allen Memorial Scholarship
January 2000	Millennium Scholarship
September 2000	Purdy MacDonald Scholarship
April 2001	Accepted to Canadian Memorial Chiropractic College
September 2001	New Faculty Scholarship
May 2003	Dean's Graduate Student Travel Fund
	President/Student Fund

Presentations

July 2002	Thesis proposal to the College of Kinesiology at the University of Saskatchewan

Presentations Cont

February 2003	"Joel and Dale's Ultimate Adventure" in the College of Kinesiology's seminar series at the University of Saskatchewan
May 2003	"Comparing Health-Related Physical Fitness Between Old Order Mennonite and Urban Children in Canada" at the Saskatchewan Exercise Science Association's annual conference in Saskatoon, Saskatchewan, Canada, and at the American College of Sports Medicine's 50th Annual Meeting in San Francisco, California, United States.
November 2003	Thesis defense to the College of Kinesiology at the University of Saskatchewan

Publications

January 2002	Barnes, J.D. The relationship between body mass index and body fat assessed by dual-energy x-ray absorptiometry in adolescent boys and girls. *The Ninth Annual Life Sciences Student Research Day*, 21.
April 2003	Esliger, D.W., Barnes, J.D., Copeland, J.L., and Tremblay, M.S. Is the physical activity and fitness of rural children declining? Prepared for the Institute of Agricultural, Rural and Environmental Health's Fifth International Symposium. *Future of rural peoples: Rural economy, healthy people, rural communities*, October 19-23.

Publications Cont

May 2003 — Barnes, J.D., Esliger, D.W., Copeland, J.L., Baxter-Jones, A.D.G., and Tremblay, M.S. Comparing health-related physical fitness between Old Order Mennonite and urban children in Canada. *Medicine and Science in Sports and Exercise*, 35, S13 (abstract).

September 2003 — Tremblay, M.S., Barnes, J.D., Esliger, D.W., and Copeland, J.L. Fitness level of children living traditional vs. contemporary lifestyles. *Portuguese Journal of Sport Sciences*, 3, 142-3.

Tremblay, M.S., Barnes, J.D., Esliger, D.W., and Copeland, J.L. Validity of the PAQ-C self-report questionnaire for children living traditional vs. contemporary lifestyles. *Portuguese Journal of Sport Sciences*, 3, 134-5.

October 2003 — Tremblay, M.S., Barnes, J.D., Esliger, D.W., and Copeland, J.L. Comparison of physical activity behaviour between Old Order Mennonite and contemporary-living children. *Canadian Journal of Applied Physiology*, 28, S110 (abstract).

Esliger, D.W., Copeland, J.L., Tremblay, M.S., and Barnes, J.D. We may know how active our children are, but how are they active? *Canadian Journal of Applied Physiology*, 28, S50-1 (abstract).

Publications Cont

November 2003 Esliger, D.W., Barnes, J.D., Copeland, J.L., and Tremblay, M.S. The influence of lifestyle and gender on physical activity behaviour in children. Prepared for North American Society of Pediatric Exercise Medicine's Biennial Scientific Meeting, August 2004.

Tremblay, M.S., Barnes, J.D., Esliger, D.W., and Copeland, J.L. Seasonal variation in the physical activity of Canadian children assessed by accelerometry. Prepared for North American Society of Pediatric Exercise Medicine's Biennial Scientific Meeting, August 2004.