

**The effect of the Manitoba  
grade 11 and 12 high school physical education curriculum  
on fitness-related health, academic and behavioural outcomes**

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## ABSTRACT

There is universal agreement that school physical education (PE) and school-community sports participation (SCSP) enhance adolescent health and well-being. However, virtually no study has objectively evaluated the effects for grade 11 and 12 high school students. The primary aim of this study was to assess the impact of a newly implemented PE curriculum on health-related fitness, psychological well-being and academic performance for grade 11 and 12 students. Secondary aim was to evaluate the influence of students involved in SCSP (n=44) with those not involved in SCSP (non-SCSP) (n=57). A convenience sample of 101 students (female=52, male=49) participated in the study. Students determined group allocation based on course registration, in-school PE (IN, n=22); out-of-school PE (OUT, n=65); and no-PE (CONTROL, n=14) were assessed with a battery of fitness tests [20-meter shuttle run (20MSR), push-ups (PU), sit-ups (SU), and modified pull-ups (MPU)]; anthropometry [body fat percent (BF%), body mass index (BMI) and waist circumference (WC)]; and the Physical Self-Description Questionnaire (PSDQ) that assessed psychological well-being. Grade point average (GPA) was also appraised. Baseline testing was conducted at the beginning of the 2008-2009 school year, and was repeated in December. At baseline, univariate ANOVA controlling for sex and Tukey's post hoc revealed significant differences ( $p < 0.05$ ) between the groups for age (IN=15.73±0.55 vs. OUT=16.26±0.69 vs. CONTROL=15.50±0.52 years); GPA (OUT=76.92±8.33 vs. CONTROL=70.72±6.55%); BMI (IN=20.56±2.18 vs. OUT=23.02±4.22 kg/m<sup>2</sup>) and WC (IN=74.02±6.25 vs. OUT=80.35±11.65 cm). Repeated measures ANOVA controlling for sex was conducted for each group. For IN, the data revealed significant increases for cardiovascular fitness (CVF) ( $p < 0.001$ ), PU ( $p = 0.033$ ), MPU ( $p = 0.004$ ), aggregate strength (AS) ( $p = 0.017$ ), and height ( $p < 0.001$ ); in addition to significant decreases for GPA ( $p = 0.001$ ) and BF% ( $p = 0.003$ ). Time by sex interaction was significant for height ( $p = 0.018$ ) and SU ( $p = 0.04$ ). For OUT, significant increases were observed for CVF ( $p = 0.002$ ), PU ( $p < 0.001$ ), AS ( $p < 0.001$ ), height ( $p < 0.001$ ), and PSDQ variables of coordination (CO) ( $p = 0.038$ ), strength (ST) ( $p = 0.043$ ) and flexibility (FL) ( $p = 0.013$ ). Time by sex interactions were significant for PU ( $p = 0.01$ ), AS ( $p = 0.044$ ) and PSDQ variable of CO

( $p=0.015$ ). For CONTROL, there was a significant decrease in PA ( $p=0.006$ ), WC ( $p=0.05$ ), MPU ( $p=0.034$ ) and GPA ( $p=0.028$ ). Data revealed significant increases in PU ( $p=0.039$ ) and height ( $p=0.039$ ). Time by sex interactions was significant for the PSDQ variable of strength (ST) ( $p=0.014$ ). The IN group scored significantly higher than both OUT ( $p=0.019$ ) and CONTROL ( $p=0.019$ ) groups with respect to the mean (95% CI) change in  $\text{maxVO}_2$ . For testing in September, SCSP scored significantly higher ( $p<0.001$ ) for the fitness variables of CVF, PU, SU, MPU and AS; and the PSDQ variables of CO, PA, BF, SP, GP, ST, EN and SE. PSDQ variable of appearance was also significantly higher ( $p=0.003$ ) for SCSP. In addition, SCSP scored significantly lower for BF% ( $p<0.001$ ) and WC ( $p=0.013$ ). Sex by sport significant interaction was noted for height ( $p=0.045$ ). Follow up testing in December between SCSP and non-SCSP produced identical results except for WC becoming insignificant ( $p=0.058$ ). Significant improvements in health-related fitness and psychological well-being warrant continued efforts to provide quality PE and SCSP programming for all high school students.

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## INTRODUCTION

During the past 30 years the prevalence of overweight and obesity in Canadian children has risen dramatically (Torrance, McGuire et al. 2007). Changes in the social, economical and physical environment are contributing factors in the increased consumption of energy dense foods and sweetened beverages, decreased exercise related physical activity (PA) and the creation of a generally more sedentary lifestyle (Doak, Visscher et al. 2006). Since 1978, the prevalence of obesity in boys and girls between the ages of 2-17 has tripled while overweight has doubled (Tremblay, Katzmarzyk et al. 2002; Statistics Canada 2004). In Manitoba, 22% of children between the ages of 2-17 are considered overweight and 9% obese (overweight/obese combined percentage of 31%) these figures exceed the National combined overweight/obesity rate of 26% (www.statcan.gc.ca). The socio-economic costs to the Canadian Health Care System each year due to obesity and physical inactivity is staggering. In 2001, it was estimated that 4.8% of the total health care budget was due to obesity (\$4.3 billion) and physical inactivity (\$5.3 billion) from direct costs through the Health Care System and indirect costs such as missed workdays and increased short and long term disability (Katzmarzyk and Janssen 2004). Clearly, the need for the implementation of effective prevention and intervention programs to combat obesity and inactivity in our youth is paramount.

Serious medical complications are associated with childhood obesity (Daniels 2006). Consequences due to obesity include elevated blood pressure values (McGavock, Torrance et al. 2007), dyslipidaemia, reduced insulin sensitivity, alterations of blood vessels, psychosocial dysfunction, reduced levels of self-esteem and self-confidence, discrimination and depression (Skidmore and Yarnell 2004; Schiel, Beltschikow et al. 2006). Childhood obesity due to a lack of sufficient PA has been demonstrated to track well into adulthood resulting in but not limited to, cardiovascular disease (CVD), type II diabetes, hypertension and osteoporosis (McKenzie, Nader et al. 1996; Doak, Visscher et al. 2006; Zahner, Puder et al. 2006; van Sluijs, McMinn et al. 2007). Alternatively, benefits of physical fitness in adolescents include reduced levels of obesity (Wardle, Brodersen et al. 2007), lower lipid and metabolic risk factors for CVD (Sallis and McKenzie 1991; Rimmer and Looney 1997; Garcia-Artero, Ortega et al. 2007), improved

body satisfaction (Perry, Rosenblatt et al. 2002), self-esteem (Wilson, Evans et al. 2005) and improved academic performance (Sallis, McKenzie et al. 1999).

Several PA recommendations for children and youth have been proposed in order to prevent the consequences of inactivity while promoting the benefits of regular exercise (Janssen 2007). In 2005, an evaluation of the relationship between PA to several health and behavioural outcomes concluded that school aged children and youth should accumulate a minimum of 60 minutes of PA each day (Strong, Malina et al. 2005). Sixty minutes of moderate to vigorous PA each day was recommended to allow for inter-individual differences (e.g. a 30-45 min/day workout may only be effective for the average individual), take into account intermittent activities such as walking to school, and improving not only morbidity and mortality factors such as high blood pressure and CVD, but controlling and reducing adiposity (Strong, Malina et al. 2005). Additionally, 60 min/day of moderate PA has been associated with an acceptable level of body composition in children (Wittmeier, Mollard et al. 2007). Finally, the minimum value of 60 min/day seems more realistically achievable than the recommended value of 90 min/day, proposed by Health Canada and the Canadian Society for Exercise Physiology in 2002.

Pedometer data revealed by the Canadian Fitness and Lifestyle Research Institute showed that from a sample of 6000 children and youth (5-19 yrs), the average step count recorded was 11,356 steps/day (Canadian Fitness and Lifestyle Research Institute 2005). This data was part of the Canadian Physical Activity Levels Among Youth (CANPLAY) study conducted between April 2005 and March 2006. Tudor-Locke et al. (2004) suggested that the recommended step count for maintaining an appropriate body mass was 12,000 and 15,000 steps/day for girls and boys, respectively. Only 27% of the CANPLAY participants were above these thresholds. While pedometry does provide useful PA information it is not as accurate as accelerometry when attempting to assess the intensity of PA. One study measured the intensity and duration of PA in 8-10 year old children (n=251) using accelerometers. The authors concluded that reduced body fat and BMI was associated with 45 minutes of moderate PA in addition to 15-minutes of vigorous PA (Wittmeier, Kriellaars et al. 2008). These PA thresholds may be used in the development of more appropriate pedometer values in the battle against obesity and

overweight in youth. The Canadian Fitness and Lifestyle Research Institute also stated that 90 min/day of PA was equivalent to a daily step count of 16,500 of which only 12% boys and 5% girls (9% total) were able to achieve. Thus, 91% of 5-19 years old individuals are not active enough. In addition, it was estimated that only 45% of adolescents between the ages of 15-19 are active enough ( $>3$  kcal/kg/day) (Statistics Canada 2004). Wittmeier, Mollard & Kriellaars (2007) using accelerometry data demonstrated that only 4% of 8-10 year old children meet the 90 minute guideline and an additional 14% exceeded the 60 minute threshold.

In Manitoba, the Government has mandated compulsory physical education (PE) in grade 11 and 12 beginning in September of 2008 to combat the rising prevalence in obesity through provision of sufficient PA. The new curriculum includes; i) PE classes provide an environment that allows students to participate in a wide variety of activities that promote and develop physical fitness and reduce sedentary behaviour (Kohl and Hobbs 1998); ii) provision of PA may be optimized when provided by a certified physical educator (Beets and Pitetti 2005); and iii) enrollment in PE experiences a linear decline from grades 9 to 12 in jurisdictions where PE across all grades is not mandated (Centers for Disease and Prevention 2007). It remains to be seen whether this form of widespread intervention will have any effect on the high levels of overweight and obesity in high school students, but minimally the curriculum needs to be evaluated in terms of its efficacy in induction of physical activity. The study school will provide an ideal environment in which to test the efficacy of the new curriculum in improving the PA levels of its students. Highly trained and motivated PE teachers, supportive parents and school administrators, state-of-the-art school and community training facilities are factors that may aid the successful implementation of the new PE curriculum. If the curriculum succeeds in improving PA in a “best practice environment” (i.e. current study school), then its effectiveness may be inferred to other jurisdictions that are able to provide the same level of support.

The urgency for effective PE intervention programs to combat overweight and obesity is widely recognized (Doak, Visscher et al. 2006). Several studies have evaluated the effectiveness of school based intervention programs at the elementary and middle

school level (Gortmaker, Peterson et al. 1999; Carrel, Clark et al. 2005; Faigenbaum, McFarland et al. 2007; Jiang, Xia et al. 2007; Macdonald, Kontulainen et al. 2007).

In contrast, few studies (Hortz and Petosa 2006; Lubans and Sylva 2007) have reported the effects of PA on the overall health and welfare outcomes of grade 11 and 12 high school adolescents throughout the course of a semester or school year. In fact, there is virtually no objective scientific evidence assessing the effect of a PE curriculum on health-related outcomes. Most studies have focused on applying alternative forms of interventions in an effort to improve existing PE programs. Some studies have reported that regular PE classes are insufficient in enhancing fitness. However, these studies were reported for elementary school children and not older adolescents (i.e. grade 11 and 12). High school adolescent PA interventional studies are essential in order to assess current PE practices in an effort to improve health outcomes. In addition, interventions in the adolescent age group are critical in preventing the consequences associated with inactivity (Young, Phillips et al. 2006).

Special attention directed towards at-risk populations supports the evidence identifying females (Centers for Disease and Prevention 2004; Centers for Disease and Prevention 2007) and obese adolescents (Gutin, Barbeau et al. 2002; Kang, Gutin et al. 2002) as being at the greatest risk for developing hypokinetic illnesses. Study of these groups should continue, however commitment to the general adolescent population in terms of PA interventional research is just as vital in order to make improvements in PE programming.

Fourteen school and non-school interventional studies presented here incorporated a repeated measures experimental design. Two studies (same experiment) focused on obese males and females; one discussed the effect of exercise program coupled with exercise physiology education for both sexes; ten investigated the effects of providing a female only PE classes in an effort to reduce obesity, hypertension, sedentary behaviour and bone loss; and the final study evaluated the effect of the number of PE sessions per week on waist circumference (WC) and body mass index (BMI) over a 5 year period (grades 7 to 11).

Obese adolescents that engage in moderate to vigorous training sessions along with lifestyle education have demonstrated reductions in body fat percentage (BF%),

visceral adipose tissue (VAT) and diastolic blood pressure (DBP) (Gutin, Barbeau et al. 2002; Kang, Gutin et al. 2002). In addition, reported gains were evident in low-density lipoprotein cholesterol (LDLC) and cardiovascular fitness (CVF). Frequency of training to achieve these results was estimated to be 5 times per week, at moderate (55-60% peak  $\text{VO}_2$ ) to high intensities (75-80% peak  $\text{VO}_2$ ), over an eight-month period. Nutritional data and total daily PA was estimated from subject recalls. The results from this study are promising for improving several CVD risk factors in obese adolescents that engage in a non-school PA intervention program. Subjective measurements of PA (i.e. self-reports) have resulted in an overestimation of activity levels (Wong, Leatherdale et al. 2006). This has implications for the interpretation of the necessary physical activity dose required to achieve results. In a Florida high school, 161 students (mean(SD) age= $16.5 \pm 0.89$  years) in the experimental group received physical training (aerobic and resistance exercise) coupled with exercise physiology theory. A group of 33 students (mean(SD) age= $15.61 \pm 0.84$  years) served as a control group, received a standard biology curriculum. The experimental group scored significantly higher in flexibility, aerobic capacity, muscular strength/endurance, body satisfaction and exercise physiology knowledge in comparison to the control (Perry, Rosenblatt et al. 2002).

Several other school-based studies focused their attention solely on the female adolescent population. These studies incorporated a fitness component in order to improve health. Girls only PE classes were designed to reduce several health-related risk factors such as high blood pressure (Ewart, Young et al. 1998), bone loss (Schneider, Dunton et al. 2007), coronary artery disease (CAD) (Bayne-Smith, Fardy et al. 2004) and sedentary behaviour (Jamner, Spruijt-Metz et al. 2004; Dunton, Schneider et al. 2007). Other strategies focused on modifying existing behaviours in order to facilitate a shift to a healthier lifestyle.

Interventions such as The Lifestyle Education for Activity Program (LEAP) and New Moves were based on the Social Cognitive Theory (SCT) which was comprised of socio-environmental (i.e. supportive school), personal (i.e. self-efficacy and self-perception), and behavioural (i.e. goal setting) factors, and their interaction with one another (Neumark-Sztainer, Story et al. 2003; Dishman, Motl et al. 2004; Dishman, Motl et al. 2005; Felton, Saunders et al. 2005). Manipulating the various aspects of SCT was a

part of the overall strategy to affect positive change in the female adolescent PA levels. These interventions were based on essential elements required to accomplish this goal which involved the PE program (e.g. offering noncompetitive activities, emphasizing lifelong PA, etc.); school environment (e.g. providing opportunities to be active outside of school, faculty/staff becoming involved in modeling healthy lifestyles, etc.); involving the family and community; and ensuring organizational change from school administration.

In LEAP, twenty-four schools and 2087 grade 9 girls were allocated to control and interventional groups. Outcomes measures included goal setting, self-efficacy, outcome-expectancy value, satisfaction and self-reported PA with the 3-Day Physical Activity Recall (3DPAR). The girls in the interventional group reported significant increases in moderate-to-vigorous physical activity (MVPA) and vigorous physical activity (VPA) through the manipulation of self-efficacy. While LEAP had positive effects on self-efficacy in adolescent girls, caution must be exercised when interpreting PA levels due to the tendency to over-predict from self-reported PA methodologies (Bender, Brownson et al. 2005; Wong, Leatherdale et al. 2006). As a follow-up, LEAP 2 examined the degree to which the initial effects from LEAP involvement were maintained in grade 12 girls for those schools that maintained the key elements of the intervention. The study concluded that the girls attending the high schools that had fully implemented the intervention were more physically active than girls from the schools that did not fully implement the intervention.

The New Moves program was designed as a girls' only PE class providing PA opportunities (i.e. strength training, walking program, etc.), nutritional guidance (i.e. benefits of healthy eating) and social support (i.e. skills in asking for support from family), in an effort to prevent obesity among adolescent girls. Main outcome measures included self-reported PA, eating patterns, self-perceptions, and direct measurement of BMI. Data was collected at baseline, postintervention and at 8-month follow-up. Six schools participated involving 89 girls in the intervention and 112 girls in the control condition from grades 9 to 12. Overall, New Moves was well received by the students, parents and school staff. However, there were no significant differences at postintervention and follow-up between the intervention and control groups for the

majority of the outcome variables (including self-reported PA and BMI). A significant improvement ( $p=0.004$ ) was noted for the “PA stage of change” variable for the girls in the intervention, which is comprised of one question that places the respondent within a PA continuum ranging from precontemplation to the maintenance of PA.

Again, PA levels were recorded by self-reported questionnaire for both LEAP and New Moves. Interestingly, the studies did not objectively assess any physiological measurements such as aerobic capacity, muscular strength and endurance, body composition, etc. This was especially surprising considering that the New Moves intervention provided one resistance training session per week. By incorporating some form of physical fitness testing (i.e. FITNESSGRAM push-ups, sit-ups and modified pull-ups) the physiological benefits (if any) of the intervention with respect to the resistance training session may have been accessible.

Studies that employed multifaceted PE-based interventions in an effort to improve health have shown modest improvements in PA, CVF, hemodynamic variables and body composition.

Project Heart, a study assessing the effects of aerobics on BP for girls at risk of hypertension (Ewart, Young et al. 1998) and the PATH Program, a study involving a behavioural and fitness component (Bayne-Smith, Fardy et al. 2004), both reported significant improvements in systolic blood pressure over the regular PE program (control). For both studies assessment of CVF involved a sub-maximal step-test protocol. For Project Heart the aerobic exercise group (intervention) was able to exercise an average of one minute more at posttest than at pretest ( $p<0.0003$ ), whereas the PE group (control) reported no increase. For the PATH study, there were no significant differences in CVF between PATH (intervention) participants and PE participants (control). Sub-maximal exercise tests carry assumptions that may not accurately assess CVF. The relationship between steady-state heart rate and intensity, mechanical efficiency and the wide variation in heart rate maximum ( $HR_{max}$ ) between individuals could result in  $\max VO_2$  error between  $\pm 10-15\%$  (Whaley, Kaminsky et al. 1992).

Maximal assessment of aerobic power was conducted in only two of the interventional studies reported in this document. School-based multifaceted PE-based interventions examined the effects of the intervention on fitness, bone health and

psychosocial factors in insufficiently active adolescent females (Jamner, Spruijt-Metz et al. 2004; Schneider, Dunton et al. 2007). The interventions combined supervised PA sessions as well as an educational component designed to increase PA outside of school. Both interventions conducted baseline (summer) and post-intervention (semesters 1 and 2) testing between intervention and control groups. In both studies CVF (peakVO<sub>2</sub>, L/min.) was directly assessed through a maximal cycle ergometer progressive exercise test. Cycle power output was continuously increased until the subjects reached voluntary fatigue. Self-reported PA was measured using a 2-Day (Jamner, Spruijt-Metz et al. 2004) or 3-Day (Schneider, Dunton et al. 2007) PA recall. While disappointingly, there were no significant changes for BMI and BF% between the two groups for both studies, the intervention did indicate significant improvements for PA, CVF, bone development and light MVPA levels (Jamner, Spruijt-Metz et al. 2004; Schneider, Dunton et al. 2007). Psychosocial factors related to exercise were not affected by the intervention conducted by Schneider and Dunton (2007).

A school-based, five-year longitudinal PE study involving 34 secondary schools in London, England examined the effect of PE on male and female adolescent adiposity (Wardle, Brodersen et al. 2007). Of the 34 schools in the study 25 schools offered PE once a week, seven schools reported two PE sessions/week, and two boys only schools offered three PE sessions/week. Main measures included WC and BMI. These measures were taken annually from the first and fifth year of the study on 2727 students, beginning in grade seven and concluding in grade 11. For boys, comparisons were made for those receiving one, two or three weekly sessions. For girls, comparisons were conducted for one and two sessions. The boys in schools providing 3 weekly PE sessions gained approximately 3 cm less for WC when compared to boys in school offering 1-2 PE sessions per week ( $p < 0.001$ ). No significant difference for WC was encountered for the girls. BMI results indicated no statistical difference in either boys or girls across all PE sessions (Wardle, Brodersen et al. 2007). The lack of change in BMI may be due to the fact that BMI is less sensitive and specific than WC. Perhaps an increase in muscle mass due to additional PA may have increased the BMI of the active group. This muscle mass enhancing BMI has been reported elsewhere (Carrel, Clark et al. 2005). For boys, increasing the number of PE sessions had favourable effects on WC. This is an important



finding since WC has been demonstrated to predict CVD risk factors among adolescents (Janssen, Katzmarzyk et al. 2004). Unfortunately, the inclusion of a CVF fitness test such as the shuttle run test may have provided additional information on the relationship of changes in WC and adolescent susceptibility to CVD. Also the fact that the curriculums were not controlled, and the quality of teaching instruction and facilities was not known in this natural experiment limit the utility of the findings to recommend the number of PE sessions per week.

The majority of the high school-based interventions to date have attempted to improve PA levels through some form of behaviour modification. Most of the studies reported improved participation and attitude towards PA. However, the reported quantity and intensity of PA data may have been over-estimated due to self-reported methods such as a 3-day PA recall (3-DPAR). In addition, results obtained from sub-maximal testing of cardiovascular endurance carries assumptions that may affect validity. Interventions that incorporate physical training along with educational sessions designed to improve PA have demonstrated improved cardiovascular and increased moderate –to-vigorous physical activity (MVPA). Interestingly, most studies evaluated the effects of special PE classes on the health outcomes for female adolescents only with only a minimal number focusing on older youth (i.e. grade 11 and 12 students).

In Manitoba, an opportunity arose to evaluate the impact of a new curriculum focused on the provision of PA. A study was designed to assess the impact of the new curriculum on PA, fitness, body composition, physical self-perception, self-esteem and academic variables. As such this study will help to fill the gap in our knowledge, due to the limited research to date by using objective measures of PA along with measures of fitness in both male and female adolescents. Few studies to date have examined the impact of extracurricular participation in sport for this age group. Outside participation in sport can be a confounding influence to the interpretation of the results. Thus, the effect of sports participation will also be examined.

Several objective measures have been selected in an effort to acquire as much information to properly assess effectiveness of the PE curriculum. This approach contrasts the approaches of previous high school intervention studies that relied on subjective techniques (i.e. self-reported PA) in order to gauge PA levels. In essence, the

proposed study will provide initial information on the effectiveness of the new curriculum on the health of grade 11 and grade 12 students.

## **PURPOSE**

The primary aim of the study will be to determine the effect of mandatory grade 11 and grade 12 Manitoba physical education curriculum on physical activity, physical fitness, academic performance and physical self-concept.

Secondary aim will be to examine the participation school and/or community sports participation (SCSP) and its impact on physical activity, physical fitness, academic performance and physical self-concept.

## **OBJECTIVES AND HYPOTHESES**

- Objective #1: Examine the change in physical activity, health-related fitness (cardiovascular fitness, physical activity, muscular strength and endurance and body composition), physical self-concept, self-esteem and academic performance of youth within the new grade 11 and 12 physical education/health curriculum.
- Hypothesis #1: There will be an improvement in physical activity, health-related fitness, physical self-concept and self-esteem and academic performance over the semester for in-school and out-of-school physical education students.
- Objective #2: Examine the change in physical activity, health-related fitness (cardiovascular fitness, muscular strength and endurance and body composition), physical self-concept, self-esteem and academic performance between grade 11 and 12 males and females.
- Hypothesis #2: There will be significant differences between males and females with respect to physical activity and health-related fitness. No differences will be observed between the sexes for physical self-perception, self-esteem and academic success.
- Objective #3: Examine the change in physical activity, health-related fitness (cardiovascular fitness, muscular strength and endurance and body composition), physical self-concept, self-esteem and academic performance between those involved (SCSP) and those not involved (non-SCSP) in school-community sports.
- Hypothesis #3: SCSP will have significantly improved physical activity, health-related fitness, physical self-perception, self-esteem and academic outcomes than non-SCSP.

## **MATERIALS AND METHODS**

### **PARTICIPANTS**

Adolescents of both sexes between the ages of 15-17, in grades 11 and 12 attending a suburban high school in Manitoba were invited to participate. A one-hour study information session was presented to all grade 11 and 12 students and parents. Study information letter along with student assent and parent consent forms were sent home and returned prior to the start of the study (Appendices B, C, D). Students were excluded from the study if they suffered from an injury or illness that prevented them from completing the exercise assessments. Study approval was granted by the School Division, school Principal and University of Manitoba Health Research and Ethics Board HREB Approval number: H2008:111).

### **PHYSICAL EDUCATION CURRICULUM OVERVIEW**

The new Manitoba Physical Education/Health (PE/HE) Curriculum consists of a 1 credit hour in grade 11 and grade 12. One credit hour is approximately 110 hours of delivery. During the transition year (2008/2009), grade 11 and 12 students will be required to complete the Grade 11 Active Healthy Lifestyles PE/HE Curriculum. Students must accumulate a minimum of 29 credits for graduation, three of which must be from PE/HE courses (i.e., 10F, 20F and 40F). In the following school year (2009/2010) students will require a minimum of 30 credits for graduation, four of which must be from PE/HE (i.e., 10F, 20F, 30F and 40F credits). Evaluation of the PE/HE courses will be given a Complete or Incomplete designation.

The three components comprising the Grade 11 Active Healthy Lifestyles PE/HE Curriculum include, a core component (modules B-E), a physical activity (PA) practicum (module A), and a flexible delivery component. These components are illustrated in Figure 1. The flexible delivery component is extra time that can be devoted towards the core and/or PA practicum components. The study school decided to allocate the entire 25% flexible delivery component towards the PA practicum, resulting in a 25% Core and 75% PA practicum course structure.

25%	75%	
Minimum in-class time	Maximum out-of-class time	
25%	25%	50%
Core Component	Flexible Delivery Component (Extension of <b>core</b> or <b>practicum</b> )	Physical Activity Practicum

**Figure 1 - Implementation model, grade 11 and 12 mandatory PE curriculum.**

(Derived from: Manitoba Education, Citizenship and Youth. Implementation of Grades 11 and 12 Physical Education/Health Education: A Policy Document. Winnipeg, MB: Manitoba Education, Citizenship and Youth, 2007. 10).

The Core component (approximately 30 hours) contains specific learning outcomes (SLO) divided into four blocks of content called modules. Each module represents content from at least one of the general learning outcomes (GLO) from the *Kindergarten to Grade 12 PE/HE Education: Manitoba Framework of Outcomes for Active Healthy Lifestyles Curriculum*. The modules include: Module B: Fitness Management, Module C: Mental-Emotional Health, Module D: Social Impact of Sport and Module E: Substance Use and Abuse Prevention.

The school division hired one PE specialist to facilitate an online program (InForm Net), for the completion of the core component for all grade 11 and 12 students in the division. InForm Net is an online alternative environment providing high schools students with the opportunity to achieve credits through courses approved by Manitoba Education, Citizenship and Youth. In order to successfully complete the core component, students were required achieve a minimum score of 70% on each of the four module tests. Students that did not achieve a passing mark were required to re-write the test.

Grade 11 students in the study met once a week, during their blocked PE class to work on the modules. The grade 12 students in the study were not required to attend classes during the instructional day. No formal lectures and/or submitted assignments

were required in this program. The online tests were available to students 24 hours a day, 7 days a week.

The PA practicum component was offered in the study school as an In-school (IN) or Out-of-school (OUT) option. Grade 11 students were provided with both options, while grade 12 students were only given the OUT option due to budgetary, timetable and gymnasium limitations of the school division.

IN or In-school refers to instructional time that is teacher-directed and based on learning outcomes from the curriculum. Students were required to attend timetabled classes during the instructional day. The goals of the PE department at the study school were to maximize playing or activity time, and provide activities challenging students to achieve MVPA levels consistent with the curriculum objectives. Students not putting forth sufficient effort during the activities and/or missed too many classes were required to attend make-up sessions outside of school time. Students failing to meet this requirement were denied credit in the course.

OUT or Out-of-school refers to instructional time that is student-directed and not part of the regular school day. Students were required to complete the PA practicum on their own initiative through school-based and/or non-school-based activities. School-based activities are organized by the school and include school teams, intramurals, fitness clubs, etc. Non-school-based activities are activities that are not organized by the school, such as, community club teams, local fitness centers, exercising at home, etc. All OUT activities regardless of whether they were school or non-school based required a student, parent and PE teacher pre-sign-off and post-sign-off process. This sign-off process ensured that the chosen activities were safe, age appropriate and were capable of fulfilling the MVPA intensity levels.

In the pre-sign-off process the student submitted three documents to the PE department for approval. The documents include an activity safety checklist; student assent forms and parent consent forms that were divisional based. For the post-sign-off process students were provided with a PA practicum log form to track their hours (Appendix F). Once the student documented the required minimum of 75 hours of MVPA, the log was submitted to the PE department for credit.

**Study Groups**

Three distinct arms were naturally present in the study school based on student course interest upon course registration for semester 1 (September-December, 2008):

- 1) IN (In-school PE in semester 1).
- 2) OUT (Out-of-school PE in semester 1).
- 3) CONTROL (students not enrolled in PE in semester 1).

IN and OUT served as the curriculum intervention groups. Students not enrolled in PE in semester 1 comprised the natural CONTROL group (Figure 2).

***IN***

<b>25% Core-Online</b> OUT Student-Directed	<b>75% PA Practicum</b> IN Teacher-Directed
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***OUT***

<b>25% Core-Online</b> OUT Student-Directed	<b>75% PA Practicum</b> OUT Student-Directed
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***CONTROL***

<b>No PE Course</b>
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**Figure 2 - Study groups.**

**Data Collection Periods**

Study participants met on Monday, September 1, 2008 in the school theatre for orientation to the study. Baseline data collection began on Tuesday, September 2, 2008 over 2-weeks. During this time period IN students did not participate in any PE class physical activity. This was done to prevent curriculum effects before baseline testing could be completed. All measures were repeated beginning on Wednesday, December 3, 2008 over a 2-week block (Figure 3) prior to the winter holiday break (2 weeks).

Orientation Sept. 1	Baseline measures Sept. 2-15	<b>INTERVENTION-GR. 11/12 PE CURRICULUM</b> <b>Sept. 16 – Dec. 16</b>	Repeated measures Dec. 3-16
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**Figure 3 - Study timeline.**

## **SAMPLE SIZE ANALYSIS**

Although this was a natural experiment, a sample size calculation was utilized to provide an estimate of the power of the study. A power analysis ensures the determination of genuine differences between groups will likely occur given adequate subject numbers. An alpha ( $\alpha$ ) level of 0.05 (one-tailed) and power level of 0.95 (one-tailed) were used and therefore the risk of a Type II ( $\beta$ ) error was set at 5%. Power index (PI) was determined by  $\alpha$  (one-tailed) 0.05 (1.64) +  $\beta$  (one-tailed) 0.05 (1.64) = 3.28. Based on studies by (Bayne-Smith et al. 2004) and (Kang et al. 2002) on CVF in adolescents the standard deviation was set to be 3.8 ml/kg/min (standard deviation or sigma) and mean difference or delta was expected to be 4.69 ml/kg/min. Thus,  $\sigma/\mu_1 - \mu_2$  was set at 3.8 ml/kg/min  $\div$  4.69 ml/kg/min = 0.8102 (effect size). Calculated sample size was 14.12 or 15 subjects. This sample size is suitable for a between groups comparison (between PE class types including the no PE class “control” group). So, a sample of 15 subjects per class type was required for detection of a change in cardiovascular fitness. This arm of the study (the between groups arm) requires a higher sample size than the within group comparison over time. As such, the repeated measures arm will be sufficiently powered given sufficient power in the between groups arm.



## **PHYSICAL ACTIVITY**

Pedometry has demonstrated to be a reliable method for determining the PA levels of adolescents (Tudor-Locke et al. 2002). Students wore a pedometer (TC02, StepsCount) for two weeks in September and two weeks in December. Students were instructed on the use of pedometers including appropriate placement. Students recorded the number of step counts at the end of each day on a record sheet (Appendix H). The average daily step count was determined, along with the average weekend step counts.

Due to the nature of participation and activity detection at this age, the ability to wear the pedometers in sports (hockey, volleyball, swimming, etc.) was limited. Also for those participating in gym fitness activities, pedometers have limited uses on certain fitness equipment such as cycle, elliptical trainers, etc. Also pedometry does not capture activity intensity information, except that a person walking or running at higher speeds will accrue greater steps as a result of higher step rates. This is, however, indistinguishable from a person undergoing a slower gait for a longer period of time. Due to funding reasons these devices were not available for all the study participants.

## **CARDIOVASCULAR FITNESS**

### **20 Meter Shuttle Run**

The 20-meter shuttle run (20MSR) has been shown to be a valid and reliable maximal exertion field test for the estimation of CVF in adolescents (Liu, Plowman & Looney 1992, van Mechelen, Hlobil & Kemper 1986). The course was marked with two pylons set at a distance of 20 meters. An audio timing cue was provided for proper pacing. The subjects completed as many 20-meter lengths as possible. The test was stopped when two consecutive lines were not reached by the beep or when they reached volitional fatigue. A “talk test” was used to verify maximal exertion. Students failing the “talk test” were required to repeat the test on a separate day. The last full stage completed determined maximal running speed in km/hr. Maximal oxygen consumption ( $\text{maxVO}_2$ ) was calculated using the regression equation  $31.025 + 3.238 (\text{speed in km/hr}) - 3.248 (\text{age in years}) + 0.1536 (\text{age} \times \text{speed})$ .

While the validity and reliability of the 20MSR is robust in assessing aerobic power in terms of relative performance, it does not assess performance based on fat free mass (FFM). This is a limitation of this method. However, it has been shown to have a moderate correlation to oxygen consumption during maximal cycle ergometry with indirect calorimetry in this age group which is a fat mass independent measure of CVF (McGarry 2007).

### **Rockport One Mile Walk**

For exploratory purposes, a second test of CVF was performed. This sub-maximal test predicts maximal oxygen consumption ( $\text{maxVO}_2$ ) by applying a regression equation for individuals between the ages of 8-17. Concurrent validity of the 1 mile walk test is strong ( $R=0.72$ ) with a  $\text{SEE}=4.8$  ml/kg/min (Cureton et al. 1995). Students walk the distance as fast as possible but at a fixed pace and record the time and heart rate at the end of 1.0 mile (1604.39 m).

$$\begin{aligned} \text{maxVO}_2 \text{ (ml/kg/min)} &= 132.853 (0.0769 \times \text{body weight in [pounds]}) \\ &- (0.3877 \times \text{age [years]}) \\ &+(6.3150 \times \text{sex [female = 0; male = 1]}) \\ &- (3.2649 \times \text{1-mile walk time [in minutes and hundredths]}) \\ &- (0.1565 \times \text{1-minute heart rate at end of mile [beats per minute]}) \end{aligned}$$

September testing was conducted on the school track, while December testing had to be carried out inside the school. Four laps on the outdoor track and 8 laps within the school provided the required distance.

## **BODY COMPOSITION**

### **Body Fat**

Skin fold measurements (mm) were taken from the triceps brachii at a point midway between the elbow and acromion process of the scapula and the calf on the right side. Harpenden skin fold calipers (0.5 mm resolution) were used. Slaughter regression equations calculated percent body fat for boys:  $BF\% = 0.735(\text{tricep} + \text{calf}) + 1.0$  and girls  $BF\% = 0.610(\text{tricep} + \text{calf}) + 5.1$  (Slaughter et al. 1988). Measurements were taken in triplicate, on the right side of the body to the nearest 0.5-millimeter. The Slaughter equations are recommended for adolescents due to their simplicity and accuracy when a relative index of body fat percentage is required (Rodriguez et al. 2005).

### **Body Mass Index**

Height (m) and mass (kg) will be measured with subjects dressed in physical activity clothing with the shoes removed. Body mass index (BMI) was derived by the following equation:  $BMI = \text{mass (kg)} / \text{height (m}^2\text{)}$ . Height (nearest 1 mm) and mass (nearest 0.1 lbs = 0.045 kg) were measured on a scale (Seca Beam #700).

### **Waist Circumference**

Waist circumference measurement (cm), is taken by placing the tape in a horizontal position, over the umbilicus. Fat located inside the abdominal wall (visceral fat) contributes more to risk of cardiovascular disease and diabetes than does fat located in other areas (Bjorntorp 1992). Some experts suggest waist circumference may be a better predictor of visceral fat than widely used waist-to-hip ratio (Pouliot et al. 1994). Waist circumference may overestimate health risk in tall individuals and underestimate health risk in short individuals (Welborn, Dhaliwal & Bennett 2003) and weight trained individuals, or those with thicker waist musculature.

## **MUSCULAR STRENGTH AND ENDURANCE**

### **90 Degree Push-Ups**

Subjects begin the test with the feet together, hands placed slightly wider than shoulder width apart, and arms fully extended. The FITNESSGRAM CD was used to properly pace the subjects. On command, the subject lowers to a 90° angle at the elbow joint. The test was stopped when the subject either broke form or was unable to continue due to volitional fatigue. Reliability and validity for push-ups in male and female adolescents ranges from 0.50 to 0.86. This test evaluates the pectoralis and triceps muscle groups.

### **Modified Pull-Ups**

Student lies on back with shoulders in line with a bar 1-2 inches out of their reach. An elastic band is placed 7-8 inches below the bar. Student clears the elastic band with chin as they pivot on their heels during the “upward” section. Only the heels are in contact with the floor during the test. The same track for the push-ups from the FITNESSGRAM CD was used to properly pace the subjects. Test was terminated if the subject exhibited improper form and/or cadence. This test evaluates the latissimus dorsi muscle and related agonists.

### **Sit-Ups**

Sit-ups and curl-ups are common field tests used in the assessment of abdominal strength and endurance health-related fitness. The test that was utilized in this study was a sit-up performed at maximal speed in one minute. The subject lay supine on a mat with the legs parallel, knees bent at ninety degrees, and feet flat on the floor secured by a partner. The hands were placed over the ears with the elbows pointed forwards in order to prevent hyper flexion of the neck, while at the same time eliminating arm swing. A successful repetition involved flexion at the hip, scapulae completely coming off the ground, and elbows contacting the knees.

Sit-ups were selected over other abdominal field tests for two reasons: 1) the speed of the exercise promotes greater trunk muscular activation which make the exercise

more challenging (Vera-Garcia, 2008, Chong, 2008); 2) field tests such as the curl-up from the FITNESSGRAM test battery is performed with a cadence set at 20 repetitions/minute, with a maximum of 80 repetitions, are subject to a 'ceiling effect'. In a study by Knudson (2001), 86% of the males and 82% of the females were able to complete the maximum number of repetitions. In other words, partial sit-up/curl-up tests performed at a slow cadence are not recommended for adolescents and young adults due to their ease (Knudson, 2001).

## **PHYSICAL SELF DESCRIPTION QUESTIONNAIRE**

A 70-item scale designed for adolescents for the measurement of 10 facets of physical self-concept and general self-esteem (Marsh, Richards et al. 1994). Students rated each of the 70-items from a scale of 1 (false) to 6 (true). Scores closer to 6 represented a more positive perception. The 20 negatively worded items were reverse scored. For example, a response of 2 for item number 44 was reversed to 5 for correct representation of the item. The PSDQ will allow for the comparison of student physical self-perceptions to objectively measured health related fitness tests.

## **ACADEMIC PERFORMANCE**

Grade point average (GPA) data was collected via school administrative software for the June 2008 (GPA 1) and January 2009 (GPA 2) reporting periods. This was done in order to investigate the impact (if any) of additional PE on academic achievement. Higher GPA scores have been related to higher levels of PA among high school students (Field, Diego & Sanders 2001). The addition of PE into the curriculum has also resulted in modest gains in academic achievement in young school children (Dwyer et al. 1983).

## **SCHOOL-COMMUNITY SPORTS PARTICIPATION**

School and/or community club sponsored sporting activities included: indoor/outdoor/cross-country track, ultimate, volleyball, basketball, water polo, curling, hockey, golf, badminton and soccer. Student interscholastic athletic participation was collected via the Sport Participation Database (FileMaker Pro). This data will be useful for the determination of how additional physical activity impacts health and behavioral factors. Students that are enrolled in a PE program and compete on inter-scholastic sports have demonstrated significantly higher fitness scores when compared to students that only participated in regular PE (Beets and Pitetti 2005).

## **WEATHER DATA**

Winnipeg weather data was gathered from Environment Canada's website at [www.weatheroffice.gc.ca](http://www.weatheroffice.gc.ca). Daily mean temperatures and precipitation values were obtained for the months of September and December 2008 (Appendix I).

## RESULTS

The results of this thesis are presented in two manuscripts entitled “*The effect of mandatory high school physical education on physical activity, health-related fitness, academic and psychological outcomes*” and “*The influence of school-community sports participation on academic, fitness and psychological factors for high school students*”.

The first manuscript addresses the effect of a PE curriculum on health-related fitness (cardiovascular fitness, physical activity, muscular strength and endurance and body composition), physical self-concept, self-esteem and academic performance of youth within the new grade 11 and 12 physical education/health curriculum. Differences between males and females will also be discussed in the first manuscript. The first manuscript will address objectives #1 and #2.

The second manuscript addresses the degree to which participation in extra-curricular activities health-related fitness (cardiovascular fitness, physical activity muscular strength and endurance and body composition), physical self-concept, self-esteem and academic performance between SCSP and non-SCSP. The second manuscript will address objective #3 and is located in Appendix A.

Some extra characterizations of the study data are included in appendix form. Appendix K – The relationship between general physical self-concept and global self-esteem and objectively measured physical characteristics and fitness.

Appendix L – Changes in physical activity, health-related fitness, body composition separated by group and body composition class.

Appendix M – Cardiovascular fitness tertile assessments.

**The effect of a mandatory high school physical education  
program on physical activity, health-related fitness, academic  
and psychological outcomes**

by

Peter Sdrolas and Dean J. Kriellaars



## **ABSTRACT**

In the fall of 2008, all grade 11 and 12 students in the Province of Manitoba were required to enroll in daily physical education (PE), in an effort to address the adolescent overweight and obesity epidemic through a curriculum direct to enhancing moderate to vigorous physical activity (MVPA). This study was designed to assess the efficacy of a newly implemented PE curriculum on physical activity (PA), health-related fitness, psychological and academic performance for grade 11 and 12 students. A natural experiment was formed in which the grade 11 and 12 students [(n=101, mean (SD) age, 16.0 (0.7)] formed three groups, in-school PE (IN), out-of-school PE (OUT) and no PE (CONTROL). Fifty-five percent were female and 46% were involved in at least one school or community based sports team. Over the term, the IN and OUT groups had significant improvements for cardiovascular fitness ( $p<0.001$  and  $p<0.001$ ) and aggregate strength ( $p<0.001$  and  $p<0.001$ ), while the CONTROL group had no significant differences. There was no change in the OUT and CONTROL groups with respect to body fat percentage, however there was a significant reduction for the IN-group ( $p<0.01$ ). PA levels did not change for the IN and OUT, but dropped significantly for CONTROL with a change into winter ( $p<0.01$ ). No significant change was observed for IN and CONTROL with respect to all 11 Physical Self-Description Questionnaire variables, however the OUT had significant increases in flexibility ( $p=0.002$ ) and coordination ( $p=0.005$ ). The IN group scored significantly higher than both OUT ( $p=0.019$ ) and CONTROL ( $p=0.019$ ) groups with respect to the mean (95% CI) change in  $\text{maxVO}_2$ . The initial effects of the newly implemented grade 11 and 12 PE curriculum improved health-related fitness, body composition and preserved PA levels for IN and OUT students. Students not enrolled in PE demonstrate a significant reduction in PA coupled with no improvement in health-related fitness.

## INTRODUCTION

The rising prevalence of adolescent overweight and obesity, along with the associated health problems and costs, has become a serious concern for health care professionals, policy makers, parents and even for children themselves. A possible intervention strategy to deal with this major health crisis is to implement school physical education/health education (PE/HE) programs, which are physical activity (PA) based. Evidence-based studies have linked physical inactivity with adolescent obesity, while those who exercise on a regular basis are less likely to become overweight (Tremblay and Willms 2003). Pre-pubertal children with decreased adiposity and increased fitness have improved cardiovascular health (Sakuragi, Abhayaratna et al. 2009). After puberty there is an age related decline in PA levels leading to reduction in cardiovascular health and a host of other deleterious conditions. PE has the potential to enhance adolescent health-related fitness, cognitive and socio-emotional development by involving youth in regular PA and ultimately engaging them in lifelong participation in PA (Keays and Allison 1995; Chad, Humbert et al. 1999).

Most PA interventions designed to improve health-related fitness and well being among students, have occurred at the elementary (kindergarten to grade 4) and middle school (grades 5-8) levels (McKenzie, Stone et al. 2001; Sallis, McKenzie et al. 2003; Hoelscher, Feldman et al. 2004; Haerens, De Bourdeaudhuij et al. 2007). High school PA interventions have focused their attention on the at-risk adolescent groups, such as, females, obese and the sedentary (Neumark-Sztainer, Story et al. 2003; Doak, Visscher et al. 2006). However, a study evaluating the effects of a national PE curriculum on flexibility, balance, strength, percentage body fat, aerobic fitness, and physical activity, determined that a PE curriculum was not sufficient in achieving desired levels of fitness in a group of grade 7 boys (Koutedakis and Bouziotas 2003). The study concluded that the PE program which is not PA based was insufficient to improve health related parameters, but that a PE group prompted with enhancing extracurricular PA had significantly improved body fat, aerobic fitness and time spent in MVPA.

In August of 2004, the Manitoba Government announced the creation of the Healthy Kids, Healthy Futures All-Party Task Force. The Task Force presented 47 key

recommendations aimed at improving the health and welfare of Manitoba students.

Three of the recommendations focused in the area of school PE/HE and proposed that the government: 1) mandate the time of 110 hours for PE courses from grades 9-12; 2) develop a grade 11 and 12 PE/HE Curriculum that is PA based to be implemented in the fall of 2008; and 3) require that all grade 11 and 12 students complete two PE/HE credits for graduation.

The new Manitoba based PE curriculum for grade 11 and 12 students is a flexible curriculum which is PA based. The purpose of this study was to employ a natural experimental design to evaluate the new PE curriculum in Manitoba in a single school case design.

## **MATERIALS AND METHODS**

### **Participants**

Adolescents of both sexes between the ages of 15-17, in grades 11 and 12 attending a suburban high school in Manitoba were invited to participate. Student assent and parent consent forms were completed. Students were excluded if they suffered from an injury or illness that prevented them from completing the exercise assessments. Study approval was granted by the School Division, school Principal and University of Manitoba Health Research and Ethics Board (HREB, H2008:111).

### **Study Design**

The study examined the change in physical activity, health related fitness, physical self-concept and academic outcomes during the delivery of the new mandatory grade 11 and 12 physical education/health education (PE/HE) curriculum in the province of Manitoba.

The three components comprising the Active Healthy Lifestyles PE/HE Curriculum include, a core component (modules B-E), a physical activity (PA) practicum (module A), and a flexible delivery component (Figure 1). The flexible delivery component is extra time that can be devoted towards the core and/or PA practicum components. The study school decided to allocate the entire 25% flexible delivery component towards the PA practicum, resulting in a 25% Core and 75% PA practicum course structure. A total of 110 hours is devoted to the course delivered over a semester of the school year. The PA practicum component was offered as an In-school (IN) or Out-of-school (OUT) option.

IN refers to instructional time that is teacher-directed and based on learning outcomes from the curriculum. Students were required to attend timetabled classes during the instructional day. The goals of the PE department at the study school were to maximize physical activity time consistent with the curricular goals, and provide activities that challenged students to achieve a moderate to vigorous intensity level.

OUT refers to instructional time that is student-directed and not part of the regular school day. Students were required to complete the PA practicum on their own initiative through school-based and/or non-school-based activities. School-based activities are organized by the school and include school teams, intramurals, fitness clubs, etc. Non-school-based activities are activities that are not organized by the school, such as, community club teams, local fitness centers, exercising at home, etc. All OUT activities regardless of whether they were school or non-school based, required a student, parent and PE teacher pre-sign-off and post-sign-off process. This sign-off process ensured that the chosen activities were safe, age appropriate and fulfilled the MVPA requirement.

Three distinct treatment groups are present on this natural experiment based on student course interest upon course registration for semester 1 (September-December, 2008): IN, OUT and CONTROL (students not enrolled in PE in semester 1). IN and OUT served as the curriculum intervention groups.

Baseline data collection began on Tuesday, September 2, 2008 over 2-weeks. During this time period students did not participate in any PE class physical activity. All measures were repeated beginning on Wednesday, December 3, 2008 over a 2-week block. The assessment period corresponded to 10-weeks of PE curriculum implementation.

### **Physical Activity**

Students wore a pedometer (TC02, StepsCount) for two weeks for each assessment period. Students recorded the number of step counts at the end of each day on a record sheet. An overall average daily step count was derived along with weekday and weekend averages. Pedometry has demonstrated to be a reliable method for determining PA levels of adolescents (Tudor-Locke, Williams et al. 2002). It has limitations in not being a measure of exercise intensity.

### **Cardiovascular Fitness**

The 20 meter shuttle run (20MSR) has been shown to be a valid and reliable field-test for the prediction of CVF in adolescents (Liu, Plowman et al. 1992). An audio cue was used for proper pacing over a course marked with two pylons set at a distance of 20

meters. The subjects were instructed to complete as many 20-meter lengths as possible. The test was stopped when two consecutive lines were not reached by the audio cue, or when students reached volitional fatigue. A “talk test” was used to verify maximal exertion. Students failing the “talk test” were required to repeat the test on a separate day. The total number of completed segments determined maximal running speed in km/hr. Maximal oxygen consumption ( $\text{maxVO}_2$ ) was predicted by applying the regression equation (Leger, Mercier et al. 1988).

### **Body Composition**

Validated regression equations calculated body fat using two site skin fold (Harpender Calipers) measurements taken at the triceps brachii and the medial aspect of the gastrocnemius (Slaughter, Lohman et al. 1988). Measurements were taken in triplicate, on the right side of the body to the nearest 0.5-millimeter. The Slaughter regression equations for boys and girls are recommended for adolescents due to their simplicity and accuracy when a relative index of body fat percentage is required (Rodriguez, Moreno et al. 2005).

Height (m) and mass (kg) was measured with the subjects dressed in physical activity clothing with the shoes removed. Body mass index (BMI) was derived by the following equation:  $\text{BMI} = \text{mass (kg)} / \text{height (m}^2\text{)}$ . Waist circumference (WC) measurement (cm) was taken by placing the tape in a horizontal position over the umbilicus.

### **Muscular Strength and Endurance**

The strength and endurance of three major muscle groups were assessed using push-ups, pull-ups and sit-ups. The number of repetitions completed for each test was recorded. The push-up (PU) test was executed with the feet together, hands placed slightly wider than shoulder width apart and the arms fully extended and using audible pacing. The test was stopped when the subject either broke form or was unable to continue due to volitional fatigue. Modified pull-ups (MPU) were performed with the subjects on their backs and shoulders in line with a bar 5 cm out of their reach. Subjects then grasped the bar and performed pull-ups to an audio pacing cue. A chest level

physical cue (elastic band) was used to insure the range of motion was executed. Improper form and/or cadence resulted in test termination. Sit-ups (SU) were performed with the subject lying supine on a mat, knees bent at 90 degrees, feet flat on the floor secured by a partner and hands over the ears. On command the subject performed as many repetitions as possible in one minute while maintaining proper form. An aggregate strength score was determined by the sum of the repetitions performed in the three tests.

### **Physical Self-Description Questionnaire**

The Physical Self-Description Questionnaire (PSDQ) was used for the measurement of 10 facets of physical self-concept and general self-esteem (Marsh 1996). The instrument is comprised of eleven subscales: Health (HE); Coordination (CO); Physical Activity (PA); Body Fat (BF); Sport Competence (SP); General Physical Self-Concept (GP); Appearance (AP); Strength (ST); Flexibility (FL); Endurance/Fitness (EN); and Self-Esteem (SE). The PSDQ will allow for the comparison of student physical self-perceptions to objectively measured health related fitness tests. The PSDQ has undergone rigorous psychometric testing, with validity and reliability established for secondary school students in several countries, including Canada (Wilson and Rogers 2002).

### **Academic Performance**

Overall grade point average (GPA) data was collected via school administrative software for the June 2008 (GPA 1) and January 2009 (GPA 2) reporting periods.

### **School-Community Sports Participation**

The participation of students in school-community sports (SCSP) was assessed. Student interscholastic athletic participation was collected via the school's Sport Participation Database, which verified student participation on a school-community sports team.

## **Statistical Analyses**

Univariate ANOVA controlling for sex was utilized to detect differences at baseline. When significance was identified, Tukey's post hoc test was used for detecting differences between groups. Repeated measures ANOVA was used to detect changes in the dependent variables and sex serving as fixed factors. Pearson's correlation coefficient was used to test for variable associations. The level of significance was set at 0.05. Data are presented as mean (SD or 95% CI). All analyses were performed with SPSS version 17.0 for MAC OSX (SPSS Inc., Chicago, IL, USA).



## RESULTS

Grade 11 and grade 12 students (N=101) attending a suburban high school in Manitoba participated. Baseline measures were successfully completed by all of the study participants. Only 92 of the subjects successfully completed all post intervention. Of the nine subjects that did not complete post measures, three were from the IN group, four from the OUT and two from the CONTROL group. Reasons for not completing post measures included a lack of interest (n=5); left the country (n=2) and injury/illness (n=2). All IN subjects successfully completed the PA practicum course component, which involved a minimum of 75 hours of MVPA. Table 1 depicts the baseline characteristics of the groups (IN, OUT, CONTROL). Using BMI, 20.8% of the sample was characterized as overweight or obese, and based upon BF% 30.7% were overweight or obese.

Table 2 outlines the mean differences in primary health related fitness and body composition parameters. Individual strength measures revealed a significant improvement in OUT for PU ( $p<0.001$ ) and in MPU ( $p=0.004$ ) and PU ( $p=0.033$ ) for IN. The CONTROL group improved in PU ( $p=0.039$ ) but had a significant reduction in MPU ( $p=0.034$ ). There was no change for any of the groups for SU.

For the IN group, there was a significant increase for height ( $p<0.001$ ) and significant decrease for GPA ( $p=0.001$ ). For OUT, the data indicated significant increases for height ( $p<0.001$ ) and the PSDQ variables of coordination ( $p=0.038$ ), strength ( $p=0.043$ ) and flexibility ( $p=0.013$ ). CONTROL had a significant increase in height ( $p=0.039$ ) and significant decrease in GPA ( $p=0.028$ ).

Figures 4 to 7 depict the changes in primary dependent variables of PA, CVF, BF% and AS within each group and split by sex. For the IN-females, there was a significant ( $p<0.05$ ) improvement for CVF (Figure 5) and a significant ( $p<0.05$ ) decline in PA (Figure 4). No significance was observed for BF% and AS. IN-males reported significant increases for CVF ( $p<0.001$ ) and AS ( $p=0.04$ ), while BF% significantly decreased ( $p<0.05$ ). There was no significant change in PA. OUT-males experienced significant increases for CVF ( $p=0.001$ ) (Figure 5) and AS ( $p=0.001$ ) (Figure 7). PA and BF% were non-significant. No significant changes were observed for OUT-females. For

the CONTROL-females, there was a significant decrease in PA ( $p=0.018$ ) (Figure 4), with no significant change for the other 3 measures. The boys in this group reported no significant changes for any of other measures.

Significant between group differences with respect to the mean (95% CI) change in  $\text{maxVO}_2$  are presented in Figure 5. The IN group scored significantly higher than both OUT ( $p=0.019$ ) and CONTROL ( $p=0.019$ ) groups. In addition, the IN-females reported significantly ( $p=0.041$  and  $p=0.037$ ) higher mean (95% CI) changes in  $\text{maxVO}_2$  than both the OUT and CONTROL females, respectively. There were no differences between the groups for PA, AS and BF%.

Tests of between-sex effects within each group were analyzed. Compared to the OUT-girls, the IN-boys reported significantly higher scores for height ( $p=0.04$ ); SU ( $p<0.001$ ); MPU ( $p<0.001$ ); AS ( $p<0.002$ ); CVF ( $p<0.001$ ) and PSDQ variables coordination ( $p<0.001$ ), body fat ( $p=0.009$ ), sports competence ( $p<0.001$ ), global self-esteem ( $p=0.002$ ), appearance ( $p=0.008$ ), strength ( $p=0.035$ ), endurance/fitness ( $p<0.001$ ) and physical activity ( $p<0.001$ ).

Compared to the OUT-girls the OUT-boys scored significantly higher for height ( $p<0.001$ ); weight ( $p=0.002$ ); WC ( $p=0.042$ ); PU ( $p<0.001$ ); SU ( $p=0.007$ ); MPU ( $p<0.001$ ); AS ( $p<0.001$ ); CVF ( $p<0.001$ ); and PSDQ variables of sports competence ( $p=0.039$ ) and endurance/fitness ( $p=0.028$ ). Boys scored lower for GPA ( $p<0.01$ ).

Compared to the CONTROL-girls the CONTROL-boys scored higher for height ( $p<0.001$ ); weight ( $p<0.001$ ); MPU ( $p<0.001$ ); AS ( $p<0.001$ ); and PSDQ variables coordination ( $p<0.001$ ), body fat ( $p=0.022$ ), sports competence ( $p<0.001$ ), global self-esteem ( $p=0.002$ ), strength ( $p=0.002$ ), self-esteem ( $p=0.038$ ).

The boys scored significantly lower BF% ( $p<0.001$ ,  $p<0.001$ ,  $p=0.029$ ) than their female counterparts for IN, OUT and CONTROL groups respectively.

Figure 8 depicts the average daily step counts histograms separated by sex with reference to step count standards.

ANOVA analyzing the mean (95% CI) change was repeated for non-SCSP ( $n=57$ ) in each of the 4 main measures (PA, CVF, BF% and AS) and is presented in Figures 9, 10 and 11. For CVF, IN-males, IN-females, OUT-males, IN and OUT groups reported significant ( $p<0.05$ ) improvement. The IN group scored a significantly ( $p<0.05$ ) higher

change in CVF than the CONTROL group. For AS, only the OUT-males and OUT group improved ( $p < 0.05$ ). For PA, the IN-females and CONTROL group reported a decline in step count ( $p < 0.05$ ). The IN-males and IN group significantly ( $p < 0.05$ ) reduced BF%.

Analysis of BF% tertiles (LOW:  $< 17.27$ , MIDDLE:  $17.27-30.72$ , HIGH:  $30.73+$ ) and CVF (ml/kg/min) tertiles (LOW:  $< 40.15$ , MIDDLE:  $40.16-46.00$ , HIGH:  $46.01+$ ) compared to the mean changes for each of the four main measures (CVF, PA, AS and BF%) are presented in Tables 3 and 4, respectively. The LOW and HIGH BF% groups significantly improved ( $p < 0.05$ ) CVF while the MIDDLE significantly increased AS ( $p < 0.05$ ) and decreased in PA ( $p < 0.05$ ). The LOW and HIGH CVF groups significantly improved ( $p < 0.05$ ) CVF while the MIDDLE had a significant decrease in PA ( $p < 0.05$ ). There were no between group effects for both BF% and CVF tertiles.

**Table 1 - Baseline characteristics.**

<b>Variables</b>	<b>IN (M=12:F=10)</b>	<b>OUT (M=31:F=34)</b>	<b>CONTROL (M=6:F=8)</b>
Grade point average (%) ‡	74.63 (7.50)	76.92 (8.33)	70.72 (6.55)
Age (y) * ‡	15.73 (0.55)	16.26 (0.69)	15.50 (0.52)
Height (m)	1.73 (0.10)	1.72 (0.08)	1.73 (0.08)
Mass (kg)	62.18 (10.50)	68.38 (14.83)	64.00 (8.37)
Body mass index (kg/m <sup>2</sup> ) *	20.56 (2.18)	23.02 (4.22)	21.53 (2.64)
Body fat (%)	19.61 (8.37)	23.10 (10.36)	21.01 (8.31)
Waist circumference (cm) *	74.02 (6.25)	80.35 (11.65)	76.50 (6.88)
Push-ups (#repetitions)	19.90 (9.51)	18.97 (10.80)	15.71 (7.04)
Sit-ups (#repetitions)	43.23 (9.41)	37.08 (11.94)	39.79 (7.65)
Modified pull-ups (#repetitions)	13.50 (6.41)	13.80 (8.82)	12.15 (6.94)
Aggregate strength (# repetitions)	75.86 (21.35)	70.00 (27.95)	68.29 (19.02)
Shuttle run maxVO <sub>2</sub> (ml/kg/min)	46.50 (6.65)	45.26 (7.92)	47.31 (5.89)
Physical activity (#steps)	11427.36 (3305.93)	9765.15 (3599.89)	12057.14 (3634.49)
SPORT Participation (%) §	55	43	29
<b><i>Physical self-description questionnaire (PSDQ) - maximum out of 6</i></b>			
Health	4.92 (0.73)	4.78 (0.93)	4.30 (0.94)
Coordination	4.44 (1.01)	4.35 (0.97)	4.64 (0.84)
Physical activity	4.58 (1.20)	4.78 (1.29)	4.50 (1.05)
Body fat	5.10 (1.33)	4.78 (1.35)	4.32 (1.44)
Sports competence	4.31 (1.21)	4.17 (1.37)	4.62 (0.85)
General physical self concept	4.60 (1.34)	4.65 (1.14)	4.35 (0.98)
Appearance	4.44 (1.01)	4.64 (0.86)	4.14 (0.95)
Strength	4.14 (1.23)	4.12 (1.19)	4.29 (0.94)
Flexibility	4.10 (1.03)	3.87 (1.26)	4.35 (0.95)
Endurance/fitness	4.16 (1.26)	4.13 (1.38)	4.30 (1.21)
Global self esteem	5.09 (0.75)	5.23 (0.67)	4.67 (0.84)

Note. Values are means (SD). M=males, F=females, IN=in-school physical education, OUT=out-of-school physical education, CONTROL=no physical education. Significance was assessed with univariate ANOVA controlling for sex. When significance was detected Tukey's post hoc test was utilized.

\* Significant difference (p<0.05) for IN vs. OUT.

‡ Significant difference (p<0.05) for OUT vs. CONTROL.

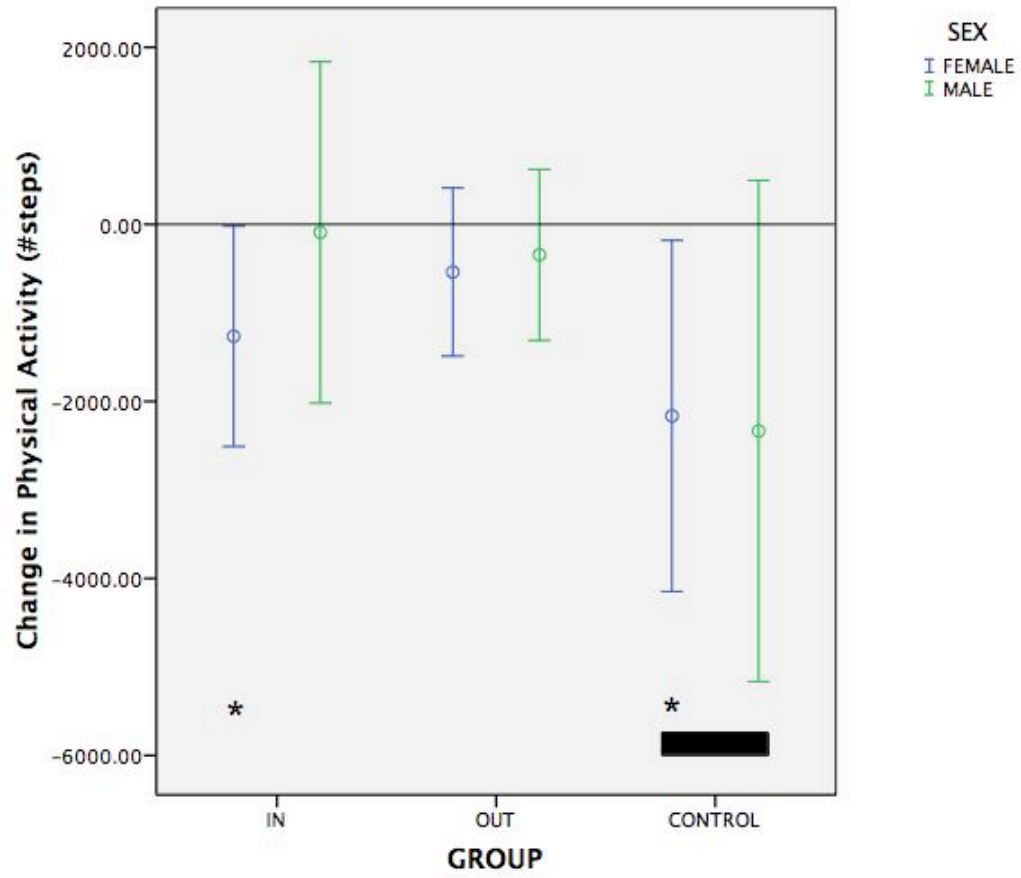
§ Chi squared analysis revealed no significant difference between group and SCSP distribution.

**Table 2 - Change in health-related fitness and body composition.**

<b>Variables</b>		Mean difference (post-pre)	95% Confidence Interval (Lower, Upper Bounds)	Time*Sex Interaction (p-value)
Physical activity (#steps)	<i>IN</i>	-678	-1776, 421	.277
	<i>OUT</i>	-442	-1107, 224	.770
	<i>CONTROL</i>	-2250*	-3728, -771	.902
Shuttle run (maxVO <sub>2</sub> : ml/kg/min)	<i>IN</i>	2.9*	1.5, 4.4	.888
	<i>OUT</i>	1.1*	0.4, 1.8	.053
	<i>CONTROL</i>	0.5	-0.7, 1.7	.134
Body fat (%)	<i>IN</i>	-1.3*	-2.1, -0.5	.544
	<i>OUT</i>	-0.01	-0.7, 0.7	.952
	<i>CONTROL</i>	-0.9	-1.9, 0.1	.820
Body mass index (kg/m <sup>2</sup> )	<i>IN</i>	0.22	-0.20, 0.64	.359
	<i>OUT</i>	-0.24	-0.51, 0.03	.835
	<i>CONTROL</i>	0.01	-0.28, 0.28	.398
Waist circumference (cm)	<i>IN</i>	0.9	-1.2, 3.0	.726
	<i>OUT</i>	0.04	-0.8, 0.8	.595
	<i>CONTROL</i>	-0.5	-2.3, 1.2	.796
Aggregate strength (#repetitions)	<i>IN</i>	5.0*	1.0, 9.0	.358
	<i>OUT</i>	4.3*	1.9, 6.7	.044
	<i>CONTROL</i>	1.6	-1.4, 4.7	.262

Note. IN=in-school physical education, OUT=out-of-school physical education, CONTROL=no physical education.

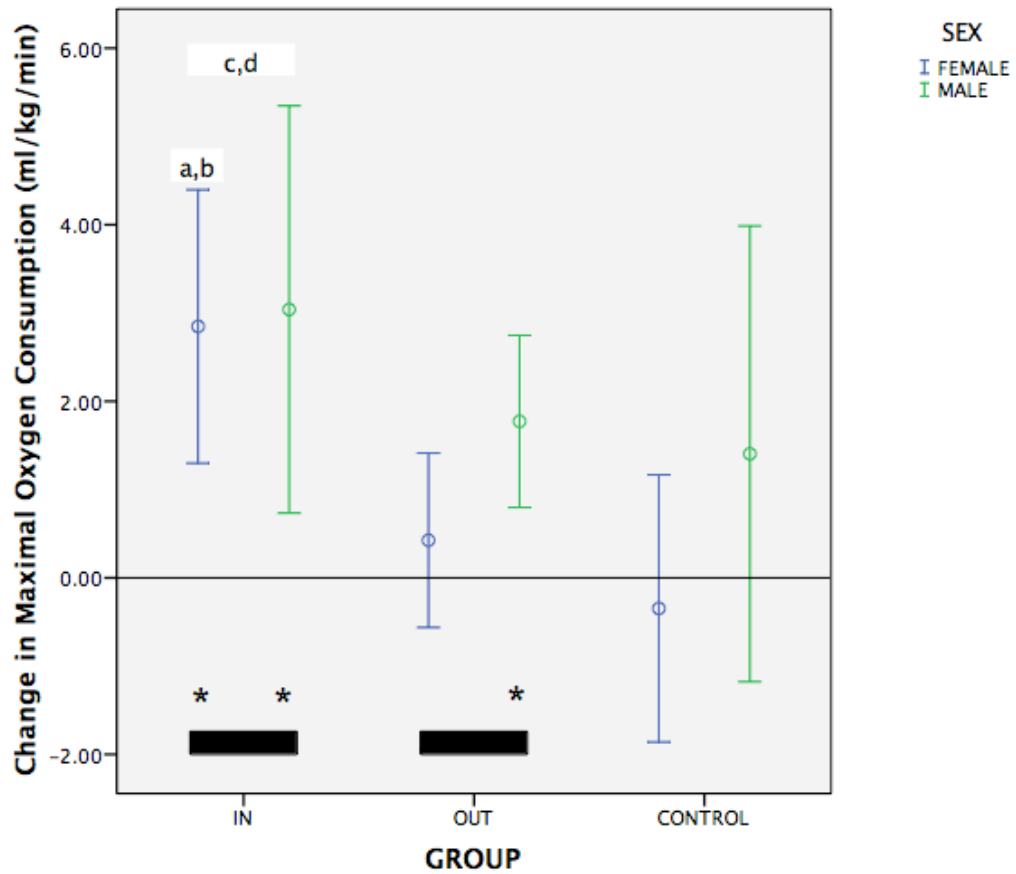
\*The mean difference is significant at the 0.05 level.



**Figure 4 - Mean (95% CI) change in daily step count by group and sex.**

■ Significant mean difference for the group (p<0.05).

\*Significant mean difference for sex (p<0.05).



**Figure 5 - Mean (95% CI) change in cardiovascular fitness by group and sex.**

■ Significant mean difference for the group ( $p < 0.05$ ).

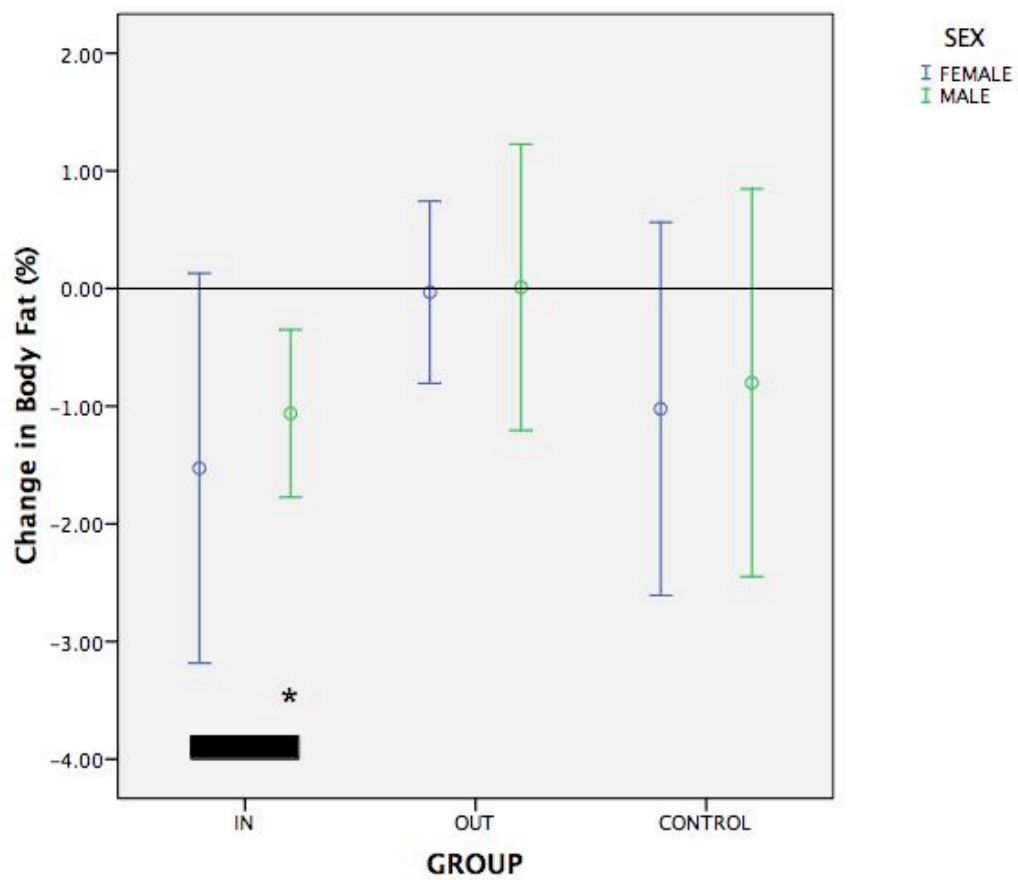
\* Significant mean difference for sex ( $p < 0.05$ ).

<sup>a</sup> IN-FEMALES > OUT-FEMALES

<sup>b</sup> IN-FEMALES > CONTROL-FEMALES

<sup>c</sup> IN > OUT

<sup>d</sup> IN > CONTROL

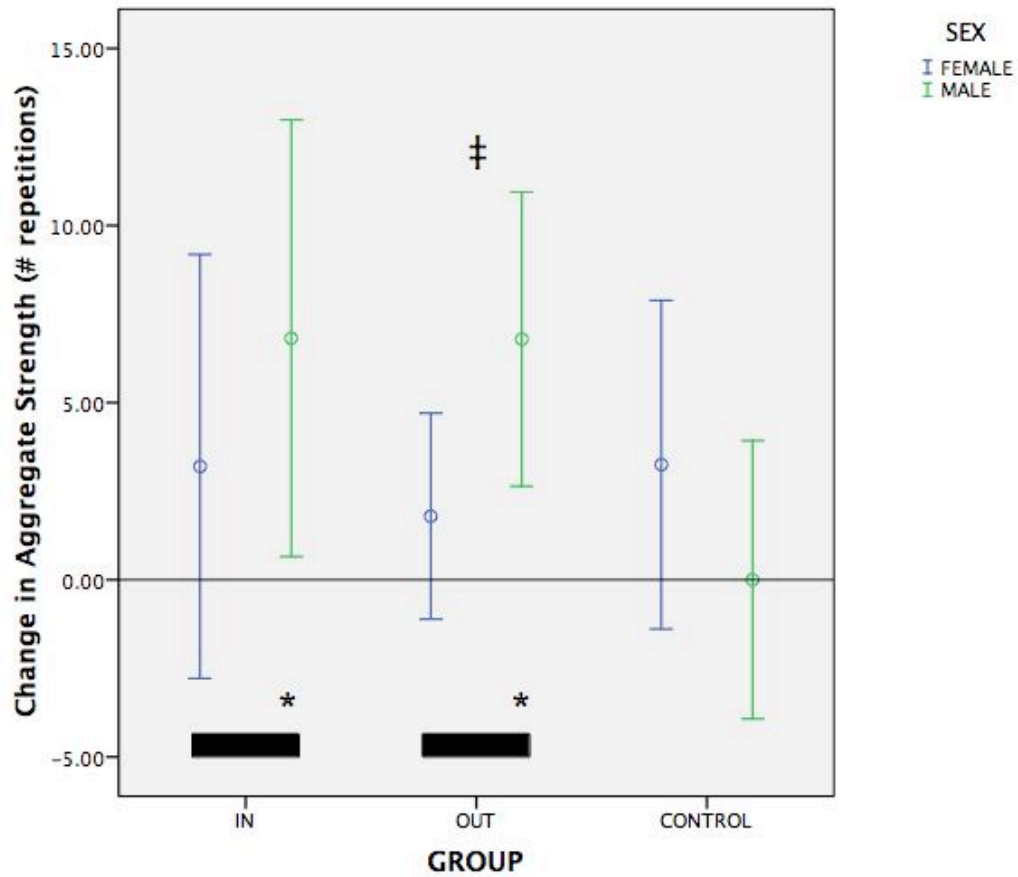


**Figure 6 - Mean (95% CI) change in body fat percentage by group and sex.**

■ Significant mean difference for the group ( $p < 0.05$ ).

\* Significant mean difference for sex ( $p < 0.05$ ).



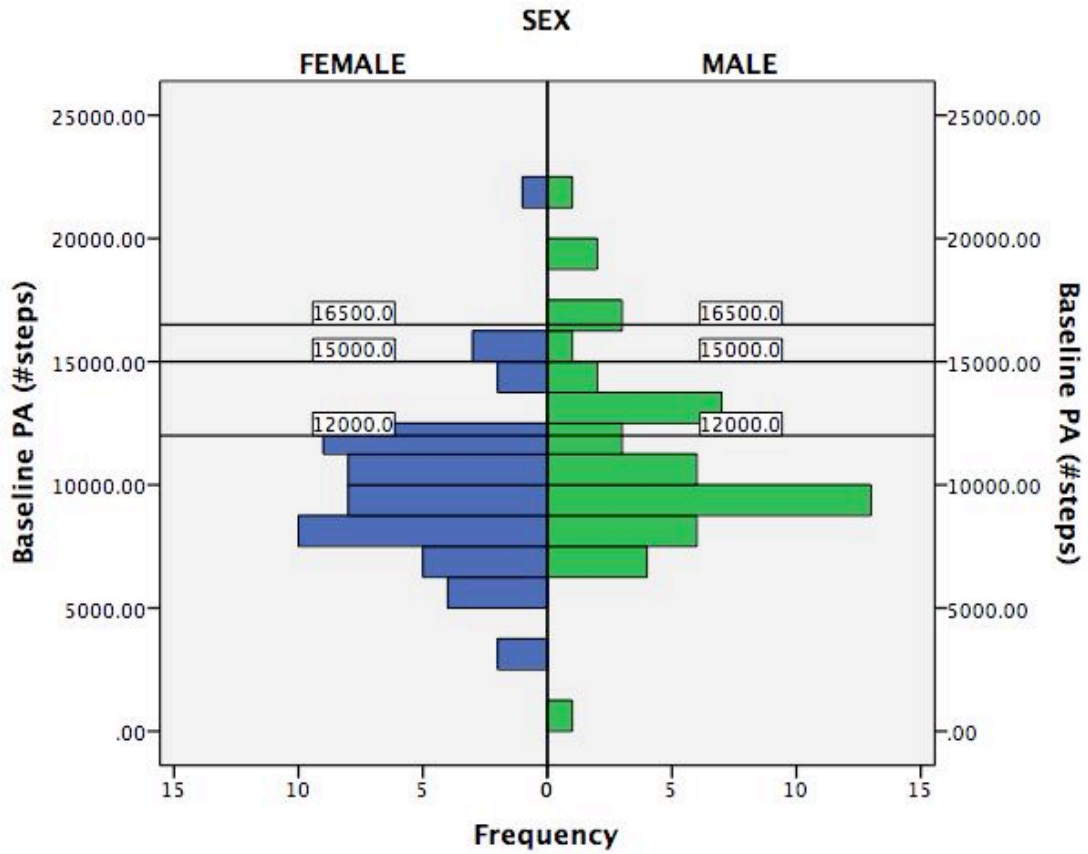


**Figure 7 - Mean (95% CI) change in aggregate strength by group and sex.**

■ Significant mean difference for the group ( $p < 0.05$ ).

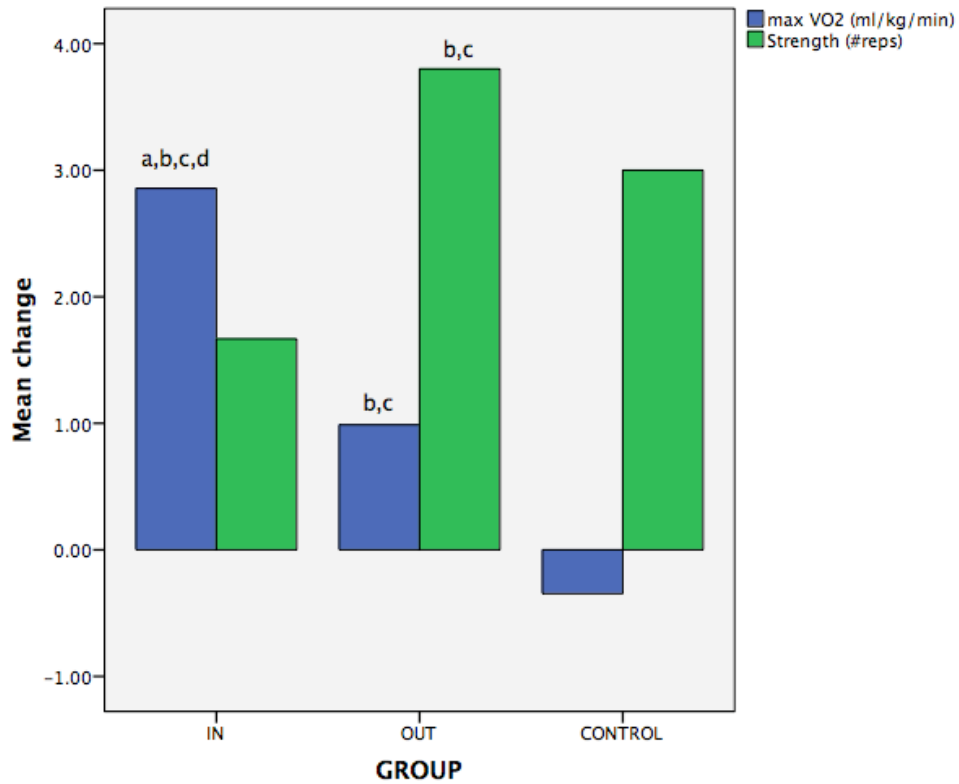
\* Significant mean difference for sex ( $p < 0.05$ ).

‡ Males > Females ( $p < 0.05$ ).



**Figure 8 - Step count frequency by sex at two recommended PA guidelines**

- 1) Tudor-Locke et al., 12-16 year old girls=12,000 steps/day, boys=15,000 steps/day.
- 2) Canadian PA Guideline for Children and Youth=16,500 steps/day.



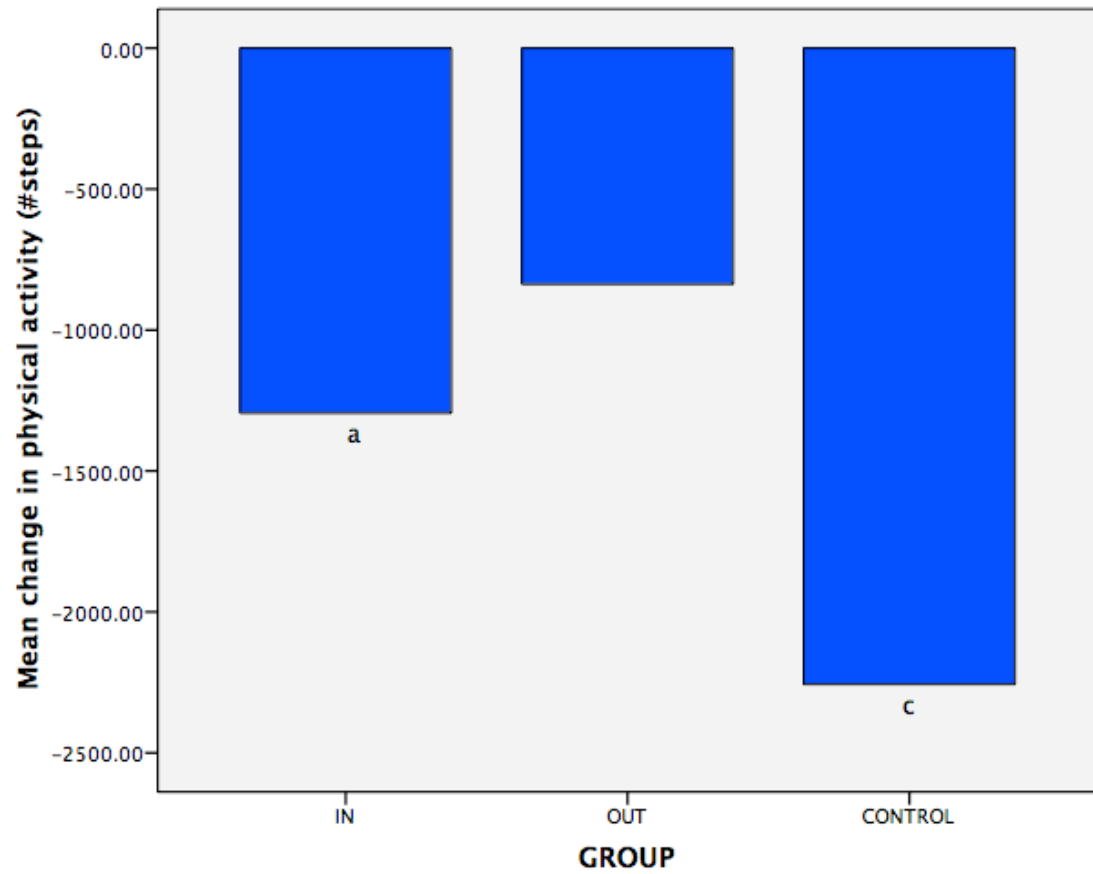
**Figure 9 - CVF and aggregate strength mean change for non-SCSP.**

<sup>a</sup>Significant for the females within the group ( $p < 0.05$ ).

<sup>b</sup>Significant for the males within the group ( $p < 0.05$ ).

<sup>c</sup>Significant for the group ( $p < 0.05$ ).

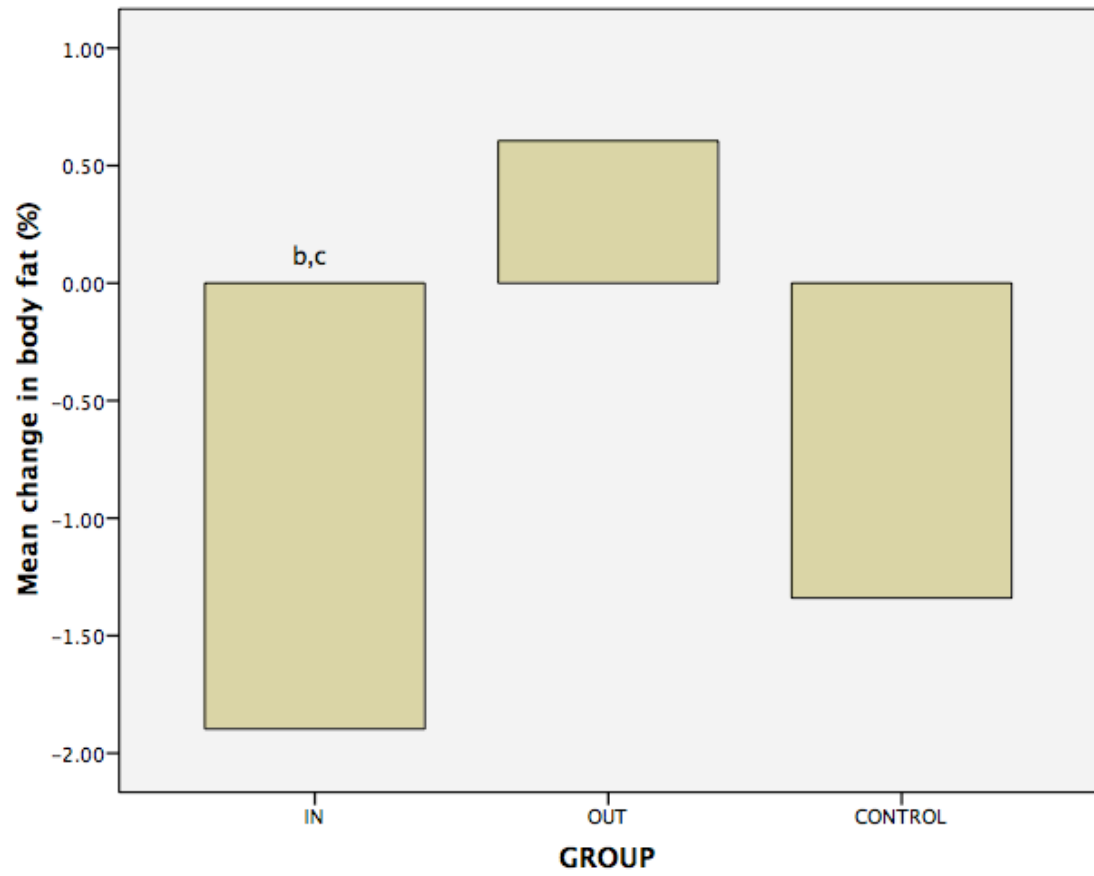
<sup>d</sup>IN > CONTROL ( $p < 0.05$ ).



**Figure 10 - Physical activity mean change for non-SCSP.**

<sup>a</sup>Significant decrease for IN-females ( $p < 0.05$ ).

<sup>c</sup>Significant decrease for CONTROL ( $p < 0.05$ ).



**Figure 11- Body fat % mean change for non-SCSP.**

<sup>b</sup>Significant decrease for IN-males ( $p < 0.05$ ).

<sup>c</sup>Significant decrease for IN ( $p < 0.05$ ).

**Table 3 - Body fat % tertiles compared to main outcomes for non-SCSP for between and within groups.**

	Between groups		Within groups		
	LOW (<17.26)	MID (17.27-30.72)	LOW <17.26	MIDDLE 17.27-30.72	HIGH 30.73+
Δ BF (%)	NS	NS	NS	NS	NS
Δ CVF (ml/kg/min)	NS	NS	↑ p<0.05	NS	↑ p<0.05
Δ AS (#reps)	NS	NS	NS	↑ p<0.05	NS
Δ PA (#steps)	NS	NS	NS	↓ p<0.05	NS

Note: Δ= “change in”, ↑= increase, ↓=decrease, BF=body fat, AS=aggregate strength, PA=physical activity.

**Table 4 - Cardiovascular fitness tertiles compared to main outcomes for non-SCSP for between and within groups.**

	Between groups		Within groups		
	LOW (<40.15)	MID (40.16-46.00)	LOW <40.15	MIDDLE 40.16-46.00	HIGH 46.01+
Δ BF (%)	NS	NS	NS	NS	NS
Δ CVF (ml/kg/min)	NS	NS	↑ p<0.05	NS	↑ p<0.05
Δ AS (#reps)	NS	NS	NS	NS	NS
Δ PA (#steps)	NS	NS	NS	↓ p<0.05	NS

Note: Δ= “change in”, ↑= increase, ↓=decrease, BF=body fat, AS=aggregate strength, PA=physical activity.

## DISCUSSION

To date, there has been very little research on the effects of a PE curriculum of high school students (McKenzie, Stone et al. 2001; Fairclough and Stratton 2005). Using objective measures instead of subjective assessment tools was a major strength of this study, which is one of the first to assess the efficacy of a newly implemented PE curriculum on health-related fitness, psychological and academic outcomes for grade 11 and 12 students. Based on the data collected in this study, it appears that the initial effects of the PE curriculum were successful in enhancing physical fitness and body composition.

A major finding revealed that students who were enrolled in PE (IN, n=22 and OUT, n=65) preserved their level of PA while those not enrolled in PE (CONTROL, n=14) had a significant reduction ( $p<0.05$ ) of approximately 2250 steps/day (Table 2). This corresponded to a change in season with a mean temperature reduction of 32°C (+13 to -19 °C) and the presence of snow cover by the second assessment. These results are in agreement with previous research, indicating greater step counts for those who were, versus those who were not enrolled in PE (Wilde, Corbin et al. 2004). When delivered by trained health professionals PE can provide structured and regular PA, which contributes to student fitness and health (Fairclough and Stratton 2005). However, the evidence supporting this notion is equivocal. For example, despite the step count preservation during PE class in this study, previous research involving elementary children reported insufficient PA levels during PE (Simons-Morton, O'Hara et al. 1990; Simons-Morton, Taylor et al. 1994). Conversely, in a study of high school students (Fairclough and Stratton 2005), PE made a significant contribution to PA levels when the lessons were designed and delivered with MVPA goals.

The total study group mean of 10,445 steps/day is comparable to other pedometer-based research (Wilde, Corbin et al. 2004; Lubans, Morgan et al. 2008), which does not adequately fulfill the following recommended thresholds necessary for improving overall health (Figure 8). In fact, only 7% (12% of girls, 2% of boys) of the study participants met Canada's PA Guideline for Children and Youth criterion of 16,500 steps/day (Health Canada and the Canadian Society for Exercise Physiology 2002*ab*)

while only 15% (19% of girls, 10% of boys) had step counts above the recommended thresholds of 12,000 and 15,000 steps/day, required for the maintenance of a healthy body mass in girls and boys (between the ages of 6-12 years), respectively (Tudor-Locke, Pangrazi et al. 2004). Compared to the popular value of 10,000 steps/day for adults (Le Masurier, Sidman et al. 2003), just over half (52%) of the study participants met the requirement.

Based on the findings, and the aforementioned recommendations, it appears that the study participants are not active enough. For example, when compared to the Canadian PA guidelines for children and youth, 93% of the students would be classified as inactive. However, it is important to point out that currently Canadian PA guidelines for 15 to 19-year-olds do not exist (Janssen 2007). This makes it difficult to prescribe adequate levels of PA using step counts for this age group. More PA research is required to develop an understanding of the PA requirements for high school adolescents in grades 11 and 12.

During the study period, the subjects reported a decline of approximately 750 steps/day. Several sources have suggested, that as teens progress through their high school years their PA levels drop (Caspersen, Pereira et al. 2000; Trost, Pate et al. 2002). The substantial drop in average temperature from September to December (Appendix L) may be responsible for the decrease in PA. Some of the study participants may have opted out of active transportation in favour of driving to school on inclement days.

Interestingly, the decline in daily steps/day may not have a detrimental effect on fitness levels. In fact, several studies have reported a weak association between self-reported PA and physical fitness in adolescents (Baquet, Twisk et al. 2006; Garcia-Artero, Ortega et al. 2007; Hurtig-Wennlof, Ruiz et al. 2007). In the current study, no significant relationship was observed between PA and all fitness measures at baseline (CVF, PU, SU, MPU and AS). Further, students participated in a number of activities that would not be suitable for detection by pedometry including cycling, elliptical devices, swimming, hockey, volleyball, etc. Future study is required to determine the utility of pedometers in this age group. Certainly, accelerometry and heart rate monitoring would be improved methods for detecting quantity and intensity of physical activity.



Sex differences found in the current study are consistent with those of previous research reporting higher activity levels in boys (Flohr, Todd et al. 2006; Hands and Parker 2008). The greater mean daily steps/day of 11,128 for boys and 9800 for the girls are similar to an American grade 11 and 12 study that reported a range of 10,329 to 10,652 for boys, and 9068 to 9846 for girls (Wilde, Corbin et al. 2004). This trend explains the rationale of several high school PA interventions that have targeted the female population in an effort to increase their PA levels (Dishman, Motl et al. 2004; Jamner, Spruijt-Metz et al. 2004; Young, Phillips et al. 2006; Dunton, Schneider et al. 2007). Interestingly, when PA levels within each study group were separated by sex, the CONTROL females had a significant reduction in mean daily steps, while the girls in the IN and OUT groups did not demonstrate a significant change (Figure 4). These new findings support the success of the PE program in sustaining PA.

Another major finding revealed that PE students (IN and OUT) significantly improved their CVF and muscular strength and endurance, while those not taking PE (CONTROL) reported a decline and/or no improvement (Table 2). At first glance, these findings conflict with previous research assessing the effectiveness of PE on CVF parameters, in which the authors concluded that PE alone was not sufficient to elicit improvement in CVF (Koutedakis and Bouziotas 2003). However, the PE curriculum used in the former study was not PA based while the new Manitoba curriculum is based on achieving specific targets of MVPA activity (75-80 hrs per semester). Indeed the study of Koutedakis and Bouziotas demonstrated that a PE program combined with extracurricular PA was sufficient to enhance CVF fitness and other health-related parameters. This is similar to the IN and OUT groups in this study.

In a study where the heart rates of high school students were assessed during fitness activities, team and individual sports (Laurson, Brown et al. 2008) heart rates were highest for fitness, followed by team and finally individual sports. However, boys and girls responded differently to the activities with the boys exhibiting higher heart rates for team sports, and the females during individual activities. The study school provided the IN students with programming flexibility by offering the students a variety of activities options for CVF enhancement. For example, the girls were exposed to individual fitness

activities such as, Tae Bo, Pilates, Yoga, hip hop abs, etc., whereas the boys mainly chose to participate in team activities (i.e. touch football, floor hockey, polo, etc.).

As a result of the variety and activity choice offered by the PE program, the IN-girls significantly ( $p < 0.05$ ) improved their CVF, while the OUT and CONTROL girls reported no change. These findings are congruent with other research, that reported significant improvements in CVF when the activities were presented in attractive and relevant ways to girls (Bailey 2006).

The change in aggregate strength was significant only for the boys in the IN and OUT groups (Figure 7). Significant time by sex interactions within the IN and OUT PE groups may be attributed to hormonal differences between boys and girls and also to gender differences in attitude towards fitness training. For example, boys are more willing to engage in resistance training whereas females prefer participation in individually based aerobics (i.e. Tae Bo, Hip –Hop-Abs, etc.).

BF% was significantly reduced for IN (mean difference = -1.2%, -0.3 to -2.1, 95% CI,  $p = 0.01$ ). More specifically, Figure 6 illustrates that change was significant for the IN boys, and not the IN girls. Nevertheless, this finding has important implications due to the wide range of serious medical and psycho-social consequences associated with adolescent obesity (Doak, Visscher et al. 2006). PE curricula must continue to explore effective strategies to improve body composition in adolescents, especially for females.

In a recent study by Sakuragi et al. (2009) the influence of adiposity and PA on arterial stiffness (marker of CVD in adults) was conducted in a healthy sample of 573 children (mean age $\pm$ SD, 10.1 $\pm$ 0.3, 51% males). The study measured carotid-femoral pulse wave velocity (PWV), cardio-respiratory fitness (CRF, 20 meter shuttle run), PA (7-day pedometer step count), BMI, WC and BF% (dual-energy x-ray absorptiometry). PWV was positively correlated ( $p < 0.001$ ) with each of the adiposity measures (BMI,  $r = 0.34$ ; WC,  $r = 0.32$  and BF%,  $r = 0.32$ ).

“Our observation that increased body mass and adiposity and decreased CRF are associated with arterial stiffening at an early age has important public health and clinical implications. The findings support the adoption of population-level strategies directed at the prevention of childhood

overweight and obesity through the promotion of lifestyle measures, including increased PA, CVF, and dietary modification.”

Certainly, the results from Sakuragi (2009) in part, support the implementation of the new grade 11 and 12 PE curriculum (PA promotion strategy).

The following limitations must be considered when interpreting the results. First of all, the results were only collected for only one semester that may limit the analysis of the long-term effects of PE. Longitudinal studies have been recommended in order to ascertain the long-term impact of PE (Trudeau and Shephard 2008).

Secondly, data collection was confined to one high school that is located within a middle class neighborhood. The school had a well-equipped gym with motivated PE specialist teachers. Geographically, there were many options for leisure time physical activities pursuits including recreation/fitness centres and sporting fields. In addition, students at this school are not restricted by monetary concerns when approached to participate in school and/or community initiated physical fitness activities (i.e. school-community sport team trips, outside fitness facility user fees, etc.). Unfortunately, individuals within communities of low socioeconomic status are more likely to be less physically fit than those in more prosperous communities (Shishehbor, Gordon-Larsen et al. 2008).

Thirdly, the low average age, teaching experience, and involvement of the PE staff in extracurricular activities (i.e. intramurals), may have contributed to the positive findings. Teachers and coaches have been cited as credible role models by children outside immediate family members (Gilmer, Speck et al. 1996). PE teachers that appear to be physically fit have more influence on students' willingness to exercise than PE teachers that appear to be physically unfit (Cardinal 2001). In addition the positive relationships that are formed between students and their teachers and coaches can increase student participation in PA (Bailey 2006). While the above components are favourable and welcomed they may not exist in every high school.

Based upon the cited specific characteristics of this case study school, the study findings may only be applied to other like schools, and generalization to schools with different settings is imprudent.

Overall, the initial effects of the new grade 11 and 12 PE curriculum has shown promise in increasing CVF and muscular strength/endurance, while at the same time reducing body fat. The inclusion of PE also prevented a deterioration of PA over seasonal change. More longitudinal studies are required to assess the long-term impact of PE for this age group.

## SUMMARY AND CONCLUSIONS

Significant improvements in CVF, muscular strength and endurance, body composition and the preservation of PA were all key findings with respect to those students enrolled in PE (IN and OUT). Students not enrolled in PE demonstrated significant reductions in PA and academic performance, in addition to no improvement in any of the health-related fitness and PSDQ parameters. This natural experiment illustrates the efficacy of the specific forms of implementation of the curriculum within a single school. This bodes well for the overall implementation in that this is a necessary condition for success province wide. Lack of success in this school would have heralded a curriculum without the means to achieve the desired end. The setting of this school was important to consider in the success observed, the school had motivated specialists, an excellent exercise facility, very good proximity to fitness and recreation facilities, and was middle income. The transferability (the overall effectiveness) of this success to like schools is reasonable but generalization to schools without similar facilitative factors would be imprudent. There are 319 secondary schools in the province of Manitoba ([www.edu.gov.mb.ca/K12/schools/index/html](http://www.edu.gov.mb.ca/K12/schools/index/html)), and the variation in curricular implementation of the HE/PE initiative would be substantive in number of hours (50 to over 75 hours of PA), as well as in terms of students provided with IN school and OUT of school options for PA. Can we determine the effectiveness of the curriculum from his study...no. This provides at best single case study evaluation of a program efficacy.

The minimal semester based hourly allocation for moderate to vigorous physical activity was between 75 and 80 from September 15 to January 23 with 2 holiday weeks. For the period of study, about 10 weeks, the allocation was 40 hours, or 4 hrs/week. The successful response to the intervention of the IN and OUT groups to this stimulus is encouraging.

One of the primary goals of the newly implemented grade 11 and 12 PE curriculum was enhancing physical activity. From the pedometry data it appears to be efficacious in the conservation of PA. The IN and OUT groups did not significantly or substantially decrease step counts from September to December despite a decrease in mean daily temperature from +13°C to -19°C. The natural control group reduced step

counts by 2215 steps. Although pedometry has been shown to be representative of PA activity levels in adolescents (Tudor-Locke, Pangrazi et al. 2004), it has limitations in not accurately measuring intensity. Certainly, the higher the intensity of locomotor behavior the greater the step rate and hence the greater the accumulation of steps per day. However, a person that is walking for longer durations could have the same average daily step count as a person that is an hour a day runner. It is interesting to note that the daily step counts for males and females, as well as between SPCP and non-SPCP are similar in magnitude. So other than the preservation of daily step counts, we cannot infer about the intensity except through indirect means because of the stimuli response observed in CVF. From a public health perspective mandating daily PE for all students in the Province of Manitoba appears to have been justified in a school of this nature. Exclusion of daily PE for grade 11 and 12 students would more than likely have result in significant reductions in PA (as was the case for the CONTROL group).

However, these overall positive health and psychological effects may have been supplemented by the unique characteristics of the study school environment. Families from the study school are from middle to upper middle class socioeconomic backgrounds. This provides students with the opportunity to become involved in activities (both in and out-of-school) that may require monetary support. It has been reported in studies that students from affluent families are generally more fit than those from a disadvantaged background (Sherwood, Wall et al. 2009). In addition, the community has access to two state-of-the-art fitness facilities equipped with indoor pools, weight training and cardiovascular training equipment, all within a two-mile radius of the school. Close proximity (i.e. within two-mile radius) to multipurpose commercial fitness facilities has been significantly correlated to improvements in VPA in grade 12 girls (Dowda, Dishman et al. 2009).

Study participants have been exposed to a diverse and dynamic PE program since grade 9. Opportunities in extracurricular programs include intramurals (operate during lunch break), competitive school teams (i.e. cross-country track, indoor/outdoor track and field, basketball, hockey, soccer, Ultimate, etc.) and fitness clubs (i.e. Olympic lifting clinics, Hip Hip dance, circuit training sessions). Moreover, staff at the school is heavily involved in all aspects of extracurricular programming. Thus, student participation in PA

opportunities may be enhanced due to the effects of role modeling. Students taught by physical educators that engage in regular health-living habits have a significant positive influence on student attitudes towards PA (Cardinal 2001). Finally, parents in the community are also very supportive of any initiative involving the health and welfare of their children.

The results of this study must be cautiously interpreted within the following limitations. The subjects that volunteered may not necessarily be representative of the study population – a small under-representation of obese. Larger scale studies involving multiple schools would provide a wider representation. However, the present study does provide valuable initial data obtained by objective means. Most of the students are from middle to upper middle class Caucasian backgrounds. Therefore, the results obtained in this setting may not be applicable for schools with greater ethnic and cultural diversity.

This study has clearly demonstrated that students participating in organized sport have superior fitness-related health and a more positive physical self-description than those students not involved in sport. In light of these results, sport advocating associations as well as School Divisions and individual high schools need to continue to provide quality sport programming for their students. In addition, support must also be directed to those students that do not wish to become involved on competitive school sport teams. The new PE curriculum attempts to satisfy this niche by providing a vast array of sport and physical activity options that are accompanied with detailed information outlining supervision, facility, equipment and attire requirements for each activity. The level of risk associated with each activity is also clearly outlined.

Overall, this natural experiment provides an initial assessment of the new PE curriculum providing an evidence-based benefit within a best practice PE school. In other words, schools and communities that amass appropriate supports (i.e. adequately trained and active PE staff, school and divisional administrative support, access to fitness facilities, strong parental support, etc.) have an increased likelihood to significantly improve the health and welfare of its students as they progress into adulthood.

## **FUTURE RESEARCH**

- 1) Examine the long-term effects of the newly implemented PE curriculum from grades 9 to 12. If possible expanding the research into one to two years post-high school would also provide information regarding the carry-over effect of the PE curriculum into adulthood.
  
- 2) Substitute pedometry with more accurate measures of PA such as accelerometry. The use of pedometry in high school students may not accurately capture the intensity and magnitude of PA due to the wide variety of activities (i.e. aquatics, weight training, machine operated cardiovascular fitness equipment such as elliptical, treadmills, etc.).
  
- 3) Examine curricular effects across several high schools for a more representative study sample.
  
- 4) Promote Provincial wide fitness assessments comparative to those applied in the States of Texas and California, aided with valid and reliable fitness test batteries..
  
- 5) Conduct an inventory examining the internal and external supports (i.e. school and community fitness facilities access, parental, school and divisional support, etc.) at other high schools in order to assess the capability of effectively implementing the new grade 11 and 12 PE curriculum.



## **RECOMMENDATIONS**

- 1) That the IN model with a 75% PA and 25% Health split be adopted where possible.
- 2) That the IN model with a 75% PA and 25% Health split be provided for all grade 11 and 12 students in all Manitoba high schools.
- 3) That the 110 hours of the PE curriculum be spread out over the course of one year (every second day) instead of one semester (daily).
- 4) That every high school in Manitoba provide (or upgrade where necessary) a well-equipped and readily accessible school fitness facility.
- 5) That School Divisions continue efforts in establishing partnerships with local fitness/recreation centers in order to accommodate the needs of the students (i.e. special reduced membership rates, special fitness classes, improved access, etc.).

## **APPENDICES**

### **Appendix A: The influence of school-community sports participation on academic, fitness and psychological factors for high school students.**

by

Peter Sdrolias and Dean J. Kriellaars

## ABSTRACT

The benefits of sport participation has been touted as a means to improve physical fitness for youth, as well as improving psychological well being without detriment to academic performance. Yet few studies have examined the effects across board domains. This study compared academic, psychological and health-related fitness measures for grade 11 and 12 high school students [16.0 (0.7) years] between those involved in school or community sports (SCSP) and those that did not participate (non-SCSP). Students (n=101; 44 SCSP, 57 non-SCSP; 16.0 (0.7) years) were assessed with a battery of tests measuring physical fitness (20 m shuttle run, push-ups, sit-ups and modified pull-ups), physical activity (pedometry), anthropometrics (body fat, waist circumference and body mass index), and the Physical Self-Description Questionnaire (PSDQ), which assessed the perception of personal fitness and health. The study also evaluated the difference between the groups with respect to academic achievement using grade point average (GPA). Students involved in SCSP had significantly higher ( $p<0.001$ ) predicted maximal oxygen consumption (SCSP=49.82; non-SCSP=42.64 ml/kg/min), push-ups (22.6, 15.7 repetitions), sit-ups (43.0, 35.6), modified pull-ups (16.3, 11.4), and aggregate strength (81.9, 62.8). The PSDQ was improved ( $p<0.001$ ) for coordination, physical activity, body fat, sports competence, general physical self-concept, strength, endurance/fitness and global self-esteem. In addition, the PSDQ variable of appearance was also significantly higher ( $p<0.05$ ) for SCSP. The SCSP group demonstrated significantly lower body fat (mean difference of 5.5%) and waist circumference (mean difference of 5 cm). Non-significant variables between SCSP and non-SCSP included GPA, height, body mass, body mass index and mean daily step counts. These findings demonstrate a very positive effect of sport participation in key areas of overall well being, physiological and psychological.

## INTRODUCTION

Without question, regular physical activity (PA) and school-community sports participation (SCSP) have been linked to innumerable health benefits in children and adolescents (Strong, Malina et al. 2005; Faigenbaum, McFarland et al. 2007; Leary, Ness et al. 2008). The following health components are enhanced due to increased PA; adiposity; metabolic syndrome; lipid (HDL and LDL) levels; blood pressure; cardiovascular fitness (CVF); muscular strength; asthma; mental health (anxiety and depression, self-concept); and skeletal health (Strong, Malina et al. 2005). In addition, academic performance, reduced student drop out, and increased probability of attending post-secondary school has also been associated with PA and SCSP (Strong, Malina et al. 2005; Coatsworth and Conroy 2007).

Physical inactivity in adolescence has been identified as a major risk factor for health problems such as, cardiovascular disease, hypertension and type II diabetes that track into adulthood (Felton, Saunders et al. 2005). Despite the overwhelming health benefits that PA has to offer, PA levels continue to decline as students move from childhood to adolescence (Neumark-Sztainer, Story et al. 2003; Canadian Fitness and Lifestyle Research Institute 2005; Centers for Disease and Prevention 2007). However, students who are involved in sport from an early age are more likely to engage in sport into their high school years (Bergeron 2007; Pate, Dowda et al. 2007). Moreover, high school sports participants were much more likely to exhibit favourable health behaviours (i.e. reduction in substance abuse, sexual activity and violent behaviour) in addition to participation in regular vigorous activity than nonparticipants (Pate, Trost et al. 2000).

In a cross sectional study by Beets (2005), the association between SCSP and non-SCSP was assessed for CVF, muscular strength, BMI and flexibility in high school boys and girls. For CVF, a significant linear increase was observed in maxVO<sub>2</sub> as the number of sports increased, with non-SCSP reporting the lowest scores. The differences observed for CVF were observed within both sexes, while no significant differences were observed for BMI and flexibility between SCSP and non-SCSP. In terms of muscular strength SCSP boys involved in three or more sports scored significantly higher than their non-SCSP counterparts. There was no significant difference in push-ups between SCSP

and non-SCSP for the females. Sports participation has also been shown to positively affect muscle function (i.e. muscular buffer capacity) in 19 year old girls participating on competitive sport teams (Edg, Bishop et al. 2006). In 2003, Tsunawake *et al* compared the fitness levels between 17-year-old elite volleyball and basketball players. All athletes had mean BF% and mean maxVO<sub>2</sub> values that were comparable to elite volleyball and basketball players. In addition, these athletes reported mean O<sub>2</sub>debt max values that were approximately three times as high as the average value in high school students.

The contribution of sport towards academic achievement is mixed, due to the cross-sectional design of the studies as well as the multitude of confounding factors associated with sports participation and academic success. Nevertheless, studies have determined that sports participation was a significant predictor of academic achievement, was positively correlated to mathematics and English marks, and resulted in indirect academic benefits such as reduced rates of absenteeism and drop out (Melnick, Sabo et al. 1992; Dexter 1999; Field, Diego et al. 2001). Conversely, in other studies a weak and negative correlation was observed between academic performance and participation in sport (Melnick, Sabo et al. 1992; Fisher, Juszczak et al. 1996; Daley and Ryan 2000).

Improvement in self-image (Kirkcaldy, Shephard et al. 2002), self-concept and sport competence (Donaldson and Ronan 2006; Linver, Roth et al. 2009) are augmented through participation in sport. In addition, Linver (2009) established that SCSP had greater levels of confidence (self-concept) than non-SCSP.

The present study further extends previous research by incorporating a multifaceted approach, in an effort to examine the effect of SCSP on several health-related fitness (5 fitness tests and 3 measures of body composition), academic (pre-GPA vs. post-GPA) and psychological factors (11 factors from PSDQ). Based on previous research, it was hypothesized that SCSP would exhibit higher levels of CVF, greater muscular strength/endurance, lower BF%, high physical self-perception and self-esteem in both rounds of testing. No significant differences in GPA are expected.

## **MATERIALS AND METHODS**

### **Participants**

Male and female students in grades 11 and 12 from a single high school in Manitoba were invited to participate. Student assent and parent consent forms were completed. The University of Manitoba Health Research and Ethics Board (H2008:111) provided ethical approval, permission was provided by the School Division and school Principal.

A battery of tests measuring physical fitness (20 m shuttle run, push-ups, sit-ups and modified pull-ups), physical activity (pedometry), anthropometrics (body fat, BMI, waist circumference), and the Physical Self-Description Questionnaire (PSDQ), was administered twice. Once in the beginning of term and once at the end of term, 10 weeks apart.

Height (m) and mass (kg) was measured and BMI was derived. Slaughter regression equations calculated percent body fat (BF) for boys and girls (Slaughter et al. 1988) from a two-site skin fold method (Harpenden skin fold calipers). Waist circumference (WC) measurement (cm) was in a horizontal position over the umbilicus. Subjects wore a pedometer (TC02, StepsCount) for two weeks and recorded daily step counts. The 20-meter shuttle run test (20MSRT) was used to predict  $\text{maxVO}_2$  (ml/kg/min). Muscular strength and endurance was assessed for three major muscle groups by performing push-ups (PU), modified pull-ups (MPU) and sit-ups (SU). The total number of repetitions performed for each was recorded. An aggregate strength score was derived.

The Physical Self-Description Questionnaire (PSDQ) (Marsh 1996) was used for the measurement of perceived physical self-concept. The full PSDQ is comprised of 70-items on a 6-point Likert scale (1=False, 6=True). The instrument is comprised of eleven subscales: Health; Coordination; Physical Activity; Body Fat; Sport Competence; General Physical Self-Concept; Appearance; Strength; Flexibility; Endurance/Fitness; and Self-Esteem.

Overall grade point average (GPA) data was collected for the June 2008 (GPA 1) and January 2009 (GPA 2) reporting periods.

## **School-Community Sports Participation**

School-community sports participation (SCSP) sponsored sporting activities included: indoor/outdoor/cross-country track, ultimate, volleyball, basketball, water polo, curling, hockey, golf, badminton and soccer. Student interscholastic athletic participation was collected from the PE Department at the school.

## **Statistical Analyses**

Univariate ANOVA controlling for sex was utilized to detect differences between SCSP and non-SCSP groups. Chi squared analysis evaluated the distribution of males and females for SCSP and non-SCSP. Pearson's correlation coefficient was applied to test for association between selected continuous measures. The level of significance was set at  $\alpha = 0.05$ . Data are presented as mean  $\pm$  SD. All analysis was performed with SPSS 17.0 for MAC OSX (SPSS Inc., Chicago, IL, USA).

## RESULTS

The initial (September) physical characteristics of the study participants for SCSP and non-SCSP are presented in Table 3. Chi squared analysis revealed no significant difference with regard to sex distribution by sport ( $\chi^2=1.465$ ,  $df=3$ ,  $p=0.525$ ). There were significant differences ( $p<0.001$ ) between SCSP and non-SCSP for BF%,  $18.99\pm 5.58\%$  and  $24.65\pm 11.29$ ; shuttle run predicted  $\max\text{VO}_2$ ,  $49.62\pm 6.21$  ml/kg/min and  $42.64\pm 6.54$ ; PU,  $22.63\pm 8.73$  repetitions and  $15.71\pm 10.18$ ; SU,  $43.00\pm 9.29$  and  $35.64\pm 11.32$ ; MPU,  $16.30\pm 7.68$  and  $11.42\pm 7.93$ ; and aggregate strength,  $81.93\pm 19.38$  and  $62.76\pm 26.80$ , respectively. Additionally, WC was significant ( $p<0.05$ ) between SCSP ( $75.49\pm 6.43$  cm) and non-SCSP ( $80.34\pm 11.94$  cm). Significant differences in age, height, body mass and BMI, were not detected.

Initial academic and physical self-concept variables are presented in Table 4. There was no significant difference between groups with respect to grade point average (GPA). The Physical Self-Description Questionnaire (PSDQ) factors of health and flexibility also failed to reach significance. Conversely, all other factors reached significance at the  $p<0.001$  level and appearance at the  $p<0.05$  level.

Repeated testing in December revealed identical results to the initial values with the only exception being WC ( $p=0.058$ ). Sport x sex interactions were all insignificant except for height (m) ( $p=.05$ ) and the PSDQ variable of PA ( $p=0.018$ ) for both September and December trials.



**Table 5 - Physical characteristics between SCSP and non-SCSP controlling for sex.**

<b>Measures</b>	<b>SCSP (n=44)</b>	<b>Non-SCSP (n=57)</b>
Age (y)	16.14 (0.71)	15.96 (0.72)
Height (m)	1.73 (0.09)	1.72 (0.08)
Mass (kg)	64.86 (10.06)	67.68 (15.60)
Body mass index (kg/m <sup>2</sup> )	21.64 (1.92)	22.80 (4.76)
Body fat (%)**	18.99 (5.58)	24.65 (11.29)
Waist circumference (cm)*	75.49 (6.43)	80.34 (11.94)
Pedometry (#steps)	9995.60 (3859.41)	10805.98 (3428.53)
Shuttle run VO <sub>2</sub> max (ml/kg/min)**	49.82 (6.21)	42.64 (6.54)
Push-ups (#reps)**	22.63 (8.73)	15.71 (10.18)
Sit-ups (#reps)**	43.00 (9.29)	35.64 (11.32)
Modified pull-ups (#reps)**	16.30 (7.68)	11.42 (7.93)
Strength (#reps)**	81.93 (19.38)	62.76(26.80)

Note. Data are presented as the mean (SD). SCSP: school-community sport participation; non-SCSP: non-school-community sport participation. Univariate ANOVA performed with SCSP and sex serving as fixed factors.

\*Significant at  $p < 0.05$ .

\*\*Significant at  $p < 0.001$ .

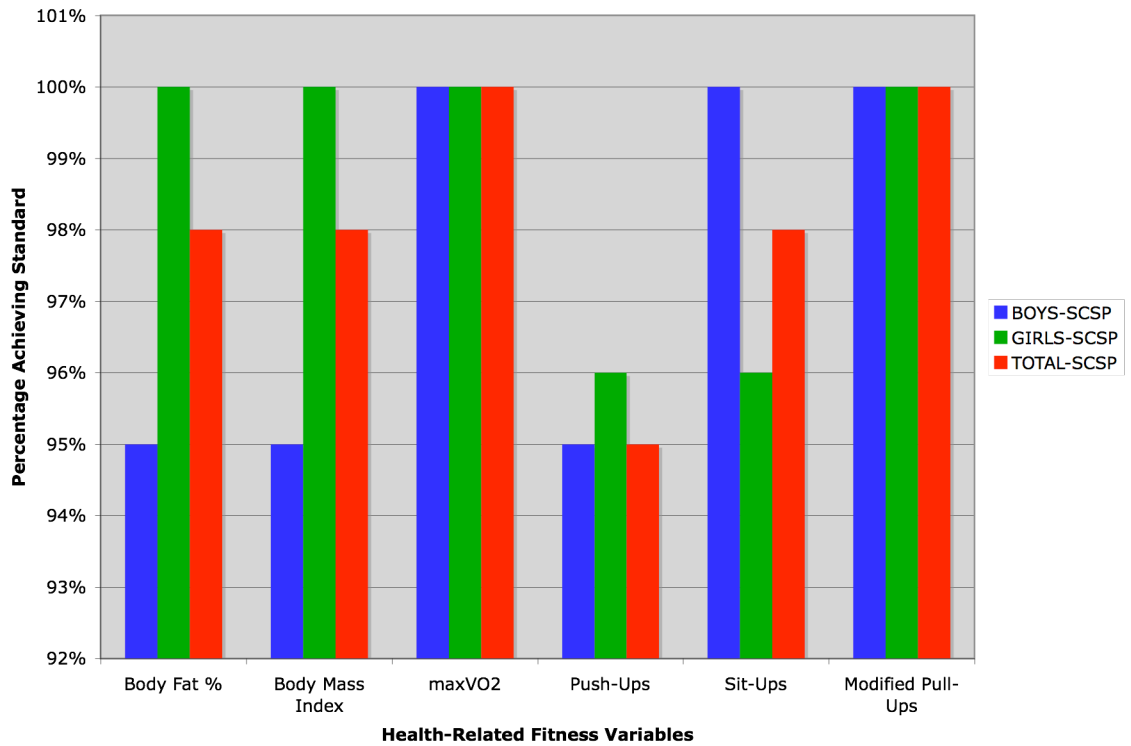
**Table 6 - Academic and physical self-concept between SCSP and non-SCSP controlling for sex.**

<b>Measures</b>	<b>SCSP (n=44)</b>	<b>NON-SCSP (n=57)</b>
Grade point average (%)	76.28 (7.40)	74.96 (8.74)
<i>Physical self-description questionnaire factors (maximum of 6)</i>		
Health	4.93 (0.68)	4.60 (1.03)
Coordination**	4.82 (0.81)	4.08 (0.94)
Physical activity**	5.37 (0.69)	4.14 (1.32)
Body fat**	5.37 (0.83)	4.32 (1.53)
Sports competence**	4.93 (0.80)	3.73 (1.33)
General physical self concept**	5.24 (0.71)	4.10 (1.20)
Appearance*	4.83 (0.78)	4.28 (0.94)
Strength**	4.66 (0.99)	3.74 (1.13)
Flexibility	4.21 (1.13)	3.81 (1.20)
Endurance/fitness**	4.89 (0.98)	3.57 (1.27)
Global self esteem**	5.44 (0.46)	4.87 (0.81)

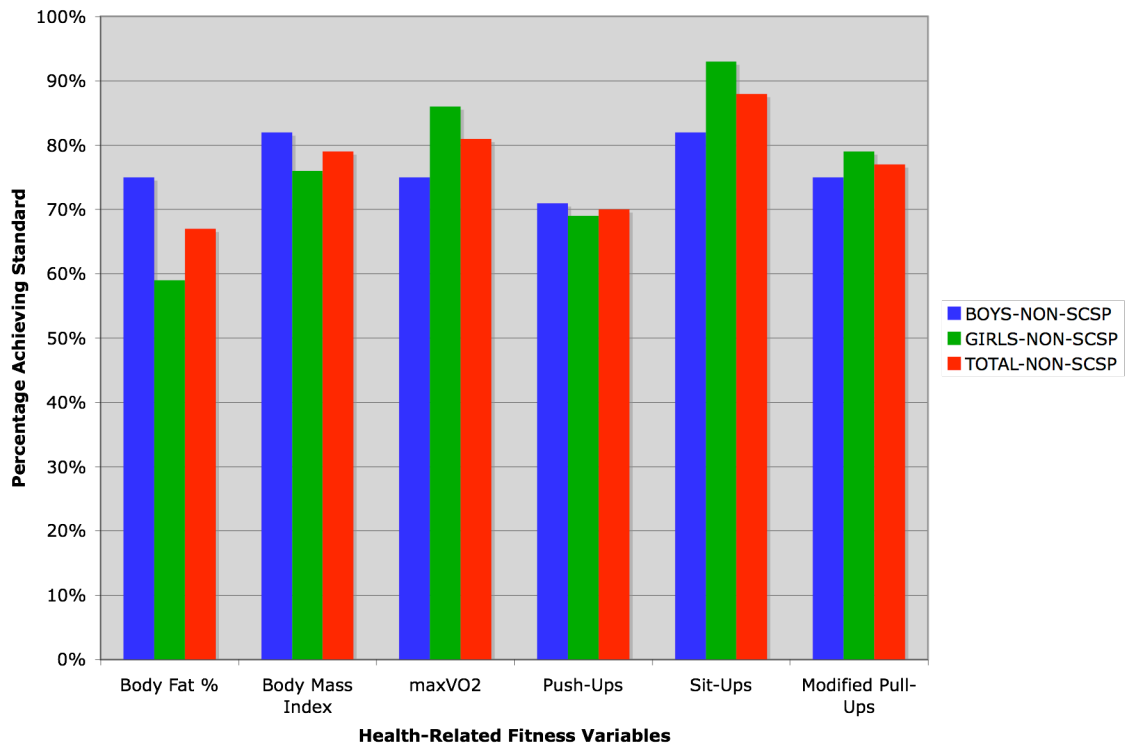
Note. Data are presented as the mean (SD). SCSP: school-community sport participation; non-SCSP: non-school-community sport participation. Univariate ANOVA performed with SCSP and sex serving as fixed factors.

\*Significant at  $p < 0.05$ .

\*\*Significant at  $p < 0.001$ .



**Figure 12 - School-community sport participants meeting FITNESSGRAM Health-Related Fitness Zone Standards.**



**Figure 13 - Non-school-community sport participants meeting FITNESSGRAM Health-Related Fitness Zone Standards.**

## DISCUSSION

This study examined the relationship between SCSP and non-SCSP to health-related fitness, behavioural and academic outcomes for grade 11 and 12 students. The main findings from the present study indicated significantly favourable scores for SCSP when compared to non-SCSP for all fitness parameters (CVF, PU, SU, MPU, and AS); BF% and WC; as well as nine out of eleven PSDQ variables). The current findings are echoed in previous research identifying improvements in key areas of overall health-related fitness, mental and emotional well being due to sports participation (Michaud, Narring et al. 1999; Beets and Pitetti 2005; Bailey 2006; Donaldson and Ronan 2006; Phillips and Young 2009; Zahner, Muehlbauer et al. 2009).

Sports participation is a common form of activity in Canadian adolescents. Approximately 66% of adolescents 15-19 years old indicated involvement in sport through a self-reported survey (Canadian Fitness and Lifestyle Research Institute 2004). In contrast, the current study participation rate of 43.6% (44 out of 101) is substantially lower due to the direct determination of student involvement in SCSP. Thus, the Canadian average (66%) may be inaccurate due to limitations usually associated with self-reporting (Bender, Brownson et al. 2005; Wong, Leatherdale et al. 2006; Esliger and Tremblay 2007; Shiely and MacDonncha 2009). Without question, advocates of health and fitness hope to see as much involvement in organized and unorganized PA as possible. Increasing PA by 10% by 2010 in every jurisdiction of Canada has become a goal for Ministers at the federal, provincial and territorial (FPT) levels. In addition, the mission of the Canada Sport Policy is to increase the degree of “Canadians from all segments of society who are involved in quality sport activities at all levels and in all forms of participation.”

Current study distribution of participants with respect to sex and SCSP may be advantageous for SCSP and non-SCSP comparisons. Testing the observed distribution between sex (boys and girls) and sports (SCSP and non-SCSP) by means of a chi squared analysis was not significant ( $\chi^2=1.465$ ,  $df=3$ ,  $p=0.525$ ). In other words, the distribution of SCSP was evenly distributed between the sexes (i.e. ideal due to the dominant results

obtained by the boys when compared to girls), allowing for a fair comparison between SCSP and non-SCSP.

There is strong evidence to support the declining levels of PA during adolescence in the United States and other developed nations (Canadian Fitness and Lifestyle Research Institute 2005; Phillips and Young 2009). In contrast, children and youth (5-19 years old) averaged 11 950 steps/day from the Canadian Physical Activity Levels Among Youth (CANPLAY) study collected in year 3 (2007-2008) of the study. This value exceeded both previous years' values by a few hundred steps per day that translates into approximately 5-6 extra minutes of activity per day. While this trend seem promising it is still below Canada's Physical Activity Guide (CPAG) recommendation, that children and youth acquire 90-minutes of moderate to vigorous PA per day (equivalent to approximately 16,500 steps/day) in addition to everyday activities, in order to maintain good health. The PA levels for students in the present study were well below the CPAG guidelines, SCSP ( $9996 \pm 3859$  steps/day) and non-SCSP ( $10,806 \pm 3429$  steps/day). In light of these results it appears that these students may be at risk of developing diseases related to the inadequate amount of accumulated daily PA.

In order to assess the health-related fitness levels between SCSP and non-SCSP, the FITNESSGRAM Standards for Healthy Fitness Zones (HFZ) were utilized for the following measures; CVF; BF%; BMI; PU; SU; and MPU. FITNESSGRAM consists of a complete battery of health-related fitness tests that are scored using age and sex specific criterion-referenced standards. These standards are based on values necessary for sound health. The percentages of students in each group that fulfilled or exceeded the FITNESSGRAM Standards for HFZ were as follows (Figures 9 and 10): CVF (SCSP=100%, non-SCSP=81%); BF% (98%, 67%); BMI (98%, 79%); PU (95%, 70%); SU (98%, 88%); and MPU (100%, 77%). Thus, despite the insufficient mean daily step count, a large proportion of students in this study possess adequate fitness levels that are necessary for good health. This is especially true for SCSP that demonstrated nearly perfect fitness levels based upon these standards.

There was no significant difference ( $p=0.285$ ) in mean daily step counts between SCSP and non-SCSP. These results are accordant with data from the CANPLAY study which reported no significant difference in step counts, despite 1500 steps more for SCSP when compared to non-SCSP (Canadian Fitness and Lifestyle Research Institute 2005). In the present study, SCSP accumulated approximately 800 fewer steps/day compared to non-SCSP. These results conflict with data collected examining PA levels of high school students from grade 9-12 (Wilde, Corbin et al. 2004). In summary, teens involved in sport accumulated significantly ( $p<0.05$ ) 5000 more steps/day than those not in sport. This difference in steps was the same for both boys and girls. This inconsistency may have resulted from the removal of the pedometer during sport competition and training sessions in the current study, thus underestimating the amount of PA.

Interestingly, the PSDQ variable of PA perception indicated a significant difference ( $p<0.001$ ) between the two groups with SCSP ( $5.37\pm0.69$ ) perceiving a higher degree of PA than non-SCSP ( $4.14\pm1.32$ ) (Table 6). Moreover, SCSP and non-SCSP did not report any significant correlations when PA (step count) was compared to each of the following fitness tests: 20MSR, PU, SU and MPU. Other studies have also enunciated low correlations ( $r = 0.10$  to  $0.15$ ) when comparing PA to CVF for SCSP (Sallis, Patterson et al. 1988; Payne and Morrow 1993). Rationale for the weak association may have been due to environmental influences, BMI and the complexities associated with CVF (Michaud, Narring et al. 1999). However, what is promising about the present study is the fact that students involved in sport are more physically fit (CVF, muscular strength and endurance), have a lower BF%, and have better self-esteem and physical self-perception than non-SCSP (Tables 5 and 6). This finding is consistent with previous research (Ara, Vicente-Rodriguez et al. 2004) supporting improved fitness due to noncurricular approaches. In addition to increased aerobic capacity, participation in sport that requires vigorous exertion may also provide that individual with cardioprotective benefits (Swain and Franklin 2006). Both male and female performance on the 20MSR related significantly to participation in sport. SCSP achieved significantly ( $p<0.001$ ) greater  $\text{maxVO}_2$  scores than non-SCSP (mean  $\text{maxVO}_2$  difference  $\sim 7$  ml/kg/min). When observed by sex similar significant  $\text{maxVO}_2$  differences were noted

(boys-SCSP=56.43±4.0 vs. boys-non-SCSP=47.52±6.8 ml/kg/min,  $F=18.6$ ,  $df\ 1\ \&\ 47$ ,  $p<0.001$ ; girls-SCSP=47.15±4.2 vs. girls-non-SCSP=39.84±4.7,  $F=26.9$ ,  $df\ 1\ \&\ 50$ ,  $p<0.001$ ).

In a cross-sectional study of high school students Beets and Pitetti (2005), CVF was assessed for students in PE and students in PE plus extracurricular sports. The results were similar to the present study in that, SCSP acquired significantly higher maxVO<sub>2</sub> values compared to non-SCSP (boys-SCSP=50.73±7.0 vs. boys-non-SCSP=40.57±5.3 ml/kg/min,  $p=0.01$ ; girls-SCSP=42.45±5.8 vs. girls-non-SCSP=35.05±3.4 ml/kg/min,  $p=0.01$ ). These results are in agreement with data collected for the assessment of a National PE curriculum. CVF (maxVO<sub>2</sub>=43.9±4.2 ml/kg/min) in 13 year old boys participating in sport significantly ( $p<0.001$ ) exceeded those not involved in sport (maxVO<sub>2</sub>=34.7±3.7 ml/kg/min) after adjusting for age, height, body mass, and SCSP (Koutedakis and Bouziotas 2003). Competitive athletes are often exposed to vigorous PA (i.e. >6 METS or approximately 65% to 80% of maxVO<sub>2</sub>) that can significantly improve CVF. For example, in a group of 13-16 year old males and females CVF was significantly improved after an 8-month high intensity (77% of max VO<sub>2</sub>) physical training program (Kang, Gutin et al. 2002). In some cases the magnitude of CVF in student athletes can be comparable to professional athletes (Tsunawake, Tahara et al. 2003).

No significant difference for BMI was observed between SCSP and non-SCSP. These results were also observed in another study (Beets and Pitetti 2005). This was possibility due the inability of BMI to distinguish between fat-mass (FM) and fat-free-mass (FFM). However, BF% and WC were significantly ( $p<0.001$ ,  $p<0.05$ ) lower for SCSP and non-SCSP, respectively. The BF% for SCSP (~18% BF) is in agreement with those of Tsunawake et al (2003) who reported BF% for competitive high school basketball (~15% BF) and volleyball players (~18% BF). Young athletes engaging in intense physical training were more likely to have lower BF% than sedentary individuals (Maffulli and Pintore 1990). From a public health perspective, low BF% and healthy WC diameters may help to reduce the incidence of metabolic disorders.



With respect to the PSDQ, SCSP scored higher in every measure and significantly higher in all but two [Health (HE) and Flexibility (FL)]. These results are not surprising considering the dominance of SCSP in all of the fitness tests. Sport participation has been established as an important factor in enhancing adolescent self-esteem and well-being (Steptoe and Butler 1996; Donaldson and Ronan 2006). SCSP has also been shown to reduce emotional and behavioural problems in youth (Wiles, Jones et al. 2008).

The evidence attempting to link the potentially direct and indirect beneficial effects of SCSP on academic performance and cognitive functioning in adolescents has been equivocal. Difficulty in controlling for confounding factors has been cited as the main challenge (Trudeau and Shephard 2008). The current study GPA data for SCSP ( $76.28 \pm 7.40\%$ ) and non-SCSP ( $74.96 \pm 8.74$ ) failed to reach significance ( $p=0.397$ ). Based on these results it is clear that participation in sport does not compromise academic achievement when compared to nonparticipants.

A major advantage of this study was the use of objective measures that provided comprehensive evidence based results. Since only a single investigator conducted all of the tests the amount of error due to experimental procedures may have been reduced. Moreover, the testing was repeated approximately 4-months later allowing for a verification of the initial results.

The subjects may not accurately be representative of the population (grade 11 and 12 students) in question. Students on sport teams such as volleyball and hockey reported removing the pedometer that may have significantly underestimated PA. Academic achievement was assessed with the GPA from the previous school year (i.e. grade 10 year end GPA for grade 11 students, and grade 11 year end GPA for the grade 12 students). GPA results should be cautiously interpreted due to the varying degree of course difficulty between grades, combined with the varying array of student timetables.

Clearly, SCSP has the potential to make significant positive contributions to CVF, muscular strength and endurance and body composition. Involvement in sport has also been shown to improve student self-esteem and physical self-perception. Sports participation may also enhance cognitive function and academic performance, although further research would aid in the comprehension of the nature of these contributions. Though the results in this study were not significant the higher GPA obtained by SCSP certainly reinforces that widely regarded notion that additional involvement in PA does not negatively affect school grades.

## Appendix B: Cover Letter

**Dear Parent/Guardian of a child entering grade 11 or 12 in September 2008.**

**RE: Participation in a research study**

A research study will be taking place in Westwood Collegiate School conducted by a Master of Science candidate from the University of Manitoba. The study investigators are Mr. Peter Sdrolias and Dr. Dean Kriellaars from the Faculty of Medical Rehabilitation. The St. James-Assiniboia School Division Board has given permission for this study to take place within the school.

The study is entitled '*The effect of the grade 11 and 12 Manitoba high school physical education curriculum on health-related fitness, behavioural and academic outcomes*'. This study is a very low risk study measuring physical activity in high school youth using pedometer step counts. CVF will be measured using a PACER test ('beep test') and the Rockport Walk Test (one mile walk test). Body composition will be assessed using height, mass and skinfold measurements.

You will find information regarding this study attached to this letter in the form of a parental consent form. **You are invited to attend an informational session that will be held on Tuesday, June 17, 2008 at the school.** Please bring the consent form with you to the meeting. All parents/guardians of grade 11 and 12 students are encouraged to attend this session to ask questions regarding the study. If you are unable to attend this session an appointment can be made by calling Mr. P. Sdrolias. For your convenience study information may be downloaded from my website at [www](http://www).

**Parental consent to present this study to your child must be obtained prior to obtaining assent from your child to take part in this study.** We will meet with you and your child individually at the information session.

We look forward to meeting with you and your child on Tuesday, June 17, 2008 at 7:00 pm in the Westwood theatre.

Sincerely yours,

Peter Sdrolias, B.P.E., B. Ed.  
Dean Kriellaars, PhD

## Appendix C: Parent Consent

### PARENT/GUARDIAN RESEARCH INFORMATION AND CONSENT FORM

Title of Study: The effect of the Manitoba grade 11 and 12 high school physical education curriculum on fitness-related health, behavioural and academic outcomes.

Co-Investigators: Mr. Peter Sdrolias, Westwood Collegiate, St. James-Assiniboia School Division #2.

Dr. Dean Kriellaars, Health Sciences Centre Rehabilitation Hospital.

Your child is being asked to participate in a research study. Please take your time to review this consent form and discuss any questions you may have with the study staff. You may take your time to make your decision about your child participating in this study and you may discuss it with your friends, family or (if applicable) your doctor before you make your decision. This consent form may contain words that you do not understand. Please ask the study staff to explain any words or information that you do not clearly understand.

#### Purpose of Study

It has been demonstrated that Canadian youth are becoming less physically active, more overweight and less fit. This places youth at risk for health problems. It is unknown what the effects of newly implemented physical education curricula have on physical, behavioral and academic outcomes for grade 11 and 12 students. The study will examine the effect of the mandatory grade 11 and 12 physical education curriculum on health-related fitness, behavioral and academic outcomes.

A maximum total of 120 participants will participate in this study.

#### Study procedures

If your child takes part in this study, he/she will have the following procedures:

- 1) He/she will be asked to specify age, date of birth, and gender.
- 2) Height and weight will be measured using a Seca #700 scale. These values will determine your child's body mass index (BMI).
- 3) Percent body fat will be calculated by measuring 2 skinfold sites. In this method a skin fold caliper will be used. Your child's skin will be gently pinched with this device and the skin fold will be measured.
- 4) Waist circumference will be taken.
- 5) Your child will be asked to wear a pedometer for a two-week period. He/she will record the total steps for each day. **Do not reset the pedometer**, just keep recording the new total. The pedometer is to be worn on the right hip along the

pants seam. Please wear the pedometer all day long. Your child may remove the pedometer while having a bath/shower, while swimming and while sleeping.

- 6) Your child will also take part in two measures of CVF.
  - a. The 20 meter shuttle run, or the 'beep test'. In this test he/she will run between 20 meter pylons at the sound of a beep. Your child will be asked to run this distance until he/she is unable to run any further. Level of ability will then be recorded. To validate that your child has run to his/her maximal ability, they will be tested using a talking test. The talking test determines how out of breath you are.
  - b. The Rockport One Mile Walk Test. In this test your child will walk the distance as fast as possible but at a fixed pace and record the time and heart rate at the end of 1.0 mile (1604.39 m).
- 7) Your child will also complete three muscular strength and endurance measures:
  - a. The 90° push up test. This test is a measure of upper body strength. Students begin with the feet together and bend 90° at the elbow. A cadence is followed to ensure a smooth rhythm. Students perform as many push-ups as possible.
  - b. The modified pull up test. Another measure of upper body strength, but focusing on the back muscles. Students start on their back, grasp a supported Olympic bar and pull up until they make contact with an elastic band. A cadence is followed to ensure a smooth rhythm. Students perform as many pull-ups as possible.
  - c. The sit-up test. This test measures abdominal and hip flexor strength and endurance. Your child will lie on his/her back with knees bent at 90° and feet on floor. Hands are placed on the side of the head. On the command "go" the subject contacts the elbows to the knees. Subject performs as many sit-ups as possible in one minute.
- 8) Overall grade point average (GPA) will be collected via School Administrative Software. This will be done in order to investigate the impact (if any) of additional PE on academic achievement.
- 9) Your child will also complete the Physical Self-Description Questionnaire (PSDQ). This is a 70-item scale designed for adolescents for the measurement of 10 facets of physical self-concept and general self-esteem. The PSDQ will allow for the comparison of student physical self-perceptions to objectively measured health related fitness tests.

The height, mass and skin fold measurements will take place at your child's school, as will the fitness tests. These tests are a part of the overall Physical Education Program at Westwood Collegiate. The researchers will take these measurements.

The data that is not normally collected as part of the regular fitness-testing program include the PSDQ and grade point average.

Your child will need to take recordings from the pedometer at school and home. Teacher and/or parents may assist.

The researchers may decide to take your child off this study if they are unable to complete the fitness tests safely.

Your child can stop participating at any time. However, if he/she decides to stop participating in the study, we encourage you and your child to talk to the study staff first.

There are no serious consequences of sudden withdrawal from the study.

Individual and aggregate results may be provided to the participants upon request immediately following completion of the analysis of data.

#### Risks and Discomforts

The risks of this study are minimal and limited to physical injury, which may result from accidental fall while running in the CVF test. An out of breath sensation immediately following the fitness test may also occur, but this is a temporary effect.

#### Benefits

There may or may not be direct benefit to your child from participating in this study. We hope the information learned from this study will benefit a wide variety of people in the future.

#### Costs

All the procedures, which will be performed as part of this study, are provided at no cost to you or your child.

#### Payment for participation

Your child will receive no payment or reimbursement for any expenses related to taking part in this study.

### Confidentiality

Information gathered in this research study may be published or presented in public forums, however your child's name and other identifying information will not be used or revealed. Despite efforts to keep your child's personal information confidential, absolute confidentiality cannot be guaranteed. Your child's personal information may be disclosed if required by law.

The University of Manitoba Health Research Ethics Board may review records related to the study for quality assurance purposes.

All records will be kept in a locked secure area and only those persons identified will have access to these records. If any of your child's medical/research record need to be copied to any of the above, your child's name, and all identifying information, will be removed. No information revealing any personal information such as your child's name, address or telephone number will leave the University of Manitoba Human Performance Laboratory, RR359 Rehabilitation Hospital, Health Sciences Centre.

### Voluntary Participation/Withdrawal from the Study

Your decision for your child to take part in this study is voluntary. You and your child may refuse to participate or you and your child may withdraw from the study at any time. If the study staff feel that it is in the best interest of your child to withdraw from the study, they will remove your child without your consent.

We will tell you about any new information that may affect your child's health, welfare, or willingness to stay in this study.

### Medical Care for Injury Related to the Study

You are not waiving any of your legal rights by signing this consent form nor releasing the investigator(s) or the sponsor(s) from their legal and professional responsibilities.

### Questions

You are free to ask any questions that you may have about your child's rights as a research participant. If any questions come up during or after the study or if your child has a research-related injury, contact the study doctor and the study staff: Dr. Dean Kriellaars or Peter Sdrolas.

For questions about your child's rights as a research participant, you may contact The University of Manitoba, Bannatyne Campus Research Ethics Board.

Do not sign this consent form unless you have had a chance to ask questions and have received satisfactory answers to all of your questions.

Statement of Consent

I have read this consent form. I have had the opportunity to discuss this research study with the study staff. I have had my questions answered by them in language I understand. The risks and benefits have been explained to me. I believe that I have not been unduly influenced by any study team member to participate in the research study by any statements or implied statements. Any relationship (such as employer, supervisor or family member) I may have with the study team has not affected my decision to allow my child to participate. I understand that I will be given a copy of this consent form after signing it. I understand that my child's participation in this study is voluntary and that I may choose to withdraw my child at any time. I freely agree to allow my child to participate in this research study.

I hereby give consent to the study investigators to present information regarding this study to my child. I understand that if my child does not want to participate in this study, even though I have already given consent, my child's decision is binding.

I understand that information regarding my child's personal identity will be kept confidential, but that confidentiality is not guaranteed. I authorize the inspection of any of my child's records that relate to this study by The University of Manitoba Research Ethics Board for quality assurance purposes.

By signing this consent form, I have not waived any of the legal rights that I have as a parent/guardian of my child's participation in a research study.

Parent/legal guardian's signature \_\_\_\_\_ Date \_\_\_\_\_ (dd/mm/yy)

Parent/legal guardian's printed name: \_\_\_\_\_

Child's printed name: \_\_\_\_\_ Date \_\_\_\_\_ (dd/mm/yy)

To be completed by investigator:

I, the undersigned, have fully explained the relevant details of this research study to the parent/guardian named above and believe that the parent/guardian has understood and has knowingly given their consent for their child to participate in the study. I understand that assent from the child must be obtained prior to his/her participation in the study.

Printed Name: \_\_\_\_\_ Date \_\_\_\_\_ (dd/mm/yy)

Signature: \_\_\_\_\_

Role in the study: \_\_\_\_\_

Relationship (if any) to study team members: \_\_\_\_\_



## **Appendix D: Student Assent**

**Study title: ‘The effect of the grade 11 and 12 Manitoba high school physical education curriculum on health-related fitness, behavioural and academic outcomes’.**

Investigators: Peter Sdrolias and Dean Kriellaars

### **Why you are here?**

The study investigators would like to inform you about a study involving the new mandatory Manitoba physical education curriculum. You are invited to be a subject in this study. This form tells you about the study. If there is anything you do not understand, please ask your parent, your guardian or the study staff.

### **Why are they doing this study?**

The study investigators want to learn more about how physically active children are compared to how fit they are and what their body composition is.

### **What will happen to you?**

If you want to be in the study these things will happen:

The study will last from September 2, 2008 to December 17, 2008. All measurements will be conducted within a 2-3 week block, at 2 different time periods (September and December). You will be asked to use a pedometer to collect information about your daily activity from September 2<sup>nd</sup>-16<sup>th</sup> and December 3<sup>rd</sup>-17<sup>th</sup>. During the pedometer collection period, you will be asked to complete the fitness, body composition and PSDQ survey measurements.

### **The following are the main study procedures:**

You will record the number of steps you take each day using a pedometer. (A pedometer is a tool that measures how many steps you take.)

You will need to record the steps taken several times throughout the day on the form provided to you. Your teacher, parent and study staff may assist you.

You will need to record the steps for 14 days.

During the same 14 days that you record your steps, you will be asked to make comments related to your activities.

The study staff will collect body composition information. These include your weight, height, skin fold thickness and waist circumference. . Skin fold thickness is measured using an instrument that gently pinches your skin. Seven skin fold sites will be measured from your triceps (back of arm) and gastrocnemius (calf).

You will be asked to take part in a fitness test called the '20 meter shuttle run' also known as the 'beep test'. In this test you will run back and forth in the gymnasium keeping time to a beep sound. When you can no longer keep up with the beep sound, the number of runs completed will be recorded.

**The data that is not normally collected as part of the regular fitness-testing program include the PSDQ and grade point average.**

**Will the study hurt?**

You should feel out of breath when you complete the 'beep test'. This is only for a short period of time and should pass quickly. You must tell the study staff or your teacher if you do not catch your breath quickly or feel sick after the 'beep test'.

You will feel a gentle pinch when they measure your skin fold thickness.

**Will you get better if you are in the study?**

This study may not make you become more fit. But the study staff might find out something that will help you set goals to achieve fitness. This study will also provide schools with important information in order to improve the physical education curriculum.

**What if you have any questions?**

You can ask questions any time, now or later. You can talk to the study staff, your family or someone else.

**Who will know what I did in the study?**

Any information you give to the study staff will be kept confidential. Your name will not be on any study paper and no one but the study staff will know that it was you who was in the study.

**Do you have to be in the study?**

You do not have to be in the study. We will also ask your parents if they would like you to be in the study. Even if your parents want you to be in the study you can still say no. Even if you say yes you can change your mind later. It's up to you.

## Assent

I want to take part in this study. I know I can change my mind at any time.

Written assent.

\_\_\_\_\_  
Student name-print                      Student-signature      Age                      Date

[The following statement and signature is required]:

I confirm that I have explained the study to the participant to the extent compatible with the participants understanding, and that the participant has agreed to be in the study.

\_\_\_\_\_  
Printed name of                              Signature of                              Date  
Person obtaining assent                      Person obtaining assent

## Appendix E: Physical Activity Plan

Name: \_\_\_\_\_ Teacher Supervisor: \_\_\_\_\_ Group#: \_\_\_\_\_

I \_\_\_\_\_ plan to complete my 75 hours of moderate-to-vigorous physical activity required to gain credit for Westwood's PE 30/40F OUT-OF-SCHOOL Physical Education Credit. I will also complete the 5 online health modules that are required to receive a COMPLETE in this course.

My plan to complete my hours is as follows:

<u>ACTIVITY(IES)</u>	<u>SUPERVISOR/COACH</u>	<u>LOCATION</u>
----------------------	-------------------------	-----------------

_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

I will be physically active at these activities \_\_\_\_\_ times per week. To gain the health benefits of regular exercise the student should maintain a heart rate of 70%-90% (moderate to vigorous) of their maximum heart rate. This is the criterion that must be followed in order for the activity to count towards credit.

By signing you are aware of the criteria and the plan you have set out and are committed to completing it in order to receive the credit. The role of the parents will be to monitor and encourage this plan and criteria.

Student signature: \_\_\_\_\_

Parent signature: \_\_\_\_\_

Teacher Supervisor signature: \_\_\_\_\_

## Appendix F: Physical Activity Practicum Log

GR. 11 & 12 75-HOUR PHYSICAL ACTIVITY PRACTICUM LOG FORM				
STUDENT:			TEACHER SUPERVISOR SIGNATURE:	
<u>MONTH</u>	<u>ACTIVITIES</u>	<u># HOURS</u>	<u>ACTIVITY SUPERVISOR/PARENT SIGNATURE</u>	<u>STUDENT SIGNATURE</u>
AUGUST				
SEPTEMBER				
OCTOBER				
NOVEMBER				
DECEMBER				
JANUARY				
FEBRUARY				
MARCH				
APRIL				
MAY				
JUNE				
	<b>TOTAL</b>			

## Appendix G: Subject Data

Name: \_\_\_\_\_

ANTHROPOMETRY				
Height (cm)				
Body mass (kg)				
Waist circumference (cm)				
Skin-fold (triplicate, mm)	Tricep			
	Gastroc			
FITNESS				
20 mSRT (#lengths)				
1.6 km Rockport Walk	Time (min/sec):		HR (10 sec):	
90 degree push-ups				
Modified Pull-ups				
Sit-ups				

## Appendix H: Pedometry Data

Name: \_\_\_\_\_ Grade: \_\_\_\_\_

Instructions:

- 1) **PLACE THIS FORM ON YOUR FRIDGE DOOR FOR EASY RECORDING!**
- 2) Calibrate your pedometer by taking 50 steps (count them). Your pedometer should record between 48-52 steps. If not, move the pedometer along your waist and repeat. Continue until you achieve the 48-52 step reading. Perform this calibration on Wednesday, September 10, 2008.
- 3) Begin using the pedometer on Wednesday, September 10, 2008.
- 4) Clip the pedometer to the waist of your pants on your right side between the middle of your leg and your hip. Put the pedometer on as soon as you wake in the morning. Attach the safety cord to your pocket or along your waistband. Reset the pedometer to zero by pressing and holding the reset button for 3 seconds. Cover the cover. (The pedometer only records while the cover is closed and in the upright position).
- 5) Record the TOTAL NUMBER OF STEPS AT BEDTIME IN THE CHART. RESET THE PEDOMETER IN THE MORNING BEFORE WEARING.
- 6) Remove the pedometer if you feel that it may be damaged (ie swimming, showering, volleyball practice, etc.).
- 7) QUESTIONS/CONCERNS/PROBLEMS: Contact Mr. Sdrolias **IMMEDIATELY.**
- 8) Hand in the completed form to Mr. Sdrolias on **WEDNESDAY, SEPTEMBER 17, 2008!**
- 9) Forms may be downloaded from <http://www>.

**WEEK #2**

	<b># STEPS</b>	<b>COMMENTS</b>
<b>Wednesday September 10</b>		
<b>Thursday September 11</b>		
<b>Friday September 12</b>		
<b>Saturday September 13</b>		
<b>Sunday September 14</b>		
<b>Monday September 15</b>		
<b>Tuesday September 16</b>		



## Appendix I: Weather Data

MONTH	DAY	MAX TEMP °C	MIN TEMP °C	MEAN TEMP °C	TOTAL PRECIP mm
SEPTEMBER	02	20.8	5.6	13.2	0.0
	03	18.3	8.3	13.3	0.0
	04	16.5	8.1	12.3	2.5
	05	19.0	6.1	12.6	3.5
	06	15.3	3.5	9.4	2.5
	07	16.2	2.9	9.6	0.0
	08	22.2	4.1	13.2	0.0
	19	21.6	10.8	16.2	0.0
	10	20.8	8.3	14.6	0.0
	11	25.4	11.0	18.2	0.0
	12	18.5	11.1	14.8	0.0
	13	16.8	6.1	11.5	0.5
	14	20.4	9.6	15.0	0.0
	15	20.9	5.5	13.2	0.0
	<b>MEAN</b>	<b>19.48</b>	<b>7.21</b>	<b>13.36</b>	<b>0.64</b>
DECEMBER	03	-10.2	-18.3	-14.3	0.0
	04	-10.4	-16.5	-13.5	0.0
	05	-8.1	-14.2	-11.2	1.0
	06	-12.7	-23.8	-18.3	0.0
	07	-12.2	-23.5	-17.9	1.5
	08	-13.4	-23.6	-18.5	0.0
	09	-16.5	-24.6	-20.6	0.0
	10	-12.9	-23.9	-18.4	4.0
	11	-20.6	-30.5	-25.6	0.5
	12	-7.1	-26.2	-16.7	1.0
	13	-9.3	-26.0	-17.7	0.0
	14	-24.9	-26.9	-25.9	0.5
	15	-24.6	-30.4	-27.5	0.0
	16	-21.0	-26.9	-24.0	0.5
	<b>MEAN</b>	<b>-14.56</b>	<b>-23.95</b>	<b>-19.29</b>	<b>0.64</b>
<b>MEAN DIFFERENCE (SEPT-DEC)</b>		<b>34.04</b>	<b>31.16</b>	<b>32.65</b>	<b>0.0</b>

## Appendix J: Initial BMI and Body Fat Distribution by Sex and Age

**Table 7 - Initial Body Mass Index Distribution by Sex and Age**

SEX	AGE	n	NORMAL	OVERWEIGHT	OBESE
MALES	15	7	7	0	0
	16	27	17	7	3
	17	15	13	2	0
	Total	49	37	9	3
FEMALES	15	16	10	5	1
	16	24	23	1	0
	17	12	10	1	1
	Total	52	43	7	2
TOTALS		101	80	16	5

**Table 8 - Initial Body Fat Percentage Distribution by Sex and Age**

SEX	AGE	n	<25% Normal	25-30% At-Risk	30%+ Obese
MALES	15	7	7	0	0
	16	27	22	1	4
	17	15	12	1	2
	Total	49	41	2	6
FEMALES	15	16	7	3	6
	16	24	15	2	7
	17	12	7	2	3
	Total	52	29	7	16
TOTALS		101	70	9	22

**Appendix K: The relationship between general physical self-concept and global self-esteem and objectively measured physical characteristics and fitness.**

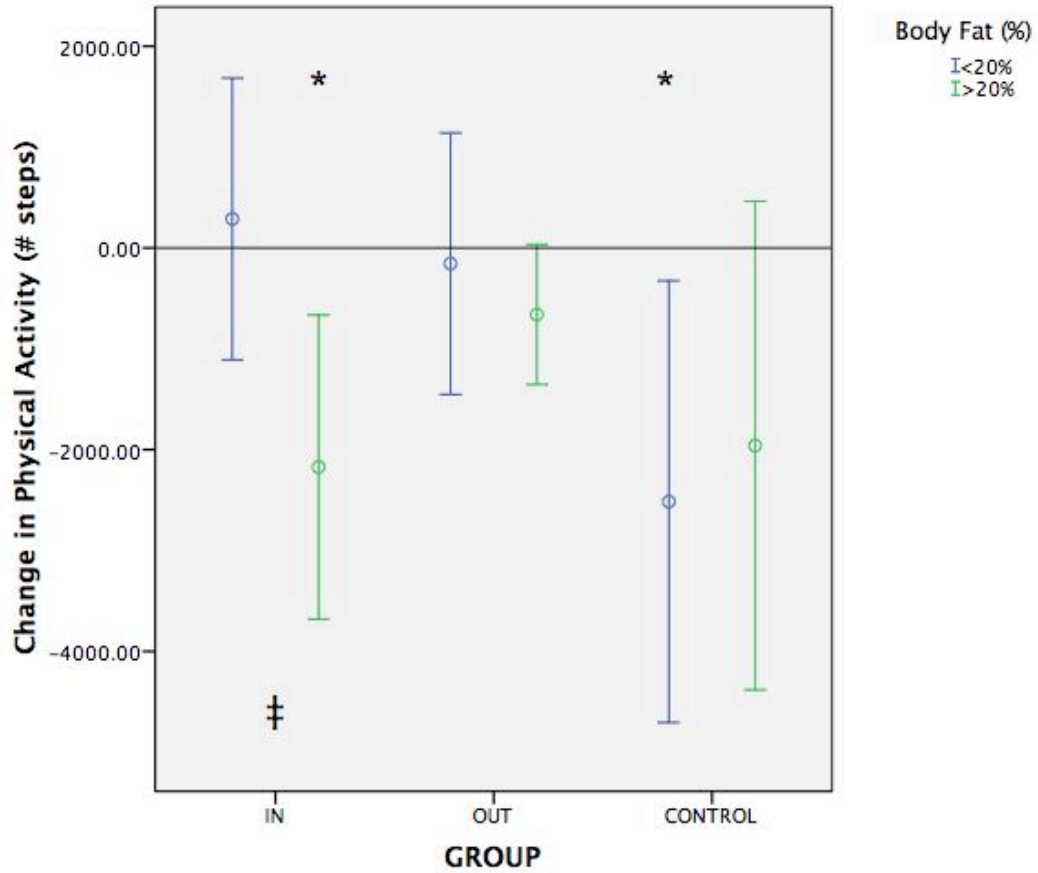
**Table 9 - Relationship between PSDQ variables and corresponding health-related fitness parameters.**

PSDQ VARIABLE	HEALTH-RELATED FITNESS PARAMETER	SPEARMAN'S CORRELATION COEFFICIENT	P-VALUE
Body Fat	Body Fat (%)	-0.555	<0.001
Endurance/Fitness	maxVO <sub>2</sub> (ml/kg/min)	0.723	<0.001
Strength	Aggregate Strength (# reps)	0.489	<0.001
Physical Activity	Mean Daily Step Count	0.007	0.949

**Table 10 - Relationship between PSDQ variables of GP and SE with main health-related fitness parameters.**

PSDQ VARIABLE		HEALTH-RELATED FITNESS PARAMETER			
		Body Fat (%)	maxVO <sub>2</sub> (ml/kg/min)	Aggregate Strength (# reps)	Mean Daily Step Count
General Physical Self Concept (GP)	Spearman r	-0.568	0.411	-0.035	0.454
	p-value	p<0.001	p<0.001	0.731	<0.001
Global Self-Esteem (SE)	Spearman r	-0.169	0.144	-0.073	0.132
	p-value	0.091	0.150	0.470	0.192

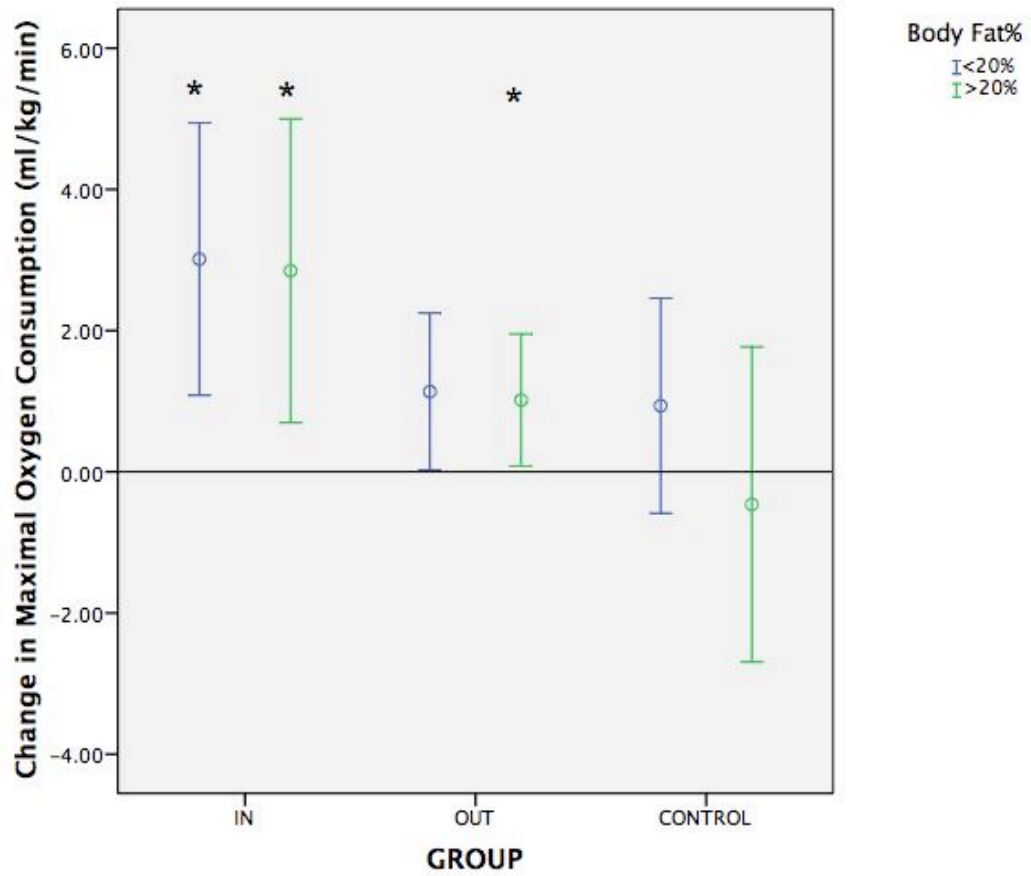
**Appendix L: Changes in physical activity, health-related fitness, body composition separated by group and body composition class.**



**Figure 14 - Mean (95% CI) change in physical activity by group and body fat category.**

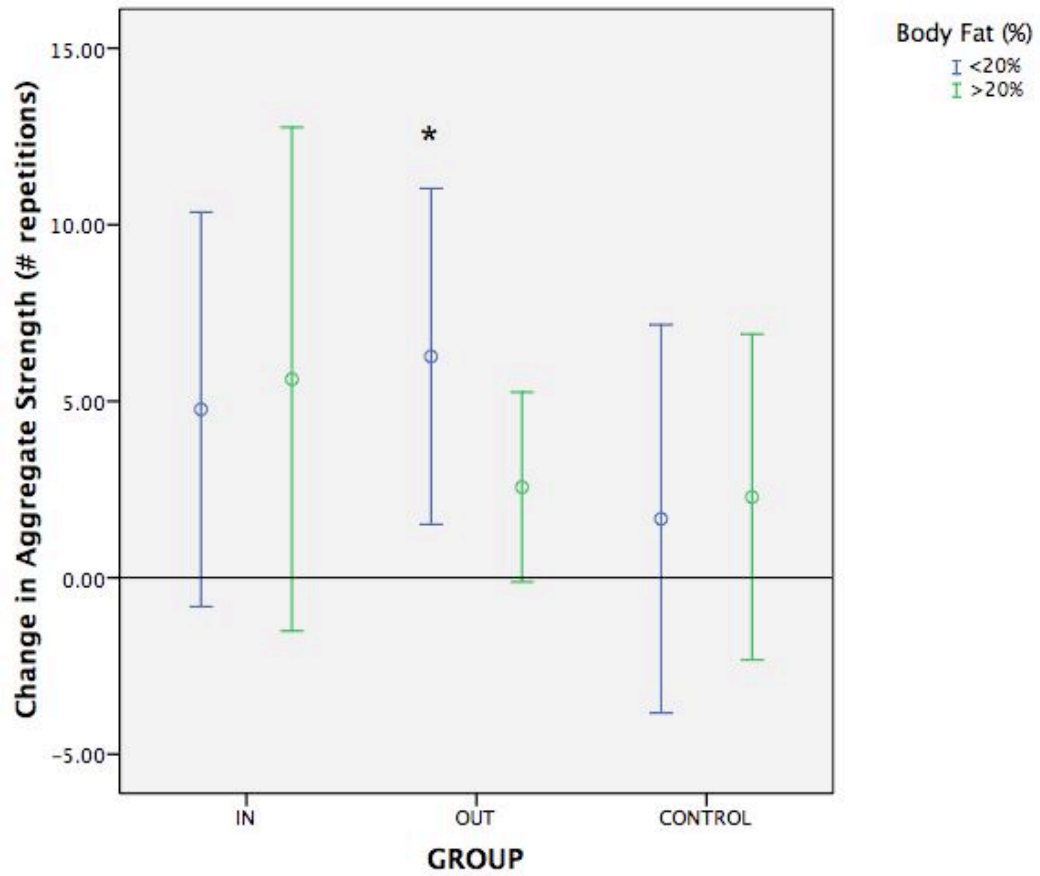
\*Significant mean difference for body fat group ( $p < 0.05$ ).

‡Significant mean difference between >20% and <20% ( $p < 0.05$ ).



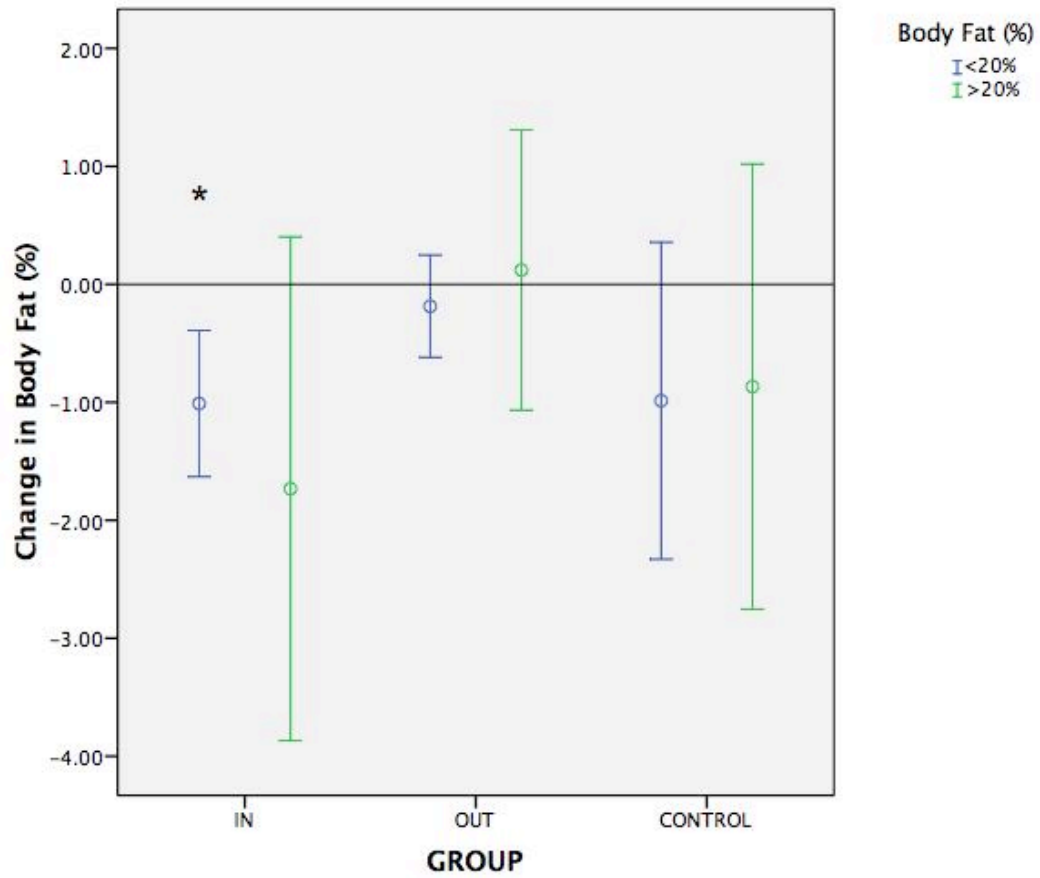
**Figure 15 - Mean (95% CI) change in maximal oxygen consumption by group and body fat category.**

\*Significant mean difference for body fat group (p<0.05).



**Figure 16 - Mean (95% CI) change in aggregate strength by group and body fat category.**

\*Significant mean difference for body fat group ( $p < 0.05$ ).



**Figure 17 - Mean (95% CI) change in body fat by group and body fat category.**

\*Significant mean difference for body fat group (p<0.05).

## Appendix M: Cardiovascular fitness tertile assessments.

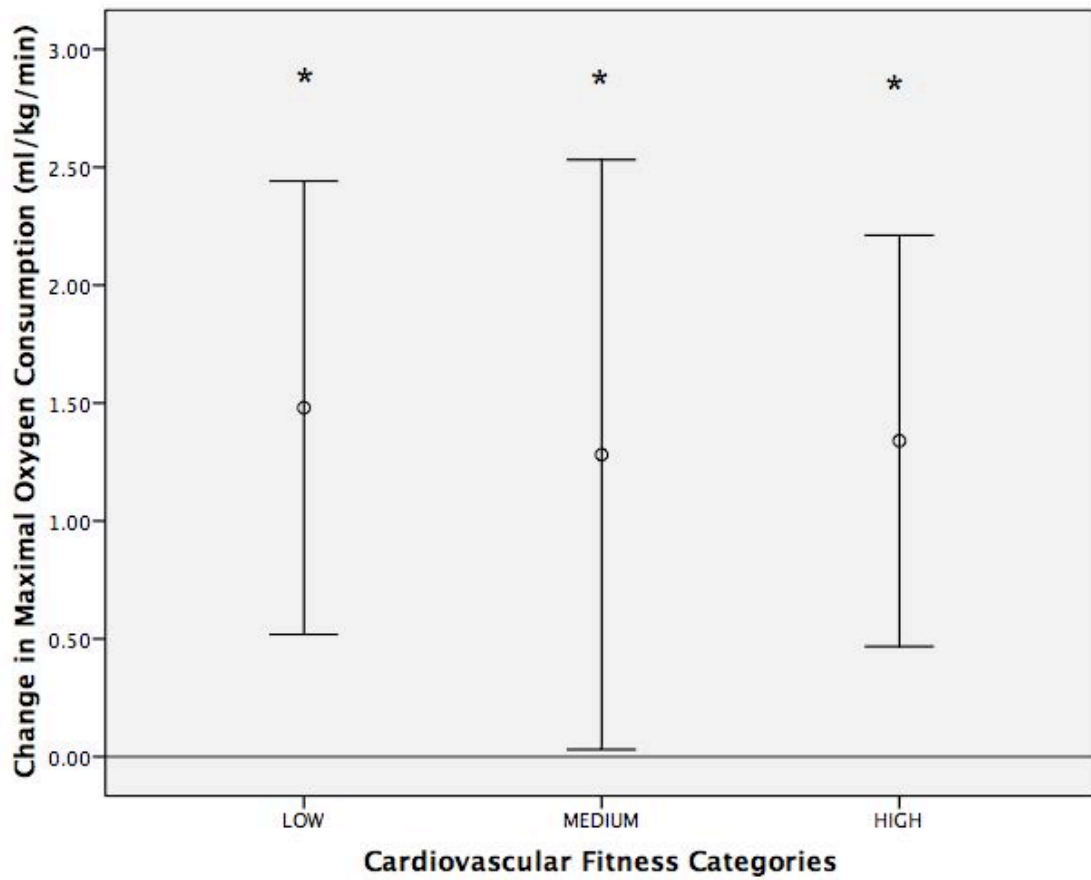
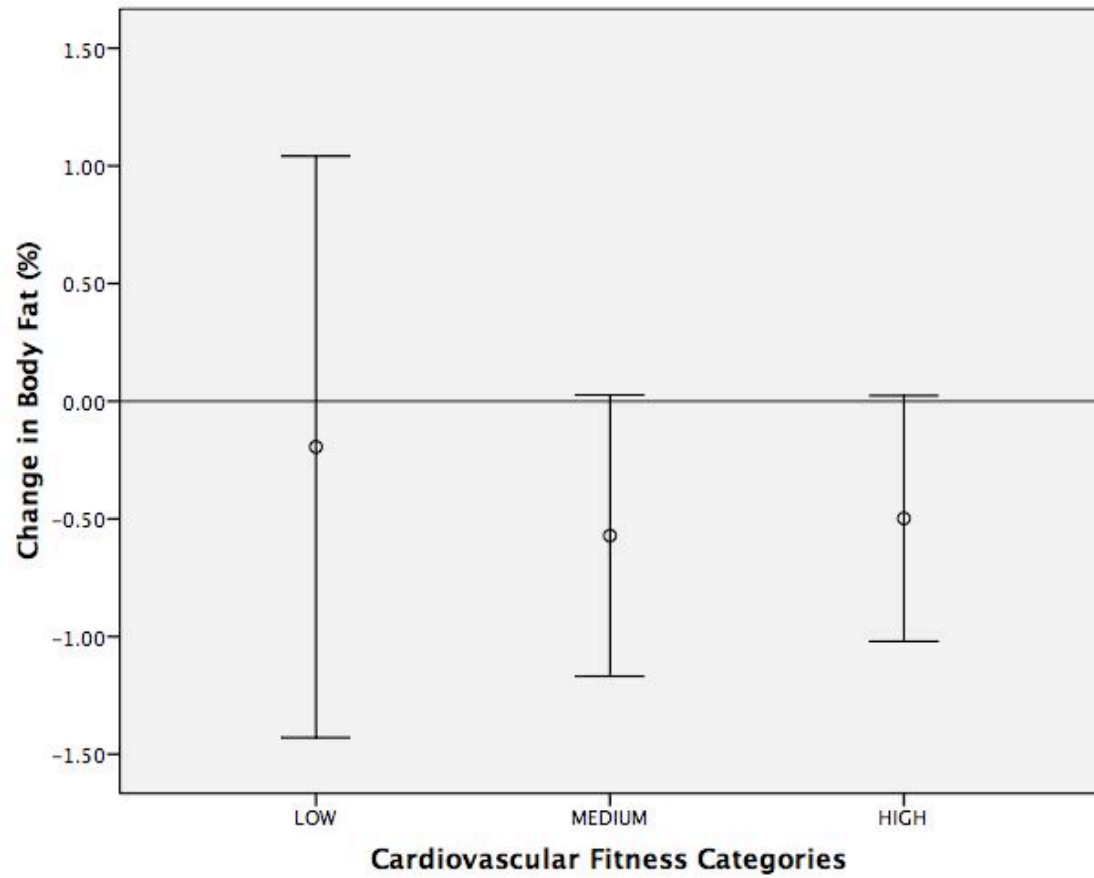


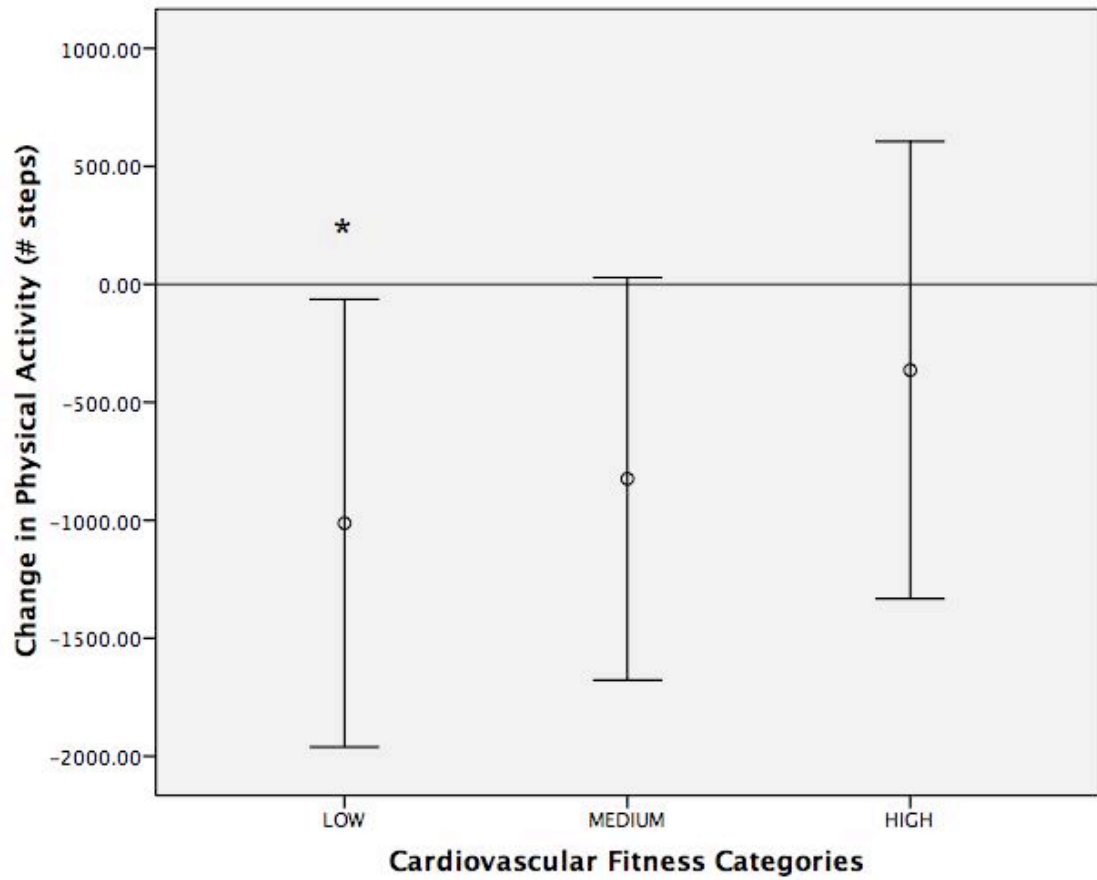
Figure 18 - Mean (95% CI) change in maxVO<sub>2</sub> by cardiovascular fitness tertile.

\*Mean difference is significant at 0.05.



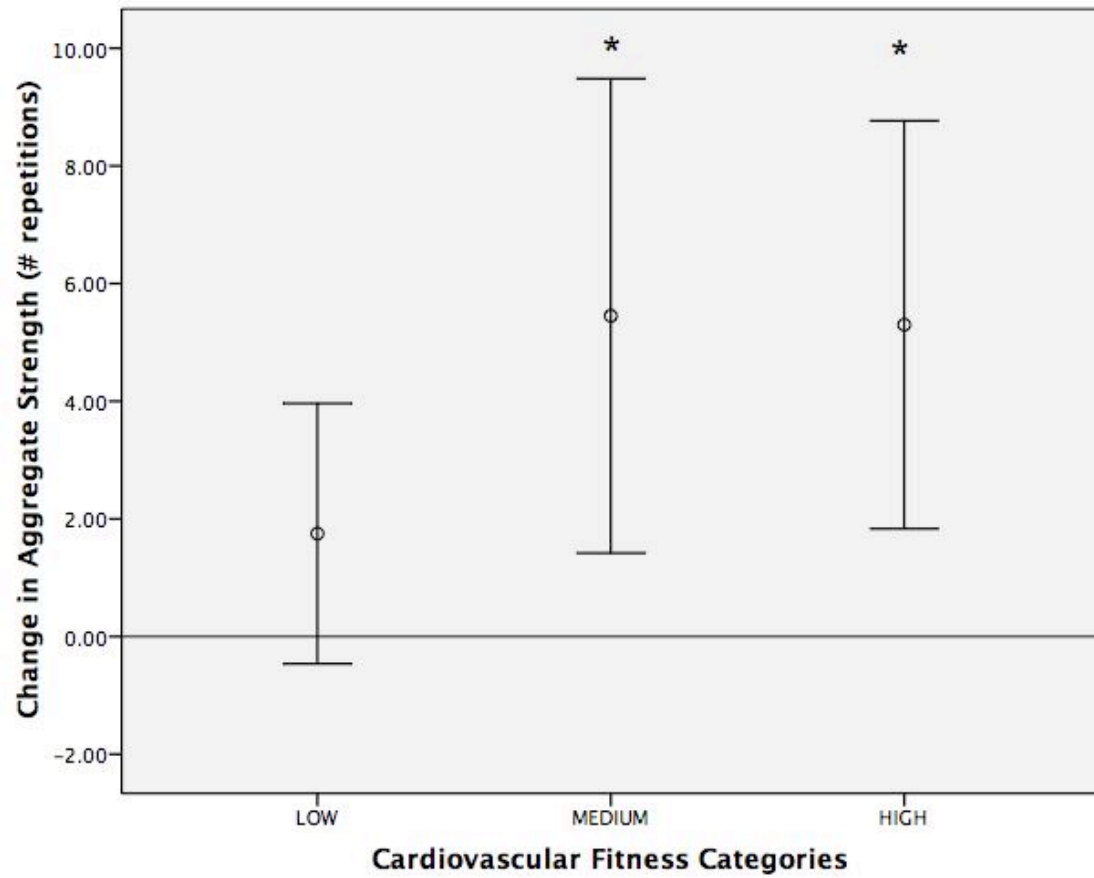


**Figure 19 - Mean (95% CI) change in body fat percentage by cardiovascular fitness tertile.**



**Figure 20 - Mean (95% CI) change in physical activity by cardiovascular fitness tertile.**

\*Mean difference is significant at 0.05.



**Figure 21 - Mean (95% CI) change in aggregate strength by cardiovascular fitness tertile.**

\*Mean difference is significant at 0.05.

## REFERENCES

- Ara, I., G. Vicente-Rodriguez, et al. (2004). "Regular participation in sports is associated with enhanced physical fitness and lower fat mass in prepubertal boys." International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity **28**(12): 1585-1593.
- Bailey, R. (2006). "Physical education and sport in schools: a review of benefits and outcomes." J Sch Health **76**(8): 397-401.
- Baquet, G., J. W. Twisk, et al. (2006). "Longitudinal follow-up of fitness during childhood: interaction with physical activity." Am J Hum Biol **18**(1): 51-8.
- Bayne-Smith, M., P. S. Fardy, et al. (2004). "Improvements in heart health behaviors and reduction in coronary artery disease risk factors in urban teenaged girls through a school-based intervention: the PATH program." American Journal of Public Health **94**(9): 1538-1543.
- Beets, M. W. and K. H. Pitetti (2005). "Contribution of physical education and sport to health-related fitness in high school students." The Journal of school health **75**(1): 25-30.
- Bender, J. M., R. C. Brownson, et al. (2005). "Children's physical activity: using accelerometers to validate a parent proxy record." Medicine and science in sports and exercise **37**(8): 1409-1413.
- Bergeron, M. F. (2007). "Improving health through youth sports: is participation enough?" New Dir Youth Dev(115): 27-41, 6.
- Canadian Fitness and Lifestyle Research Institute (2004). 2004 Physical Activity Monitor. Canadian Fitness and Lifestyle Research Institute. Ottawa, Ontario.
- Canadian Fitness and Lifestyle Research Institute (2005). 2005 Physical Activity Monitor. Canadian Fitness and Lifestyle Research Institute. Ottawa, Ontario.
- Cardinal, B. J. (2001). "Role modeling attitudes and physical activity and fitness promoting behaviors of HPERD professionals and preprofessionals." Research quarterly for exercise and sport **72**(1): 84-90.
- Carrel, A. L., R. R. Clark, et al. (2005). "Improvement of fitness, body composition, and insulin sensitivity in overweight children in a school-based exercise program: a randomized, controlled study." Archives of Pediatrics & Adolescent Medicine **159**(10): 963-968.
- Caspersen, C. J., M. A. Pereira, et al. (2000). "Changes in physical activity patterns in the United States, by sex and cross-sectional age." Med Sci Sports Exerc **32**(9): 1601-9.
- Centers for Disease, C. and Prevention (2004). "Participation in high school physical education--United States, 1991-2003." MMWR.Morbidity and mortality weekly report **53**(36): 844-847.
- Centers for Disease, C. and Prevention (2007). "Participation in high school physical education--Ontario, Canada, 1999-2005." MMWR.Morbidity and mortality weekly report **56**(3): 52-54.
- Chad, K. E., M. L. Humbert, et al. (1999). "The effectiveness of the Canadian Quality Daily Physical Education program on school physical education." Research quarterly for exercise and sport **70**(1): 55-64.

- Coatsworth, J. D. and D. E. Conroy (2007). "Youth sport as a component of organized afterschool programs." New Dir Youth Dev(115): 57-74, 7-8.
- Daley, A. J. and J. Ryan (2000). "Academic performance and participation in physical activity by secondary school adolescents." Percept Mot Skills **91**(2): 531-4.
- Daniels, S. R. (2006). "The consequences of childhood overweight and obesity." The Future of children / Center for the Future of Children, the David and Lucile Packard Foundation **16**(1): 47-67.
- Dexter, T. (1999). "Relationship between sport knowledge, sport performance and academic ability: empirical evidence from GCSE Physical Education. General Certificate of Secondary Education." J Sports Sci **17**(4): 283-95.
- Dishman, R. K., R. W. Motl, et al. (2004). "Self-efficacy partially mediates the effect of a school-based physical-activity intervention among adolescent girls." Preventive medicine **38**(5): 628-636.
- Dishman, R. K., R. W. Motl, et al. (2005). "Enjoyment mediates effects of a school-based physical-activity intervention." Medicine and science in sports and exercise **37**(3): 478-487.
- Doak, C. M., T. L. Visscher, et al. (2006). "The prevention of overweight and obesity in children and adolescents: a review of interventions and programmes." Obesity reviews : an official journal of the International Association for the Study of Obesity **7**(1): 111-136.
- Donaldson, S. J. and K. R. Ronan (2006). "The effects of sports participation on young adolescents' emotional well-being." Adolescence **41**(162): 369-89.
- Dowda, M., R. K. Dishman, et al. (2009). "Commercial facilities, social cognitive variables, and physical activity of 12th grade girls." Ann Behav Med **37**(1): 77-87.
- Dunton, G. F., M. Schneider, et al. (2007). "Factors predicting behavioral response to a physical activity intervention among adolescent females." American Journal of Health Behavior **31**(4): 411-422.
- Edg, E. J., D. Bishop, et al. (2006). "Comparison of muscle buffer capacity and repeated-sprint ability of untrained, endurance-trained and team-sport athletes." Eur J Appl Physiol **96**(3): 225-34.
- Esliger, D. W. and M. S. Tremblay (2007). "Physical activity and inactivity profiling: the next generation." Can J Public Health **98 Suppl 2**: S195-207.
- Ewart, C. K., D. R. Young, et al. (1998). "Effects of school-based aerobic exercise on blood pressure in adolescent girls at risk for hypertension." American Journal of Public Health **88**(6): 949-951.
- Faigenbaum, A. D., J. E. McFarland, et al. (2007). "Preliminary evaluation of an after-school resistance training program for improving physical fitness in middle school-age boys." Percept Mot Skills **104**(2): 407-15.
- Faigenbaum, A. D., J. E. McFarland, et al. (2007). "Preliminary evaluation of an after-school resistance training program for improving physical fitness in middle school-age boys." Perceptual and motor skills **104**(2): 407-415.
- Fairclough, S. and G. Stratton (2005). "'Physical education makes you fit and healthy'. Physical education's contribution to young people's physical activity levels." Health education research **20**(1): 14-23.

- Fairclough, S. and G. Stratton (2005). "'Physical education makes you fit and healthy'. Physical education's contribution to young people's physical activity levels." Health Educ Res **20**(1): 14-23.
- Felton, G., R. P. Saunders, et al. (2005). "Promoting physical activity in girls: a case study of one school's success." The Journal of school health **75**(2): 57-62.
- Field, T., M. Diego, et al. (2001). "Exercise is positively related to adolescents' relationships and academics." Adolescence **36**(141): 105-110.
- Fisher, M., L. Juszczak, et al. (1996). "Sports participation in an urban high school: academic and psychologic correlates." J Adolesc Health **18**(5): 329-34.
- Flohr, J. A., M. K. Todd, et al. (2006). "Pedometer-assessed physical activity in young adolescents." Res Q Exerc Sport **77**(3): 309-15.
- Garcia-Artero, E., F. B. Ortega, et al. (2007). "Lipid and metabolic profiles in adolescents are affected more by physical fitness than physical activity (AVENA study)." Revista espanola de cardiologia **60**(6): 581-588.
- Gilmer, M. J., B. J. Speck, et al. (1996). "The Youth Health Survey: reliability and validity of an instrument for assessing cardiovascular health habits in adolescents." J Sch Health **66**(3): 106-11.
- Gortmaker, S. L., K. Peterson, et al. (1999). "Reducing obesity via a school-based interdisciplinary intervention among youth: Planet Health." Archives of Pediatrics & Adolescent Medicine **153**(4): 409-418.
- Gutin, B., P. Barbeau, et al. (2002). "Effects of exercise intensity on cardiovascular fitness, total body composition, and visceral adiposity of obese adolescents." The American Journal of Clinical Nutrition **75**(5): 818-826.
- Haerens, L., I. De Bourdeaudhuij, et al. (2007). "School-based randomized controlled trial of a physical activity intervention among adolescents." The Journal of adolescent health : official publication of the Society for Adolescent Medicine **40**(3): 258-265.
- Hands, B. and H. Parker (2008). "Pedometer-determined physical activity, BMI, and waist girth in 7- to 16-year-old children and adolescents." J Phys Act Health **5 Suppl 1**: S153-65.
- Health Canada and the Canadian Society for Exercise Physiology (2002*ab*). Canada's physical activity guide for youth. Minister of Public Works and Government Services Canada. Ottawa, Ontario. **Cat. No. H39-611/2002-IE/2E**.
- Hoelscher, D. M., H. A. Feldman, et al. (2004). "School-based health education programs can be maintained over time: results from the CATCH Institutionalization study." Preventive medicine **38**(5): 594-606.
- Hortz, B. and R. Petosa (2006). "Impact of the "Planning to be Active" leisure time physical exercise program on rural high school students." The Journal of adolescent health : official publication of the Society for Adolescent Medicine **39**(4): 530-535.
- Hurtig-Wennlof, A., J. R. Ruiz, et al. (2007). "Cardiorespiratory fitness relates more strongly than physical activity to cardiovascular disease risk factors in healthy children and adolescents: the European Youth Heart Study." European journal of cardiovascular prevention and rehabilitation : official journal of the European Society of Cardiology, Working Groups on Epidemiology & Prevention and Cardiac Rehabilitation and Exercise Physiology **14**(4): 575-581.

- Jamner, M. S., D. Spruijt-Metz, et al. (2004). "A controlled evaluation of a school-based intervention to promote physical activity among sedentary adolescent females: project FAB." The Journal of adolescent health : official publication of the Society for Adolescent Medicine **34**(4): 279-289.
- Janssen, I. (2007). "Physical activity guidelines for children and youth." Canadian journal of public health.Revue canadienne de sante publique **98 Suppl 2**: S109-21.
- Janssen, I., P. T. Katzmarzyk, et al. (2004). "Waist circumference and not body mass index explains obesity-related health risk." The American Journal of Clinical Nutrition **79**(3): 379-384.
- Jiang, J., X. Xia, et al. (2007). "The effects of a 3-year obesity intervention in schoolchildren in Beijing." Child: care, health and development **33**(5): 641-646.
- Kang, H. S., B. Gutin, et al. (2002). "Physical training improves insulin resistance syndrome markers in obese adolescents." Medicine and science in sports and exercise **34**(12): 1920-1927.
- Katzmarzyk, P. T. and I. Janssen (2004). "The economic costs associated with physical inactivity and obesity in Canada: an update." Canadian journal of applied physiology = Revue canadienne de physiologie appliquee **29**(1): 90-115.
- Keays, J. J. and K. R. Allison (1995). "The effects of regular moderate to vigorous physical activity on student outcomes: a review." Canadian journal of public health.Revue canadienne de sante publique **86**(1): 62-65.
- Kirkcaldy, B. D., R. J. Shephard, et al. (2002). "The relationship between physical activity and self-image and problem behaviour among adolescents." Soc Psychiatry Psychiatr Epidemiol **37**(11): 544-50.
- Kohl, H. W., 3rd and K. E. Hobbs (1998). "Development of physical activity behaviors among children and adolescents." Pediatrics **101**(3 Pt 2): 549-554.
- Koutedakis, Y. and C. Bouziotas (2003). "National physical education curriculum: motor and cardiovascular health related fitness in Greek adolescents." British journal of sports medicine **37**(4): 311-314.
- Laurson, K. R., D. D. Brown, et al. (2008). "Heart rates of high school physical education students during team sports, individual sports, and fitness activities." Res Q Exerc Sport **79**(1): 85-91.
- Le Masurier, G. C., C. L. Sidman, et al. (2003). "Accumulating 10,000 steps: does this meet current physical activity guidelines?" Res Q Exerc Sport **74**(4): 389-94.
- Leary, S. D., A. R. Ness, et al. (2008). "Physical activity and blood pressure in childhood: findings from a population-based study." Hypertension **51**(1): 92-98.
- Leger, L. A., D. Mercier, et al. (1988). "The multistage 20 metre shuttle run test for aerobic fitness." Journal of sports sciences **6**(2): 93-101.
- Linver, M. R., J. L. Roth, et al. (2009). "Patterns of adolescents' participation in organized activities: are sports best when combined with other activities?" Dev Psychol **45**(2): 354-67.
- Liu, N. Y., S. A. Plowman, et al. (1992). "The reliability and validity of the 20-meter shuttle test in American students 12 to 15 years old." Research quarterly for exercise and sport **63**(4): 360-365.
- Lubans, D. R., P. J. Morgan, et al. (2008). "The Relationship Between Pedometer Step Counts and Estimated VO2Max as Determined by a Submaximal Fitness Test in Adolescents." Pediatr Exerc Sci **20**(3): 273-84.

- Lubans, D. R. and K. Sylva (2007). "Mediators of change following a senior school physical activity intervention." Journal of science and medicine in sport / Sports Medicine Australia.
- Macdonald, H. M., S. A. Kontulainen, et al. (2007). "Is a school-based physical activity intervention effective for increasing tibial bone strength in boys and girls?" J Bone Miner Res **22**(3): 434-46.
- Maffulli, N. and E. Pintore (1990). "Intensive training in young athletes." Br J Sports Med **24**(4): 237-9.
- Marsh, H. W. (1996). "Physical Self Description Questionnaire: stability and discriminant validity." Research quarterly for exercise and sport **67**(3): 249-264.
- Marsh, H. W., G. E. Richards, et al. (1994). "Physical Self-Description Questionnaire: Psychometric properties and a multitrait-multimethod analysis of relations to existing instruments." Journal of Sport and Exercise Psychology **16**(3): 270.
- McGarry, K. M. (2007). The effect of body composition on aerobic power in children. School of Medical Rehabilitation. Winnipeg, Manitoba. **Master of Science**.
- McGavock, J. M., B. Torrance, et al. (2007). "The relationship between weight gain and blood pressure in children and adolescents." American Journal of Hypertension : Journal of the American Society of Hypertension **20**(10): 1038-1044.
- McKenzie, T. L., P. R. Nader, et al. (1996). "School physical education: effect of the Child and Adolescent Trial for Cardiovascular Health." Preventive medicine **25**(4): 423-431.
- McKenzie, T. L., E. J. Stone, et al. (2001). "Effects of the CATCH physical education intervention: teacher type and lesson location." American Journal of Preventive Medicine **21**(2): 101-109.
- Melnick, M. J., D. F. Sabo, et al. (1992). "Educational effects of interscholastic athletic participation on African-American and Hispanic youth." Adolescence **27**(106): 295-308.
- Michaud, P. A., F. Narring, et al. (1999). "Sports activity, physical activity and fitness of 9- to 19-year-old teenagers in the canton of Vaud (Switzerland)." Schweiz Med Wochenschr **129**(18): 691-9.
- Neumark-Sztainer, D., M. Story, et al. (2003). "New Moves: a school-based obesity prevention program for adolescent girls." Preventive medicine **37**(1): 41-51.
- Neumark-Sztainer, D., M. Story, et al. (2003). "Factors associated with changes in physical activity: a cohort study of inactive adolescent girls." Archives of Pediatrics & Adolescent Medicine **157**(8): 803-810.
- Pate, R. R., M. Dowda, et al. (2007). "Change in physical activity participation among adolescent girls from 8th to 12th grade." J Phys Act Health **4**(1): 3-16.
- Pate, R. R., S. G. Trost, et al. (2000). "Sports participation and health-related behaviors among US youth." Archives of Pediatrics & Adolescent Medicine **154**(9): 904-911.
- Payne, V. G. and J. R. Morrow, Jr. (1993). "Exercise and VO2 max in children: a meta-analysis." Research quarterly for exercise and sport **64**(3): 305-313.
- Perry, A. C., E. S. Rosenblatt, et al. (2002). "The effects of an exercise physiology program on physical fitness variables, body satisfaction, and physiology knowledge." J Strength Cond Res **16**(2): 219-26.



- Phillips, J. A. and D. R. Young (2009). "Past-year sports participation, current physical activity, and fitness in urban adolescent girls." J Phys Act Health **6**(1): 105-111.
- Rimmer, J. H. and M. A. Looney (1997). "Effects of an aerobic activity program on the cholesterol levels of adolescents." Research quarterly for exercise and sport **68**(1): 74-79.
- Rodriguez, G., L. A. Moreno, et al. (2005). "Body fat measurement in adolescents: comparison of skinfold thickness equations with dual-energy X-ray absorptiometry." European journal of clinical nutrition **59**(10): 1158-1166.
- Sakuragi, S., K. Abhayaratna, et al. (2009). "Influence of adiposity and physical activity on arterial stiffness in healthy children: the lifestyle of our kids study." Hypertension **53**(4): 611-6.
- Sallis, J. F. and T. L. McKenzie (1991). "Physical education's role in public health." Research quarterly for exercise and sport **62**(2): 124-137.
- Sallis, J. F., T. L. McKenzie, et al. (2003). "Environmental interventions for eating and physical activity: a randomized controlled trial in middle schools." American Journal of Preventive Medicine **24**(3): 209-217.
- Sallis, J. F., T. L. McKenzie, et al. (1999). "Effects of health-related physical education on academic achievement: project SPARK." Research quarterly for exercise and sport **70**(2): 127-134.
- Sallis, J. F., T. L. Patterson, et al. (1988). "Relation of cardiovascular fitness and physical activity to cardiovascular disease risk factors in children and adults." Am J Epidemiol **127**(5): 933-41.
- Schiel, R., W. Beltschikow, et al. (2006). "Overweight, obesity and elevated blood pressure in children and adolescents." European journal of medical research **11**(3): 97-101.
- Schneider, M., G. F. Dunton, et al. (2007). "Impact of a school-based physical activity intervention on fitness and bone in adolescent females." Journal of physical activity & health **4**(1): 17-29.
- Sherwood, N. E., M. Wall, et al. (2009). "Effect of socioeconomic status on weight change patterns in adolescents." Prev Chronic Dis **6**(1): A19.
- Shiely, F. and C. MacDonncha (2009). "Meeting the international adolescent physical activity guidelines: a comparison of objectively measured and self-reported physical activity levels." Ir Med J **102**(1): 15-9.
- Shishebor, M. H., P. Gordon-Larsen, et al. (2008). "Association of neighborhood socioeconomic status with physical fitness in healthy young adults: the Coronary Artery Risk Development in Young Adults (CARDIA) study." Am Heart J **155**(4): 699-705.
- Simons-Morton, B. G., N. M. O'Hara, et al. (1990). "Children's frequency of participation in moderate to vigorous physical activities." Res Q Exerc Sport **61**(4): 307-14.
- Simons-Morton, B. G., W. C. Taylor, et al. (1994). "Observed levels of elementary and middle school children's physical activity during physical education classes." Prev Med **23**(4): 437-41.
- Skidmore, P. M. and J. W. Yarnell (2004). "The obesity epidemic: prospects for prevention." QJM : monthly journal of the Association of Physicians **97**(12): 817-825.

- Slaughter, M. H., T. G. Lohman, et al. (1988). "Skinfold equations for estimation of body fatness in children and youth." Human biology; an international record of research **60**(5): 709-723.
- Statistics Canada (2004). **2004**.
- Steptoe, A. and N. Butler (1996). "Sports participation and emotional wellbeing in adolescents." Lancet **347**(9018): 1789-92.
- Strong, W. B., R. M. Malina, et al. (2005). "Evidence based physical activity for school-age youth." The Journal of pediatrics **146**(6): 732-737.
- Swain, D. P. and B. A. Franklin (2006). "Comparison of cardioprotective benefits of vigorous versus moderate intensity aerobic exercise." The American Journal of Cardiology **97**(1): 141-147.
- Torrance, B., K. A. McGuire, et al. (2007). "Overweight, physical activity and high blood pressure in children: a review of the literature." Vascular health and risk management **3**(1): 139-149.
- Tremblay, M. S., P. T. Katzmarzyk, et al. (2002). "Temporal trends in overweight and obesity in Canada, 1981-1996." International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity **26**(4): 538-543.
- Tremblay, M. S. and J. D. Willms (2003). "Is the Canadian childhood obesity epidemic related to physical inactivity?" International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity **27**(9): 1100-1105.
- Trost, S. G., R. R. Pate, et al. (2002). "Age and gender differences in objectively measured physical activity in youth." Med Sci Sports Exerc **34**(2): 350-5.
- Trudeau, F. and R. J. Shephard (2008). "Is there a long-term health legacy of required physical education?" Sports Med **38**(4): 265-70.
- Trudeau, F. and R. J. Shephard (2008). "Physical education, school physical activity, school sports and academic performance." Int J Behav Nutr Phys Act **5**: 10.
- Tsunawake, N., Y. Tahara, et al. (2003). "Body composition and physical fitness of female volleyball and basketball players of the Japan inter-high school championship teams." J Physiol Anthropol Appl Human Sci **22**(4): 195-201.
- Tudor-Locke, C., R. P. Pangrazi, et al. (2004). "BMI-referenced standards for recommended pedometer-determined steps/day in children." Preventive medicine **38**(6): 857-864.
- Tudor-Locke, C., J. E. Williams, et al. (2002). "Utility of pedometers for assessing physical activity: convergent validity." Sports medicine (Auckland, N.Z.) **32**(12): 795-808.
- van Sluijs, E. M., A. M. McMinn, et al. (2007). "Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials." BMJ (Clinical research ed.) **335**(7622): 703.
- Wardle, J., N. H. Brodersen, et al. (2007). "School-based physical activity and changes in adiposity." Int J Obes (Lond) **31**(9): 1464-8.
- Whaley, M. H., L. A. Kaminsky, et al. (1992). "Predictors of over- and underachievement of age-predicted maximal heart rate." Medicine and science in sports and exercise **24**(10): 1173-1179.

- Wilde, B. E., C. B. Corbin, et al. (2004). "Free-Living Pedometer Step Counts of High School Students." Pediatr Exerc Sci **16**(1): 44-53.
- Wiles, N. J., G. T. Jones, et al. (2008). "Physical activity and emotional problems amongst adolescents : a longitudinal study." Soc Psychiatry Psychiatr Epidemiol **43**(10): 765-72.
- Wilson, D. K., A. E. Evans, et al. (2005). "A preliminary test of a student-centered intervention on increasing physical activity in underserved adolescents." Annals of Behavioral Medicine : A Publication of the Society of Behavioral Medicine **30**(2): 119-124.
- Wittmeier, K. D., D. J. Kriellaars, et al. (2008). "Physical activity intensity and risk of overweight and adiposity in children." Obesity (Silver Spring) **16**(2): 415-20.
- Wittmeier, K. D., R. C. Mollard, et al. (2007). "Objective assessment of childhood adherence to Canadian physical activity guidelines in relation to body composition." Applied physiology, nutrition, and metabolism = Physiologie appliquee, nutrition et metabolisme **32**(2): 217-224.
- Wong, S. L., S. T. Leatherdale, et al. (2006). "Reliability and validity of a school-based physical activity questionnaire." Medicine and science in sports and exercise **38**(9): 1593-1600.
- Young, D. R., J. A. Phillips, et al. (2006). "Effects of a life skills intervention for increasing physical activity in adolescent girls." Arch Pediatr Adolesc Med **160**(12): 1255-61.
- Young, D. R., J. A. Phillips, et al. (2006). "Effects of a life skills intervention for increasing physical activity in adolescent girls." Archives of Pediatrics & Adolescent Medicine **160**(12): 1255-1261.
- Zahner, L., T. Muehlbauer, et al. (2009). "Association of sports club participation with fitness and fatness in children." Med Sci Sports Exerc **41**(2): 344-50.
- Zahner, L., J. J. Puder, et al. (2006). "A school-based physical activity program to improve health and fitness in children aged 6-13 years ("Kinder-Sportstudie KISS"): study design of a randomized controlled trial [ISRCTN15360785]." BMC public health **6**: 147.