CHILDREN'S COMMUNITY-BASED GUIDED ACTIVE PLAY; INFLUENCE ON PHYSICAL ACTIVITY PARTICIPATION AND CARDIOVASCULAR RESPONSES

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A DISSERTATION SUBMITTED TO
THE FACULTY OF GRADUATE STUDIES
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

GRADUATE PROGRAM IN KINESIOLOGY AND HEALTH SCIENCE
YORK UNIVERSITY
TORONTO, ONTARIO

November 2021

ABSTRACT

It is well established that the decline in children's physical activity (PA) participation contributes to increases in the prevalence of paediatric obesity, risks for developing cardiovascular disease and decreases in physical fitness. PA interventions that are regimented and conducted in structured environments, such as laboratories, hospitals and school-based curricula, have shown to improve healthy PA behaviours and health-related fitness (i.e., health-enhancing PA). The increased costs and labour intensiveness of these programs have raised questions about their attractiveness in recreational/community summer camps and/or after-school settings. The importance of community-based programming where play (i.e., free play [FP], active play [AP], guided active play [GAP]) may provide increased opportunities for children to be active and facilitate social interactions should not be overlooked when considering children's PA participation. Previous studies have shown that in a simulated AP environment using cooperative games, children elicit a wide range of energy expenditures and percentage of time spent in moderate-to-vigorous PA (%MVPA). The overarching purpose of this dissertation was to use cooperative games in community summer camp programs for school-aged children to determine if select health PA behaviour outcomes (energy expenditure, intensity) and health-related fitness (blood pressure, aerobic fitness, body composition) improvements are associated with long-term GAP programs.

The major findings are that: 1) energy expenditure (EE) and %MVPA associated with children's GAP using cooperative games over an 8-week community summer camp are maintained and sufficient to improve blood pressure and estimated maximal oxygen consumption (VO_2max; Ch. 3.2); 2) following a shorter (5-wk) GAP program, school-aged

children showed statistically higher forearm vascular perfusion controlled by endothelial independent processes that preceded changes in estimated VO_2max (Ch. 3.3); and 3) during development, PA tracking over 1 year intervals were moderately high when assessed by GAP and using cooperative games (Ch. 3.1).

In conclusion, cooperative games within a longer-term community summer camp GAP program are effective in sustaining health-enhancing PA and improving school-aged children's health and fitness. PA participation over a one-year period for GAP using cooperative games is stable in children 5-12 years. A community camp that includes GAP programming with cooperative games seems to be an effective strategy to engage children in health-enhancing PA during time away from school (i.e., afterschool, weekends, summer).

ACKNOWLEDGEMENTS

I would like to express my most sincere gratitude and appreciation to everyone who has made this journey possible.

First and foremost, I would like to thank my supervisor Dr. Angelo Belcastro. I am forever appreciative for all that you have taught me. Your mentorship, guidance, and enthusiasm for this work have been inspiring to say the least. I am grateful to have had your kind spirit and positivity throughout my academic career. You have been incredibly understanding and have truly made my graduate study experience an unforgettable one—in the best way possible. Thank you for this opportunity, I hope I have done the research justice.

I wish to express my sincere thanks to Dr. Veronica Jamnik and Dr. Emilie Roudier—the members of my supervisory committee who have provided me with extensive personal and professional guidance and taught me a great deal about both scientific research and life in general. Thank you both for your kindness and support. Thank you also to all the members of my examining committee Dr. Alison Macpherson, Dr. Gordon Flett and Dr. Patricia Tucker for all your feedback and contribution to the completion of my doctoral degree.

I am grateful to all of those with whom I have had the pleasure to work with during this and other related projects.

> <u>Vascular Study:</u> This study was financially supported by the Faculty of Health Research Grant Program. A special thank you goes to Dr. Agnes Vinet from the University of Avignon for all your guidance, support and expertise in the field of cutaneous microvascular perfusion. Thank you to Dr. Olivier Birot for generously providing us with the Laser Doppler Imaging equipment. Thank you to Dr. Heather Edgell for your input and expertise in vascular function. Thank you to Christopher Morrisey for your support and help with the data collection set up and to our student volunteer Geoffrey Sem for your help with data collection.
>
> <u>Adaptation Study:</u> Thank you to Shameeza Allard for your involvement in working with the children and helping with the data collection.
>
> <u>Tracking Study:</u> Thank you to the students involved in working with the children and helping collect the data—Urooj Taqvi, Erran Lee and Caitlin Lee.
>
> <u>Pilot Studies:</u> Thank you to Mike M, Donya M, Negin M, Christian N, Faith B, and Samantha F for all your help with the children during Kinkids and your involvement in the data collection process.

Our studies would not be possible without the help of our 100+ Kinesiology student volunteers that helped us with our guided active play—Kinkids program throughout the years, thank you to each of you that were involved.

A special thank you goes to the community centre directors Jasmine Surkari and Tamasha Grant at the Driftwood Community Centre and Franciso Vidal, Giancarlo Pflucker and the Teach2Learn organizers at the Centre for Spanish Speaking People Community Camp Program for their partnership and support of this research. Thank you also to all the parents that accepted to be a part of the studies and appreciated the value of our guided active play program.

The biggest thank you goes to all the adorable children that made my research experience the most rewarding. I cannot explain the feeling I get when I walk into the gym and see all the children running towards me in excitement, thank you for always making me feel so special.

The completion of my dissertation could not have been accomplished without the moral support of my closest friends. To Abhishek, Aisan, Ardavan, Aurash, Helin, Kayvon, Kristina, Shirin and Wamika—you may not know this but each of you have contributed to me getting to this stage of my life. I'm forever grateful that you all, in your own way, have guided me, helped me stay grounded and made my life so enjoyable.

A heartfelt thanks goes to my wonderful parents Behnam and Mercedeh, who have supported me in every way possible, thank you for your unconditional love and unwavering support. You both have been there for me during the highs and lows and I'm deeply appreciative of the sacrifices you have made that led me to this point of my career. To my mini-me/little sister/junior-sous-chef-at-a-fancy-fine-dining-restaurant Darya, I'm proud of all that you have accomplished and love you with everything that I am, thank you for always being there for me and for picking a career path that benefits my appetite. May you always make me yummy fancy food.

And finally, to my late grandfather, I thank you for your contagious laughter, fun-loving spirit, kind soul and charming ways, it was a blessing to have ever even known you. Thank you for all the memories, I promise to do my best to keep your happy spirit alive on this side of the world. My hero, my sensei, my grandfather, my pedar joon, to you I dedicate this dissertation. May your soul rest in paradise my love. Until we meet again…

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LIST OF ACRONYMS *(listed alphabetically)*

ACC	Accelerometer
ACH	Acetylcholine
ANCOVA	Analysis of covariance
ANOVA	Analysis of variance
ANTHRO	Anthropometric
AUC	Area under the curve
BL	Baseline
BP	Blood pressure
BMI	Body mass index
CV	Cardiovascular
CVD	Cardiovascular disease
COFF	Coefficient
CVC	Cutaneous vascular conductance
DBP	Diastolic blood pressure
ED	Endothelial dependent
EI	Endothelial independent
EE	Energy expenditure
EPOC	Excess post-exercise oxygen consumption
FU-1	Follow up year 1
FU-2	Follow up year 2
FITT	Frequency, intensity, time and type
GAP	Guided active play
HR	Heart rate
HDL	High density lipoprotein
HIIT	High intensity interval training
LDPI	Laser Doppler Perfusion Imaging
LDL	Low density lipoprotein
HRmax	Maximal heart rate
VO_2max	Maximal oxygen consumption
MET	Metabolic equivalent(s)
MPA	Moderate physical activity
MVPA	Moderate to vigorous physical activity
MSRT	Multistage 20 metre shuttle run test
NO	Nitric oxide
NW	Normal weight
OW	Overweight
VO_2peak	Peak oxygen uptake
PedsQL	Pediatric Quality of Life Questionnaire

% Diff	Percent difference (%Diff=(post-pre)*100)
%CV	Percentage of coefficient of variation
%LPA	Percentage of time spent in light activity
%MPA	Percentage of time spent in moderate physical activity
%MVPA	Percentage of time spent in moderate to vigorous physical activity
%Sed	Percentage of time spent in sedentary activity
%VPA	Percentage of time spent in vigorous physical activity
PA	Physical activity
PARQ+	Physical Activity Readiness Questionnaire
PEH	Post-exercise hypotension
HRr	Resting heart rate
SNP	Sodium nitroprusside
SD	Standard deviation
SEE	Standard error of estimate
SPSS	Statistical Package for the Social Sciences
SBP	Systolic blood pressure
VPA	Vigorous physical activity
WC	Waist circumference

LIST OF MEASUREMENT AND SYMBOL ABBREVIATIONS *(listed alphabetically)*

~	approximate number
pu	arbitrary perfusion unit(s)
bpm	beats per minute
cm	centimetre(s)
r^2	Coefficient of determination
k	Cohen's Kappa statistic
$cnts \cdot 10s^{-1}$	counts per 10 seconds
$d \cdot wk^{-1}$	days per week
^{o}C	degrees Celsius
g	gram(s)
$hr \cdot d^{-1}$	hour per day
kcal	kilocalories
$kcal \cdot camp^{-1}$	kilocalories for the entire during of the camp
$kcal \cdot min^{-1}$	kilocalories per minute
$kcal \cdot session^{-1}$	kilocalories per session
$kcal \cdot wk^{-1}$	kilocalories per week
$kg \cdot ht^2$	kilogram per height squared
kg	kilogram(s)
$kg \cdot m^2$	kilograms per metres squared
$kJ \cdot kg^{-1} \cdot day^{-1}$	kilojoules per kilogram per day
$km \cdot h^{-1}$	kilometres per hour
µL	microliter(s)
µA	microampere (microamps)
mm	millimeter(s)
mmHg	millimeters of Mercury
$mL \cdot kg^{-1} \cdot min^{-1}$	milliliters per kilogram per minute
$mL^{-1} \cdot min^{-1}$	milliliters per minute
min	minute(s)
$min \cdot d^{-1}$	minutes per day
p	p level
r	Pearson product moment correlation
%	percent
pu·mmHg	perfusion per millimetres of Mercury
n	sample size
sec	second

rho	Spearman rank order correlation
w	watts
yr	year(s)

CHAPTER 1: INTRODUCTION

FOREWARD TO THE THESIS

This thesis is organized as three separate manuscripts as described below, preceded by an introductory set of chapters including; a general introduction, a review of literature, a list of objectives and hypotheses for each study, and descriptions of common methodologies across each of the studies. The manuscripts are followed by an executive summary, limitations and solutions, knowledge translation and comments regarding future research in the field. The thesis concludes with a detailed list of references and appendices relevant to the program.

The thesis consists of the following three manuscripts:

1. Tracking Children's Physical Activity Participation During Guided Active Play;
2. Children's Physiological Adaptations to a Cooperative Games-based Guided Active Play Community Program;
3. Short-Term Vascular Responses to Children's Guided Active Play.

1.1 GENERAL INTRODUCTION

It is well established that regular physical activity (PA) at moderate-to-vigorous PA (MVPA) intensities is associated with more favourable markers of cardiovascular and metabolic health along with reducing the risk factors and prevalence of childhood obesity (69, 75). Previous studies have shown that higher levels of MVPA are associated with a lower likelihood of developing elevated cardiometabolic risk factors including; significantly reduced waist circumference (WC), fasting triglycerides, diastolic blood pressure (DBP) and higher values of high-density lipoprotein (HDL) cholesterol (75). It was also shown that vigorous intensity activities (VPA) can confer cardio-protective benefits through improving aerobic power, blood pressure and lowering percent body fat (69). To achieve these health-related fitness benefits, Canadian children between the ages of 5 and 17 years are recommended to accumulate at least 60 minutes of moderate to vigorous intensity PA (MVPA) daily, VPA, and activities that strengthen muscle and bone at least 3 days per week (181). However, according to results from the Canadian Health Measures Survey, only 9 percent of Canadian children and youth meet the daily recommendation of at least 60 minutes of MVPA (40). These findings are alarming as it demonstrates that the health and fitness status of Canadian children are deteriorating and contributing to an increase in the prevalence of paediatric obesity, an increased risk for developing chronic disease, and a decrease in physical fitness (cardiorespiratory, muscular strength, and flexibility) (27, 52, 110, 170). The importance of these childhood behaviours and outcomes should not be overlooked since risk factors and protective behaviours may track into adolescence, youth and adulthood (10, 79, 93).

To expand the time and opportunities for children to be physically active, the development of play-based PA programs in community settings, summer camps and during afterschool time has been suggested to be an important component to supporting positive growth and developmental outcomes, such as physical health, psychosocial health, physical abilities and academic performance (86). Several play-based approaches used for children's PA programs are available, these include: a) free-play - unstructured activities with no instruction and few targeted goals or outcomes: b) active play - self-paced, unstructured fun activities with minimal instruction while encouraging increased energy expenditure (EE) and percentage of time spent in moderate to vigorous physical activity (%MVPA) for the majority of time with specified outcomes; and c) professionally-led play programs with complex structured targets/goals and outcomes (38, 58, 87, 186). Findings from these studies demonstrate that children's levels of PA for free play and professionally led instruction programs are lower than for active play programs. Moreover findings from these play-based programs show little or no improvements in maximal aerobic power for children due to the lower total PA levels and a lack of MVPA intensity (14, 92, 174). It has been suggested that active play, with its higher levels of physical activity, more MVPA and less sedentary time may be the preferred play-based approach for preschool and school-aged children (2, 53, 60, 87, 99). Several reports demonstrate that community-based active play interventions (6-12 weeks) are associated with improved psychosocial and motor skill responses of children and adolescents (87, 103, 186). Adaptations of health-related cardiovascular and muscle fitness for school-aged children participating in a summer camp active play or guided/facilitated active play (GAP) program is less certain and requires further investigation (28). Whether children participating in freely chosen self-paced active play and/or GAP can achieve and sustain the total amount of PA and intensity over weeks and months in community summer camp programs is not available in the literature. Finally, the attractiveness of a self-paced GAP program throughout childhood and adolescence (5-12 years) is unknown.

1.2 LITERATURE REVIEW

1.2.1. Relationship Between Physical Activity and Health-Related Risk Factors During Child Development

The relationship between children's PA characteristics (i.e., total amount of PA and %MVPA) and biomarkers of adiposity and cardiovascular disease show weak associations

(78). Specifically, of the biomarkers assessed in a multi-level modelling analysis, including fasting glucose, fasting insulin, homeostats model of assessment – insulin resistance, total cholesterol, triglycerides, high density lipoprotein (HDL), low density lipoprotein (LDL), HDL/total cholesterol ratio, apolipoprotein A-1, apolipoprotein B, and total adiponectin only the relationship between apolipoprotein A-1 and %MVPA was significant (r=0.63) and only after the children's age and BMI were partitioned out (33). It was reported that for Finnish children (4-6 years) the amount and intensity of physical activity (PA) correlated weak-to-fair with CVD risk factors, such as the concentration of total serum cholesterol, HDL cholesterol, HDL/total cholesterol ratio, triglycerides, systolic blood pressure (SBP) and BMI (159). Furthermore, the relationships between PA and specific CVD risk factors were not consistent and varied by age, gender and the type of PA. For the 24 BMI correlations determined over three age ranges (4-7 years), for boys and girls and the four PA conditions (playing indoors, playing outdoors, low-activity PA and high-activity PA) only two were significant; girls at 4 years with low-level PA (r=0.24) and girls at 5 years with playing indoors (r=0.29). Of the remaining 22 correlations, none were deemed significant, and Pearson Product (r) relationships ranged from 0.01 to 0.19. In regard to blood pressure, there were no significant relationships across gender, age and PA for diastolic BP ($p>0.05$); whereas for PA and systolic BP only the boys and only at 5 years were there significant correlations identified (r from -0.32 to 0.25). Sporadic results were also observed for total and HDL cholesterol, HDL/total cholesterol ratio and triglyceride concentrations (159). It has been suggested that the large variations noted with cross-sectional studies among cardiovascular health, physical fitness and physical activity for children might contribute to the weak relationships (133). Specifically, the large variation and poor stability (i.e. tracking) of PA levels during childhood and adolescence has been suggested to contribute to our lack of understanding of PA and CVD risk factors during development (16, 167, 179). Although it is well documented that the proportion of children participating in the recommended amount of PA is decreasing throughout the paediatric years (5-19 years) (42); in recent years, our understanding of children's PA behaviours in different settings has been challenged (17, 43, 67, 184). Despite the quantification of PA with accelerometry, specific challenges with defining wear times (i.e., number of hours assessed; number of days assessed), averaging data, and the nature of the physical activity have all been identified as confounding variables (29, 127).

Another major factor that may contribute to this uncertainty is the environment in which PA has been assessed (83). Generally, identification (and quantification) of PA across different venues and/or formats (from organized and/or unorganized camp-like structured programs; school programs, and free play opportunities both indoors and/or outdoors) are inconsistent (19, 78). Much of the inconsistency in PA levels are known to be affected by PA settings, measurement and assessment protocols (30). Although motion sensors (accelerometers), alone or in combination with other physiological sensors, have been suggested to be the 'gold standard' (173, 183), several factors impact the quantification of PA, including: i) use of accelerometers from different manufactures (54); ii) varying data capture times (epochs ranging from 1 second to 1 minute) (26); iii) choice of accelerometers outputs (i.e., single axis, vector, total volume of PA) (54); and, iv) the nature of PA activity (paced vs self-paced) (123). Large variations (5-40%) in PA levels for children's activities of daily living have been reported for estimated EE and/or metabolic equivalencies (MET) (5, 46). As well, the use different of instruments/methodologies (i.e., self-report surveys, observational techniques and/or motion sensors) to quantify PA pose a challenge to determine PA stability over the childhood years (157). In light of these many challenges, it is not surprising that the relationships between PA and CVD risk factors during childhood and adolescents are weak and/or inconsistent.

Since the relationships between PA and CV health during children's development is important, it has been suggested that quantifying children's PA participation in an environment that provides a stable setting (i.e. shows strong tracking statistics) might be a good strategy to positively promote/influence health status during adolescence and youth (160, 187). Whether GAP formats using cooperative games are stable for the total amount of PA and PA intensity levels during childhood is unclear. Therefore, the importance of identifying a play-based PA format that is stable or shows strong tracking characteristics for school-aged children cannot be overstated.

Over the past several years a renewed focus on the value and importance of children having fun, playing age-appropriate games (i.e., active play) has been suggested as a means to improve PA participation during childhood and adolescence (63). To better understand the developmental relationships between PA and CV health it is important to assess PA participation in an environment that promotes positive PA behaviours while reducing the negative influences. In this way, the large variations noted for PA in other settings (i.e., indoor vs outdoor playing; organized vs unorganized formats; low vs high intensity) should be minimized. Whether providing a standard PA format (guided active play) over children's developmental period will contribute to improving the weak and inconsistent relationships reported for PA and CVD risk factors during childhood is unknown. Therefore, determining relationships between children's PA, in a guided active play format, and CV health over time (tracking) would not only expand our understanding of the developmental changes for each variable, but also provide a better understanding of the nature of the relationship between PA and CV health for children.

1.2.2. Children's Physical Activity and Cardiovascular Responses to Guided Active Play

Children's physiological and cardiovascular adaptations to structured endurance exercise and/or training programs in a laboratory setting using treadmill and/or cycle ergometer exercise have reported improvements for VO_2peak, aerobic fitness, blood pressure and metabolic variables (lipids, glucose) when working at 80-90% of the children's HRmax for at least 20 minutes in a program ranging from 6 to 12 weeks (18, 105, 113, 117). By definition, play is often unstructured and can occur indoors and/or outdoors with limited reports available on physiological adaptations to play-based community summer day camp programs (71, 86). Although previous research showing that children (9–11 years) can elicit significant increases in MVPA during an active play session (28), it is important to understand that unlike adults, children's PA movement patterns are characterized by short bouts of intensive exercise rather than prolonged continuous exercise with rapid changes from rest to VPA (9, 97). It has been hypothesized that there is greater value in PA programs that include short term, high intensity, intermittent aerobic training (HIIT) in regards to improving the health and fitness of children (51, 97). Partial support for this hypothesis exists showing that HIIT can improve aerobic performance and anaerobic capacity in children when children's games are introduced into a training program in combination with running and circuit training (97). It is questionable if the improvements seen in aerobic power and other measures of health and fitness for children would occur when they participate in self-paced GAP offered in community programming. Furthermore, it was suggested that the volume of PA and safety considerations required for children's HIIT programs are lacking in the literature (37).

1.2.3. Physical Activity and Vascular Function During Development

The rates of childhood obesity, pre-hypertension (i.e., high blood pressure) and pre-diabetes are growing due to the decline in physical activity participation. Moreover, the higher blood pressure associated with poor vascular (blood flow) function are also reflected in a sedentary lifestyle and/or overweight/obesity for children and young adults (94). Although many genetic and lifestyle factors underline these trends, the worldwide decline in PA participation rates for children and young adults have been implicated in the decline in vascular health (17). Vascular function in school aged children over a range of health and fitness status has not been widely studied. Most of these studies (125, 193) report the changes in vascular function with obesity and/or severe CVD; however, the relationship of physical activity participation to the endothelial control of microvascular function in children with low and high fitness status is uncertain.

Endothelial dysfunction is a globalized systemic disease process consisting of attenuated endothelium-dependent vasodilation, augmented vasoconstriction, and micro vessel structural remodeling that occurs simultaneously in multiple vascular beds (1). Pathology-induced vascular dysfunction (including impaired endothelium-dependent vasodilation) is evident in the cutaneous circulation (35, 76) and may mirror generalized systemic vascular dysfunction in magnitude and underlying mechanisms (1, 80, 171).

Remodeling of vasculature and an attendant loss of endothelial-derived vasodilators, including nitric oxide (NO), may be the earliest pathological finding associated with CVD (41, 101, 151). Impaired endothelial function and arterial wall stiffness has recently been identified in obese children and adolescents (135, 193, 198). A study comparing dietary intervention alone to diet plus exercise demonstrated that overweight and obese children aged 9-12 years exhibit vascular dysfunction that is partially reversible at 6 weeks with dietary modification and particularly with a combination of diet and exercise (141). At 12 months, however, vascular function further improved only in those children undertaking exercise training in addition to dietary modification, highlighting the importance of exercise relative to diet in terms of vascular function. A recent exercise training study for obese children and adolescents showed improvements in training-induced endothelial function but did not change plasma lipids, blood pressure, blood insulin or glucose levels, suggesting the exercise training program had a direct beneficial effect on vasculature, likely secondary to repetitive increases in shear stress (66, 107). As a result, interventions such as exercise training, which improve endothelial-dependent NO-mediated vasodilator function, may therefore be cardioprotective (193). Further treatment of endothelial dysfunction using structured exercise programs may also represent a novel primary prevention strategy in children or adolescents who are at elevated risk for development of cardiovascular disease in later life (141).

The study of children's vascular function has expanded in recent years since the cutaneous circulation has emerged as an accessible and potentially representative vascular bed to examine the mechanisms of microcirculatory function and dysfunction (1, 35, 77, 81, 162, 174). Furthermore, minimally invasive skin-specific methodologies make the cutaneous circulation a useful translational model for investigating mechanisms of vascular disease and providing preclinical data about the state of microcirculatory function in high-risk populations. With these advancements in assessing vascular function, it was of interest to determine if children can achieve intensity levels during self-paced guided active play community-based programming, using cooperative games to improve vascular function.

1.2.4. Community Settings, Guided Active Play and Cooperative Games

For children and adolescents, PA participation is influenced by many factors including, motor skill competencies, physiological capabilities, socioeconomic status and behavioural attributes (160, 172, 187). These ‘influencers’ may have both positive and negative effects on children’s PA participation in either organized and/or unorganized formats. Unorganized activities refer to activities that are self-directed, self-paced and not regulated, which may occur in community playgrounds. Organized activities refer to activities that involve structure and supervision – coach, teacher, parent - the children may be free to participate but within a prescribed format (sport camps, dance, gymnastics) (70). Studies that compare organized and unorganized PA conclude that the benefits of participation in unorganized sport and physical activity increase with age, and are more important than involvement in organized sport (182). It appears that although organized and unorganized sport activities remove some of the barriers to PA participation during childhood development, unfortunately they may also contribute new challenges for children participating in PA. Some of the barriers involved with unorganized PA include issues with safety due to lack of supervision, whereas the issues with organized PA are often due to the high cost involved with running the programs (70). Finally, organized and unorganized activities are associated with large variations for the amount, intensity and type of physical activity (70).

School-aged children registered in community recreation centre and afterschool programs spend more time in recreational (89%; arts/crafts, videos), social (84%; listening to music, TV), and self-improvement (54%; musical instruments, skilled chores) activities and less time in physically active endeavours (39%; sport skills, biking, skateboarding) (2, 5, 46, 175, 177). In addition to spending less time in physical activity components, the efficacy of community-based PA programs has also been questioned, since it was observed that children's PA is only 11.4%MVPA when attending summer day camps (15, 111, 130). It has been suggested that children should be encouraged to participate in spontaneous PA, rather than being directed towards programs with free time and/or unpredictable sporting activities (65). In fact, children (9-11 years) spontaneously engage in more MVPA when playing actively during the afterschool period, with the PA characterized by intermittent activity with rapid changes from rest to VPA (28, 78). As well, during the early years of life, it was reported that children engage in active play that is significantly above resting metabolic rate (167). Whether children can achieve health-enhancing PA (i.e., total PA and PA intensity) during self-paced guided active play in community-based summer camp programming is uncertain. This is relevant since the total amount and intensity of children's PA is strongly associated with a number of positive health outcomes, compared to light-to-moderate PA (36, 37, 133, 134).

Cooperative Games: Research findings show that in a simulated play environment, children elicit ranges of energy expenditures and percentages of moderate-vigorous intensity (%MVPA) when playing cooperative games (21). Interestingly, children undergoing a 6-week intervention program using treadmill exercise and simulated games in a laboratory setting showed improvements for VO_2peak (51.4±8.5 vs 54.3±9.6 $mL \cdot kg^{-1} min^{-1}$), peak running speed (11.3±1.6 vs 11.9±1.6 $km \cdot h^{-1}$), reduced oxygen cost of submaximal exercise, improved waist circumference (73.2±10.2 to 70.9±8.7 cm), and muscle mass (17.1±3.4 to 18.1±2.2 kg) (97), Moreover, it was reported that five months of active play using a combination of free play and sport activities significantly increased habitual PA levels and reduced body fat (-1.8%) in overweight and obese children (22). Although these previous studies encouraged the use of active playing of games to increase energy expenditure and improve cardiometabolic risk parameters and fitness, especially for overweight/obese children, the combination of running, circuit training and child-specific games in these programs limits the generalizability of the results to play-based community programming just focused on games.

Reports showing that children's intermittent movement patterns with stops and starts of 3-12 second intervals (26) and performed in short bouts of 6 minutes or less (5, 111) has led to the suggestion that cooperative (social) games may be an effective PA strategy to promote PA participation (77, 146). The benefits of active play using cooperative games have improved psychosocial status and motor skills (2, 20, 31, 57). Whether cooperative games when used in a GAP intervention will result in sufficient EE and %MVPA to improve children's health-related fitness is unknown. When studying cooperative games using portable indirect calorimetry, it was reported that children exhibited energy expenditure (EE) values of 3.8 to 3.9 $kcal \cdot min^{-1}$, which were approximately 4.3 times higher than watching television (68). Moreover, children and adolescents playing cooperative games (tag, relays) in an active play format exhibit PA levels ranging from 3.9 to 4.4 kcal·min^{-1} (122). To investigate the attractiveness of cooperative games in programming school-aged children's PA, it was reported that the metabolic demands of children's self-paced cooperative (social) games performed in a simulated play environment can be clustered into low-to-high EE groups (21). Using cooperative games in a 6-week active play intervention focusing on asthmatic children (10-12 years) demonstrated that moderate intensity levels (152 bpm and/or ~76%HRmax) was sustained for 22 minutes over a 1 hour session (196). Using cooperative games in a guided active play intervention resulted in increased PA enjoyment scores from 67±13 % to 76±9 % for girls (9.8 years) (122). In addition, cooperative games when performed in an acute session (30 minutes) can elicit post-exercise hypotension and lower blood pressure reactivity related to the greater PA intensity (146). It was suggested that this response may account for a lower blood pressure with repeated exposure to the use of cooperative games. These studies demonstrate that the use of cooperative (social) games within a play-based active play program is not only feasible, but that school-aged children show the potential for health-enhancing PA levels over 5-day summer camps. It has been proposed that use of individual cooperative games may provide the dose of physical activity and corresponding energy expenditure to yield health-related fitness benefits for longer-term intervention studies (77), which as yet has not been investigated in community summer camp programs. This distinction is essential when considering that greater amounts of time spent in intense PA are associated with several positive health and fitness benefits (69, 134, 135, 180).

Over the past several years a renewed focus on the value and importance of children having fun, playing age-appropriate games (i.e., active play) has been suggested as a means to improve PA participation during childhood and adolescence (63). To better understand the developmental relationships between PA and CV health it is important to assess PA participation in an environment that promotes positive PA behaviours while reducing the negative influences. In this way, the large variations noted for PA in other settings (i.e., indoor vs outdoor playing; organized vs unorganized formats; low vs high intensity) should be minimized. Therefore, it is of interest to determine if a standard PA format (guided active play with cooperative games) over the school-aged years will contribute to: a) improving the stability (tracking) of PA; b) result in statistical increases in EE and %MVPA over an 8-week program in a summer day camp; and c) improve health related CV fitness over a shorter (5 weeks) and longer (8 weeks) summer day camp.

1.3 SUPPORTIVE DATA FOR THIS THESIS

Published reports (20, 21, 121–123) and pilot studies (Appendix E) from our laboratory have provided evidence that cooperative games whether included in a simulated play environment, an active play and/or guided active play session are associated with a characteristic range of energy expenditures and %MVPA. The range of low-to-high EE and %MVPA for cooperative games remain regardless of the order in which they are played, and are repeatable when the games were performed on different days (21, 122). Importantly individual cooperative games show EE and %MVPA levels ranging from 13.57 $kcal \cdot 5\ min^{-1}$ to 25.00 $kcal \cdot 5\ min^{-1}$ ($p<0.05$) and %MVPA from 10% to 39% ($p<0.05$) across all games. Therefore, the results of our studies confirm that PA outputs for cooperative game may be clustered in a manner that may be useful in programming GAP for school-aged children in community/summer day camp settings that might provide health-enhancing PA.

Following a GAP program children's quality of life using questionnaires focusing on psychosocial status (i.e., social functioning, emotional functioning, school function and perceived physical abilities) and attraction/enjoyment to PA, our results showed that children enjoyed themselves during active play and improved their base levels of Quality of Life following weeks of summer day camp programming (20). Specifically, the results showed that PA participation in the active play program showed a group average of 39±11 % time spent in moderate-vigorous PA (%MVPA) with boys averaging 45% MVPA and girls averaging 30% MVPA ($p<0.05$). PA attractiveness scores for boys did not change following the program; whereas girls improved from 67±1 % to 76±9 % ($p<0.05$) (123). This is important as girls generally exhibit a larger decline in PA participation between the ages of 9 to 19 years, with an average decline of approximately 4% per year (48). Findings that the rate of decline is not consistent across ages with early maturing girls exhibiting a greater decline at 13 years of age compared to girls with average maturation. Moreover, girls approaching maturity are more reluctant to participate in physical activity and/or sports in comparison to girls who are further away from maturity (47). It has been suggested that the biological (physical) and /or psychosocial characteristics of girls reaching physical maturity impacts their decreasing rate of PA participation (47, 50). Our findings provide supporting evidence that girls closer to maturity feel that they are different from the norm, and as a result face peer pressure when taking part in PA programs (160). Guided active play programming design may overcome these obstacles.

Other published work from our laboratory reported that changes in quality of life indicators after an active play program vary between normal weight (NW) and overweight (OW) children (20). The results showed that OW children had a statistically reduced waist circumference (1 mm) and sum of skinfold (12 mm) ($p<0.05$), in contrast to NW group ($p>0.05$). The changes in body composition (body mass, WC and sum of skinfolds) were related (r from -0.36 to -0.51) with psychosocial function for OW children ($p<0.05$). Interestingly, NW and OW groups experienced similar reductions in blood pressure, albeit OW children had a more pronounced change compared to NW children ($p<0.05$).

Regarding changes in fundamental motor skills for children (5-7 years) we reported statistically improved locomotor and object control skills following 5-weeks of GAP, but not for an active play program led by a single professional instructor (122). These findings are relevant during development since improving motor competence has been hypothesized to promote PA participation, which should lead to improvements in health-related fitness (172).

In conclusion our previous results provide a rationale for using cooperative games with guided active play programming associated with community centre summer day camps for the studies presented in this dissertation. Therefore, guided active play sessions and/or programs (5 and 8 weeks in duration), in contrast to the use of habitual daily PA and/or training programs, may be effective in tracking the stability of PA and improving health-related fitness for school-aged children attending summer day camp.

CHAPTER 2: OVERALL STUDY DESIGN and METHODOLOGY

The following chapter outlines the overall objectives of the dissertation projects and also provides a description of the study designs and respective methodologies of three different research studies. A more detailed description of the methodologies and outcomes of the three studies are provided in their respective manuscript chapters (see chapter 3.1, 3.2, and 3.3).

2.1 OVERALL RESEARCH METHODOLOGY

2.1.1. Overall Objectives

The objectives of the research program are to determine if school-aged children's (5-12 years) guided active play (GAP) physical activity (PA) program delivered in a community recreational centre setting will: i) track PA during the developmental period by calculating rank order correlation coefficients and assessing relative rank (i.e., comparing percentile scores) over one- and two-year intervals ii) result in maintained energy expenditures and time spent in moderate and vigorous PA over an 8-week GAP program which improve cardiovascular and musculoskeletal characteristics; and iii) improve the control and responsiveness of the microvascular system conducted over a short-term five-week GAP program.

2.1.2. Statement of Ethics

All three studies and pilot studies were conducted in accordance with Canada's Tri-Council Policy for the Ethical Conduct of Research Involving Humans. York University's Human Participant Research Ethics committee granted approval for all aspects of the research projects. The participants along with their parents/guardians were provided with an orientation session to explain the different aspects of the research studies and written consent was obtained. Children were also provided with their own verbal assent to participate. Certificates of approval along with a copy of all the informed consent forms are provided in Appendix A.

2.1.3. Participants and Recruitment

Children were recruited from a community recreation centre in the Greater Toronto Area, in particular Neighborhoods 24 and 25 (also referred to as Ward 8: York West), which are associated with underserved health services. Prior to starting the study, and after receiving parents/guardians completed informed consent forms, a physical activity readiness questionnaire (PARQ+) was conducted. Participants without contraindications to readiness for PA and those that provided verbal assent to participate completed the age-appropriate Pediatric Quality of Life survey (PedsQL) and community-based field assessments for health and fitness. All procedures were approved by the Human Participants Research Committee at York University. A list of the consent forms and supplementary documents are presented in Appendix A.

2.1.4. Guided Active Play Program

GAP is designed to improve a child's self-confidence and self-efficacy within an environment that also considers the necessary amount and intensity of physical activity needed for positive benefits on health and fitness (20, 123). GAP is characterized by self-paced activities with minimal formal instruction time but rather using non-instructional role models (guides) at a ratio of 5:1 for children-to-guide (20, 121, 122, 144, 166, 186). Experienced undergraduate senior kinesiology majors, with 15 hours in a combination of workshops (encouragement strategies; bullying) and simulated children's program delivery (rules of the games, practicing skills), served as volunteers to act as positive role models and provided visual encouragement to children to expand their experiences and increase participation. Student volunteers that completed all the training sessions before the start of camp and were able to handle simulated scenarios during workshops were offered volunteer positions (PA leader or outrider) during the start of the program. PA leaders were in charge of program delivery by explaining the instructions to games that were scheduled that day, managing the amount of time each game is played and making sure enough water breaks are taken. The volunteers that were PA outriders were in charge of playing all the games with the children and they also promoted PA participation by acting as a positive role model. The outriders in collaboration with the community centre staff attended to children that may require extra attention, such as accompanying during water/washroom break, injuries/not feeling well, fights, etc. Instructions and feedback were provided during the sessions, and no child was forced into playing games (24). Examples of PA programing during the GAP program are shown in Appendix G.

The GAP program consisted of PA for 1 hour each day. The one-hour session consisted of five to six randomly assigned self-paced age appropriate cooperative games selected from the Ready-to-Use Physical Education Activities and previous reports (20, 21, 24, 98, 121–123). Within the 60-minute session, a warm-up period (3 min) and a water break (2 min - halfway through the session) were included, which on average results in 55 minutes of programming. The program was designed in a way to follow the FITT (frequency, intensity, time and type) principle and the use of age appropriate cooperative games were used to guide the intensity of the session. Each day (~55-minute sessions) included a warm-up period consisting of one game between 1 to 3 MET and the remainder of the session was 5 to 6 games that were greater than 4 MET. In addition, the sedentary time was targeted at less than 20% of the session. As the weeks continued the main bulk of games that were played were above 5 MET. Although the games were specifically planned for each day, children had the opportunity to suggest different games to play, therefore keeping with the principles of guided active play (see Appendix G for more details on games programming and examples of daily observations).

The cooperative games (n=~100) used for progamming were grouped into (light, moderate and vigorous games (21)) and motor skills, such as locomotor skill activities (i.e., running, hopping, jumping, leaping, sliding, and galloping), and object control skills (i.e., striking, rolling, throwing, dribbling and catching) (122). A sample of games used to support activities during the guided active play sessions included: Giants Wizards Elves, Shipwreck, Octopus, Clothes Pin Tag, Four Corners, Archers Tag, Dr. Dodgeball, Crash, Monkey in the Middle, Handball, Croc-Croc, Line Tag, Toilet Tag, What Time is it Mr. Wolf, Bacon Tag, 4-corner soccer/basketball, basketball/soccer Scrimmage, Zombie Tag, Fishes and Whales, Blob Tag, Soccer Baseball, Pizza Oven, The Floor is Lava, Flip the Fish (122). See Table 1 for a more detailed explanation of some of the cardiometabolic responses of the games (see Appendix F for instructions on how to play some of the metioned games). All activity sessions were conducted in a temperature controlled (20±1^{o}C) gymnasium.

Table 1: Energy costs of selected cooperative games (n=21) for children and adolescents. Treadmill data is also presented for comparative reasons. Physical activity was quantified using vector magnitude (VM). Portable oxygen consumption system (Cosmed 2) was used to measure oxygen consumption (VO_2) and determine energy expenditure (EE) and metabolic equivalents (MET).

Games	VM	Measured VO_2			EE	MET
	cnts·10s^{-1}	mL·kg·min^{-1}	min	max	kcal·min^{-1}	
Mr. Wolf (n = 5)	449 ± 114	17.82 ± 6.43	9.22	30.03	3.85 ± 1.16	3.70 ± 1.31
Soccer Baseball (n = 5)	373 ± 150	18.26 ± 4.10	15.80	43.82	3.94 ± 0.96	3.79 ± 1.40
Soccer Pass (n = 3)	406 ± 203	19.00 ± 6.33	12.23	48.73	4.10 ± 1.14	3.94 ± 1.72
Fishes and Whales (n = 4)	460 ± 195	19.70 ± 8.51	8.20	44.02	4.26 ± 1.53	4.09 ± 1.76
Rock/Paper/Scissor (n = 3)	301 ± 199	19.94 ± 7.44	5.10	43.82	4.31 ± 1.38	4.14 ± 1.54
Crocodile/Crocodile (n = 5)	513 ± 205	20.45 ± 4.26	12.99	28.92	4.42 ± 0.77	4.24 ± 0.88
Bean Bag Race (n = 1)	497 ± 155	21.03 ± 6.50	9.70	36.50	4.54 ± 0.50	4.36 ± 0.70
Obstacle Course (n = 3)	520 ± 182	21.55 ± 5.88	13.30	37.70	4.66 ± 1.32	4.47 ± 2.03
Blob Tag (n = 2)	677 ± 208	21.69 ± 7.33	9.35	38.57	4.69 ± 1.32	4.50 ± 1.52
Four Corners (n = 2)	528 ± 194	21.72 ± 6.04	8.70	38.60	4.69 ± 1.17	4.51 ± 2.04
Hurdles (n = 2)	537 ± 220	21.91 ± 7.11	10.57	35.67	4.73 ± 1.38	4.55 ± 2.35
Red Ball Relay (n = 2)	566 ± 207	22.56 ± 6,43	9.35	28.60	4.87 ± 1.18	4.68 ± 1.92
Dr Dodgeball (n = 2)	532 ± 181	22.77 ± 6.48	14.30	35.82	4.92 ± 1.17	4.72 ± 1.34
Coloured Eggs (n = 2)	618 ± 216	23.73 ± 7.33	7.90	33.30	5.13 ± 1.16	4.92 ± 2.21
Freeze Tag (n = 3)	621 ± 214	23.80 ± 4.44	8.30	31.40	5.14 ± 1.24	4.94 ± 0.96
Archers Tag (n = 3)	701 ± 130	23.29 ± 4.61	14.04	36.13	5.14 ± 1.21	4.94 ± 1.43
Octopus (n = 2)	674 ± 253	24.97 ± 8.30	10.22	38.57	5.39 ± 1.24	5.18 ± 2.04
Zombie Tag (n = 2)	1120 ± 324	28.33 ± 8.30	5.10	49.12	6.12 ± 1.32	5.88 ± 1.91
Toilet Tag (n = 4)	1291 ± 337	29.24 ± 6.10	10.30	44.02	6.32 ± 1.14	6.07 ± 1.97

Bicycle tag (n = 2)	1449 ± 304	31.18 ± 7.32	19.40	38.60	6.74 ± 1.38	6.47 ± 1.82
Clothes Pin Tag (n = 3)	1604 ± 312	32.08 ± 8.70	14.54	41.66	7.08 ± 1.57	6.80 ± 1.80
TREADMILL						
4 $km \cdot h^{-1}$ (n = 15)	496 ± 138	15.6 ± 4.62	10.17	17.8	1.52 ± 0.38	3.24 ± 0.75
6 $km \cdot h^{-1}$ (n = 15)	1028 ± 254	21.7 ± 5.08	19.3	24.4	5.95 ± 0.50	4.50 ± 1.24
8 $km \cdot h^{-1}$ (n = 15)	1424 ± 325	30.7 ± 5.17	25.02	34.9	8.83 ± 0.47	6.37 ± 1.77

2.2 MEASUREMENTS

2.2.1. Physical Activity

During all GAP interventions physical activity was quantified using accelerometry. Children wore an accelerometer (Actigraph GT3X+; weighing 27g) around their waist, on top of their clothing held in place with an elastic band. This is similar to wearing a pedometer, and is not restricting in any way. The ActiGraph GT3X+ was programmed (ActiLife v2.1 software) to capture acceleration data from each of the three axes (vertical, horizontal, and perpendicular) in 10 second intervals (epochs) (26). It has been reported that when comparing uniaxial and triaxial accelerometers, uniaxial is a better predictor of locomotor activities such as walking and running, and triaxial is better for lifestyle activities involving children’s games, sports, and household chores (114, 194). Other studies have shown that vector magnitude counts (triaxial) are a better predictor through a smaller standard error of estimate for energy expenditure (EE) compared to vertical counts (uniaxial) (54, 158). Subsequently, it was concluded that when comparing a triaxial accelerometer to pedometry and heart rate, the triaxial accelerometer provided the best assessment of children’s PA when predicting oxygen consumption (VO_2), the coefficient of determination (R^2) was 0.650 for pedometry, 0.638 for heart rate, and 0.825 for the triaxial accelerometer (54). This is particularly important when trying to estimate energy expenditure in a fieldwork setting. The Actigraph GT3x+ was used in this particular study when assessing children's movements in a self-directed active play program where movements occur in all three directions. With respect to the placement of the accelerometer it should ideally be placed close to a body's center of mass (192). The hip or waist (lower trunk area) is the most common site to wear an accelerometer throughout literature. Hip ACC has been known to be a better indicator of habitual PA (152).

Following each GAP intervention, accelerometer outputs were converted to an arbitrary unit (counts) and expressed in counts per 10 seconds ($cnts \cdot 10s^{-1}$) for each of the following output variables: vertical axis; horizontal axis; prependicular axis; total PA counts and vector magnitude counts (ActiLife v2.1 software). The accelerometer outputs were used to estimate EE (kcal/session; kcal/min) and metabolic equivalents (MET) using laboratory derived equations (20, 123) (see Appendix E). To assess the intensity of physical activity, the estimated MET values was classified into sedentary, light, moderate and/or vigorous, using either laboratory derived cutoff criteria (20, 123) and/or estimate of MET values (122).

2.2.2. Community-Based Field Assessments for Health and Fitness

Community-based field assessments for health and fitness included measures of height (cm), body mass (kg), waist circumference (cm), resting heart rate (bpm), resting blood pressure (mmHg), grip strength (kg), and vertical jump (cm). In addition, a walk/jog/run light to maximal effort 20 metre shuttle run was used to estimate maximal oxygen consumption (VO_2max in $mL \cdot kg^{-1} \cdot min^{-1}$) (100). These measurements were chosen to allow for easy comparison to other published articles (85, 91, 106, 109, 162, 178). All assessments were completed by the principle investigator and/or experienced undergraduate students trained with the equipment and procedures (20, 123). All administrators that completed training needed an inter- and intra-rater reliabilty score of under 3% to participate and were assigned to specific asessment stations based on their strengths.

The following is a brief description of the set up of the health and fitness assessments (see Appendix D for a more detailed explanation):

Height: With a measuring tape secured against the wall starting from the floor, the participant stood straight with their heels and shoulder against the wall. The respondent's head was ensured to be in the Frankfort plane (eyes forward, chin straight). Measurement (cm) was taken after a normal breath.

Body Mass: A digital scale (Omron Hn-286) was used**.** Digital scale was turned on and once the scale was stable (zero), the participant stepped on the scale with hands by their sides and looking straight ahead. The participants were instructed to have minimal clothing (no heavy sweaters, no shoes) and nothing in their pockets. The body mass (kg) was recorded and presented on the scale once the measurement was stable. The Body Mass Index was calculated using the standard formula:

BMI = body mass (kg) / height (m)^2

Waist Circumference: The participant stood relaxed with their feet shoulder width apart, and arms crossed on their chest. Any clothing that would interfere with measuring their waist was removed. If they are not comfortable, the measurement was taken over a thin layer of clothing. The tape measure was placed around the waist directly on their skin. The assessor used their hands to find the uppermost border of the hip bones on both sides of the body. The top of the hip bones were marked with an ‘x’. The tape measure was adjusted so that the lower edge of the measuring tape is in line with the uppermost edge of the hip bones. The tape measure was checked for correct placement (i.e., horizontally, and not twisted or caught on clothing). The tape measure was placed tight, but not indenting the skin. The waist measurement was taken after a normal breath to the closest 0.5 cm.

Resting Heart Rate: The participant was asked to sit in a quiet area free of distractions and acclimatize for 15 minutes. Heart rate (bmp) was recorded using a digital heart rate monitor.

Blood Pressure: The participant was asked to sit in a quiet area free of distractions and acclimatize for 15 minutes. Blood pressure (mmHg) was recorded using an automatic blood pressure monitor.

Grip Strength: An electronic hand dynamometer was used (Takei5401). The dynamometer was turned on and stabilized to zero (if required), and the dynamometer grip was adjusted so that the base rests on heel of palm, with the handle on middle of four fingers. The arms were kept straight and to the side of the body. The participant was asked to squeeze the dynamometer as hard as possible, ensuring that the participant breathes out as they squeeze. The value was recorded and the test was repeated twice for each hand, alternating hands.

Vertical Jump: The participant was instructed to stand flat footed with their side against the scale (measuring tape) on the wall. They were asked to reach as high up on the wall as possible and that height was recorded(cm)(Standing Reach Height). The participant was asked to take a half step away from the wall and jump as high as possible and touch the scale at the maximum height of the jump. (A piece of masking tape wrapped around the participants finger with the sticky side out was used and the participant was asked to stick this to the scale at the peak of their jump). The participant was instructed to pause at the base of their squat. Bounce and pre-jumps were prohibited. The jump test was repeated two times (add a third trial was used if the first two scores are greater than 10% difference).

The following formula was used to calculate mean power in watts (64):

Power (W) = 54.2 × vertical jump height (cm) + 34.4 × body mass (kg) - 1,520.4

20 Metre Shuttle Run Test: Aerobic power was measured using the multistage Leger 20 metre shuttle run test (MSRT). This multistage fitness test progresses in difficulty until one has to exert maximal effort during the final stages of the test. The MSRT has proven to be a valid and reliable method for the assessment of aerobic endurance among youth. It is also a practical test as large groups of students can be assessed at once. To facilitate assessment, instructor divided children into groups.

To administer the MSRT, the instructor measured the gymnasium/space with lines, 20 metres apart which was shown to all children (see diagram in Appendix D). Children were required to run back and forth between the two designated lines (known as a shuttle) following the cadence emitted from a pre-recorded compact disc. Beginning at a speed of 8.5 kilometres per hour ($km{\cdot}h^{-1}$), the frequency of emitted signals increased at a rate of 0.5 $km{\cdot}h^{-1}$ every minute. Procedures were explained to all children prior to the testing, and they were advised to start off slow and not run past the lines in order to conserve energy. The test was terminated when participants voluntarily stop or when a participant was no longer capable of successfully completing two successive shuttles. There were a maximum of 20 stages involved with this test, each stage lasting approximately one minute. The last successfully completed full stage by each participant was recorded.

Using the following regression equation developed by Léger et al. (100), maximal oxygen consumption ($mL \cdot kg^{-1} \cdot min^{-1}$) was predicted from the results obtained on the MSRT:

$$VO_2max = 31.025 + 3.238(speed) – 3.248(age) + 0.1536(age * speed)$$

• where speed corresponds to 8 + (0.5 * last stage number completed). Age in years was used for the calculation.

2.3 MANUSCRIPT I: Tracking Children's Physical Activity Participation During Guided Active Play

Purpose: To investigate the stability of PA over a one-year interval using tracking statistics with a GAP format during development (5-12 years).

Hypothesis: The tracking statistics for PA during children's development will show a strong relationship. Profiles for physical fitness and CV risk factors will show a strong relationship to PA when PA is assessed within a self-paced guided active play environment.

Study Design:

Of the children (n=105) registered in a summer community-based camp program, seventy-two (10.13±1.6 years) were recruited to participate in a one-hour afternoon PA session, which incorporated a GAP program using fun, self-paced based cooperative games (20, 121–123, 186). Children's PA participation was assessed from two GAP session, separated by one-week, and averaged to determine a child's PA response. Children were assessed for growth, health and fitness variables one-week prior to the start of the GAP program. The initial year was described as baseline (BL). The children from the BL session returning to the summer community-based camp for two consecutive years completed the same protocol and procedures, with the first year and second-year identified as follow-up 1 (n=65) and follow-up 2 (n=7), respectively.

Data Analysis: Growth, fitness and levels of PA at baseline and follow-up were assessed by paired t-tests with *p* levels reported for each comparison. Tracking was assessed using Spearman rank order correlations (*rho*) to quantify the relationship for physical activity, growth and fitness variables between BL and follow-up 1 and 2 with *p* levels are reported for each comparison. To determine the likelihood that a particular child would be classified in the same group from baseline to follow-up, tracking was assessed using an agreement score, Cohen's Kappa (*k*) statistic. Children were divided into percentiles and using empirical tertials for each variable before applying the Cohen's Kappa (*k*) statistic. The strength of the agreement scores were interpreted using the following scheme: poor (κ = 0.00-0.20), fair (κ = 0.21- 0.40), moderate (κ = 0.41 – 0.60), good (κ = 0.61 – 0.80), and strong (κ = 0.81 – 1.0) (116). All statistics were performed in SPSSv24.

2.4 MANUSCRIPT II: Children's Physiological Adaptations to a Cooperative Games-Based Guided Active Play Community Program

Purpose: To determine the impact of an eight-week GAP intervention by measuring changes before and after the program on children's body mass, waist circumference, resting blood pressure, resting heart rate and estimated VO_2max. To investigate the relationship between estimated energy expenditure (kcal·wk^{-1}) and improvements in body mass, waist circumference, resting blood pressure, resting heart rate and estimated VO_2max.

Hypotheses: 1) A self-paced GAP program will improve children's resting blood pressure, resting heart rate and estimated maximal oxygen consumption (VO_2max); but not body mass and waist circumference, 2) Individual responses for select CV variables (resting blood pressure, resting heart rate and estimated VO_2max) will occur in a dose-dependent manner to energy expenditure ($kcal \cdot wk^{-1}$) following an eight-week GAP program.

Study Design:

Children (n=17) participated in a GAP program for eight-weeks (4 days/week; 1 hour/day) during July and August within a community recreation centre summer camp setting (PA was assesssed each day) (see chapter 2.1.4 for GAP details). Selected health and fitness variables (as outlined in chapter 2.2.2) were assessed during the first and last week of summer camp (see table 2).

Table 2: Measurement schedule of children's (n=17) physical activity (quantified using accelerometry (ACC) for 1hr·day^{-1}; 4d·wk^{-1}) during an eight-week guided active play (GAP) intervention. ACC outputs were used to estimate energy expenditure (kcal·wk^{-1}) and percent time at moderate-vigorous physical activity. Anthropometric (ANTHRO) and cardiovascular (CV) parameters were measured before (PRE) and after (POST) the 8-week GAP intervention.

		WEEK								
	PRE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**POST**
Physical Activity (ACC)		✔	✔	✔	✔	✔	✔	✔	✔	
ANTHRO	✔									✔
CV	✔									✔

Data Analysis: Descriptive statistics (mean and standard deviation [SD]) were determined for anthropometric and cardiovascular parameters before (pre) and after (post) the GAP program. The percent change was calculated using the formula [((pre-post) ÷ pre) x 100]. A paired t-test was applied to compare pre-post changes at a p level of 0.05. A one-way analysis of variance (ANOVA) was used to determine differences for weekly estimated energy expenditures ($kcal \cdot wk^{-1}$) and percentage of time spent in moderate to vigorous intensity PA (%MVPA), with a Tukey post-hoc analysis to compare differences among weeks at a *p* level of 0.05. The dose-response relationships between PA outputs and measures of anthropometric (ANTHRO) and CV parameters was determined by Pearson Product Moment Correlation Coefficient (r) using a *p* level of 0.05.

2.5 MANUSCRIPT III: Short-term Vascular Responses to Children's Guided Active Play

Purpose: 1) To determine if children's microvascular perfusion, including endothelial-dependent (ED) and endothelial-independent (EI) control of perfusion, blood pressure, heart rate and estimated VO_2max will improve following a five-week GAP program. Microvascular perfusion status was determined from baseline perfusion, peak perfusion, average perfusion, total perfusion (area under the curve) and rate of perfusion using coefficients a and b from quadratic equations.

2) To investigate if the pre and post changes in select CV parameters (i.e., vascular perfusion, blood pressure, heart rate and estimated VO_2max) are related to PA levels (accelerometric (ACC) - estimated energy expenditure ($kcal \cdot wk^{-1}$) and %MVPA over the 5-weeks of GAP.

Hypotheses: 1) A self-paced short-term GAP program will be associated with improvements in ED stimulated microvascular perfusion but with minimal influence on EI stimulated perfusion, blood pressure, heart rate and estimated VO_2max responses. 2) The relationship among the ACC estimates of energy expenditure ($kcal \cdot wk^{-1}$) and %MVPA with pre-post percent change in ED stimulated microvascular perfusion will be positive; but with minimal influence on EI stimulated perfusion, blood pressure, heart rate and estimated VO_2max responses.

Study Design:

Children (n=18) participated in a five-week GAP program (1 $hr \cdot d^{-1}$; 4 $d \cdot wk^{-1}$) during a community recreation centre summer camp setting. ANTHRO and CV parameters were measured during the first and last week of camp (see table 3).

Table 3: Measurement schedule of children's (n=18) physical activity (accelerometry (ACC) for 1 $hr \cdot day^{-1}$; 4 $d \cdot wk^{-1}$) during a 5-week guided active play (GAP) intervention. ACC outputs were used to estimate energy expenditure ($kcal \cdot wk^{-1}$) and percent time at moderate -vigorous PA (%MVPA). Anthropometric (ANTHRO) and cardiovascular (CV) parameters were measured before (PRE) and after (POST) the 5-week GAP intervention.

	PRE	Week 1	Week 2	Week 3	Week 4	Week 5	POST
Physical Activity (ACC)		✔	✔	✔	✔	✔	
ANTHRO	✔						✔
CV	✔						✔

Microvascular Assessments:

Prior to the physical activity session children were asked to sit (rest) for a minimum of 15-minute during which they were familiarized with the Laser Doppler Perfusion Imaging (LDPI) equipment and the iontophoresis patches. During the familiarization period children (and parents if they wish) were given a chance to ask any questions about the procedures/equipment. Following the introduction (and provided they wish to proceed) resting skin temperature and blood pressure will be assessed on the non-dominant hand (~5 min). Following the baseline recordings, two adhesive patch electrodes (150mm diameter) were placed on the forearm mid-point between the wrist and elbow while children remained seated with their arm extended and resting on a cushion. Next a baseline current (20uA) was applied to the electrode patches for 180 seconds (according to manufactures specification) (126), at which time 200 microliters of a saline solution containing either one of two vasodilators: acetylcholine (ACH) (1%) or sodium nitroprusside (SNP) (1%) were placed on patches to begin the iontophoresis. ACH and SNP have been widely used to analyze ED and EI function, respectively (44, 120, 154). Each child sat quietly until 20min of LDPI analysis is taken. This protocol is based on similar studies conducted on children by the Dr. Agnes Vinet's laboratory at the University of Avignon (125, 126). The protocol was finished when the participant wanted to stop and/or the 20min is obtained.

Data Analysis: Descriptive statistics (mean and SD) was determined for anthropometric and cardiovascular parameters pre and post of the GAP program. The percent change was calculated using the formula [((pre-post) ÷ pre) * 100]. A paired t-test was applied to compare pre-post changes at a *p* level of 0.05. A one-way analysis of variance (ANOVA) was used to determine differences for weekly estimated energy expenditures ($kcal \cdot wk^{-1}$) and %MVPA, with a Tukey post-hoc analysis to compare differences among weeks at a *p* level of 0.05. The dose-response relationships between PA outputs and measures of ANTHRO and select CV parameters was determined by Pearson Product Moment Correlation Coefficient using a *p* level of 0.05. To assess the influence of resting (starting) perfusion values on ED and EI stimulated control of perfusion, and the combined effect of PA, a 'PA Factor' (i.e., EE plus %MVPA) an analysis of covariance (ANCOVA) was performed to compare pre-post changes using an *p* level of 0.05.

CHAPTER 3: MANUSCRIPTS

3.1 MANUSCRIPT I

Tracking Children's Physical Activity Participation During Guided Active Play

3.1.1. Abstract

Background: Cardiometabolic risk factors and changes in body composition established during childhood show poor-to-moderate relationships with physical activity (PA) participation and fitness. It has been debated that the parameters surrounding the quantification of PA (laboratory vs field settings; assessment periods of 1-day vs 3-day vs 7-day) contribute to the poor and inconsistent relationships reported for children of all ages and stages of development. The poor tracking of year-over-year PA participation may underly the poor-to-moderate relationships between PA and risk factors reported in the literature. This study aims to assess the tracking of children's PA participation during a self-paced guided active play program using cooperative games. **Methods**: Children (n=72; 10.13±1.6 years; range 5-12 years) were recruited from a community centre day camp program and assessed over three consecutive summers for height, body mass, body mass index (BMI), waist circumference (WC), combined grip strength, vertical jump height, systolic blood pressure (SBP), diastolic blood pressure (DBP) and estimates of maximal oxygen consumption (VO_2max). PA participation was assessed during a self-paced guided active play (GAP) program (1 hr·d^{-1} on 2 d·wk^{-1} for 5 weeks). PA was measured with accelerometry (ACC) (ActiGraph GT3X+) using vector outputs (10second epochs) to estimate energy expenditure (EE) (kcal·$session^{-1}$), metabolic equivalents (MET) and intensity levels with laboratory derived equations. Tracking of the variables between the 3 years were analyzed using Spearman rank order correlations and agreement scores using percentile ranks with the Kappa statistics. Paired *t*-tests were used to assess differences in performance and PA between the baseline first summer year (BL) and the follow up at years 1 and 2. **Results**: Children's developmental changes from BL to year 1 showed age related group changes across all growth and physiological variables. PA (kcal·session^{-1}) was greater at year 1 vs BL (p<0.001) and showed strong tracking (r=0.88, p=0.001) and moderate agreement (k=0.54). During the 1-yr interval %MVPA showed moderately high tracking (0.74, p=0.003) and moderate agreement (0.47, p=0.02). The proportion of time identified as sedentary did not show significant tracking statistics (p>0.05). For physiological variables children's grip strength, leg power, systolic blood pressure and estimated VO_2max showed significant tracking statistics (p<0.05). No analysis was attempted for BL to follow up 2 due to the smaller number of children returning. An analysis of PA tracking at each age group (i.e., 7-8, 8-9, 9-10, 10-11 and 11-12 years) showed strong coefficients (p<0.05), except for the 9-10 years children. The PA levels associated with GAP showed moderate to strong relationships for BMI r=0.70 (p<0.01), WC r=0.62 (p<0.01), grip strength r=0.79 (p<0.01), SBP r=0.57 (p<0.05), DBP r=0.65 (p<0.01) and estimated VO_2max r=0.38 (p<0.05). **Conclusion**: The results show that PA levels in school-aged children are stable with moderate-to-strong tracking statistics when participating in guided active play. Evidence suggests that a GAP approach to track children's PA participation may also promote stronger relationships between cardiometabolic risk factors during development.

3.1.2. Introduction

During childhood and adolescence, the individual differences in growth, biological and behavioural development, and maturity status make it challenging to design and implement intervention strategies to promote physical activity (PA) participation and improve physical fitness (108). The concept of tracking or stability is focused on identifying useful and relevant variables that if improved would benefit health- and/or performance-related factors, such as adiposity, hypertension, and motor coordination during childhood. Tracking refers to measuring a child at different points in time and quantifying the relationship using inter-age correlation coefficients, agreement scores for percentile rankings, odds ratios, and/or multiple linear regression models to evaluate the longitudinal stability of a variable (61, 106, 108, 195). The stability of tracking coefficients varies by sex (boys generally higher than girls), age at baseline (i.e., the younger the child the lower the coefficient) and the time interval between measurements (i.e., longer the time internal the lower the coefficient), which must be considered when interpreting inter-age coefficients. The tracking or stability of the correlation coefficient is classified as low, r<0.30; moderate, r=0.30 to 0.60; moderately high, r>0.60 (108).

Research findings report tracking of physical fitness increases from grades 1 to 4 and exhibit the highest coefficients between grades 1 to 2 (baseline of 6.8 years) for the 6-minute run (r=0.48), 20m sprint (r=0.55), standing long jump (r=0.64), sit-ups (r=0.68), push-ups (r=0.38), balancing backwards (r=0.59), jumping sideways (r=0.49), and stand and reach (r=0.59). Body Mass Index (BMI) was stable with a coefficient of r=0.85 (153). Agility, motor coordination and subcutaneous fat (skinfolds on triceps and medial calf) were also classified as stable during elementary school between 2nd to 6th grades (55) and kindergarten to 5th grade (119). The tracking coefficients for physical fitness parameters during late childhood (baseline of 10 to 11 years) were classified as moderate to moderately high for grip strength (r=0.88), abdominal endurance (r=0.83 sit-ups), and leg power (r=0.58 cycle ergometer); whereas systolic (SBP) (r=0.32) and diastolic (DBP) (r=0.28) blood pressure are less stable. As well, during the transition to adolescence (from 10 to 13 years), the 3 year interval coefficients for physical fitness parameters were higher than the 1 year intervals, except for SBP and DBP, which remain less stable (185). These data demonstrate that for school-aged children classified with low to moderate tracking (from grades 1 to 6 over a 1-to-3-year time interval) would be expected to have more stable fitness parameters (aerobic power, muscle strength, leg power and abdominal endurance) when they reach adolescence. Therefore, intervention strategies throughout childhood should emphasize PA participation to maintain and improve physical fitness (153). In addition, the importance of increasing PA participation for unfit adolescents should not be overlooked.

Research findings show that tracking coefficients for PA were less stable over the paediatric years. The highest tracking coefficients for PA were reported for 1 year intervals during the preschool years (<5 years) when measuring total PA ($min \cdot d^{-1}$) (r=0.49), moderate PA (r=0.53), vigorous PA (r=0.43) and MVPA (r=0.47) (32). The stability of tracking for PA from grades 5 to 8 were reported to be lower for time at moderate-to-vigorous PA (r= 0.24) and EE (r=0.41) (136). Inter-age correlations during late childhood (10-12 years) and adolescence (13-14 years) were lowest, ranging from r=0.03 to r=0.18, respectively, for estimated active EE ($kJ \cdot kg^{-1} \cdot day^{-1}$) and for time in PA ($min \cdot d^{-1}$) (59). It has been proposed that since most studies concerning tracking of PA report a range of protocol characteristics across different settings and with different indicators, these may account for the lower trends in coefficients for PA tracking during childhood and adolescence (59, 108, 109, 115, 163). The factors contributing to the low stability of PA include the method of quantification (survey, recall and/or physiological and movement sensors), the timing of PA measurements (i.e., one day a week or multiple days per weekday and/or weekend), the variability in the number of bouts, duration and intensity, and the types of PA (organized versus unorganized; sports versus free play) (39, 71, 90, 163). In addition to methodological and measurement challenges, it has been suggested that tracking studies should attempt to quantify PA in settings where the physiological, psychosocial, and environmental factors important for promoting positive behaviours in support of increasing the amount and intensity of PA participation are integrated (108, 138).

Research findings have indicated that the settings used for tracking children's and adolescent's PA, such as school, home, and neighbourhood environments, and the types of PA patterns (i.e., the number of physical activity/sedentary bouts/ breaks of a certain duration, the total time spent and intensity of activity/sedentary bouts) can all significantly influence opportunities to engage in total PA and/or in moderate-to-vigorous intensity physical activity (MVPA) (90, 95, 163). Consideration of organized and unorganized PA are important during childhood and adolescence, with report findings showing that organized PA in extracurricular activities during afterschool and/or sports clubs increased by 8% during the transition to adolescence, while unorganized PA decreased by 7% (163). Moreover, the use of PA self-report methods to quantify PA minimizes the contribution of intermittent habitual unorganized activity (e.g., active transport, free play) with a tendency to under or overestimate the PA behaviours being assessed (71). The findings from a systematic review identified the need to consider and define the associations between PA patterns across the entire activity spectrum from being sedentary to walking and to low and high intensity PA patterns in children and adolescents aged 5–19 years (188). As well, seasonal variations and/or outdoor and indoor venues influence the tracking results during childhood and adolescence. Seasonal variations in PA behaviours showed children's MVPA in outdoor venues tend to be lower in winter months compared to summer and fall; but reported higher MVPA outputs for winter indoor activities (95). When these factors and/or correlates influencing PA behaviours are considered, it is not surprising that the tracking coefficients for PA over the paediatric years show less stability during childhood and adolescence.

The attractiveness of assessing the stability or tracking of PA by engaging children and adolescents in active play sessions that promote increased PA participation with different PA patterns or movements is not available in the literature. Active play is characterized by self-paced, freely chosen, unorganized fun activities with minimal instruction to encourage increased PA participation (197). When children's games are played in a simulated free and/or guided active play (GAP) environments, results show that they are repeatable over a range of EE and MVPA (20, 77). Furthermore, active play programs reported more total active time and higher levels of MVPA in different settings (i.e., school, afterschool, and community recreation centres) when focused on the physiological, psychosocial, and environmental factors that encourage PA participation (74, 87, 122, 123). These studies demonstrate that active play can increase time in activity and MVPA while promoting positive PA behaviours (enjoyment, social interaction, encouragement) and reducing the negative influences and/or barriers (bullying, low self-efficacy) (20, 61, 186, 197). These attributes make active play, and guided or facilitated active play, using cooperative games a good candidate for tracking of PA during childhood and adolescence. Whether children's participation in GAP sessions, using cooperative games, will be stable or track during childhood to adolescence (6-12 years) is not certain.

The purpose of this study was to determine the tracking of PA for school-aged children (5-12 years.) during a GAP session (55 minutes) using cooperative games delivered over two consecutive summer day camps in community recreation centre setting. As well, growth, select health plus health-related fitness parameters were assessed over the same period. Tracking statistics for variables were determined with Spearman Rho coefficients and percentile agreement scores (Cohen's *kappa*) on percentile rankings for five different age groups ranging from 7-8, 8-9, 9-10, 10-11, and 11-12 years. The hypothesis is that GAP, which considers physiological, psychosocial, and environmental factors for PA behaviours while using cooperative fun and social games, will result in stable PA tracking (i.e., moderate-to-high coefficients). The PA tracking results of this study will be relevant for physical activity studies with school-aged children by identifying if PA active play outputs are stable or PA remains susceptible to changes over the school-aged years.

3.1.3. Methodology

Study Design and Participants

Participants (n=164) in this study were registered in a community summer day camp program in Northwest Toronto and completed the initial assessments (Baseline-BL). Seventy-two children (9.9±1.7 years) returned in the subsequent year and completed the follow up 1 year assessments (44% retention). Seven children (11.6±1.3 years) returned in follow up 2 year and completed the assessments (10% retention). The procedures used in this study were approved by the York Human Participants Review Sub-committee (certificate number 2012—137, renewed for two years to 2014). Written consent was obtained from parents/guardians of the children involved with this study. The summer programs operated from 9:00am to 3:30pm, and included a one-hour afternoon PA session, which incorporated guided active play using fun, self-paced based cooperative games (20, 121–123, 186). Children were assessed for growth, health-related fitness variables one-week prior to the guided active play sessions. Children's participation in two guided active play sessions separated by one-week.

Guided Active Play Session

The GAP session was characterized by self-paced PA with non-instructional role models (guides) at a ratio of 5:1 for children-to-guide (20, 121, 122, 144, 166, 186). Experienced undergraduate senior kinesiology majors, with 15 hours in a combination of workshops (encouragement strategies; bullying) and simulated children's program delivery (rules of the games, practicing skills), served as positive role models provided visual encouragement to children to expand their experiences. No instructions and feedback were provided during the sessions, and no child was forced into playing games.

The GAP session consisted of PA for $1hr{\cdot}d^{-1}$ duration on two days separated by one-week in community-based summer recreations program. Sessions consisted of age appropriate cooperative games adopted from the Ready-to-Use Physical Education Activities and previous reports (20, 21, 24, 98, 121–123). A sample of games used to support activities during the GAP sessions included: Giants Wizards Elves, Shipwreck, Octopus, Clothes Pin Tag, Four Corners, Archers Tag, Dr. Dodgeball, Crash, Monkey in the Middle, Handball, Croc-Croc, Line Tag, Toilet Tag, What Time is it Mr. Wolf, Bacon

Tag, 4-corner soccer/basketball, basketball/soccer Scrimmage, Zombie Tag, Fishes and Whales, Blob Tag, Soccer Baseball, Pizza Oven, The Floor is Lava, Flip the Fish (see Appendix F for a detailed description of the games) (21). Each day 5-6 games were played within a 1-hour time slot, with one water break halfway through the session. The games were conducted in a temperature-controlled (20 ^{o}C) gymnasium.

Measurements

Physical Activity – ActiGraph GT3X+ accelerometers were used to quantify PA during each session. ACC were placed at the hip with elastic bands and outputs expressed as vector in counts/10-seconds (26). Oxygen Consumption (VO_2) was estimated using a laboratory generated linear regression equation (21, 122, 123), with a standard error of estimate (SEE) of 0.75 $mL{\cdot}kg^{-1}min^{-1}$ for children (5-8 years) during treadmill exercise and 3.23 $mL{\cdot}kg^{-1}min^{-1}$ when playing active games (123). To classify the volume and intensity of PA, the VO_2 estimates derived from ACC outputs were used to calculate total EE per session ($kcal{\cdot}session^{-1}$). The intermittent nature (i.e., frequent starts-stops) associated with GAP results in situations where minimal detectable movement are associated with VO_2 values of 5 to 15 $mL{\cdot}kg^{-1}min^{-1}$ and/or 1-3 MET (27). As a result, intensity levels (MET) were predicted by linear regression based on ACC vector outputs and the percent of time spent at different MET were determined and described as sedentary (0 – 1.5 MET), very light (1.6 to 2.9 MET), light (3 – 3.9 MET), moderate (4-5.9 MET) and vigorous (>6 MET) (122). Finally, the percentage of time spent at each intensity level (expressed as % PA) was determined for each child during all GAP sessions.

Health and Fitness Measures

Anthropometric and Cardiorespiratory Fitness – body mass, standing height and WC were determined, as previously described (20, 123). An automatic blood pressure cuff was used to assess resting SBP, and resting DBP (mmHg). Each variable was assessed with two trails and the average determined. All measurements had a coefficient of variability of $\pm$ 3% for all variables. The Leger 20 metre multi-stage shuttle run (MSSR) test was performed to estimated VO_2max ($mL \cdot kg^{-1} min^{-1}$) as previously described (20, 122). The proportion of children completing the 20 metre MSSR stages were 35.6% (stage 0-1), 44.4% (stage 1-2), 15.6% (stage 2-3), 2.2% (stage 3-4) and 2.2% (stage >5), which agrees with previous reports (8).

Muscle Strength and Power

Muscle strength was assessed using a handgrip dynamometer (Takei 5401) performed two times on each hand, alternating hands between each trial. Muscle strength measures from both hands were combined to assess handgrip strength, which is a surrogate of whole body strength for children (124, 128, 197). A vertical jump test was used to measure peak leg power (64). Children were instructed to stand flat footed with their side against the scale on the wall and reached as high up on the wall as possible, and the height was recorded. Next, children took a half step sideway from the wall, and were instructed to jump as high as possible and touched the scale at the maximum height of the jump, and the height was recorded. The test was repeated two times. All measurements had a coefficient of variability of $\pm$3% for muscle function variables.

Statistical Analyses

Growth, fitness and levels of PA at baseline and follow-up were assessed by paired t-tests with *p* levels reported for each comparison. Tracking was assessed using Spearman rank order correlations (*rho*) to quantify the relationship for PA level, growth and fitness variables between baseline (BL) and follow-up 1 and 2 with *p* levels are reported for each comparison. Children were divided into three percentile groups using empirical tertials for each variable before applying the Cohen's Kappa (*k*) statistic. To determine the likelihood that a particular child would be classified in the same group from baseline to follow-up, tracking was assessed using an agreement score, Cohen's Kappa (*k*) statistic. The strength of the agreement scores were interpreted using the following scheme: poor (κ = 0.00-0.20), fair (κ = 0.21- 0.40), moderate (κ = 0.41 – 0.60), good (κ = 0.61 – 0.80), and strong (κ = 0.81 – 1.0) (116). All statistics were performed in SPSSv24.

3.1.4. Results

Children participating in this study showed average growth-related changes in body mass, height, body mass index and waist circumference from BL to follow-up 1 (FU-1) and follow up 2 (FU-2) (Table 1). The small number of children returning for FU-2 prevented a detailed statistical analysis for all variables, so annual changes are only compared from BL to FU-1. Health-related fitness results are found in Table 2 (group mean) which showed increases for strength, leg power and blood pressures, but not estimated VO_2max which was similar from BL and FU-1.

Physical activity levels are found in Table 3. Energy expenditure (EE) increased during GAP sessions, which were statistically increased from ~208 to 250 kcal·session^{-1} comparing BL to FU-1. Regarding PA intensity, although the BL and FU-1 %MVPA was not statistically different, children at FU-1 were engaged in more vigorous intensity PA (from 6.3 to 12.6%) and less moderate intensity PA (27.9 to 19.8% MPA). In addition to changes in PA intensity the proportion of sedentary time increased at FU-1 compared to BL.

Table 1. Participant growth and body composition characteristics at baseline, 1-year follow-up and 2-year follow-up. Measurements were obtained one week prior to physical activity program. Values are presented as means ± standard deviation (* indicates *p*<0.05).

	Baseline (n = 65)	1 Year follow-up (n = 65)	2 Year follow-up (n = 7)
Age (year)	8.9 ± 1.7	9.9 ± 1.7*	11.6 ± 1.3
Body Mass (kg)	37.5 ± 12.8	42.6 ± 12.5*	51.0 ± 12.7
Height (cm)	140.0 ± 15.6	145.2 ± 15.1*	160.4 ± 5.2
Body Mass Index ($kg·m^2$)	18.8 ± 4.0	19.7 ± 4.4*	20.5 ± 4.1
Waist Circumference (cm)	56.4 ± 19.6	67.8 ± 12.5*	69.2 ± 8.3

Table 2. Physical activity and physical fitness characteristics at baseline, 1- and 2-year follow-up for school-aged children. Measurements were obtained one week prior to physical activity program. Values are presented as means ± standard deviation (* indicates *p*<0.05).

	Baseline (n = 65)	1 Year follow-up (n = 65)	2 Year follow-up (n = 7)
Combined Grip Strength (kg)	27.5 ± 11.7	34.9 ± 13.3*	51.5 ± 11.6
Vertical Jump height (cm)	30.9 ± 20.5	25.3 ± 10.5	33.4 ± 8.2
Leg Power (Watts) (n=59)	1060.9 ± 564.2	1377.5 ± 791.1*	N/A
Systolic Blood Pressure (mmHg)	99.9 ± 11.3	95.4 ± 12.0*	98.9 ± 15.5
Diastolic Blood Pressure (mmHg)	65.4 ± 10.6	61.5 ± 10.6*	58.6 ± 9.0
Estimated VO_2max ($mL·kg^{-1}·min^{-1}$)	45.6 ± 4.7	44.8 ± 5.4	41.9 ± 8.7
Estimated Energy Expenditure ($kcal·session^{-1}$)	207.8 ± 71.3	250.1 ± 84.6*	297.7 ± 55.9

Table 3. School-aged children's physical activity participation presented as a percentage of time (% time) spent during various intensity levels; sedentary (0 – 2 MET), light (3.0 – 3.99 MET), moderate (4.0 – 5.99 MET), and vigorous (>6 MET) for 1 hour guided active play sessions at baseline and 1-year follow-up. Values are presented as means ± standard deviation (* indicates *p*<0.05).

	Baseline (n = 65)	1 Year follow-up (n = 65)
Sedentary (% time)	12.7 ± 5.5	23.1 ± 6.5*
Very Light PA (% time)	28.1 ± 5.6	30.1 ± 5.3
Light PA (% time)	23.9 ± 2.84	14.0 ± 2.5*
Moderate PA (% time)	27.9 ± 6.6	19.8 ± 3.8*
Vigorous PA (% time)	6.3 ± 2.8	12.5 ± 5.0*
Moderate-Vigorous PA (% time)	34.3 ± 8.6	32.4 ± 7.6

Tracking statistics included Spearman's rank order correlations and *k* statistic for blood pressure, muscle strength and leg power and PA levels variables between BL to 1-year follow-up are presented in Table 4. Systolic blood pressure exhibited low tracking (rho=0.38; *k*=0.283), as did diastolic blood pressure (rho=0.21; *k*=0.192), combined grip strength exhibited moderately high tracking (*rho*=0.86; *k*=0.608) (Table 4). Considering estimated VO_2max, a moderate tracking (*rho*=0.57) and fair agreement score (*k*=0.215) was obtained for the group data (Table 4). Regarding estimated EE for PA during GAP, moderately high tracking was observed between BL and 1-year follow-up, as assessed by Spearman's rank order correlations (rho=0.88) and a moderate agreement was noted for Cohen's Kappa statistic (*k*=0.538) (Table 4). The tracking of %MVPA was identified as moderately high (rho=0.75) and moderate agreement (*k*=0.466) from BL to 1-year follow-up. The %MPA and %VPA showed similar tracking potential (Table 4).

Table 4. Tracking statistics for physical activity and physical fitness of school-aged children (n=65) during guided active play sessions at baseline to 1-year follow-up. All *p* levels are presented in brackets.

	Spearman's rank order correlation	Cohen's Kappa
	rho	***k***
Estimated Energy Expenditure (kcal/session)	0.88 (0.000)	0.538 (0.000)
Combined Grip Strength (kg)	0.86 (0.000)	0.608 (0.000)
Leg Power (Watts)	0.78 (0.000)	0.667 (0.005)
Systolic Blood Pressure (mmHg)	0.38 (0.002)	0.283 (0.001)
Diastolic Blood Pressure (mmHg)	0.21 (0.101)	0.192 (0.028)
Estimated VO_2 max ($mL \cdot kg^{-1} \cdot min^{-1}$)	0.57 (0.000)	0.215 (0.014)
%Sedentary	0.45 (0.104)	0.377 (0.127)
%MPA	0.74 (0.002)	0.569 (0.006)
%VPA	0.65 (0.012)	0.138 (0.585)
%MVPA	0.74 (0.003)	0.466 (0.022)

When determining the Spearman's rank order correlations across the age range from 7-11 years, it is evident that the strong tracking reported for EE during GAP was consistent from middle to late childhood (Table 5). The tracking characteristics for the muscle strength and leg power showed was also strong throughout middle to late childhood (Table 5). Blood pressures showed a low tracking from potential from 7 to 11 years. The moderate tracking obtained for the estimated VO_2max in the group data shows that the 7-, 10- and 11-year-old children contribute to the moderate tracking throughout school-aged years (Table 5).

Table 5. Comparison of age-related (n=59; ages 7-11 yr) tracking using Spearmen correlations analysis (*rho*) for energy expenditure during guided active play sessions and physical fitness characteristics from baseline to 1-year follow-up. Columns represent different ages from 7 to 11 years. Values are presented as means + standard deviation (* indicates *p*<0.05).

	7 years (n=9)	8 years (n=13)	9 years (n=11)	10 years (n=11)	11 years (n=15)
Energy Expenditure ($kcal \cdot session^{-1}$)	0.900*	0.907*	0.509	0.818*	0.829*
Combined Grip Strength (kg)	0.900*	0.707*	0.784*	0.624*	0.800*
Leg Power (Watts)	0.867*	0.511	0.891*	0.136	0.579*
Systolic Blood Pressure (mmHg)	0.496	0.739*	0.18	-0.389	0.508
Diastolic Blood Pressure (mmHg)	0.194	0.165	-0.116	-0.174	0.512
Estimated VO_2 max ($mL \cdot kg^{-1} \cdot min^{-1}$)	0.747*	0.141	0.423	0.612*	0.609*

Pearson coefficients assessed at baseline identified moderate relationships between EE during GAP with BMI r=0.70 (*p*<0.01) and WC r=0.62 (*p*<0.01) and fitness variables including combined grip strength r=0.79 (*p*<0.01), SBP r=0.57 (*p*<0.05), DBP r=0.65 (*p*<0.01) and estimated VO_2max r=0.38 (*p*<0.05). At 1-year follow-up the relationships for PA levels and adiposity variables increased to r=0.83 (*p*<0.01) for BMI and r=0.77 (*p*<0.01) for WC. Regarding fitness variables, the Pearson coefficients remained similar to those reported in the previous year (baseline), the only exceptions were SBP with a r=0.79 (*p*<0.01).

3.1.5. Discussion

The aim of the study was to investigate the tracking of selected growth and fitness variables delivered over two consecutive summers, as well as PA levels from a self-paced GAP session using cooperative games. The increased EE ($kcal \cdot session^{-1}$) from BL to 1 year and 2-year follow-up confirmed our hypothesis that a self-paced, GAP session focused on enjoyment and social interactions provides strong tracking (*rho*) and moderate agreement (*k*) during childhood. Regarding selected fitness variables combined grip strength also showed strong tracking (rho) and moderate agreement (kappa score); while estimated VO_2max reported moderate tracking. Time at moderate intensity PA (%MPA) and %MVPA were identified to also track moderate (kappa score) during childhood. The results of this study demonstrate that children's participation in a self-paced GAP session and combined grip strength are effective at tracking children during childhood. Finally, the moderate relationship reported for GAP with adiposity and selected fitness variables suggests that participation in GAP is an important contributor to childhood development.

Previous findings showed that PA levels assessed over a 7-day period during early childhood reported weak tracking and fair agreement (62). Moreover, tracking showed fair and slight agreement scores during early childhood for %MPA and %MVPA, respectively, when measured over a 7-day PA period (62). In this study the baseline and 1-year follow-up for %MPA and %MVPA showed moderate agreement with a κ statistic of 0.74 for both variables. Importantly, during GAP the time spent in light PA decreased and the time in VPA increased, this change was observed to have more short-burst movements.

The lower levels of PA in previous studies is likely due to the measurement of habitual PA (62). This is likely due to the external social and environmental factors coming into play during the measurement of habitual PA (39). For instance, the environmental and social changes occurring with childcare transitions have an influence on PA, notably decreasing the degree of tracking (39). In the study, GAP is focused on assessment of PA at key times and places that allow children to be active, unlike habitual PA, which is not representative of the entire day's PA patterns (62). There is little data on the patterns of PA with respect to different time periods, and its impact on the degree of tracking of PA (178). One study aimed to identify the weekday patterns of MVPA to determine if there are specific times of the day that could be most representative of PA participation and found that girls tend to be more active during school periods (morning and early afternoon), while boys are more active after school (late afternoon and evening). In this study, the PA sessions took place during the summer, when school was not in session, thus the school environment was not a factor (178). Furthermore, a common limitation in previous studies is the lack of precision in the measurement of PA. In this study, the measurement of PA with an accelerometer was objective compared to studies with a self-reported measure, and the 10-second epochs reflects children's pattern of short-burst movements (21).

Another objective was to examine the changes in PA from baseline to 1- and 2-year follow-up. Total PA increased at both follow up time points, which is different from a study by Gabel and colleagues where there was no difference in total PA between baseline to follow-up (62). Our results are consistent with a study by Jackson and colleagues, where there was an increase in total PA through the preschool years (82).

Evidence suggests that children are more likely to participate in PA with an unstructured play environment, which aligns with the self-paced, cooperative, non-competitive nature of this program. Intense, "boot camp-style" exercise programs tend to negatively affect PA participation in children (121). Due to their skilled nature and involvement of drills, they may negatively affect interest in PA engagement, which consequently may contribute to development of chronic diseases, and other diseases associated with inactivity (121). Additionally, the pattern of the traditional exercise programs tends to be prolonged and continuous, whereas children's' normal activity pattern is in short bursts, approximately 3 seconds in duration. Instead, facilitated play is shown to promote higher levels of PA compared to these traditional exercise programs (121).

The reported increased in total PA with cooperative, non-competitive games is also likely attributed to the program's encouragement of play and aspects of child well-being. The program allows children to experience the joys of movement through various games, and the language used to promote PA, particularly "play", is used to encourage movement (121). With the growing obesity epidemic, it is important to rephrase the way in which PA is promoted, in a way that children and parents find meaningful. Play has been associated with benefits on children's social, emotional, and cognitive development (31).

The results of this study disagree with a previous report (62), which showed mean muscle power performed on a cycle ergometer to significantly track. The older children in our study showed fair tracking of mean muscle power by vertical jump height. This inconsistency in findings is possibly due to age difference in the study, in which children were younger (age, 4.4 ± 0.8 years at year 1), as opposed to this study, where children were older (age, 8.9 ± 1.7 years at year 1). It has been shown that vertical jump height through anaerobic performance does increase with age (with a plateau during adolescence) (142), these differences in age can be a possible reason for the difference in tracking. Another possible reason for the inconsistency is the difference in assessment protocols. In the study by Gabel and colleagues, muscle power was assessed with a modified 10-second Wingate test, however in this study, muscle power was assessed by a vertical jump test (62). Additionally, the older children showed excellent muscle strength tracking (r=0.86) and a moderate agreement score from BL to 1-year follow-up.

There are many challenges that occur when conducting experiments in a community setting. The limitations of the study included a lower sample size in the second follow up year, due to this set back the data could not be separated to look at different groups such as sex differences, developmental differences or comparing normal versus obese children. However, our previous studies have shown that separating children based on sex or BMI classes does not influence the total EE and it has been shown that an integrated program can lead to an increase in enjoyment and participation (20, 121) . Another limitation is that we were only able to look at 2 follow-up years, an increased number of follow up would allow us to make better conclusions regarding tracking. Therefore, observations of this study need to be confirmed with the use of a larger sample size in follow-up years, an increased number of follow-up years for comparison and include different age groups of children to account for different developmental stages.

To conclude, the evidence suggests that children are more likely to participate in PA with an unstructured play environment, which aligns with the self-paced, cooperative, non-competitive nature of this program. This GAP approach showing stable tracking of children's PA participation may promote stronger relationships between cardiometabolic risk factors during development. With the growing obesity epidemic, it is important to rephrase the way in which PA is promoted, in a way that children and parents find meaningful.

3.2 MANUSCRIPT II

Children's Physiological Adaptations to a Cooperative Games-Based Guided Active Play Community Program

3.2.1. Abstract

Background: It is well established that the decline in children's physical activity (PA) participation can contribute to an increase in the prevalence of paediatric obesity, decrease in physical fitness, and an increased risk for developing disease. It has been shown that higher levels of moderate to vigorous physical activity (MVPA) intensity levels are associated with a lower likelihood of developing these adverse health effects. Although laboratory-based PA intervention studies in a regimented and structured environment have shown improvements in health and fitness variables, this set up has been suggested to be unrealistic and not maintained for community settings. It is uncertain whether these changes will occur in a more realistic setting such as a community program with self-paced guided active play (GAP). Previous studies have shown that in a simulated play environment, children elicit ranges of energy expenditures and percentages of MVPA using games prescribed to initiate active play. It is uncertain whether guided active play over time will lead to improvements in health and fitness variables or whether active play over time will continue to keep children motivated and interested. This study aims to assess children's health-related physical and physiological fitness outcomes in a community setting following a self-paced guided active play program using cooperative games. **Methods**: Children (n=22; 9.8. ±1.3 years) were recruited from a community centre summer day camp program and assessed for height, body mass, body mass index (BMI), waist circumference (WC), combined grip strength, vertical jump height, systolic blood pressure, diastolic blood

pressure and estimates of aerobic power. PA participation was quantified during a self-paced GAP program (1hr·d^{-1} on 3d·wk^{-1} for 8-wks) using accelerometry (ACC) (ActiGraph GT3X+) vector outputs (10 second epochs) to estimate oxygen consumption (VO_2), metabolic equivalents (MET) and EE (kcal·session^{-1}). Anthropometric, health-related physical and physiological variables were compared before and after the 8-wk GAP program using a paired t-test (p level of 0.05). The relationships among the amount of PA (kcal·min^{-1}) and intensity of PA (time spent in moderate to vigorous intensity PA [%MVPA], time spent in moderate intensity PA [%MPA] and time spent in vigorous intensity PA [%VPA]) and select health-related fitness measures were assessed by Pearson correlation coefficients. **Results**: During the 1 hour a day GAP program children completed a weekly average of 677.5±120.3 kcal·wk^{-1} at 41.8±9.9 % MVPA. The %MVPA was higher for boys compared to girls for both %MPA (28.6±4.6 vs 23.4±2.7 %) ($p<0.05$) and %VPA (19.2±5.1 vs 9.7±2.9 %) ($p<0.05$). In contrast, girls time spent in light intensity PA (45.8±5.8 %) was higher compared to boys (31.4±7.8 %) ($p<0.05$), while minimal differences existed for the sedentary classification ($p>0.05$). The relationship for the estimated EE during the program with intensity classifications were for percentage of time spent in sedentary PA (r=0.42; $p=0.05$), light PA (r=-0.24; $p=0.28$) and MVPA (r=0.12; $p=0.59$). The GAP program reduced systolic blood pressure (-7.0±11.3 mmHg), diastolic blood pressure (-11.7±8.8 mmHg) and increased estimated VO_2max (5.3±8.4 ml·kg^{-1}·min^{-1}) ($p<0.05$), with no significant differences observed for body mass, body mass index, waist circumference, and resting heart rate. **Conclusion**: Cooperative games with GAP can be effective in exhibiting high PA and %MVPA and improving children's health-related fitness.

3.2.2. Introduction

The relevance of play in today's changing world is important for children to learn a variety of skills and gain a deeper understanding of the world around them. Play based skills and experiences occur best when children are engaged in broad practices such as free play, guided play, playing games and direct professionally led instruction (86). Research evidence indicates that play related practices can support a variety of skills and learning outcomes for academic literacy, numeracy, and social interactions (3, 45, 58). When free play practices contain an active component, such as exploration and obstacle courses, children's improvements in academic learning outcomes are significantly enhanced (169). As well, children with poor, moderate, and strong motor skills participating in free play show a positive relationship between motor skills and academic performance (190). Unlike free play, guided play involves play facilitators, such as parents, teachers, professionals, and siblings, that provide increased opportunities for children to interact but without directing their movements/actions, while maintaining choice for children on what to do and how to do be engaged (i.e., self-directed/paced) (186). An important advantage of a guided play program (GAP) is that children's activities can focus on one or more outcomes by layering additional skills and experiences into a practice session (89). When children's games are incorporated into guided play practices, the games serve a very useful function by providing rules (structure) that support targeted skill development and learning outcomes suggested to be more effective than adult instructions (86). For example, with music-based games children's self-esteem and self-control significantly improved over an eight-week intervention focused on motor skills (164). A report observing children's active game playing during recess, using balls and hoops, found that children participated more in game play and had improved social competence skills and adjustment scores (137). Although guided play with active games is shown to be an effective strategy for enhancing academic performance and social skills, our understanding of children's guided play with active games (expressed as guided active play [GAP]) is limited for health-related fitness outcomes.

It has been reported that for play-based programs, the time for uninterrupted free and guided play, which embeds practice or participatory experiences, is an effective method to engage children's active participation (144). Cooperative games are a form of play in which children work together (cooperate) with one another to achieve a common objective. The goal of a cooperative game is to reduce emphasis on competition and increase emphasis on the social aspects of play or sport (20, 199). The findings that children's movement patterns are intermittent and conducted in short bouts of 120 seconds or less (5, 111) has led to the suggestion that cooperative (social) games may be an effective approach to promote higher physical activity (PA) levels and cardiorespiratory fitness (2, 20, 58). Support for this suggestion was provided when it was observed that cooperative games could be clustered from low to high PA levels based on estimated energy expenditure (EE) and/or intensity (21). A previous study investigating children's response for oxygen consumption (VO_2), heart rate and metabolic equivalence to traditional cooperative games such as, run and catch, dodgeball and capture the flag, showed PA levels of 50% maximal oxygen consumption (VO_2max), 65% heart rate maximum (HRmax) and 3.25 metabolic equivalents (MET) during a 30-min play session (146). Asthmatic children (n=6) engaging in an active play intervention using cooperative games showed ~76 % HRmax and ~36% moderate to vigorous intensity PA (MVPA) for 22 minutes over a 1 hour session (196).

Although no final assessments were taken for cardiorespiratory fitness, the active play intervention resulted in a high satisfaction rate and increased quality of life with children perceiving that their fitness and asthma had improved. Following an 8-week GAP intervention using cooperative games, children's physical activity scores for fun or enjoyment significantly improved from 67±13% to 76±9% (121). These studies demonstrate the potential of cooperative (social) games within a play-based active play program to improve psychosocial functioning, but whether school-aged children participating in a community-based summer day camp GAP program achieve adiposity and cardiovascular benefits comparable to traditionally structured PA programs is uncertain (31, 63, 165, 176). Furthermore, the importance of summer day camps in community parks and recreational centres have been suggested to be an excellent setting for children to be exposed to health-enhancing environments outside of the academic school year, and that more studies focused on community-based programs are warranted (15, 72).

It has been well documented that children's structured training programs using treadmill and/or cycle ergometer exercise for 6 to 12 weeks of vigorous activity at 80%-90% of HRmax result in improving aerobic fitness, peak oxygen uptake (VO_2peak) and metabolic variables (lipids, glucose) (18, 105, 113, 117). As well, in-school training programs composed of sport skills/games, obstacle courses, and/or circuit training at 85% HRmax, show improved cardiorespiratory fitness (i.e., VO_2max, VO_2peak) (11, 156). Furthermore, children (8-10 years) participating in a 6-week in-school supplementary high intensity interval training (HIIT) program, including circuit training and high intensity games, showed improvements for VO_2peak of 3.4% and 6.5% for normal weight and obese children, respectively (97). These findings, and improvements in waist circumference (WC) for obese children, occurred following children's participation in 6 high intensity games (selected from a total of 14 games) for 6 min each (~36 min) twice a week in a school setting (97). School play-based interventions consisting of both guided play (30 min) and free play (30 min) with physical activity using balls, tennis racquets, hockey sticks, and skipping ropes have been investigated. Findings show that %MVPA for children (7.1±0.3 years) ranged from 30.1% to 39.4% MVPA (87, 88). Although children's fitness adaptations to in-school structured endurance training interventions and/or sport-specific training programs are important, the generalizability of the structured training programs to community play-based active programs have been questioned (168, 192). The poor generalizability is due, in part, to the necessity of having a rigid training programs (i.e., percentage of VO_2max, or %HRmax), expensive equipment, expertise of teacher/professionally led activities. For intervention programs with active game activities, these are inadequately described and/or designed games incorporated into active play studies (186). Therefore, for community-based programs to be effective, a selection of games/activities that encourage children and adolescents to participate in PA are important and need to align with the characteristics, attributes, and qualities associated with GAP programs (186).

The two purposes of this study were to first determine if children's (7-12 years) PA participation over an 8-week community-based GAP program included in a summer day camp environment is maintained. PA was quantified during a 1-hour GAP program ($3d \cdot wk^{-1}$ for 8 weeks) using accelerometer estimated EE, %MVPA and percent of time in sedentary activity (%Sed). Second to assess the impact of a GAP program on the pre-post changes in body composition (i.e., weight; body mass index [BMI]; WC, systolic blood pressure

[SBP]; diastolic blood pressure [DBP]; resting heart rate [HRr]; and aerobic power [estimated VO_2max]). In addition, the range of children's EE and %MVPA were compared to pre-post changes for all variables. Although the summer day camp environment prohibits the possibility of a control group, the observational pre-post study design will further our knowledge of GAP and the effectiveness of using cooperative games in a community centre summer day camp to understand the nature of children's self-paced PA participation on health-related fitness benefits.

3.2.3. Methodology

Thirty-six children between the ages of 7-12 years were registered to participate in a community recreation centre children's summer day camp program for an eight-week period (July-August). This was a convenient sample that was registered and planning to attend all 8 weeks of the camp (Monday to Friday). Prior to start of the summer camp, children and their parents or guardians attended an information/orientation session. As a result, fourteen children decided not to participate in the research study; however, they did participate in all aspects of the summer camp including the GAP sessions with no data obtained. The remaining twenty-two (n=22) children were recruited into the study with parents/guardians submitting informed consent forms and a physical activity readiness questionnaire (PARQ+). Children's participation in the study was also dependent on their assent to start and continue in the research program. The study was approved by the University's Human Participants Research Ethics Committee.

Physical activity programming in the eight-week summer camp for all 36 children included GAP sessions, which were delivered three days per week for $60 min \cdot d^{-1}$ in the afternoon (1-2pm or 2-3pm). The rationale for selecting a GAP format was that children can set their own pace (i.e., self-paced) when participating in physically active cooperative games, such as tag and relays, to promote physiological benefits; and the activities are guided (facilitated) to encourage PA participation but with minimal instruction and feedback using positive role models (186). The guided positive role models involved in the GAP were experienced kinesiology undergraduate majors, who attended 3 workshops and participated in 3 GAP sessions in a ratio of five-children for one-undergraduate student. The positive role models participated in the games to encourage children to participate but at no time were the children forced and/or ridiculed for not participating; children's engagement in the games is self-chosen and under their control.

The GAP sessions (~55 minutes) included a warm-up period, approximately six self-paced, age-appropriate cooperative games, and a water break (122). The cooperative games identified for the GAP sessions included games with sprinting, switching direction and starting and stopping such as tag, red light green light and fishes and whales (see Appendix F for a more detailed description of games that were played) (77, 98). The GAP sessions were semi-structured, so the researchers and physical activity leaders had games planned for each session that provided opportunity for children to increase the volume of PA participation (EE) and/or spend time at moderate-to-vigorous intensity levels (%MVPA). In addition to the proposed cooperative games there was always an option for the children to suggest alternative games. Appendix E includes examples of cooperative games classified by intensity levels. All activity sessions were conducted in a temperature-controlled 20±1^{o}C gymnasium.

Anthropometric, cardiovascular (blood pressure and heart rate), and aerobic fitness assessments were completed at the community centre in the first week of the camp between

10:00am to 12:00pm. The assessments were completed by the researchers and supported by physical activity leaders (kinesiology students) trained and experienced in children's measurement techniques. Anthropometric assessments included i) body mass (kg) measured on an electronic weight scale; ii) height (cm) measured twice to the nearest 0.25cm without footwear and while standing with their arms at the side looking straight ahead; and iii) waist circumference (cm) was measured and averaged over two trials to the closest 0.25cm. Body Mass Index (BMI) was also calculated for each child ($kg{\cdot}m^2$). For anthropometric variables, the percentage of coefficient of variation (%CV) for each assessor (n=4) on each variable was <3.0%. Select cardiovascular assessments were conducted at rest after a period of 10 minutes of quiet sitting. Resting systolic and diastolic blood pressures (mmHg) and resting heart rate (bpm) were measured electrically (Omron 3214). All cardiovascular measures were assessed twice and averaged with a %CV for systolic and diastolic blood pressure of 0.4% and 0.5%, respectively). Aerobic power (estimated VO_2max – $mL{\cdot}kg.min^{-1}$) was assessed using the Leger multistage 20 meter shuttle run as previously described (100, 122).

Physical activity was quantified with ActiGraph GT3X+ accelerometers (ACC) for the GAP sessions. ACC were placed at the hip with elastic bands and outputs expressed as vector in counts ($cnts{\cdot}10s^{-1}$) (26). VO_2 was estimated using a laboratory generated linear regression equation (21, 121), with a standard error of estimate of 0.75 $mL{\cdot}kg^{-1}{\cdot}min^{-1}$ for children during treadmill exercise and 3.23 $mL{\cdot}kg^{-1}{\cdot}min^{-1}$ when playing active games (123). To classify the volume of PA, the VO_2 estimates derived from ACC outputs were used to calculate EE per minute, per session, per week and/or per camp (using SPSSv24).

Metabolic equivalents (MET) were determined using a laboratory generated linear regression equation (21, 123) with a standard error of estimate of 0.3 MET for children during treadmill exercise and 1.2 MET when playing active games. Classification of intensity levels were as follows; sedentary (0 – 2.99 MET); light PA classified (3 – 3.9 MET), moderate PA (4-5.9 MET) and vigorous PA (>6 MET). The percent time spend in each category was calculated for each child, for each session over the eight weeks and reported as sedentary (%Sed), light (%LPA), moderate (%MPA), vigorous (%VPA), and/or moderate to vigorous (%MVPA) physical activity. Because of the intermittent (stop-start) nature of PA when children play self-paced cooperative games, the %Sed activity (up to 2.99 MET) was used to reflect the metabolic cost of recovery periods that range from ~5 to 15 $mL \cdot kg^{-1} \cdot min^{-1}$, rather than movements classified by cut-off points. This increased metabolic response (i.e., metabolic recovery) occurs at a time when minimal to no movement is captured by the accelerometer (i.e., <200 $cnts \cdot 10s^{-1}$). The metabolic cost during recovery has been reported to be important in children's physiological adaptations to exercise (56).

Descriptive data are presented as the mean ± standard deviation (SD). Anthropometric, health-related fitness variables were compared before and after the 8-wk GAP programs using a paired t-test (*p* level of 0.05). Comparison of main effects for daily and weekly estimated EE and percent of time at intensity levels (i.e., sedentary, light, moderate, and vigorous PA) were performed with analysis of variance, and group mean differences assessed by Tukey post-hoc test at ($p<0.05$). Relationships among estimated EE ($kcal \cdot min^{-1}$; $kcal \cdot session^{-1}$; $kcal \cdot wk^{-1}$ and $kcal \cdot camp^{-1}$), intensity of PA (%Sed; %LPA; %MPA; %VPA and %MVPA) and health-related fitness measures were assessed by

Pearson Product Moment Correlation coefficients. All statistical analyses were conducted using the SPSS v24.

3.2.4. ***Results***

Participant Characteristics

Children's characteristics can be found in Table 1. Out of the 22 participants, there were 9 girls and 13 boys. The average age was 9.8±1.3 years with minimal age differences between girls and boys (p>0.05). The children's average body mass, height, body mass index (BMI) and WC were 42.5±12.1 kg, 144.1±9.8 cm, 20.3 ± 4.7 $kg \cdot m^2$, and 67.2±11.0 cm respectively, with minimal sex differences (p>0.05). The mean SBP, DBP, HRr and estimated VO_2 max were 102±11 mmHg, 68±7 mmHg, 77±12 bpm, and 43.6±5.0 $mL \cdot kg^{-1} \cdot min^{-1}$. There were no sex significant differences for systolic and diastolic blood pressure and heart rate. Boys had a significantly higher estimated VO_2max than the girls.

Table 1: Characteristics of children prior to the guided active play program. Values are presented as means ± standard deviation. Sex differences between girls and boys are denoted by an asterisk (*) for a *p*<0.05.

	Total (n=22)	Girls (n=9)	Boys (n=13)
Age (years)	9.8 ± 1.3	9.9 ± 1.2	9.8 ± 1.4
Body Mass (kg)	42.5 ± 12.1	41.7 ± 10.6	43.0 ± 13.5
Standing Height (cm)	144.1 ± 9.8	145.2 ± 8.6	143.4 ± 10.9
Body Mass Index ($kg{\cdot}m^2$)	20.3 ± 4.7	19.6 ± 3.5	20.8 ± 5.4
Waist Circumference (cm)	67.2 ± 11.0	65.6 ± 7.9	68.3 ± 12.9
Systolic Blood Pressure (mmHg)	102 ± 11.0	100 ± 11.0	104 ± 10.0
Diastolic Blood Pressure (mmHg)	68 ± 7.0	66 ± 7.0	70 ± 8.0
Resting Heart Rate (bpm)	77 ± 12.0	81 ± 12.0	74 ± 12.0
Estimated VO_2 max ($mL{\cdot}kg^{-1}{\cdot}min^{-1}$)	43.6 ± 5.0	41.2 ± 2.9	*45.9 ± 5.3

Physical Activity Levels During the Eight Week Guided Active Play Program

The GAP program was planned for 4 $d{\cdot}wk^{-1}$ for 8 weeks (i.e., 32 days) from July-to-August; however, considering vacation days and field trips there were 29 days available for the GAP programming. On average children participated in 75% of the available sessions (22.5±2.1 days) or 3 $d{\cdot}wk^{-1}$, which was consistent regardless of sex, age, BMI and/or VO_2max (p>0.05). The average duration of a GAP session was 55±3 $min{\cdot}d^{-1}$ over the eight weeks. The cumulative 8-week average estimated EE for the ~1-hour GAP program was 5076.0±1124.7 $kcal{\cdot}camp^{-1}$, with a range of 3439.1 to 7229.3 $kcal{\cdot}camp^{-1}$. Boys EE levels were 5256.6±1165.7 $kcal{\cdot}camp^{-1}$, compared to girls with 4816.6±1074.3 $kcal{\cdot}camp^{-1}$ (p>0.05). The cumulative 8-week estimated EE for the 1hr of GAP were moderately related to number of participation days (r=0.64; p<0.05), but not with age (r=0.37; p=0.092), BMI (r=0.42; p=0.069), and/or VO_2max (r=-0.19; p=0.39). The estimated weekly EE outputs for the children's self-paced GAP program are depicted in Figure 1. The estimated EE per week (3 $d \cdot wk^{-1}$) during the 1-hour GAP sessions were 677.5±120.3 $kcal \cdot wk^{-1}$. During summer day camp, the daily EE for a ~1-hour GAP session was 225.6±39.8 $kcal \cdot session^{-1}$ and the average EE per minute was 4.1±0.1 $kcal \cdot min^{-1}$. The weekly EE outputs for most of the 8-weeks were not different (p>0.05) with the exception of week 2, which was higher than week 1 (p<0.05) (Figure 1).

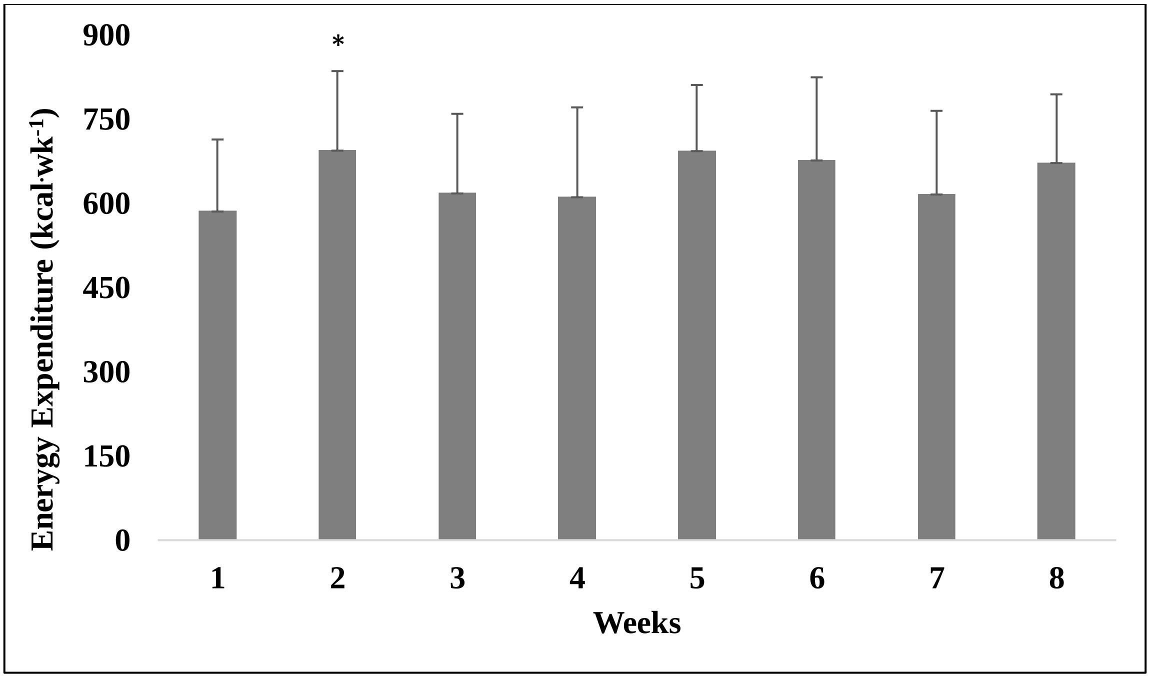

Figure 1: Children's (n=22) average weekly estimated energy expenditure (EE) ($kcal \cdot wk^{-1}$) for the eight-week, 1 $hr \cdot d^{-1}$, 3 $d \cdot wk^{-1}$ guided active play program. The difference in energy expenditures between week 1 and week 2 were significant (* *p*<0.05). EE for week 1 was not different than the other weeks (*p*>0.05). Standard deviation error bars are included.

The 8-week GAP program average for percentage of time spent in each intensity classification is reported in Figure 2. The moderate-to-vigorous intensity PA was highest with 41.8±9.9 %MVPA, while the time spent in the remaining classifications were sedentary (21.0±2.9 %Sed), light (37.3±10.0 %LPA), moderate (26.5±4.7 %MPA) and vigorous PA (15.4±6.4 %VPA) (Figure 2). Boys had a greater %MVPA compared to girls with 47.8±7.8 %MVPA and 33.1±5.00 %MVPA, respectively ($p<0.05$). The higher time spent in MVPA for boys compared to girls was contributed to by both the %MPA (28.6±4.6 vs 23.4±2.7 %MPA) ($p<0.05$) and %VPA (19.2±5.1 vs 9.7±2.9 %VPA) ($p<0.05$) (Figure 3). In contrast, girls spent more time in light PA (45.8±5.8 %LPA) compared to the boys (31.4±7.8 %LPA) ($p<0.05$), while minimal differences existed for the sedentary classification ($p>0.05$). The relationship for the estimated camp EE with intensity classifications were for %Sed (r=0.42; $p=0.05$), %LPA (r=-0.24; $p=0.28$) and %MVPA (r=0.12; $p=0.59$).

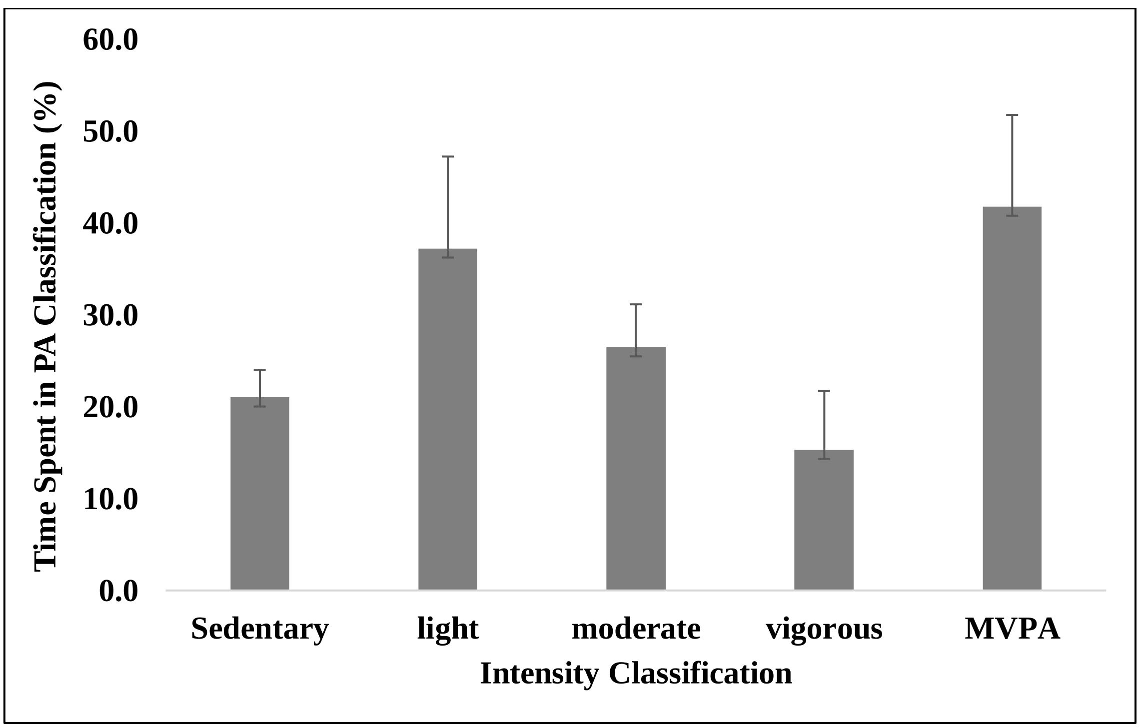

Figure 2: Children's (n=22) percentage of time spent in five intensity classifications for sedentary (0 – 2 MET), light (3.0 – 3.99 MET), moderate (4.0 – 5.99 MET), and vigorous (>6 MET) during an 8-week guided active play program. MVPA represents the cumulative time spend in moderate and vigorous combined. Standard deviation error bars are included.

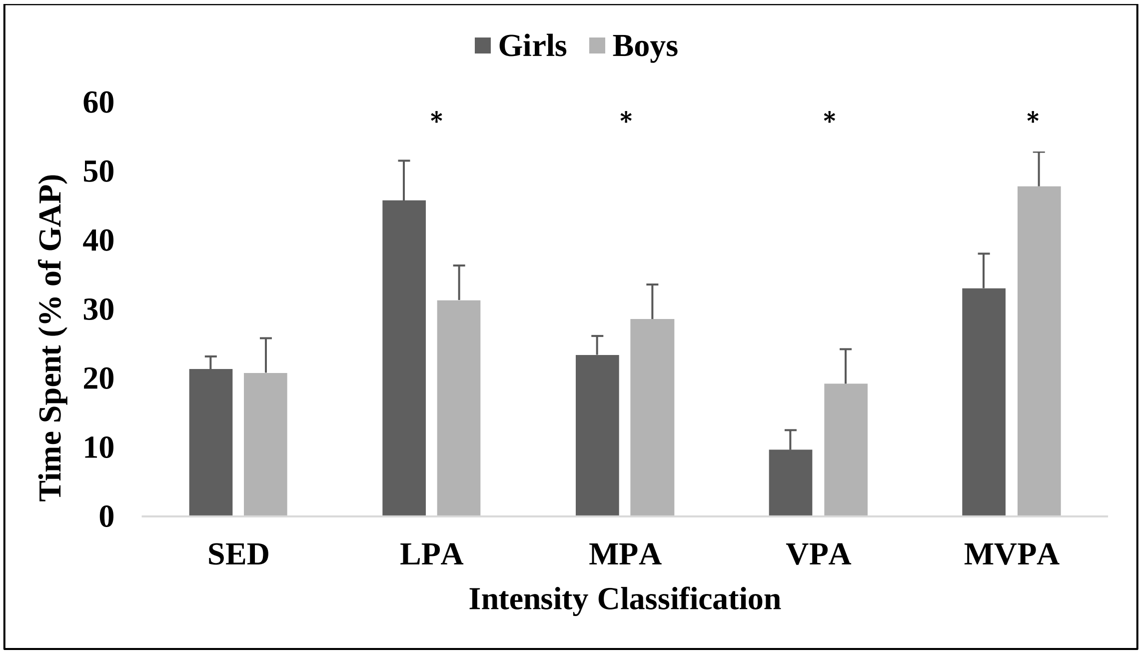

Figure 3: Proportion of time spent in four intensity classifications during an eight-week summer day camp that incorporated a one-hour a day, three days per week guided active play program. Intensity classification included sedentary (SED) (0 – 2 MET), light (LPA) (3.0 – 3.99 MET), moderate (MPA) (4.0 – 5.99 MET), and vigorous (VPA) (>6 MET) by girls and boys. MVPA represents the cumulative proportion of time spend in moderate and vigorous combined. Standard deviation error bars are included Sex differences between boys and girls are denoted by an asterisk (*) for a *p*<0.05.

Figure 4 illustrates the percentage of time spent in each intensity classification by week over the GAP program with the percentage of time spent in %MVPA representing approximately 42% from week-to-week. The %LPA was approximately 37% over a week-to-week comparison, with the %Sed classification at approximately 21% from week to week (Figure 4).

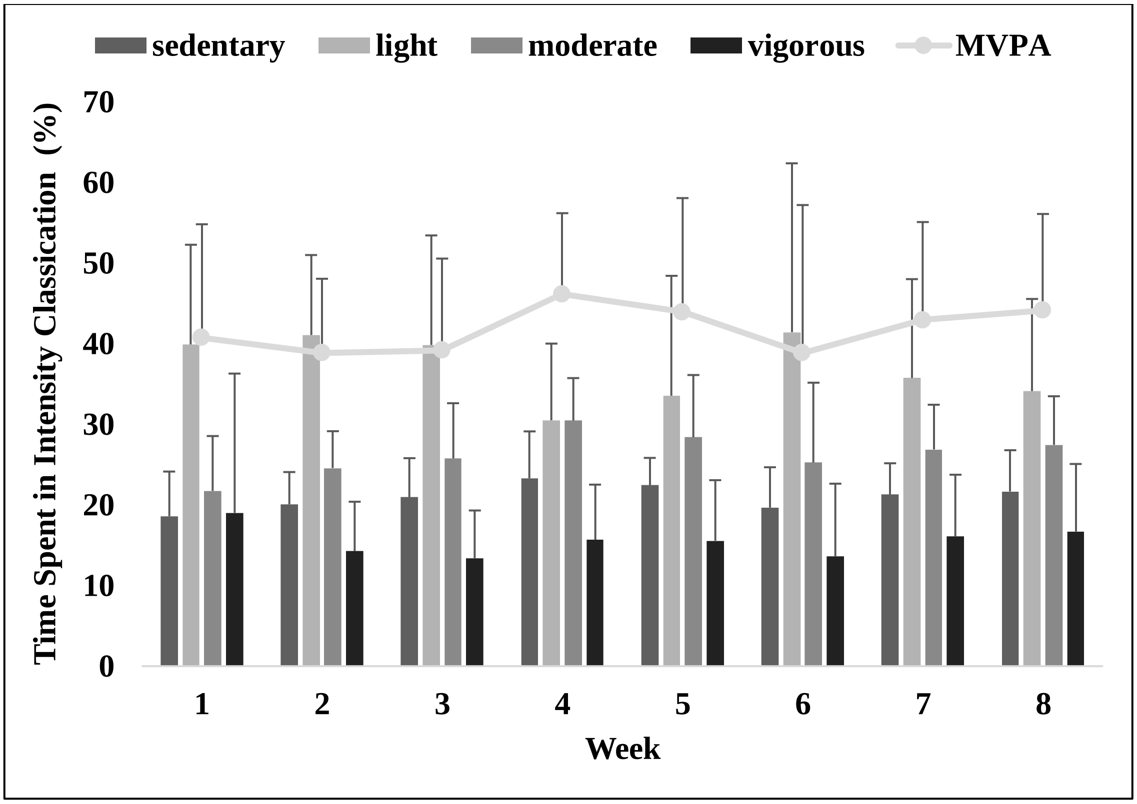

Figure 4: Children's (n=22) average weekly percentage of time spent in four intensity classifications during a summer day camp that incorporated a one-hour a day, three days per week guided active play program. Intensity classifications were described as sedentary (0 – 2 MET), light (3.0 – 3.99 MET), moderate (4.0 – 5.99 MET), and vigorous (>6 MET). MVPA represents the cumulative percent of time spend in moderate and vigorous combined. Standard deviation error bars are included.

Pre-Post Anthropometric, Select Health-Related Fitness Variables

Following 8-weeks of GAP children (n=22) showed percent improvements in resting SBP (-7.0±11.3 %) ($p<0.05$), resting DBP (-11.7±8.8 %) ($p<0.05$), and estimated VO_2max (5.3±8.4 %) ($p<0.05$) (Table 2). Sex differences observed for body mass, body mass index, waist circumference, resting SBP, resting HR and VO_2max were not different (data not shown) ($p>0.05$). Comparing pre-post percent changes following the GAP program identified that boys only had a greater improvement in resting DBP compared to girls with -15±9 % vs -7±6 % ($p<0.05$). Guided active play resulted in non-significant changes for body mass, body mass index (BMI), waist circumference and resting heart rate after 8-weeks (p>0.05) (Table 2).

Table 2: Pre-post comparisons between anthropometric (body mass, body mass index, waist circumference), cardiovascular (resting systolic blood pressure, resting diastolic blood pressure, resting heart rate) and fitness (estimated VO_2max) for school-aged children (n=22). Significant difference (p<0.05) between pre and post values are denoted by an asterisk (*). Relative change percentage referred to as percent difference (% Diff) is also included. Values are presented as means ± standard deviation.

Total (n=22)	PRE	POST	% Diff
Body Mass (kg)	42.5 ± 12.1	41.7 ± 12.6	-1.6 ± 9.2
Body Mass Index ($kg{\cdot}m^2$)	20.3 ± 4.7	20.0 ± 5.0	-1.9 ± 9.3
Waist Circumference (cm)	67.2 ± 11.0	68.1 ± 10.6	1.5 ± 3.9
Systolic Blood Pressure (mmHg)	102 ± 11.0	94 ± 8.0 *	-7.0 ± 11.3
Diastolic Blood Pressure (mmHg)	68 ± 7.0	60 ± 6.0 *	-11.7 ± 8.8
Heart Rate (bpm)	77 ± 12.0	80 ± 12.0	3.9 ± 9.6
Estimated VO_2 max ($mL{\cdot}kg^{-1}{\cdot}min^{-1}$)	44.0 ± 5.0	46.3 ± 6.0 *	5.3 ± 8.4

3.2.5. Discussion

The primary purpose of this study was to investigate if children's (7-12 years) PA participation, assessed by EE and intensity levels (%MVPA) are maintained over an eight-week summer day camp that incorporates a GAP program (1 $hr{\cdot}d^{-1}$, 3 $d{\cdot}wk^{-1}$) using cooperative games. The second objective was to identify if a children's GAP program incorporated into a community centre summer day camp would improve adiposity (BMI, WC) and/or cardiovascular fitness variables (SBP, DBP, estimated VO_2max) in children. A novel finding of this study was that children registered in a summer day camp and participating in an 8-week self-paced GAP program (~1 hour of GAP for 3 $d{\cdot}wk^{-1}$) achieved a cumulative camp average of 5076.0±1124.7 kcal with a range of 3439.1 to 7229.3 kcal. The boys cumulative EE for GAP was higher than girls, however the differences were not significant. During the ~1-hour GAP session children's EE averaged 225.6 ± 39.8 $kcal \cdot session^{-1}$ with a weekly EE average of 677.5±120.3 $kcal \cdot wk^{-1}$ sustained over the 8-weeks. In regard to PA intensity, children participating in the self-paced GAP program had a weekly average of 41.8±9.9 %MVPA. Boys were assessed to have higher %MPA and %VPA than girls during 1-hour self-paced GAP, whereas girls participated in significantly more %LPA throughout the 8-weeks. The second novel finding was that children's participation in 8-weeks of self-paced GAP using cooperative games resulted in health-enhancing PA as evidenced by pre-post improvements for cardiovascular fitness variables (blood pressure (BP) - systolic and diastolic and estimated VO_2max). The pre-post differences for boys and girls were not significant, except for diastolic blood pressure where, although the girls' showed significant improvements, the percentage change was less than that for the boys. Minimal pre-post observations for the adiposity variables were noted for boys and girls following self-paced GAP. The findings from this study are relevant for community-based summer programs that target school-aged children's GAP formats and wish to use cooperative games to generate health-enhancing PA for improvements in cardiovascular fitness. The finding that physiological variables can be improved with GAP aligns very well with the improvements reported for fundamental motor skill, positive psychosocial functioning, and academic performance outcomes.

Metabolic Characteristics of Cooperative Games in a Guided Active Play Program:

School-aged children (n=28; 8.6 years) involved in simulated free-playing of ~10 out of 30 possible cooperative games for 6 minutes each had an average EE of 4.1 $kcal \cdot min^{-}$

^{1} and relative EE of 0.118 kcal·kg·min^{-1} at an average intensity of 5.1 MET using a portable metabolic analyzer (77). The 30 cooperative games were observed to have a range of EE from 3.3 to 5.4 kcal·min^{-1} and intensity levels from 4.4 to 6.3 MET with no significant differences between boys and girls. It was reported that during simulated guided active play clusters of cooperative games based on average EE could be identified ranging from 2.7 to 5.1 kcal·min^{-1} (21). These previous results for small groups of children (n=2-5) playing individual games for ~5-minutes were compared to longer bouts of active play with ~25 children. During a 30-minute active play session using traditional cooperative games that included run and catch, dodgeball and capture the flag, school-aged children (n=16; age = 9.6 year) performed at 65% HRmax reported EE levels of 3.9 kcal·min^{-1} with a relative EE of 0.127 kcal·kg·min^{-1} for a total of 118.5 kcal·30min^{-1} at an average of 3.25 MET (146). Similar findings were reported for pre-school children (n=11; age = 4.7 year) performing active for 20 minutes with an average EE level of 3.9 kcal·min^{-1} with a range of 3.1–5.1 kcal·min^{-1} and an average intensity level of 5.91 MET using a portable metabolic analyzer (68). To the best of our knowledge the current study is the first to show that cooperative games performed in a longer GAP session (~55 minutes) with 22 school-aged children over 8-weeks had an average EE of 4.1 kcal·min^{-1} and a relative EE of 0.174 kcal·kg·min^{-1} for a total of 225.6 kcal·session^{-1} at an average of 4.80 MET (range from 3.70 to 6.77 MET). The finding that children could not only maintain single game EE and %MVPA levels, but also sustain them over an 8-week summer camp program is important for community recreational centre's aiming to improve health-related physical and physiological fitness parameters during the summer camp (72, 140). Finally, the findings that poor to moderate relationships between PA levels occurring during the PA components of a summer camp with age (r=0.37; p=0.092), BMI (r=0.42; p=0.069), and/or VO_2max (r=-0.19; p=0.39) suggests that cooperative games within a GAP format may be an effective programming strategy for children's summer day camps regardless of large differences in children's body composition and fitness levels that exist with diverse camp registrants. This is an important finding in support of providing health-enhancing PA in community centre programming for boys and girls participating in a self-paced, fun environment.

While all activities occurring in the full day summer camp were not evaluated, it has been suggested that the effectiveness of the physical activities component of a summer day camp must include a proportion of time at MVPA in either continuous and/or bouts of activity and should be studied over several weeks/months to provide positive health-related fitness benefits (68, 146, 188). The weekly %MVPA levels for cooperative games during GAP in this study were 41.8 %MVPA with a range of 38.9% to 46.2 %MVPA were higher than those previously reported for children (5-12 years) attending a summer day camp. Previous findings showed daily averages of 15.6 %MVPA for play-based programming (i.e., free-play and structured play opportunities both indoor and outdoor) and 24.0 %MVPA for sport focused summer day camp (i.e., tennis) (15).

The higher intensity levels for cooperative games and self-paced GAP that includes short burst/sporadic activity patterns, compared to free-play activities, have been suggested to promote children's cardiorespiratory fitness and blood pressure improvements (188). Although boys had a greater %MVPA compared to girls with ~48 %MVPA (or 26 minutes per session) versus ~33 %MVPA (or 18 minutes per session) over the 8-weeks, these levels are within the range identified to improve cardiorespiratory fitness and blood pressure (188). As well, the finding that girls spent more time in light PA (~46 %LPA) may have also contributed to improvements in cardiorespiratory fitness (140), and should not be overlooked in programming summer day camp PA components.

In light of the greater %MVPA for cooperative games during GAP noted for this study compared to previous reports requires some explanation. It has been reported that while a linear regression model to predict MET from ACC output accounts for 65% of the variability found in activities of daily living, there are intrinsic errors in estimating MET based on ACC outputs using a linear regression model (96). The errors are associated with the inability of ACC outputs to determine MET values for upper body effort (i.e., carrying a load), to assess MET levels from walking up a grade compared to walking on the ground, and to accurately predict MET values when ascending stairs (i.e., intermittent high-intensity activity). To address these possible errors and lower the possibility of incorrect classifications of PA intensity, this study used cooperative games that do not promote upper body effort, grade walking, and/or stair climbing. Second, MET levels predicted from a linear regression model were used to classify PA intensities for cooperative games instead of aligning ACC outputs to cut-off levels (122). In addition, the MET values for cooperative games were estimated from ACC vector outputs (3-axes in $counts \cdot 10s^{-1}$) and not ACC vertical outputs (1-axis in $counts \cdot min^{-1}$) by a linear regression model with a coefficient of determination (R^2) of 0.951 and a standard error of estimate of 0.355 MET for cooperative games (123) (see Appendix E). This is important since ACC outputs using epoch intervals of 60 seconds for classifying intensity results in a large proportion (i.e., 65% to 71%) of the simulated free-play cooperative games to be classified incorrectly (77, 143). Epoch intervals between 6.4 and 12.8 seconds were used since they have been associated with improved accuracy (93%) for classifying intensity and type of PA (26). In addition, the stop-and-start movement patterns that occur with children's games may underestimate MET levels when using ACC cut-off levels to classify PA intensity levels. To minimize the underestimation of MET associated with assigning cut-off values, this study used predicted MET value to assign intensity levels. For example, ACC outputs for cooperative games have been reported to have relatively low counts (0 to 200 cnts.10^{s-1}), which is characteristic of minimal to no movement (i.e., sedentary) despite a metabolic cost of 3-5 MET (123). This phenomenon (minimal movement with higher metabolic rate) is referred to metabolic recovery and is associated with excess post-exercise oxygen consumption (EPOC), which is important in physiological adaptation processes for children (56). A third possible explanation for these higher %MVPA results may be that during the PA components children playing cooperative games in a GAP program were able to engage in more social interactions and enjoyment with their peers and the kinesiology leaders. A previous study reported that children's activity levels during school playtime promoted many social interactions, as well as being active, resulting in more positive behaviours (150). In fact, the findings showed that both the time spent alone, and antisocial behaviours decreased as the program continued. Similar results were reported for a simulated free-play environment where cooperative games showed enjoyment levels of 71% across 30 games (77). In addition, a GAP intervention using cooperative games resulted in children's PA scores for fun or enjoyment significantly increased from 67±13 % to 76±9 % (121). Taken together the results of this study support the suggestion that cooperative games (and GAP) are important and relevant features that should be incorporated into children's summer camps (15, 72, 81).

Physiological Adaptations Following a Guided Active Play Program Using Cooperative Games:

The children in the current study showed a statistical, +5.3% improvement in estimated VO_2max, which is similar in magnitude to those observed in previous studies for prepubertal children during high intensity interval sprint training (HIIT) (running) and aerobic endurance training. Following 13 weeks of continuous run endurance training at MVPA (>80%HRmax; 3 times per week) VO_2max increases ranged from +7 to +15% with minimal differences observed between boys and girls (112, 132). When comparing continuous run training with HIIT, both groups reported increases in peak VO_2, however, the HIIT group alone was associated with increases for other cardiorespiratory variables (i.e., peak oxygen pulse, oxygen pulse at the ventilatory threshold, and ventilatory threshold). As a result, it was suggested that a HIIT program confers a different training effect in comparison to continuous steady-state training (11, 13, 118). Despite similarities in cardiorespiratory responses following 7-weeks of continuous moderate and/or HIIT programs, the intermittent nature of a HIIT program, which resembles the intermittent and sporadic nature of children's PA movement patterns, may be better suited to elicit children's physiological adaptations (11, 13). A systematic review concluded that HIIT programs (i.e., two or three times a week for 7 weeks) show the greatest improvement in physical and cardiovascular health among children and adolescents (51).

The significant improvements in systolic and diastolic BP of -8 mmHg (-7.0%) and -8 mmHg (-11.7%) for school-aged children following the GAP program are comparable to adaptations (i.e., SBP [-4.3 %] and DBP [-5.0 %]) from previous reports using HIIT programming (145, 180). In contrast children engaged in continuous moderate intensity PA programs, showed lower BP responses for SBP (-1.6 %) and DBP (-2.4 %) (145, 180). The reason for this finding is uncertain, however the repeated effects of post-exercise hypotension (PEH) associated with the intermittent PA movements during cooperative games may contribute to the larger improvements in blood pressure (146). When adjusted for exercise intensity a 30-minute session of playing cooperative games compared to playing video games and watching television showed significant increases for SBP (+19 %) and DBP (+8 %) during the cooperative games. Following 40 minutes of recovery from cooperative games the average BP were significantly reduced for SBP (-5.4%) and DBP (-6.1%) compared to TV watching (146). To verify the BP responses to cooperative games, video games and TV watching a 60-second cold pressor test was administered immediately following recovery and showed a reduced post-exercise BP reactivity linked to unknown vasodilatory responses. While the current study did not evaluate BP responses during GAP, if the acute PEH continued during the 8-week GAP program then this may have contributed to the improved BP changes noted in this study (146). Although the mechanism(s) underlying the BP changes are unknown, future studies focused on vasodilatory control (i.e., endothelial-dependent, and endothelial-independent) mechanisms need to be investigated.

Regarding adiposity parameters, no significant improvements were reported for body mass, BMI and WC after 8-wks of the summer camp GAP program. Following a summer recreational and educational day camp focused on adiposity variables for overweight and obese children (9-11 year) no significant changes were noted for body mass and BMI (147). Furthermore, the lack of changes in body composition agrees with observations from a systematic review which concluded that little evidence is available to suggest that HIIT can elicit significant changes in body composition (51). Although no significant improvement in measures of body mass and/or BMI occurred for this summer day camp program, children (9.4 year) attending a residential camp, focused on lifestyle behaviours including PA as well as nutritional and stress management classes for 2 weeks have shown improvements in body composition (148). Under these conditions, a multi-professional team lead the children through all aspects of camp activity, including educational programs, PA sessions and stress management counselling, which resulted in improved body mass, BMI and WC. In summary, it appears that summer day camps using GAP and cooperative games as PA interventions can target cardiorespiratory and cardiovascular variables but are not necessarily associated with significant adiposity improvements in school-aged children. A systematic literature review by Strong et al., (2005) showed that moderate PA for 30 to 60 minutes lead to reduced total body and visceral adiposity in overweight children but such programs do not influence the percentage of body fat in normal weight children thereby indicating the normal weight children may require a larger volume of intense PA to achieve such benefits (174). Whether the total PA EE, %MVPA and/or the intermittent and sporadic movement patterns observed for cooperative games within the GAP program contributed directly to these improvements is unclear.

The current study has some limitations. First, the recruitment of a convenient sample/cohort from a community recreational centre's summer camp program limits the generalizability of these results. The children in the current study may have been accustomed/attracted to PA, thereby contributing to higher levels of PA participation. Future studies should consider recruiting a control group and/or comparator group to deal with potential bias that may exist within a convenient sample group. Second, the total sample size and the number of boys and girls is limited and do not allow for statistical assumptions to be achieved (i.e., power of the test) for comparisons between genders. Third, although the assumption that cooperative games within a GAP format are associated with intermittent and sporadic movement PA patterns for children is valid, future studies should quantify the number and duration of stop-and-start movements, and diagonal (perpendicular) movements. These data are important before the role and/or impact of movement PA patterns are assigned to children's PA participation and physiological adaptations. Fourth, we only recorded PA levels within the 60-minute GAP program. Therefore, it is unknown whether the recreational and social program activities within the full day at summer camp might have influenced the PA levels and subsequent physiological adaptation for children. Although a full day summer camp energy expenditure and %MVPA showed lower EE ($kcal \cdot min^{-1}$) and %MVPA compared to the GAP program (see Appendix E for pilot study). Lastly, it is well known that genetic factors and ethnicity could be related to hypertension in adulthood, but no evidence is available regarding such differences in children. In this study, our convenient group was composed of African-American, East Asians and Caucasians, it may be interesting to look for such potentially genetic differences in future studies.

In summary, the most relevant finding of the current study was that a community summer day camp containing 60 minutes of cooperative games within a GAP program (8-weeks, 3 $d \cdot wk^{-1}$) resulted in increased VO_2max and improved BP in children. The mechanism(s) underlying these changes could be due to increased metabolic demands and energy expenditures elicited during cooperative games and guided active play. Therefore, cooperative games in a GAP based intervention appear to be very practical to include in the PA components of a summer day camp when considering PA levels, and participation. Further studies should be undertaken to investigate the impact of PA intensity, type and duration of PA movement patterns on children's cardiovascular and adiposity risk factors during GAP.

3.3 MANUSCRIPT III

Short-Term Vascular Responses to Children's Guided Active Play

3.3.1. Abstract

Background: This study examines the effectiveness of a guided active play (GAP) intervention on body composition changes and cardiovascular (blood pressure and heart rate) parameters of school-aged children. Identifying early, short-term responses to play-based physical activity (PA) are required to encourage children to be physically active and improve cardiometabolic health and fitness. This study aims to determine the impact of PA levels on anthropometric, musculoskeletal fitness, cardiorespiratory and microvascular function following a 5-week GAP program. **Methods**: This was a pre-post design for children (n=18; 9.8±1.5 years) participating in a 5-week (4 days·week^{-1}; 1 hour·day^{-1}) self-paced GAP program using cooperative games. Height, body mass, body mass index (BMI), waist circumference (WC), grip strength and estimated leg power, blood pressure, and estimated aerobic power (VO_2max) were assessed. Vascular function was assessed by Laser Doppler Perfusion Imaging paired with iontophoresis to assess cutaneous microvascular flow stimulated by endothelial dependent (ED) and endothelial independent (EI) mechanisms at a current of 20 µA for 210 seconds (ED) and 400 seconds (EI) using acetylcholine (ACH) and sodium nitroprusside (SNP). **Results**: Children completed an average of 556±132 kcal·wk^{-1} at 34.3±16.8 % time at moderate-to-vigorous intensity (%MVPA) throughout the GAP program. Short-term GAP program reduced resting heart rate (-9.5%) ($p<0.05$) and diastolic blood pressure (-7.8%) ($p<0.05$), with no significant differences observed for body mass, WC, BMI, musculoskeletal fitness (grip strength and leg power) and estimated VO_2max ($p>0.05$). EI stimulated vascular perfusion was higher

for measures of peak perfusion (19.8%) (p>0.05), average perfusion (36.8%) (p<0.05), and area under the curve (28.8%) (p<0.05). Following GAP, the relationships between EI perfusion with mean arterial pressure and systolic blood pressure were r=0.60 (p<0.05) and r=0.63 (p<0.05). No significant differences were observed for ED stimulated vascular perfusion and their relationship to any other variables (p>0.05). The relationship between changes in EI stimulated vascular peak perfusion with energy expenditure and %MVPA were r=0.74 (p<0.05) and r=0.70 (p<0.05). ED stimulated peak, average and total perfusion following the GAP were mixed. Following the 5-weeks of self-paced GAP program, the rates of vascular perfusion, assessed by quadratic equations, showed pre- versus post differences for coefficient a of 1.09±0.78 and 1.63±0.9 (p<0.05) and a coefficient b of -0.17±0.81 and -0.74±1.03 (p<0.05), respectively. **Conclusion**: Children benefitted from a relatively high energy expenditure and %MVPA during the self-paced PA. The GAP intervention showed early cardiovascular changes without changes in body composition, musculoskeletal fitness and VO_2max. Children's control of vascular function following a short-term GAP program shows a positive adaptative response of EI stimulation (or smooth muscle control) of perfusion compared to ED stimulation.

3.3.2. Introduction

The importance of increasing physical activity (PA) levels as a strategy to improve select health-related cardiometabolic risk factors during childhood and adolescence has been well documented (7, 12, 139). Endurance training protocols employing progressive intensity levels of 80-90% maximal oxygen consumption (VO_2max) and/or maximal heart rate (HRmax) over approximately 10-weeks report improvements for children's peak oxygen uptake (VO_2peak), blood pressure, blood lipids and glucose (18, 105, 113, 117). Children's high intensity interval training programs (HIIT) are associated with improvement of cardiometabolic variables (11, 18). Although the importance of increasing PA levels to promote cardiometabolic health and fitness is supported by public health policy, only a small percentage of children and adolescents achieve daily PA levels recommended by global guidelines (42). These findings have led to weak-to-moderate relationships and weak treatment effect sizes between children's habitual PA levels and cardiometabolic improvements for school-aged children (7, 84). Moreover, challenges associated with quantifying habitual daily PA have contributed to the weak relationship between PA and cardiometabolic improvements for children and adolescents (6, 49).

The paucity of studies that investigate children's cardiometabolic responses to endurance or aerobic activity for unorganized training further complicates our understanding of these responses. In an attempt to enhance our understanding of children's cardiometabolic adaptations, studies used varied formats ranging from relatively simple unorganized activities with minimal equipment and instructions (i.e., free play), to self-paced, unstructured fun activities with limited instruction to encourage increased energy expenditure (EE) for the majority of time (i.e., active play) (186) to complex organized, professionally led, endurance training with targeted outcomes accomplished within and outside of the physical education curriculum (11, 18). Free play leads to insufficient time spent on increasing both the amount of PA and the time spent in moderate-to-vigorous intensity (%MVPA) levels (63). Professionally delivered school-based physical education (PE) classes and programs lack the necessary amount and intensity of PA for cardiometabolic improvements (38). These findings question the feasibility of implementing free play and/or school-based interventions targeting multiple goals and delivered over several months.

To overcome the challenges associated with free play and/or organized school-based programs, it has been suggested that the attributes and qualities of guided active play (GAP), including limited instruction time, self-paced, freely chosen activities and positive enjoyment levels may promote increased PA participation for children (186). When GAP is combined with children's cooperative games, their attractiveness for increasing self-paced EE and time spent at %MVPA has been reported (21). Reported findings show that GAP interventions have increased the volume of PA and %MVPA levels which may promote cardiometabolic and psychosocial benefits for school-aged children (20, 121, 122). Furthermore, when children's cooperative games are incorporated into either an 8-week GAP program (122) or an endurance training program, cardiorespiratory fitness is improved (97), which is comparable to continuous or interval aerobic training delivered over 8-12 weeks in school-based programs (11, 112, 156). The relevance of these findings for implementing GAP interventions are encouraging, since PA levels provide children with improved cardiometabolic adaptations.

Despite the improvement in children's cardiometabolic parameters driven by long-term endurance programs (greater than 8 weeks), our understanding of the early or short term (4-5 weeks) changes require further investigation. Short term changes in cardiometabolic parameters, primarily VO_2max, may be relevant in monitoring training progression in structured school settings and/or clinical settings since not all parameters adapt at the same time/rate (34). Findings show that changes in markers of cardiovascular (CV) risk (i.e., VO_2max, plasma lipids, blood pressure, blood insulin or glucose levels) followed improvements in the control of microvascular perfusion (131, 193). Furthermore, studies with overweight, obese and/or diabetic children suggest that the short-term adaptations for microvascular responses to cardiorespiratory endurance training may play an important early role in further cardiorespiratory adaptations. In these studies, the control of microvascular perfusion by endothelial-dependent mechanisms shows a greater response to exercise training (129, 149, 193). Although children's fitness is associated with improved CV and microvascular function (149), the role and timing of endothelial-dependent (ED) and endothelial-independent (EI) functions in normal-weight children following a self-paced GAP program are lacking in the literature.

The purpose of this study was to: 1) determine the PA participation of healthy children throughout a five-week community-based GAP program by assessing EE ($kcal \cdot wk^{-1}$) and %MVPA; 2) measure the impact of a GAP program on children's resting blood pressure, VO_2max, body mass index (BMI) and waist circumference (WC) before and after participation in a 5-week GAP program; and 3) measure the impact of the program on the cutaneous microvascular flow stimulated by ED and EI mechanisms. The results of this study will provide important information about the control and responsiveness of the children's vascular system to self-paced GAP.

3.3.3. Methodology

Participants & Recruitment: Children (8-12 years) were recruited to participate prior to starting a summer school program. Parents/guardians completed an informed consent form and a physical activity readiness questionnaire (PARQ+). In addition, children provided verbal assent to participate in the study before each of the health-related fitness assessments and the GAP program. All procedures were approved by the University's Human Participants Research Committee .

Study Design: Children participated in a one-hour GAP program conducted four-days a week, for five-weeks during July and August. The GAP session served as an afternoon 'recess' period, scheduled from either 1-2pm or 2-3pm, during the summer school program. During the remainder of the summer school children were engaged in academic pursuits (mathematics and writing) and creative arts (theatre). Select health, fitness and vascular function parameters were assessed during the first and last week of summer school. PA partication was assessed each day and quantified during the GAP program.

Procedures and Measurements:

<u>Health-Related Fitness:</u> Body mass (kg) was assessed using an electronic scale, height (cm) and waist circumference (cm) (landmark was placed on uppermost border of the hip bones on both sides of the body) were assessed using a measuring tape, and an automatic blood pressure cuff was used to assess resting heart rate (HRr) (bpm), resting systolic blood pressure (SBP) (mmHg), and resting diastolic blood pressure (DBP) (mmHg). The blood

pressure and heart rate assessments were taken after a 15 min acclimitization period in a recline position prior to the starting the microvascular function assessment (21). Mean arterial pressure (MAP) was calculated using a standard mathematical formula by the pulse pressure [SBP +(2 x DBP)] divided by three (154, 191). In addition, the Leger 20 metre shuttle run was used to estimate VO_2max in $mL·kg^{-1}·min^{-1}$ (100). All assessments were conducted by the investigators and/or kinesiology students experienced with the equipment and procedures to within a coefficient of variation of ± 3% (20, 123).

Physical Activity: The GAP program consisted of a warm-up (3 minutes), a water break (2 minutes) and 55 minutes of self-paced PA incorporating age appropriate cooperative games (5-6 games per session) selected from a compendium of children's games (20, 21, 123) (see Appendix F for more details on the games that were played). The GAP sessions were delivered with the support of experienced Kinesiology undergraduate majors serving as positive role models and encouraging children to participate, at a ratio of five children per one kinesiology student (5:1). At no time were the children forced to participate. All children were able to participate without feelings of incompetency; and were provided the opportunity to cooperate and socialize with peers while having fun and being active (20, 123).

PA was quantified during the summer school program with accelerometers (ACC; ActiGraph GT3X+), which were affixed on the right hip an elastic band. ACC outputs were determined by ActiLife v2.1 software and the vector (expressed in 10 second epochs) (26) used to estimate oxygen consumption (VO_2) ($mL·kg^{-1}·min^{-1}$) with laboratory derived linear equations (20, 123). The explained variance (R^2) and Standard Error of Estimate (SEE) were 0.95 and 1.07 $mL·kg^{-1}·min^{-1}$, respectively. EE ($kcal·wk^{-1}$; $kcal·min^{-1}$) and metabolic equivalents (MET) were calculated. PA intensity was estimated from MET values classified as sedentary (<1.9 MET), very light (2.0-2.9 MET), light (3.0-3.9 MET), moderate (4.0-5.9 MET) and vigorous (>6 MET), using published cutoff criteria (20, 123) and expressed in percentage of PA time (i.e., %PA).

Microvascular Function: ED and EI regulated vascular function was assessed by Laser Doppler Perfusion Imaging (LDPI) paired with iontophoresis (Periont System for PeriScan PIM) using acetylcholine (ACH) (ED-control) and sodium nitroprusside (SNP) (EI-control). Perfusion analysis was performed from scanned images recorded with a distance of 12-14 cm to the forearm and a resolution ranging from 1.2-1.4 mm. The described protocol is based on previous studies conducted on children (91, 126). Children arrived in a fasted state (5-hours) and before assessment of vascular function, the children sat (rest) for a minimum of 15-minute during which they were familiarized with the LDPI equipment and the iontophoresis patches. During the familiarization period children (and parents if they wish) were provided an opportunity to ask questions about the procedures and equipment. Following the introduction and familiarization periods, children were reclined on a bed for measurement of resting skin temperature (using an automatic skin thermometer) and blood pressure of the non-dominant hand (~5 minutes).

Iontophoresis protocols were conducted using two adhesive patch electrodes (150mm diameter) placed on the forearm mid-point between the wrist and elbow with the arm extended and resting on a cushion. Next a baseline current (20 uA) was applied to the electrode patches for 210 seconds (according to manufactures specification) (25), at which time 200 uL of either ACH (1%) or SNP (1%) were delivered to iontophoresis patches. Analysis of microvascular function assessed by LDPI occurred for 20 minutes. The selection of ACH and SNP (prepared in a 0.9% saline solution) were used to provide vasodilation through ED and EI mechanisms, respectively (154, 155). See Appendix E (pilot study 5) for more details regarding the procedures and mechanism used for iontophoresis. Baseline perfusion (expressed in arbitrary blood perfusion unit [PU]) was established during the last minute prior to the start of the iontophoresis. Following iontophoresis, the vascular responses were quantified for peak perfusion (highest perfusion value during the entire iontophoresis protocol), average perfusion (calculated by the average perfusion from the start of iontophoresis to the time when iontophoresis was stopped) (17, 25) and the full perfusion (calculated by area under the curve [AUC]). Progression curves (i.e., rate of change over time/current during iontophoresis) for ED and EI were compared using linear ($y' = b(x) + c$) and quadratic ($y' = a(x^2) + b(x) + c$) curve fitting procedures. The equation-derived coefficients (a and b) and constants (c) assess the rate of change in ED and EI regulated vascular function, while the goodness of the curve fitting procedures is determined by the R^2 and SEE. Peak cutaneous vascular conductance (CVC), is an important function as it takes into account the variations in blood pressure that may affect local blood flow. CVC was expressed as pu·mmHg, determined by the ratio of peak iontophoresis perfusion divided by the mean arterial pressure for both EI and ED. Subsequently the peak CVC was expressed in percentage of change reported for both ACH and SNP stimulation using the following calculation (peak CVC - resting CVC / peak CVC) multiplied by 100 (102, 155).

<u>Statistical Analysis and Data Treatment</u>: Descriptive statistics were determined for all measures and expressed as mean and standard deviations (mean ± SD). Select health-related fitness and vascular function parameters (peak perfusion, average perfusion, AUC

perfusion, peak-CVC and peak-percent-CVC) before and after the GAP program were compared with a paired t-test (*p* level = 0.05). Linear (LIN) and quadratic (QUAD) curve fitting models were performed (using SPSSv.24) to generate coefficients (a and b), and constants (c). The EI and ED curve fitting data (coefficients and constants) were compared before and after the GAP program using a paired t-test (*p* level = 0.05).

Prior to comparing the PA measures, the homogeneity-of-variance assumption (Levene's Test of Equality of Error Variance) was confirmed. Weekly active play PA measures for $kcal \cdot week^{-1}$, $kcal \cdot min^{-1}$, %MVPA and percent time at sedentary activity (%Sed) were compared by analysis of analysis of variance (ANOVA) (SPSSv24). A Tukey post-hoc test was used to compare the weekly changes (*p* level = 0.05). Relationships among select health-related fitness, microvascular functions and PA parameters were assessed using the Pearson correlation co-efficient.

Before performing the analysis of covariance (ANCOVA) an evaluation of the relationships between the covariate and the pre levels of vascular perfusion was accomplished by testing the homogeneity-of-regression (slope) assumption – importantly the interactions between covariate and pre levels were not different. Furthermore, a test of the homogeneity-of-variance assumption (Levene's Test of Equality of Error Variance) reported no significant differences across pre levels of vascular perfusion (independent variable). Therefore, the covariate (PA Factor – composed of $kcal \cdot week^{-1}$ and %MVPA) was included in the analysis to evaluate the relationship between the PA Factor (covariate) and the post minus pre changes in vascular function (dependent variable) controlling for the impact of the starting levels on the post minus pre changes. The One-Way ANCOVA was used to test for any differences that the pre or starting level may have on vascular perfusion after the GAP program (i.e., post minus pre data) for functional measures of peak, average and total (AUC) perfusion. As well, a covariate (i.e., PA Factor was used to evaluate the interaction between the PA Factor and the post minus pre changes (dependent variable), while controlling for pre levels on vascular perfusion. The PA Factor (covariate) was generated prior to the ANCOVA and was composed of kcal·week^{-1} and %MVPA.

3.3.4. Results

The average weekly PA levels assessed by estimated EE, %MVPA and %Sed time were 556±132 kcal·wk^{-1}, 34.3±16.8 %MVPA and 12.7±5.1 %Sed, respectively, over the 5-week self-paced GAP program. The average weekly EE ranged from 317 kcal·wk^{-1} to 783 kcal·wk^{-1}. The range of PA for %MVPA and %Sed behaviours were 22.2 to 52.4 %MVPA and 5.3 to 24.8 %Sed, respectively. Minimal differences between boys (n=12) and girls (n=6) were observed (p>0.05).

Children's growth, health and fitness parameters in response to the 5-week self-paced GAP program are presented in Table 1. Minimal changes were noted for children's height, body mass, BMI, combined grip strength, and leg power (p>0.05). Resting blood pressure and heart rates responses, obtained during a 15min rest in a reclined position, and estimated VO_2max were compared before and after the program (Table 2). Following the 5-week GAP program, decreases were observed for resting DBP (64±8 vs 59±5 mmHg) ($p<0.05$) and HRr (84±17 vs 76±12 bpm) ($p<0.01$), with no significant differences for SBP and MAP ($p>0.05$) (Table 2).

Table 1: Children's (n=18) anthropometric and musculoskeletal fitness responses to a 5-week (4 days·week^{-1}; 1 hour·day^{-1}) guided active play program. Measurements were obtained in the first (PRE) and last (POST) week. Anthropometric variables include; age, height, body mass, body mass index. Musculoskeletal fitness variables include; combined grip strength and vertical jump height. Data is presented as means ± standard deviations.

	PRE	POST	*p* Level
Age (years)	9.8 ± 1.5	9.9 ± 1.4	0.43
Height (cm)	137.8 ± 10.5	139.2 ± 10.6	0.69
Body Mass (kg)	38.3 ± 10.2	40.1 ± 10.2	0.39
Body Mass Index (kg·m^2)	19.7 ± 4.3	20.2 ± 4.4	0.43
Combined Grip Strength (kg)	30.6 ± 5.1	33.5 ± 7.9	0.13
Vertical Jump Height (cm)	20.0 ± 5.4	21.6 ± 4.8	0.27

Table 2: Cardiovascular responses of children participating in a short-term (5-weeks, 4 days·week^{-1}; 1 hour·day^{-1}) guided active play program (n=18). Resting blood pressure and heart rate measurements were taken in a reclined position following 15 minutes of rest. Oxygen consumption levels were estimated from the Leger 20-meter shuttle run test (estimated VO_2max). Data is presented as means ± standard deviations.

Variable	PRE	POST	P Level
Systolic Blood Pressure (mmHg)	99 ± 10	98 ± 8	0.83
Diastolic Blood Pressure (mmHg)	64 ± 8	59 ± 5	0.05
Mean Arterial Pressure (mmHg)	75 ± 7	72 ± 4	0.13
Pulse Pressure (mmHg)	34 ± 12	39 ± 10	0.123
Resting Heart Rate (bpm)	84 ± 17	76 ± 12	0.01
Estimated VO_2max (mL·kg^{-1}·min^{-1})	46.8 ± 5	47.8 ± 5	0.21

The protocol for assessing children's microvascular function included ED (ACH) and EI (SNP) stimulation of vascular perfusion. Children's (n=18) responses to ED and EI regulated perfusion showed a rise phase followed by a steady state with a current of 20 µA for 210 seconds for ED protocol and 400 seconds for the EI protocol (Figure 1).

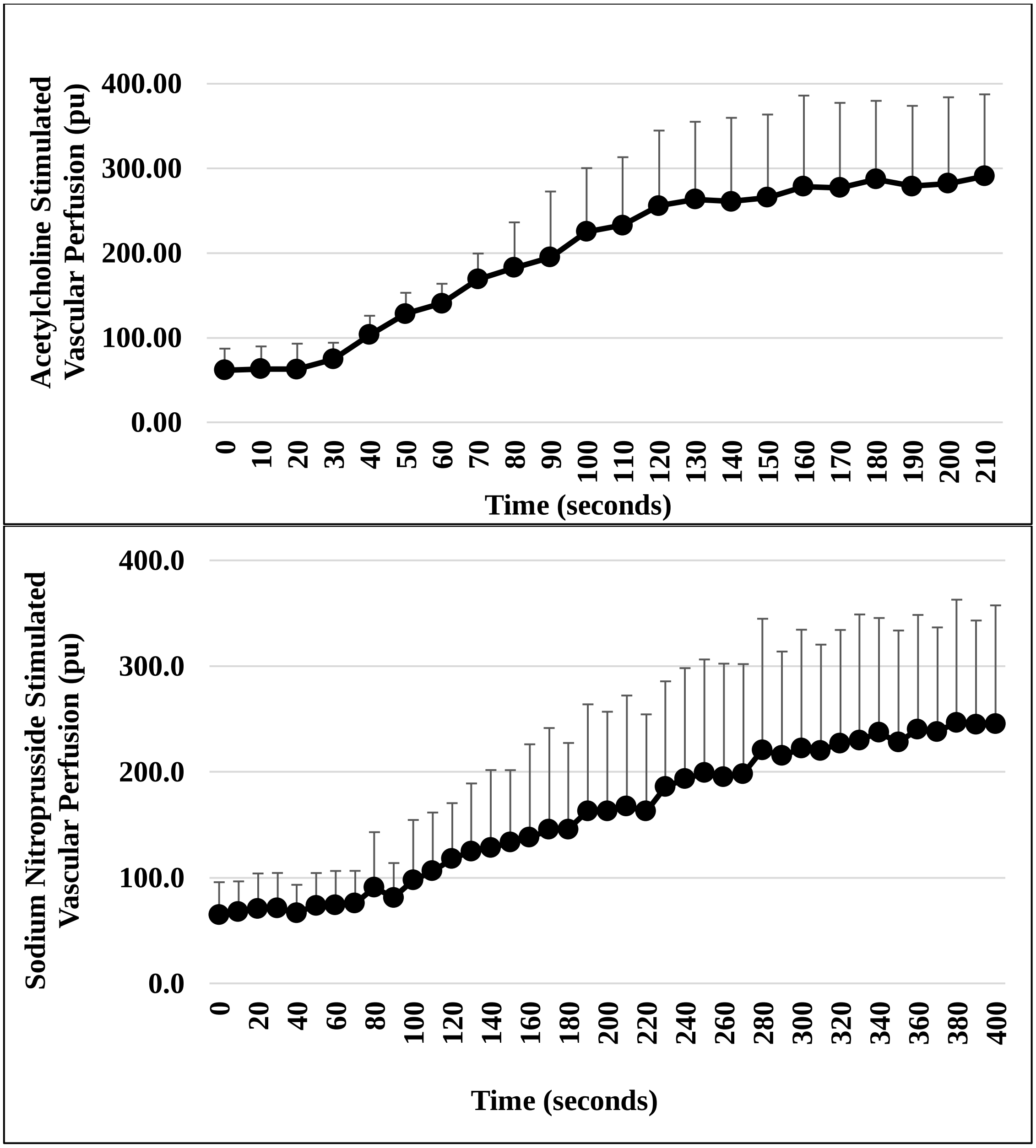

Figure 1. Children's (n=18) microvascular cutaneous forearm perfusion in response to acetylcholine stimulated/endothelial-dependent (ED)(top panel) (i.e., 20 µA for 210 seconds) and sodium nitroprusside stimulated/endothelial-independent (EI)(lower panel) (i.e., 20 µA 400 seconds) vascular perfusion. Error bars are standard deviations.

ED-acetylcholine and EI-sodium nitroprusside stimulated perfusion was quantified for baseline, peak perfusion, average perfusion, and total perfusion (AUC) before and after the GAP program (Figures 2 and 3). The GAP had no significant influence on ED and EI baseline vascular perfusion ($p>0.05$). The ED stimulated vascular perfusion was not significantly lower when determined for peak (-6.8%) ($p>0.05$), average (-10.3%) ($p>0.05$) and area under the curve (-7.2%) ($p>0.05$) following the 5-week GAP program (Figure 2). In contrast, the GAP program increased EI stimulated vascular perfusion for peak (19.8%) ($p>0.05$), average (36.8%) ($p<0.05$), and AUC (28.8%) ($p<0.05$) (Figure 3). The ambient, room and skin temperatures assessed during the microvascular assessments remained unchanged throughout the study. The ambient and indoor temperatures during the first and last week of the GAP program were 27.6±1.9 ^{o}C and 28.2±1.6 ^{o}C, and 25.9±0.3 ^{o}C and 26.1±1.5 ^{o}C, respectively. The forearm cutaneous skin temperatures during the first and last week of the GAP program were 36.1±0.3 ^{o}C and 36.2±0.3 ^{o}C, respectively.

To identify the influence of the baseline levels on peak perfusion, the percentage increase from baseline to peak perfusion was determined. For ED stimulation, the peak at the start of the GAP program compared to baseline was 393.2% with 392.4% ($p>0.05$) observed after the program. The percentage change for peak perfusion compared to baseline perfusion with EI stimulation before and after 5-weeks were 309.6% and 348.3% ($p>0.05$). ED stimulation showed peak CVC before and after 5-weeks of 4.0±1.3 pu·mmHg and 4.0±1.2 pu·mmHg ($p>0.05$). The peak CVC at pre and post measurements were 3.7±1.9 pu·mmHg and 4.6±1.6 pu·mmHg with EI stimulation ($p>0.05$).

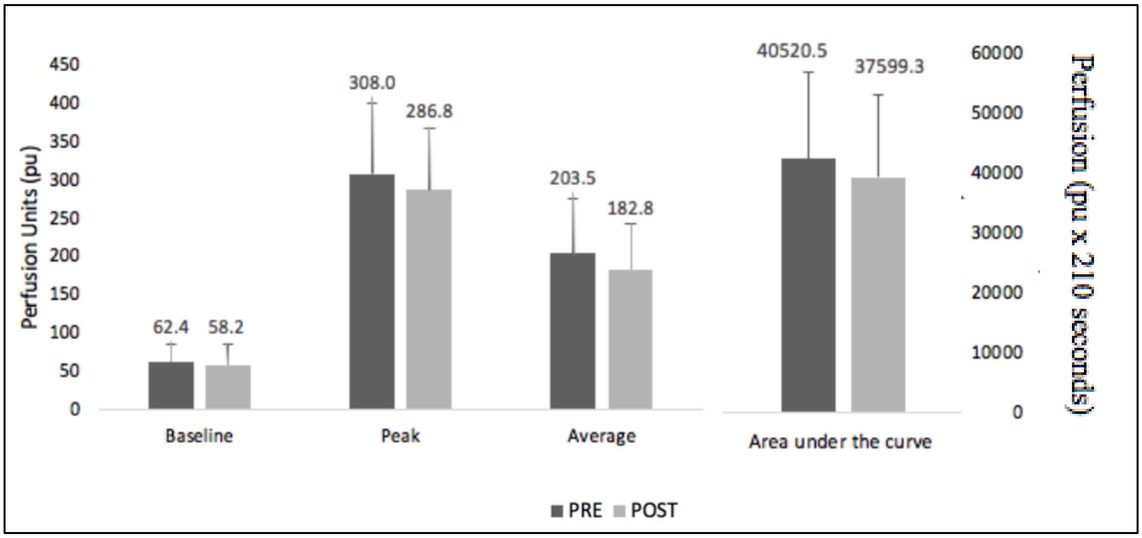

Figure 2. Children's (n=18) cutaneous forearm perfusion during the endothelial-dependent (ED, 210 seconds at 20μA) protocol for the baseline, peak, average (see primary axis) and total area under the curve (see secondary axis) before (PRE) and after (POST) a 5-week self-paced guided active play program. Data is presented as means and error bars are standard deviations. PRE and POST differences are denoted by an asterisk (*) for a *p*<0.05.

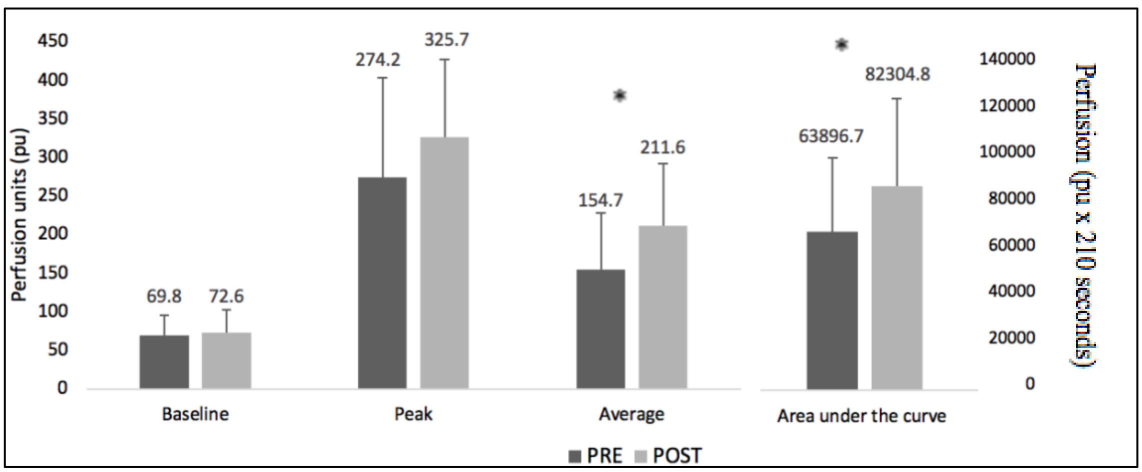

Figure 3. Children's (n=18) cutaneous forearm perfusion during the endothelial-independent (EI, 400 seconds at 20μA) protocol for the baseline, peak, average (see primary axis) and total area under the curve (see secondary axis) before (PRE) and after (POST) a 5-week self-paced guided active play program. Data is presented as means and error bars are standard deviations. PRE and POST differences are denoted by an asterisk (*) for a *p*<0.05.

Next we calculated the difference between the pre and post microvascular response for all children. More children had positive change to EI stimulation (12 of 18 children) compared to the ED stimulation (7 of 18 children) regardless of the vascular function (i.e., peak, average, area under the curve and rate of perfusion) assessed following the program. A correlation analysis between the post minus pre vascular function changes (AUC) with growth (body mass, height), health (BMI, SPB, DBP, resting HR) and/or fitness (combined grip strength, vertical jump height or leg power and estimated VO_2max) showed mixed results (Table 3). The Pearson Correlation Coefficient between post minus pre changes for ED and EI stimulated vascular perfusion with growth, health and fitness parameters ranged from low to moderate ($p>0.05$). The relationships between pulse pressure and peak perfusion were not significant with for ED r=0.088 ($p>0.05$) and for EI r=-0.044 ($p>0.05$). The relationship between change in the average vascular perfusion and change in pulse pressure was r=-0.001 for the ED ($p>0.05$) and r=-0.113 for EI ($p>0.05$). The relationship between the total (AUC) perfusion and the change in pulse pressure for the ED was r=0.005 ($p>0.05$) and for the EI was r=-0.044 ($p>0.05$).

Table 3. Pearson Correlation coefficient relationships between the endothelial independent and dependent area under the curve and health and fitness variables before (PRE) and after (POST) the entire 5-week guided active play program (n=14).

		Endothelial Independent Area Under the Curve				**Endothelial Dependent Area Under the Curve**			
		PRE	**p value**	**POST**	**p value**	**PRE**	**p value**	**POST**	**p value**
Body Mass Index (kg·m²)	**PRE**	0.208	0.476	0.093	0.751	-0.182	0.533	-0.111	0.706
	POST	0.035	0.905	-0.037	0.901	0.004	0.99	-0.232	0.424
Waist Circumference (cm)	**PRE**	0.14	0.634	-0.044	0.883	0.249	0.39	-0.14	0.634
	POST	0.149	0.61	-0.09	0.759	-0.275	0.341	-0.124	0.674
Systolic Blood Pressure (mmHg)	**PRE**	0.223	0.443	0.399	0.158	0.165	0.574	0.364	0.201
	POST	0.014	0.962	-0.012	0.967	-0.215	-0.459	-0.117	0.691
Diastolic Blood Pressure (mmHg)	**PRE**	0.221	0.447	0.63	***0.016***	0.452	0.104	0.275	0.341
	POST	0.114	0.697	0.232	0.425	0.117	0.69	-0.096	0.745
Mean Arterial Pressure (mmHg)	**PRE**	9.231	0.427	0.599	***0.024***	0.401	0.155	0.307	0.286
	POST	0.091	0.757	0.165	0.573	-0.018	0.952	-0.127	0.666
Estimated Oxygen Consumption (mL·kg⁻¹·min⁻¹)	**PRE**	-0.109	0.712	0.027	0.928	0.14	0.633	0.356	0.212
	POST	0.004	0.988	0.231	0.426	0.419	0.135	0.416	0.139

The relationships between the initial (pre) level of ED and EI stimulated vascular perfusion with the post minus pre changes for peak perfusion (pu), average perfusion (pu) and total perfusion (AUC) (pu) are presented in Table 4. The relationships between the PA ($kcal \cdot wk^{-1}$ and %MVPA) with the post minus pre changes for peak perfusion (pu), average perfusion (pu) and total perfusion (AUC) (pu) are also presented in Table 4.

For peak perfusion the relationship between the starting level (pre) level of vascular perfusion and post minus pre changes were significant for ED and EI conditions. For average perfusion and the total AUC, the relationship between the starting level (pre) level of vascular perfusion for ED stimulated perfusion were significant (Table 4). In contrast, average perfusion and the total AUC perfusion with EI stimulation for post minus pre changes were not significant. In summary, it was observed that the higher the starting level, the less adaptation (%change) was evident for ED and EI stimulation.

The relationship between PA participation and the ED and EI stimulated post minus pre changes on the vascular functions for peak perfusion (pu), average perfusion (pu) and total perfusion (AUC) (pu) showed mixed results (Table 4). For peak perfusion the relationship between EE ($kcal \cdot wk^{-1}$) and vascular perfusion for ED and EI stimulated post minus pre changes were r = -0.54 ($p<0.05$) and r = -0.74 ($p<0.01$), respectively. For peak perfusion the relationship between %MVPA and vascular perfusion for ED and EI stimulated post minus pre changes were r = -0.52 ($p<0.01$) and r = -0.70 ($p<0.01$), respectively. For average perfusion the relationship between EE ($kcal \cdot wk^{-1}$) and %MVPA on vascular perfusion for ED post minus pre changes were not significant ($p>0.05$). With EI stimulated average perfusion, a r=-0.45 ($p<0.05$) was observed. Non-significant relationships were noted for total (AUC) perfusion with EE ($kcal \cdot wk^{-1}$) and %MVPA with

ED and EI stimulated responses to GAP. In summary, PA as expressed in energy expenditure ($kcal \cdot wk^{-1}$) only showed a significant change for the peak perfusion and not the average or area under the curve for both ED and EI. For the PA intensity as expressed in %MVPA, there was a significant change for the peak perfusion for both ED and EI and only the stimulated average perfusion for EI. It is apparent that the amount and intensity of PA increases the peak perfusion response for both the ED and EI resulting from a GAP program.

Table 4. Relationship (Pearson Product Moment Correlation Coefficients) between starting levels of microvascular perfusion or physical activity levels and the post minus pre differences of peak, average, and area under the curve responses of microvascular perfusion for endothelial dependent (ED) and endothelial independent (EI) stimulated vascular perfusion following a guided active play program.

	Peak	**Average**	**Area Under the Curve**
ED (Starting)	-0.43 ($p<0.01$)	-0.49 ($p<0.05$)	-0.48 ($p<0.05$)
EI (Starting)	-0.68 ($p<0.01$)	-0.37 ($p>0.05$)	-0.38 ($p>0.05$
ED ($kcal \cdot wk^{-1}$)	-0.54 ($p<0.05$)	-0.41 ($p>0.05$)	-0.41 ($p>0.05$)
ED %MVPA	-0.52 ($p<0.01$)	0.34 ($p>0.05$)	0.34 ($p>0.05$)
EI ($kcal \cdot wk^{-1}$)	-0.74 ($p<0.01$)	0.23 ($p>0.05$)	0.26 ($p>0.05$)
EI %MVPA	-0.70 ($p<0.01$)	-0.45 ($p<0.05$)	-0.41 ($p>0.05$)

An ANCOVA was performed to evaluate whether the PA participation may have impacted the post minus pre changes for vascular functions using peak, average and total AUC perfusion. PA participation parameters (i.e., $kcal \cdot wk^{-1}$ and %MVPA) were combined into single a covariate—PA factor, to evaluate the interaction between the PA and the post minus pre changes following the GAP program. Prior to ANCOVA an evaluation of the interaction between the covariate and the pre level of vascular perfusion was accomplished by testing the homogeneity-of-regression (slope) assumption. Importantly, the interactions between covariate and pre levels were not statistically different. Furthermore, the required homogeneity-of-variance assumption was achieved using Levene's Test of Equality of Error Variance. As a result, the PA factor (covariate) was included in the analysis to evaluate the interaction between the PA and the post minus pre changes in vascular function (dependent variable), while controlling for the impact of the starting levels (independent variable) on the post minus pre changes.

When evaluating the relationship between the PA factor (covariate) and the post minus pre perfusion changes, the EI stimulated vascular functions showed a positive increase for peak perfusion, which was significant ($p<0.05$), but no significant differences were notes for average ($p>0.05$) and total AUC perfusions ($p>0.05$). The ED stimulated vascular functions for the composite PA factor (covariate) and the post minus pre perfusion changes were not different regardless of the perfusion function assessed. The positive impact of the PA factor on post minus pre changes for peak perfusion suggests that EI control (or smooth muscle control) on vascular function may be influenced by participation in a short-term GAP program.

Firstly, to characterize the rate of increase in vascular perfusion over time (i.e., the rate of progress) regulated by ED stimulation, the pre-data for all children were assessed using linear and quadratic curve fitting models. When submitted to curve fitting models the rate of ED stimulation showed that quadratic model had a better fit than the linear model as assessed by the R^2 (p<0.01) and SEE (p<0.01) (Figure 4).

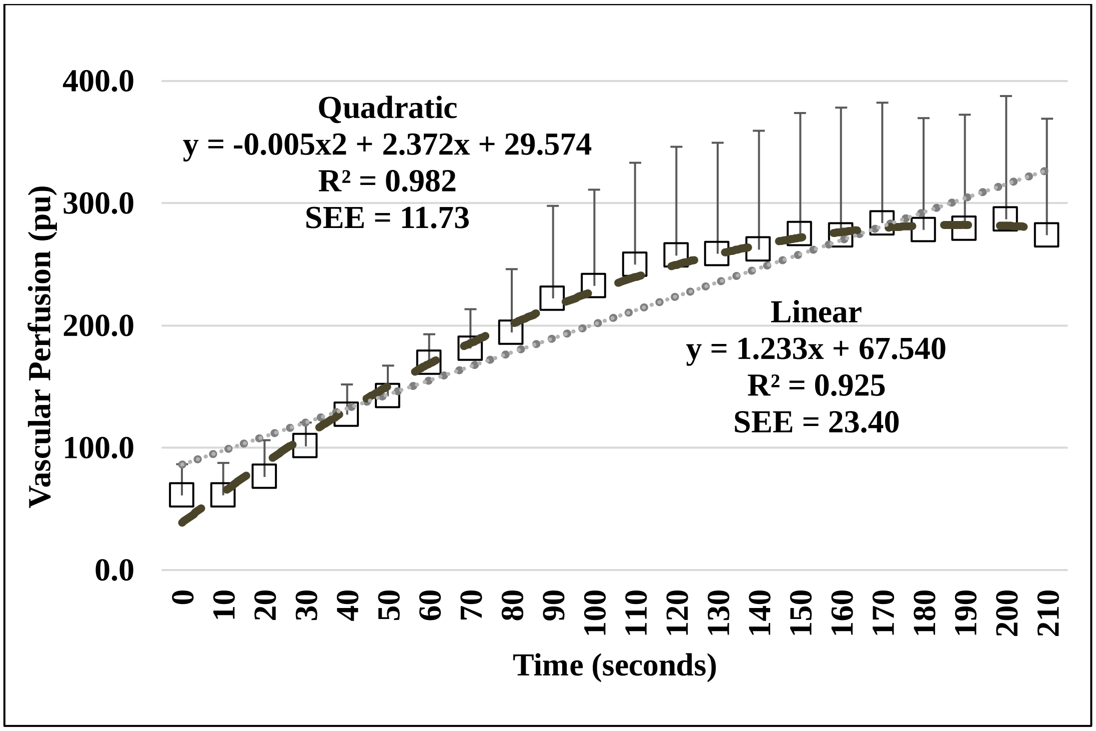

Figure 4. Assessment of the rate of progress for children's (n=18) microvascular response to endothelial-dependent cutaneous forearm perfusion using linear and quadratic curve fitting models. Raw data (mean ± SD) collected over 210 seconds (open squares) from the start of the intervention were fitted to linear (dotted line) and quadratic (dashed line) equations (SPSS v26). Differences noted between linear and quadratic equations for the proportion of variance accounted (R^2) and the Standard Error of the Estimate (SEE) were *p*<0.01 and *p*<0.01, respectively.

The accuracy of the curve fitting models to estimate vascular function was accomplished by predicting peak perfusion from both linear and quadratic equations. The linear equation showed a larger bias in the prediction of peak perfusion with an average [measured - predicted peak] of 83.1 pu. Regarding the quadratic equation the average [measured - predicted peak] was 29.4 pu (Figure 5). Since the quadratic equation [$y' = a(x^2) + b(x) + c$] demonstrated a better fit for vascular perfusion, the rate of progress for ED and EI stimulated vascular perfusion were compared for coefficients (COFF a and b) and constants before and after the 5-week self-paced GAP.

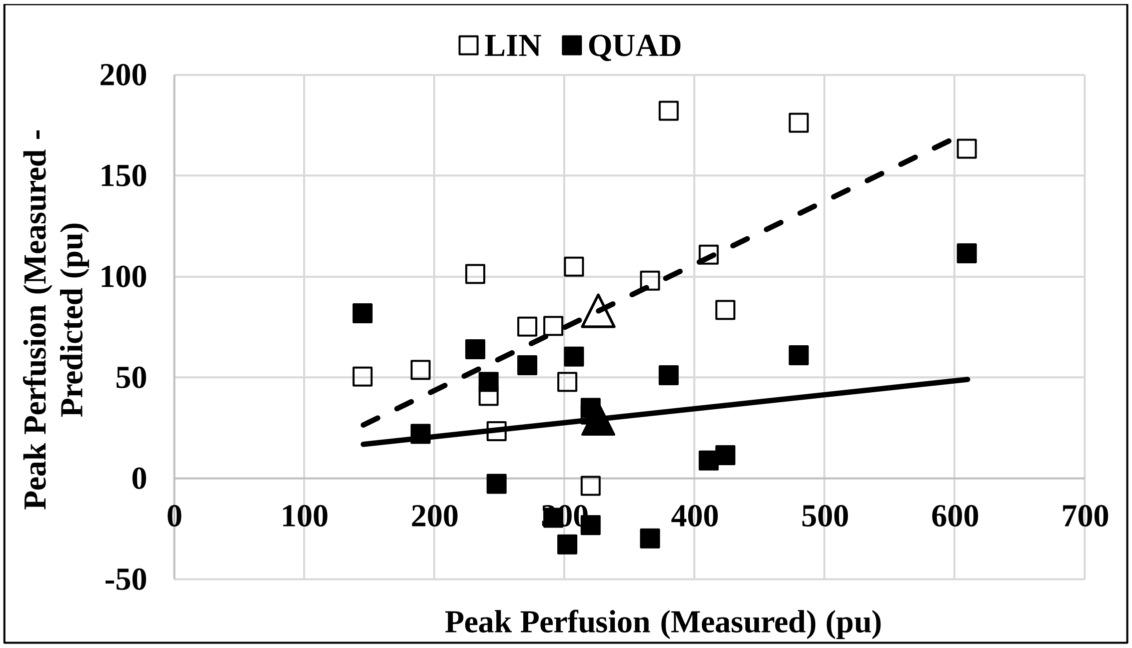

Figure 5. Accuracy of predicting endothelial dependent (ED) stimulated peak perfusion using linear (LIN) and quadratic (QUAD) curve fitting models. Linear model predicts a larger (i.e., less accurate) average peak perfusion (open triangle) compared to a smaller (i.e., better accuracy) average peak prediction (solid triangle) using the quadratic model (SPSS v26).

The ED quadratic equations generated for all children (n=18) before and after the GAP program were [y' = -0.005(x^2) + 2.372(x) + 29.574] (R^2=0.99 and SEE=11.73) and [y' = -0.001(x^2) + 1.479(x) + 24.304] (R^2=0.96 and SEE=18.34), respectively. The EI quadratic equations generated for all children (n=18) before and after the GAP program were [y' = -0.0001(x^2) + 0.597(x) + 46.001] (R^2=0.98 and SEE=8.40) and [y' = -0.002(x^2) + 1.258(x) + 63.551] (R^2=0.99 and SEE=8.47), respectively. The average coefficients (COFF a and b) and constants generated by quadratic curve fitting results for all children (n=18) with ED and EI stimulation protocols before and after the 5-week self-paced GAP program are presented in Table 5. The results (i.e., post minus pre differences for COFF a and b [$p<0.05$]) reflect a greater faster rise (rate of progress) to EI stimulation (SNP) of vascular perfusion following the GAP program. No significant post minus pre changes differences were observed for ED stimulation (ACH). Based on this analysis, children's participation in a 5-week self-paced GAP program increases and/or improves the sensitivity of EI regulation of vascular perfusion, while the responses to ED regulation is not changed.

Table 5. Assessing the rate of progress for vascular perfusion for endothelial dependent (ED) and endothelial independent (EI) stimulation protocols using quadratic curve fitting model [y' = a(x^2) + b(x) + c]. Differences in children's (n=18) coefficients (COFF a and b) and constants were compared before (PRE) and after (POST) a 5-week self-paced guided active play program. An assessment of the fit of the quadratic model, using the variability accounted for (R^2) and Standard Error of Estimation (SEE), were included for both ED and EI conditions measured at PRE and POST of the guided active play program.

	Variable	PRE	POST	*p* level
Endothelial Dependent	R squared	0.92 ± 0.04	0.87 ± 0.12	0.09
	SEE	23.7 ± 12.9	28.1 ± 15.6	0.23
	COFFa	1.78 ± 1.02	1.83 ± 0.61	0.87
	COFFb	-0.91 ± 1.14	-0.97 ± 0.69	0.85
	Constant	10.24 ± 37.57	7.00 ± 35.87	0.79
Endothelial Independent	R squared	0.89 ± 0.06	0.92 ± 0.03	0.06
	SEE	21.2± 15.0	23.2 ± 8.3	0.75
	COFFa	1.09 ± 0.78	1.63 ± 0.9	0.05
	COFFb	-0.17 ± 0.81	-0.74 ± 1.03	0.05
	Constant	42.55 ± 32.34	33.46 ± 36.28	0.49

3.3.5. Discussion

The present study aimed to investigate the effect of a community-based 5-week self-paced GAP program on body composition, musculoskeletal fitness, and select health-related fitness parameters including blood pressure, estimated VO_2max and ED and EI control of microvascular perfusion in children aged 8–12 years. Throughout the self-paced GAP program children expended an average of 556 kcal·wk^{-1} at 39 %MVPA. Children showed significant improvements in resting values for heart rate, diastolic blood pressure, and EI vascular perfusion. Whereas, body composition, musculoskeletal and VO_2max, estimated from the Leger 20-m shuttle run, and ED vascular perfusion showed no significant changes. The relationship between changes in EI microvascular perfusion and PA factors (i.e., kcal·wk^{-1}; %MVPA), was significant. Children's control of vascular function following a short-term GAP program shows a positive adaptative response of EI stimulation (or smooth muscle control) of perfusion compared to ED stimulation. In conclusion children that participated in a self-paced GAP program presented an improvement of the vascular function as shown by an increase in EI vasodilation, a lower DBP and reduced MAP.

It has been suggested that short term (4-5weeks) cardiorespiratory endurance training is useful for improving children's cardiometabolic health, primarily VO_2max, in a structured school setting and/or a clinical setting (34). Children (9.6 years of age) participating in a continuous or interval aerobic training program improved peak VO_2 by 7.0% and 4.8%, respectively, after ~7 weeks (11). In this study, the estimated VO_2max increased by 2.2% (or 0.99 mL·kg^{-1}·min^{-1}) (p=0.21) after 5 weeks of self-paced GAP program. Moreover, the range of children's VO_2max changes (-4.48% to 15.6%) were consistent with the range of VO_2max adaptions (-2.4% to +19.7%) observed following a structured school based aerobic training program (156). The improvements in HRr and DBP, which accompanied 5 weeks of GAP, are consistent with changes reported for children (11.1 years of age) following 5 weeks of structured cardiorespiratory endurance training at either moderate-intensity continuous training (at 66%HRmax) and/or high-intensity interval training (HIIT at >80%HRmax), (23). The non-significant responses observed for body composition, grip strength and leg power following the GAP program agree with results following 4 weeks of structured school-based aerobic circuit training intervention (4). It is evident from this study that 5 weeks of children's self-paced GAP can elicit weekly EE (556 kcal·wk^{-1}) and exercise intensity (77%HRmax for 22.3 minutes and 85%HRmax for 6.5 minutes) for microvascular adaptations. Lona and colleagues conducted a study in children looking at arteriolar remodeling and cardiorespiratory fitness (as predicted by the Leger 20 metre shuttle run test), their findings indicated that a wider diameter of retinal arterioles were evident in children with higher cardiorespiratory fitness, suggesting that PA could be link with arteriolar remodeling in children (104). These adaptations as a response to fitness levels or PA suggest physiological changes can be made to children's control of vascular function. This was in line with our findings in this study showing that following a short-term GAP program there was a positive adaptative response of EI stimulation (or smooth muscle control) of perfusion compared to ED stimulation.

The results of this study indicate that the body composition parameters (height, body mass, BMI) and VO_2max of the children did not change after the 5-week GAP intervention program. Although many studies have shown that PA intervention programs can impact these body composition and fitness parameters (84, 97, 139), there seems to be a dose-response relationship in that as you increase the amount of activity you see more improvements (84). A possible reason to the lack of changes seen in body composition as well as the leg power and combined grip strength could be due to the short duration of the programming. However, changes in health parameters were seen after the 5-week PA program, through improvements in DBP and HRr. This means that although the PA was short and not long enough for body composition changes, initial changes in health parameters are seen. Pearson Correlation analysis was used to further analyze the relationship of perfusion and health and fitness variables, the results showed that the relationship between vascular function for all functions (baseline, peak, and average) and the various health and fitness parameters ranged from low to moderate but were not significant. The relationship between the post EI stimulated perfusion using the AUC and the DBP and MAP were significantly different. It is evident that a 5-week GAP program played for one hour a day, 4 times a week will not be enough activity to elicit changes in height, body mass, BMI, grip strength, vertical jump height or leg power, and estimated VO_2max, but can improve blood pressure and MAP. These results are, however, in line with endurance trained young adults, showing an increase in SNP response and no changes in ACH for endurance trained individuals compared to the sedentary individuals of the same age (25). Although, this particular study did not have any PA/exercise training intervention, to be considered a trained athlete participants had to be endurance training 4 times a week at least 3 months prior to the study (25). This indicates that perhaps the vascular perfusion of a healthy child following a PA intervention may mimic similar vascular regulation as that of an endurance trained young adult.

A recent exercise training study for obese children and adolescents showed improvements in training-induced endothelial function but did not change plasma lipids, blood pressure, blood insulin or glucose levels, suggesting the exercise training program had a direct beneficial effect on vasculature, likely secondary to repetitive increases in shear stress (66, 107). The results of this study indicate that after a 5-week GAP intervention program the ED vascular flow through the iontophoresis of ACH did not change, and the EI assessment (SNP) increased, while the baseline assessments of both ACH and SNP were similar. The results of the SNP assessment are consistent with the literature (66, 107) following an intervention program, however the results of the ACH are inconsistent with the literature. A study by Higashi and colleagues (73) reported the effects of 12-week physical exercise on forearm hemodynamics in untreated adult patients with mild essential hypertension who were divided randomly into an exercise group (n=10) and a control group (n=7). After 12 weeks, the forearm blood flow response to ACH increased significantly, from 25.8±9.8 to 32.3±11.2 $mL^{-1} \cdot min^{-1}$ for 100 mL of tissue ($p<0.05$), in the exercise group but not in the control group (73). However, this study was conducted on adults and the intervention program was for a longer period of time, these could be some of the underlying factors as to why we found the inconsistent results. The nature of the self-paced GAP program might be a possible explanation as to why the discrepancies in vascular perfusion exist. Most training studies that report improvements with ED (ACH) control use activities in a confined laboratory environment, but also with children in an at risk population (either severely obese, hypertensive or dealing with cardiovascular disease) (131). The GAP community programming focused on playing children's games that were age appropriate and promoted participation through fun with friends. This study focused on implementing a program within the community for healthy children that did not have any predisposing cardiovascular conditions.

The current study has some limitations. First, the limited number of participants do not allow for sex or ethnic comparisons. Ensuring the participants comply to the procedures of the study was also a challenge (children had to come in a fasted state/no breakfast, and without performing any physical activities that morning), if they did not comply it would slow down the process of data collection, and at times we were not able to reschedule their assessments due to logistical reasons. The Laser Doppler Imaging is also a very sensitive system and any slight movements can interfere with the data collected and thereby final results. This presented a problem because a few of the children had a hard time staying still during the entire procedure for the ACH and/or the SNP. For these reasons, some of the data collected was not able to be used as part of the results. This resulted in a smaller sample size, which is important for generalizability. Another limitation is that, the data collection and assessment of cutaneous microvascular perfusion only occurred before and after the GAP program, which does not allow for a time course analysis. Lastly, collecting data during a resting state may not be reflective of the responses during exercise or PA.

In conclusion, the most relevant finding of the present study is that the short-term GAP using cooperative games showed vascular changes primarily under the EI (smooth muscle) control. The mechanisms underlying changes in vascular control may be related to the post exercise hypotension response found in a single session of cooperative games (30 minutes) (146). These results could be due to greater exercise intensity and metabolic demands found during cooperative games, which have been associated with post exercise hypotension. Although the influence of intensity, mode and duration of activities usually performed by children are unknown, the impact of these findings suggest a mechanism for the protective cardiovascular effect during repeated physical activity using GAP.

CHAPTER 4: OVERALL DISCUSSION AND CONCLUSION

4.1 EXECUTIVE SUMMARY

4.1.1. Summary of Research

The value and importance of children having fun, playing age-appropriate games (i.e., active play) has been suggested as a means to improve physical activity (PA) participation during childhood and adolescence (63). To better understand the developmental relationships between PA and body composition, and health-related fitness, it is important to assess PA participation in an environment that promotes positive PA behaviours (109). The evidence suggests that children are more likely to participate in PA with an unstructured play environment, which aligns with the self-paced, cooperative, non-competitive nature of the guided active play (GAP) program. Children reported higher levels of PA enjoyment following the GAP program. This is important because children need to have fun to feel motivated to increase PA participation and intensity levels. GAP is a program designed to promote PA for children in a non-competitive format when using cooperative games. GAP performed in a community-based five-day summer camp has been shown to elicit health-enhancing PA normally associated with improvements in health and fitness parameters (15). Whether a GAP program used in longer-term (5 to 8 weeks) summer camp settings can sustain health-enhancing PA for several weeks, thereby resulting in physiological improvements, is uncertain. Considering the continuing concern of Canadian children who are not meeting the daily recommendation of 60 minutes of moderate to vigorous PA, a GAP program maybe a solution to help overcome the decline in children's PA participation. It has also been suggested that risk factors associated with a decline in PA participation may track into adulthood, which illustrates the importance of intervening early in life to help formulate good health behaviours allowing children to become healthier and fitter adults (10, 79, 93). The overall research question addressed in this dissertation is to analyzes the attractiveness of a GAP program and determine whether children participating in freely chosen self-paced active play and/or GAP can achieve and sustain the total amount of PA and intensity over weeks and months in community summer camp programs.

The results demonstrated that even though the level of intensity to play was solely based on the child's choice throughout the 5- and 8-week programs, school-aged children will spend about 40 percent of the time in moderate and vigorous intensities. Thus, the finding that GAP programming using cooperative games elicits moderate and vigorous PA that is maintained over time is important for community summer camps targeting children's health and physical fitness (72).

4.1.2. Summary of Conclusions – Manuscript I

Currently habitual daily physical activity and PA during organized sporting activities show poor to modest tracking for children and adolescents. GAP with its self-paced, fun and non-competitive approach (when using cooperative games) may show more favourable (i.e., stronger) tracking for children and adolescents. PA participation during GAP may also show a stronger relationship with cardiometabolic risk factors during development. With the growing obesity epidemic, it is important to rephrase the way in which PA is promoted, in a way that children and parents find meaningful. The tracking of PA levels from a self-paced GAP session using cooperative games were assessed at baseline (BL) and over two consecutive summers (follow up 1 and follow up 2). In addition, growth, health and fitness variables were assessed. The increased energy expenditure (EE) ($kcal \cdot session^{-1}$) from BL to 1-year and 2-year follow-up - confirmed our hypothesis that a self-paced, GPA session focused on enjoyment and social interactions provides strong tracking (*rho*) and moderate agreement (*k*) during childhood. In regard to selected fitness variables combined grip strength also showed strong tracking (rho) and moderate agreement (kappa score); while estimated VO_2max reported moderate tracking. Time at moderate intensity PA physical activity (%MPA) and moderate-to vigorous intensity PA (%MVPA) were identified to also track moderately (kappa score) during childhood. The results of this study demonstrate that children's participation in a self-paced guided active play session and combined grip strength are effective at tracking children during childhood. Finally, the moderate relationship reported for guided active play with adiposity and selected health-related fitness variables suggests that participation in active play is an important contributor to childhood development.

4.1.3. Summary of Conclusions – Manuscript II

The PA levels (EE and intensity) of school-aged children involved in GAP using cooperative games was investigated. A novel finding was that children between the ages of 7 and 12 years had the ability to put forth various levels of EE and intensity when participating in a GAP program ($1hr \cdot d^{-1}$ for $3d \cdot wk^{-1}$). Throughout the 8 weeks, children were able to sustain their total PA (oxygen consumption (VO_2) estimated by linear regression using accelerometer (ACC) output vector magnitude $counts \cdot 10s^{-1}$ and their time spent in various intensities (metabolic equivalents [MET] estimated by linear regression using ACC output – vector magnitude [$counts \cdot 10s^{-1}$]). Findings showed significant improvements in VO_2max (+5.3%), systolic blood pressure (-7.0%) and diastolic blood pressure (-11.3%). A potential explanation for these results is that the children sustained PA levels due to the fun and social behaviours with their peers and the Kinesiology leaders. This increased interaction and enjoyment from the program may have allowed them to be more willing to be physically active. Therefore, the playing of cooperative games through the GAP program offered the children the opportunity for fun and enjoyment in addition to increasing their activity levels.

4.1.4. Summary of Conclusions – Manuscript III

The effect of a community-based 5-week self-paced GAP program on body composition, musculoskeletal fitness, and cardiovascular (BP and HR) parameters, estimated VO_2max and endothelial dependent (ED) and endothelial independent (EI) control of microvascular perfusion in children aged 8–12 years was investigated. Throughout the self-paced GAP program children expended an average of 556 $kcal \cdot wk^{-1}$ at 39%MVPA. Children showed statistical improvements in resting heart rate, diastolic blood pressure, and EI vascular perfusion. Whereas, body composition, musculoskeletal fitness, estimated maximal oxygen consumption (VO_2max) (Leger 20 metre shuttle run), and ED vascular perfusion showed no statistical changes following the 5-weeks. The relationship between changes in microvascular perfusion, specifically peak EI perfusion and PA factors (i.e., $kcal \cdot wk^{-1}$; %MVPA), was significant. In summary, children's control of vascular function following a short-term GAP program shows a positive adaptative response of EI stimulation (or smooth muscle control) of perfusion compared to ED stimulation. In conclusion, the benefits of a short-term self-paced GAP summer camp program on reducing cardiovascular risk factors for school-aged children should be an important first step in lowering the increased prevalence of hypertension of children in a local community centre setting.

4.2 GENERAL CONCLUSION

The overall objective of this dissertation was to investigate the relationship between health-related PA and it's influences on physiological outcomes through the use of a play-based approach in a community summer day camp setting. Two GAP sessions using cooperative games in a community summer day camp setting showed PA levels that tracked moderately high over a 1-year interval and were stable for children between the ages of 7-12 years. Following an 8-week GAP program PA EE and intensity levels were maintained and associated with improvements in children’s physiological outcomes including blood pressure, resting heart and oxygen consumption. Following 5-weeks of GAP resulted in PA EE and intensity levels that had an important influence on endothelial independent microvascular control which may underlie the improvements in children’s blood pressure. These results conclude that a program using a GAP format can be integrated into a community summer day camp (and perhaps school settings) to not only provide an opportunity for children to be active but also to improve health and fitness outcomes.

4.3 LIMITATIONS to COMMUNITY-BASED PROGRAMS

4.3.1. Limitations and Suggestions to Community-Based Physical Activity Programs

The importance of providing opportunities for children to be active PA programs in underserved communities cannot be underestimated however, there are numerous challenges that may limit the research process. It is therefore important to outline these challenges and provide feedback on how we were able to overcome them. When starting a research program within the community it is very important to build a rapport with community partners in order to solidify the execution of the research program. That is why developing a relationship with community partners is the first step in starting a research program in the community. This allows you to build trust and clearly explain the research you intend to implement and blend their ideas and needs to decide what is feasible.

It is also important to review the facility before designing the program to account for equipment that is available, size of the space. Even something as minor as a lack of air conditioning can be detrimental to the efficacy of a physical activity program because you need to program hot days a certain way to avoid heat exhaustion. A possible solution for weather complications and lack of air conditioning in combination with hot days, is to adapt the program for that day to include more water breaks. Once the community partners are in agreeance and the facility has been reviewed, the research design can be formed.

When working with children it is important to obtain consent from the parents as well as the children themselves in order to make sure every is aware of the research that is taking place and the anonymity of the data that is collected. Obtaining consent can be difficult when there may be a language barrier present, a solution that was used in our research project was to use translated consent forms (an example can be found in Appendix

A). It is also important to be culturally competent by being aware of any cultural or religious beliefs that may impact data collection and be cognisant of those rules.

Overall, when it comes to running experiments in the community it is important to be flexible and adapt to any situations that may arise, one main problem with children registered in camp programs is that they may not attend the camp every day, and data collection may be cancelled due to events, this makes it hard to have a true research design because you have to be accommodating to their schedule as well. A possible solution is to accommodate for events and trips in advance, so you are aware of which days are suitable for data collection. When working with children it's important to have your research team aware of problems that may arise including fights, injuries, bullying, etc. Developing workshops and training the research team for scenarios that may arise is a great way to be prepared and learning problem solving skills when it comes to children’s physical activity participation.

4.3.2. Limitations to Research Design and Data Collection in a Community Setting

Conducting research in a community setting is challenging due to the inability undertake a true or fixed research design, as well many complications may arise that need to be accounted for in the project. A limitation in this study was that a convenient group (i.e., pre-registered children) \ was used without the possibility of having a control group. Future research should be conducted using a research design that includes age and sex matched children to act as a control group. Although to account for this what we have done is collected accelerometry data during the full day of camp and found that the GAP is significantly higher in time spent in moderate and vigorous intensity PA, meaning that the main portion of their EE is during the GAP program. We also did not monitor the children outside of the camp hours (9am to 3pm Monday to Friday), there are a lot of factors that can affect adaptations in vasculature as well as PA at home and also their diet/nutrition. This means that have no control of what happens to the children outside of camp which may or may not have contributed to the changes that were seen. Another limitation is the low sample sizes this is because we can only work with the children that have signed up for the camp and that have obtained consent from their parents. Another possible limitation to data collection in a community setting is that the measurements may not be accurate due to the childrens attire. For example, if a child is wearing a sweater during the waist circumference measurements it may be challenging to get a true recording of their waist, we also have to respect the privacy and rights of the children that may not feel comfortable doing measurements on their skin. A possible solution is to make notes during data collection and keep it consistent by wearing similar clothing for pre and post testing. Another example of inappropriate attire is when children forget to bring their running shoes for the shuttle run test, this can definitely change the results of the test but to account for this we always remind the parents and community partners to make sure they have back up shoes in the camp so we are always prepared.

4.4 KNOWLEDGE TRANSLATION

Despite the many challenges that may arise while conducting research with children in a community summer camp setting it is still important to collect as much data as possible to better understand children's patterns of movement on increasing PA participation. GAP using cooperative games has shown to be a strong tracking variable children's PA during development into adolescence. The GAP program using cooperative games are inclusive and provides an opportunity for children to be active, have fun and be socially interactive. These attributes are especially important for children in underserved communities who may not be able to afford extra-curricular sports and activities. The GAP program regardless of duration (5 and 8 weeks) showed improvements in cardiovascular parameters. The longer 8-week program also showed statistical increases in aerobic fitness (VO_2max), as well as PA attractiveness/enjoyment (123). This means that not only does GAP increase PA participation, but it also provides sufficient health-enhancing PA as evidenced by statistical changes for CV health and health-related physical fitness parameters. PA is a behaviour and to improve health it needs to be consistent, by providing children a fun interactive way to play they are more likely to participate because children are motivated through enjoyment. It appears that cooperative games when used in GAP format may be a possible solution to the international decline in children's PA participation. Future directions should focus on the role and impact of GAP in a variety of environmental settings (i.e., community, school, urban. rural), psychological status (i.e., depression, anxiety) and physical disabilities to determine the attractiveness of guided active play in supporting children's developmental trajectories for improving their health-related fitness.

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APPENDIX A

INFORMED CONSENT AND SUPPLEMENTARY HANDOUTS

Informed consent (2012-2015)

YORK UNIVERSITÉ UNIVERSITY

Date: July 2012-2015

Angelo Belcastro, PhD, Professor

School of Kinesiology and Health Science

Faculty of Health

Paediatric Exercise Science Laboratory

KIN Kids Activity Program

Muscle Health Research Centre (MHRC)

333 Norman Bethune College
York University
4700 Keele Street
Toronto, ON, M3J 1P3
Canada

Tel: +1 416 736 2100 ext. 21088
Fax: +1 416 435 3511
Email: anbelcas@yorku.ca

Dear Parent/Guardian:

Subject: **Informed Consent** – Kin Kids: Children's Guided Active Play Program Focused on Improvements in Health and Fitness Part IV

Researchers:
Angelo Belcastro, Ph.D., anbelcas@yorku.ca, School of Kinesiology and Health Science, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3; tel: 416-736-5403
Asal Moghaddaszadeh, project assistant, asalmz@yorku.ca, School of Kinesiology and Health Science, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3; tel: 416-736-2100 x20222
Samantha Feldman, research assistant, feldmansyorku.ca, School of Kinesiology and Health Science, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3; tel: 416-736-2100 x20222

Purpose of the Research:

The purpose of this study is to determine whether KIN Kids, a children's guided active play program, instils the value of physical activity in children through self-selected, non-competitive playing of age-appropriate games. The program is designed to promote a child's self-confidence and efficacy within an environment that also considers the necessary amount and intensity of physical activity needed for positive benefits on health and fitness. Children's active self-selected playing of cooperative games can provide sufficient amount and intensity of physical activity during early childhood (5-7yrs) compared to middle-late childhood (8-12yrs). It is of interest to determine if active playing of games results in sufficient energy expenditure to approach Canada's Physical Activity Guideline recommendations throughout the childhood period. The purposes of this study are: 1) to

determine cooperative game programming (embedded within the KIN Kids program at the Driftwood Community Centre Programming) elicits physical activity levels sufficient to achieve Health Canada's recommended physical Activity guidelines for children and adolescents; 2) to assess whether the children participating in the cooperative games sessions experience positive health and fitness benefits or improvements.
3) to find out whether younger children participating in cooperative games programming a summer camp environment will be effective for enhancing their amount/volume and or effort of physical activity compared to older children.

What You Will Be Asked to Do in the Research:

Before programming begins, each participant will be assessed on some pre-testing measurements. Your child will be asked to walk/run on a treadmill while wearing a heart rate monitor and a mouth-mask for measuring oxygen use. Your child's standing and sitting height, leg length, body weight, skinfold (pinch test) and standing jump height will be taken and recorded during this session. Prior to Driftwood Communinty Centre program start date, you will fill asked to complete a physical activity readiness questinonire (PAR-Q) for your child. Your child will also undergo pre-testing at York University Paediatric Exercise Physiology Laboratory. Your child will perform a walking/jogging/running treadmill test at 4, 6, 8 and/or 10 kpm, all at 0% grade, for three-minutes at each pace. They will wear a mouth-mask connected to the FitMate Oxygen Collection System. There will be an orientation for your child to get used to breathing into the mouth-mask while walking on the treadmill. The test will finish when your child completes the last speed (10 kpm) or when they can not or do not wish to continue. This laboratory session will occur outside of the regular DCC 2015 2016 programming. Parents are welcome to attend these laboratory sessions but this is not a requirement.

During the DCC programs your child will participate the KIN Kids 'sportability' sessions during the DCC programming (2015-2016). Your child will be asked to wear an accelerometer used to determine steps and/or the amount and type of activity achieved within the 'sportability' sessions. An accelerometer is a small device that they will wear on their right hip only during the DCC sessions. There will be no movement restricitions while wearing the accelerometer (dimensions: 1.5 x 1.44 x 0.7 inches and weight: 27g). They will wear the accelerometer for about 1.5 hours each day for one week (summer program) and/or for 1.0 hr during the afterschool program.

Risks and Discomforts: Any risks or discomfort from your child's participation in the research is minimal. These may include; a) muscle cramping from insufficient warm-up; b) increased anxiety associated with lack of familiarity with a treadmill; and c) loss of balance and slipping/falling on the treadmill. All laboratory staff have experience with the necessary equipment requirements and at assessing sub-maximal VO2 in children. In the case of emergencies, the laboratory and/or Driftwood Community Centre's staff have Standard First Aid and CPR-Level C certification. In all instances a senior member of the research team, either faculty (Dr. Angelo Belcastro), project coordinators (Asal Moghaddaszadeh) and/or research assistants (Christian Nyugen, Michael Meyerovich) will be present. Should one be required the laboratory contains first aid kit and an AED device. Depending on the circumstances, the child will be immediately stabilized and concurrently the University's Emergency response serves will be contacted – through security at 33333 so that they can contact external emergency support.

Benefits of the Research and Benefits to You: The benefits of this study is to gain knowledge on the types of activities that provide sufficient energy expenditures to promote increased health and fitness while maintaining a high quality of life/enjoyment scale. Activities can be implemented into programs (e.g., school-based) to increase physical activity of children.

Voluntary Participation: The participation in the study is completely voluntary and your child may choose to stop participating at any time. Their decision not to volunteer will not influence their involvement in any current or future Driftwood Community Centre Program involving the physical activity sessions. As well this will not change the nature of your relationship with York University either now, or in the future.

Withdrawal from the Study: Your child can stop participating in the study at any time, for any reason, if you or they so decide. The decision to stop participating, or to refuse to answer particular questions, will not affect your child's relationship with the researchers, York University, or any other group associated with this project. In the event they withdraw from the study, all associated data collected will be immediately destroyed wherever possible.

Confidentiality: All information you supply during the research will be held in confidence and unless you specifically indicate your consent, your name will not appear in any report or publication of the research. The data will be safely stored in a locked facility in the office of the Principal Investigator and only research staff will have access to this information. All electronic records will be stored ion a computer in the PI's laboratory, which is password protected. The data will be stored for seven years and then will be destroyed by a shredder. All electronic data will be deleted. Confidentiality will be provided to the fullest extent possible by law.

Questions About the Research? If you have questions about the research in general or about your role in the study, please feel free to contact Dr. Angelo Belcastro either by telephone at (416) 736-2011 x21088 or by e-mail (anbelcas@yorku.ca). This research has been reviewed and approved by the Human Participants Review Sub-Committee, York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, please contact the Sr. Manager & Policy Advisor for the Office of Research Ethics, 5th Floor, York Research Tower, York University (telephone 416-736-5914 or e-mail ore@yorku.ca).

Legal Rights and Signatures:

I ______________________________________ , consent to have my

(above Print Parent/Guardian Name)

child ____________________________ participate in (**Kin Kids: A Guided**

(above Print Child's Name)

Active Play Approach to Children's 'Sportability' Programming) conducted by Angelo Belcastro. I have understood the nature of this project and wish to participate. I am not waiving any of my legal rights by signing this form. My signature below indicates my consent.

Signature ______________________ **Date** ____________________

(Parent/Guardian)

Signature ____ ___ **Date January 2016** ______

Principal Investigator

Parental Information Handout (2013-2016)

Date July 2013-2016

Dear Parent/Guardian

Subject: Kin Kids: A Guided Active Play Approach to Children's 'Sportability' Programming

Angelo Belcastro, PhD,
Professor

School of Kinesiology and Health Science

Faculty of Health

Paediatric Exercise Science Laboratory

KIN Kids Activity Program

Muscle Health Research Centre (MHRC)

333 Norman Bethune College,
York University
4700 Keele Street
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Canada

Tel: +1 416 736 2100 ext. 21088
Fax: +1 416 435 3511
Email: anbelcas@yorku.ca

The KIN Kids Children's Physical Activity Program is a guided active play format, which offers meaningful opportunities for children (ages 5 to 12) to engage in a variety of active play that incorporates developmentally, age-appropriate, self-selected and non-competitive games. The feedback from the parents and children who have participated in KIN Kids in the past has been excellent.

The Program Directors for the Driftwood Community Centre and the KIN Kids Program of York's School of Kinesiology and Health Science are collaborating in the 2015-2016 Driftwood Community Centre's children's physical activity programing; through a sport skills program referred to as "Sportability', which uses many of the best practices identified for the KIN Kids Guided Active Play. A small research study will also be conducted to determine if the KIN Kids 'Sportability' sessions can provide more health and fitness benefits then cooperative games when undertaken in either a summer camp (every day) and/or once a week over a few weeks (afterschool). We are interested in assessing measures of quality of life, self-confidence, and enjoyment (fun) with different amounts of physical activity when playing children's 'sportability' games.

We are requesting 120 children to participate in the research study. Regardless, if your child is in the research study or not, all children registered in the DCC program will participate in all program activities, but not the research and laboratory sessions. The research portion will occur during the physical activity sessions (~ 1 hr each day) by having participants with parental consent wearing a small accelerometer attached around the waist prior to activity and collected after the session is over. There is no restriction to movement. In addition, we are requesting a pre-testing session that will occur prior to the DCC program at the Paediatric Exercise Physiology Laboratory at York University. The 1.5hr laboratory session will include; measures of height (standing and sitting), leg length, weight, wasit size, 'fat pinch test', and a stand and jump test. As well, a walk/jog/run treadmill test on a motor-driven treadmill at 4, 6, 8 and/or 10 kpm and 0% grade, for three-minutes at each pace preceeded by a warm-up (orientation) and a cool-down period after the exercise. During the laboratory session children will be required to wear head-gear attached to a mouth-mask (value/tubing) for the purposes of collecting air as your child breathes out. The air collection system does not restrict breathing and weighs less than 0.25kg. Parents are welcome to attend the assessment session at York University. Further details are discussed further in the parent/guardian consent form.

If you are interested being a participant in the research study, or should you have any questions or concerns, please contact either Asal Moghaddaszadeh, project coordinator, by email asalmz@yorku.ca or telephone at 416-736-2100 x 20222, Michael Myerovich, research assistant, by email mikemdm@yorku.ca or telephone at 416-736-2100 x 20222, and/ or Angelo Belcastro, prinicpal investigator, by email at anbelcas@yorku.ca or telephone at 416-736-2100 x21088.

Sincerely,

Angelo Belcastro, PhD
York University, Kinesiology and Health Science

Minor Assessment Script (2013-2016)

YORK

UNIVERSITÉ
UNIVERSITY

Dear Child,

Subject: Minor Assent Form - Kin Kids: A Guided Active Play Approach to Children's 'Sportability' Programming

Angelo Belcastro, PhD,
Professor

School of Kinesiology and Health Science

Faculty of Health

Paediatric Exercise Science Laboratory

KIN Kids Activity Program

Muscle Health Research Centre (MHRC)

333 Norman Bethune College
York University
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Toronto, ON, M3J 1P3
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Tel: +1 416 736 2100 ext. 21088
Fax: +1 416 435 3511
Email: anbelcas@yorku.ca

Researchers:
Angelo Belcastro, Ph.D., anbelcas@yorku.ca, School of Kinesiology and Health Science, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3; tel: 416-736-5403
Asal Moghaddaszadeh, project assistant, asalmz@yorku.ca, School of Kinesiology and Health Science, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3; tel: 416-736-2100 x20222
Christian Nyugen, research assistant, kkhoa@yorku.ca, School of Kinesiology and Health Science, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3; tel: 416-736-2100 x20222
Michael Meyerovich, research assistant, mikemdm@yorku.ca, School of Kinesiology and Health Science, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3; tel: 416-736-2100 x20222

Purpose of the Research:

When children play games or exercise, positive things happen to their body. They use energy or the calories that are stored in their body, which is good for their muscles and heart. Also, when exercising or playing sports, games, children are having fun and can start to feel good about themselves. KIN Kids is a program that children play sport specific skills referred to as 'sportability' where that kids learn and play together while having fun.

The reason why we are doing this study is to see whether, when children are in a program such as KIN Kids 'Sportability' how much of the energy stored do children use up? We also want to see how much fun the children are having while playing these games, and if these two things are different from children who only play games and those participating in 'sportability'.

What You Will Be Asked to Do in the Research:

Before the Drftwood Community Centre programs begin, you will come to York University and do some exercising for us on the treadmill. You will walk and do a little running on a treadmill. We will have an elastic strap around your rib area that will show us your heart rate and you will have to breathe in and out of your mouth into a mouthpiece because you will also wear a nose clip. Before you begin walking and running, we will take your height and weight and then make sure that you are okay with walking on the treadmill and breathing into the mouthpiece. We will have you sit on a chair and rest for a few minutes, then walk/run at three different speeds (e.g., walk, fast walk, and jog) for three-minutes each which is only a total of nine minutes of exercise. When the last speed is finished, the test is over, unless you cannot finish. We want you to try to do the best that you can do for the whole time. You will also wear something that is called an accelerometer around your waist. It is very small and it you will barely know it is there (like wearing an elastic belt). It is similar to a pedometer that measures the amount of steps you take. Finally your height, weight, leg length, and waist size will measured.

Once the DCC program starts, everyday for the summer camp and/or the afterschool program, members of the research team will ask you to put the accelerometer around your waist You will wear it for the entire time (about an hour) while playing the 'sportability' games for that day. We do not want you to take it off or play with it, but you can ask to have it taken off at any time. At the end of the time, the members of the research team will collect it from you with no consequences. All you have to do is wear the accelerometer. It will be like an elastic belt around your waist.

Risks and Discomforts: Any risks or discomfort from your participation in the research is minimal. These may include; a) muscle cramping from insufficient warm-up; b) increased anxiety associated with lack of familiarity with a treadmill; and c) loss of balance and falling on the treadmill. Laboratory staff have experience with the necessary equipment requirements and at assessing sub-maximal use of oxygen in children. In the case of emergencies, the laboratory and/or Driftwood Community Centre's staff have Standard First Aid and CPR-Level C certification. In all instances a senior member of the research team, either faculty (Dr. Angelo Belcastro), project coordinators (Asal Moghaddaszadeh) and/or research assistants (Christian Nyugen, Michael Meyerovich) will be present. Should one be required the laboratory contains first aid kit and an AED device. Depending on the circumstances, the child will be immediately stabilized and concurrently the University's Emergency response serves will be contacted – through security at 33333 so that they can contact external emergency support.

Benefits of the Research and Benefits to You: If you help us with this project, it assists us in knowing which activities uses the most and less amounts of energy when being played. We can help children with their fitness, health, self-confidence and have lots of fun while being active.

Voluntary Participation: If you decide to help us in our research study it is entirely up to you. You can decide to stop participating in the study at any time. You will still do all the program activities that are asked of you though such as physical activity, or arts and crafts.

Withdrawal from the Study: You can stop participating in the study at any time, for any reason, if you so decide. If you decide to stop participating, it will not affect anything that you do and we will throw away everything that you have already done.

Confidentiality: All information you give us during the research will be held in confidence and kept a secret. You are going to be given an ID number and your name will not be used for anything. Everything we get from our research is kept safe and locked up. All computer files will be stored in the laboratory with a secure password. All file are thrown away after seven years.

Questions About the Research? If you have questions about the research in general or about your role in the study, please feel free to contact Dr. Angelo Belcastro either by telephone at (416) 736-5403or by e-mail (anbelcas@yorku.ca). This research has been reviewed and approved by the Human Participants Review Sub-Committee, York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, please contact the Sr. Manager & Policy Advisor for the Office of Research Ethics, 5th Floor, York Research Tower, York University (telephone 416-736-5914 or e-mail ore@yorku.ca).

Signatures:

I, (Print Child's Name) ________________________, give my assent to participate in (**Kin Kids: A Guided Active Play Approach to Children's Physical Activity Programming**) conducted by Angelo Belcastro.

I have been told what this project is about and I would like to help. My signature below indicates my assent to participate.

Signature ______________________ **Date** ____________________
Child Participant

Signature ______________________ **Date** ____________________
Principal Investigator

Informed Consent (2016)

Date: June/July 2016

Angelo Belcastro, PhD,
Professor

School of Kinesiology and Health Science

Faculty of Health

Paediatric Exercise Science Laboratory

KIN Kids Activity Program

Muscle Health Research Centre (MHRC)

333 Norman Bethune College
York University
4700 Keele Street
Toronto, ON, M3J 1P3
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Tel: +1 416 736 2100 ext. 21088
Fax: +1 416 435 3511
Email: anbelcas@yorku.ca

Dear Parent/Guardian:

Subject: **Informed Consent** – Kin Kids: Children's Guided Active Play Program Focused on Improvements in Health and Fitness Part IV

Researchers:
Angelo Belcastro, Ph.D., anbelcas@yorku.ca, School of Kinesiology and Health Science, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3; tel: 416-736-5403
Asal Moghaddaszadeh, project assistant, asalmz@yorku.ca, School of Kinesiology and Health Science, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3; tel: 416-736-2100 x20222
Samantha Feldman, research assistant, feldmansyorku.ca, School of Kinesiology and Health Science, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3; tel: 416-736-2100 x20222

Purpose of the Research:

The purpose of this study is to determine whether KIN Kids, a children's guided active play program, instils the value of physical activity in children through self-selected, non-competitive playing of age-appropriate games. The program is designed to promote a child's self-confidence and efficacy within an environment that also considers the necessary amount and intensity of physical activity needed for positive benefits on health and fitness. Children's active self-selected playing of cooperative games can provide sufficient amount and intensity of physical activity during early childhood (5-7yrs) compared to middle-late childhood (8-12yrs). It is of interest to determine if active playing of games results in sufficient energy expenditure to approach Canada's Physical Activity Guideline recommendations throughout the childhood period. The purposes of this study are: 1) to determine cooperative game programming (embedded within the KIN Kids program at the Driftwood Community Centre Programming) elicits physical activity levels sufficient to achieve Health Canada's recommended physical Activity guidelines for children and

adolescents; 2) to assess whether the children participating in the cooperative games sessions experience positive health and fitness benefits or improvements.
3) to find out whether younger children participating in cooperative games programming a summer camp environment will be effective for enhancing their amount/volume and or effort of physical activity compared to older children.

What You Will Be Asked to Do in the Research:

Before programming begins, each participant will be assessed on some pre-testing measurements. Your child will be asked to have their standing and sitting height, leg length, body weight, skinfold (pinch test) and standing jump height will be taken and recorded during this session. Prior to Driftwood Communinty Centre program start date, you will fill asked to complete a physical activity readiness questinonire (PAR-Q) for your child. The measurements will occur inside of the regular DCC 2016 2017 programming. Parents are welcome to attend these sessions but this is not a requirement.

During the DCC programs your child will participate in the KIN Kids cooperative games sessions during the DCC programming (2016-2017). Your child will be asked to wear an accelerometer used to determine steps and/or the amount and type of activity achieved within the sessions. An accelerometer is a small device that they will wear on their right hip only during the DCC sessions. There will be no movement restricitions while wearing the accelerometer (dimensions: 1.5 x 1.44 x 0.7 inches and weight: 27g). They will wear the accelerometer during each KIN kids sessions for about 1.5 hours/session.

Risks and Discomforts: Any risks or discomfort from your child's participation in the research is minimal. These may include; a) muscle cramping from insufficient warm-up; and b) loss of balance and slipping/falling while playing. All staff have experience with the necessary equipment requirements and assessment protocols. In the case of emergencies, the Driftwood Community Centre's staff and or KIN Kids UG students have Standard First Aid and CPR-Level C certification. In all instances a senior member of the research team, either faculty (Dr. Angelo Belcastro), project coordinators (Asal Moghaddaszadeh) and/or research assistants (Samantha Feldman) will be present. Should one be required the DCC facility contains first aid kit and an AED device. Depending on the circumstances, the child will be immediately stabilized and concurrently Emergency response serves will be contacted.

Benefits of the Research and Benefits to You: The benefits of this study is to gain knowledge on whether cooperative games/activities that provide sufficient energy expenditures will result in simlar imporvements for health and fitness paremetrs youger and older children.
Voluntary Participation: The participation in the study is completely voluntary and your child may choose to stop participating at any time. Their decision not to volunteer will not influence their involvement in any current or future Driftwood Community Centre Program involving the physical activity sessions. As well this will not change the nature of your relationship with York University either now, or in the future.

Withdrawal from the Study: Your child can stop participating in the study at any time, for any reason, if you or they so decide. The decision to stop participating, or to refuse to answer particular questions, will not affect your child's relationship with the researchers, York University, or any other group associated with this project. In the event they withdraw from the study, all associated data collected will be immediately destroyed wherever possible.

Confidentiality: All information you supply during the research will be held in confidence and unless you specifically indicate your consent, your name will not appear in any report or publication of the research. The data will be safely stored in a locked facility in the office of the Principal Investigator and only research staff will have access to this information. All electronic records will be stored ion a computer in the PI's laboratory, which is password protected. The data will be stored for seven years and then will be destroyed by a shredder. All electronic data will be deleted. Confidentiality will be provided to the fullest extent possible by law.

Questions About the Research? If you have questions about the research in general or about your role in the study, please feel free to contact Dr. Angelo Belcastro either by telephone at (416) 736-2011 x21088 or by e-mail (anbelcas@yorku.ca). This research has been reviewed and approved by the Human Participants Review Sub-Committee, York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, please contact the Sr. Manager & Policy Advisor for the Office of Research Ethics, 5th Floor, York Research Tower, York University (telephone 416-736-5914 or e-mail ore@yorku.ca).

Legal Rights and Signatures:

I ____________________________________ , consent to have my

(above Print Parent/Guardian Name)

child _____________________________ participate in (**Kin Kids: A Guided**

(above Print Child's Name)

Active Play Program Part IV) conducted by Angelo Belcastro. I have understood the nature of this project and wish to participate. I am not waiving any of my legal rights by signing this form. My signature below indicates my consent.

Signature______________________ **Date**____________________

(Parent/Guardian)

Signature__ **Date**________________

Principal Investigator

Parent Information Handout (2016)

Date June/July 2016

Angelo Belcastro, PhD,
Professor

School of Kinesiology and Health Science

Faculty of Health

Paediatric Exercise Science Laboratory

KIN Kids Activity Program

Muscle Health Research Centre (MHRC)

333 Norman Bethune College,
York University
4700 Keele Street
Toronto, ON, M3J 1P3
Canada

Tel: +1 416 736 2100 ext. 21088
Fax: +1 416 435 3511
Email: anbelcas@vorku.ca

Dear Parent/Guardian

Subject: Kin Kids: Children's Guided Active Play Program Focused on Improvements in Health and Fitness Part IV

The KIN Kids Children's Physical Activity Program is a guided active play format, which offers meaningful opportunities for children (ages 5 to 12) to engage in a variety of active play that incorporates developmentally, age-appropriate, self-selected and non-competitive games. The feedback from the parents and children who have participated in KIN Kids in the past has been excellent.

The Program Directors for the Driftwood Community Centre and the KIN Kids Program of York's School of Kinesiology and Health Science are collaborating in the 2016-2017 Driftwood Community Centre's children's physical activity programing; through a cooperative games 'play' program identified as KIN Kids Guided Active Play. A small research study will also be conducted to determine if the KIN Kids active playing of children's games can provide similar health and fitness benefits for younger and older children when undertaken in a summer camp environment. We are interested in assessing measures of body composition (muscle and fat) and heart and lung function with games.

We are requesting 80 children to participate in the research study. Regardless, if your child is in the research study or not, all children registered in the DCC program will participate in all program activities, but not the research assessments. The research portion will occur during the physical activity sessions (~ 1 hr each day) by having child with parental consent wear a small accelerometer attached around the waist prior to activity and collected after the session is over. There is no restriction to movement. In addition, we are requesting an assessment session that will occur at DCC prior to the program. This inlcudes about 1.5hr and will include; measures of height (standing and sitting), leg length, weight, wasit size, 'fat pinch test', and a stand and jump test. As well, a walk/jog/run assesment. Parents are welcome to attend the assessment sessions. Further details are discussed further in the parent/guardian consent form.

If you are interested being a participant in the research study, or should you have any questions or concerns, please contact either Asal Moghaddaszadeh, project coordinator, by email asalmz@yorku.ca or telephone at 416-736-2100 x 20222, Samantha Ffeldman, research assistant, by email feldmans@yorku.ca or telephone at 416-736-2100 x 20222, and/ or Angelo Belcastro, prinicpal investigator, by email at anbelcas@yorku.ca or telephone at 416-736-2100 x21088.

Sincerely,

Angelo Belcastro, PhD
York University, Kinesiology and Health Science

Minor Assessment Script (2016)

Minor Assent Script

Study Name: KinKids: Children's Guided Active Play Aerobic Program for Health and Fitness Part IV

Purpose of the Research:

When children play games or exercise, positive things happen to their body. They use energy or the calories that are stored in their body, which is good for their muscles and heart. Also, when exercising or playing games, children are having fun and can start to feel good about themselves. KIN Kids is a program that children play games such as tag games or games that kids work together in while having fun.

The reason why we are doing this study is to see whether, when children are in a program such as KIN Kids and playing games like a tag game that is non-competitive and is selected on their own, how much of the energy stored do children use up? We also want to see how much fun the children are having while playing these games, and if these two things are different from children who only play sports.

What You Will Be Asked to Do in the Research:

As the Drftwood Community Centre programs begin, you will be asked to take measurements for your height, weight, blood pressure, muscle mass (skinfolds), hand and leg jumping strength. You will also be asked to do the beep test.

During the DCC physical activity games program, you will be asked to put the accelerometer around your waist before the physical activity part of the camp begins. You will wear it for the entire time (about an hour) while playing the games for that day. It is very small and it you will barely know it is there (like wearing an elastic belt). It is similar to a pedometer that measures the amount of steps you take. We do not want you to take it off or play with it, but you can ask to have it taken off at any time. At the end of the time, the members of the KINkids program will collect it from you with no consequences. All you have to do is wear the accelerometer. It will be like an elastic belt around your waist.

We want you to try to do the best that you can and have fun the whole time while playing.

Risks and Discomforts: During the games programs you might feel tired or have sore muscles – if this happens you can stop and rest until you feel you would like to play again. Also id you feel uncomfortable playing a game then you don't have to play it – you can sit out – that is not a problem. All program leaders staff have experience with the games but in the case of emergencies let the KINKids leaders and/or Driftwood Community Centre's staff know. They can help.

Benefits of the Research and Benefits to You: If you help us with this project, it assists us in knowing which activities uses the most and less amounts of energy when being played. We can help children with their fitness, health, self-confidence and have lots of fun while being active.

Voluntary Participation: If you decide to help us in our research study it is entirely up to you. You can decide to stop participating in the study at any time. You will still do all the program activities that are asked of you though such as physical activity, or arts and crafts.

Withdrawal from the Study: You can stop participating in the study at any time, for any reason, if you so decide. If you decide to stop participating, it will not affect anything that you do and we will throw away everything that you have already done.

Informed Consent English and Spanish Version (2017-2018)

YORK U UNIVERSITÉ UNIVERSITY

Angelo Belcastro, PhD,
Professor

School of Kinesiology and Health Science

Faculty of Health

Paediatric Exercise Science Laboratory

KIN Kids Activity Program

Muscle Health Research Centre (MHRC)

333 Norman Bethune College
York University
4700 Keele Street
Toronto, ON, M3J 1P3
Canada

Tel: +1 416 736 2100 ext. 21088
Fax: +1 416 435 3511
Email: anbelcas@yorku.ca

Date: June/July 2017

Dear Parent/Guardian:

Subject: **Informed Consent** – Kin Kids: Children's Guided Active Play Program Focused on Improvements in Health and Fitness

Researchers:
Angelo Belcastro, Ph.D., anbelcas@yorku.ca, School of Kinesiology and Health Science, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3; tel: 416-736-5403
Asal Moghaddaszadeh, MSc, project assistant, asalmz@yorku.ca, School of Kinesiology and Health Science, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3; tel: 416-736-2100 x20222
Donya Mahiny, research assistant, donya8@my.yorku.ca, School of Kinesiology and Health Science, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3; tel: 416-736-2100 x20222

Purpose of the Research:

The purpose of this study is to determine whether KIN Kids, a children's guided active play program, using self-paced, non-competitive playing of age-appropriate games will encourage children to participate in physical activity The program is designed to promote a child's self-confidence and enjoyment, while providing the necessary amount and intensity of physical activity needed for positive benefits on health and fitness. It is of interest to determine if; a) active playing of games results in sufficient energy expenditure to approach Canada's Physical Activity Guideline recommendations within a summer program; b) children participating in the play/games sessions experience positive health and fitness benefits or improvements; and c) children with higher fitness levels participating in play/games summer program will enhance their amount and effort of physical activity compared to with lower fitness levels children.

What You Will Be Asked to Do in the Research:

You will fill asked to complete a physical activity readiness questinonire (PAR-Q+) for your child prior/during the Summer Camp. You and you child will not be asked to do more than what is contained within the Centre for Spanish Speaking Peoples summer camp. Only the information collected during the CSSP - KINKids active play program is required. This includes; a quallity of life and enjoyment surveys, plus standing and sitting height, body weight, waist circumference, skinfold (pinch test), standing jump height and a 20 metre walk/jog/run test in the first and last week of the summer

During the summer program your child will be asked to wear an accelerometer during the KINkids program. An accelerometer is a small device that fits on a belt (on right hip - dimensions: 1.5 x 1.44 x 0.7 inches and weight: 27g) during the physical activity sessions.

It does not restrict movement. The accelerometer is used to determine the number of steps and/or the amount of activity that occurs within the program.

Risks and Discomforts: Any risks or discomfort from your child's participation in the KINKIds Guided Active Play program is minimal. These may include; a) muscle cramping from insufficient warm-up; and b) loss of balance and slipping/falling while playing. All staff have experience with the necessary equipment requirements and assessment protocols. In the case of emergencies, the CSSP staff and or KIN Kids UG students have Standard First Aid and CPR-Level C certification. In all instances a senior member of the research team, either faculty (Dr. Angelo Belcastro), project coordinators (Asal Moghaddaszadeh) and/or research assistants (Donya Mahiny) will be present. Should one be required the CSSP facility contains first aid kit and an AED device. Depending on the circumstances, the child will be immediately stabilized and concurrently Emergency response serves will be contacted.

Benefits of the Research and Benefits to You: The benefits of this study is to gain knowledge on whether cooperative games/activities that provide sufficient energy expenditures will result in improvements for health and fitness parameters.

Voluntary Participation: The participation in the research study is completely voluntary and your child may choose to stop participating at any time. Their decision not to volunteer will not influence their involvement in any current or future Centre for Spanish Speaking Peoples Program involving the physical activity sessions. As well this will not change the nature of your relationship with York University either now, or in the future.

Withdrawal from the Study: Your child can stop participating in the study at any time, for any reason, if you or they so decide. The decision to stop participating, or to refuse to answer particular questions, will not affect your child's relationship with the researchers, York University, or any other group associated with this project. In the event they withdraw from the study, all associated data collected will be immediately destroyed wherever possible.

Confidentiality: All information you supply for the research will be held in confidence and unless you specifically indicate your consent, your name will not appear in any report or publication of the research. The data will be safely stored in a locked facility in the office of the Principal Investigator and only research staff will have access to this information. All electronic records will be stored ion a computer in the PI's laboratory, which is password protected. The data will be stored for seven years and then will be destroyed by a shredder. All electronic data will be deleted. Confidentiality will be provided to the fullest extent possible by law. Finally, the data collected may also be used for research purposes and statistical analysis, but the results will only be reported in a n anonymous group format.

Questions About the Research? If you have questions about the research in general or about your role in the study, please feel free to contact Dr. Angelo Belcastro either by telephone at (416) 736-2011 x21088 or by e-mail (anbelcas@yorku.ca). This research has been reviewed and approved by the Human Participants Review Sub-Committee, York

University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, please contact the Sr. Manager & Policy Advisor for the Office of Research Ethics, 5th Floor, York Research Tower, York University (telephone 416-736-5914 or e-mail ore@yorku.ca).

Legal Rights and Signatures:

I ___________________________________ , consent to have my

(above Print Parent/Guardian Name) child ____________________________

participate in (**Kin Kids: A Guided**

(above Print Child's Name)

Active Play Program) conducted by Angelo Belcastro. I have understood the nature of this project and wish to participate. I am not waiving any of my legal rights by signing this form. My signature below indicates my consent.

Signature______________________ **Date**__________________________
(Parent/Guardian)

Signature___________________ **Date**__ _______________
Principal Investigator

Fecha: Junio/julio de 2017

Estimado padres/guardianes :
Asunto: **Formulario de Consentimiento Informado** – KinKids: Programa de Juego Activo Infantil Guiado centrado en mejoras en salud y forma física.

Investigadores:

Angelo Belcastro PH.d., anbelcas@yorku.CA , Escuela de Kinesiología y Ciencias de la salud, Universidad de York, 4700 Keele Street, Toronto, Ontario M3J 1 P 3, tel: 416-736-5403
Asal Moghaddaszadeh MSc, asistente del proyecto, asalmz@yorku.CA ,

Escuela de Kinesiología y Ciencias de la salud, Universidad de York, 4700 Keele Street, Toronto, Ontario M3J 1 P 3, tel: 416-736-2100 x20222
Donya Mahiny Asistente de investigación, donya8@My.yorku.CA , Escuela de Kinesiología y Ciencias de la salud, Universidad de York, 4700 Keele Street, Toronto, Ontario M3J 1 P 3, tel: 416-736-2100 x20222 **Propósito de la investigación:**

El propósito de este estudio es determinar si en lo Programa de juegos activos guiado KIN kids, los niños, utilizando su ritmo, jugando juegos que no son competitivos apropiados para la edad se alentar a los niños a participar en actividad física. El programa está diseñado para promover la confianza en sí mismo y disfrute, mientras que proporciona la cantidad necesaria y la intensidad de actividad física necesaria para beneficios de salud y aptitud del niño. Resulta de interés determinar siempre que: a) jugando juegos activos resulta en gasto energético suficiente a recomendaciones do Guia Canadiense de actividad física en niños dentro de un campamento de verano; b) los niños que participan en las sesiones de juegos tienes experiencia positivas para la salud y fitness o mejoras; y c) niños con niveles más altos de aptitud participando en juegos do programa de campamento de verano aumentará su cantidad y esfuerzo de la actividad física en comparación con los niños de bajos niveles de aptitud.

Lo que se le pedirá que hacer en la investigación:

Llenará el pedido para completar un cuestionario de preparación de la actividad física (PAR-Q +) para su niño antes y durante lo campamento de verano. Usted y su hijo no le pedirá que hacer más que lo que está contenido dentro do campamento de verano de lo centro para gente de habla hispana. Sólo la información recogida durante el CSSP - KINKids programa de juego activo se requiere. Esto incluye; una calidad de vida y las encuestas de disfrute, además altura de pie y sentado, peso, circunferencia de la cintura, pliegues cutáneos (pinzada de la piel), altura del salto vertical y a caminar/trotar/correr de 20 metros (test course navette) en la primera y última semana del campamento de verano. Todas las medidas se producirán dentro de la programación regular y ningún tiempo adicional es requerido. Los padres son Bienvenidos a asistir a estas sesiones, pero esto no es un requisito. Durante el campamento de verano su hijo/hija va a usar un acelerómetro durante el programa de KINkids. Un acelerómetro es un dispositivo pequeño que se adapta a una correa (en la cadera derecha - dimensiones: 1.5 x 1.44 x 0,7 pulgadas y peso: 27g) durante las sesiones de actividad física, no estará restricto a lo movimiento. El acelerómetro es para determinar el número de pasos o la cantidad de actividad que se produce dentro del programa. **Riesgos y molestias:** Cualquier riesgo o malestar de su participación en el programa KINKIds es mínima. Estos pueden incluir; a) músculo calambres de calentamiento insuficiente; y b) pérdida de equilibrio y deslizarse/caer mientras jugaba. Todo el personal tiene experiencia con los equipos necesarios requisitos y protocolos de evaluación. En el caso de emergencias, el personal CSSP y los estudiantes KIN kids UG tienen certificación estándar de primeros auxilios y CPR-nivel C. En todos los casos, un miembro del equipo de investigación, tanto de la facultad (Dr. Angelo Belcastro), coordinadores del proyecto (Asal Moghaddaszadeh) o asistentes de investigación (Donya Mahiny) estará presente. Si necesario lo CSSP tiene kit de primeros auxilios y un dispositivo de AED. Dependiendo de las circunstancias, el niño será inmediatamente estabilizado y al mismo tiempo se llamará lo servicio de emergencia.

Beneficios de la investigación y beneficios para usted: Los beneficios de este estudio es conocer en si juegos y actividades cooperativas que proporcionan suficiente gasto energético que producirá mejoras de parámetros de salud y forma física.

Participación voluntaria : La participación en el estudio de investigación es totalmente voluntaria y su hijo puede optar por dejar de participar en cualquier momento. La decisión de tu hijo/hija de no ser voluntario no influirá en su participación en cualquier programa actual o futuro en lo centro para gente de habla hispana. Y lo mismo no va a mudar la naturaleza de su relación con la Universidad de York ahora o en el futuro.

Retiro del estudio : Su hijo puede dejar de participar en el estudio en cualquier momento, por cualquier razón, si usted o ellos así lo deciden. La decisión de dejar de participar o rehusarse a contestar preguntas particulares, no afectará la relación de su hijo con los investigadores, la Universidad de York, o cualquier otro grupo asociado a este proyecto. En caso de que se retiren del estudio, asociados todos los datos recogidos se serán destruidos inmediatamente siempre que sea posible.

Confidencialidad : Toda la información la fuente para la investigación se llevará a cabo en confianza y a menos que usted indique específicamente su consentimiento, su nombre no aparecerá en ningún informe o publicación de la investigación. Los datos se almacenarán con seguridad en una instalación cerrada en la oficina del Investigador Principal y personal de investigación sólo tendrá acceso a esta información. Todos los registros electrónicos serán almacenados ion una computadora en el laboratorio de la PI, que está protegido con contraseña. Los datos se almacenarán durante siete años y luego serán destruidos por una trituradora de papel. Se eliminarán todos los datos electrónicos. Confidencialidad se proporcionará en la mayor medida posible por la ley. Finalmente, los datos recogidos pueden también usarse para fines de investigación y análisis estadístico, pero sólo se reportarán los resultados en un formato de grupo anónimo n.

Preguntas sobre la investigación? Si tiene preguntas sobre la investigación en general o sobre su papel en el estudio, sienta por favor libre para entrar en contacto con el Dr. Angelo Belcastro por teléfono al (416) 736-2011 x21088 o por correo electrónico (anbelcas@yorku.ca). Esta investigación ha sido revisada y aprobada por las personas participantes de Subcomité, Universidad de York de la Junta de revisión ética y cumple con las normas de las directrices canadienses Tri-Consejo de ética de investigación. Si usted tiene alguna pregunta sobre este proceso, o sobre sus derechos como participante en el estudio, por favor póngase en contacto con el Gerente y asesor de política de la oficina de ética de la investigación, 5th Piso, torre de investigación de York, York University (teléfono 416-736-5914 o e-mail ore@yorku.ca).

Firmas y derechos legales:

Autorizo a **____**, mi

(escribe el nombre de padres) niño **_______________________________**

participar en *(***Kin kids:**

(escribe el nombre del niño)

Programa de juego activos guiados) conducido por Angelo Belcastro. Han comprendido la naturaleza de este proyecto y desea participar. No estoy renunciando a ninguno de mis derechos legales al firmar este formulario. Mi firma abajo indica mi consentimiento.

Firma: __________________________________ Fecha________________

(Padres/guardianes)

Firma ___________________________________ **Fecha** _______________

Investigador principal

Parent Information Handout in Spanish (2017-2018)

YORK UNIVERSITÉ UNIVERSITY

Estimados padres/guardianes

Asunto: información sobre Kin Kids: Programa de Juegos Activos Guiados centrado en mejoras en salud y Fitness

Programa de actividad física de KIN kids es un formato de juego activo guiado, que ofrece oportunidades significativas para los niños (5 a 12 años) a participar en una variedad de juegos que incorpora al desarrollo, juegos apropiados para la edad, auto elegidos y no competitivos. Los comentarios de los padres y los niños que han participado en parientes de niños en el pasado ha sido excelente.

El centro para gente de habla hispana (CSSP) y el programa KIN kids de York, escuela de Kinesiología y Ciencias de la salud, colaboran en la campamento de verano de 2017-2018 CSSP. El propósito es apoyar la actividad física de los niños a través de una cooperativa de juegos de 'play' programa identificado como KIN. Los niños registrados en el programa de campamento de verano de CSSP participará por una hora cada día jugando. Durante el día el niño lleve un pequeño acelerómetro atado alrededor de su cintura para controlar el nivel de participación de la actividad física. No existe ninguna restricción al movimiento. Además algunas medidas de salud y forma física se producen en lo campamento de verano durante la primera y última semana del programa. Estas medidas incluyen una calidad de como y disfrute encuestas; Además de la altura del niño (de pie y sentado), longitud de las piernas, peso, tamaño de cintura, 'prueba del pellizco de la piel' (medición de los pliegues cutáneos), la prueba de salto vertical y una evaluación de caminar/trotar/correr 20 metros de cardiorrespiratorio. Información de los niños se proporcionará a lo campamento de verano de CSSP. Los padres / guardianes son Bienvenidos a asistir a las sesiones de evaluación.

Estudio de investigación:

La información no se utilizará para fines de investigación, salvo consentimiento de los padres. Estamos solicitando para evaluar información de salud y bienestar de los niños para determinar si el KIN kids juegos activos pueden proporcionar beneficios de salud y fitness para niños en un ambiente de campamento de verano. Estamos interesados en la evaluación de estas medidas al inicio y al final de la campamento de verano. No más tiempo o actividad fuera de lo campamento de verano de CSSP se requiere de ningún niño o padre o guardián para participar en el estudio de investigación. Solicitamos 50 niños y niñas a participar en el estudio de investigación. Más detalles se discuten en el formulario de consentimiento informado para padres/guardianes.

Si usted está interesado en ser un participante en el estudio de investigación, o si usted tiene alguna pregunta o inquietud, póngase en contacto con cualquiera de los dos Asal Moghaddaszadeh, Coordinador del proyecto, por correo electrónico asalmz@yorku.CA o por teléfono en el 416-736-2100 x 20222 y/o Angelo Belcastro, investigador principal, por correo electrónico a anbelcas@yorku.CA o teléfono 416-736-2100 x21088.

Atentamente,

Angelo Belcastro, PhD
Universidad de York de Kinesiología y Ciencias de la salud

Minor Assessment Script English and Spanish (2017-2018)

Minor Assent Script

Study Name: Kin Kids: Children's Guided Active Play Program Focused on Improvements in Health and Fitness

Purpose of the Research:

When children play games or exercise, positive things happen to their body. They use energy or the calories that are stored in their body, which is good for their muscles and heart. Also, when exercising or playing games, children are having fun and can start to feel good about themselves. KIN Kids is a program that children play games such as tag games or games that kids work together in while having fun.

The reason why we are doing this study is to see whether, when children are in a program such as KIN Kids and playing games like a tag game that is non-competitive and is selected on their own, how much of the energy stored do children use up? We also want to see how much fun the children are having while playing these games, and if these two things are different from children who only play sports.

What You Will Be Asked to Do in the Research:

As the summer camp (with Centre for Spanish Speaking Peoples) begin, you will be asked to take measurements for your height, weight, blood pressure, body fat (pinch test), hand strength, leg jumping strength and 20 metre jog/run test (beep test). You will also be asked some questions about if you enjoy physical activity.

During the summer camp games program, you will be asked to put the accelerometer around your waist before the physical activity begins. You will wear it for the entire time while playing the games for that day. It is very small and it you will barely know it is there (like wearing an elastic belt). It is similar to a pedometer that measures the amount of steps you take. We do not want you to take it off or play with it, but you can ask to have it taken off at any time. At the end of the time, the members of the KINkids program will collect it from you with no consequences. All you have to do is wear the accelerometer. It will be like an elastic belt around your waist.

We want you to try to do the best that you can and have fun the whole time while playing.

Risks and Discomforts: During the games programs you might feel tired or have sore muscles – if this happens you can stop and rest until you feel you would like to play again. Also if you feel uncomfortable playing a game then you don’t have to play it – you can sit out – that is not a problem. All program leaders staff have experience with the games but in the case of emergencies let the KINKids leaders and/or Centre for Spanish Speaking Peoples Summer Camp’s staff know. They can help.

Benefits of the Research and Benefits to You: If you help us with this project, it assists us in knowing which activities uses the most and less amounts of energy when being played. We can help children with their fitness, health, self-confidence and have lots of fun while being active.

Voluntary Participation: If you decide to help us in our research study it is entirely up to you. You can decide to stop participating in the study at any time.

Withdrawal from the Study: You can stop participating in the study at any time, for any reason, if you so decide. If you decide to stop participating, it will not affect anything that you do and we will throw away everything that you have already done.

Confidentiality: All information you give us during the research will be held in confidence and kept a secret. You are going to be given an ID number and your name will not be used for anything. Everything we get from our research is kept safe and locked up and once the study is over, everything is thrown away after seven years.

Questions About the Research? If you have questions about the research in general or about your role in the study, please feel free to contact Dr. Angelo Belcastro either by telephone at (416) 736-5403or by e-mail (anbelcas@yorku.ca). This research has been reviewed and approved by the Human Participants Review Sub Committee, York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, please contact th the Sr. Manager & Policy Advisor for the Office of Research Ethics, 5 Floor, York Research Tower, York University (telephone 416-736-5914 or e-mail ore@yorku.ca).

Información para menores de edad/Asentimiento

Titulo del estudio : Kin kids: Programa de Juegos Activos Guiados centrado en mejoras en la salud y fitness

Propósito de la investigación:

Cuando los niños jugam o hacen ejercicio fisico, suceden cosas positivas a su cuerpo. Utilizan energía o las calorías que se almacenan en su cuerpo, que es bueno para los músculos y el corazón. También, cuando jugam, los niños divierten y pueden empezar a sentirse bien sobre sí mismos. KIN Kids es un programa que los niños juegan juegos como de persecución o juegos que los niños trabajam juntos y se divierten.

La razón por qué estamos haciendo este estudio es ver si, cuando los niños están en un programa como KIN KIDS y jugar juegos de persecución que es no competitivo y es seleccionado por su propia cuenta, ¿cuánto de la energía almacenada lo niños están a utilizar?

También queremos ver cuánto diversión que tienen los niños jugando estos juegos, y si estas dos cosas son diferentes de los niños que sólo juegan deportes.

Lo que se le pedirá que hacer en la investigación:

Como empezar el campamento de verano (con el centro para gente de habla hispana), le pedirá que tome medidas de su altura, peso, presión arterial, antropometría (medición de los pliegues cutáneos), fuerza de la mano, fuerza de las piernas al saltar y trotar y prueba de sonido de 20 metros (test course navette). También se le pedirá algunas preguntas acerca de si le gusta la actividad física.

Durante el programa de juegos del campamento de verano, se le pedirá para poner el acelerómetro alrededor de su cintura antes de que comience la actividad física. Usted lo usa durante todo el tiempo jugando los juegos para ese día. Es muy pequeña y apenas sabes lo es (como el uso de un cinturón elástico). Es similar a un podómetro que mide la cantidad de pasos que tomar. No queremos que se quite o juga
con él, pero usted puede pedir que se saca en cualquier momento. Al final del tiempo, los miembros del programa KINkids recogerá lo de usted sin consecuencias. Todo lo que tienes que hacer es usar el acelerómetro. Será como una banda elástica alrededor de su cintura.

Queremos intentar hacer lo mejor que puede y divertirse todo el tiempo jugando.

Riesgos y molestias : Durante los programas de juegos podría sentirse cansado o tener dolores musculares – si esto sucede que usted puede parar y el resto hasta que sienta que gustaría jugar otra vez. También si usted se siente incómodo jugando un juego y luego no tienes que jugar, usted puede sentarse, no es un problema. Todo el personal del programa tiene experiencia con los juegos pero en el caso de emergencias dejó los líderes de KINKids o las personas del campamento de verano del centro para gente de habla hispana saber. Le pueden ayudar.

Beneficios de la investigación y beneficios : Si nos ayudan con este proyecto, nos ayuda a saber qué actividades utiliza los más y menos cantidades de energía cuando se está reproduciendo. Podemos ayudar a los niños con su fitness, salud, confianza en sí mismos y tienen un montón de diversión mientras está activo.

Participación voluntaria : Si decides ayudarnos en nuestro estudio de investigación es totalmente su decisión. Usted puede decidir dejar de participar en el estudio en cualquier momento.

Retiro del estudio : Puede dejar de participar en el estudio en cualquier momento, por cualquier razón, si usted así lo decide. Si usted decide dejar de participar, no afectará cualquier cosa que hagas y que le Tiramos todo lo que ya hiciste.

Confidencialidad : Toda la información que nos da durante la investigación se llevó a cabo en confianza y mantienen en secreto. Se va a dar un número de identificación y su nombre no se utilizará para nada. Todo lo que obtenemos de nuestra investigación se mantiene seguro y cerrado y una vez terminado el estudio, todo se tiran después de siete años.

Preguntas sobre la investigación? Si tiene preguntas sobre la investigación en general o sobre su papel en el estudio, sienta por favor libre para entrar en contacto con el Dr. Angelo Belcastro ya sea por teléfono al (416) 736-5403 o por correo electrónico (anbelcas@yorku.ca). Esta investigación ha sido revisada y aprobada por los participantes de Subcomité, Universidad de York se ajusta a las normas de las directrices de ética canadiense Tri - Consejo de investigación y de la Junta de revisión ética. Si usted tiene alguna pregunta sobre este proceso, o sobre sus derechos como participante en el estudio, por favor póngase en contacto con el Sr. Gerente y asesor de política para la oficina de ética de investigación, 5to Piso, torre de investigación de York, York University (teléfono 416-736-5914 o e-mail ore@yorku.ca).

Informed Consent (Microvascular Function 2017)

Date: June/July 2017

Angelo Belcastro, PhD,
Professor

School of Kinesiology and Health Science

Faculty of Health

Paediatric Exercise Science Laboratory

KIN Kids Activity Program

Muscle Health Research Centre (MHRC)

333 Norman Bethune College
York University
4700 Keele Street
Toronto, ON, M3J 1P3
Canada

Tel: +1 416 736 2100 ext. 21088
Fax: +1 416 435 3511
Email: anbelcas@yorku.ca

Dear Parent/Guardian:

Subject: **Informed Consent** – Regulation of microvascular function in children and youth

Researchers:
Angelo Belcastro, Ph.D., anbelcas@yorku.ca, School of Kinesiology and Health Science, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3; tel: 416-736-5403
Asal Moghaddaszadeh, MSc, project assistant, asalmz@yorku.ca, School of Kinesiology and Health Science, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3; tel: 416-736-2100 x20222

Purpose of the Research:
The purpose of this study is to determine how much physical activity and/or fitness is needed to promote cardiorespiratory and vascular health. This is important because high blood pressure and impaired (poor) blood flow in children are present when they are not physical active, lead a sedentary lifestyle and/or are overweight. Therefore, studying how much physical activity and fitness is needed to improve cardiorespiratory health and blood flow is an important measure of children's health. Physical activity of children will occur with their participation in an active play program where they will play age-appropriate social games (running games (tag), jumping and hoping activities) (i.e., KINkids: Children's Guided Active Play Program).

What You Will Be Asked to Do in the Research:
Your child will be asked to participate in two parts of testing: aerobic power and microvascular function.

During the aerobic power assessment children will participate in a standardized paced shuttle run, which requires them to jog/run back and forth between two pylons (a 20-meter distance). The audio signals are separated by stages and start off with an increased time between signals requiring, as the stages progress the time between signal decreases. During the shuttle physical activity children start with a slow jog and continuously increase their speed. The children terminate the shuttle run when they can no longer make it between the two pylons or when they want to stop.

To determine microvascular function children will be sitting in a chair with their arm extended and resting in a cushion. Blood pressure and skin temperature will be monitored. Children will be fitted with two stick on patches (about the size of a toonie) on their right forearm just below the elbow. The patches are connected to an insulated wire that can deliver very small quantities of current (20uA for about 180seconds). During this time 5 millilitres of two substances, either acetylcholine or sodium nitroprusside will be placed on the ‘toonie sized’ patches.

Risks and Discomforts: Any risks or discomfort from your child’s participation in the active Play program and/or the shuttle jog/run activity is minimal. These may include; slipping, sweating, and lose of balance – things that would normally occur when children are playing. In regard to the microvascular function, a child may experience a) minimal skin irritation b) discomfort from sitting still for 20 minutes.

All staff have experience with the necessary equipment requirements and assessment protocols. In the case of emergencies, the CSSP staff and or KIN Kids UG students have Standard First Aid and CPR-Level C certification. In all instances a senior member of the research team, either
faculty (Dr. Angelo Belcastro) and/or project coordinator (Asal Moghaddaszadeh) will be present.

Benefits of the Research and Benefits to You: The benefits of this study is to gain knowledge on the children's and young adult's health and development of their physiological systems as well as their health and physical plus physiological fitness status. Other benefits include learning more about vascular biology and the function of the microvasculature.

Voluntary Participation: The participation in the research study is completely voluntary and your child may choose to stop participating at any time. Their decision not to volunteer will not influence their involvement in any current or future Centre for Spanish Speaking Peoples Program involving the physical activity sessions. As well this will not change the nature of your relationship with York University either now, or in the future.

Withdrawal from the Study: Your child can stop participating in the study at any time, for any reason, if you or they so decide. The decision to stop participating, or to refuse to answer particular questions, will not affect your child’s relationship with the researchers, York University, or any other group associated with this project. In the event they withdraw from the study, all associated data collected will be immediately destroyed wherever possible.

Confidentiality: All information you supply for the research will be held in confidence and unless you specifically indicate your consent, your name will not appear in any report or publication of the research. The data will be safely stored in a locked facility in the office of the Principal Investigator and only research staff will have access to this information. All electronic records will be stored ion a computer in the PI’s laboratory, which is password protected. The data will be stored for seven years and then will be destroyed by a shredder. All electronic data will be deleted. Confidentiality will be provided to the fullest extent possible by law.

Questions About the Research? If you have questions about the research in general or about your role in the study, please feel free to contact Dr. Angelo Belcastro either by telephone at (416) 736-2011 x21088 or by e-mail (anbelcas@yorku.ca). This research has been reviewed and approved by the Human Participants Review Sub-Committee, York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, please contact the Sr. Manager & Policy Advisor for the Office of Research Ethics, 5th Floor, York Research Tower, York University (telephone 416-736-5914 or e-mail ore@yorku.ca).

Legal Rights and Signatures:

I ___________________________________ , consent to have my

(above Print Parent/Guardian Name) child _____________________________

participate in (**Kin Kids: A Guided**

(above Print Child's Name)

Active Play Program) conducted by Angelo Belcastro. I have understood the nature of this project and wish to participate. I am not waiving any of my legal rights by signing this form. My signature below indicates my consent.

Signature_____________________ **Date**_________________________

(Parent/Guardian)

Signature___________________ **Date**_______________

Principal Investigator

Parent Information Handout (Microvascular Function 2017)

Date June/July 2017

Angelo Belcastro, PhD,
Professor

School of Kinesiology and Health Science

Faculty of Health

Paediatric Exercise Science Laboratory

KIN Kids Activity Program

Muscle Health Research Centre (MHRC)

333 Norman Bethune College,
York University
4700 Keele Street
Toronto, ON, M3J 1P3
Canada

Tel: +1 416 736 2100 ext. 21088
Fax: +1 416 435 3511
Email: anbelcas@yorku.ca

Dear Parent/Guardian

Subject: Information about microvascular function of children and youth with self-paced physical activity

The Centre for Spanish Speaking Peoples (CSSP) and the KIN Kids Program of York's School of Kinesiology and Health Science are collaborating in the 2017-2018 CSSP Summer School. The purpose of this study is to determine how much physical activity and/or fitness is needed to promote cardiorespiratory and vascular health. This is important because high blood pressure and impaired (poor) blood flow in children are present when they are not physical active, lead a sedentary lifestyle and/or are overweight. Therefore, studying how much physical activity and fitness is needed to improve cardiorespiratory health and blood flow is an important measure of children's health. Physical activity of children will occur with their participation in an active play program where they will play age-appropriate social games (running games (tag), jumping and hoping activities) (i.e., KINKids: Children's Guided Active Play Program).

Research Study:
The assessment information will not be used for research purposes, unless parental consent is given. We are requesting to evaluate the children's health and fitness information to determine if the KIN Kids active games (play) can provide health and fitness benefits for children in a summer school environment. We are interested in assessing these measures at the start and end of the Summer School. No further time and/or activity outside of the CSSP Summer School is required from any child and/or parent/guardian to participate in the research study. We are requesting 50 children to participate in the research study. Further details are discussed further in the parent/guardian consent form

If you are interested being a participant in the research study, or should you have any questions or concerns, please contact either Asal Moghaddaszadeh, project coordinator, by email asalmz@yorku.ca or telephone at 416-736-2100 x 20222 and / or Angelo Belcastro, prinicpal investigator, by email at anbelcas@yorku.ca or telephone at 416-736-2100 x21088.

Sincerely,

Angelo Belcastro, PhD
York University, Kinesiology and Health Science

Minor Assessment Script (Microvascular Function 2017)
Study Name: Microvascular function of children and youth with self-paced physical activity

Purpose of the Research:

When children play games or exercise, positive things happen to their body. It can help improve circulation in the blood vessels in order for you to be healthy and fit.

The reason why we are doing this study is to see whether, when children play in a physical activity program that uses fun and social games and/or participates in a jogging/running shuttle protocol. We want to know if children do well in a shuttle run test have better circulation in their blood vessels. This will help us understand children's physiological development, which is important because we want to help children improve their health and fitness.

What You Will Be Asked to Do in the Research:

You will be asked to participate in two parts of testing: the shuttle run test and the iontophoresis test.

During the aerobic power assessment children will participate in a standardized paced shuttle run, which requires them to jog/run back and forth between two pylons (a 20-metere distance). The audio signals are separated by stages and start off with an increased time between signals requiring During the shuttle physical activity children start with a slow jog and continuously increase their speed. The children terminate the shuttle run when they can no longer make it between the two pylons or when they want to stop.

To determine microvascular function children will be sitting in a chair with their arm extended and resting in a cushion. Blood pressure and skin temperature will be monitored. Children will be fitted with two stick on patches (about the size of a toonie) on their right forearm just below the elbow. The patches are connected to an insulated wire that can deliver very small quantities of current (20uA for about 180seconds). During this time 5 millilitres of two substances, either acetylcholine or sodium nitroprusside will be placed on the 'toonie sized' patches.

Risks and Discomforts: During the shuttle run test you might feel tired or out of breath which is normal after running but if this happens you can stop and rest until you feel better. During the microvascular assessment you might feel uncomfortable because you are sitting still for a while and the skin on your forearm might be minimally irritated. If you feel uncomfortable at any point you can choose to stop the assessment.

Benefits of the Research and Benefits to You: If you help us with this project, it assists us in learning about children's health and development of their physiological systems and fitness status.

Voluntary Participation: If you decide to help us in our research study it is entirely up to you. You can decide to stop participating in the study at any time.

Withdrawal from the Study: You can stop participating in the study at any time, for any reason, if you so decide. If you decide to stop participating, it will not affect anything that you do and we will throw away everything that you have already done.

Confidentiality: All information you give us during the research will be held in confidence and kept a secret. You are going to be given an ID number and your name will not be used for anything. Everything we get from our research is kept safe and locked up and once the study is over, everything is thrown away after seven years.

Questions About the Research? If you have questions about the research in general or about your role in the study, please feel free to contact Dr. Angelo Belcastro either by telephone at (416) 736-5403or by e-mail

(anbelcas@yorku.ca). This research has been reviewed and approved by the

Human Participants Review Sub-Committee, York University's Ethics Review

Board and conforms to the standards of the Canadian Tri- Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, please contact the Sr. Manager & Policy th
Advisor for the Office of Research Ethics, 5 Floor, York Research Tower, York University (telephone 416-736-5914 or e-mail ore@yorku.ca).

Letter of Support from Community Centre (2017-2018)

Centre for Spanish Speaking Peoples

2141 Jane Street, 2nd Floor
Toronto, ON
M3M 1A2

Tel: (416) 533-8545 exr 132

June 1 2017

Dr. Angelo Belcastro, Chair
KinKids – Guided Active Play Program,
School of Kinesiology and Health Sciences
York University

Dear Professor Belcastro,

It is with great enthusiasm that I welcome the KINKids Guided Active Play Program, School of Kinesiology and Health Sciences to the Centre for Spanish Speaking Peoples (CSSP) Summer School 2017.

The CSSP Summer School offers children from the Jane Street community an opportunity to build their self esteem, share friendships, try new activities and have fun. Our Summer School is for children ages 7 to 12 and runs for 7 weeks during the summer months of July and August. We present Spanish speaking children with challenging and exciting new methods of learning numeracy skills by integrating a variety of themes and special events into our Summer School. We also include opportunities for children to move and/or be physical active into their daily program.

I am delighted to have the Kin Kids program as a part of our Summer School activities this year. The Kin Kids program and CSSP share the same concerns for the children in this community when it comes to the lack of physical activity and the affects this has on a child's psychological and social health. Through this collaboration, participants will not only benefit from the physical health aspects of the program, but also aid in their social and cognitive development as well. The parents of the participants will also gain valuable knowledge as well as to their child's well-being.

The Centre for Spanish Speaking Peoples is proud to be a partner of this initiative. As a partner, the CSSP will provide in-kind resources such as space and instructor time in our Summer School to support the Kin Kids Program.

We look forward to ongoing collaboration with Kin Kids program now and in future endeavors.

Sincerely,

Francisco Vidal,
Programs and Services Director,
Centre for Spanish Speaking Peoples
2141 Jane Street, 2nd Floor
(416) 533-8545 ext 132 (phone)
fvidal@spanishservices.org

APPENDIX B

PARQ+ (2011 and 2017 versions)

PAR-Q+

The Physical Activity Readiness Questionnaire for Everyone

Regular physical activity is fun and healthy, and more people should become more physically active every day of the week. Being more physically active is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

GENERAL HEALTH QUESTIONS

Please read the 7 questions below carefully and answer each one honestly: check YES or NO.	**YES**	**NO**
1) Has your doctor ever said that you have a heart condition **OR** high blood pressure?	☐	☐
2) Do you feel pain in your chest at rest, during your daily activities of living, **OR** when you do physical activity?	☐	☐
3) Do you lose balance because of dizziness **OR** have you lost consciousness in the last 12 months? Please answer **NO** if your dizziness was associated with over-breathing (including during vigorous exercise).	☐	☐
4) Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)?	☐	☐
5) Are you currently taking prescribed medications for a chronic medical condition?	☐	☐
6) Do you have a bone or joint problem that could be made worse by becoming more physically active? Please answer **NO** if you had a joint problem in the past, but it <u>does not limit your current ability</u> to be physically active. For example, knee, ankle, shoulder or other.	☐	☐
7) Has your doctor ever said that you should only do medically supervised physical activity?	☐	☐

If you answered NO to all of the questions above, you are cleared for physical activity.
Go to Page 4 to sign the PARTICIPANT DECLARATION. You do not need to complete Pages 2 and 3.

- Start becoming much more physically active – start slowly and build up gradually.
- Follow Canada's Physical Activity Guidelines for your age (www.csep.ca/guidelines).
- You may take part in a health and fitness appraisal.
- If you have any further questions, contact a qualified exercise professional such as a Canadian Society for Exercise Physiology - Certified Exercise Physiologist® (CSEP-CEP) or a CSEP Certified Personal Trainer® (CSEP-CPT).
- If you are over the age of 45 yr and **NOT** accustomed to regular vigorous to maximal effort exercise, consult a qualified exercise professional (CSEP-CEP) before engaging in this intensity of activity.

If you answered YES to one or more of the questions above, COMPLETE PAGES 2 AND 3.

Delay becoming more active if:

- You are not feeling well because of a temporary illness such as a cold or fever - wait until you feel better
- You are pregnant - talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the **ePARmed-X+ at www.eparmedx.com** before becoming more physically active
- Your health changes - answer the questions on Pages 2 and 3 of this document and/or talk to your doctor or qualified exercise professional (CSEP-CEP or CSEP-CPT) before continuing with any physical activity program.

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PAR-Q+

FOLLOW-UP QUESTIONS ABOUT YOUR MEDICAL CONDITION(S)

1. Do you have Arthritis, Osteoporosis, or Back Problems?

If the above condition(s) is/are present, answer questions 1a-1c — If **NO** ☐ go to question 2

1a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
1b.	Do you have joint problems causing pain, a recent fracture or fracture caused by osteoporosis or cancer, displaced vertebra (e.g., spondylolisthesis), and/or spondylolysis/pars defect (a crack in the bony ring on the back of the spinal column)?	YES ☐ NO ☐
1c.	Have you had steroid injections or taken steroid tablets regularly for more than 3 months?	YES ☐ NO ☐

2. Do you have Cancer of any kind?

If the above condition(s) is/are present, answer questions 2a-2b — If **NO** ☐ go to question 3

2a.	Does your cancer diagnosis include any of the following types: lung/bronchogenic, multiple myeloma (cancer of plasma cells), head, and neck?	YES ☐ NO ☐
2b.	Are you currently receiving cancer therapy (such as chemotheraphy or radiotherapy)?	YES ☐ NO ☐

3. Do you have Heart Disease or Cardiovascular Disease? *This includes Coronary Artery Disease, High Blood Pressure, Heart Failure, Diagnosed Abnormality of Heart Rhythm*

If the above condition(s) is/are present, answer questions 3a-3e — If **NO** ☐ go to question 4

3a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
3b.	Do you have an irregular heart beat that requires medical management? (e.g., atrial fibrillation, premature ventricular contraction)	YES ☐ NO ☐
3c.	Do you have chronic heart failure?	YES ☐ NO ☐
3d.	Do you have a resting blood pressure equal to or greater than 160/90 mmHg with or without medication? (Answer **YES** if you do not know your resting blood pressure)	YES ☐ NO ☐
3e.	Do you have diagnosed coronary artery (cardiovascular) disease and have not participated in regular physical activity in the last 2 months?	YES ☐ NO ☐

4. Do you have any Metabolic Conditions? *This includes Type 1 Diabetes, Type 2 Diabetes, Pre-Diabetes*

If the above condition(s) is/are present, answer questions 4a-4c — If **NO** ☐ go to question 5

4a.	Is your blood sugar often above 13.0 mmol/L? (Answer **YES** if you are not sure)	YES ☐ NO ☐
4b.	Do you have any signs or symptoms of diabetes complications such as heart or vascular disease and/or complications affecting your eyes, kidneys, and the sensation in your toes and feet?	YES ☐ NO ☐
4c.	Do you have other metabolic conditions (such as thyroid disorders, pregnancy-related diabetes, chronic kidney disease, liver problems)?	YES ☐ NO ☐

5. Do you have any Mental Health Problems or Learning Difficulties? *This includes Alzheimer's, Dementia, Depression, Anxiety Disorder, Eating Disorder, Psychotic Disorder, Intellectual Disability, Down Syndrome)*

If the above condition(s) is/are present, answer questions 5a-5b — If **NO** ☐ go to question 6

5a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
5b.	Do you **ALSO** have back problems affecting nerves or muscles?	YES ☐ NO ☐

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PAR-Q+

6.	**Do you have a Respiratory Disease?** *This includes Chronic Obstructive Pulmonary Disease, Asthma, Pulmonary High Blood Pressure*	
	If the above condition(s) is/are present, answer questions 6a-6d	If **NO** ☐ go to question 7
6a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
6b.	Has your doctor ever said your blood oxygen level is low at rest or during exercise and/or that you require supplemental oxygen therapy?	YES ☐ NO ☐
6c.	If asthmatic, do you currently have symptoms of chest tightness, wheezing, laboured breathing, consistent cough (more than 2 days/week), or have you used your rescue medication more than twice in the last week?	YES ☐ NO ☐
6d.	Has your doctor ever said you have high blood pressure in the blood vessels of your lungs?	YES ☐ NO ☐
7.	**Do you have a Spinal Cord Injury?** *This includes Tetraplegia and Paraplegia*	
	If the above condition(s) is/are present, answer questions 7a-7c	If **NO** ☐ go to question 8
7a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
7b.	Do you commonly exhibit low resting blood pressure significant enough to cause dizziness, light-headedness, and/or fainting?	YES ☐ NO ☐
7c.	Has your physician indicated that you exhibit sudden bouts of high blood pressure (known as Autonomic Dysreflexia)?	YES ☐ NO ☐
8.	**Have you had a Stroke?** *This includes Transient Ischemic Attack (TIA) or Cerebrovascular Event*	
	If the above condition(s) is/are present, answer questions 8a-8c	If **NO** ☐ go to question 9
8a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
8b.	Do you have any impairment in walking or mobility?	YES ☐ NO ☐
8c.	Have you experienced a stroke or impairment in nerves or muscles in the past 6 months?	YES ☐ NO ☐
9.	**Do you have any other medical condition not listed above or do you have two or more medical conditions?**	
	If you have other medical conditions, answer questions 9a-9c	If **NO** ☐ read the Page 4 recommendations
9a.	Have you experienced a blackout, fainted, or lost consciousness as a result of a head injury within the last 12 months **OR** have you had a diagnosed concussion within the last 12 months?	YES ☐ NO ☐
9b.	Do you have a medical condition that is not listed (such as epilepsy, neurological conditions, kidney problems)?	YES ☐ NO ☐
9c.	Do you currently live with two or more medical conditions?	YES ☐ NO ☐

GO to Page 4 for recommendations about your current medical condition(s) and sign the PARTICIPANT DECLARATION.

PAR-Q+

If you answered NO to all of the follow-up questions about your medical condition, you are ready to become more physically active - sign the PARTICIPANT DECLARATION below:

- It is advised that you consult a qualified exercise professional (e.g., a CSEP-CEP or CSEP-CPT) to help you develop a safe and effective physical activity plan to meet your health needs.
- You are encouraged to start slowly and build up gradually - 20-60 min of low to moderate intensity exercise, 3-5 days per week including aerobic and muscle strengthening exercises.
- As you progress, you should aim to accumulate 150 minutes or more of moderate intensity physical activity per week.
- If you are over the age of 45 yr and **NOT** accustomed to regular vigorous to maximal effort exercise, consult a qualified exercise professional (CSEP-CEP) before engaging in this intensity of activity.

If you answered **YES** to **one or more of the follow-up questions** about your medical condition:

You should seek further information before becoming more physically active or engaging in a fitness appraisal. You should complete the specially designed online screening and exercise recommendations program - the **ePARmed-X+ at www.eparmedx.com** and/or visit a qualified exercise professional (CSEP-CEP) to work through the ePARmed-X+ and for further information.

Delay becoming more active if:

- You are not feeling well because of a temporary illness such as a cold or fever - wait until you feel better
- You are pregnant - talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the **ePARmed-X+ at www.eparmedx.com** before becoming more physically active
- Your health changes - talk to your doctor or qualified exercise professional (CSEP-CEP) before continuing with any physical activity program.

- You are encouraged to photocopy the PAR-Q+. You must use the entire questionnaire and NO changes are permitted.
- The PAR-Q+ Collaboration, the Canadian Society for Exercise Physiology, and their agents assume no liability for persons who undertake physical activity. If in doubt after completing the questionnaire, consult your doctor prior to physical activity.

PARTICIPANT DECLARATION

- Please read and sign the declaration below.
- If you are less than the legal age required for consent or require the assent of a care provider, your parent, guardian or care provider must also sign this form.

I, the undersigned, have read, understood to my full satisfaction and completed this questionnaire. I acknowledge that this physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if my condition changes. I also acknowledge that a Trustee (such as my employer, community/fitness centre, health care provider, or other designate) may retain a copy of this form for their records. In these instances, the Trustee will be required to adhere to local, national, and international guidelines regarding the storage of personal health information ensuring that they maintain the privacy of the information and do not misuse or wrongfully disclose such information.

NAME ________________________________ DATE ____________________________

SIGNATURE ____________________________ WITNESS __________________________

SIGNATURE OF PARENT/GUARDIAN/CARE PROVIDER ______________________________

For more information, please contact
www.eparmedx.com or
Canadian Society for Exercise Physiology
www.csep.ca

Citation for PAR-Q+
Warburton DER, Jamnik VK, Bredin SSD, and Gledhill N on behalf of the PAR-Q+ Collaboration. The Physical Activity Readiness Questionnaire (PAR-Q+) and Electronic Physical Activity Readiness Medical Examination (ePARmed-X+). Health & Fitness Journal of Canada 4(2):3-23, 2011.

The PAR-Q+ was created using the evidence-based AGREE process (1) by the PAR-Q+ Collaboration chaired by Dr. Darren E. R. Warburton with Dr. Norman Gledhill, Dr. Veronica Jamnik, and Dr. Donald C. McKenzie (2). Production of this document has been made possible through financial contributions from the Public Health Agency of Canada and the BC Ministry of Health Services. The views expressed herein do not necessarily represent the views of the Public Health Agency of Canada or BC Ministry of Health Services.

Key References

1. Jamnik VJ, Warburton DER, Makarski J, McKenzie DC, Shephard RJ, Stone J, and Gledhill N. Enhancing the effectiveness of clearance for physical activity participation; background and overall process. APNM 36(S1):S3-S13, 2011.
2. Warburton DER, Gledhill N, Jamnik VK, Bredin SSD, McKenzie DC, Stone J, Charlesworth S, and Shephard RJ. Evidence-based risk assessment and recommendations for physical activity clearance; Consensus Document. APNM 36(S1):S266-s298, 2011.

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2017 PAR-Q+

The Physical Activity Readiness Questionnaire for Everyone

The health benefits of regular physical activity are clear; more people should engage in physical activity every day of the week. Participating in physical activity is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

GENERAL HEALTH QUESTIONS

Please read the 7 questions below carefully and answer each one honestly: check YES or NO.	YES	NO
1) Has your doctor ever said that you have a heart condition ☐ OR high blood pressure ☐?	☐	☐
2) Do you feel pain in your chest at rest, during your daily activities of living, **OR** when you do physical activity?	☐	☐
3) Do you lose balance because of dizziness **OR** have you lost consciousness in the last 12 months? Please answer **NO** if your dizziness was associated with over-breathing (including during vigorous exercise).	☐	☐
4) Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)? **PLEASE LIST CONDITION(S) HERE:** ____________	☐	☐
5) Are you currently taking prescribed medications for a chronic medical condition? **PLEASE LIST CONDITION(S) AND MEDICATIONS HERE:** ____________	☐	☐
6) Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (muscle, ligament, or tendon) problem that could be made worse by becoming more physically active? Please answer **NO** if you had a problem in the past, but it ***does not limit your current ability*** to be physically active. **PLEASE LIST CONDITION(S) HERE:** ____________	☐	☐
7) Has your doctor ever said that you should only do medically supervised physical activity?	☐	☐

If you answered NO to all of the questions above, you are cleared for physical activity.
Go to Page 4 to sign the PARTICIPANT DECLARATION. You do not need to complete Pages 2 and 3.

- Start becoming much more physically active – start slowly and build up gradually.
- Follow International Physical Activity Guidelines for your age (www.who.int/dietphysicalactivity/en/).
- You may take part in a health and fitness appraisal.
- If you are over the age of 45 yr and **NOT** accustomed to regular vigorous to maximal effort exercise, consult a qualified exercise professional before engaging in this intensity of exercise.
- If you have any further questions, contact a qualified exercise professional.

If you answered YES to one or more of the questions above, COMPLETE PAGES 2 AND 3.

Delay becoming more active if:

- You have a temporary illness such as a cold or fever; it is best to wait until you feel better.
- You are pregnant - talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the ePARmed-X+ at **www.eparmedx.com** before becoming more physically active.
- Your health changes - answer the questions on Pages 2 and 3 of this document and/or talk to your doctor or a qualified exercise professional before continuing with any physical activity program.

OSHF

2017 PAR-Q+

FOLLOW-UP QUESTIONS ABOUT YOUR MEDICAL CONDITION(S)

1.	**Do you have Arthritis, Osteoporosis, or Back Problems?** If the above condition(s) is/are present, answer questions 1a-1c	If **NO** ☐ go to question 2
1a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
1b.	Do you have joint problems causing pain, a recent fracture or fracture caused by osteoporosis or cancer, displaced vertebra (e.g., spondylolisthesis), and/or spondylolysis/pars defect (a crack in the bony ring on the back of the spinal column)?	YES ☐ NO ☐
1c.	Have you had steroid injections or taken steroid tablets regularly for more than 3 months?	YES ☐ NO ☐
2.	**Do you currently have Cancer of any kind?** If the above condition(s) is/are present, answer questions 2a-2b	If **NO** ☐ go to question 3
2a.	Does your cancer diagnosis include any of the following types: lung/bronchogenic, multiple myeloma (cancer of plasma cells), head, and/or neck?	YES ☐ NO ☐
2b.	Are you currently receiving cancer therapy (such as chemotheraphy or radiotherapy)?	YES ☐ NO ☐
3.	**Do you have a Heart or Cardiovascular Condition?** *This includes Coronary Artery Disease, Heart Failure, Diagnosed Abnormality of Heart Rhythm* If the above condition(s) is/are present, answer questions 3a-3d	If **NO** ☐ go to question 4
3a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
3b.	Do you have an irregular heart beat that requires medical management? (e.g., atrial fibrillation, premature ventricular contraction)	YES ☐ NO ☐
3c.	Do you have chronic heart failure?	YES ☐ NO ☐
3d.	Do you have diagnosed coronary artery (cardiovascular) disease and have not participated in regular physical activity in the last 2 months?	YES ☐ NO ☐
4.	**Do you have High Blood Pressure?** If the above condition(s) is/are present, answer questions 4a-4b	If **NO** ☐ go to question 5
4a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
4b.	Do you have a resting blood pressure equal to or greater than 160/90 mmHg with or without medication? (Answer **YES** if you do not know your resting blood pressure)	YES ☐ NO ☐
5.	**Do you have any Metabolic Conditions?** *This includes Type 1 Diabetes, Type 2 Diabetes, Pre-Diabetes* If the above condition(s) is/are present, answer questions 5a-5e	If **NO** ☐ go to question 6
5a.	Do you often have difficulty controlling your blood sugar levels with foods, medications, or other physician-prescribed therapies?	YES ☐ NO ☐
5b.	Do you often suffer from signs and symptoms of low blood sugar (hypoglycemia) following exercise and/or during activities of daily living? Signs of hypoglycemia may include shakiness, nervousness, unusual irritability, abnormal sweating, dizziness or light-headedness, mental confusion, difficulty speaking, weakness, or sleepiness.	YES ☐ NO ☐
5c.	Do you have any signs or symptoms of diabetes complications such as heart or vascular disease and/or complications affecting your eyes, kidneys, **OR** the sensation in your toes and feet?	YES ☐ NO ☐
5d.	Do you have other metabolic conditions (such as current pregnancy-related diabetes, chronic kidney disease, or liver problems)?	YES ☐ NO ☐
5e.	Are you planning to engage in what for you is unusually high (or vigorous) intensity exercise in the near future?	YES ☐ NO ☐

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6. Do you have any Mental Health Problems or Learning Difficulties? *This includes Alzheimer's, Dementia, Depression, Anxiety Disorder, Eating Disorder, Psychotic Disorder, Intellectual Disability, Down Syndrome*

If the above condition(s) is/are present, answer questions 6a-6b — If **NO** ☐ go to question 7

6a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
6b.	Do you have Down Syndrome **AND** back problems affecting nerves or muscles?	YES ☐ NO ☐

7. Do you have a Respiratory Disease? *This includes Chronic Obstructive Pulmonary Disease, Asthma, Pulmonary High Blood Pressure*

If the above condition(s) is/are present, answer questions 7a-7d — If **NO** ☐ go to question 8

7a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
7b.	Has your doctor ever said your blood oxygen level is low at rest or during exercise and/or that you require supplemental oxygen therapy?	YES ☐ NO ☐
7c.	If asthmatic, do you currently have symptoms of chest tightness, wheezing, laboured breathing, consistent cough (more than 2 days/week), or have you used your rescue medication more than twice in the last week?	YES ☐ NO ☐
7d.	Has your doctor ever said you have high blood pressure in the blood vessels of your lungs?	YES ☐ NO ☐

8. Do you have a Spinal Cord Injury? *This includes Tetraplegia and Paraplegia*

If the above condition(s) is/are present, answer questions 8a-8c — If **NO** ☐ go to question 9

8a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
8b.	Do you commonly exhibit low resting blood pressure significant enough to cause dizziness, light-headedness, and/or fainting?	YES ☐ NO ☐
8c.	Has your physician indicated that you exhibit sudden bouts of high blood pressure (known as Autonomic Dysreflexia)?	YES ☐ NO ☐

9. Have you had a Stroke? *This includes Transient Ischemic Attack (TIA) or Cerebrovascular Event*

If the above condition(s) is/are present, answer questions 9a-9c — If **NO** ☐ go to question 10

9a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
9b.	Do you have any impairment in walking or mobility?	YES ☐ NO ☐
9c.	Have you experienced a stroke or impairment in nerves or muscles in the past 6 months?	YES ☐ NO ☐

10. Do you have any other medical condition not listed above or do you have two or more medical conditions?

If you have other medical conditions, answer questions 10a-10c — If **NO** ☐ read the Page 4 recommendations

10a.	Have you experienced a blackout, fainted, or lost consciousness as a result of a head injury within the last 12 months **OR** have you had a diagnosed concussion within the last 12 months?	YES ☐ NO ☐
10b.	Do you have a medical condition that is not listed (such as epilepsy, neurological conditions, kidney problems)?	YES ☐ NO ☐
10c.	Do you currently live with two or more medical conditions?	YES ☐ NO ☐

PLEASE LIST YOUR MEDICAL CONDITION(S) AND ANY RELATED MEDICATIONS HERE: ____________________

GO to Page 4 for recommendations about your current medical condition(s) and sign the PARTICIPANT DECLARATION.

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If you answered NO to all of the follow-up questions about your medical condition, you are ready to become more physically active - sign the PARTICIPANT DECLARATION below:

- It is advised that you consult a qualified exercise professional to help you develop a safe and effective physical activity plan to meet your health needs.
- You are encouraged to start slowly and build up gradually - 20 to 60 minutes of low to moderate intensity exercise, 3-5 days per week including aerobic and muscle strengthening exercises.
- As you progress, you should aim to accumulate 150 minutes or more of moderate intensity physical activity per week.
- If you are over the age of 45 yr and **NOT** accustomed to regular vigorous to maximal effort exercise, consult a qualified exercise professional before engaging in this intensity of exercise.

If you answered **YES** to **one or more of the follow-up questions** about your medical condition:

You should seek further information before becoming more physically active or engaging in a fitness appraisal. You should complete the specially designed online screening and exercise recommendations program - the **ePARmed-X+ at www.eparmedx.com** and/or visit a qualified exercise professional to work through the ePARmed-X+ and for further information.

Delay becoming more active if:

- You have a temporary illness such as a cold or fever; it is best to wait until you feel better.
- You are pregnant - talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the ePARmed-X+ **at www.eparmedx.com** before becoming more physically active.
- Your health changes - talk to your doctor or qualified exercise professional before continuing with any physical activity program.

- You are encouraged to photocopy the PAR-Q+. You must use the entire questionnaire and NO changes are permitted.
- The authors, the PAR-Q+ Collaboration, partner organizations, and their agents assume no liability for persons who undertake physical activity and/or make use of the PAR-Q+ or ePARmed-X+. If in doubt after completing the questionnaire, consult your doctor prior to physical activity.

PARTICIPANT DECLARATION

- All persons who have completed the PAR-Q+ please read and sign the declaration below.
- If you are less than the legal age required for consent or require the assent of a care provider, your parent, guardian or care provider must also sign this form.

I, the undersigned, have read, understood to my full satisfaction and completed this questionnaire. I acknowledge that this physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if my condition changes. I also acknowledge that a Trustee (such as my employer, community/fitness centre, health care provider, or other designate) may retain a copy of this form for their records. In these instances, the Trustee will be required to adhere to local, national, and international guidelines regarding the storage of personal health information ensuring that the Trustee maintains the privacy of the information and does not misuse or wrongfully disclose such information.

NAME ______________________________ DATE ______________________________

SIGNATURE ______________________________ WITNESS ______________________________

SIGNATURE OF PARENT/GUARDIAN/CARE PROVIDER ______________________________

For more information, please contact

www.eparmedx.com

Email: eparmedx@gmail.com

Citation for PAR-Q+

Warburton DER, Jamnik VK, Bredin SSD, and Gledhill N on behalf of the PAR-Q+ Collaboration. The Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) and Electronic Physical Activity Readiness Medical Examination (ePARmed-X+). Health & Fitness Journal of Canada 4(2):3-23, 2011.

The PAR-Q+ was created using the evidence-based AGREE process (1) by the PAR-Q+ Collaboration chaired by Dr. Darren E. R. Warburton with Dr. Norman Gledhill, Dr. Veronica Jamnik, and Dr. Donald C. McKenzie (2). Production of this document has been made possible through financial contributions from the Public Health Agency of Canada and the BC Ministry of Health Services. The views expressed herein do not necessarily represent the views of the Public Health Agency of Canada or the BC Ministry of Health Services.

Key References

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01-01-2017

APPENDIX C

DATA COLLECTION SHEETS

Paediatric Exercise Physiology Laboratory
York University

Project Name: ____

(**PRINT CLEARLY)**
Today's Date: ________________ 20XX
Child's Name: FIRST: ____________________________ LAST: ___________________________

Date of Birth: Month_________________ Date: _____ Year ________________

SKELETAL/ MUSCULAR MEASUREMENTS AND STRENGTH MEASUREMENT

Weight	**Final ____________ kg**
Standing Height	T1: __________cm T2: _________ cm **Final ____________ cm**
Seated Height in chair (From top of head to floor)	T1: __________cm T2: _________ cm **Final ____________ cm**
Chair Height: (From seat to floor)	_____________ cm
Sitting Height (Calculated using formula)	*(Seated Height in Chair - Chair Height = Sitting Height)* **Final ___________ cm** ___________cm - ___________cm = ____________cm
Leg Length (estimated) (Calculated using formula)	*(Standing Height - Sitting Height = Leg Length)* **Final ___________ cm** ___________cm - ___________ cm = ____________ cm
Grip Strength	Right Hand: _________ kg _________ kg **Final: ___________ kg** Left Hand: _________ kg _________ kg **Final: ___________ kg**
Vertical Jump	T1: __________cm T2: _________ cm **Final ___________ cm**

SKINFOLD FAT MEASUREMENTS AND WAIST CIRCUMFERENCE

Waist Circumference	T1: __________cm T2: _________ cm **Final ____________ cm**
Iliac crest	T1: __________mm T2: _________ mm T3: _________ mm **Final ____________ mm**
Abdominal	T1: __________mm T2: _________ mm T3: _________ mm **Final ____________ mm**
Front Thigh	T1: __________mm T2: _________ mm T3: _________ mm **Final ____________ mm**
Medial Calf	T1: __________mm T2: _________ mm T3: _________ mm **Final ____________ mm**

Triceps	T1: _________mm T2: ________ mm T3: ________ mm **Final ___________ mm**
Subscapular	T1: _________mm T2: ________ mm T3: ________ mm **Final ___________ mm**

SUM of 6 Skinfolds ____________mm

BLOOD PRESSURE MEASUREMENT

Blood Pressure:	Systolic _____________ mmHg _____________mmHg Diastolic _____________ mmHg _____________mmHg
Heart Rate	__________ bpm __________ bpm

AERОBIC FITNESS MEASUREMENT:

Multistage 20 metre shuttle run test (MSRT)

Last Stage Completed: ___________

APPENDIX D

Measurement Descriptions

Health-Related and Fitness-Related Parameters*

[Selected Aspects Adopted from the Canadian Health Measures Survey]

Stature and Anthropometric Component

Stature Body Measurements

NOTE: See Canadian Health Measures Survey Protocols for further details on measurement protocols and procedures (ACI).

Height and Weight Measurement

To be completed by all children except those meeting the exclusion criteria below: 1. The respondent has an acute condition and should be excluded from the tests in this component 2. Respondents who need help standing or sitting.

<u>Height</u>: I'm going to start by measuring how tall you are. Please remove your shoes and stand with your feet together and your heels, buttocks, back, and head in contact with the measuring tape/device. Look straight ahead and stand as tall as possible.

Now, take a deep breath in and hold it.

<u>INSTRUCTION</u>:

- Ensure the respondent's head is in the Frankfort plane (eyes forward, chin straight).
- Take the measurement while the breath is being held.
- Record the standing height in centimetres on worksheet.
- If the measurement could not be taken, specify the reason.

<u>Body Mass</u>: Next I'm going to measure how much you weigh. Please step onto the centre of the scale and face me. Keep your hands at your sides and look straight ahead.

<u>INSTRUCTION</u>:

- Ensure the respondent has on only minimal clothing (no shoes) and has nothing in his/her pockets.

- Note: any exceptions to a normal weight measurement such as amputations, pregnancy, wheelchair, castings etc.
- Record the data weight when the measurement is stable.
- Record the weight (in kilograms)
- If the measurement could not be taken, specify the reason.

Waist Circumference: Now I'm going to measure your waist circumference. First I need to feel for your hipbones and for the bottom of your ribs. I will take the measurement between these two points. Please stand up straight with your arms hanging loosely at your sides, and breathe normally. I may need to move your clothing slightly because the measurement has to be taken directly on the skin. To ensure I have the correct position, I am going to make two small marks on your skin with a washable marker where the tape measure is to go. These marks will wash off with soap and water.

INSTRUCTION:

- The subject should stand relaxed with their feet shoulder width apart (25-30 cm), and arms crossed on their chest.

- Remove any clothing that would interfere with measuring their waist. If they are not comfortable, take the measure over thin clothing.

- Put the tape measure around the waist directly on their skin.

- Use your hands to find the uppermost border of the hip bones on both sides of the body.

- Mark the top of the hip bones with an 'x'

- Adjust the tape measure so that the lower edge of the measuring tape is in line with the uppermost edge of the hip bones.

- Ensure that you have placed the tape measure correctly (ie. horizontally, and not twisted or caught on clothing).

- Have the subject relax, and pull the tape measure tight, but do not indent the skin.

- Take the waist measurement after a normal breath out to the closest 0.5 cm (see figure below)

- Repeat the measure twice. If the measures deviate more than 2 cm then take a third measure and take the average of the two closest scores.

Figure: Measuring Waist Circumference at the Iliac Crest

- Read the measurement at the side of the body.
- Take the measurement at the end of a normal expiration – just at the end of a normal exhale.
- If the respondent will not allow measurement on the skin, take the measurement over the shirt (make note)
- Record the waist circumference (in centimetres)
- If the measurement could not be taken, specify the reason.

Blood Pressure Measurement

Automated Blood Pressure Measurement

Now I will take your blood pressure and heart rate using an automated blood pressure cuff. During this test you will need to sit with your feet flat on the floor with your back against the back rest of the chair, and have your right arm straight on the table.

INSTRUCTION:

- Select the appropriate cuff size based on arm circumference, secure it on the right arm and ensure the respondent is in the correct seated position.
- If respondent refuses, go to next parameter.

The blood pressure cuff will fill with air, squeezing your arm a little. During the test you cannot talk, and you need to sit really still and keep both feet flat on the floor or step. You should stay relaxed to ensure we get good results. Do you have any questions before we begin?

INSTRUCTION:

- Answer any questions as thoroughly as possible.
- **Now I will start the machine.**

- Press <Start> . Check that the instrument collects the first measurement properly. Allow the instrument to collect two measurements. Lock the fields containing the data. Save the measurements on the worksheet.
- Check the blood pressure and heart rate data. If there are large discrepancies in the measurements, or if the variation between any of the systolic or heart rate measurements exceeds prescribed limits, then redo the measurements:
- If an error exists, the entire measurement sequence is repeated, up to 2 times, using the following script:

There were too many problems with that set of measurements, so we have to do the test again. I will retake your blood pressure and heart rate, but this time I will remain in the room to monitor the results. Now I will retake your blood pressure and heart rate.

- If measures fall within normal ranges, end assessment, otherwise go to go to next measurement.

Strength Component

Grip Strength

<u>INSTRUCTION</u>:

- Demonstrate the procedure while explaining the technique.

I am going to measure your upper body strength with a hand grip dynamometer. You will perform this test two times on each hand, alternating hands each time. When performing the test you hold your hand away from your body, and squeeze the handle as hard as you can, blowing out while you squeeze. Hold the handle so that the 2nd joints of your fingers fit snugly under the handle; we can adjust the size if necessary. Remember, hold your arm straight and away from your body, and squeeze the handle as hard as you can, blowing out while you squeeze.

<u>INSTRUCTION</u>:

- Record the <u>first</u> grip strength measurement for the <u>right</u> hand on the worksheet.
- Right hand grip strength (in kilograms of pressure).
- If the measurement could not be taken, specify the reason.
- Record the <u>first</u> grip strength measurement for the <u>left</u> hand on the worksheet.
- Left hand grip strength (in kilograms of pressure)
- If the measurement could not be taken, specify the reason.
- Record the <u>second</u> grip strength measurement for the <u>right</u> hand on the worksheet.
- Right hand grip strength (in kilograms of pressure)
- If the measurement could not be taken, specify the reason.
- Record the <u>second</u> grip strength measurement for the <u>left</u> hand on the worksheet.
- Left hand grip strength (in kilograms of pressure)
- If the measurement could not be taken, specify the reason.

Power (Explosive) Measurement

Vertical Jump for Explosive Peak Power

<u>INSTRUCTION AND METHOD (adopted from the KINE 1020 Lab Manual):</u>

- Instruct the child to stand flat footed with your side against the scale on the wall
- Reach as high up on the wall as possible and record that height (Standing Reach Height).
- Take a half step away from the wall
- Jump as high as possible and touch the scale at the maximum height of the jump. (If you find it difficult to see the mark attained, you can put a piece of masking tape wrapped around your finger with the sticky side out. Stick this to the scale at the peak of your jump).
- Make sure that you pause at the base of the squat. You are not allowed to bounce or pre-jump
- Repeat test two times (add a third trial if the first two scores are greater than 10% difference)
- The following formula was used to calculate mean power in watts (64):

Power (W) = $54.2 \times$ vertical jump height (cm) + $34.4 \times$ body mass (kg) - 1,520.4

Aerobic Fitness Component – Children
<u>Aerobic Fitness and Capacity Assessment in Children and Youth</u>

Submaximal Exercise Testing: Clinical Application and Interpretation by Vanessa Noonan and Elizabeth Dean Physical Therapy, 80:782-870, 2000.

Children: Overview of Prediction Equations for Cardio-Respiratory Field Test

Field Test: Walk/Run	Equation for VO_2*max* ($mL \cdot kg^{-1} \cdot min^{-1}$)	Reference
1 mile steady-state jog	100.5 - 0.1636(BW,kg) - 1.438(time,min) - 0.1928(HR,bpm) + 8.344(gender, 1=male; 0=female)	George, et al, Med Sci Sport Exer, 25:401, 1993
1 mile walk/run	108.94 – 8.41(time,min) + 0.34$(\text{time,min})^2$ + 0.21(age x gender) – 0.84(BMI)	Cureton, et al, Med Sci Sport Exer, 27:445, 1995
1.5 mile W/R	88.02 – 0.1656(BW,kg) – 2.76(time,min) + 3.716(gender)	George et al, , 1993
12-min run	0.0268(distance,metres) – 11.3	Cooper, J Amer Med Assoc, 203:201. 1968
15 min-run	0.0178(distance, metres) + 9.6	Balke, Fed Aviation Agency Report, 1963
1 mile walk	132.853 – 0.0769(BW,lbs) – 0.3877(age, yr) + 6.31$(\text{gender})^2$ – 3.2649(time, min) – 0.1565(HR,bpm)	Kline et al, Med Sci Sport Exer, 19:253, 1987
Field Test: Shuttle		
20 m MSRT	VO_2max = 31.025 + 3.238 (speed) – 3.248 (age) + 0.1536 (age * speed); where speed corresponds to 8 + (0.5 * last stage number completed).	Leger, 1982
Field Tests: Step Tests		
mCanadian Home Fitness Test (MCAFT)	a. V02peak = 2.63(OC) - .29(SS4) + .49(age) - 29.57	Garcia and Zakrajsek, Ped Exer Sci, 12:300, 2000

	b. VO,peak = 3.53(0C) - .52(SS2) + .55(age) - 54.62 c. VO2peak+ = 3.23(0C) - 1.31(BMI) + 1.39(age) - 49.21 • *OC = Oxygen cost; ss= skinfolds*	

Multistage 20 metre shuttle run test (MSRT)

Aerobic endurance will be measured using the multistage 20 metre shuttle run test (MSRT), otherwise known as the beep test. This multistage fitness test progresses in difficulty until one has to exert maximal effort during the final stages of the test. The MSRT has proven to be a valid and reliable method for the assessment of aerobic endurance among youth. It is also a practical test as large groups of students can be assessed at once. To facilitate assessment, instructor must divide children into groups. Each child will be assigned a partner.

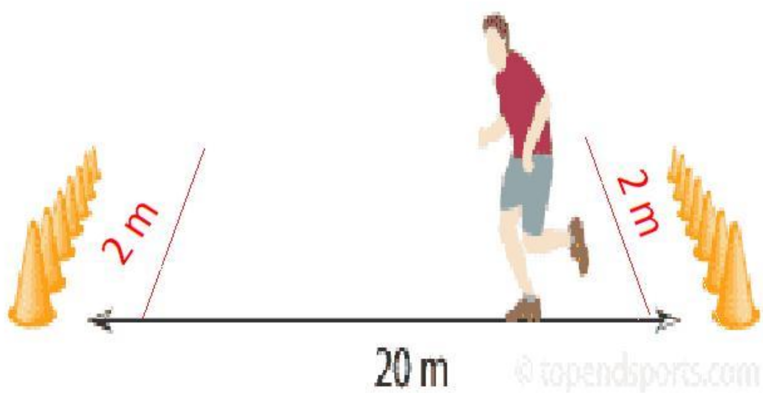
To administer the MSRT, the Instructor will measure the gymnasium/space with lines 20 metres apart shown to all children (see image below). Children will be required to run back and forth between the two designated lines (known as a shuttle) following the cadence emitted from a pre-recorded compact disc. Beginning at a speed of 8.5 kilometres per hour (km/h), the frequency of emitted signals will increase at a rate of 0.5 km/h every minute. Procedures will be explained to all children prior to commencement and they must be advised to start off slow and not run past the lines in order to conserve energy. The test will be terminated when participants voluntarily stop or when a participant is no longer capable of successfully completing two successive shuttles. There are a maximum of 20 stages involved with this test, each stage lasting approximately one minute. The last successfully completed stage by each participant will be recorded.

Using the following regression equation developed by Léger et al. (1988) (100), maximal oxygen consumption will be predicted from results obtained on the MSRT:

$$VO_2max = 31.025 + 3.238 (speed) – 3.248 (age) + 0.1536 (age * speed)$$

- where speed corresponds to 8 + (0.5 * last stage number completed).

Also, VO_2max will be used to determine whether subjects care within the healthy fitness zone for their age group.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APPENDIX E

PILOT STUDIES

To be able to complete the experiments described in the dissertation four pilot studies were undertaken, these included:

Pilot Study 1 – Relationship Between Children's Physical Activity, Oxygen Consumption and Metabolic Equivalence Using Treadmill Exercise - Development of Linear Regression Models for Children's Physical Activity.

Pilot Study 2 – Oxygen Consumption (VO_2 – $mL{\cdot}kg^{-1}{\cdot}min^{-1}$) and Metabolic Equivalents (MET) of Cooperative Games for Children and Adolescents During Guided Active Play.

Pilot Study 3 – Predicting Oxygen Consumption (VO_2 – $mL{\cdot}kg^{-1}{\cdot}min^{-1}$) for Individual Cooperative Games Classified as Light (Mr. Wolf), Moderate (Archers Tag) and Vigorous (Clothes Pin Tag) During a Guided Active Play Session.

Pilot Study 4 – Physical Activity Levels for Children and Adolescents During Guided Active Play in a Community Recreation Centre Summer Camp and a Community Summer School Camp.

The pilot studies were conducted in accordance with Canada's Tri-Council Policy for the Ethical Conduct of Research Involving Humans and approved by the Human Participant Research Ethics Committee at York University. Children registered in a local community centre summer day camp were recruited to participate in the pilot studies. Children (and their parents/guardians) participating in the studies underwent an information and orientation session prior to the studies. Written consent was obtained from parents/guardians; as well children also provided verbal assent to participate.

The summer day camp program was scheduled from 9:00am to 3:30pm for days a week, with approximately 75 children (8-12 yr) and 30 children (5-7 yr) registered weekly through July and August. Many of the children attended all 8-weeks, which provided a convenient sample not only for the experiments detailed in the dissertation, but also for the pilot studies.

Pilot studies 1, 2 and 3: Children (n=22) were randomly selected for oxygen consumption (VO_2) and physical activity (PA) assessments during the first week and agreed to participate in laboratory-based and summer camp-based activities occur the following 4-weeks. For the treadmill exercise, groups of 4-5 children arrived (10am) for their VO_2 and PA assessments (procedures described below) at the Paediatric Exercise Science Laboratory at York University under the guidance of a Counsellor from the summer day camp. For children (n=35) participating in a GAP session using cooperative games, small subsets of (2-3) children were randomly assigned for VO_2 and PA assessments during the summer camp (procedures described below). The VO_2 and PA assessments were performed on two days per week for 4 weeks while children participated in a guided active play session (total of 22 children). To minimize the possible impact of a training effect that might occur over the 4 weeks, children were assigned to GAP sessions separated by at least one week. Furthermore, to reduce the possible impact of fatigue during single session children were only assessed for VO_2 for approximately 3-4 games or ~20minutes in a session. Finally, the impact of a child wearing the portable VO_2 analyzer on game participation an analysis of children were wearing and not wearing the portable VO_2 analyzer while playing identical games over a minimum of two sessions was performed. The findings showed no statistical differences for PA levels when children were wearing the portable VO_2 analyzer (123).

Procedures – Accelerometer Calibration - Before any testing, children were familiarized with the gas collection system for determination of oxygen consumption (VO_2 in ml $O_2 \cdot kg \cdot min^{-1}$) and the treadmill protocol. Children were measured for height (nearest 0.1cm) and body mass (nearest 0.1kg) and then fitted with an accelerometer (ActiGraph GT3X+). A CosMed[2]/FitMate portable metabolic system was used to measure oxygen consumption.

Prior to testing, the metabolic system was calibrated according to manufacturer's specification. The resting protocol consisted of 10 minutes in a seated position with breadth-by-breadth gas collection (summed in 10 second intervals). The treadmill protocol consisted of continuous submaximal walk/run test on a motorized treadmill for 5 minutes each at speeds of 4, 6 and 8 $km \cdot hr^{-1}$ and 0% grade (173). The session was terminated when the child completed the last speed (8 $km \cdot hr^{-1}$) or when the child did not wish to continue. In addition, PA counts (in 10 second epochs) using the ActiGraph GT3X+ accelerometer located on the right hip were collected throughout the treadmill protocol. The coefficient of variability for the submaximal oxygen consumption procedure was ±3.3%, and the accelerometer inter-instrument reliability was 1.3%.

Procedures - Guided Active Play Program: The GAP sessions were focused on self-paced, social and fun cooperative games (186). In addition to these attributes, our GAP sessions also included non-instructional role models (guides) at a ratio of ~5:1 (range 4.3:1 to 5.3:1) for children-to-guide (166). Experienced undergraduate senior kinesiology majors, with 15 hours of workshops (encouragement strategies; bullying) and simulated children's program delivery (rules of the games, practicing skills), served as positive role models (guides) provided visual encouragement to children to expand their experiences. They provided no instructions and feedback during the sessions, and no child was forced into playing games. During the pilot studies, cooperative games were chosen by the physical activity leader. However, during the session, if requested, and children were supportive, a game would be removed, and a different game(s) inserted into the program for total of ~5-6 different games, each lasting 5-10 minutes. All PA programs were conducted in temperature controlled (20±1 ^{o}C) gymnasiums.

Procedures – Anthropometric Data: Children's age, height, body mass and aerobic power were assessed as previous reported (123).

Data Analysis - Data for all pilot studies are summarized as means ± stand deviation (s). For Pilot 1 a univariate analysis of variance was used to assess differences between means for oxygen consumption, metabolic equivalents and ACC outputs (vector magnitude – VM) for the treadmill speeds and cooperative game sessions Intercept and slope values from linear regression equations for physical activity (vertical and vector magnitude) versus oxygen consumption of the treadmill data and the self-paced games were compared (SPSS version 21.0) by analysis of variance (ANOVA) using a Tukey post-hoc test at a $p \leq 0.05$. Pearson correlation coefficients were used to quantify the relationships between PA and VO_2 for treadmill and/or cooperative games.

For Pilot 2 univariate analysis of variance was used to assess differences between means for oxygen consumption, metabolic equivalents and ACC outputs (vector magnitude – VM) for the cooperative games. An analysis of variance was used to test the differences for classifying the PA intensity of games (i.e., light, moderate and vigorous).

For Pilot 3 the means for the VO_2 measured (VO_2m) and VO_2 predicted (VO_2p) for cooperative games were analyzed using a paired t-test, with a *p* level of 0.05. The mean differences for VO_2m and VO_2p across all games were compared to zero using a single group T-Test. Finally, a Bland-Altman Plot analysis was performed to assess the agreement between the measured and predicted VO_2 for the games. To test for proportional bias, a linear regression analysis was used to compare the constant and coefficient between the mean differences and the mean of the measured and predicted VO_2.

For Pilot 4 the PA characteristics (EE, %MVPA and %SED) for community summer day camp program activity compared to the guided active play session was analysed using an independent t-test (*p* level of 0.05). A similar analysis was performed for children participating in a summer school camp.

Participant Characteristics

For Pilots 1, 2, 3 and 4, the characteristics of the children participating in these studies are found in Table 1.

Table 1a: Anthropometric and Physical Fitness Characteristics of Children (n=22) Participating in the assessment of cooperative games and treadmill exercise Pilot 1, 2 and 3

	Age (years)	Weight (kg)	Standing Height (cm)	BMI ($kg·m^2$)	VO_2max ($mL·kg^{-1}·min^{-1}$)
mean	10.0	41.3	145.6	19.63	47.8
SD	1.6	14.3	10.7	4.7	4.6

Table 1b: Anthropometric and Physical Fitness Characteristics of Children (n=21) participating in the summer school camp (Pilot study 4).

	Age (years)	Weight (kg)	Standing Height (cm)	BMI ($kg·m^2$)	VO_2max ($mL·kg^{-1}·min^{-1}$)
mean	9.5	38.2	140.2	19.6	46.8
SD	1.7	12.0	11.3	4.0	5.4

Table 1c: Anthropometric and Physical Fitness Characteristics of Children (n=36) Participating in the summer camp Pilot (pilot study 4).

	Age (years)	Weight (kg)	Standing Height (cm)	BMI ($kg·m^2$)	VO_2max ($mL·kg^{-1}·min^{-1}$)
mean	10.5	47.6	147.0	21.90	43.21
SD	1.6	14.7	13.9	6.29	6.75

The results and discussion points for each pilot study are described individually below.

Pilot Study 1 – Relationship Between Children's Physical Activity, Oxygen Consumption and Metabolic Equivalence Using Treadmill Exercise - Development of Linear Regression Models for Children's Physical Activity

A. Children's Oxygen Consumption (VO_2 – $mL \cdot kg^{-1} \cdot min^{-1}$) During Treadmill Exercise

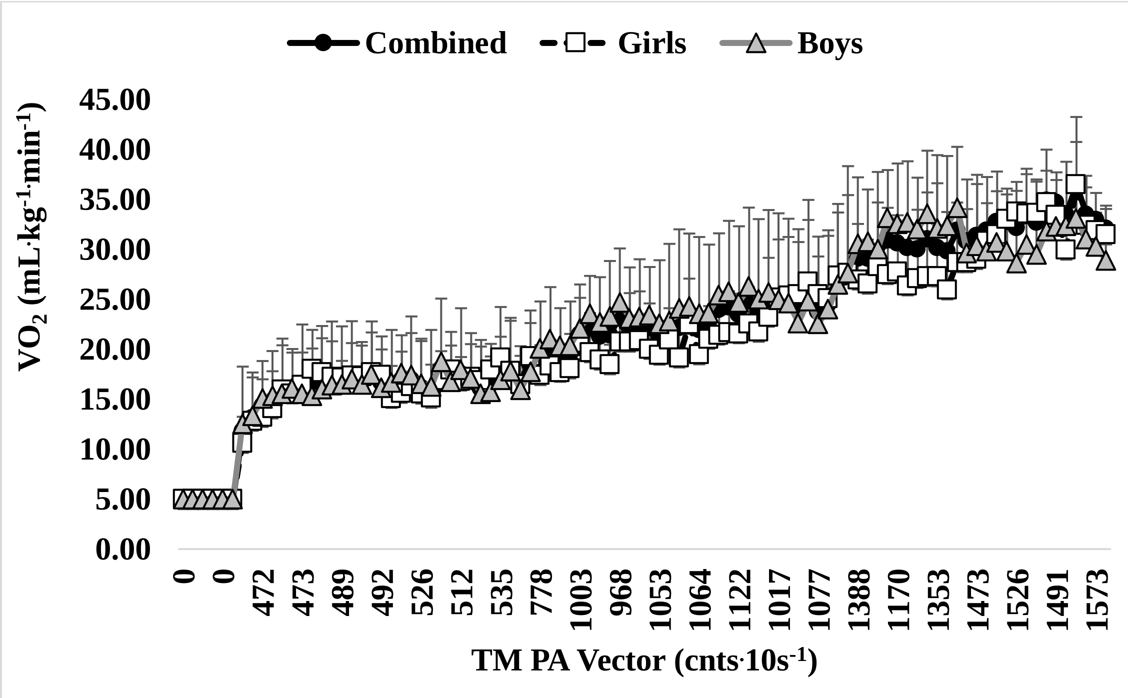
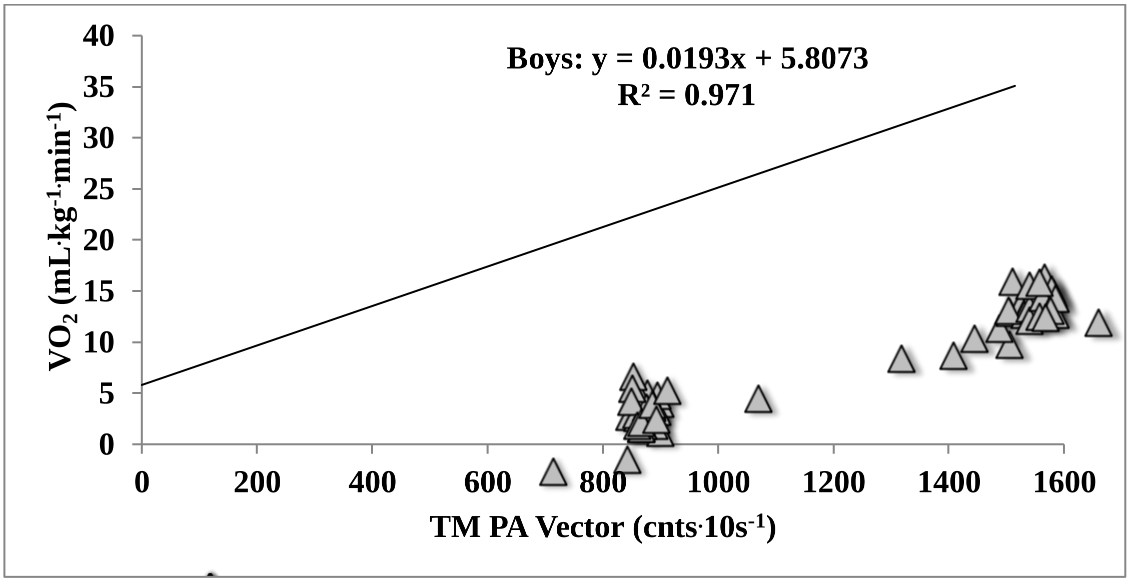


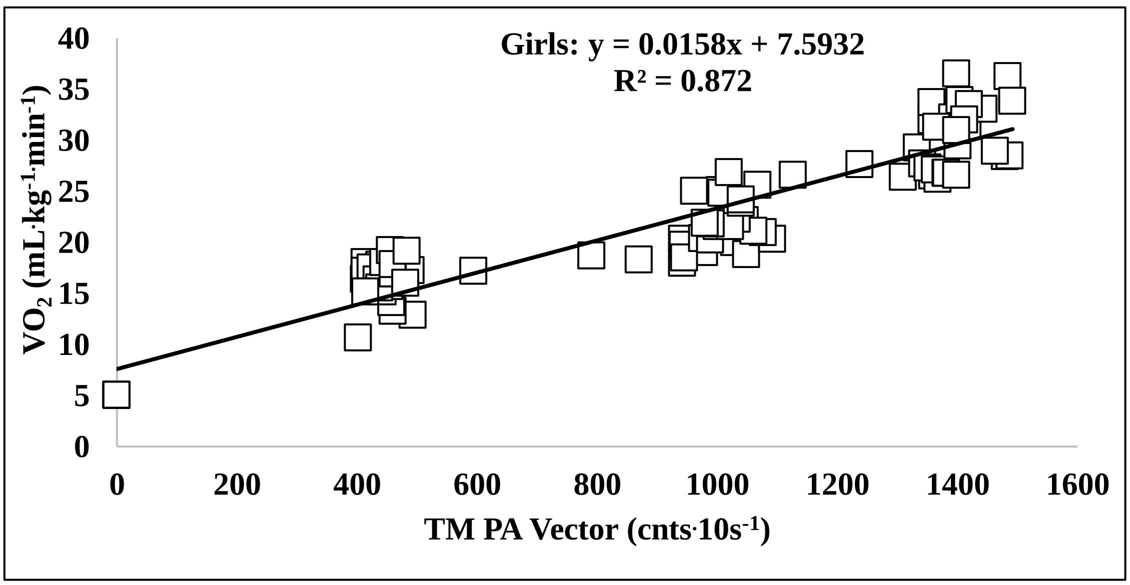
Figure 1: Oxygen Consumption (VO_2) for School-aged Children (n=22; Girls = 9; Boys = 13) During 15 minutes of Treadmill (TM) Exercise (5 minutes at speeds of 4, 6 and 8 $km \cdot h^{-1}$). Physical Activity was Quantified by Accelerometry (ActiGraph GTX3+) with the Vector Determined in 10 second ($cnts \cdot 10s^{-1}$) epochs. Oxygen Consumption was Measured Continually Using a Portable Oxygen Analyzer System ($CosMed^2$/Fitmate).

Table 2: Comparison of Average Oxygen Consumption for School-aged Children (n=22; Girls = 9; Boys = 13) During 15 minutes of Treadmill Exercise (5min at speeds of 4, 6 and 8 $km \cdot h^{-1}$). Oxygen Consumption was Measured Continually Using a Portable Oxygen Analyzer System ($CosMed^2$/Fitmate). No Statistical Differences Were Noted between boys and girls ($p>0.05$).

Variable	Girls	Boys	Combined
VO_2 ($mL \cdot kg^{-1} \cdot min^{-1}$)	22.61 ± 6.24	24.03 ±6.92	23.32 ±6.47

B. Regression Equations for Treadmill Exercise and Oxygen Consumption:





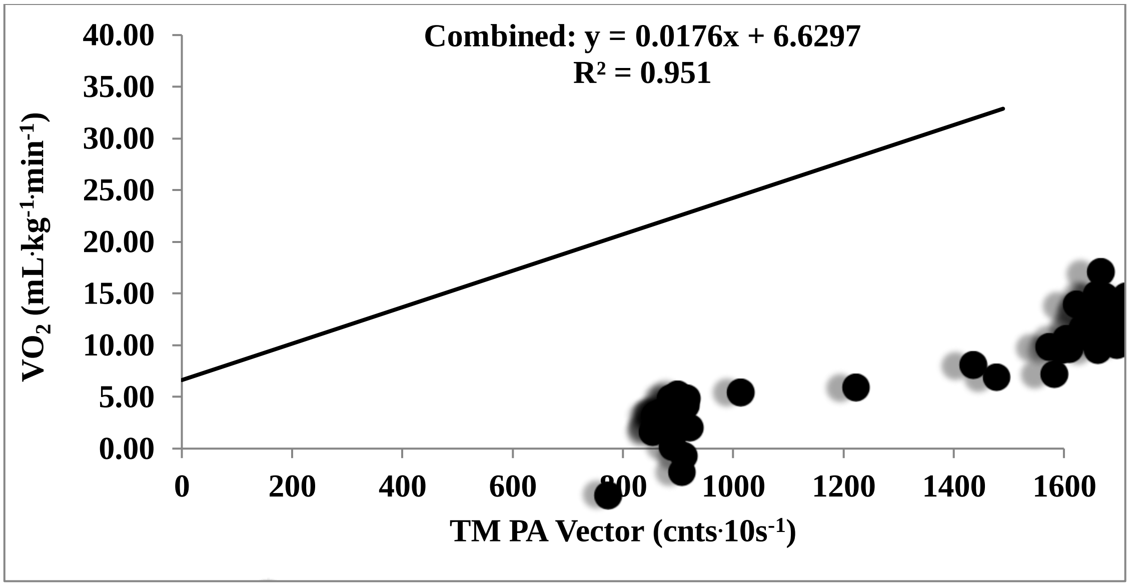


Figure 2: Comparison of Linear Regression Equations Generated for School-aged Girls (n=9 *Top Panel*), Boys (n= 13 *Middle Panel*) and Combined Data (n=22 *Lower Panel*) During 15 minutes of Treadmill (TM) Exercise (5 minutes each at speeds of 4, 6 and 8 km·h^{-1}). Data from Treadmill Exercise Was Used to Determine Equations (EQ) Between Physical Activity quantified by Vector from Accelerometry (ActiGraph GTX3+) outputs, captured in 10 second (cnts·10s^{-1}) and 1-minute (cnts·min^{-1}) epochs, and VO_2 responses.

Table 3: Comparison of Linear Regression Equations Generated for Oxygen Consumption for School-aged Children (n=22; Girls = 9; Boys = 13) During 15 minutes of Treadmill Exercise (5min each at 4, 6 and 8 km·h^{-1}). Data Was Used to Determine Equations (EQ) Between Physical Activity quantified by Vector from Accelerometry (ActiGraph GTX3+) outputs captured in 10 second (cnts·10s^{-1}) and 1-minute (cnts·min^{-1}) epochs and VO_2 responses. Pearson Coefficients (r), Coefficients of Determination (R^2) and Standard Error of the Estimate (SEE) are Provided.

Girls (n=9)				
	EQ	**r**	**R^2**	**SEE**
Cnts·10s^{-1}	0.0158x+7.5932	0.934*	0.872	2.76
Cnts·min^{-1}	0.0026x+7.5932	0.934*	0.872	
Boys (n=13)				
	EQ	**r**	**R^2**	**SEE**
Cnts·10s^{-1}	0.0193x+5.8073	0.985*	0.971	1.46
Cnts·min^{-1}	0.0032x+5.8073	0.985*	0.971	
Combined (n=22)				
	EQ	**r**	**R^2**	**SEE**
Cnts·10s^{-1}	0.0176x+6.6297	0.975*	0.951	1.78
Cnts·min^{-1}	0.0029x+6.6297	0.975*	0.951	

C. Children's Metabolic Equivalence (MET) During Treadmill Exercise

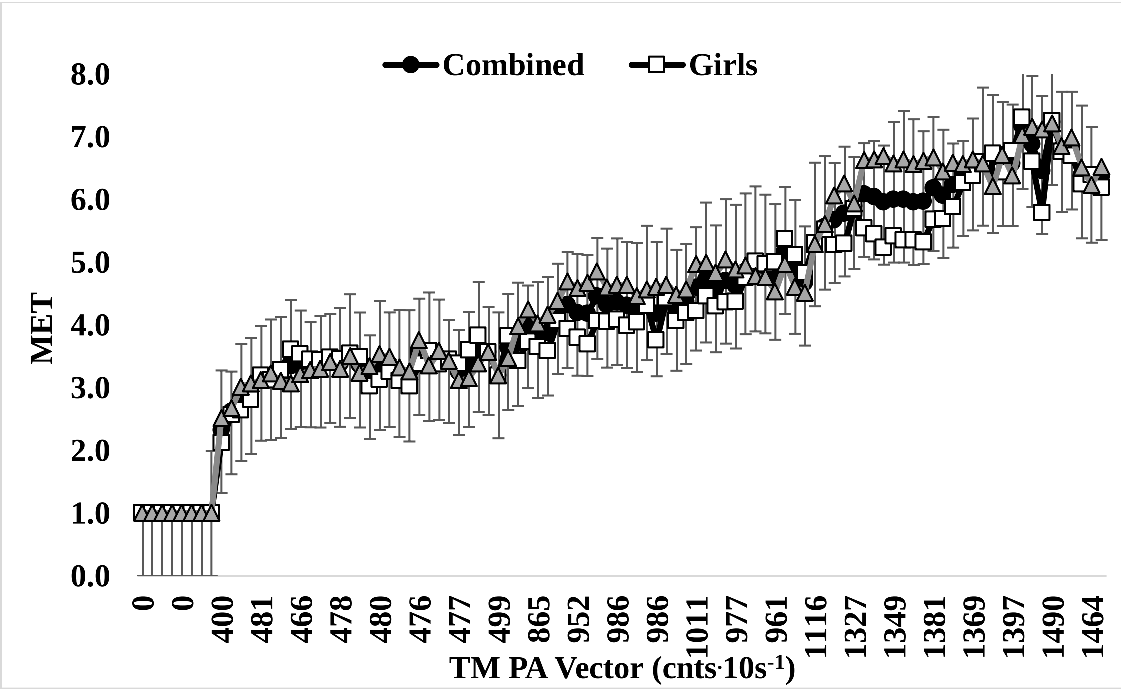
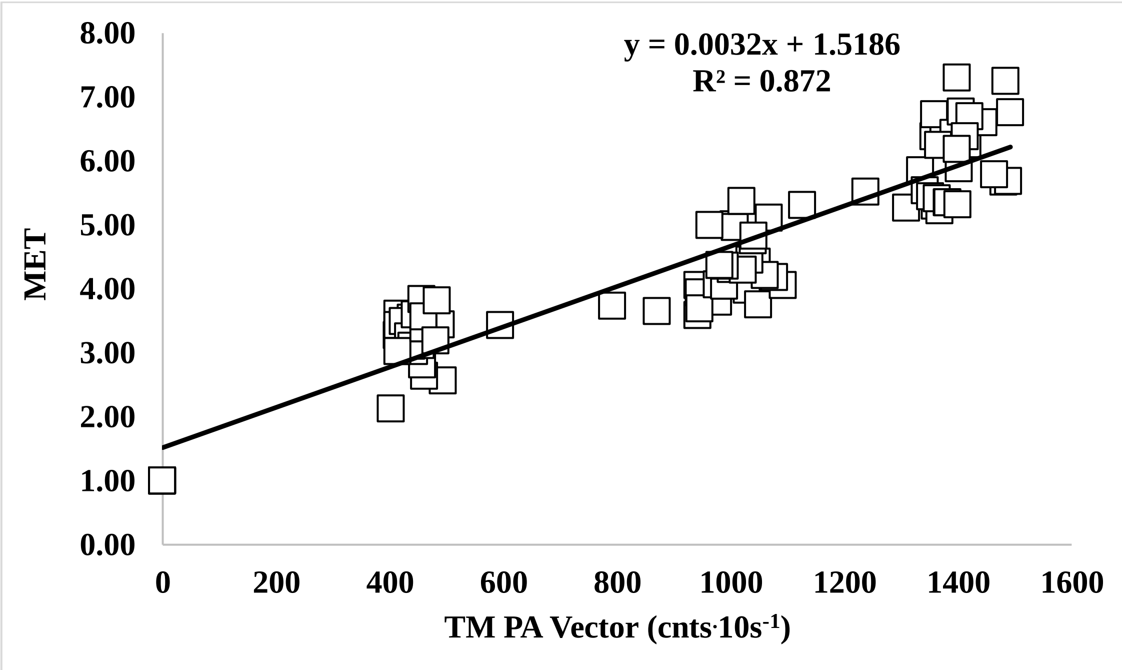


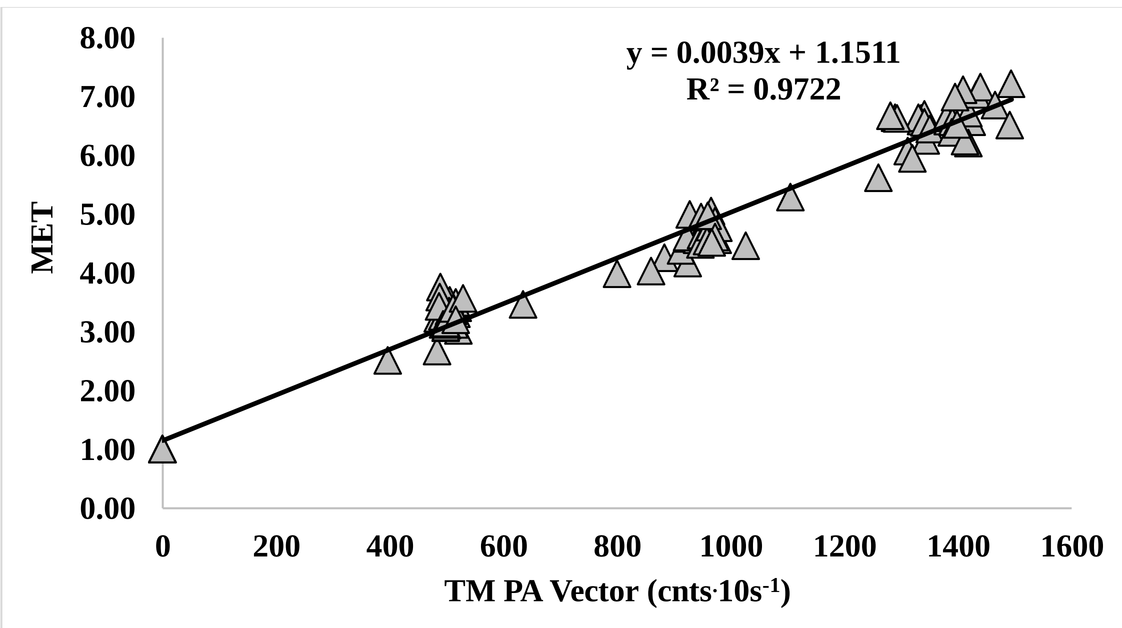
Figure 3: Metabolic Equivalence (MET) for School-aged Children (n=22; Girls = 9; Boys = 13) During 15 minutes of Treadmill Exercise (5min at speeds of 4, 6 and 8 km·h^{-1}). Physical Activity was Quantified by Accelerometry (ActiGraph GTX3+) with the Vector Determined in 10 second (cnts·10s^{-1}) epochs. Oxygen Consumption was Measured Continually Using a Portable Oxygen Analyzer System (CosMed^2/Fitmate) and MET Values Determined with a Resting VO_2 of 5.21 mL·kg^{-1}·min^{-1} Equivalent to 1 MET.

Table 4: Comparison of Average MET for School-aged Children (n=22; Girls = 9; Boys = 13) During 15 minutes of Treadmill Exercise (5min at speeds of 4, 6 and 8 km·h^{-1}). Oxygen Consumption was Measured Continually Using a Portable Oxygen Analyzer System (CosMed^2/Fitmate) and Used to Determine Metabolic Equivalence (MET) with a Resting VO_2 of 5.21 mL·kg^{-1}·min^{-1} Equivalent to 1 MET. No Statistical Differences Were Noted ($p>0.05$).

Variable	Girls	Boys	Combined
MET	4.23 ± 1.54	4.49 ± 1.69	4.36 ± 1.59

D. Regression Equations for Treadmill Exercise and Metabolic Equivalents:





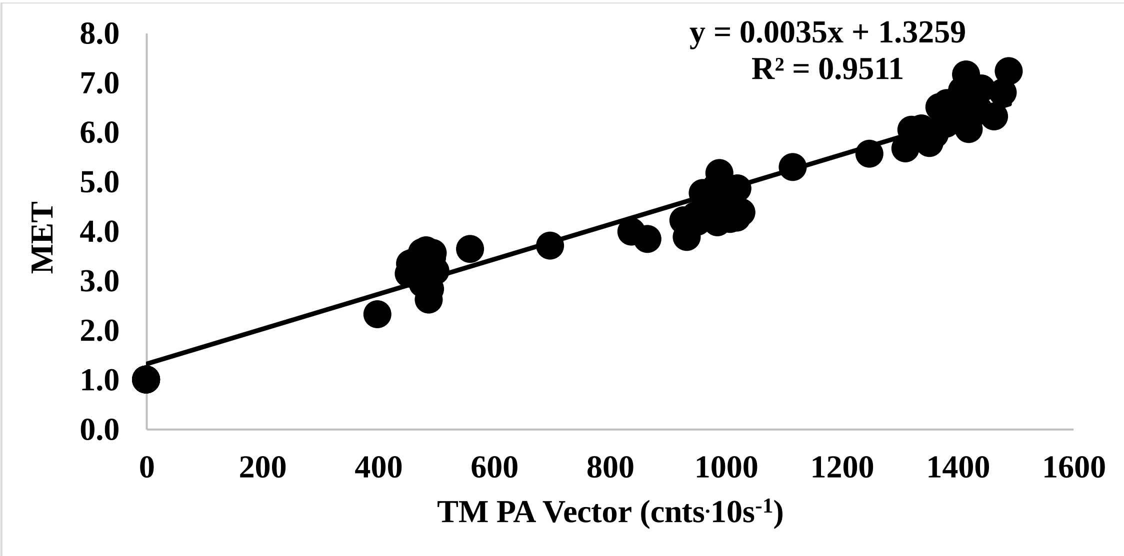


Figure 4: Comparison of Linear Regression Equations Generated for School-aged Girls (n=9 *Top Panel*), Boys (n= 13 *Middle Panel*) and Combined Data (n=22 *Lower Panel*) During 15 minutes of Treadmill Exercise (5min each at speeds of 4, 6 and 8 $km \cdot h^{-1}$). Data from Treadmill Exercise Was Used to Determine Equations Between Physical Activity quantified by Vector from Accelerometry (ActiGraph GTX3+) Outputs, Captured in 10 Second ($cnts \cdot 10s^{-1}$) and 1-Minute ($cnts \cdot min^{-1}$) Epochs, and VO_2 Responses Used to Determine Metabolic Equivalence (MET) with a Resting VO_2 of 5.21 $mL \cdot kg^{-1} \cdot min^{-1}$ Equivalent to 1 MET.

Table 5: Comparison of Linear Regression Equations Generated for Metabolic Equivalents (MET) for School-aged Children (n=22; Girls = 9; Boys = 13) During 15 minutes of Treadmill Exercise (5min each at 4, 6 and 8 km·h^{-1}). Data Was Used to Determine Equations (EQ) Between Physical Activity Quantified by Vector from Accelerometry (Actigraph GTX3+) Outputs Captured in 10 Second (Cnts·10s^{-1}) and 1-Minute (Cnts·Min^{-1}) Epochs and VO_2 Responses. Metabolic Equivalence (MET) Were Determined Using a Resting VO_2 of 5.21 mL·kg^{-1}·min^{-1} as 1 MET. Pearson Coefficients (r), Coefficients of Determination (R^2) and Standard Error of the Estimate (SEE) Are Provided.

Girls (n=9)				
	EQ	**r**	**R^2**	**SEE**
Cnts·10s^{-1}	0.0032x+1.5186	0.934*	0.872	0.499
Boys (n=13)				
	EQ	**r**	**R^2**	**SEE**
Cnts·10s^{-1}	0.0039x+1.1511	0.985*	0.971	0.311
Combined (n=22)				
	EQ	**r**	**R^2**	**SEE**
Cnts·10s^{-1}	0.0035x+1.3259	0.975*	0.951	0.355

<u>Findings and Conclusions:</u>

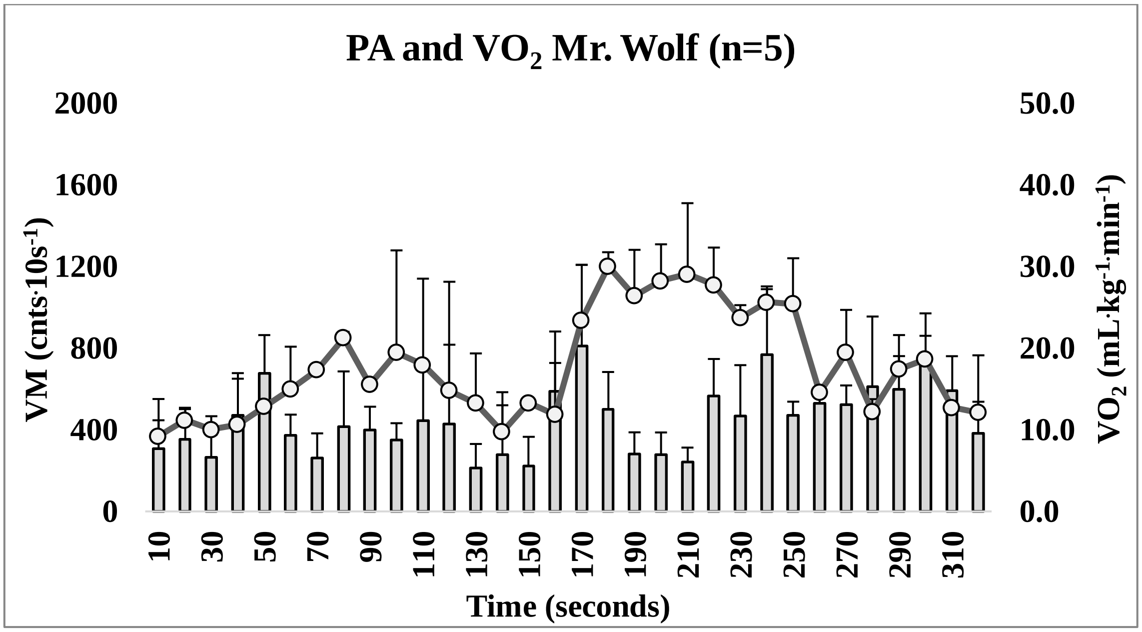
a) Children's physical activity and measured oxygen consumption and metabolic equivalence during treadmill exercise showed no statistical differences between girls and boys.

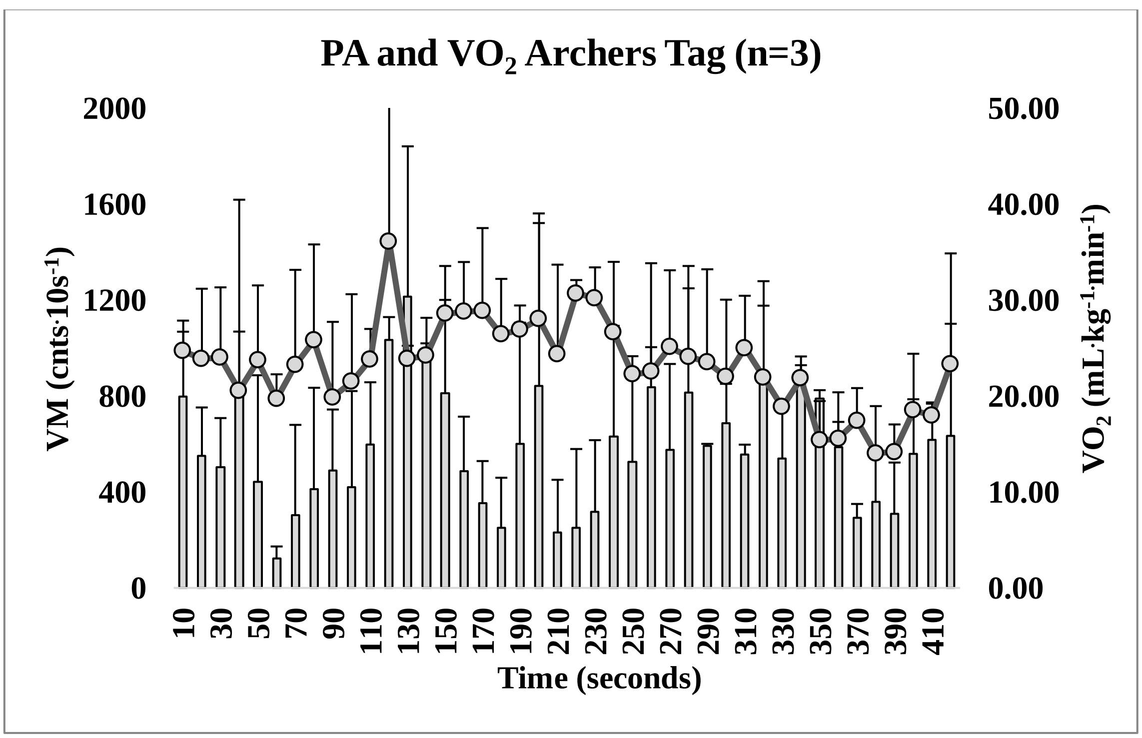
b) Linear regression equations for oxygen consumption (VO_2 in mLO_2·kg·min^{-1}) for girls and boys were not different from the combined equations, which were used in the guided active play studies.

c) Linear regression equations for metabolic equivalents (MET) for girls and boys were not different from the combined equations, which were used in the guided active play studies.

Pilot Study 2 – Oxygen Consumption (VO_2 – $mL \cdot kg^{-1} \cdot min^{-1}$) and Metabolic Equivalents (MET) of Cooperative Games for Children and Adolescents During Guided Active Play.

A. Cooperative Games (Mr. Wolf, Archers Tag, and Clothes Pin Tag) During Guided Active Play





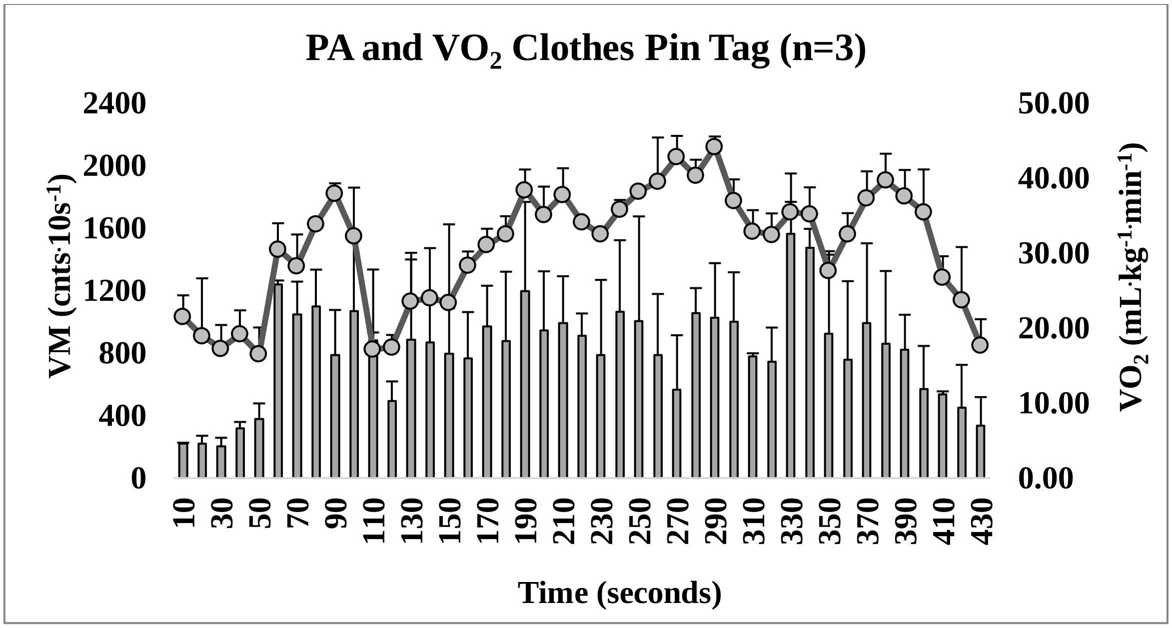
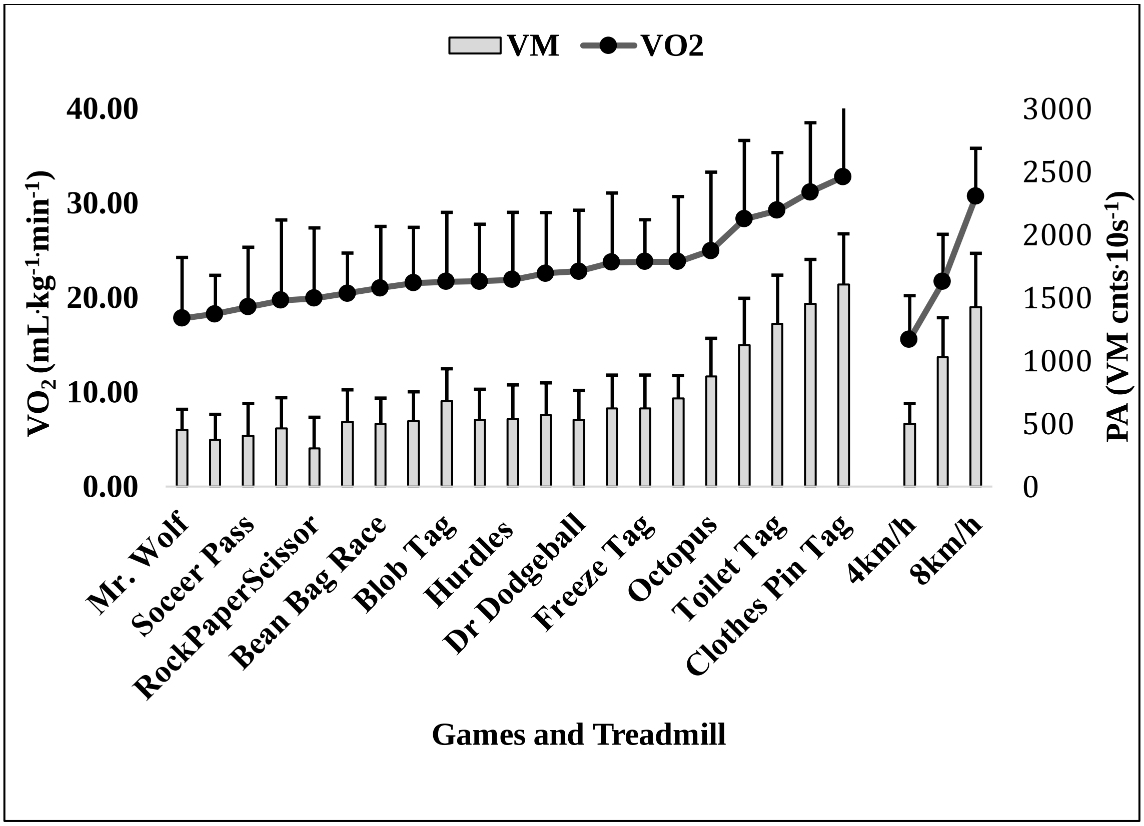


Figure 5: Examples of Children's Physical Activity (VM) and Oxygen Consumption (VO_2) Responses to Cooperative Games of Light Intensity (i.e., What Time is it Mr. Wolf?) (*Top Panel*), Moderate Intensity (i.e., Archer's Tag) (*Middle Panel*) and Vigorous Intensity (i.e., Clothes Pin Tag) (*Lower Panel*) During a Guided Active Play Session. Oxygen Consumption (VO_2 in $mL{\cdot}kg^{-1}{\cdot}min^{-1}$) for the Cooperative Game were Assessed by Children Fitted with a Cosmed[2]/Fitmate Portable Gas Analyzer was Placed on the Back Using a Secured Backpack. Physical Activity (PA) was Quantified using ACC Outputs Expressed as Vector Magnitude (VM – counts in 10second intervals). Accelerometers (Actigraph GT3X+) Were Secured by an Elastic Band on the Child's Right Hip.

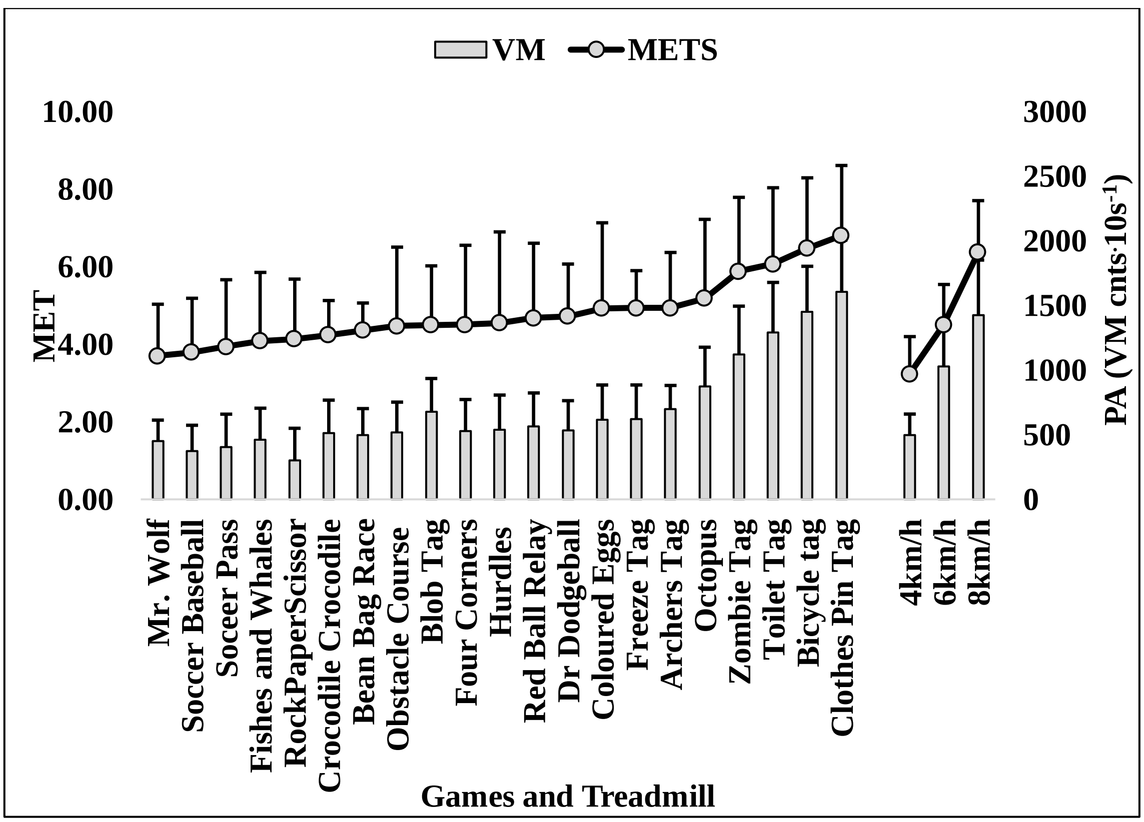
Table 6: Oxygen Consumption (VO_2 – $mL{\cdot}kg^{-1}{\cdot}min^{-1}$) and Metabolic Equivalents (MET) of Cooperative Games for Children and Adolescents During Guided Active Play and Treadmill Exercise (5 minutes each at speeds of 4, 6 and 8 $km{\cdot}h^{-1}$). Oxygen Consumption was Measured Continually Using a Portable Oxygen Analyzer System (CosMed[2]/Fitmate) and Used to Calculate Metabolic Equivalence (MET) and Energy Expenditure (EE). Physical Activity was Quantified by Accelerometry (ActiGraph GTX3+) with the Vector (VM) Determined in 10 second ($cnts{\cdot}10s^{-1}$) epochs.

	VM	**VO_2**			**EE**	**MET**
Games	**$cnts{\cdot}10s^{-1}$**	**$mL{\cdot}kg^{-1}{\cdot}min^{-1}$**	**min**	**max**	**$kcal{\cdot}min^{-1}$**	
Mr. Wolf (n = 5)	449 ± 114	17.82 ± 6.43	9.22	30.03	3.85 ± 1.16	3.70 ± 1.31
Soccer Baseball (n = 5)	373 ± 150	18.26 ± 4.10	15.80	43.82	3.94 ± 0.96	3.79 ± 1.40
Soccer Pass (n = 3)	406 ± 203	19.00 ± 6.33	12.23	48.73	4.10 ± 1.14	3.94 ± 1.72

Fishes and Whales (n = 4)	460 ± 195	19.70 ± 8.51	8.20	44.02	4.26 ± 1.53	4.09 ± 1.76
Rock/Paper/Scissor (n = 3)	301 ± 199	19.94 ± 7.44	5.10	43.82	4.31 ± 1.38	4.14 ± 1.54
Crocodile/Crocodile (n = 5)	513 ± 205	20.45 ± 4.26	12.99	28.92	4.42 ± 0.77	4.24 ± 0.88
Bean Bag Race (n = 1)	497 ± 155	21.03 ± 6.50	9.70	36.50	4.54 ± 0.50	4.36 ± 0.70
Obstacle Course (n = 3)	520 ± 182	21.55 ± 5.88	13.30	37.70	4.66 ± 1.32	4.47 ± 2.03
Blob Tag (n = 2)	677 ± 208	21.69 ± 7.33	9.35	38.57	4.69 ± 1.32	4.50 ± 1.52
Four Corners (n = 2)	528 ± 194	21.72 ± 6.04	8.70	38.60	4.69 ± 1.17	4.51 ± 2.04
Hurdles (n = 2)	537 ± 220	21.91 ± 7.11	10.57	35.67	4.73 ± 1.38	4.55 ± 2.35
Red Ball Relay (n = 2)	566 ± 207	22.56 ± 6,43	9.35	28.60	4.87 ± 1.18	4.68 ± 1.92
Dr Dodgeball (n = 2)	532 ± 181	22.77 ± 6.48	14.30	35.82	4.92 ± 1.17	4.72 ± 1.34
Coloured Eggs (n = 2)	618 ± 216	23.73 ± 7.33	7.90	33.30	5.13 ± 1.16	4.92 ± 2.21
Freeze Tag (n = 3)	621 ± 214	23.80 ± 4.44	8.30	31.40	5.14 ± 1.24	4.94 ± 0.96
Archers Tag (n = 3)	701 ± 130	23.29 ± 4.61	14.04	36.13	5.14 ± 1.21	4.94 ± 1.43
Octopus (n = 2)	674 ± 253	24.97 ± 8.30	10.22	38.57	5.39 ± 1.24	5.18 ± 2.04
Zombie Tag (n = 2)	1120 ± 324	28.33 ± 8.30	5.10	49.12	6.12 ± 1.32	5.88 ± 1.91
Toilet Tag (n = 4)	1291 ± 337	29.24 ± 6.10	10.30	44.02	6.32 ± 1.14	6.07 ± 1.97
Bicycle tag (n = 2)	1449 ± 304	31.18 ± 7.32	19.40	38.60	6.74 ± 1.38	6.47 ± 1.82
Clothes Pin Tag (n = 3)	1604 ± 312	32.08 ± 8.70	14.54	41.66	7.08 ± 1.57	6.80 ± 1.80
TREADMILL						
4 $km \cdot h^{-1}$ (n = 15)	496 ± 138	15.6 ± 4.62	10.17	17.8	1.52 ± 0.38	3.24 ± 0.75
6 $km \cdot h^{-1}$ (n = 15)	1028 ± 254	21.7 ± 5.08	19.3	24.4	5.95 ± 0.50	4.50 ± 1.24
8 $km \cdot h^{-1}$ (n = 15)	1424 ± 325	30.7 ± 5.17	25.02	34.9	8.83 ± 0.47	6.37 ± 1.77



VM
VO2
40.00
30.00
20.00
10.00
0.00
VO_2 (mL·kg-1·min-1)
3000
2500
2000
1500
1000
500
0
PA (VM cnts·10s-1)
Mr. Wolf
Soccer Pass
RockPaperScissor
Bean Bag Race
Blob Tag
Hurdles
Dr Dodgeball
Freeze Tag
Octopus
Toilet Tag
Clothes Pin Tag
4km/h
8km/h
Games and Treadmill



VM
METS
10.00
8.00
6.00
4.00
2.00
0.00
MET
3000
2500
2000
1500
1000
500
0
PA (VM cnts·10s-1)
Mr. Wolf
Soccer Baseball
Soccer Pass
Fishes and Whales
RockPaperScissor
Crocodile Crocodile
Bean Bag Race
Obstacle Course
Blob Tag
Four Corners
Hurdles
Red Ball Relay
Dr Dodgeball
Coloured Eggs
Freeze Tag
Archers Tag
Octopus
Zombie Tag
Toilet Tag
Bicycle tag
Clothes Pin Tag
4km/h
6km/h
8km/h
Games and Treadmill

Figure 6: Cooperative Games assessed for Measured Oxygen Consumption (VO_2 in $mL\cdot kg^{-1}\cdot min^{-1}$) (*Top Panel*) and Metabolic Equivalents (MET) (*Lower Panel*) During Guided Active Play and Treadmill Exercise (5min each at speeds of 4, 6 and 8 $km\cdot h^{-1}$). Children (n=11) Played a Total of 21 Randomized Cooperative Games During Eight 1-Hour Guided Active Play Sessions Distributed Over Two Weeks. The CosMed[2]/FitMate Portable Gas Analyzer Was Placed on the Back Using a Secured Backpack. Physical Activity (PA) was Quantified Using Accelerometers (Actigraph GT3X+) Secured by an Elastic Band on the Right Hip.

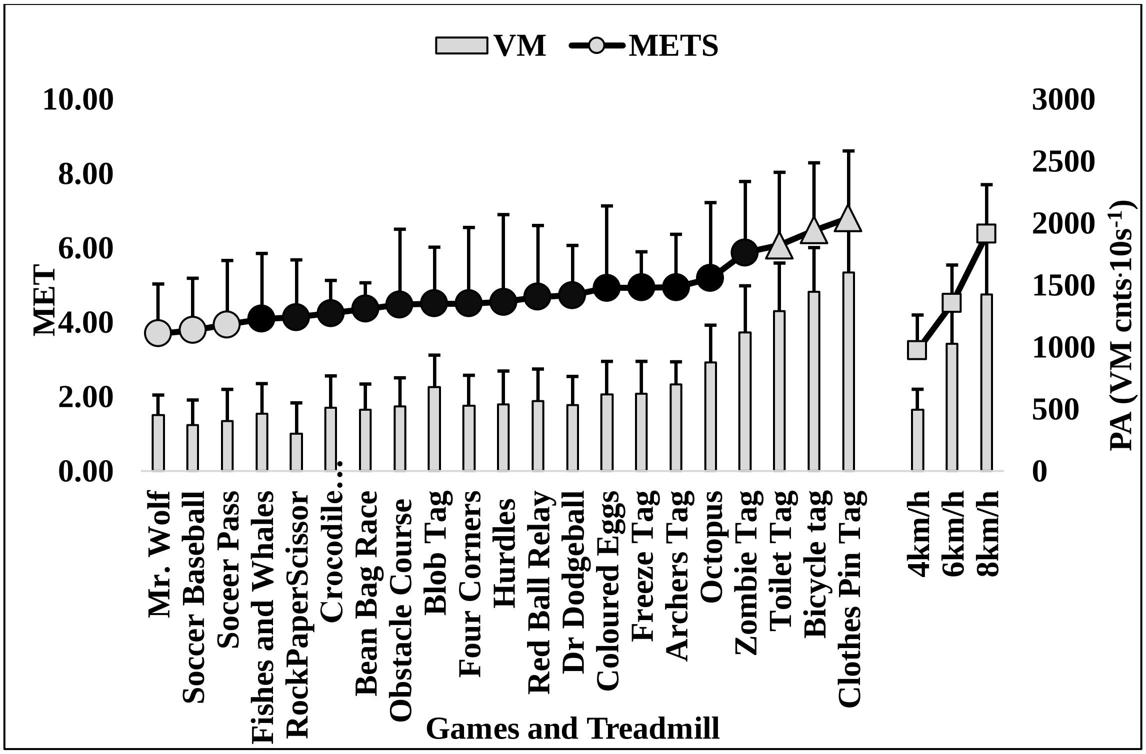


Figure 7: Classifying Physical Activity Intensity of Cooperative Games were Based on Directly Measured Metabolic Equivalents (MET) for Eight 1-hour Guided Active Play Sessions. Games were Classified as Light (1.5-3.99 MET) (open circle), Moderate (4.00-5.99 MET) (filled in circle) and Vigorous (>6,00 MET) (triangle) Physical Activity. Comparison to Treadmill Exercise (5min each at speeds of 4, 6 and 8 $km\cdot h^{-1}$) is Provided.

Table 7: Classification of Physical Activity Intensity for Cooperative Games Based on Directly Measured Metabolic Equivalents (MET) were Assessed for Oxygen Consumption (VO_2 in $mL\cdot kg^{-1}\cdot min^{-1}$) and Physical Activity Quantified by Accelerometry (VMACC). Children (n=11) Played a Total of 21 Randomized Cooperative Games for Eight 1-Hour Guided Active Play Sessions Distributed Over Two Weeks. The Cosmed[2]/Fitmate Portable Gas Analyzer was Placed on The Back Using a Secured Backpack. Physical Activity was Quantified Using Accelerometers (Actigraph GT3X+) Secured by an Elastic Band on the Right Hip.

Physical Activity Classification	Group VO_2	Group VMACC	Group MET	No. of Games
Light 1.5-3.99 MET	18.36 ± 0.60	409 ± 38	3.81 ± 0.12	3
Moderate 4.00-5.99 MET	22.53 ± 2.21	604 ± 191	4.68 ± 0.46	15
Vigorous >6.00 MET	31.07 ± 1.78	1448 ± 157	6.45 ± 0.37	3

Table 8: Statistical Comparison of Intensity Classifications Assessed by Measured Metabolic Equivalents (MET) and compared to Oxygen Consumption (VO_2 in $mL{\cdot}kg^{-1}{\cdot}min^{-1}$) and Physical Activity Quantified by Accelerometry (VM ACC) for Children Playing Cooperative Games During Guided Active Play.

Variable	Intensity Classification	Comparison	*p* level	95% Confidence Interval	
				Lower Bound	Upper Bound
MET	Light	Moderate	.012	-1.5493	-.1800
		Vigorous	.000	-3.5206	-1.7528
	Moderate	Light	.012	.1800	1.5493
		Vigorous	.000	-2.4567	-1.0873
	Vigorous	Light	.000	1.7528	3.5206
		Moderate	.000	1.0873	2.4567
VO_2	Light	Moderate	.012	-7.4745	-.8669
		Vigorous	.000	-16.9785	-8.4482
	Moderate	Light	.012	.8669	7.4745
		Vigorous	.000	-11.8465	-5.2389
	Vigorous	Light	.000	8.4482	16.9785
		Moderate	.000	5.2389	11.8465
VM ACC	Light	Moderate	.217	-480.34	90.34
		Vigorous	.000	-1407.04	-670.30
	Moderate	Light	.217	-90.34	480.34
		Vigorous	.000	-1129.01	-558.33
	Vigorous	Light	.000	670.30	1407.04
		Moderate	.000	558.33	1129.01

Findings and Conclusions:

a) Cooperative games elicit varying rates of oxygen consumption that are associated with increases in physical activity quantified by accelerometry output (Vector Maximum [VM]).

b) Cooperative games elicit varying levels of metabolic equivalents that are associated with increases in physical activity quantified by accelerometry output (Vector Maximum [VM]).

c) Cooperative games can be classified into light, moderate, and vigorous physical activity based on MET, which are useful when characterizing oxygen consumption (VO_2) and energy expenditure (EE) levels of children and adolescents during guided active play.

Pilot Study 3 – Predicting Oxygen Consumption (VO_2 – mL·kg^{-1}·min^{-1}) for Individual Cooperative Games Classified as Light (Mr. Wolf), Moderate (Archers Tag) and Vigorous (Clothes Pin Tag) During a Guided Active Play Session.

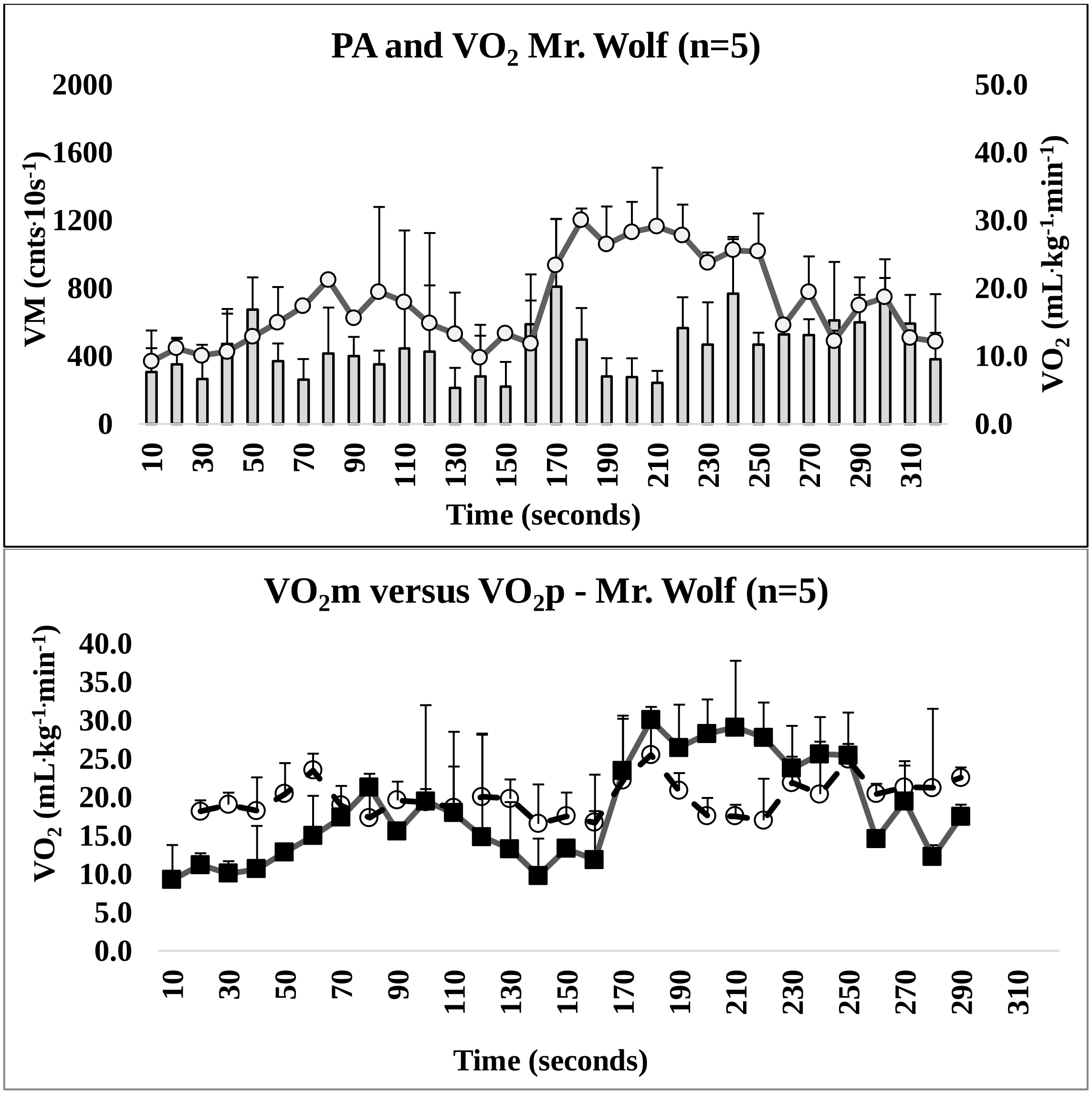


Figure 8: Example of Children's (n=5) Physical Activity (VM) and Oxygen Consumption (VO_2) Responses to a Light Intensity Cooperative Game (What Time is it Mr. Wolf?) During a Guided Active Session (*Top Panel*). Oxygen Consumption (VO_2 in mL·kg^{-1}·min^{-1}) was measured for Children Fitted with a Cosmed[2]/Fitmate Portable Gas Analyzer Placed on the Back Using a Secured Backpack. Physical Activity Participation Were Quantified using ACC Outputs Expressed as Vector Magnitude (VM – counts in 10second intervals) from Accelerometers Secured by an Elastic Band on the Right Hip. A Comparison of Measured Oxygen Consumption (Filled Square - VO_2m) to Predicted Oxygen Consumption (Open Circle - VO_2p) (*Lower Panel*) using laboratory derived linear regression equation (y` = 0.0176x + 6.6297).

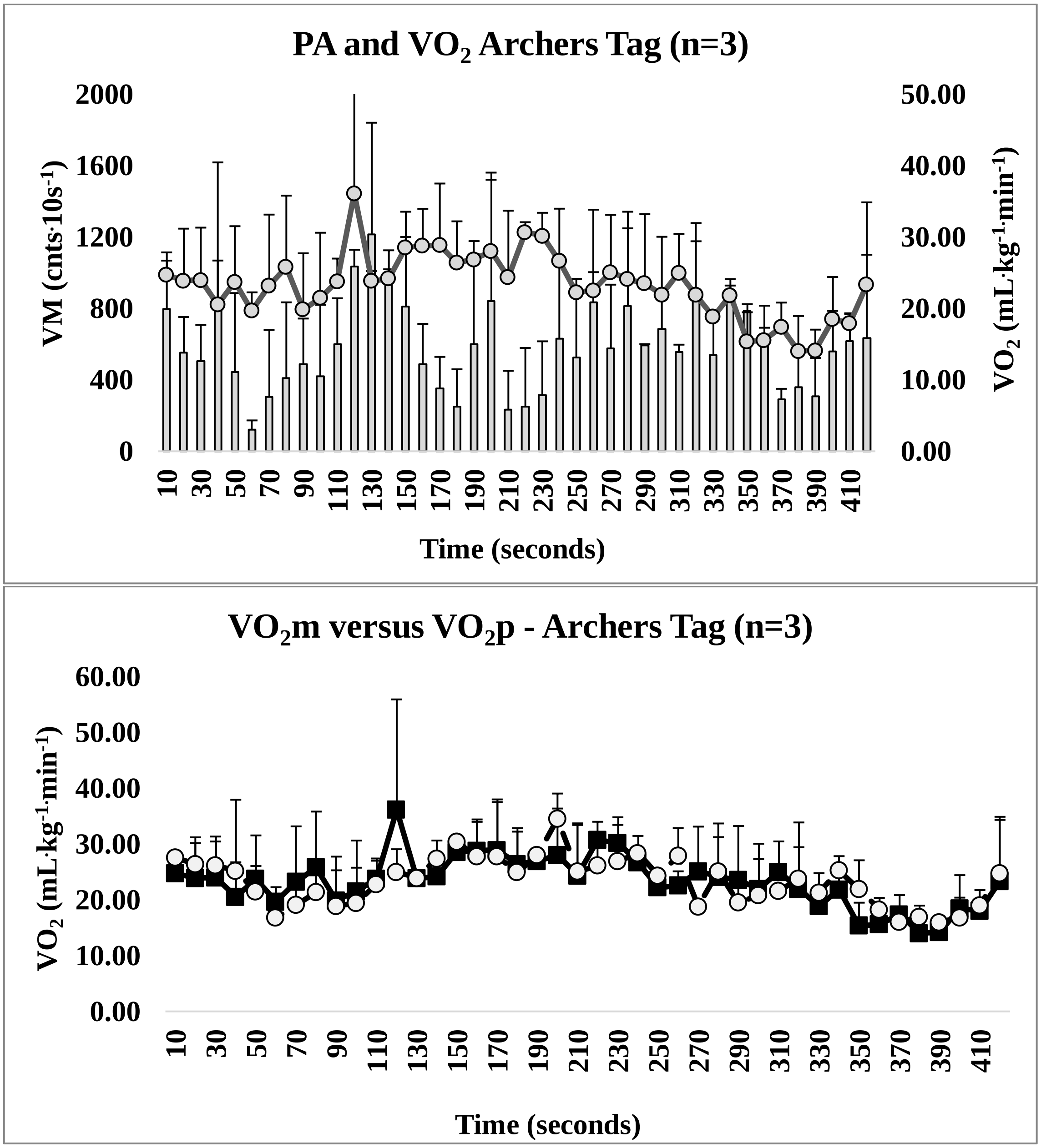


Figure 9: Example of Children's (n=3) Physical Activity (VM) and Oxygen Consumption (VO_2) Responses to a Moderate Intensity Cooperative Game (Archer's Tag) During a Guided Active Session (*Top Panel*). Oxygen Consumption (VO_2 in $mL{\cdot}kg^{-1}{\cdot}min^{-1}$) was measured for Children Fitted with a Cosmed[2]/Fitmate Portable Gas Analyzer Placed on the Back Using a Secured Backpack. Physical Activity Participation Were Quantified using ACC Outputs Expressed as Vector Magnitude (VM – counts in 10second intervals) from accelerometers Secured by an Elastic Band on the Right Hip. A Comparison of Measured Oxygen Consumption (Filled Square - VO_2m) to Predicted Oxygen Consumption (Open Circle - VO_2p) (*Lower Panel*) using Laboratory Derived Linear Regression Equation (y` = 0.0176x + 6.6297).

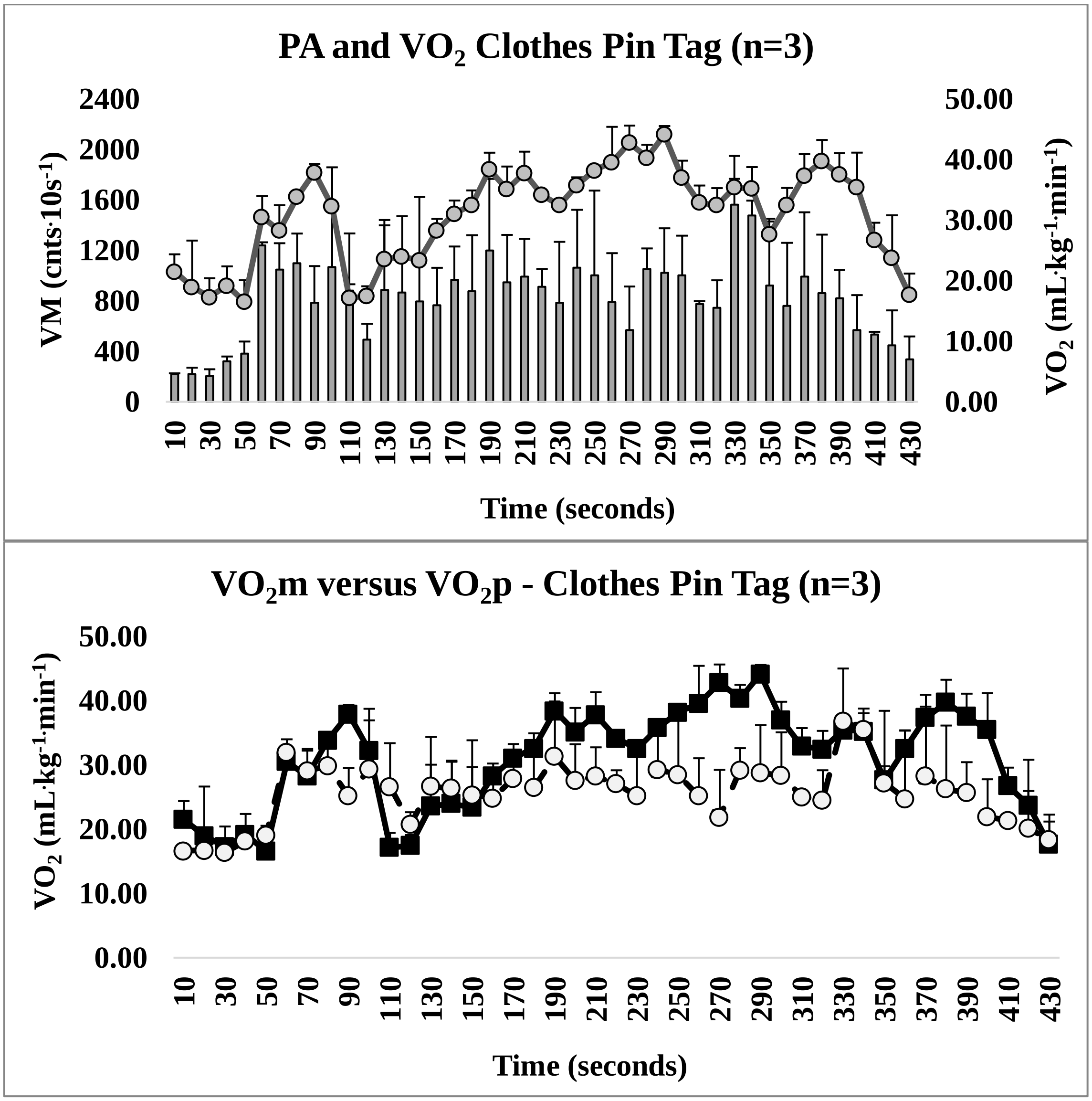


Figure 10: Example of Children's (n=3) Physical Activity (VM) and Oxygen Consumption (VO_2) Responses to a Vigorous Intensity Cooperative Game (Clothes Pin Tag) During a Guided Active Session (Top Panel). Oxygen Consumption (VO_2 in $mL{\cdot}kg^{-1}{\cdot}min^{-1}$) was measured for Children Fitted with a Cosmed[2]/Fitmate Portable Gas Analyzer Placed on the Back Using a Secured Backpack. Physical Activity Participation Were Quantified using ACC Outputs Expressed as Vector Magnitude (VM – counts in 10second intervals) from accelerometers Secured by an Elastic Band on the Right Hip. Comparison of Measured Oxygen Consumption (Filled Square - VO_2m) to Predicted Oxygen Consumption (Open Circle - VO_2p) (*Lower Panel*) using Laboratory Derived Linear Regression Equation (y` = 0.0176x + 6.6297).

Table 9: Comparison of Children's Measured Oxygen Consumption (VO_2m) and Predicted Oxygen Consumption (VO_2p) for Cooperative Games During a Guided Active Session. Oxygen Consumption (VO_2 in $mL \cdot kg^{-1} \cdot min^{-1}$) was measured for Children Fitted with a Cosmed[2]/Fitmate Portable Gas Analyzer Placed on the Back Using a Secured Backpack. Predicted Oxygen Consumption (VO_2p) Using Obtained Using Laboratory Derived Linear Regression Equation (y` = 0.0176x + 6.6297). The Differences Between the Measured and Predicted Oxygen Consumption Values (VO_2 Diff) and the Average Oxygen Consumption Per Game (VO_2 Mean) Were Obtained.

Games	VO_2m	VO_2p	VO_2 Diff	VO_2 Mean
Mr. Wolf	17.82 ± 6.43	19.25 ± 2.29	-1.43	18.54
Soccer Baseball	18.26 ± 4.10	19.13 ± 3.87	-0.87	18.69
Soccer Pass	19.00 ± 6.33	20.04 ± 4.45	-1.04	19.52
Fishes and Whales	19.70 ± 8.51	20.26 ± 3.23	-0.56	19.98
Rock Paper Scissor	19.94 ± 7.44	17.99 ± 3.24	1.95	18.96
Crocodile Crocodile	20.45 ± 4.26	21.05 ± 3.22	-0.60	20.75
Bean Bag Race	21.03 ± 6.50	22.25 ± 4.07	-1.22	21.64
Obstacle Course	21.55 ± 5.88	20.83 ± 5.01	0.72	21.19
Blob Tag	21.69 ± 7.33	23.52 ± 5.52	-1.83	22.60
Four Corners	21.72 ± 6.04	22.87 ± 4.97	-1.15	22.30
Hurdles	21.91 ± 7.11	21.56 ± 5.19	0.35	21.74
Red Ball Relay	22.56 ± 6.04	24.12 ± 5.74	-1.56	23.34
Dr Dodgeball	22.77 ± 6.48	21.34 ± 3.61	1.43	22.06
Coloured Eggs	23.73 ± 7.33	23.41 ± 4.72	0.32	23.57
Freeze Tag	23.80 ± 4.44	22.89 ± 4.77	0.91	23.34
Archers Tag	23.29 ± 4.61	23.32 ± 4.32	-0.03	23.30
Octopus	24.97 ± 8.30	26.07 ± 5.37	-1.10	25.52
Zombie Tag	28.33 ± 8.30	29.18 ± 6.11	-0.85	28.75
Toilet Tag	29.24 ± 6.10	27.92 ± 5.33	1.32	28.58
Bicycle tag	31.18 ± 7.32	30.33 ± 6.62	0.85	30.76
Clothes Pin Tag	32.08 ± 8.70	29.37 ± 7.59	2.71	30.72
Mean	23.10 ± 4.03	23.18 ± 3.55	-0.079* ± 1.27	23.14 ± 3.74

** Denotes the mean difference between VO_2m and VO_2p of -0.079 was not statistically different from zero with p=0.776.*

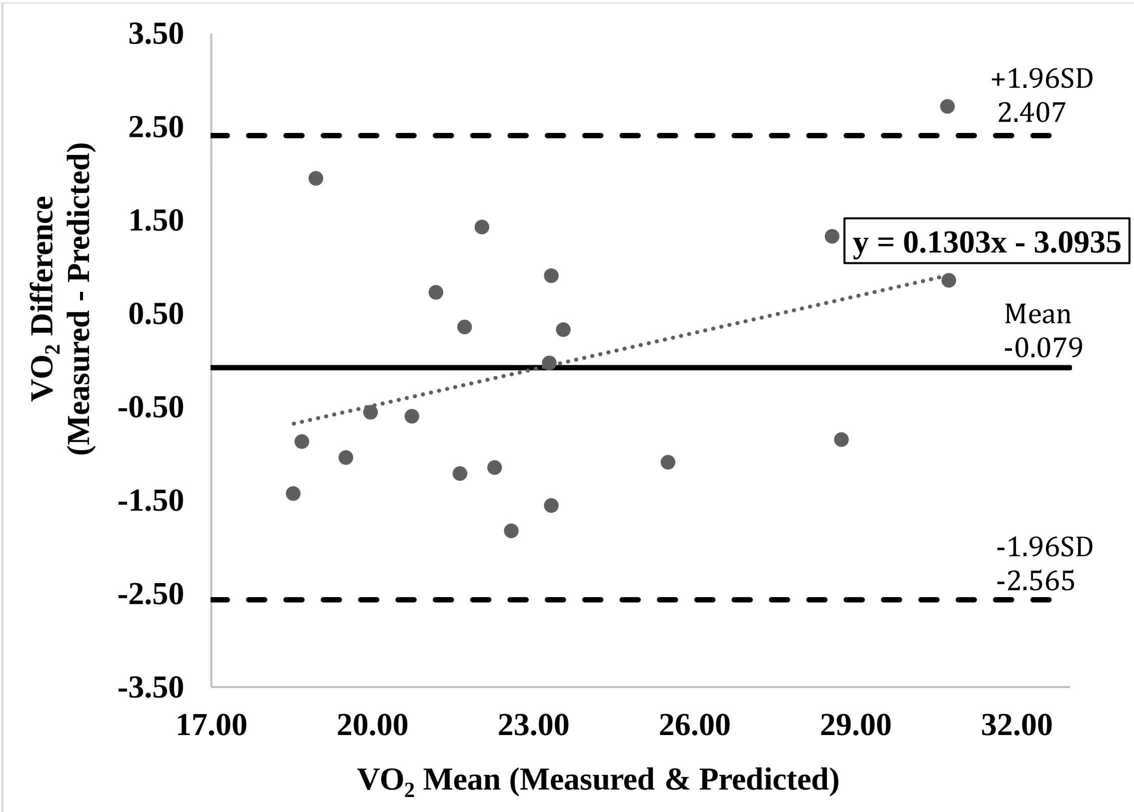


Figure 11: A Bland-Altman Plot Analysis of the Mean Differences between VO_2m and VO_2p with Lower and Upper Limits of Assessment (dash-lines) and the Mean Difference (solid line). To Test for Proportional Bias, Linear Regression Analysis Between the Mean Differences and the Mean of the Measured and Predicted VO_2 Resulted in a Constant of -3.0935 and Coefficient of 0.1303, Which Were not Significant ($p>0.05$) and Indicative of no Proportional Bias Between Measured and Predicted VO_2 Levels for Cooperative Games During Guided Active Play.

Table 10: The Oxygen Consumption – Time Profiles (Area Under the Curve [AUC]) Were Compared to Assess a Measure of Separability for Children's Average Measured Oxygen Consumption (VO_2m) and Predicted Oxygen Consumption (VO_2p) for Cooperative Games During a Guided Active Session. Oxygen Consumption (VO_2 in $mL \cdot kg^{-1} \cdot min^{-1}$) was measured for Children Fitted with a Cosmed[2]/Fitmate Portable Gas Analyzer Placed on the Back Using a Secured Backpack. Predicted Oxygen Consumption (VO_2p) Using Obtained Using Laboratory Derived Linear Regression Equation (y` = 0.0176x + 6.6297). The AUC Differences (VO_2 Diff AUC) Between the Measured Oxygen Consumption (VO_2m AUC) and Predicted Oxygen Consumption (VO_2p AUC) are Reported for Cooperative Games

Games	VO_2m AUC	VO_2p AUC	VO_2Diff AUC
	VO_2 ($mL \cdot kg^{-1} \cdot min^{-1}$)		
Mr. Wolf	181.5 ± 36.3	197.8 ± 26.1	-16.3
Soccer Baseball	173.5 ± 38.7	190.2 ± 22.3	-16.7
Soccer Pass	190.6 ± 35.5	181.2 ± 22.8	9.4
Fishes and Whales	192.3 ± 37.1	219.1 ± 27.4	-26.8
Rock Paper Scissor	196.4 ± 32.9	181.2 ± 21.5	15.2
Crocodile Crocodile	209.2 ± 34.4	204.3 ± 23.7	4.9
Bean Bag Race	211.8 ± 36.7	226.2 ± 24.6	-14.4
Obstacle Course	224.1 ± 32.8	239.5 ± 22.2	-15.4
Blob Tag	215.0 ± 35.6	235.1 ± 27.3	-20.1
Four Corners	220.7 ± 39.9	215.2 ± 24.8	5.5
Hurdles	229.4 ± 31.6	239.9 ± 29.5	-10.5
Red Ball Relay	233.5 ± 43.3	239.1 ± 28.8	-5.6
Dr Dodgeball	252.9 ± 39.4	203.7 ± 31.3	49.2
Coloured Eggs	257.9 ± 38.5	237.8 ± 27.4	20.1
Freeze Tag	241.2 ± 37.1	236.5 ± 23.9	4.7
Archers Tag	217.9 ± 37.7	226.2 ± 29.0	-8.3
Octopus	254.7 ± 36.2	248.3 ± 30.8	6.4
Zombie Tag	266.0 ± 42.6	260.1 ± 32.5	5.9
Toilet Tag	282.5 ± 44.7	260.6 ± 29.4	21.9
Bicycle tag	298.4 ± 40.8	279.9 ± 34.3	18.5
Clothespin Tag	315.6 ± 43.4	259.0 ± 32.7	56.6
Mean	231.7 ± 38.1	227.7 ±27.3	4.0* ± 21.6

** Denotes the mean VO_2Diff AUC between VO_2m AUC and VO_2p AUC of 4.0 was not statistically different from zero with $p=0.404$.*

Findings and Conclusions:

a) Cooperative games exhibit intermittent patterns of movement (with frequent starts and stops) regardless of light-moderate-vigorous PA. The timing of PA changes and changes in VO_2 show varied response patterns throughout the cooperative games.

b) Prediction of mean and total (AUC) oxygen consumption of cooperative games, using treadmill generated linear regression equations, were not statistically different from measured oxygen consumption.

c) Bland-Altman analysis revealed no statistically significant proportional bias between measured and predicted VO_2 levels for cooperative games during guided active play across the range of intensities.

d) Therefore, the use of linear regression equations is a useful tool to assess/estimate oxygen consumption to be used in calculating energy expenditures for children's cooperative games.

Pilot Study 4 – Physical Activity Levels for Children and Adolescents During Guided Active Play in a Community Recreation Centre Summer Camp and a Community Summer School Camp.

A. Community Recreation Centre Summer Camp (see table 1b for children's characteristics)

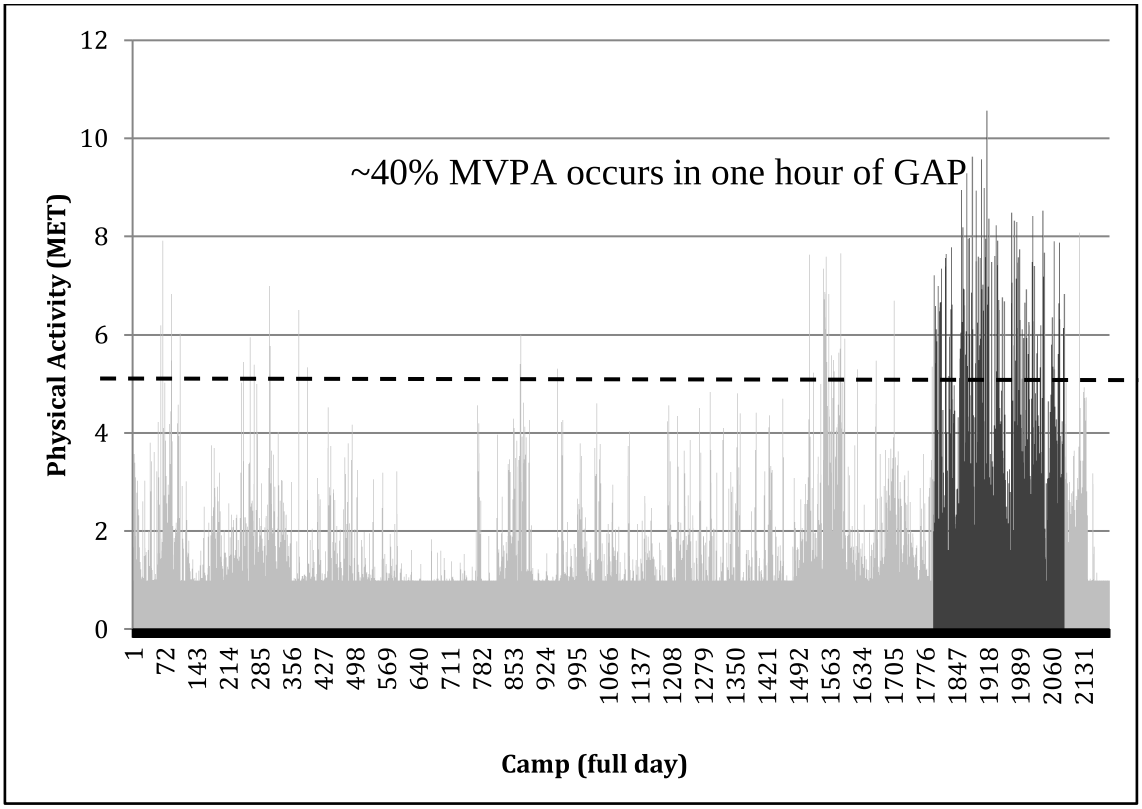


Figure 12: Comparison of physical activity intensity for children (n=36) during a full day of summer camp (n=15) and during children's guided active play program (n=21) (presented in darker gray).

Table 11. Children's (7-12 years) Physical Activity Levels During a Community Recreation Summer Camp Program (n=3 days) with and without Guided Active Play

	Physical Activity (kcal·hr^{-1})	**Sedentary (% time)**	**Light PA (% time)**	**Moderate-Vigorous PA (% time)**
Camp-Only (n=15)	119.5 ± 48.3	45.1 ± 12.9	40.5 ± 2.3	14.8 ± 11.2
GAP Program (n=21)	258.2 ± 55.2 (p=0.000)	19.4 ± 13.9 (p=0.000)	41.8 ± 3.1 (p=0.711)	38.9 ± 11.6 (p=0.000)

B. Community Summer School Camp

Table 12. Children's (n=84) Physical Activity Patterns During a Summer School Program (n=4 days) with and without Guided Active Play. Days 1-4 represent main effect comparison observed across all days (1-4) with *p* levels.

	Physical Activity (kcal·session^{-1})	Sedentary (% time)	Light PA (% time)	Moderate-Vigorous PA (% time)
School Time	138.2 ± 52.8	46.7 ± 13.1	40.3 ± 9.8	12.6 ± 6.3
Days 1-4 (*p*)	0.680	0.029	0.548	0.315
GAP Program (vs School)	259.0 ± 79.4 (p=0.000)	21.4 ± 9.7 (p=0.000)	43.1 ± 10.9 (p=0.314)	37.0 ±10.9 (p=0.000)
Days 1-4 (*p*)	0.456	0.118	0.671	0.093

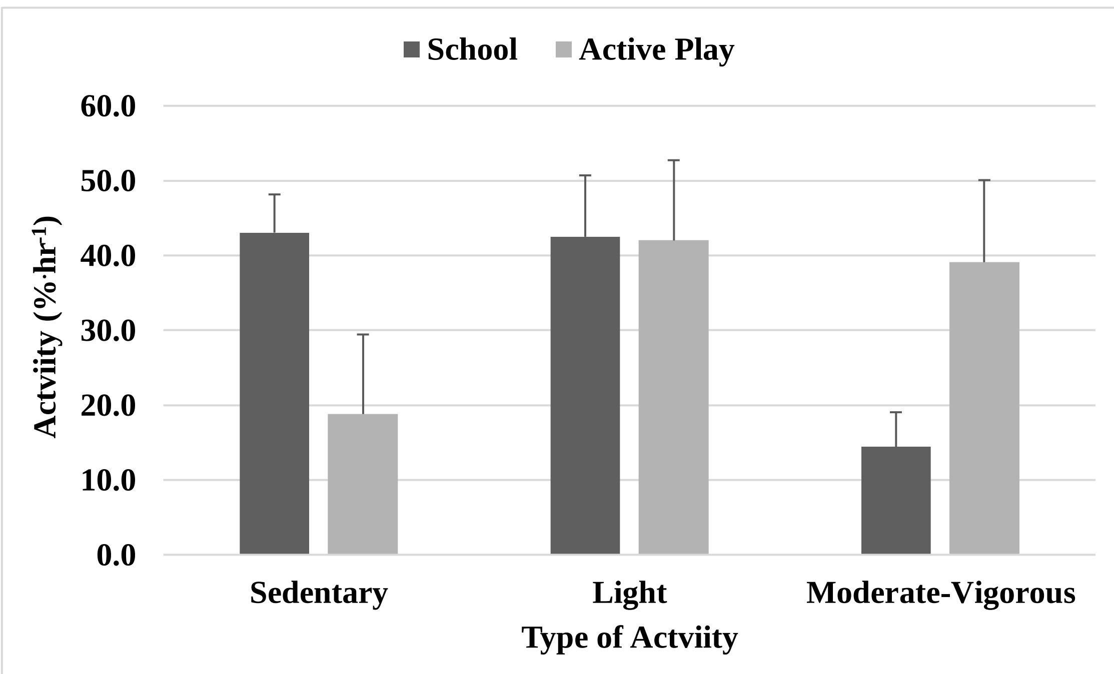


Figure 13: Children's (n=84) Physical Activity Intensity Levels During a Summer School Program (n=4 days) with and without Guided Active Play. The * denotes difference (*p*<0.05) between school and active play across the four-day averages.

Findings and Conclusions:

a) The physical activity programming for summer day camps provides an important level of energy expenditure and moderate-to-vigorous physical activity compared to other camp programming elements (i/e. arts/crafts, social time, and free play activities).

b) The recess programming for summer school camps provides an important level of energy expenditure and moderate-to-vigorous physical activity compared to summer school academic programming.

Pilot Study 5 – Procedures and Supplementary Information for Vascular Blood Flow (associated with Chapter 3.3)

Procedures

1. Preparing the vasodilator substances:

- Prepared 1% solutions of Acetylcholine (ACH) and Sodium Nitroprusside (SNP) by dissolving the vasodilator substance in saline
- Prepared vasodilator substance solutions the night before and stored in refrigerator

2. Preparing the participant:

- Subjects had a 20 minute acclimatization period (ensured participants are in a fasted state, avoided exercise for 24 hours, and female participant were prior to menarche)
- Following acclimatization, recorded room temperature and skin temperature
- Following acclimatization, recorded initial/resting blood pressure
- Insert drugs into syringe so they are ready for insertion

3. Computer and laser set up:

- Determined 12-15 cm for height of laser to skin was effective
- Selected low point density (in order to keep a low time per image)
- Determined area of region of interest (ROI) to be 30mm^2 in the center of image
- Monitored raw image recording to account for any movement the subject may have had during data collection (review image to image of recording and change ROI to the center of the image following data collection)

4. Iontophoresis protocol (see figure 14):

- Removed vasodilator substance solutions from the refrigerator 1 hour prior to participant arrival (wrap SNP in tin foil to keep in a dark environment)

<u>Endothelial dependent vasodilation (ACH)</u>

- Attached electrodes and iontophoresis patches on participant forearm and recorded 1.5 minutes of imaging (laser doppler imaging) with no vasodilator substance
- Following the electrode check, the vasodilator solution (1000µL) was inserted onto the patch
- Baseline vasodilation was recorded for 1 minute
- Started ACH iontophoresis protocol (inserted electronic markers to record the start and stop of iontophoresis), as follows:
    - Applied 20 µA for 3 minutes and 20 seconds – recorded vasodilation using laser doppler
    - Terminated iontophoresis current and continued to record vasodilation for 3-4 minutes
- Removed patches and recorded skin temperature, room temperature and blood pressure

<u>Endothelial independent vasodilation (SNP)</u>

- Attached electrodes and iontophoresis patches on participant forearm and recorded 1.5 minutes of imaging (laser doppler imaging) with no vasodilator substance

- Following the electrode check, the vasodilator solution (1000µL) was inserted onto the patch
- Baseline vasodilation was recorded for 1 minute
- Started SNP iontophoresis protocol (inserted electronic markers to record the start and stop of iontophoresis), as follows:
    - Applied 20 µA for 6 minutes and 40 seconds – recorded vasodilation using laser doppler
    - Terminated iontophoresis current and continued to record vasodilation for 3-4 minutes
- Removed patches and recorded skin temperature, room temperature and blood pressure

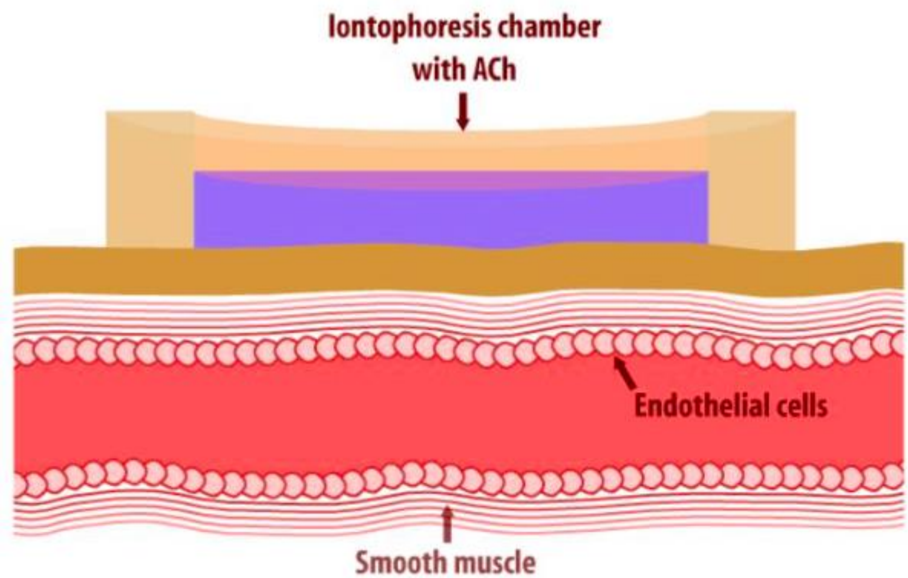


Figure 14. Perfusion response to iontophoresis (Ach; Acetylcholine). Image from the Ernest Orlando Lawrence Berkeley National Laboratory (https://image3.slideserve.com/6395287/perfusion-response-to-iontophoresis-l.jpg).

5. Quantification of vasodilation

Baseline	calculated by the last minute prior to the start of iontophoresis (Ionto)
Average	average of iontophoresis from start of current to the time the current was stopped (ACH: 3mins 20sec, SNP: 6min 40sec, based on respective protocols)
Peak	highest perfusion value during the entire iontophoresis protocol
Plateau	average of the last minute of iontophoresis (last 60 seconds of when the iontophoresis was stopped)
Area under the curve	To find the area under the curve y **= f(x) between x = a and x = b**, integrate y = f(x) between the limits of a and b.

Pilot Study Results

Table 13: Average endothelial dependent vascular perfusion (acetylcholine; ACH) of two trials for adults (n=8, average age of 23 years) and children (n=2, average age of 10 years). The average and standard deviation (ST DEV) for the participants are presented.

ACH		
n	**Baseline**	**Average**
1	68.70	337.02
2	71.97	326.20
3	75.54	403.29
4	69.76	408.80
5	52.65	266.25
6	102.16	356.27
7	65.86	371.21
8	84.73	336.82
AVERAGE	**73.92**	**350.73**
ST DEV	**18.63**	**84.77**
child 1	61.86	311.31
child 2	87.29	294.69
AVERAGE	**74.58**	**303.00**
ST DEV	**17.98**	**11.75**

Table 14: Average endothelial independent vascular perfusion (acetylcholine; ACH) of two trials for adults (n=8, average age of 23 years) and one child (11 years of age). The average and standard deviation (ST DEV) for the participants are presented.

SNP		
n	**Baseline**	**Average**
1	43.66	314.02
2	98.67	452.74
3	72.23	445.04
4	78.10	414.66
5	64.15	216.91
6	88.46	343.31
7	68.04	449.56
8	86.73	500.52
AVERAGE	75.00	392.09
ST DEV	22.82	99.37
child 1	87.10	205.74

Vasodilation Mechanisms:

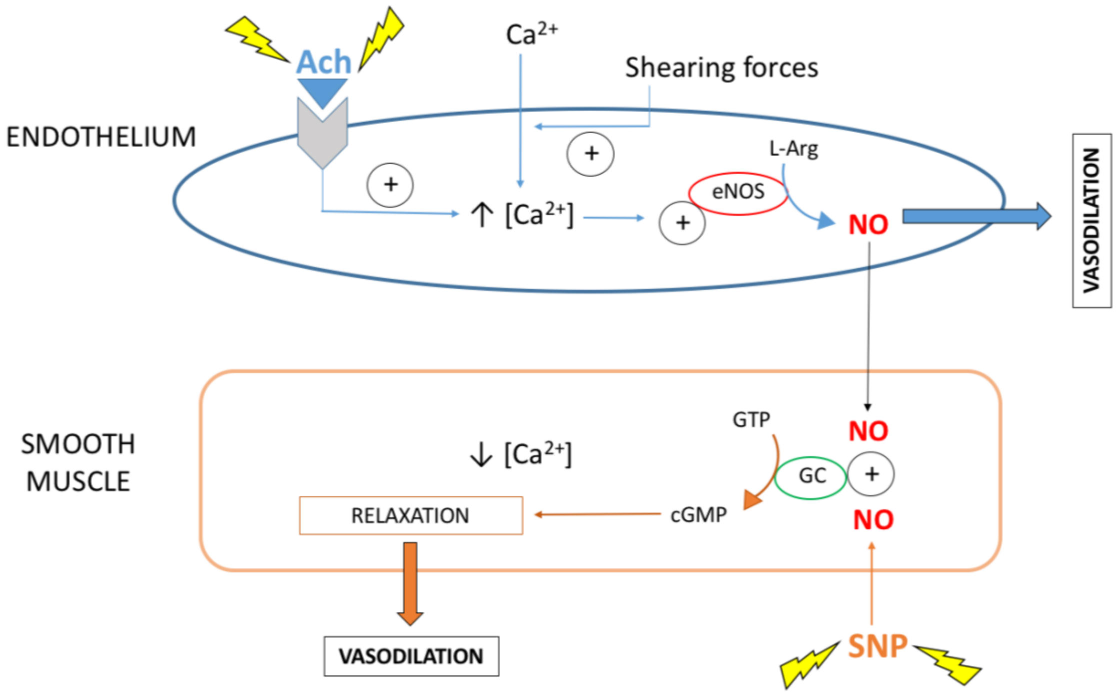


Figure 15. Nitric oxide (NO) mediated vasodilated through the stimulation of acetylcholine (Ach) acting on the endothelium and sodium nitroprusside (SNP) acting on the smooth muscle. (BK, bradykinin; Ca++, calcium; GC, guanylate cyclase; cGMP, cyclic guanosine monophosphate; eNOS, endothelial nitric oxide synthetase; NGC, nitroglycerine). Figure adapted from: **Vázquez-rey E**, **Kaski JC**. Cardiovascular syndrome X and endothelial dysfunction. *Rev Española Cardiol* 56: 181–192, 2003.

APPENDIX F

Games Descriptions
<u>Red Light, Yellow Light, Green Light</u>

Equipment: None Required

Participants: More than 2

Instructions: One person stands at the opposite side of the gym, away from the rest of participants. The participants at the other end of the gym are the 'stop light'; he/she must face the back wall and call out red, yellow or green light. When the person who is the stop light calls green, the kids can take as many steps forward until the stop light calls a red light. When the person who is the stop light calls a red light, everyone must stop moving. Once the person who is the stop light calls a red light, they must turn around quickly to judge which of the players are still moving. When a yellow light is called the players must walk forward in slow motion until another color light is called. The point of this game is to be the first player to reach the person who is the stop light. Once a player reaches the person who is currently the stop light, they get to become the new stop light and the game is re-started from the beginning.

<u>Triangle and One (aka Monkey in the Middle)</u>

Equipment: bouncy ball, soft ball, or something that is safe to throw and catch

Participants: Minimum of 4

Instructions: Groups form a triangle with one defender in the middle. Players attempt to complete throwing passes without dropping the ball or having the defender intercept the pass. An unsuccessful pass results in the defender and thrower switching roles. Roles switch after ten complete passes. Defender may not grab the object from an opponent's hand.

Other variations can be made using soccer passes or by incorporating more participants by forming a circle and incorporating 3 persons in the middle rather than the one.

Adapted from: ophea.net

Magical Island

Equipment: Hula Hoops or coloured paper

Participants: Minimum of 6

Instructions: A variety of islands are spread out around the room. Participants move around the room as quickly as possible. When the leader calls out "Islands in 5-4-3-2-1", the participants have five seconds to be touching an island and freeze in a position. Participant can share islands. Resume moving after all have found an island.

Variations: Removing islands; Limiting the number of islands that participants can go to (all participants with birthdays between January and June must find a BLUE island, everyone else must find a GREEN island); Defining the number of participants who can share an island and asking participants to incorporate specific criteria into their frozen position; Give all instructions while participants continue to move around the room.

Adapted from: ophea.net

Steal the Bacon

Equipment: one ball

Participants: 12 Minimum

Instructions: Divide the group into two teams, have them line up across opposite sides of the playing area, and give each player a number. Place the ball in the middle of the playing area. One leader will sit out to call numbers. When a number is called, the player from each team with that number runs to get the ball and bring it back to their team. If the player with the ball is tagged by their opponent the round is over and they return to their teams.

Variation 1: Call more than one number at a time. Teammates can throw the ball to each other to move it across the floor faster.

Variation 2: After picking up the ball, you have to throw it at the wall behind the opposing team in order to get a point. The teammates still on the line can jump or move to try to block the ball from hitting the wall.

Commander (aka Simon Says)

Equipment: none

Participants: any

Instructions: Participants begin the game by running or jogging around the playing area. Have one leader be in charge and call out commands such as hop on one foot, form a group of 3, skip sideways, run backwards, put your knee on the floor, etc. Participants only have to follow the command if the leaders says "Simon says…" If they do a command wrong, have them do a fun challenge (such as 5 jumping jacks) and then continue with the game.

What time is it Mr. Wolf?

Equipment: none

Participants: 8 minimum

Instructions: Choose one wolf out of the group and have them go to the opposite side of the playing area. Have the rest of the group line up across the end of the playing area. The wolf should be facing away from the group. To begin everyone says, "what time is it Mr. Wolf?" The wolf answers by saying, "______ o'clock." The participants step forward the number that the wolf said. When the wolf says "lunchtime", he/she turns around to chase everyone as they try to run back to the start without getting tagged. If they are tagged they join the wolf at the other end. The game continues until everyone has been tagged.

Wizards, Elves & Giants

Equipment: None required

Participants: Minimum of 6

Instructions: Spilt group into teams. There are two safety zones, one on each team's side of the gym and there is a middle area (middle line of gym). Each team will huddle up before approaching the middle line and decide whether they want to be giants, wizards or elves. Giants put their hands up over there heads. Wizards put their hands straight out and wiggle their fingers. Elves make pointy ears with their fingers on top of their heads. Once teams have decided what they will be, they approach the center line, lining up place to place. Giants beat elves, elves beat wizards and wizards beat giants. (If participants have a hard time remembering what beats what, you could always replace giants, elves and wizards with rock, paper, scissors and play the game the exact same way.) The winner of the two chases the other and tries to tag as many members of the losing team before they reach the other wall. The members tagged become part of the other team until one side has all participants.

Crash

Equipment: No equipment required

Participants: 8 Minimum

Instructions: All participants in the group begin the game by mingling, constantly moving until the leader shouts out a number. All players must then try to get into groups of that number. Any group/s that does not succeed is out of the game. Or this can also be played as a non-elimination game to keep participants moving around and included.

Variation: Players find others who have things in common, such as same shoe size.

Adapted from: Funandgames.org

<u>Crash</u>

Equipment: none

Participants: 12 minimum

Instructions: Participants begin the game by running or jogging around the playing area. Have one leader be in charge and call out commands. The commands will always have a number and a body part. If the leader calls out 5 feet, then the participants must get in groups of five and put their feet together in the middle. If there are not enough people for everyone to be in a group, have those who didn't find a group do a fun challenge and then continue on.

<u>Cat and Mouse or Trio Dodge</u>

Equipment: none

Participants: 4 minimum

Instructions: Designate one person to be the cat (the chaser) and one person to be the mouse (the runner), and have the rest of the group form a circle and join hands. When the game begins, the cat chases the mouse trying to tag him/her. Those in the circle walk around in one direction and lift their arms up and down to allow the mouse to pass through and to try and slow down the cat. The game continues for a minute or two or until the cat catches the mouse. Then change positions and start again.

Variation: Divide the group into teams of 4. For each team, choose one chaser (the cat). Have the other three players join hands to form a circle and choose one person to be chased (the mouse). The cat has to try to tag the mouse on the back. Those in the circle manoeuvre around to protect the mouse from being tagged. The cat cannot cut through the middle of the circle but has to run around it. Change chasers after a minute even if they do not catch the mouse.

Doctor, Doctor!

Equipment: One ball per player, and two hula hoops or 8 cones to mark out a "hospital" for each team

Participants: 8 minimum

Instructions: Designate an area on each side of the play area to be the "hospital". Divide the group into two teams and have them each choose a doctor for their team. The doctor goes to the hospital area and the rest of the players are given a ball and spread out around the play area. Using only their feet, players dribble their ball up to the opposing team members and try to "injure" them by hitting them with the ball below the waist. If they are hit, they kneel down on the ground and can rejoin the game when they are tagged by the doctor. The doctor must run out of the hospital in order to tag their injured teammates. The doctor is safe when they are in the hospital, but when they leave they take the risk of getting hit. One round lasts until the doctor has been hit.

Fishes and Whales

Equipment: None

Participants: 12 minimum

Instructions: Split the group into two teams, "fishes" and "whales", and select 1-3 people to be "sharks". The Fish and Whales go to opposite sides of the gym or playing area, and the Sharks go to the middle. The object of the game is for the Fish and Whales to get from one side to the gym to the other, when called, without getting tagged by a Shark. The Sharks call either “fish” (only fish run), “whales” (only whales run), or “ocean” (both fish and whales run). When you are tagged you become “seaweed”. Seaweed cannot move their feet, but they try to tag people that run past them. If you are tagged by seaweed, you also become seaweed.

<u>Crocodile Crocodile</u>

Equipment: None

Participants: 10 minimum

Instructions: Have the group be on one side of the gym or playing area, and select 1-3 people to be crocodiles. When ready, the group calls out, “Crocodile, crocodile, can we cross the river?” The Crocodiles reply with, “Only if you’re _________________”. This blank can be filled in with a colour of an article of clothing, hair, eyes; month of a birthday; etc. If you fit into the category called you try to run to the other side without getting tagged by a crocodile. If you are tagged you become a crocodile. If you are not tagged you continue on.

<u>Coloured Eggs</u>

Equipment: None

Participants: 12 minimum

Instructions: Have the group on one end of the gym or playing area, and select 1-3 people to be “it” and have them go to the centre. Each individual gets to choose a colour for themselves, and a team colour is also chosen. When ready, the “it” people call out a colour. If it is your individual colour or the team colour you try to run to the other side without getting tagged. If you are tagged you go to “jail”, which is a bench or space to the side, until a “jail break” is called. If you are not tagged, you choose a new colour and continue with the game.

Air Raid

Equipment: 6-12 small, soft, stuffed balls

Participants: 10 minimum

Instructions: Select 2

-3 “gunners” to begin and have the rest of the group go to one side of the gym or playing area to be “jets”. The Gunners select a spot in the playing area, are stationary, and given ammo of small, soft balls. When called, the Jets take off and try to run to the other side of the area without getting “shot down” (hit with a ball) on their way across. If they are hit they become a Gunner where they went down. If they are not hit they continue until everyone is hit.

Dr. Dodgeball

Equipment: 5-6 small, soft, stuffed balls.

Participants: 10 minimum

Instructions: Split the group into two teams. Each team selects a “doctor” for their team. Start with the balls at the centre line, and when ready have the teams line up on each end and run to get the balls to start. If you are hit with a ball, below the head, you sit down where you were hit. To get free again, your Doctor can tag you. If the Doctor gets hit they sit down and the game continues until everyone on that team is hit.

Pin Dodgeball

Equipment: 5-6 small, soft, stuffed balls and 4 pins.

Participants: 10 minimum

Instructions: Split the group into two teams, going to opposite sides of the gym or playing area. Set up two pins on each end, in opposite corners. The object of the game is to knock down the other team's pins and/or get everyone out from the other team. Players can stand around the pins to protect them, but once they fall down they stay down, whether hit with a ball or by someone hitting them. When hit with a ball, below the head, you are out.

This game can also be combined with Dr. Dodgeball to increase the playing time of the kids. Or have a different consequence for being hit with a ball (i.e., do 10 jumping jacks, etc.) before returning to the game.

Dodgeball

Equipment: 4-8 small, soft balls

Participants: 8 minimum

Instructions: Divide the group into two teams and have them go to opposite sides of the playing area. Begin with the balls in the middle and everyone lining up, on your mark they will run to get the balls and the game begins. If you are hit below the neck, you are out and go to the area behind the opposing team. From here you can catch balls that come to you and throw them at the opposing team. If you hit someone they are out and go to the designated area behind the opposite team. The game continues until everyone on one team has been hit.

Soccer Baseball

Equipment: One soccer ball, four cones or something to be used as bases

Participants: 12 minimum

Instructions: Set up the bases like a baseball diamond and have the pitcher in the middle. Divide the group into two teams, one starts infield and the other outfield. Have the pitcher role the ball to the first person up, once they kick it they run to first base without getting out. Note: Allow each player to kick before switching from infield to outfield (rather than just using 3 outs). This helps keep with the non-competitive environment and just having fun.

Variation: make up different ways to travel from one bas to the other. Example: two foot hop from home to first, run backwards from first to second, skip from second to third, and one foot hop from third to home.

Relay - Team Take

Equipment: multi-coloured clothespins, shoes, plastic bugs, bean bags, etc. Enough for all players

Participants: 8 minimum

Instructions: Divide the group into teams and have them go to separate corners of the playing area. Place all of the clothespins, shoes, toys, bean bags, etc. in the centre of the area. Have the teams line up and the first person runs out, grabs one of the objects in the middle, runs back to their team, and then the next person can go. The game continues until everyone has had a turn.

Variation: Have the teams decide amongst themselves which object they want to collect (for example, only red bean bags). And play the game until a team has collected 5 of one object, for example.

<u>Relay – Ball and Pairs</u>

Equipment: one ball per team

Participants: 8 Minimum

Instructions: Divide the group into teams of 4-8 players and give each team one ball. The players must pair up (if you have an odd number one player can go twice) and work together to carry the ball from the start to the other side of the playing area without using their hands (ie. Between their backs, using their elbows, etc.). If they drop the ball they can pick it up again and keep on their way. They go down to the end and back and then pass the ball to the next pair until everyone on the team has had a turn. To make it more interesting, you can't copy how your teammates carried the ball. Ie. If the first pair carried it between their shoulders, the second group has to come up with a different way, and so on.

<u>Relay – Crab Walk and Bean Bag</u>

Equipment: one bean bag per team

Participants: 6 Minimum

Instructions: Divide the group into teams of 3-6 players and give each team one ball. The first person in line gets ready to do the crab walk, but they have to carry the bean bag on their stomach as they walk from one end to the other. You can make it easier or harder depending on how far they have to carry the bean bag, or easier by only doing the crab walk one way and running on the way back, for example. When they get back to the line the next person goes until everyone on the team has had a turn.

<u>Moderate-High Intensity Activities</u>

<u>Safety Zone Tag</u>

Equipment: 3-6 hula-hoops or skipping ropes

Participants: 10 minimum

Instructions: Lay out the hula-hoops, or skipping ropes layed in a circle, around the gym or playing area; these are the "safety zones". Select 1-3 people to be "it". Everyone runs around trying not to get tagged. When standing in one of the "safety zones" you are safe, but you can only stay in one safety zone for up to 5 seconds. There is an unlimited number of people that can be in each safety zone at one time. When you are tagged, you also become "it". The game continues until everyone is "it".

To increase interest and challenge, you can also take away safety zones or limit the amount of people that can be in a safety zone at one time as the game progresses.

<u>Thawed Out</u>

Equipment: none

Participants: 8 minimum

Instructions: Chose 1 person to be "it" for every 8-10 players, they are called "Mr./Mrs. Freeze", and they will run around trying to tag the rest of the players as they run away. Also designate 1-2 runners to be "Mr./Mrs. Heat", but don't let Mr./Mrs. Freeze know who they are. As the game is played, if runners are tagged they become frozen. They stand still until they are thawed by Mr./Mrs. Heat tagging them. If Mr./Mrs. Heat are tagged they are also frozen and now there is no one to thaw people. Continue until everyone is frozen or for a specified amount of time.

Variation: Have the players stand on one foot (or do some other pose) while they are frozen and waiting to be thawed.

<u>Line Tag</u>

Equipment: none

Participants: 8 minimum

Instructions: This game is best played in a gym for court sports. Designate 1 person to be "it" for every 6-8 players. Everyone runs around the play area, however, they must always be running on the lines. They can jump from one line to the other. When you are tagged you are frozen until someone tags you again to free you. The game continues until everyone is frozen or for a designated time period.

Variation: Play in teams. For example, splitting a group of 16 into 4 teams of 4. Each team takes a turn to be "it" and has 60 seconds to tag as many people as possible.

<u>Jailbreak</u>

Equipment: cones or something to mark out a square area

Participants: 7 minimum

Instructions: Use cones to mark out a "jail" area in the centre of the play area (this should be approx. 7x7 metres). Choose 1 chaser for every 6-8 players. The chaser runs around trying to tag the rest of the group. When players have been tagged, they go to the designated jail area. Players who have not been tagged try to free the captured players by running through the jail and tagging them. The chasers are not allowed to go inside the jail at any time.

<u>Arches Tag</u>

Equipment: none

Participants: 12 Minimum

Instructions: Have the participants to form pairs and choose one pair to be "it" for every 5-6 pairs. Everyone holds hands or wrists as they run around and those who are it run after the other pairs trying to tag them. If one person is tagged then the pair is caught and they have to stand and make an arch (face each other and put your hands up and together with the partner). To become free, another pair must run under the arch. You can also make an arch by sitting on the floor and lifting your feet in the air and putting them together. Once you and your partner are free you continue with the game.

Bicycle Tag

Equipment: none

Participants: 6 Minimum

Instructions: Designate 1 person to be "it" for every 6 players. This is a regular tag game, except when you are tagged you lie down on the floor and move your legs like you are riding a bicycle. You continue this until you are tagged by someone who is not it, then you can return to the game.

Help Tag

Equipment: balls, bean bags, or something that can be thrown with out causing injury

Participants: Minimum of 6

Instructions: Designate one person in the group to be "it". Give two to three other people objects such as a ball or bean bag. Everyone is moving around the playing space. When the game begins the "it" player tries to tag the other participants but if the participant is holding one of the objects they cannot be tagged. The objects can also be passed to those who are being pursued by the "it" player. The participants are allowed to ask for "HELP!" if they think they are going to get tagged at which point any participant with an object can pass it to them. If you get tagged you stand frozen in one spot. The game goes until only those with objects are left unfrozen.

Blob Tag

Equipment: None required

Participants: 10 Minimum

Instructions: Two participants start out as "the blob" linking their arms to stay together and run around trying to tag other participants. When you get tagged by "the blob", you become a part of "the blob". Once the blob gets big enough (4-5 participants) they are encouraged to break off into smaller blobs of 2 and 3. The game ends once everyone has become a part of a blob.

Band-aid Tag

Equipment: None

Participants: Minimum of 6

Instructions: Designate 1-3 taggers in the group and have everyone else run around. When a participant is tagged by one of the taggers they have to put their hand where they were tagged. Participants continue to run around. If a participant gets tagged again they have to put their other hand on the spot they were tagged. Participants continue to run around. The third time a participant gets tagged they become frozen. In order to be freed someone has to crawl through their legs.

Example: 1st tag is on your head. Put your hand on your head and keep running around. 2nd tag is on your shoulder. Keep one hand on your head and put the other hand on your shoulder. 3rd you are frozen and wait for someone to crawl through your legs to free you.

Clothespin Tag

Equipment: Clothespins

Participants: Minimum of 6

Instructions: All participants are given two clothespins and instructed to attach them to the bottom of their shirt (preferably of the sides). Everyone begins by dispersing around the playing area. When the instruction for the game to begin is indicated everyone tries to get everyone else's clothespins. When you get someone else's clothespin you attach it onto your shirt so others can take it as well. The game continues on and at the end of the game each player can count their clothespins.

Wizard Tag

Equipment: No equipment required

Participants: 6 Minimum

Instructions: Designate one or two members of the group to be "the wizards". Everyone else in the group begins to run around the designated area much like normal tag. When a "wizard" player tags you in the game you must freeze on the spot and crouch to the ground yelling "I'm an elf! I'm an elf! I'm an elf!" repeatedly until two other players come along and free you from being an elf by crouching down around the tagged "elf" and linking hands to make a circle around them. The "elf" is now free and becomes human again. The game runs until the "wizards" have turned all of the humans into "elves".

<u>Toilet Tag</u>

Equipment: No equipment required

Participants: Unlimited

Instructions: Designate one or two members of the group to be "it". Everyone else in the group begins to run around the designated area much like in a normal game of tag. When an "it" player tags you in the game you must bend down to the ground and form a toilet bowl by placing your arms out in the shape of a circle. In order to be untagged another participant who is not it has to come "flush" the toilet (this is done by lightly tapping the ear). The player who has been "flushed" must rise up from the ground spinning and making a flushing noise (such as "pppssshhhhhh!"). They can then return to the game by continuing to run around the playing area and can "flush" anyone of the tagged players. Rotate the "it" players and play the game for as long as the facilitator feels is appropriate or until the "it" players have tagged all of the participants before they could flush each other.

<u>Link Tag</u>

Equipment: No equipment required

Participants: 8 Minimum

Instructions: Pair off all the remaining participants and have each pair disperse themselves around the playing surface. Once this occurs, get all of the pairs to link arms with their partner. Choose one of the pairs to unlink and have one of them be the chaser and the other be the participant getting chased. The game begins with this pair of participants dodging the linked participants while one chases the other. In order to end the chase, the player that is being chased has to link on to one of the pairs that are dispersed on the playing area. However, there can only ever be two players linked at a time, therefore the player that links on to a new pair forces the player on the other end of the link to release and become the person getting chased. If the person getting chased cannot make it to another link before the chaser tags them, then they become the chaser. The game can go for however long the facilitator feels it is appropriate.

Gold Rush

Equipment: bean bags, small balls, or some other small objects to be used as "gold"

Participants: 12 Minimum

Instructions: Divide the group into two teams. Each team has their own half of the play area and a designated spot at the back of their side where the "gold" is stored (this can be marked out with cones, lines on the floor, a hula-hoop, etc.). When the game begins, players from each team try to steal gold from the opposite team and bring it back to their side. You are safe on your side of the area, but when you cross over half the other team can tag you. However, you are not allowed to guard the pile of gold. If you are tagged, you have to put give the gold back and then return to your side. Work together with your teammates to create distractions so you and/or your teammates can get to the pile of gold and toss the gold between each other to move it across the floor quicker.

APPENDIX G

Games Programming

The table below outlines the criteria used to program guided active play sessions.

KIN Kids Daily Physical Activity Lesson Plan

<table>
<tr><th colspan="3">KIN Kids Physical Activity Program Plan – YYC Summer Camp</th></tr>
<tr><td>Date:</td><td>Total Time:
9:00 – 10:15am</td><td>Facility:
Outdoor Fields □ Indoor Gymnasium □</td></tr>
<tr><td colspan="3">Equipment Needed:</td></tr>
<tr><td colspan="3">Safety:</td></tr>
<tr><td>Activity</td><td>Time:</td><td>Physical Activity Level</td></tr>
<tr><td>Warm – up:</td><td>5 – 10 mins</td><td>Low-Moderate □ Moderate-Vigorous □</td></tr>
<tr><td>Activity #1:</td><td></td><td>Low-Moderate □ Moderate-Vigorous □</td></tr>
<tr><td>Activity #2:</td><td></td><td>Low-Moderate □ Moderate-Vigorous □</td></tr>
<tr><td>Activity #3:</td><td></td><td>Low-Moderate □ Moderate-Vigorous □</td></tr>
<tr><td>Activity #4:</td><td></td><td>Low-Moderate □ Moderate-Vigorous □</td></tr>
<tr><td>Activity #5:</td><td></td><td>Low-Moderate □ Moderate-Vigorous □</td></tr>
<tr><td>Activity #6:</td><td></td><td>Low-Moderate □ Moderate-Vigorous □</td></tr>
<tr><td>Cool-down:</td><td></td><td>Low-Moderate □ Moderate-Vigorous □</td></tr>
<tr><td colspan="3">Variations:</td></tr>
<tr><td colspan="2">Notes for KIN Kids Head Leaders and Consultants:
□
□
□</td><td>Planning Notes and Reflection:
□
□
□</td></tr>
</table>

Example of games programming

The table below outlines the order of games that were played each day for two randomly selected weeks during the guided active play program.

	Week 2					Week 3				
Games	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul
Name game	1					1				
Yoga										
Fishes and whales	4	4	4		4				4	
Rock, paper, scissors							2			
Shipwreck							4		4	
Archers tag								4		4
Crash		4	4		4		4			
Mr Wolf	2	2				2				2
Blob tag	5	5								
Cat and mouse			5			5		5		
Clothespin Tag										
Soccer baseball				2	2				2	
Bean Bag race			4	4				4		
Crocodile crocodile		2	2							
Switch (coloured eggs)	2							2		
Flip the fish				2		2	2		2	
Red ball relay				4	4		4			
Dr. Dodgeball										
Zombie tag									4	4
Kitty corner					2					
Bicycle tag										
Line Tag				5		5		5		5
Wizard Tag										6
Total MET	14	17	19	17	16	15	16	20	16	21
Ave MET	2.8	3.4	3.8	3.4	3.2	3	3.2	4	3.2	4.2

Example of recorded daily observations

Recorded observations of the childrens activities during a full day at the community centre camp on a randomly selected day. The children wore accelerometers and their activities were recorded. The guided active play program occurred for one hour of their day which was also recorded.

Wednesday July 02, 2014 (full day)

9:18 am- kids began to play Lego/board game/colouring

9:46 am- clean up time (put away the Lego, board game and crayons)

9:49 am-finished cleaning and sat on the carpet /kids introduced themselves to their peers

9:55 am-kids finish introducing themselves to their peers and then wash their hands

10:01 am- finish washing their hands

10:02 am- snack time

10:10 am-end snack time

10:10 am-line up to go to the gym

10:15am-walk to the gym

10:20am-start Guided Active Play with stretches

10:24 am-stop stretching

10:24 am- instruction for new game “arch tag”

10:25 am –start arch tag

10:32 am-end arch tag game

10:32am-sat down in the middle /instructions for new game “clothespin tag”

10:36 am-start clothespin tag game

10:37 am-Asal stop the game because the kids were misbehaving

10:38 am-restart clothes pin tag game

10:44 am-end clothes pin tag game

10:46 am-water break

10:49 am- return from water break/instruction for new game “firefighter”

10:50 am- started the game

10:54 am-end the game

10:54am –instructions for octopus game

10:56 am-start octopus game

11:02 am-pick new octopus

11:03 am-continue to play octopus

11:08 am –end octopus game

11:08 am– instructions for “name game”

11:09 am-start name game

11:16am-end name game

11:16am –instruction for “crocodile” game

11:19 am –start crocodile game

11:23 am-end crocodile game

11:23 am –instructions for “flip the fish” game

11:29 am– start flip the fish game

11:35 am – finished Guided Active Play program

11:35 am-water break

11:39am- return back to classroom

11:40 am- sat on the carpet and played name game

11:58 am –end name game and then wash their hands

12:03 pm-lunch time

12:24 pm –end lunch time

12:24 pm- start to play with board game/Lego /colouring

12:57 pm –clean up time to put away the board game/Lego/crayons

1:00 pm-finished putting away toys /sat on the carpet

1:04 pm-walk to a different classroom and sat to listened to the camp rules

1:16 pm-finished explain the camp rules and walk to the park

1:32 pm-played at the park (played with soccer ball or hula hoop)

1:58 pm –finished playing at the park and return to class

2:03 pm- wash hands

2:11 pm-everyone finish washing their hands

2:13 pm-snack time

2:25 pm-end snack time/clean up/wait for instruction for next activity

2:34 pm art and craft time

3:02 pm end art and craft time /clean up

3:02 pm –sat on carpet and listened to new instruction for next activity "throwing ball game"

3:16 pm-end game "throwing ball game"

3:16 pm –started to play 5 up (similar game as seven up)

3:30 pm-end 5 up game/took off acc from kids