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The Measurement of Physical Activity and Self-Efficacy in Adolescents: Prospects, Problems, and Future Directions

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A thesis submitted in partial fulfillment of the requirements for the degree in Doctor of Philosophy

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THE MEASUREMENT OF PHYSICAL ACTIVITY AND SELF-EFFICACY IN ADOLESCENTS: PROSPECTS, PROBLEMS AND FUTURE DIRECTIONS

(Spine title: Measuring Physical Activity and Self-Efficacy in Adolescents)

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by

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Graduate Program in Kinesiology

A thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy

The School of Graduate and Postdoctoral Studies
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London, Ontario, Canada

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The thesis by

Nerissa Campbell

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Date ____________________________  ____________________________ Chair of the Examination Board

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Abstract

The objective of this dissertation was to address salient conceptual and measurement issues related to physical activity and self-efficacy in adolescents. Building upon previous physical activity device validation studies, Study 1 investigated the measurement of agreement between the Actiheart (a combined heart rate monitor and accelerometer device) and doubly labeled water (DLW) for estimating free-living physical activity energy expenditure (PAEE) in a sample of adolescents. The Actiheart was found to overestimate PAEE compared to DLW by a mean difference of 9.80 kcal·kg\(^{-1}\)·d\(^{-1}\) (95% limits of agreement: -21.22 to 1.72 kcal·kg\(^{-1}\)·d\(^{-1}\)). The Actiheart was found, however, to improve device wear time compliance in adolescents (i.e., the number of days valid measures of PAEE were obtained), an issue that has been raised previously with respect to using objective physical activity tools in this population.

In an attempt to improve the level of specificity of current physical activity efficacy measures, Study 2, focused on developing a conceptually based and psychometrically sound domain-specific physical activity efficacy questionnaire (The Self-Efficacy for Daily Physical Activity Questionnaire; SEPAQ). Results supported the tenability of two independent models. Model 1 consisted of five independent domain-specific factors of physical activity efficacy (leisure-time, household, transportation, school, and ambulatory transportation and school) while Model 2 included two additional domain-specific physical activity efficacy factors (occupation and active gaming).
Finally, the application of the SEPAQ was tested in a physical activity prediction study (Study 3). Model 1 explained 20% and 9% of the subjective (Physical Activity Questionnaire—Adolescents) and objective (Actiheart derived PAEE) physical activity variance, respectively. The addition of the domain-specific physical activity efficacy measures, occupation and active gaming in Model 2, increased the amount of variance explained in subjective and objective physical activity to 27% and 24%, respectively. Implications and directions for future research are discussed.

Keywords: Validation, factor analysis, prediction, physical activity energy expenditure, doubly labeled water, physical activity efficacy, domain-specific physical activity efficacy.
Co-Authorship

The information presented in this doctoral dissertation is my (Campbell’s) own original work. However, I would like to acknowledge the important contributions of my supervisor, Dr. Harry Prapvessis, and an esteemed colleague Dr. Ralph Maddison. The mentorship, assistance, and insight they provided were invaluable to the completion of all three dissertation studies.
Dedication

To my husband, for being supportive and understanding every step of the way; despite only taking me to my favourite pancake house once during my pregnancy.
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The completion of this dissertation would not have been possible without the motivation, support, and direction from an amazing group of individuals. First and foremost, I would like to recognize my supervisor Dr. Harry Prapavessis for his continued mentorship and patience over the past five years. I would especially like to thank him for sharing in his passion for New Zealand and highlighting the importance of international collaboration. It is because of this I have visited some most amazing places throughout the course of my PhD and created some wonderful friendships with fellow researchers both near and far. Furthermore, I would like to thank Dr. Ralph Madison and Dr. Craig Hall. They too have provided me with invaluable mentorship over the years, and have been exceptional travel companions on numerous occasions.

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In addition, I would like to thank my family, especially my mom and dad. The continued support and renewed confidence you have given me over the years has undoubtedly made the completion of this PhD possible.

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Chapter 1 – General Introduction

“Globesity” is a term that has been coined by the World Health Organization in 2001 to reflect the looming public health crisis created by the alarming rise in obesity levels across the globe. In Canada, the rate of obesity mirrors the world wide trend where the number of overweight and obese individuals has been on a steady incline, particularly with respect to youth populations (Public Health Agency of Canada, 2009; Shields, Connor Gorber, & Tremblay, 2008). Coincidentally there are increased incidence rates for numerous physical (e.g., metabolic syndrome, cardiovascular disease, Type II Diabetes) and psychological (e.g., anxiety and depression) health risks associated with being obese, highlighting the need to identify effective strategies to combat obesity.

During adolescence increased physical activity has been linked to preventing or delaying the early onset of several co-morbidities of obesity, including, but not limited to metabolic syndrome, cardiovascular disease, Type II Diabetes, and depression (Baranowski et al., 1992; Froberg & Anderson, 2005; Goran, Ball, & Cruz, 2003; Piko & Keresztes, 2006). However, a significant decrease in physical activity levels is found to occur during adolescence (Dumith, Gigante, Domingues, & Kohl, 2011). The promotion of physical activity during this time period is particularly important given the health benefits formerly mentioned, in addition to the positive association between adolescent and adult physical activity levels and the relationship between poor physical fitness in adolescence and poor health outcomes in adulthood (Hallal, Victora, Azevedo, & Wells, 2006).
In order to develop effective strategies for promoting physical activity, and thus targeting these significant public health outcomes, it is important that researchers have a full understanding of the determinants of being physically active (Baranowski, Anderson, & Carmack, 1998). A previous literature review has identified self-efficacy, a central component within Bandura’s Social Cognitive Theory (Bandura, 1986; 1995), as an important personal determinant of adolescent physical activity behaviour (Van der Horst, Paw, Twosk, & Van Mechelen, 2007). However, conceptual and measurement limitations with respect to both self-efficacy and physical activity have hampered advancements to better understanding this relationship (i.e., how much physical activity variance self-efficacy explains). In the section to follow, current measurement issues and concerns with respect to free-living physical activity and self-efficacious beliefs in adolescents will be discussed and critiqued; establishing the rationale behind the overall aims of this dissertation.

Measurement of Physical Activity

The need for accurate measures of physical activity is well documented in the health literature (Lamonte & Ainsworth, 2001). Improved precision in the measurement of physical activity has several implications to health research, including: a more accurate evaluation of intervention effectiveness, the ability to make cross-cultural comparisons, and improved monitoring of temporal trends of activity behaviour (Wareham & Rennie, 1998). Physical activity is complex in nature with the main dimensions being: intensity, frequency, and duration. Taken together the aforementioned dimensions comprise total volume of activity. Mode or type of activity and the context in which activity occurs are other important dimensions of physical activity that can have relevance depending on the
questions asked. While there is no standardized unit of measurement used to quantify physical activity, with respect to daily volume of physical activity, the amount of energy expended from physical activity (physical activity energy expenditure; PAEE) is a common output measure.

Physical activity assessment tools can be categorized as subjective and objective. Comprehensive reviews have outlined the validity and interpretation of data collected from various tools from each of these categories used to assess physical activity in youth, in addition to the strengths and weaknesses associated with each (Corder et al., 2008; Kohl, Fulton, & Caspersen, 2000; Trost, 2007). Thus, only a brief summary regarding the advantages and weaknesses of the most highly utilized tools in youth free-living physical activity research will be provided.

*Subjective methods of measurement.* There are a variety of subjective tools for assessing habitual activity (diaries, proxy reports, etc.), with interview- and self-administered recall questionnaires being most popular in youth research (Corder et al., 2008). Ease of administration, low cost, and reduced participant burden makes questionnaires a practical option. In addition to their practicality, questionnaires provide the only means available for collecting information about activity mode and the context in which activity is performed. Unfortunately, questionnaires are subject to recall bias. In addition, the inability of youth to accurately recall relevant physical activity details retrospectively leads to overestimations of physical activity behaviour (Both, Okely, Chey, & Bauman, 2002). Furthermore, there are issues related to the absence of an internationally accepted questionnaire for youth samples. A lack of standardization in questionnaires used and the nature of physical activity assessed by a given questionnaire
differs across studies, which has made it difficult to draw comparisons among research findings.

With respect to energy expenditure, there has been poor predictive validity of self-report questionnaires for the estimation of PAEE in youth samples (Arvidsson, Slinde, & Hulthen, 2005; Corder et al., 2009; Slinde, Arvidsson, & Rossander-Hulthen, 2003). Without a comprehensive list of reference values (Ainsworth et al., 2000; Ridley, Ainsworth, & Olds 2008) to assign standard energy costs to self-reported physical activity in youth, the continued reliance on adult-derived estimates limits the utility of questionnaires for estimating PAEE. Overall, when questionnaires are used to assess physical activity in youth populations it is highly recommended that these measures be accompanied by a more objective based measure (Janz, 2006).

*Objective methods of measurement.* A variety of objective measurement techniques rely on physiological or biomechanical parameters to assess habitual physical activity. To date, doubly labeled water (DLW) remains the gold standard for measuring the total amount of energy expended from free-living physical activity. The use of DLW for measuring free-living energy expenditure involves individuals ingesting a weighted liquid dose with known concentrations of the stable isotopes deuterium (\(^2\)H) and oxygen-18 (\(^{18}\)O). By tracking the elimination rate of \(^2\)H and \(^{18}\)O, individual levels of daily energy expenditure can be calculated. However, the large costs associated with the purchase and analysis of the \(^2\)H and \(^{18}\)O isotopes and the inability to assess frequency, intensity, and duration of physical activity behaviour using this method has rendered DLW most appropriate for use in PAEE validation studies.
Over the past two decades, there has been increased reliance on heart rate (HR) monitoring and motion sensing devices for assessing physical activity in youth. The linear relationship that exists between HR and EE during steady state activity makes this an attractive measurement tool. In terms of PAEE, group based measures of PAEE from HR monitoring are shown to be $\pm$ 10% of DLW derived values (Livingstone et al., 1992). Nevertheless, factors unrelated to being physically active (e.g., emotional stress, fatigue, heat, sickness; Melanson & Freedson, 1996; Montoye, Kemper, Saris, & Washburn, 1996) influence HR, in addition to the tendency of the HR response to lag behind changes in the cessation of movement (Rowlands, Eston, & Ingledew, 1997). This makes it difficult to differentiate the specific contribution of physical activity to HR.

Motion sensing devices consist primarily of pedometers and accelerometers. Pedometers measure vertical hip displacement during ambulatory movements and express activity in terms of steps taken. The inability of pedometers to gauge stride frequency and length, and total distance travelled brings mistrust of PAEE inferences made from pedometers. For these reasons, it is recommended that pedometers only be used to assess physical activity in term of the number of steps taken in a day (Corder et al., 2008). Accelerometers measure body acceleration in up to three planes of movement (vertically, horizontally, and/or transversely), and express physical activity in terms of “movement counts”, with a higher count being indicative of higher intensities of activity. Accelerometers are able to assess the frequency, intensity, and duration of physical activity over long durations of time. Not surprisingly, accelerometers are the most commonly used objective physical activity tools in youth populations (Trost, 2001). However, accelerometers are unable to account for the energy costs associated with
incline walking, load bearing activities (e.g., weight lifting), and activities involving movement of the arms and legs (e.g., rowing and cycling), which leads to underestimations of physical activity. Furthermore, when researchers have used accelerometry data in combination with regression equations for predicting PAEE, under- and overestimations of PAEE are evident (Corder et al., 2007; Trost, Way, & Okely, 2006).

More recently (over the last decade or so), in an effort to improve the precision of PAEE estimates, researchers have combined HR monitoring and accelerometry (Strath, Basset, Thompson, & Swartz, 2002). Instantaneous PAEE can be estimated from the HR and accelerometry data using separate HR and accelerometry prediction equations, combined by branched equation modeling which gives different weighting to HR and acceleration dependent on the level of HR and movement recorded (Brage et al., 2004). Branched modeling has been found to reduce the error in EE estimates for adults (Brage et al., 2004) and children in controlled settings (Corder et al., 2007).

The development of a single device that simultaneously collects minute-by-minute HR and accelerometry data (the Actiheart), has made this type of combined sensing applicable in free-living physical activity research. Previous validation of the Actiheart device for estimating PAEE has been established for treadmill walking and running in adults (Brage, Brage, Franks, Ekelund, & Wareham, 2005; Brage et al., 2006) and children (Corder, Brage, Wareham, & Ekelund, 2005), and for a range of sedentary-to-vigorous intensity laboratory based activities in young adults (Crouter, Churilla, & Bassett, 2007; Thompson, Batterham, Bock, Robson, & Stokes, 2006). However, limited validity exists for estimating PAEE during free-living physical activity. Only two
validation studies have been completed (Assah et al., 2011; Pomeroy, 2009) in selective adult samples (sub-Saharan African and American Indians), respectively, where validation for the Actiheart device in providing accurate measures of free-living PAEE has been equivocal. While, the Actiheart demonstrates potential for improving the precision in which free-living PAEE is assessed, before the device can be used in physical activity research studies, further validation is required particularly with respect to youth populations.

Measurement of Theoretical Determinants of Physical Activity

As highlighted earlier, self-efficacy, a central component within Bandura’s Social Cognitive Theory has been identified as an important personal determinant of physical activity behaviour in adolescents (Van der Horst et al., 2007). However, in Van der Horst’s (2007) review a number of different types or components of self-efficacy were examined (e.g., barriers efficacy, asking efficacy, environmental change efficacy, physical activity efficacy). The plethora of self-efficacy measures suggests that there is little to no consensus among researchers as to what self-efficacy constructs are important in physical activity research. This is turn makes advancements for better understanding this relationship difficult. Self-efficacy constructs generally represent one of two broad categories, a task component and/or a regulatory component (Maddux, 1995; McAuley & Mihalko, 1998). Regulatory efficacy refers to beliefs an individual has about his or her ability to manage difficulties inherent in performing physical activity, where as task efficacy refers to beliefs an individual has about his or her ability to perform a specified behaviour. The current dissertation focuses on the task component, which has received relatively little attention as an independent determinant for physical activity in
adolescents (Roberts, Maddison, Magnusson, & Prapavessis, 2010; Ryan & Dzewaltowski 2002). This is in contrast with regulatory efficacy which has received the most research attention (Deforche, Van Dyck, Verloigne, & De Bourdeaudhuij, 2010; Dishman, Dunn, Sallis, Vandenberg, & Prattt, 2010; Dishman, Saunders, Motl, Dowda, & Pate, 2009; Strauss, Rodzilsky, Burack, & Colin, 2001; Wu, Pender, & Noureddine, 2003). The lack of research on task efficacy is surprising given the theoretical importance of this construct in Bandura’s theory.  

By definition, task efficacy suggests that an individual can feel more or less efficacious in different situations and/or for particular tasks (Bandura, 2006). Ideally, to accurately assess the level of specificity associated with task efficacy, scale items should be tailored to each of the performance behaviour tasks being measured. Given that it would be next to impossible to tailor a task efficacy scale with respect to free-living physical activity behaviour, researchers have taken a more generalized approach and have assessed a non-specific task related efficacy construct, called physical activity efficacy. For example, Ryan and Dzewaltowski (2002) asked adolescents how confident they were that they could perform vigorous exercise for 20 minutes or more on three or more days of the week. Furthermore, Roberts and colleagues (2010) asked New Zealand adolescents how confident they were in performing regular physical activity at increasing intensity levels (light, moderate, and vigorous) and for increasing duration (10, 30 and 60 minutes). Overall, in adolescents, physical activity efficacy has been found to be associated with subjective measures of vigorous intensity physical activity (Ryan &

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1 Neither a detailed description of Bandura’s Social Cognitive Theory, nor an explanation of the target strategies used to enhance individual’s self-efficacy have been provided. The author does not discern the importance of this information. However, discussing self-efficacy using this level of detail is not in line with the current rationale being provided for the nature of the research being presented.
Dzewaltowski, 2002), in addition to being a significant predictor of pedometer derived step count (Roberts et al., 2010). No research has investigated the predictive validity of physical activity efficacy for more sophisticated objective based measures of physical activity (e.g., accelerometer and/or HR derived measures). However, researchers have implied that before a full understanding of physical activity efficacy’s role in predicting activity can be achieved, more attention needs to be given to how physical activity efficacy is assessed (Ryan & Dzewaltowski, 2002).

To date, the current scales used to assess physical activity efficacy are hampered by a number of problems, including: (a) the inappropriate labelling of task efficacy (i.e., referring to a construct as task efficacy when it is really physically activity efficacy) and (b) using a general single item approach to measure physical activity efficacy instead of taking into account the level and strength of efficacious beliefs as well as the specific context from which beliefs come from (i.e., school, leisure, etc.). By addressing some of these conceptual and measurement issues, improvements to the measurement of physical activity efficacy and the amount of response variance in measures of free-living physical activity captured is possible; thus, strengthening the case for physical activity efficacy in adolescent interventions promoting physical activity.
Dissertation Objectives

This dissertation attempted to address salient conceptual and measurement issues related to physical activity and self-efficacious belief in adolescents. Building upon the previous Actiheart validation studies, Study 1 examined whether the Actiheart provided a valid estimate of free-living PAEE in adolescents. In an attempt to improve the level of specificity of current physical activity efficacy scales, Study 2 focused on the construct validation of a domain-specific physical activity efficacy questionnaire (the Self-Efficacy for Daily Physical Activity Questionnaire: SEPAQ). Finally, the application of the SEPAQ was tested in a physical activity prediction study (Study 3).

The specific aims of this series of dissertation studies were threefold:

1) To determine whether the Actiheart device can provide accurate estimates of free-living PAEE in adolescents, using DLW as the criterion standard (Study 1).

2) To develop a conceptually based and psychometrically sound domain-specific (i.e., at school, at work, at home, during leisure time, and for transportation) physical activity efficacy questionnaire (SEPAQ; Study 2).

3) To determine the predictive validity of domain-specific physical activity efficacy for both objective (Actiheart derived PAEE) and subjective (Physical Activity Questionnaire for Adolescents; Crocker, Bailley, Faulkner, Kowalski, & McGrath, 1997) measures of adolescent free-living physical activity (Study 3).
Please note that this series of dissertation studies is presented in an integrated-article format. Although, Chapters 2, 3, and 4, represent distinct research studies, there is direct relevance and linkage between the studies. As such, some repetition with respect to the background and rationale should be expected, particularly concerning Chapters 3 and 4.
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Chapter 2

The Actiheart in Adolescents: A Doubly Labelled Water Validation (Study 1)

Physical activity is an important risk reducer for a variety of non-communicable diseases (e.g., type II diabetes and cardiovascular disease) and for enhancing psychological health (Piko & Keresztes, 2006; Shaibi, Faulkner, Weigensberg, & Fritschi, 2008). Precise measurement of physical activity and energy expenditure (EE) is a pre-requisite for the internal validity of health research and for establishing the efficacy of interventions targeting physical activity change (Rennie & Wareham, 1998). Increased use of objective measures (i.e., accelerometers and heart rate monitors) overcomes the limitations associated with self-report methods (Corder, Ekelund, Steele, Wareham, & Brage, 2008), and minimizes some of the challenges (recall bias and use of reference values for assigning energy costs) associated with assessing physical activity levels and energy costs in the free-living environment.

Combined monitoring, namely accelerometry (ACC) with heart rate (HR) monitoring, has improved estimations of physical activity related energy expenditure (PAEE) compared to either method independently (Corder et al., 2007; Strath, Basset, Thompson, & Swartz, 2002). The construction and commercial availability of a single device that simultaneously collects real time ACC and HR data, the Actiheart (CanNtech Ltd, Cambridge, United Kingdom [UK]; or MiniMitter, Bend OR, United States [US]) has further reduced the complexity and participant burden associated with combined sensing and improves the overall practicality of this method. At the time of this study there were two versions of the Actiheart commercially available: a UK model (CamNtech, Cambridge, UK) and a US model (MiniMitter, Respironics, OR, USA). The
two versions of the device were identical in terms of ACC and HR hardware and utilized the same prediction equations included in the Actiheart user manual (UK version). The only data collection and analysis differences between the devices were the inability of the US model to collect information on inter-beat interval and perform individual calibration. However these data and analysis options are not required for the estimation of PAEE from ACC and HR data. The US Actiheart model is no longer commercially available. At present, a new version of the Actiheart (Actiheart 4; CamNtech, Cambridge, UK) is manufactured and distributed worldwide. Nevertheless, the US device still continues to be used in research. By accounting and adjusting for differences between the US model and newest version of the UK device, findings are expected to be comparable (Spierer, Hagins, Rundle, & Pappas, 2011). Previous validation studies conducted for the earlier UK Actiheart (CamNtech, Cambridge, UK) have shown the device to provide reasonable estimates of PAEE during treadmill walking and running in adults (Brage, Brage, Franks, Ekelund, & Wareham, 2005; Brage et al., 2006) and children (Corder, Brage, Wareham, & Ekelund, 2005) and for a range of low-to-moderate intensity laboratory based activities in 25 year old adults (Thompson, Batterham, Bock, Robson, & Stokes, 2006). One study, conducted in a sample of sub-Saharan African adults has also demonstrated the Actiheart to provide valid group level estimates of free-living PAEE compared to the doubly labelled water (DLW) method (Assah et al., 2011).

Fewer validation studies have been conducted using the US Actiheart model, each involving adult samples. These studies have also shown the device to provide reasonable estimates of EE for treadmill walking and jogging (Barreira, Kang, Caputo, Farley, & Renfrow, 2009), and for a broad range of sedentary to vigorous physical activities
performed in lab- and field-based environments (Crouter, Churilla, & Bassett, 2007). Improvements in EE estimates, over and above hip worn accelerometers, have also been found with the Actiheart for activities where acceleration of the pelvis is not closely related to EE, (e.g., lifting weights, playing cards, and sweeping; Spierer et al., 2011). There has been one study that investigated the device’s ability for estimating free-living PAEE in adult American Indians (Pomeroy, 2009). However, the Actiheart was not found to provide valid estimates of PAEE given the overestimation of PAEE compared with DLW-derived PAEE.

In summary, there is a dearth of validation evidence for the Actiheart in non-adult populations. Moreover, few studies have examined the validity of the Actiheart in free-living environments, and these findings are equivocal. The purpose of this study was to extend the research by validating the Actiheart device in a sample of Canadian adolescents using DLW as the criterion standard. Adolescence is a critical time for the promotion of physical activity, given the large decreases in physical activity and daily levels of energy expenditure that are found to occur (Dumith, Gigante, Domingues, & Kohl, 2011). As mentioned, the Actiheart device has the potential for improving the assessment of free-living physical activity. However, before it can be used as a measurement tool in adolescent physical activity surveillance and intervention research its validity should be established.
Methods

Subjects. Eighteen students (10 females) with a mean age of 17.50 (SD = 0.62) years, were recruited from two secondary institutions and one post-secondary institution in London, Ontario (ON), Canada. The principal investigator made contact with interested students through a designated teacher at each institution. A verbal explanation by the primary investigator of the study of the purpose, procedures, and protocol of the study was accompanied by written documentation to all students prior to study participation. Students were excluded if they were younger than 15 or older than 18 years of age and if they had any contraindications to being physically active. Each participant completed written informed assent. In addition, parental consent was obtained for individuals under the age of eighteen. Laboratory based procedures were conducted in the Exercise and Health Psychology Laboratory at The University of Western Ontario, London, ON, Canada. All study procedures and protocols were approved by the manager of research and assessment services of the Thames Valley District School Board, in addition to the University of Western Ontario research ethics board (#15002E).

Anthropometric measures and Body Composition. Individual measures of height and weight were recorded to the nearest 0.5 cm and 0.1 kg, respectively, using a combination height and weight scale (Health-O-Meter® 500KL, Boca Raton, FL, USA). Percent body fat and percent lean fat-free mass were calculated using a dual energy x-ray absorptiometry scanner (iDEXA; Prodigy, GE/Lunar Co., enCORE 2007 software version 11.40.004, Waukesha, WI). Participants were scanned while lying on their backs. For each measure, participants wore light clothing.
**Basal metabolic rate.** Due to practical limitations (time and costs) basal metabolic rate [≈ resting energy expenditure (REE)] was predicted using standardized equations. This approach has been used previously by other researchers (Ekelund, Yngve, Brage, Westerterp, & Sjostrom, 2004). We used a set of standardized equations developed by Molnar et al. (1995; see Table 1), which have been validated by indirect calorimetry in an adolescent population and shown to underestimate REE values by an average of 3% (Slinde, Arvidsson, Sjoberg, & Rossander-Hulthen, 2003). Each REE value was converted from kilojoules and expressed as kilocalories by dividing each value by 4.186.

**Table 1. Equations used to predict basal metabolic rate in kilojoules**

<table>
<thead>
<tr>
<th></th>
<th>Males: 50.9·BW (kg) + 25.3·ht (cm) – 50.3·A(yr) + 26.9</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Females: 51.2·BW (kg) + 24.5·ht (cm) – 207.5·A(yr) + 1629.8</td>
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</table>

*Note. BW = body weight; ht = body height; A = age*

_Free-living Total Energy Expenditure by DLW._ The DLW method was used as the criterion measure for free-living total energy expenditure (TEE). Total energy expenditure was measured over a consecutive nine day period, corresponding to the wear time of the Actiheart (Figure 1). Detailed information regarding dose, sampling protocol, sample analysis, and calculation procedure have been described previously (Westerterp,
Wouters, & van Marken Lichtenbelt, 1995). In brief, following dinner on day 0 as a last consumption before the night, participants ingested an accurately weighed (±0.001g) drink of deuterium and oxygen-18 enriched water corresponding to 0.05 g of deuterium oxide (\(2^2\text{H}_2\text{O}\)) and 1.10 g of oxygen-18-water (\(\text{H}_2^{18}\text{O}\)) per kilogram of body weight. The participant then consumed tap water that was used to rinse the dose container. A urine sample was collected at baseline prior to dosing, as well as at post-dose 4-hours following isotope ingestion. Additional urine samples were collected from the second and last voidings of days 1, 5, and 9 with a recording of the exact collection time (IDECG, 1990). Samples were analyzed for \(^2\text{H}\) and \(^{18}\text{O}\) in duplicate (±δ) by continuous-flow isotope ratio mass spectrometry using a Europa Scientific ANCA-GSL GEO 20-20 IRMS (Iso-Analytical Limited, Crewe, Cheshire, U.K.).

TEE from DLW (TEE\(_{DLW}\)) was calculated by the multi-point method using linear regression from the difference between elimination constants of \(^2\text{H}\) and \(^{18}\text{O}\), based on Scholler’s estimation of carbon dioxide production (Schoeller & van Santen, 1982), which normalizes \(^2\text{H}/^{18}\text{O}\) space ratios to 1.04/1.01 = 1.03 (26, 27). TEE was observed from carbon dioxide production, assuming carbohydrate, fat and protein substrate oxidation with a respiratory quotient of 0.85 (Schoeller et al., 1986).

PAEE was calculated as 0.9 X TEE minus REE, assuming a 10% of TEE component for the thermic effect of feeding (Bassett, 2000).
Figure 1. A schematic representation of the experimental protocol. The protocol consisted of a 9-day period during which the adolescents followed their normal living. Physical activity energy expenditure was measured simultaneously by the DLW method and Actiheart device. Body weight was examined prior to DLW dosage.

<table>
<thead>
<tr>
<th>Day</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
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<tr>
<td>Body weight</td>
<td>↑</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Administration $^3$H$_2$O</td>
<td>↑</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urine collection</td>
<td>↑↑</td>
<td>↑↑</td>
<td></td>
<td>↑↑</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>Actiheart</td>
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</table>

Free-living PAEE by Actiheart. Free-living PAEE was measured using the Actiheart (MiniMitter, Respironics, OR, USA), a relatively small (approximately 188 mm in length) and lightweight (10 g) combined uni-axial ACC and HR monitor device (cf., Brage et al., 2004) that consists of two sensors connected via a short lead. The two sensors attach to the chest by clipping onto two adhesive electrodes (3M Red Dot 2560, London, ON, Canada). In line with the manufacture’s positioning instructions, the main sensor was positioned near the center of the sternum at the level of the third intercostal space, while the second sensor was placed adjacently along the mid-clavicular line approximately the length of the lead wire in distance. The Actiheart was set to record minute-by-minute HR (35 BPM to 255 BPM) and vertical acceleration (ACC; 32 Hz) over a continuous nine day period, concurrently with the DLW measurement. Participants were shown and given written instructions on how to prepare the skin,
replace the electrodes, and position the device. Participants were instructed to carry on
with their typical day-to-day routines and wear the monitor at all times, when awake or
asleep. The monitors were only to be taken off when showering, bathing or engaging in
water activities like swimming.

*Actiheart data processing and EE calculations.* Data from the Actiheart devices
were downloaded to a data base using Actiheart software (Actiheart™, software version
2.0). A sleeping HR value was calculated for each participant by the software. To do
this, the software algorithmically finds a 30-minute accumulation of time that contains
the lowest HR for each 24-hour period the device was worn and calculates an average
excluding the sleeping HR values from the first and second day of device wear time as
they may not contain an overnight period. As previously stated, the US Actiheart device
has been replaced with a newer model (Actiheart 4; CamNtech, Cambridge, UK). To
ensure findings from the Actiheart used in the present study would be valid for the
commercially available Actiheart, adjustments were made for differences in data
collection and PAEE analysis between the two models in accordance with measurement
procedures recently published concerning the US Actiheart model (Spierer et al., 2011).
Specifically, accelerometer data for each participant were re-calibrated and increased by
20%.

Raw HR was converted to heart rate above sleep (HRaS) by subtracting the
individual’s sleeping HR from the raw value. There is no function to clean and recover
or interpolate noisy and missing HR data using the Actiheart software. Accordingly, raw
HR data were cleaned using a software program developed by the current authors, in
which all zero HR values and HRaS values $< 5$ bpm and $\geq 175$ bpm an individual’s sleeping HR, respectively were identified as spurious and removed from the data set. In addition, data were scanned for non-wear time, defined as $\geq 10$ minutes of consecutive zero HR and zero ACC data (Brage et al., 2006). No imputation method was used to interpret the minute-by-minute and non-wear time data removed and thus they were excluded from analysis. Minute-by-minute HRaS and accelerometer data were converted to PAEE using the most recently published group calibration equations (Brage et al., 2007) and then combined using branched equation modeling (Brage et al., 2004) to calculate total daily PAEE\(^1\). The author contacted individuals at CamNTech in order to ensure the correct set of equations were used to calculate PAEE. The newest equations for estimating PAEE were developed from 26 women and 25 men [mean age = 25 (S.D. = 9.0) years] performing a ramped treadmill walk-run test. Both ACC and HR equations are utilized in the branched model with each extrapolated to go through the origin (RMR or SHR, or 0 count per minute, respectively). A different weighting (.90, .50 or .10) is given to the ACC and HR equations respectively to predict PAEE, with the proportions always adding to 1. The branching thresholds were derived \textit{a priori} using data from twelve young (22.7 – 30.0 years) male adults carrying out a treadmill test (Brage et al., 2004). A valid day was defined as 10 or more hours of registered monitor wear (Troiano et al., 2008), with a minimum of four valid week- and one valid weekend-day required

\(^1\) PAEE was also estimated using the children prediction equations and branched model. Results from these analyses are not reported; given the mean age of the current sample (17.5 years) was more representative of young adults opposed to children. Furthermore, PAEE was overestimated even more using the children’s equations [mean difference of 31.42 kcal·kg\(^{-1}\)·day\(^{-1}\) (95% limits of agreement: -45.70 to -17.15 kcal·kg\(^{-1}\)·day\(^{-1}\))] compared to the adult equations.
per participant in order to be included in the analysis (Troiano et al., 2008; Trost, Pate, Freedson, Sallis, & Taylor, 2000).

Statistical analyses. Analyses were carried out using PASW Statistics 18 (SPSS Inc., Chicago IL) and GraphPad Prism 5.0 (GraphPad Software Inc., San Diego CA) software programs.

Descriptive characteristics of the study participants and monitor data are presented as means and standard deviations. A linear regression analysis was used to examine the association between PAEE derived from the Actiheart and DLW method where DLW PAEE served as the dependent variable. Measurement of agreement between Actiheart PAEE estimations and PAEE measured using DLW was examined using Bland-Altman plots (Bland & Altman, 1986), where the difference between the two PAEE measures (DLW-Actiheart) are plotted against mean PAEE (DLW + Actiheart/2). The association between the PAEE differences and means for each of the methods was examined by calculating a Spearman correlation coefficient, detecting whether or not there was systematic bias between the two methods. Furthermore, a paired t-test was conducted to determine whether or not there was a statistical difference between the mean difference and the mean PAEE values derived using the DLW method and Actiheart devices.
Results

Descriptive characteristics and EE estimates of study participants are shown in Table 2. The mean (± SD) of registered monitor wear time was 1171 ± 150 minutes per day. All subjects had valid Aciheart data for ≥ 6 days [6 (n=1), 7 (n=1), 8 (n=2), and 9 (n=14) valid days].

Table 2. Participant characteristics (N = 18).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>17.50 (0.60)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>172.50 (8.00)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>65.00 (13.00)</td>
</tr>
<tr>
<td>Body Fat (%)</td>
<td>21.71 (6.00)</td>
</tr>
<tr>
<td>SleepingHR</td>
<td>51.00 (4.00)</td>
</tr>
<tr>
<td>Extracurricular sport involvement (# of sports)*</td>
<td>2.00 (1.00)</td>
</tr>
<tr>
<td>REE (kcal·day⁻¹)</td>
<td>1466 (332)</td>
</tr>
<tr>
<td>TEE_{DLW} (kcal·day⁻¹)</td>
<td>2954 (853)</td>
</tr>
<tr>
<td>PAEE_{DLW} (kcal·day⁻¹)</td>
<td>1193 (514)</td>
</tr>
<tr>
<td>PAEE_{Actiheart} (kcal·day⁻¹)</td>
<td>1819 (545)</td>
</tr>
</tbody>
</table>

Note. HR = heart rate; REE = Resting energy expenditure; TEE = total energy Expenditure; PAEE = physical activity energy expenditure. *There were over 20 extracurricular sports listed by participants (e.g., dance, football, figure skating, hockey, track and field, etc.)
The linear regression analysis showed there was a significant association between the DLW and Actiheart PAEE measures ($R = 0.53$, $R^2 = 0.29$, $P < 0.05$). The Bland-Altman plot assessing the measurement of agreement between DLW and Actiheart PAEE is shown in Figure 2. Overall, the Actiheart overestimated PAEE compared to measures obtained using the DLW method, by a mean difference of 9.80 kcal·kg$^{-1}$·d$^{-1}$ (95% limits of agreement: -21.22 to 1.72 kcal·kg$^{-1}$·d$^{-1}$). A paired t-test showed that this mean difference was statistically significant [$t (17) = -7.07$, $P < 0.00$]. A statistically non-significant correlation between the difference and the mean PAEE derived from the Acitheart and DLW ($r = 0.12$, $P = 0.65$) indicated there was no systematic bias between the two methods in estimating PAEE.

**Figure 2.** Differences between physical activity energy expenditure (PAEE) from the DLW method and Actiheart device plotted against the average PAEE of both methods in 18 adolescents. Dotted lines indicate mean and 95% limits of agreement.
Discussion

In the present study, the accuracy of the combined accelerometer and heart rate monitor, the Actiheart, for assessing free-living PAEE in adolescents against the DLW method was examined. Relatively poor agreement was found between mean PAEE from the two methods. While there was large inter-individual variability, PAEE was consistently overestimated by the Actiheart device with the exception of one individual. We were only able to find two publications that have focused on the accuracy of the Actiheart for estimating PAEE in the free-living environment with the majority of work investigating the devices ability to predict PAEE for specific types of structured activity. The present findings contradict previous work by Assah and colleagues (2011) who found the device to provide valid measures of free-living PAEE in Cameroon adults. However, our findings are in line with overestimations reported by Pomeroy (2009) who investigated the accuracy of the Actiheart for estimating free-living PAEE in a sample of American Indian adults.

To the best of the author’s knowledge this is the first time the accuracy of the device has been examined in adolescents. A lack of age appropriate group based prediction equations limits the validity of the Actiheart for assessing PAEE in adolescents. Developmental differences between children, adolescents, and adults, in terms of metabolic costs and movement economy (Morgan, 2000), impact the aerobic demand of activity for each age group. Knowingly, researchers try to avoid using equations that were not developed for their population of interest to estimate EE (Livingstone et al., 1992; Trost, 2001), however currently there are two equation models
for predicting PAEE using a combination of simultaneously collected activity and HR data; one for adults and one for children (Actiheart User Manual 4.0.35; 8). Given the mean age of our sample was more in line with young adults than children, we estimated and reported PAEE using the adult prediction model. Furthermore, this model provided a reduced overestimation of PAEE compared to the child model\(^1\).

While a lack of an age appropriate prediction model may explain some of the inaccuracies by the Actiheart in estimating PAEE, the fact that the equations used were developed from individuals performing a progressive walk-run treadmill test may also be a contributor to the overestimation of PAEE. The use of laboratory derived prediction equations for estimating PAEE in free living settings and for activities that differ from those used during the calibration study is problematic due to the relatively poor generalizability (Trost, Way, & Okely, 2006). Typically, the use of equations of laboratory run/walk activity result in the underestimation of free-living EE (Corder et al., 2007). However, overestimations of PAEE for over ground walking have been reported when researchers used accelerometer equations originally developed for predicting PAEE during treadmill walking (Yngve, Nilsson, Sjostrom, & Ekelund, 2003). The overestimation of PAEE stems from higher activity counts recorded during over ground compared to treadmill-walking. In the present study there was no assessment of the intensity, duration, or frequency of physical activities each individual performed. However, from the demographic information (see Table 2) the author was able to gather some insight regarding the type(s) of extracurricular sport participants were enrolled in (e.g., football, track and field, dance, volleyball, figure skating etc.). A variety of sporting activities were listed, with a large portion consisting of locomotive based
activity. Given the differences in activity counts that have been reported for over ground versus treadmill walking, increased participation in various forms of locomotive based activity may have contributed to the overestimation of PAEE.

Assah and colleagues (2011) found a slight reduction in the accuracy of the Actiheart for estimating free-living PAEE in rural versus urban Sub-African dwellers. The authors reported that a high prevalence of labour-intensive work involving activities such as digging, lifting, and load carrying in the rural dwellers, reduced the amount of inter-individual variance in PAEE captured by the Actiheart device, ultimately affecting the accuracy of the estimation for the higher active subsample. While the type of activities performed by a rural Sub-African dweller would be significantly different compared to the types of sporting activities engaged in by the current sample, a high prevalence of different types of extracurricular sport and physical activity participation for many individuals in our sample (see Table 2) may also have reduced the degree of inter-individual variability in PAEE. In establishing adolescent specific PAEE prediction equations, particular attention should be afforded to accounting for the variation in activity levels and range of physical activities typical of the day-to-day behavioural patterns exhibited by this population.

Monitor wear compliance has been a major issue for researchers when using objective tools to assess physical activity behaviour (i.e., having 10 hours or more of valid data in a day) (Going et al., 1999; Trost, 2007). Due to the variability in daily moderate-to-vigorous activity behaviour for adolescents, a minimum of eight monitoring days is recommended in order to obtain reliable measures (Trost et al., 2000). Poor
compliance among adolescents wearing an accelerometer has led to a reduction in the amount of valid data for each day (< 10 hours) and therefore the number of valid days physical activity is able to be measured (Troiano et al., 2008). Monitor wear compliance was not an issue in the current work, as we obtained eight or more valid days of physical activity measurements from 89% of the sample. Unlike accelerometers, the Actiheart device is to be worn 24-hours a day which reduces the likelihood of participants forgetting to wear the device.

As with many well designed research studies, a few limitations exist in the current investigation. First, the number of research participants is relatively small. Unfortunately, due to the high costs associated with purchasing and analyzing DLW, this number of participants is not uncharacteristic to other DLW studies (Plasqui & Westerterp, 2007). Second, predicted versus measured values of REE were used to calculate PAEE from DLW derived TEE. Although it would have been ideal to record actual measures of REE, it was not feasible to do so in this study. Nevertheless, the equations used to estimate REE have previously been shown to provide a valid measure of REE in adolescents (Slinde, Arvidsson, Sjoberg, & Rossander-Hulthen, 2003) and were appropriate for use in this study. Lastly, the Actiheart software that accompanies the US device does not come with the capabilities to post-process (e.g., identifying “noisy” HR data and device non-wear time, interpolate missing data) ACC and HR data. There are no standardized quality control procedures in place for identifying and managing noisy or spurious ACC and HR data or device non-wear time. The current approach taken to clean the ACC and HR data is based on a process previously used by researchers using the Actiheart device (Brage et al., 2006). The importance in confirming
biologically plausible ACC data and acceptable device compliance for assessing PA using accelerometers is well documented (Colley, Connor Gerber, & Tremblay, 2010). More attention needs to be given to the quality control and data reduction procedures using combined sensing devices (ACC and HR) given the implication it can have on the measures of PA produced.

The Actiheart is a device that shows great potential given its ability to simultaneously collect accelerometry and heart rate data in addition to increase monitor wear compliance in adolescents. Limited validity of the current group level prediction equations reduces the utility of the Actiheart device in adolescent samples and in research conducted in the free-living environment. While we found relatively poor measurement of agreement between the Actiheart and DLW for assessing free-living PAEE in adolescents, future research should look at developing adolescent-specific prediction equations using activities that are characteristic of habitual activity behaviour for this population. Such an approach is likely to enhance the validity of the Actiheart device. For now, those interested in using the device may want to apply a correction factor to account for the overestimation.
References


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Chapter 3

Construction and Validation of the Self-Efficacy for Daily Physical Activity Questionnaire (SEPAQ) for Adolescents (Study 2)

Evidence of an increased prevalence of sedentary lifestyles in today’s youth and decreased time spent in physical activity (Colley et al., 2011; Dumith, Gigante, Domingues, & Kohl, 2011; Janssen et al., 2005) highlights the need to identify effective strategies for promoting physical activity in this population. To develop effective strategies to promote physical activity in youth, an understanding of the theory-based determinants is needed (Baranowksi, Anderson, & Carmack, 1998). Self-efficacy, a central component of Bandura’s Social Cognitive Theory (Bandura, 1986), has been advanced as an important personal determinant of human behaviour. Self-efficacy can be defined as the beliefs an individual has about his or her ability to engage in behaviours that lead to expected outcomes (Bandura, 1995; 1997). The application of self-efficacy to research on physical activity centers on the hypothesis that strong beliefs in one’s ability to be physically active are related to participation in physical activity.

The most recent review conducted by Van der Horst and colleagues (2007) regarding the determinants to physical activity in youth shows evidence for self-efficacy as a determinant of physical activity in adolescents (age range 13-18). However, an earlier review (Sallis, Prochaska, & Taylor, 2000) found results concerning self-efficacy as a determinant of adolescents physical activity (age range 13-18 years) to be equivocal; some results supported self-efficacy as a determinant (Reynolds et al., 1990; Trost et al., 1996; Zakarian, Hovell, Hofstetter, Sallis, & Keating, 1994) and others did not (Bungum & Vincent, 1997; Dilorenzo, Stucky-Ropp, Van der Wal, & Gotham, 1998; Garcia et al., 2005).
Closer examination of the self-efficacy scales used in the studies included in both of these reviews shows that a number of different types or components of self-efficacy were examined. For example, the self-efficacy scale used by Wu and colleagues (2002; 2003) among Taiwanese adolescents asked questions about engaging in regular physical activity despite various conflicting conditions (e.g., being tied up with family chores).

DiLorenzo et al. (1998) included a self-efficacy scale measuring belief in one’s ability to be active relative to peers. Ryan and Dzewaltowski (2002) examined four types of self-efficacy among adolescents: efficacy for being physically active, overcoming barriers to physical activity, to ask others to be active with them, and to find and create environments that support physical activity. Finally, Strauss et al. (2001) assessed self-efficacy in adolescents by asking their confidence for seeking social support for physical activity, for overcoming barriers to physical activity, and for being active despite positive alternatives, such as their friends wanting to do something else. Consensus among researchers as to what types of self-efficacy should be measured may be contributing to the inconsistency in self-efficacy and physical activity research among adolescents.

Theoretically, differences between types of self-efficacy are important for gaining a complete understanding of the relationship between self-efficacy and physical activity.

McAuley and Mihalko (1998), in their review of self-efficacy and its measurement, suggested that different types of self-efficacy generally represent one of two broad categories or components of the self-efficacy construct, a task component and a regulatory component. The task component, which is the primary focus of this work, refers to beliefs an individual has about his or her ability to perform a specified behaviour. By definition, this suggests that an individual can feel more or less efficacious
in different situations and/or for particular tasks (Bandura, 2006). Hence, asking youth questions about how confident they are to complete regular physical activity is a measure of physical activity efficacy not task efficacy. The former assesses a general/global movement confidence while the latter assesses a specific movement confidence. Children and adolescent studies have shown that physical activity efficacy (a thematically similar construct of task efficacy) predicts both subjective and objectively measured physical activity (Foley et al., 2008; Roberts, Maddison, Magnusson, & Prapavessis, 2010). The problem, however, with these findings is that the authors incorrectly refer to the efficacy construct under investigation as task rather than physical activity. Inappropriately labelling and operationally defining task efficacy confounds the validity of the measurement tool being used.

Researchers have also sacrificed good measurement for the sake of brevity (Maibach & Murphy, 1995) and this has been particularly true in self-efficacy and physical activity youth research. For example, previous work (Ryan & Dzewaltowski 2002) assessing physical activity efficacy used a single-item measure, in which adolescents were asked how sure they were that they could do vigorous exercise for 20 minutes or more on 3 or more days of the week. A single-item approach contradicts the recommended guidelines for assessing task efficacy (McAuley & Mihalko 1998). Instead, to investigate the nature of efficacious beliefs, McAuley and Mihalko (1998) suggest that a self-efficacy scale include a hierarchy of items in order to gauge both the level (the confidence one has in his or her capabilities to execute a specified behaviour) and strength (the degree of confidence one has in his or her capability to successfully execute the behaviour). In addition, this single-item measure only assesses efficacy regarding
one’s capability to engage in moderate intensity exercise, a regular and structured subset of physical activity performed deliberately and with a specific purpose (Shephard, 2003). It fails to account for efficacy in being physically active in the complete sense, as exercise is only one of several identified classifications of physical activity behaviour that also includes but is not limited to: sport, recreation, occupational activity, and household chores (Bouchard & Shephard, 1994).

As highlighted above, task efficacy beliefs are not a general/global trait. Ideally, to accurately assess the level of specificity associated with task efficacy, scale items should be tailored to each of the performance behaviour tasks being measured. While this would be impossible to do with respect to daily free-living physical activity behaviour as a whole, a domain-specific approach to assessing a non-specific task related component of self-efficacy (i.e., physical activity efficacy) may be a more logical and practical solution (Bandura, 2006; McAuley & Mihalko 1998) and keeps in line with advancements being made in the realm of physical activity measurement.

By and large improvements are constantly being made to physical activity assessment methods. This has been achieved to a large extent by increased use of objective measurement tools (e.g., accelerometers, heart rate monitors, etc.; Wareham & Rennie, 1998). In addition to improved precision, objective measures provide a more complete assessment of all forms of physical activity, irrespective of intensity or where activity occurs (Corder et al., 2007). However, due to low costs, ease of administration, and the ability to assess activity type and the context in which physical activity is performed, self-report questionnaires remain highly utilized by health researchers...
(Corder, Ekelund, Steele, Wareham, & Brage, 2008). In an attempt to match the volume of total daily physical activity captured by objective methods, we are starting to see self-report measures prompt participants to recall physical activity in each of the main behavioural domains (e.g., during leisure time, at home, for transportation, etc.; Ridley, Olds, & Hill, 2006) and for a variety of different activities (i.e., organized versus unorganized physical activity, incidental physical activity, etc.).

Taking a domain-specific approach to assessing physical activity efficacy may improve the level of specificity of efficacy scores, and capture more response variance in measures of free-living physical activity. Not only would this strengthen the case for targeting domain-specific physical activity efficacy in adolescent interventions promoting activity (Baranowski, et al., 1998) but it may also bring some degree of standardization to how the construct is assessed across physical activity research studies.

Therefore, the overall purpose of this study was to develop a conceptually based and psychometrically sound physical activity efficacy scale [the Self-Efficacy for Daily Physical Activity Questionnaire (SEPAQ)] to assess task related efficacy in each of the main activity behavioural domains (i.e., at school, at work, at home, during leisure time, and for transportation purposes). In the development of any instrument, two fundamental concerns are (a) does the instrument measure the constructs it is intended to measure; and (b) does the instrument measure the constructs with consistency? These two questions represent the instrument’s validity and reliability. To provide preliminary evidence for these two key psychometric properties, this study focused on the content of item development (i.e., adequacy of the items that operationally define the constructs
being assessed) as well as the factor analytical structure and composition, and internal consistency of the constructs generated from the items.

Methods

Participants and procedures. Two independent samples of high school students were recruited from secondary institutions within South Western Ontario, Canada. The first sample (Sample 1) consisted of 174 students who completed a survey which provided information on adolescent’s typical physical activity behaviours and aided in the item generation portion of scale construction. The mean age of Sample 1 was 15.5 ($SD = 1.3$) years (66% female) and was predominately of Caucasian (86%) race. A second sample (Sample 2) was recruited to assess the factor structure and internal consistency of the newly constructed physical activity efficacy scale (the SEPAQ) and consisted of 272 students (55% female), with a mean age of 15.6 ($SD = 1.5$), and predominately of Caucasian (92%) race.

Ethical approval was obtained for each portion of the study (item development and factor analytic structure and composition), from the University of Western Ontario Research Ethic Board (REB#17296S; REB#18182E). In addition, permission was granted to conduct research from the school board in which students were recruited. Student participants were contacted via a designated teacher at each institution. For both samples, parents and students received a paper copy of a detailed letter of information clearly outlining the study information and procedures. Prior to participation, participant informed consent was obtained for individuals eighteen years of age or older. Parent
consent was obtained for participants under the age of eighteen years, in addition to participant assent from each interested student.

**Item generation.** Sample 1 participants were asked to complete a questionnaire package containing self-report demographic information and a physical activity survey. Participants took the questionnaire package home to complete and returned the completed package to their respected teacher. The survey asked participants to list the various types of physical activity they did on a regular basis in five independent physical activity domains: (1) at school, (2) around the house, (3) for transportation purposes, (4) during their leisure-time, and if applicable (5) at work. The domains were in line with the activity settings used to categorize physical activity on physical activity recall questionnaires (Arvidsson, Slinde, & Hulthen, 2005). In addition, participants were asked to report average duration (in minutes) and intensity level (light, moderate, or hard) of each activity.

Physical activity tasks to be retained as efficacy items for the SEPAQ were generated from the information provided from the survey data. Descriptive analyses were run to examine the frequency and distribution of the physical activities listed in each of the independent physical activity domains, and to establish the mean time each activity was reported to be performed. Based on this information scale items were generated for each of the five physical activity domains (at school, at home, at work, during leisure time, and for transportation). The authors included physical activities that were reportedly performed on a regular basis (three or more days a week). An exception was made for activities relating to around the house, as household chores were found to be
performed only two days per week but accounted for a significant portion (60% of light intensity physical activity) of household physical activity. A hierarchy of items was created for physical activity in each domain, highlighting performance changes in relation to intensity level (light, moderate, and/or hard) and duration (in minutes). In total, 39 items were generated (9 items for activity at school; 6 items for transportation activity; 6 items for household activity; 12 items for leisure time activity; 6 items for occupational activity; see appendices for a full list of SEPAQ items). In line with guides for constructing efficacy scales (Bandura, 2006), a 100-point response scale, ranging in 10-unit intervals from 0 (“not at all confident”) to 100 (“completely confident”) accompanied each item. Within the leisure time domain, an option was added to the active gaming response scale where individuals could indicate they did not play active video games. Similarly for all activity items in the occupation domain, an option was added to the response scale where individuals could indicate they were not employed.

*Expert review.* Researchers in sport, exercise, and physical activity with an expertise in self-efficacy or adolescent populations were contacted by e-mail and asked to serve as an expert reviewer, examining the linguistic, item, and response scale structure of the newly generated scale. Six researchers were contacted. No response was received from one individual, thus the final panel consisted of five individuals (2 faculty and 3 post-doctoral fellows). No items were removed from the questionnaire following expert review, however in line with the reviewer’s suggestions several linguistic changes were made to the scale items.
Construct validation. Students in Sample 2 were asked to self-report information regarding their demographics, in addition to completing a copy of the SEPAQ. The SEPAQ took approximately 10-15 minutes to complete during class time as part of the school day. These data were used to examine the factor structure and internal consistency of the SEPAQ.

An exploratory factor analysis (EFA) was conducted on 27 of the 39 SEPAQ items using IBM SPSS Statistics version 20, to examine subscale factor structure and composition. The 12 items relating to active gaming and occupational physical activity were excluded from this primary analysis, as a large portion of the sample ($n = 129$) indicated these items were irrelevant. A reliability analysis was performed to look at the internal consistency of each physical activity efficacy domain. In addition, a composite domain efficacy score was calculated for each physical activity domain factor and a correlation analysis was performed to examine the relationship between each of the domain efficacies identified in the factor structure.

A preliminary sub-analysis was conducted in which a secondary EFA was carried out on all 39-items of the SEPAQ data, to determine if the factor structure would change when items relating to active gaming and occupational physical activity were included. Once again, a reliability analysis was performed to look at the internal consistency of each domain efficacy factor. A composite domain efficacy score was calculated for each physical activity domain and a correlation analysis was performed to examine the
relationship between each of the domain efficacies identified in the second factor structure.

Results

*Primary EFA.* The 27 item SEPAQ data were examined for suitability for EFA. There is little agreement among researchers concerning how large a sample should be, however generally it is recommended: the more the better. Several recommendations in determining whether the sample size of the data was suitable for factor analysis were used. Tabachnick and Fidell (2007, p613) have stated that 300 cases is a comforting sample size but acknowledge that a smaller sample size (about 150 cases) is sufficient when solutions have several high loading marker variables (> .80). Moreover, Bryant and Yarnold (1995) state that, “one’s sample should be at least five times larger than the number of variables. In line with these recommendations, the sample size ($N = 272$) was deemed to be appropriate for EFA. Inspection of the correlation matrix verified that the majority of inter-correlations among the scale items were greater than 0.3 (Tabachnick & Fidell, 2001). Bartlett’s test of sphericity (Bartlett, 1954), relating to interdependence among items, reached significance ($x^2 = 10075.99, p < .000$) and the Kaiser-Meyer-Olkin sampling statistic of .90 was sufficient (Kaiser, 1970), indicating the factor analysis procedures were appropriate.

The EFA was conducted using an oblique rotation\(^1\), as this type of rotation assumes that the latent factors would be correlated. No restrictions were set limiting the

\(^1\) Both oblique and orthogonal rotation solutions were explored, however the oblique rotation method was preferred as this type of rotation assumes that the latent factors would be correlated.
factor structure in the analysis; thus scale items were free to load on any number of factors.

Kaiser’s criterion, Catell’s Scree test, and parallel analysis each revealed the same five factor structure. The pattern matrix was examined and the criterion for item inclusion was set for factor loadings greater than .50 on the primary factor and secondary loadings equal or less than .41. The structure matrix was consulted to verify it was consistent with the results of the pattern matrix. However, decisions to retain or eliminate items were based on the pattern matrix loadings as it reflects common variance and excludes the variance due to error.

The results from the oblique rotation produced a five-factor solution, with 27 items grouped into five logical and interpretable domain efficacy subscales: (i) leisure time (6-items), (ii) household (5-items), (iii) ambulatory transportation and school (6-items), (iv) transportation (3-items), and (v) school (6-items). In the analysis, the five factor solution accounted for 80.67% of the response variance and resulted in the elimination of a single household physical activity item that did not load on any of the five factors. Each factor represented a different physical activity domain, with the exception of light intensity school and transportation physical activity items which were grouped together (see Table 1). Examination of Cronbach’s alpha (also see Table 1) revealed desirable internal consistency for each of the five domain efficacy factors (cf. Nunally, 1978).
Table 1. Factor Loadings and Eigenvalues from the Pattern Matrix for the SPSS (26-item) Exploratory Factor Analysis with Oblique Rotation

<table>
<thead>
<tr>
<th>Domain-specific physical activity efficacy and Items</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
<th>Factor 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leisure-time efficacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEPAQ1l</td>
<td>.85</td>
<td>.07</td>
<td>-.28</td>
<td>.14</td>
<td>-.05</td>
</tr>
<tr>
<td>SEPAQ2l</td>
<td>.86</td>
<td>.01</td>
<td>-.10</td>
<td>-.01</td>
<td>.71</td>
</tr>
<tr>
<td>SEPAQ3l</td>
<td>.83</td>
<td>-.01</td>
<td>-.01</td>
<td>-.13</td>
<td>.03</td>
</tr>
<tr>
<td>SEPAQ4l</td>
<td>.86</td>
<td>-.01</td>
<td>-.10</td>
<td>.05</td>
<td>.03</td>
</tr>
<tr>
<td>SEPAQ5l</td>
<td>.76</td>
<td>.04</td>
<td>.13</td>
<td>-.14</td>
<td>.21</td>
</tr>
<tr>
<td>SEPAQ6l</td>
<td>.68</td>
<td>.08</td>
<td>.20</td>
<td>-.22</td>
<td>.19</td>
</tr>
<tr>
<td>Household efficacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEPAQ1h</td>
<td>.01</td>
<td>.89</td>
<td>-.13</td>
<td>.23</td>
<td>.01</td>
</tr>
<tr>
<td>SEPAQ2h</td>
<td>-.01</td>
<td>.99</td>
<td>-.06</td>
<td>.13</td>
<td>-.04</td>
</tr>
<tr>
<td>SEPAQ3h</td>
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<td>.95</td>
<td>-.02</td>
<td>-.10</td>
<td>-.04</td>
</tr>
<tr>
<td>SEPAQ5h</td>
<td>-.02</td>
<td>.92</td>
<td>.02</td>
<td>-.08</td>
<td>.07</td>
</tr>
<tr>
<td>SEPAQ6h</td>
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<td>.82</td>
<td>.13</td>
<td>-.27</td>
<td>.04</td>
</tr>
<tr>
<td>Ambulatory transportation and school efficacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEPAQ1s</td>
<td>.02</td>
<td>.06</td>
<td>-.82</td>
<td>.14</td>
<td>.24</td>
</tr>
<tr>
<td>SEPAQ2s</td>
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<td>.04</td>
<td>-.72</td>
<td>-.13</td>
<td>.28</td>
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<tr>
<td>SEPAQ3s</td>
<td>-.07</td>
<td>.08</td>
<td>-.50</td>
<td>-.35</td>
<td>.29</td>
</tr>
<tr>
<td>SEPAQ1t</td>
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<td>.16</td>
<td>-.75</td>
<td>.08</td>
<td>.03</td>
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<td>SEPAQ2t</td>
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<td>.15</td>
<td>-.71</td>
<td>-.17</td>
<td>-.09</td>
</tr>
<tr>
<td>SEPAQ3t</td>
<td>.20</td>
<td>.09</td>
<td>-.65</td>
<td>-.41</td>
<td>-.18</td>
</tr>
<tr>
<td>Transportation efficacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEPAQ4t</td>
<td>.08</td>
<td>.02</td>
<td>-.21</td>
<td>-.65</td>
<td>.11</td>
</tr>
<tr>
<td>SEPAQ5t</td>
<td>.08</td>
<td>.06</td>
<td>-.05</td>
<td>-.84</td>
<td>.09</td>
</tr>
<tr>
<td>SEPAQ6t</td>
<td>.10</td>
<td>.08</td>
<td>-.02</td>
<td>-.80</td>
<td>.10</td>
</tr>
<tr>
<td>School efficacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEPAQ4s</td>
<td>-.07</td>
<td>.00</td>
<td>-.20</td>
<td>.04</td>
<td>.90</td>
</tr>
<tr>
<td>SEPAQ5s</td>
<td>.03</td>
<td>.07</td>
<td>-.09</td>
<td>-.06</td>
<td>.83</td>
</tr>
<tr>
<td>SEPAQ6s</td>
<td>.12</td>
<td>.08</td>
<td>-.02</td>
<td>-.25</td>
<td>.60</td>
</tr>
<tr>
<td>SEPAQ7s</td>
<td>.24</td>
<td>-.01</td>
<td>-.06</td>
<td>.04</td>
<td>.73</td>
</tr>
<tr>
<td>SEPAQ8s</td>
<td>.32</td>
<td>.05</td>
<td>.13</td>
<td>-.09</td>
<td>.66</td>
</tr>
<tr>
<td>SEPAQ9s</td>
<td>.34</td>
<td>.13</td>
<td>.21</td>
<td>-.17</td>
<td>.51</td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>13.80</td>
<td>3.39</td>
<td>1.94</td>
<td>1.45</td>
<td>1.22</td>
</tr>
<tr>
<td>Cronbach’s alpha</td>
<td>.95</td>
<td>.95</td>
<td>.91</td>
<td>.90</td>
<td>.93</td>
</tr>
</tbody>
</table>
Descriptive statistics and correlation matrix for the relationship between the five domain efficacy factors are presented in Table 2. Correlations among the factors were reasonably strong (averaging .57) with the highest correlation found between leisure time efficacy and school efficacy.

Table 2. Correlations Among and Descriptive Statistics of the Five-Factors of Domain Efficacy (N = 272)

<table>
<thead>
<tr>
<th>Domain-specific physical activity efficacy</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Leisure-time</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Household</td>
<td>.43</td>
<td>.56</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Ambulatory transportation and school</td>
<td>.58</td>
<td>.64</td>
<td>.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Transportation physical activity</td>
<td>.64</td>
<td>.43</td>
<td>.59</td>
<td>.67</td>
<td></td>
</tr>
<tr>
<td>5 School physical activity</td>
<td>.78</td>
<td>.43</td>
<td>.59</td>
<td>.67</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>84.46</td>
<td>89.15</td>
<td>94.30</td>
<td>85.51</td>
<td>84.08</td>
</tr>
<tr>
<td><strong>SD</strong></td>
<td>16.47</td>
<td>16.23</td>
<td>10.17</td>
<td>16.19</td>
<td>15.97</td>
</tr>
</tbody>
</table>

*Note. All correlations are significant (p ≤ .000).
Secondary EFA. The 39 item SEPAQ data were examined for the suitability for EFA. The sample size ($N = 143$) was not in line with the EFA sample size recommendations outlined earlier (Bryant & Yarnold, 1995; Tabachnick & Fidell, 2007, p613). However, the additional three EFA suitability criteria were met. Examination of the correlation matrix revealed that the majority of inter-correlations among the scale items were greater than 0.3 (Tabachnick & Fidell, 2001). In addition, Bartlett’s test of sphericity was significant ($x^2 = 8917.47$, $p < .000$), examining the interdependence among items, and the Kaiser-Meyer-Olkin sampling statistic of 0.89 was sufficient (Kaiser, 1970). Given this was a secondary analysis and three out of the four suitability criteria were met, the factor analysis procedures were deemed appropriate.

The secondary EFA was conducted using an oblique rotation, again it was expected the latent factors would be correlated. Similar to the previous analysis, no restrictions were set limiting the factor structure in the analysis, allowing scale items to load freely on any number of factors.

Kaiser’s criterion, Catell’s Scree test, and parallel analysis each revealed a seven-factor structure. The pattern matrix was examined and the criterion for item inclusion was set for factor loadings greater than 0.46 on the primary factor and secondary loadings equal or less than 0.38. Similar to the first EFA, the structure matrix was consulted to verify it was consistent with the results of the pattern matrix. However, decisions to retain or eliminate items were based on the pattern matrix loadings.

The results from the oblique rotation produced a seven-factor solution, with the 39 items grouped into seven logical and interpretable physical activity domain efficacy
factors: (i) household (6-items), (ii) school (4-items), (iii) activity gaming (6-items), (iv) ambulatory transportation and school (5-items), (v) occupational (6-items), (vi) transportation (3-items), and (vii) leisure time (4-items; see Table 3). This solution resulted in the elimination of several scale items (3 school physical activity items and 2 leisure time activity items), as these items attempted to load on multiple factors. In the analysis, the seven factor solution accounted for 86.78% of the response variance. Each subscale represented a different physical activity domain, with two exceptions. Similar to the factor solution found for the primary EFA, light intensity school and transportation physical activity domain items were grouped together. In addition, items relating to active gaming, originally couched within the leisure time physical activity domain, factored as an independent domain. Examination of Cronbach’s alpha (also see Table 3) revealed desirable internal consistency for each of the seven efficacy subscales (cf. Nunally, 1978).
Table 3. Factor Loadings and Eigenvalues from the Pattern Matrix for the SPSS (34-item)

Secondary Exploratory Factor Analysis with Oblique Rotation

<table>
<thead>
<tr>
<th>Domain-specific physical activity efficacy and Items</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
<th>Factor 5</th>
<th>Factor 6</th>
<th>Factor 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household efficacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEPAQ1h</td>
<td>.96</td>
<td>-.04</td>
<td>-.07</td>
<td>-.15</td>
<td>.04</td>
<td>-.17</td>
<td>.06</td>
</tr>
<tr>
<td>SEPAQ2h</td>
<td>1.00</td>
<td>-.00</td>
<td>.00</td>
<td>-.02</td>
<td>.03</td>
<td>-.01</td>
<td>.05</td>
</tr>
<tr>
<td>SEPAQ3h</td>
<td>.92</td>
<td>.03</td>
<td>.03</td>
<td>.06</td>
<td>-.06</td>
<td>.08</td>
<td>.01</td>
</tr>
<tr>
<td>SEPAQ4h</td>
<td>.96</td>
<td>.01</td>
<td>-.01</td>
<td>-.02</td>
<td>-.02</td>
<td>-.03</td>
<td>.02</td>
</tr>
<tr>
<td>SEPAQ5h</td>
<td>.91</td>
<td>.01</td>
<td>.06</td>
<td>.00</td>
<td>-.07</td>
<td>.04</td>
<td>.01</td>
</tr>
<tr>
<td>SEPAQ6h</td>
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<td>.00</td>
<td>.07</td>
<td>.15</td>
<td>-.12</td>
<td>.13</td>
<td>-.08</td>
</tr>
<tr>
<td>School efficacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEPAQ4s</td>
<td>.07</td>
<td>-.87</td>
<td>.06</td>
<td>-.08</td>
<td>.06</td>
<td>.12</td>
<td>.11</td>
</tr>
<tr>
<td>SEPAQ5s</td>
<td>.04</td>
<td>-.74</td>
<td>.01</td>
<td>-.04</td>
<td>-.05</td>
<td>.26</td>
<td>-.06</td>
</tr>
<tr>
<td>SEPAQ6s</td>
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<td>-.63</td>
<td>.02</td>
<td>.09</td>
<td>-.13</td>
<td>.29</td>
<td>-.14</td>
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<tr>
<td>SEPAQ7s</td>
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<td>-.65</td>
<td>.08</td>
<td>-.17</td>
<td>.02</td>
<td>-.08</td>
<td>-.31</td>
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<tr>
<td>Active gaming efficacy</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEPAQav1</td>
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<td>-.06</td>
<td>.84</td>
<td>-.08</td>
<td>-.24</td>
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Table 3 Continued. Factor Loadings and Eigenvalues from the Pattern Matrix for the SPSS (34-item) Secondary Exploratory Factor Analysis with Oblique Rotation

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Descriptive statistics and correlation matrix for the relationship between the seven physical activity domain efficacy factors are presented in Table 4. Correlations among the subscales were moderate (averaging .48) and similar to the five-factor model the highest correlation found between leisure time efficacy and school physical activity efficacy.

Table 4. Correlations Among and Descriptive Statistics of the Seven-Factors of Domain Efficacy Domains (N = 143)

<table>
<thead>
<tr>
<th>Domain-specific physical activity efficacy</th>
<th>1</th>
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<th>4</th>
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<td>3 Active gaming</td>
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<td>.32*</td>
<td>-</td>
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<td>4 Ambulatory transportation and school</td>
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<td>.54*</td>
<td>.34*</td>
<td>-</td>
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<td></td>
<td></td>
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<tr>
<td>5 Occupational</td>
<td>.72*</td>
<td>.42*</td>
<td>.45*</td>
<td>.58*</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Transportation</td>
<td>.36*</td>
<td>.68*</td>
<td>.33*</td>
<td>.49*</td>
<td>.41*</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>7 Leisure time</td>
<td>.41*</td>
<td>.80*</td>
<td>.31*</td>
<td>.51*</td>
<td>.49*</td>
<td>.69*</td>
<td>-</td>
</tr>
<tr>
<td>Mean</td>
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<td>87.83</td>
<td>89.80</td>
<td>95.69</td>
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*Note.* All correlations are significant *(p ≤ .000).*
Discussion

The construction in addition to the evaluation of factor analytical structure and composition, and internal consistency of the SEPAQ, were completed and explored in the current study. The results of this investigation support the tenability of two physical activity efficacy domain models in adolescents. The first 27 item model was in line with the five domains proposed by the author (Campbell), while the 39 item model supported the addition of occupation and active gaming efficacy, respectively. Although, theoretically active gaming represents physical activity performed during ones leisure time, the skill set or capabilities required to perform this type of activity are different from those required to perform sport and exercise. As demonstrated by the EFA seven-factor solution, an adolescent’s efficacy for performing sport and/or exercise is distinct from their efficacy to engage in active video games and accordingly should not be assessed together. Nevertheless, it may be appropriate to refer to active gaming efficacy as a sub domain of leisure time efficacy. The only overlap in efficacy domains was found for ambulatory transportation and school activity. While this is conceptually incongruent with the domain approach, the grouping of these items together was not surprising as each item made reference to light intensity walking performances (see list of scale items in the appendices). Similar to active gaming efficacy, this particular factor best represents a sub-domain of transportation and school efficacies.\

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2 For ease of efficacy presentation and for the remainder of this dissertation, ambulatory transportation and school efficacy and active gaming efficacy will be referred to as domain-specific rather than sub domain-specific efficacy constructs.
Descriptive information for both the five- and seven-factor physical activity efficacy domain models, showed the highest correlation of efficacy scores (0.78 and 0.80, respectively) between the leisure time and school domains. When completing the leisure time domain efficacy items, readers are prompted to think about the sports and games (e.g., hockey, dance, horseback riding, weight lifting, etc.) they do during their free-time. With respect to the school domain efficacy items, readers are prompted to think about activities they do as part of gym class in addition to any school sport team involvement. Given the potential for overlap regarding what tasks adolescents choose to make reference to for each of the domain items, it is not surprising these two domain efficacy scores would be highly correlated. Similarly, physical activity tasks in these two domains may require a parallel skill set and thus high efficacy in the school domain may transmit to a higher efficacy belief for activities in the leisure time domain (McAuley & Mihalko, 1998). For example, an individual may be a member of the school cross-country running team but also play soccer for recreational purposes (as part of their leisure-time). Increased efficacy in ones’ ability to run cross-country may transpire into higher efficacy for their ability to play soccer during their leisure time given both sports involve similar intensities of locomotive activity performance. However, given the situation-specific nature of task related efficacy, more information regarding an individual’s efficacious belief is attained by assessing physical activity efficacy in each of these domains separately.

With respect to the active gaming and occupation physical activity items on the SEPAQ, individuals were given the option to indicate using the response scale that they did not engage in these forms of physical activity. Thus depending on how individuals
respond to these items will determine whether an efficacy score can be calculated. This
design choice ultimately led to two *domain-specific physical activity efficacy* models
being tested. It would have been ideal for all participants to provide an efficacy response
for each of the SEPAQ items (including the active gaming and occupational physical
activity items). However, to ensure that a realistic rather than imagined efficacy
perception is obtained it is important that an individual engage in the actual behaviour
that efficacy is being assessed. Although the information from the physical activity
survey data from Sample 1 indicated that a large number of adolescents reported
engaging in active gaming and physical activity at work, the author acknowledged that
for adolescents who do not active game or have a job it would be particularly difficult to
provide a realistic efficacy response for these types of activity behaviours. Nevertheless,
for those who do perform active gaming and physical activity at work, *physical activity
efficacy* in each of these domains may serve as an important predictor for physical
activity.

To the best our knowledge, this is the first time a domain-specific approach has
been taken to assess efficacious beliefs in adolescents. However, this approach has been
suggested by previous researchers with respect to self-efficacy measures (Schwarzer,
Babler, Kwiatek, & Schroder, 1997) and has been used when assessing other
psychosocial determinants of human behaviour (e.g., life satisfaction; Fugl-Meyer,
Eklund, & Fugl-Meyer, 1991). In its purest sense, *task* efficacy should be assessed at a
task-specific level. However, the comprehensive list of possible activities and individual
differences with respect to physical activity preferences make it impossible to compile a
*task* efficacy measure that encompasses every type of physical activity behaviour
adolescents performs regularly. This was confirmed presently by the physical activity survey data. While the domain efficacy measures may not provide true task efficacy scores, the SEPAQ reduces the level of generality when assessing a non-specific form of task related efficacy (i.e., physical activity efficacy), particularly with respect to existing physical activity efficacy scales.

Caution should be taken by researchers when reporting the type of efficacy being assessed. To date, poor terminology has confounded previous youth self-efficacy and physical activity literature (Foley et al., 2008; Roberts et al., 2010), and has tainted the true predictive validity of task related efficacy. More attention needs to be paid with respect to what type of physical activity behaviour(s) an efficacy scale targets, in addition to what type of efficacy construct is being investigated.

The predictive validity of domain-specific physical activity efficacy from the SEPAQ remains to be tested. Yet, it is reasonable to expect that the amount of variance explained for measures of adolescent free-living physical activity would be improved when compared to a more generalized measure of physical activity efficacy. The physical activities made reference to in the SEPAQ items, were chosen based on the information collected from the physical activity survey conducted in Sample 1 of the current study. As stated earlier, individual differences in physical activity choices made it impossible to reference only one particular activity task in each item without creating a scale that contained hundreds of items. However, activity references provided to SEPAQ readers are believed to represent the types of physical activities performed regularly by adolescents. This design element will not only help readers recall their ability to perform
activity relevant to each domain but it helps to improve the degree of correspondence between the nature of physical activity tasks referenced on the efficacy scale with those assessed as part of the physical activity outcome measure. This is a problem that has been identified previously by researchers when trying to explain the equivocal findings regarding physical activity efficacy’s role in determining adolescent free-living physical activity (Roberts et al., 2010; Ryan & Dzewaltowski 2002).

In any event, several limitations of the study should be acknowledged. Firstly, the current research investigation was exploratory in nature. This is particularly true with respect to the seven-factor domain efficacy model. A relatively small sub-sample \((n = 143)\) of students in Sample 2 completed the 12 items regarding active video gaming and occupational activity on the SEPAQ, which impacted the suitability of these data for factor analysis. While the addition of these activity items revealed two new potential domains in which efficacy can be assessed, the results concerning the seven domain efficacy measure should be interpreted with caution. Secondly, both the physical activity survey data in addition to the data sets used for EFA were collected from a sample of Canadian Caucasian adolescents. It remains unclear as to whether the SEPAQ will have application in a sample of adolescents who differ by race or reside in another part of the world, as these two demographic factors have resulted in radical differences regarding activity type and aspects of daily life (domain) in which certain activities take place (Booth, 2000). Lastly, as previously mentioned, the domain-specific physical activity efficacy measures identified are provisional and remain to be tested. The utility of a domain approach for examining the predictive validity of self-efficacy for physical activity in adolescents remains to be examined.
References


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Chapter 4

Investigating Different Measures of Physical Activity Efficacy for the Prediction of Physical Activity in Adolescents (Study 3)

Adolescence is a critical developmental time for the promotion of daily physical activity. Despite the physiological and psychological benefits associated with regular physical activity (Jansen & LeBlanc 2010), a significant decrease in activity level occurs during adolescence (Colley et al., 2011; Dumith, Gigante, Domingues, & Kohl, 2011). The promotion of physical activity in this population can result in the prevention or delaying of the early onset of certain illnesses, including cardiovascular disease (Baranowski et al., 1992), Type II diabetes (Shaibi, Faulkner, Weigensberg, Fritschi, & Goran, 2008) and depression (Piko & Keresztes, 2006). In order to develop effective strategies targeting physical activity change in youth, the theoretical determinants of physical activity should be well understood (Baranowski, Anderson, & Carmack, 1998).

Self-efficacy, a central component of Bandura’s Social Cognitive Theory (Bandura, 1986; 1997), serves as an important personal determinant of human behaviour. Self-efficacy’s application within physical activity research suggests that a strong belief in one’s ability to be physically active relates to higher levels of physical activity performance.

In a recent review conducted by Van der Horst and colleagues (2007), self-efficacy was identified as an important determinant of physical activity in adolescents (age range 13-18). However, a clear understanding regarding self-efficacy’s role for determining adolescent physical activity has been hampered by a number of problems (see Campbell, Study 2, 2012). These include: a lack of consensus among researchers as
to what self-efficacy constructs and corresponding scales should be used (e.g., barriers efficacy, support seeking efficacy, physical activity efficacy, etc); (b) the inappropriate labelling of task efficacy (i.e., referring to a construct as task efficacy when it is really physical activity efficacy); (c) using a general single item approach to measure physical activity efficacy instead of taking into account the level and strength of efficacious belief as well as the specific context from which beliefs come from (i.e., school, leisure, home, etc.). Furthermore, most of the evidence for self-efficacy as a determinant of physical activity has involved subjective measures of physical activity (Deforche, Van Dyck, Verloigne, & De Bourdeaudhuij, 2010; Motl, 2002; Neumark-Sztainer, 2003; Spence, 2010).

Distinctions have been made (Maddux, 1995; McAuley & Mihalko, 1998), in which self-efficacy constructs generally represent one of two broad categories: a regulatory or a task component. Task efficacy addresses individuals’ belief regarding their ability to perform a specific behaviour, and is the focus of the current work. By definition, this suggests that an individual can feel more or less efficacious in different situations and/or for particular tasks (Bandura, 2006). Ideally, to accurately assess the level of specificity associated with task efficacy, scale items should be tailored to each of the behaviour tasks being measured. While it may be impossible to tailor a task specific scale with respect to daily free-living physical activity behaviour, in youth activity studies researchers have relied on measures of physical activity efficacy (a thematically similar construct of task efficacy which assesses movement confidence at a global as opposed to a specific level) for explaining physical activity level (Foley et al., 2008; Roberts, Maddison, Magnusson, & Prapavessis, 2010; Ryan & Dzewaltowski, 2002). For
example, using a single item *physical activity efficacy* measure, Ryan and Dzewaltowski (2002) found that increased confidence to perform 20 minutes of vigorous intensity exercise on 3 or more days of the week was significantly related to subjective measures of vigorous activity in a sample of adolescents. Furthermore, Roberts and colleagues (2010) assessed New Zealand adolescents’ efficacy for engaging in regular physical activity of increasing intensities (light, moderate, and vigorous) and increasing durations of time (10, 30, and 60 minutes), using a nine item measure, and found *physical activity efficacy* to be a significant predictor of pedometer derived step count.

As highlighted above, *task* related efficacy beliefs are not a general/global trait. Ideally, to assess the level of specificity associated with *task* efficacy, scale items should be tailored to each of the performance behaviour tasks being measured. While this would be impossible to do with respect to daily free-living physical activity, Campbell (Study 2, 2012) has proposed a contextual domain-specific approach to assessing a non-specific *task* related component of self-efficacy (i.e., *physical activity efficacy*). Specifically, the construction of the Self-Efficacy for Daily Physical Activity Questionnaire (SEPAQ) which assesses *domain-specific physical activity efficacy* offers a logical and practical solution (Bandura, 2006; McAuley & Mihalko, 1998) to reducing the overall generality of *physical activity efficacy* and keeps in line with advancements being made in the realm of physical activity measurement. Specifically, technological advancements regarding objective physical activity measurement tools along with improvements to subjective physical activity recall questionnaires have lead to increased measurement precision and a better assessment regarding the types of physical activities being performed within each
behavioural context (or domain) by youth, respectively (Corder, Ekelund, Steele, Wareham, & Brage, 2008; Ridley, Olds, & Hill, 2006).

Although psychometric evidence for the SEPAQ factor structure and composition has been shown (Campbell, Study 2, 2012), the scales predictive validity for physical activity behaviour remains unknown. It is anticipated that by assessing efficacy for being physically active at the domain level, improvements will be seen regarding how much of the variance in physical activity will be explained. Campbell identified two tenable domain-specific physical activity efficacy models using the SEPAQ (See Figure 1 and 2). In the current study both models were tested. To compare our findings with previous research (Roberts et al., 2010), and determine whether a domain approach to assessing physical activity efficacy is more beneficial than a generalized measure, general physical activity self-efficacy was also assessed using The Self-Efficacy Scale (McAuley & Mihalko, 1998) and included in each of the models tested. Furthermore, to examine whether associations between physical activity efficacy and physical activity level differed according to the nature in which activity is assessed both models included a subjective (physical activity questionnaire for adolescents) and objective measure (Actiheart) of daily free-living physical activity.
Figure 1. Model 1 predicting subjective (PAQ-A) and objective (Actiheart derived PAEE) physical activity. *Note.* The Self-Efficacy for Daily Physical Activity Behaviour Questionnaire: SEPAQ; Physical Activity Questionnaire for Adolescents: PAQ-A; Physical activity energy expenditure: PAEE.

Figure 2. Model 2 predicting subjective (PAQ-A) and objective (Actiheart derived PAEE) physical activity. *Note.* The Self-Efficacy for Daily Physical Activity Behaviour Questionnaire: SEPAQ; Physical Activity Questionnaire for Adolescents: PAQ-A; Physical activity energy expenditure: PAEE.
Methods

Participants and procedures. With consent from school principals, researchers recruited students through designated teachers at one educational institution in Auckland, New Zealand, and two secondary school institutions within South Western Ontario, Canada. Parents and students received a paper copy of a detailed letter of information outlining the study purpose and procedures. Participants eighteen years of age provided written consent. For participants under eighteen years of age, written parental consent was obtained in addition to written assent from each of the participants, prior to participation. In total, 133 students (29 from New Zealand and 104 from Canada; 54.1% female) with a mean age of 15.97 years ($SD = 1.22$), predominately of Caucasian (70.7%) and New Zealand European (15%) race, were recruited for the study.

Preceding the start of the physical activity measurement period (T0), demographic and anthropometric measures were collected. On day one of the study (T1) each participant completed two independent questionnaires assessing individuals’ levels of physical activity efficacy followed by being equipped and instructed on how to wear an Actiheart device. Each participant wore an Actiheart device for the subsequent eight days, after which (T2) the device was collected and a physical activity recall tool was completed. Each visit (T0, T1, and T2) took approximately 20 minutes and was conducted during class time as part of the school day. See Figure 3 for a schematic representation of the study protocol. Data collection occurred in New Zealand during the month of July 2011 and in Canada between September and November of 2011. All study procedures were approved by the University of Auckland Human Participants Ethics Committee and University of Western Ontario Research Ethic Board, respectively.
In addition, permission was granted to conduct the study from each of the respected school boards.

Figure 3. Schematic representation of the study protocol. Note. SEPAQ: The Self-Efficacy for Daily Physical Activity Questionnaire; PAQ-A: The Physical Activity Questionnaire for Adolescents (Crocker, Bailley, Faulkner, Kowalski, & McGrath, 1997).

<table>
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<tr>
<td>Weight (kg)</td>
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<td></td>
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<tr>
<td>The Self-Efficacy Scale</td>
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<tr>
<td>The SEPAQ</td>
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<tr>
<td>PAQ-A</td>
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<tr>
<td>Actiheart</td>
<td>→</td>
<td>→</td>
<td>→</td>
<td>→</td>
</tr>
</tbody>
</table>

**Anthropometric measures.** Individual measures of height and weight were collected while participants wore stocking feet and light weight clothing. Height and weight were recorded to the nearest 0.5 cm and 0.10 kg, respectively. Both the height and weight measures were taken twice and final measurement values were determined by taking an average of the two measures.
**Physical activity efficacy.** Two independent efficacy scales were used to measure individual’s efficacious belief for engaging in daily physical activity. One scale provides an overall measure of *general physical activity efficacy*, while the other assesses *domain-specific physical activity efficacy*. Both of the scales were intended for use in adolescent samples and are structured based on the self-efficacy scale guidelines outlined by Bandura (2006) and McAuley and Mihalko (1998). Each school completed the scales in different sequence to control for possible order effects.

*General physical activity efficacy.* Efficacy was assessed using The Self-Efficacy Scale (McAuley & Mihalko, 1998), which consisted of nine items asking students how confident they were that they could do 10, 30, and 60 minutes of light, moderate, and vigorous intensity activity on five or more days of the week. (For a full list of scale items please see the appendices). Participants responded to each item using a 10-point scale ranging from 0% (not at all confident) to 100% (completely confident). A cumulative average was calculated from all item responses and individuals scores ranged from 0% - 100% with a higher score indicative of greater self-efficacy.

*Domain-specific physical activity efficacy.* *Domain-specific physical activity efficacy* was assessed using the SEPAQ (Campbell, Study 2, 2012). The original SEPAQ consisted of 39 items and asked students how confident they were for engaging in physical activity within different behaviour domains [school (9 items), household (6 items), occupational (6 items), leisure-time (12 items), and transportation (6 items)]. Participants responded to each item using a 10-point scale ranging from 0% (not at all confident) to 100% (completely confident), with an exception for the active gaming and
work related activity items in which participants were given an option to indicate they did not perform these types of activities. Depending on whether individuals completed the 12 items relating to active gaming and occupational physical activity, two different configurations for measuring domain efficacy were possible. See the appendices for a list of SEPAQ items used to calculate domain-specific physical activity efficacy scores for the two domain efficacy configurations. A cumulative score was calculated for each of the domain efficacies. Domain efficacy scores ranged from 0% - 100% with higher scores indicating greater self-efficacy.

Physical activity. Physical activity level was assessed subjectively via the Physical Activity Questionnaire for Adolescents (PAQ-A; Crocker, Bailley, Faulkner, Kowalski, & McGrath, 1997). In addition, the amount of energy expended from physical activity (physical activity energy expenditure; PAEE) was assessed objectively using the Actiheart device (MiniMitter, Respironics, OR, USA).

Physical Activity Questionnaire for Adolescents (PAQ-A). The PAQ-A is a self-administered 7-day recall questionnaire intended to assess general levels of moderate to vigorous physical activity in high school aged students. The PAQ-A consists of 10-items and asks individuals to rate how much activity they have done over the previous week and has previously been used in adolescent physical activity research (Crocker, Eklund, & Kowalski, 2000; Roberts et al., 2010). (Please see the appendices for a copy of the PAQ-A). Based on each of the item responses, an overall mean score ranging from 1 to 5 is calculated, where a higher score indicates a higher activity level.
Physical Activity Energy Expenditure (PAEE). The Actiheart is a combined uni-axial accelerometer and heart rate monitoring device worn on the chest. The device consists of two sensors connected via a short lead and attaches to the chest by use of adhesive electrodes (3M Red Dot, London ON, Canada). The main sensor is positioned at the level of the third intercostals space and the second sensor lays adjacently along the midclavicular line approximately the length of the lead wire in distance. A detailed description of the device is provided elsewhere (Brage, Brage, Franks, Ekelund, & Wareham, 2005). In short, simultaneous collection of minute-by-minute heart rate (HR; 35bpm to 255bpm) and vertical acceleration (ACC; 32 Hz) can be recorded by the Actiheart for up to 11 days. Participants were shown and given written instructions on how to prepare the skin, replace the electrodes, and position the device. Furthermore, participants were instructed to carry on with their typical day-to-day routines and wear the monitor at all times, when awake or asleep. The monitors were only to be taken off when showering, bathing or engaging in water activities like swimming.

Data from the Actiheart devices were downloaded to a database using Actiheart software (Actiheart™, software version 2.0). A sleeping HR value was calculated for each participant by the software. To do this, the software algorithmically finds a 30-minute accumulation of time that contains the lowest HR for each 24-hour period the device was worn and calculates an average excluding the sleeping HR values from the first and second day of device wear time as they may not contain an overnight period. The Actiheart used in this study is no longer available for purchase. To ensure findings from the Actiheart devices used provide valid data compared to the current commercially available Actiheart (Actiheart 4, CamNtech, Cambridge, UK), adjustments were made for
differences in data collection and PAEE analysis between the two models. Specifically, accelerometer data for each participant were re-calibrated and increased by 20% (Spierer, Hagins, Rundle, & Pappas, 2011).

Raw HR was converted to heart rate above sleep (HRaS) by subtracting the individual’s sleeping HR from the raw value. There is no function to clean and recover or interpolate noisy and missing HR data using the Actiheart software. Accordingly, raw HR data were cleaned using a software program developed by the current authors, in which all zero HR values and HR above sleep (HRaS) values < 5bpm and ≥ 175bpm an individual’s sleeping HR, respectively were identified as spurious and removed from the data set. In addition, data were scanned for non-wear time, defined as ≥ 10 minutes of consecutive zero HR and zero ACC data (Brage et al., 2006). No imputation method was used to interpret the minute-by-minute and non-wear time data removed and thus they were excluded from analysis. Minute-by-minute HRaS and accelerometer data were converted to PAEE using the most recently published group calibration equations (Brage et al., 2007) and then combined using branched equation modeling (Brage et al., 2004) to calculate total daily PAEE. Data from days 1 and 9 were excluded, as these are the days the device was administered and collected, thus the device was not worn for the full day. A valid day was defined as 10 or more hours of registered monitor wear (Troiano, et al., 2008), with a minimum of four valid week- and one valid weekend-day required per participant in order to be included in the analysis (Troiano et al., 2008; Trost, Pate, Freedson, Sallis, & Taylor, 2000). Previously, this device has been found to overestimate PAEE in adolescents (Campbell, Study 1, 2012) by a mean of 54%. To take into account overestimations of PAEE with the current sample, the raw PAEE measures were reduced
by applying a 0.5 correction factor. Both the raw and adjusted PAEE values are presented.

*Statistical analyses.* Only participants with complete data sets (valid measures in each of the variables collected: SEPAQ, Self-Efficacy Scale, PAQ-A, and PAEE) were included in each of the analyses. Descriptive statistics, bivariate (Pearson) correlations, and the internal consistency (alpha values) were computed for each of the study variables. To test the relationship between the different measures of efficacy and physical activity, standardized regression analyses were performed. Data were inspected for violations of the assumptions for multicollinearity (Variance Inflation Factor and Tolerance values), determining whether the independent efficacy measures were highly correlated with one another and to ensure valid results pertaining to any individual efficacy predictors within each of the models. Separate regression analyses were conducted for each efficacy model (Model 1 and 2), in addition to two separate regressions analyses for subjective and objective measures of physical activity within each of the models. In order to determine the direct effect each measure of efficacy had on physical activity, all variables were entered into the equation simultaneously. The outcomes for each regression were evaluated using a range of indices that included (a) variance accounted for per criterion variable (i.e., $R^2$ and Adjusted $R^2$ values), (b) standardized beta ($\beta$), and (c) the amount of unique variance allotted to each predictor variable [(part correlation coefficient)$^2$].
Results

A total of 94 participants were included in the Model 1 analyses. Thirty-nine participants (29%) from the original data sample ($N = 133$) were excluded due to insufficient data sets (i.e., 35 participants had insufficient days of valid PAEE data; 2 participants experienced Actiheart device malfunctions; 1 participant lost his or her Actiheart device; and 1 participant did not complete the SEPAQ). The number of participants included in the Model 2 analyses was further reduced to $n = 41$, as occupation and active gaming domain-specific physical activity efficacy scores could only be calculated for 44% of the student data included in Model 1. See Table 1 for a description of participant characteristics for each of the efficacy models. Descriptive statistics, bivariate (Pearson) correlations, and internal consistency (alpha values) for all variables in Model 1 and Model 2 are presented in Tables 2 and 3.

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ($SD$)</td>
<td>Mean ($SD$)</td>
</tr>
<tr>
<td>Age</td>
<td>15.94 ($1.16$)</td>
<td>16.15 ($1.11$)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>168.67 ($9.16$)</td>
<td>171.01 ($9.17$)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>63.70 ($12.28$)</td>
<td>65.18 ($12.29$)</td>
</tr>
<tr>
<td>% Female</td>
<td>56.4%</td>
<td>48.8%</td>
</tr>
</tbody>
</table>

Table 1. Participant descriptive for data used in Model 1 ($n = 94$) and Model 2 ($n = 41$).
Table 2. *Descriptive statistics, Bivariate Correlations, and Internal Consistency* Study Variables Included in Model 1 (N = 94).

<table>
<thead>
<tr>
<th>Physical activity efficacy and physical activity variables</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Leisure time efficacy</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Household efficacy</td>
<td>0.49**</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Transportation efficacy</td>
<td>0.55**</td>
<td>0.75**</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 School efficacy</td>
<td>0.63**</td>
<td>0.58**</td>
<td>0.66**</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Ambulatory transportation and school efficacy</td>
<td>0.42**</td>
<td>0.62**</td>
<td>0.71**</td>
<td>0.60**</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 General efficacy</td>
<td>0.73**</td>
<td>0.22*</td>
<td>0.30**</td>
<td>0.52**</td>
<td>0.24*</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 PAQ-A</td>
<td>0.32**</td>
<td>0.04</td>
<td>0.24*</td>
<td>0.25*</td>
<td>0.11</td>
<td>0.37**</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>8 PAEE</td>
<td>0.09</td>
<td>0.14</td>
<td>0.17</td>
<td>0.18</td>
<td>-0.01</td>
<td>0.06</td>
<td>0.26*</td>
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<table>
<thead>
<tr>
<th>Mean</th>
<th>86.74</th>
<th>89.57</th>
<th>85.53</th>
<th>83.68</th>
<th>94.91</th>
<th>88.06</th>
<th>2.48</th>
<th>24.15/11.11†</th>
</tr>
</thead>
<tbody>
<tr>
<td>(SD)</td>
<td>(15.39)</td>
<td>(15.37)</td>
<td>(16.84)</td>
<td>(16.36)</td>
<td>(7.93)</td>
<td>(16.63)</td>
<td>(0.53)</td>
<td>(7.06)/(3.25)†</td>
</tr>
<tr>
<td>Internal consistency (alpha)</td>
<td>.94</td>
<td>.91</td>
<td>.88</td>
<td>.91</td>
<td>.73</td>
<td>.93</td>
<td>.79</td>
<td></td>
</tr>
</tbody>
</table>

*Note.** *p < .01, *p < .05.; PAQ-A: the Physical Activity Questionnaire for Adolescents; PAEE: physical activity energy expenditure; SD: Standard deviation; †Adjusted PAEE estimates.*
Table 3. Descriptive statistics, Bivariate Correlations, and Internal Consistency of Study Variables Included in Model 2 (N = 41).

<table>
<thead>
<tr>
<th>Physical activity efficacy and physical activity variables</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Occupation efficacy</td>
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<tr>
<td>3 Leisure time efficacy</td>
<td>0.66*</td>
<td>0.04</td>
<td>-</td>
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</tr>
<tr>
<td>4 Household efficacy</td>
<td>0.56**</td>
<td>0.35*</td>
<td>0.65**</td>
<td>-</td>
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<td></td>
</tr>
<tr>
<td>5 Transportation efficacy</td>
<td>0.56**</td>
<td>0.24</td>
<td>0.76**</td>
<td>0.83</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>6 School efficacy</td>
<td>0.46**</td>
<td>0.30</td>
<td>0.55**</td>
<td>0.49**</td>
<td>0.58**</td>
<td>-</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>7 Ambulatory transportation and school efficacy</td>
<td>0.40**</td>
<td>0.22</td>
<td>0.69**</td>
<td>0.78**</td>
<td>0.81**</td>
<td>0.49**</td>
<td>-</td>
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</table>

Note. **p < .01, *p < .05.
Table 3 Continued. *Descriptive statistics, Bivariate Correlations, and Internal Consistency of Study Variables Included in Model 2 (N = 41).*

<table>
<thead>
<tr>
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<td>Physical activity</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>8 General efficacy</td>
<td>0.61**</td>
<td>0.10</td>
<td>0.63**</td>
<td>0.21</td>
<td>0.34*</td>
<td>0.49**</td>
<td>0.20</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 PAQ-A</td>
<td>0.39*</td>
<td>-0.11</td>
<td>0.32*</td>
<td>0.15</td>
<td>0.28</td>
<td>0.27</td>
<td>0.14</td>
<td>0.43**</td>
<td>-</td>
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<td>10 PAEE</td>
<td>0.01</td>
<td>-0.02</td>
<td>0.13</td>
<td>0.17</td>
<td>0.28</td>
<td>0.26</td>
<td>0.10</td>
<td>-0.04</td>
<td>0.20</td>
<td>-</td>
</tr>
<tr>
<td>Mean</td>
<td>87.52</td>
<td>88.94</td>
<td>83.11</td>
<td>88.54</td>
<td>85.77</td>
<td>84.57</td>
<td>96.05</td>
<td>87.55</td>
<td>2.54</td>
<td>24.92/11.46†</td>
</tr>
<tr>
<td>(SD)</td>
<td>(19.01)</td>
<td>(19.63)</td>
<td>(16.31)</td>
<td>(17.12)</td>
<td>(18.87)</td>
<td>(18.31)</td>
<td>(7.04)</td>
<td>(12.49)</td>
<td>(0.53)</td>
<td>(7.30)/(3.34)†</td>
</tr>
<tr>
<td>Internal consistency</td>
<td>.97</td>
<td>.95</td>
<td>.90</td>
<td>.96</td>
<td>.91</td>
<td>.87</td>
<td>.79</td>
<td>.90</td>
<td>.81</td>
<td></td>
</tr>
<tr>
<td>(alpha)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* **p < .01, *p < .05. PAQ-A: the Physical Activity Questionnaire for Adolescents; PAEE: physical activity energy expenditure; SD: Standard deviation; †Adjusted PAEE estimates.
Standard multiple regression analyses for Model 1. Two separate standard multiple regressions were used to assess the ability of the efficacy measures in Model 1 for predicting subjective (PAQ-A) and objective (PAEE) measures of free-living physical activity, respectively. Summary findings for each regression are presented in Tables 4 and 5. Inspection of Variance Inflation Factor (Range = 2.20-3.28) and Tolerance (Range = 0.31-0.45) values indicated that multicollinearity was not an issue in either of the analyses (Menard, 1995). With respect to subjective physical activity, the total variance explained by all measures of efficacy in the model as a whole was 20% (Adjusted $R^2 = 14\%$). Household and transportation efficacy were found to both be statistically significant unique contributors to subjective physical activity, with transportation efficacy recording a higher beta value ($beta = .38, p < 0.05$) than the household efficacy ($beta = -.31, p < 0.05$). In the regression analysis performed for objective physical activity, as a whole the efficacy measures explained 9% (Adjusted $R^2 = 3\%$) of the total variance. The ambulatory transportation and school efficacy was found to be the only statistically significant unique contributor to objective physical activity.
Table 4. Standard Multiple Regression for Subjectively Measured Physical Activity for Model 1.

<table>
<thead>
<tr>
<th>Physical activity efficacy constructs</th>
<th>$\beta$</th>
<th>$t$-values</th>
<th>Part $r^2$</th>
<th>Adjusted $R^2$</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Model</td>
<td>0.09</td>
<td>0.53</td>
<td>0.00</td>
<td>0.20</td>
<td>0.14</td>
</tr>
<tr>
<td>Leisure-time efficacy</td>
<td>-0.31</td>
<td>-2.02*</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household efficacy</td>
<td>0.38</td>
<td>2.19*</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation efficacy</td>
<td>0.05</td>
<td>0.32</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>School efficacy</td>
<td>-0.10</td>
<td>-0.69</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambulatory transportation and school efficacy</td>
<td>-0.25</td>
<td>1.70</td>
<td>0.03</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* *p* < .05, **p** < .00. $\beta$ = standardized beta co-efficient from multiple regression. Part $r^2$ = part correlation co-efficient squared, used to calculate the amount of unique contribution to total variance contributed by each predictor variable.
Table 5. *Standard Multiple Regression for Objectively Measured Physical Activity for Model 1.*

<table>
<thead>
<tr>
<th>Physical activity efficacy constructs</th>
<th>$\beta$</th>
<th>$t$-values</th>
<th>Part $r^2$</th>
<th>Adjusted $R^2$</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall model</td>
<td></td>
<td></td>
<td>0.09</td>
<td>0.03</td>
<td>1.40</td>
</tr>
<tr>
<td>Leisure-time efficacy</td>
<td>-0.06</td>
<td>-0.33</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household efficacy</td>
<td>0.06</td>
<td>0.37</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation efficacy</td>
<td>0.24</td>
<td>1.27</td>
<td>0.02</td>
<td></td>
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</tr>
<tr>
<td>School efficacy</td>
<td>0.24</td>
<td>1.51</td>
<td>0.02</td>
<td></td>
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</tr>
<tr>
<td>Ambulatory transportation and school efficacy</td>
<td>-0.32</td>
<td>-2.13*</td>
<td>0.05</td>
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<tr>
<td>General efficacy</td>
<td>-0.03</td>
<td>-0.20</td>
<td>0.00</td>
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</tbody>
</table>

*Note.* *$p < .05$. $\beta =$ standardized beta co-efficient from multiple regression. Part $r^2 =$ part correlation co-efficient squared, used to calculate the amount of unique contribution to total variance contributed by each predictor variable.
Standard multiple regression analyses for Model 2. Similar to the first model tested, two standard multiple regressions were conducted to examine the ability of the efficacy measures in Model 2 to predict subjective (PAQ-A) and objective (PAEE) measures of free-living physical activity. Summary findings for each regression are found in Tables 6 and 7. Once again, inspection of Variance Inflation Factor (Range = 1.43-5.18) and Tolerance (Range = 0.19-0.70) values indicated that multicollinearity was not an issue in either analysis (Menard, 1995). In the first regression performed for subjective physical activity, as a whole the efficacy measures explained 27% (Adjusted $R^2 = 9\%$) of the total variance. There was no statistically significant unique contributor to subjective physical activity. With respect to the second regression analysis performed for objective physical activity, altogether the efficacy measures were found to explain 24% (Adjusted $R^2 = 5\%$) of the variance. Once again, there was no statistically significant unique contributor to objective physical activity. However, a trend effect was detected where transportation efficacy and school efficacy both approached significance ($p = 0.10$).
Table 6. *Standard Multiple Regression for Subjectively Measured Physical Activity for Model 2.*

<table>
<thead>
<tr>
<th>Physical activity efficacy constructs</th>
<th>$\beta$</th>
<th>$t$-values</th>
<th>Part $r^2$</th>
<th>Adjusted $R^2$</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Model</td>
<td></td>
<td></td>
<td>0.27</td>
<td>0.09</td>
<td>1.51</td>
</tr>
<tr>
<td>Occupation efficacy</td>
<td>0.18</td>
<td>0.75</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active gaming efficacy</td>
<td>-0.22</td>
<td>-1.22</td>
<td>0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leisure-time efficacy</td>
<td>-0.25</td>
<td>-0.73</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household efficacy</td>
<td>-0.11</td>
<td>-0.33</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation efficacy</td>
<td>0.39</td>
<td>1.13</td>
<td>0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>School efficacy</td>
<td>0.06</td>
<td>0.28</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambulatory transportation and school efficacy</td>
<td>-0.05</td>
<td>-0.16</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General efficacy</td>
<td>0.37</td>
<td>1.46</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* $\beta =$ standardized beta co-efficient from multiple regression. Part $r^2 =$ part correlation co-efficient squared, used to calculate the amount of unique contribution to total variance contributed by each predictor variable.
Table 7. *Standard Multiple Regression for Objectively Measured Physical Activity for Model 2.*

<table>
<thead>
<tr>
<th>Physical activity efficacy constructs</th>
<th>$\beta$</th>
<th>$t$-values</th>
<th>Part $r^2$</th>
<th>Adjusted $R^2$</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Model</td>
<td></td>
<td></td>
<td>0.24</td>
<td>0.05</td>
<td>1.27</td>
</tr>
<tr>
<td>Occupation efficacy</td>
<td>-0.24</td>
<td>-0.97</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active gaming efficacy</td>
<td>-0.82</td>
<td>0.42</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leisure-time efficacy</td>
<td>0.07</td>
<td>0.20</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household efficacy</td>
<td>0.19</td>
<td>0.85</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation efficacy</td>
<td>0.60</td>
<td>1.72</td>
<td>0.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>School efficacy</td>
<td>1.64</td>
<td>0.11</td>
<td>0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambulatory transportation and school efficacy</td>
<td>-0.48</td>
<td>-1.60</td>
<td>0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General efficacy</td>
<td>-0.21</td>
<td>-0.82</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* $\beta$ = standardized beta co-efficient from multiple regression. Part $r^2$ = part correlation co-efficient squared, used to calculate the amount of unique contribution to total variance contributed by each predictor variable.
Discussion

The purpose of this study was to examine whether domain-specific physical activity efficacy could predict free-living physical activity in an adolescent sample. Another purpose was to compare the unique contribution of domain-specific physical activity efficacy with general physical activity efficacy in explaining activity. To the best of our knowledge, this is the first time a domain approach for assessing physical activity efficacy has been taken for predicting physical activity in a youth population.

Two independent models of efficacy were tested. With respect to the first model (Model 1), 20% and 9% of the subjective and objective physical activity variance was able to be explained, respectively. The addition of the domain-specific physical activity efficacy measures active gaming and occupation in Model 2, increased the amount of variance explained in subjective and objective physical activity, to 27% and 24%, respectively. The amount of activity variance explained by each of the current models is in line with (even slightly larger than) previous research, where contributions of task related and regulatory efficacy for explaining youth activity have been assessed together (Foley et al., 2008; Roberts et al., 2010). This is also the first time a measure of physical activity efficacy has been found to predict both the subjective and objective measure of physical activity collected from the same sample. Previous research has only shown physical activity efficacy to be predictive of either subjective (Ryan & Dzewaltowski, 2002) or objective (Roberts et al., 2010) measures of activity.

When compared with general physical activity efficacy, domain-specific physical activity efficacy was found to be the most significant predictor of physical activity
behaviour. In Model 1, both household efficacy and transportation efficacy provided a unique contribution to subjective physical activity, while ambulatory transportation and school efficacy was identified as a unique contributor to objective activity. No unique domain-specific physical activity efficacy measures were found in the Model 2 analyses, however a trend effect was detected for both transportation efficacy and school efficacy for predicting objectively assessed physical activity. Each of the domain specific efficacy constructs identified to providing a unique contribution to the physical activity measures in Model 1, represent activity performances that are incidental in nature. The unique relationship found between ambulatory transportation and school efficacy and objective physical activity was not surprising, given the relatively high percentage of time an adolescent spends performing this type of activity and the high degree of incidental physical activity captured when using objective measurement tools. However, the significant role transportation and household efficacy played with respect to subjective physical activity was unexpected. The PAQ-A asks individuals to recall the frequency of moderate-to-vigorous physical activity and does not take into account the time spent in light intensity activity and for the most part is structured (i.e., during physical education, straight after school). While the PAQ-A measure provides some correspondence to transportation based activities, this is not the case for household activities where household chores are performed for the most part at a light intensity level.

Consistent with previous research (Foley et al., 2008) the correlation between the subjective (PAQ-A) and objective (PAEE) physical activity measures was small in magnitude ($r = .26$). This indicates that the two physical activity constructs share common variance but are essentially measuring different types of physical activity.
Nevertheless, by assessing task related efficacy at a domain level, a proportion of physical activity variance was able to be explained irrespective of the measurement method used (subjective versus objective).

As with any research study, findings from the current study should be interpreted with the following limitations in mind. First and foremost, the sample size used to run the regression analyses were underpowered (Steven, 1996, p.72; Tabachnick & Fidell, 2007, p.123), particularly for the Model 2 data. The relatively small number of participants impacted not only the amount of physical activity variance explained by each of the models (see respective adjusted $R^2$ values) but also the level of significance ($F$ values) associated with each amount of explained variance. Only the amount of variance explained for subjective physical activity in Model 1, for instance, was found to be statistically significant. Although the inclusion of two additional domain efficacies (occupational and active gaming - Model 2) was found to increase the amount of variance explained in the subjective and objective physical activity, researchers must keep in mind that these types of activities are not performed regularly by all adolescents. Only half of the current sample was found to have completed the efficacy items regarding these types of physical activity. Therefore, if researchers are interested in including these domain-specific physical activity efficacy measures in future work, they must take into account the number of participants required for analyses to be adequately powered.

Secondly, we did not assess regulatory efficacy (e.g., barriers efficacy) in the current study. Previously, both task and self-regulatory efficacy constructs have been found to impact youth physical activity (Foley et al., 2008; Roberts et al., 2010) and together may
be able to increase the amount of physical activity variance explained presently. A domain-specific regulatory efficacy approach like the one used in the present study offers real promise and is recommended.

The weak to strong correlation coefficients ($r = 0.22 – 0.73, p < .05$) found between each of the independent domain-specific and general physical activity efficacy in Model 1, in addition to the moderate to strong correlations ($r = -, p < .01$) found between four of the seven domain efficacy scores in Model 2, indicates with some level of confidence, convergent validity for the SEPAQ. Future work should assess the discriminate validity of the SEPAQ; determining that domain-specific physical activity efficacy measures are distinct from theoretically dissimilar constructs (e.g., physical activity goal intention). Another fruitful avenue of research is to explore ways to strengthen the correspondence between domain-specific physical activity efficacy and subsequent physical activity behaviour. For instance, specific efficacious domains can be matched with physical activity being performed within specific contexts. For contextual physical activity information, objective data will need to be matched with self-reported activity patterns or ground position system devices. Through extension, leisure efficacy should predict leisure physical activity, transportation efficacy should predict transportation behaviour, school efficacy should predict school behaviour, etc.

Given the small sample size, gender differences regarding domain efficacies roles in predicting physical activity could not be examined. This type of inspection would be particularly interesting given the physical activity differences found between male and female adolescents (Dumith et al., 2011; Colley et al., 2011), specifically a larger
decrease in activity levels for female versus male adolescents. Limited research has looked at gender differences with respect to self-efficacy and physical activity (Spence et al., 2010; Wu, Pender, & Noureddine, 2003). Many adolescent studies have only targeted female participants (Dishman, 2009; 2010; Motl et al., 2002; Trost et al., 2002) or have combined the two genders together (Deforche et al., 2010; Roberts et al., 2010; Ryan & Dzewaltowski, 2002).

In summary, domain-specific physical activity efficacy assessed using the SEPAQ was found to be predictive of both subjective and objective free-living physical activity in a sample of adolescents. The present research findings provide a better understanding for task related efficacy for determining activity in adolescents, and strengthen the case for physical activity efficacy as a target strategy in intervention work promoting physical activity in this population. The domain-specific physical activity efficacy approach taken by the current research study is the first of its kind; hence it is highly recommended that these findings be replicated with larger and more diverse adolescent samples.
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Chapter 5

General Discussion

Summary, Implications, and Future Directions

The conceptualization and measurement of free-living physical activity and self-efficacious belief in adolescents can be difficult and challenging. However, accurate and valid measures of both physical activity and self-efficacy are pivotal in fully understanding what role self-efficacy plays for determining physical activity in this population (Dishman, 1994). In the present dissertation, three interrelated research studies were conducted to address the most salient issues in the literature to improve the level of response variance explained by physical activity efficacy for adolescent free-living physical activity.

The purpose of Study 1 (Campbell, 2012) was to investigate the measurement of agreement between the Actiheart device and doubly labelled water (DLW) for estimating free-living physical activity energy expenditure (PAEE) in adolescents. Overall, the Actiheart was found to overestimate PAEE. However, in contrast to physical activity measured using an accelerometer (Troiano et al., 2008), the Actiheart improved device wear time compliance for adolescents.

In Study 2, Campbell (2012) developed a domain-specific physical activity efficacy questionnaire, titled: The Self-Efficacy for Daily Physical Activity Questionnaire (SEPAQ). The questionnaire assessed physical activity efficacy in each of the main physical activity behavioural domains (i.e., at school, at home, at work, during leisure time, and for transportation). The factor structure and composition, and the internal consistency of the SEPAQ items revealed two tenable domain-specific physical activity
efficacy factor structures (or models). The first model (Model 1) revealed five domain-specific physical activity efficacy constructs (leisure-time, household, transportation, school, and ambulatory transportation and school). Two additional domain-specific physical activity efficacy constructs (occupation and active gaming) emerged in the second model (Model 2). Finally, Study 3 examined the predictive validity of domain-specific physical activity efficacy, assessed using the SEPAQ, for adolescent free-living physical activity. Both domain-specific physical activity efficacy models in Study 2 were tested. In order to determine whether a domain approach to assessing physical activity efficacy was more beneficial than a generalized measure, a general physical activity efficacy measure was also included in each of the models. Furthermore, physical activity was assessed objectively using the Actiheart device and subjectively using the Physical Activity Questionnaire for Adolescents (PAQ-A; Crocker, Bailley, Faulkner, Kowalski, & McGrath, 1997). Model 1 was found to explain 20% and 9% of the subjective and objective physical activity variance, respectively. The addition of active gaming and occupation physical activity efficacy domain measures in Model 2, increased the amount of variance explained in subjective and objective physical activity, to 27% and 24%, respectively. Compared with general physical activity efficacy, domain-specific physical activity efficacy was found to be the most significant predictor of physical activity behaviour. In Model 1, both household efficacy and transportation efficacy provided a unique contribution to subjective physical activity, while ambulatory transportation and school efficacy was identified as a unique contributor to objective activity. No unique domain-specific physical activity efficacy measures were found in the Model 2 analyses, however a trend effect was detected for both transportation efficacy and school efficacy
for predicting objectively assessed physical activity. Overall, the *domain-specific physical activity efficacy* assessed using the SEPAQ was found to be predictive of both subjective and objective free-living physical activity in a sample of adolescents. These findings offer a better understanding for *physical activity efficacy* for determining activity in adolescents, and strengthen the case for *physical activity efficacy* as a target strategy in intervention work promoting physical activity in this population.

Despite the limitations noted in each of the three studies, this dissertation research has made some notable contributions with respect to how physical activity and *physical activity efficacy* are assessed in adolescents. Furthermore, these studies provide some promising opportunities for future research. For Study 1, a lack of adolescent-derived HR and ACC prediction equations used in conjunction with the Actiheart HR and ACC data, make it difficult to conclude that this device is not a viable tool for assessing PAEE in adolescents. Future research should look at developing adolescent-specific prediction equations, as this would likely enhance the validity of the Actiheart device and potentially improve the precision in which physical activity is measured in adolescents.

The psychometric (Study 2) and predictive (Study 3) findings for *domain-specific physical activity efficacy* are new and novel. Hence, replication of these findings in more diverse adolescent samples is required. In addition, future research should investigate ways to strengthen the correspondence between *domain-specific physical activity efficacy* and subsequent physical activity behaviour. For instance, specific efficacious domains (transportation efficacy) can be matched with physical activity being performed within specific contexts (transportation physical activity). This would allow for a better understanding for the role *physical activity efficacy* has for activity performed
within different contexts, and keeps in line with advancements being made in the realm of physical activity measurement (Corder, Ekelund, Steele, Wareham, & Brage, 2008; Ridley, Olds, & Hill 2006). For instance, technological advancements regarding merging objective physical activity measurement tools with global positioning and geographic information systems and subjective recall questionnaires has lead to increased measurement precision and a better assessment regarding the types of physical activities being performed within in each behavioural context (or domain) in youth (Wheeler, 2010).
References


Appendix A

Demographic Questionnaire – Study 1
DEMOGRAPHIC INFORMATION

ID Number: ____________________

Age: ________ Date of Birth (dd/mm/yyyy): _____________________

Gender: Male Female

Race: Caucasian African Asian Aboriginal Other: (please specify) ____________________

Weight (lbs):_____________________
Height (ft/in):_____________________

Do you have any food allergies? Yes No

If yes, please specify: ________________________________

__________________________________________

__________________________________________
Appendix B

Demographic Questionnaire - Study 2 and Study 3 (Canadian participants)
DEMOGRAPHIC INFORMATION

Age: __________

Gender: Male Female

Race: (please circle the appropriate response(s))

- Aboriginal (Inuit, Métis, North American Indian)
- Arab/West Asian (e.g., Armenian, Egyptian, Iranian, Lebanese, Moroccan)
- Black (e.g., African, Haitian, Jamaican, Somali)
- Chinese
- Filipino
- Japanese
- Korean
- Latin American
- South Asian
- South East Asian
- White (Caucasian)
- Other

Weight (lbs):______ or (kg):________

Height (cm):_____________________

Current City/Town: ________________________

*For example: if your address is: 1234 Smith St., Strathroy, ON., N7G 5M3 Your City/Town would be: Strathroy
Appendix C

Demographic Questionnaire – Study 3 (New Zealand participants)
DEMOGRAPHIC INFORMATION

Participant I.D. ____________________

Age: ________

Gender: Male       Female

Ethnicity: Of the following, which ethnic group do you identify with most? I.e. the ethnic group that you feel most connected to? (select one only)

☐ Maori

☐ Pacific Island (including Samoan, Tongan, Cook Island Maori, Niuean, Fijian, Tokelauean)

☐ New Zealand European or other (such as Dutch, Japanese, Chinese, Indian)

☐ Refuse to answer

Please leave blank (researchers will take these measures)

Weight (kg): ________

Height (cm): ____________________
Appendix D

Physical activity survey
Physical Activity Survey

Please list the following physical activities you do in each of the four sections highlighted below. We are interested in physical activities that you participate in during your day-to-day routines. Physical activities will be sub-categorized by the intensity you perform each activity at (light, moderate, or hard). Please see the definitions below regarding what classifies an activity as light, moderate, or vigorous. You may leave any section(s) blank if you do not engage in that type of physical activity. You may also indicate participating in the same activity in more than one section, and more than once per section, if you engage in the same activity at two or more different intensities. In addition we ask that you include information about how much time per day (in minutes) you spend doing each activity and how many days per week you do each activity.

**Light activity:** You are moving around, but your heart rate and breathing do not increase very much. You probably will not be sweating doing these unless the weather is really hot. You would be able to talk easily through the activity.

**Moderate activity:** Your breathing and heart rate increase. You may start to sweat, your legs might feel a little bit tired and you may feel out of breath. You may also find it hard to talk during the activity.

**Vigorous activity:** your heart beats very fast, your breathing is fast and you start sweating. You may feel exhausted and out of breath. Your legs would probably feel heavy. It would be very hard to talk during the activity.
**Section 1: Commuting Activity**

Please list the 3 most usual types of physical activity (in order of most to least frequent) you do for transportation purposes - getting you to and from your destinations (e.g., getting to and from school, going over to a friend's house, going to the park). Some example activities are: walking, biking, rollerblading, and skate boarding. Remember you can leave this section blank or a portion of this section blank (e.g., no vigorous activities) if you do not participate in that type of activity.

<table>
<thead>
<tr>
<th>Light Activities</th>
<th>For how long? (minutes)</th>
<th>Number of Days per week engaged in?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1._______________</td>
<td>____________min</td>
<td>______days</td>
</tr>
<tr>
<td>2._______________</td>
<td>____________min</td>
<td>______days</td>
</tr>
<tr>
<td>3._______________</td>
<td>____________min</td>
<td>______days</td>
</tr>
</tbody>
</table>

**Moderate Activities**

| 1._______________ | ____________min          | ______days                         |
| 2._______________ | ____________min          | ______days                         |
| 3._______________ | ____________min          | ______days                         |

**Vigorous Activities**

| 1._______________ | ____________min          | ______days                         |
| 2._______________ | ____________min          | ______days                         |
| 3._______________ | ____________min          | ______days                         |
Section 2: Activity at School

Please write down the types of physical activity you do while at school (e.g., recess, sport, and physical education class). Remember you can leave this section blank or a portion of this section blank (e.g., no vigorous activities) if you do not participate in that type of activity.

<table>
<thead>
<tr>
<th>Light Activities</th>
<th>For how long?</th>
<th>Number of Days per week engaged in?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(minutes)</td>
<td></td>
</tr>
<tr>
<td>1._______________</td>
<td>_______min</td>
<td>_____days</td>
</tr>
<tr>
<td>2._______________</td>
<td>_______min</td>
<td>_____days</td>
</tr>
<tr>
<td>3._______________</td>
<td>_______min</td>
<td>_____days</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moderate Activities</th>
<th>For how long?</th>
<th>Number of Days per week engaged in?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(minutes)</td>
<td></td>
</tr>
<tr>
<td>1._______________</td>
<td>_______min</td>
<td>_____days</td>
</tr>
<tr>
<td>2._______________</td>
<td>_______min</td>
<td>_____days</td>
</tr>
<tr>
<td>3._______________</td>
<td>_______min</td>
<td>_____days</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vigorous Activities</th>
<th>For how long?</th>
<th>Number of Days per week engaged in?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(minutes)</td>
<td></td>
</tr>
<tr>
<td>1._______________</td>
<td>_______min</td>
<td>_____days</td>
</tr>
<tr>
<td>2._______________</td>
<td>_______min</td>
<td>_____days</td>
</tr>
<tr>
<td>3._______________</td>
<td>_______min</td>
<td>_____days</td>
</tr>
</tbody>
</table>
Section 3: Household and Work (if applicable) Activity

Please indicate the different activities you do around the house and/or at work (if applicable). Some example activities are vacuuming, cutting grass, cleaning, dusting, stocking shelves, and waiting tables. Remember you can leave this section blank or a portion of this section blank (e.g., no vigorous activities) if you do not participate in that type of activity.

<table>
<thead>
<tr>
<th>Light Activities</th>
<th>For how long? (minutes)</th>
<th>Number of Days per week engaged in?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1._______________</td>
<td>__________min</td>
<td>______days</td>
</tr>
<tr>
<td>2._______________</td>
<td>__________min</td>
<td>______days</td>
</tr>
<tr>
<td>3._______________</td>
<td>__________min</td>
<td>______days</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moderate Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1._______________</td>
</tr>
<tr>
<td>2._______________</td>
</tr>
<tr>
<td>3._______________</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vigorous Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1._______________</td>
</tr>
<tr>
<td>2._______________</td>
</tr>
<tr>
<td>3._______________</td>
</tr>
</tbody>
</table>
Section 4: Leisure Time Physical Activity

Please write down the physical activities you do in your leisure time (free time). This includes any physical activity you do outside of school! Example activities include: playing soccer, dancing, skipping, and playing Nintendo Wii). Remember you can leave this section blank or a portion of this section blank (e.g., no vigorous activities) if you do not participate in that type of activity.

<table>
<thead>
<tr>
<th>Light Activities</th>
<th>For how long? (minutes)</th>
<th>Number of Days per week engaged in?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.______________</td>
<td>_________min</td>
<td>_____days</td>
</tr>
<tr>
<td>2.______________</td>
<td>_________min</td>
<td>_____days</td>
</tr>
<tr>
<td>3.______________</td>
<td>_________min</td>
<td>_____days</td>
</tr>
</tbody>
</table>

Moderate Activities

| 1.______________ | _________min | _____days |
| 2.______________ | _________min | _____days |
| 3.______________ | _________min | _____days |

Vigorous Activities

| 1.______________ | _________min | _____days |
| 2.______________ | _________min | _____days |
| 3.______________ | _________min | _____days |

Do you have a condition that limits your ability to be physically active (e.g., has a physical impairment/injury, recently diagnosed with Mono)? If no please leave this section blank. If yes please list and explain:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Thank You!
Appendix E

The Self-Efficacy for Daily Physical Activity Questionnaire (SEPAQ)
The Self-Efficacy for Daily Physical Activity Questionnaire

In answering the following questions you will be asked to think about **HOW CONFIDENT** you are that you can participate in a variety of physical activities at increasing intensity levels (light, moderate, and/or vigorous) and increasing periods of time (in minutes). The word “confident” refers to your belief that you can do something well. Please see the definitions below to help familiarize you with what is considered a light, moderate, and vigorous physical activity.

**Light activity:** You are moving around, but your heart rate and breathing do not increase very much. You probably will not be sweating doing these activities unless the weather is really hot. You would be able to talk easily through the activity.

![Light activity images]

**Moderate activity:** Your breathing and heart rate increase. You may start to sweat, your legs might feel a little bit tired and you may feel out of breath. You may also find it hard to talk during the activity.

![Moderate activity images]

**Vigorous activity:** Your heart beats very fast, your breathing is fast and you start sweating. You may feel exhausted and out of breath. Your legs would probably feel heavy. It would be very hard to talk during the activity.

![Vigorous activity images]
School Physical Activity

In answering the following questions think about **HOW CONFIDENT** you are in performing the following physical activities at school.

Using the scale below, please check the appropriate response (0-100%) for each question.

<table>
<thead>
<tr>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all confident</td>
<td>Kind of confident</td>
<td>Completely confident</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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At school you may walk to and from class and/or through the halls during lunch break which can often involve a few stairs. These walking activities are typically light in intensity level.

1. How confident are you that you can walk **15 MINUTES** during school time at a **LIGHT INTENSITY** level **EVERY DAY** of the school week?

   0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
   [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

2. How confident are you that you can walk **30 MINUTES** during school time at a **LIGHT INTENSITY** level **EVERY DAY** of the school week?

   0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
   [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

3. How confident are you that you can walk **60 MINUTES** during school time at a **LIGHT INTENSITY** level **EVERY DAY** of the school week?

   0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
   [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]
At school you may be enrolled in physical education classes and/or engage in before/after school activities (band, soccer, volleyball, etc.). These activities can vary in intensity but are usually moderate to vigorous.

4. How confident are you that you can complete **30 MINUTES** of physical education and/or school activities at a **MODERATE INTENSITY** level **EVERY DAY** of the **school week**?

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5. How confident are you that you can complete **60 MINUTES** of physical education and/or school activities at a **MODERATE INTENSITY** level **EVERY DAY** of the **school week**?

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6. How confident are you that you can complete **120 MINUTES** of physical education and/or school activities at a **MODERATE INTENSITY** level **EVERY DAY** of the **school week**?

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7. How confident are you that you can complete **15 MINUTES** of physical education and/or school activities at a **VIGOROUS INTENSITY** level **EVERY DAY** of the **school week**?

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8. How confident are you that you can complete **30 MINUTES** of physical education and/or school activities at a **VIGOROUS INTENSITY** level **EVERY DAY** of the **school week**?

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9. How confident are you that you can complete **60 MINUTES** of physical education and/or school activities at a **VIGOROUS INTENSITY** level **EVERY DAY** of the **school week**?

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Transport Physical Activity

When answering the following questions think about how confident you are in performing the following physical activities for transportation purposes (getting to or from a specific location). The word confident and the physical activity intensities (light, moderate, vigorous) are described on the first page of the questionnaire package.

Using the scale below, please check the appropriate response (0-100%) for each question.

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You may walk at a light intensity level, in order to get to and/or from specific places. Some examples include getting to and/or from school or work, the bus, a friend’s house or up town for lunch.

1. How confident are you that you can complete **15 MINUTES** of walking at a **LIGHT INTENSITY** level on **FIVE OR MORE** days of the week?

   | ✔ | ❌ | ❌ | ❌ | ❌ | ❌ | ❌ | ❌ | ❌ | ❌ | ❌ |

2. How confident are you that you can complete **30 MINUTES** of walking at a **LIGHT INTENSITY** level on **FIVE OR MORE** days of the week?

   | ❌ | ❌ | ❌ | ✔ | ❌ | ❌ | ❌ | ❌ | ❌ | ❌ | ❌ |

3. How confident are you that you can complete **60 MINUTES** of walking at a **LIGHT INTENSITY** level on **FIVE OR MORE** days of the week?

   | ❌ | ❌ | ❌ | ✔ | ❌ | ❌ | ❌ | ❌ | ❌ | ❌ | ❌ |
Sometimes you may bike or jog at a moderate intensity, as a means of transportation, in order to get to or from specific place.

4. How confident are you that you can complete 15 MINUTES of biking and/or jogging at a MODERATE INTENSITY level on FIVE OR MORE days of the week?

0%  10%  20%  30%  40%  50%  60%  70%  80%  90%  100%

5. How confident are you that you can complete 30 MINUTES of biking and/or jogging at a MODERATE INTENSITY level on FIVE OR MORE days of the week?

0%  10%  20%  30%  40%  50%  60%  70%  80%  90%  100%

6. How confident are you that you can complete 60 MINUTES of biking and/or jogging at a MODERATE INTENSITY level on FIVE OR MORE days of the week?

0%  10%  20%  30%  40%  50%  60%  70%  80%  90%  100%
Household Physical Activity

In answering the following questions think about how confident you are in performing the following physical activities as part of your household chores. The word confident and the physical activity intensities (light, moderate, vigorous) are described on the first page of the questionnaire package.

Using the scale below, please check the appropriate response (0-100%) for each question.

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Cleaning (vacuuming, dusting, etc.), doing laundry and doing dishes (washing, drying, and loading/unloading the dishwasher) are common household chores that you may perform at a light or moderate intensity. If you live in a rural area, household chores may also include physical activities such as cleaning stables and feeding farm animals.

1. How confident are you that you can complete 15 MINUTES of household chores at a LIGHT INTENSITY level TWO OR MORE days of the week?

2. How confident are you that you can complete 30 MINUTES of household chores at a LIGHT INTENSITY level on TWO OR MORE days of the week?

3. How confident are you that you can complete 60 MINUTES of household chores at a LIGHT INTENSITY level on TWO OR MORE days of the week?
4. How confident are you that you can complete **15 MINUTES** of household chores at a **MODERATE INTENSITY** level on **TWO OR MORE** days of the week?

   □ 0%   □ 10%  □ 20%  □ 30%  □ 40%  □ 50%  □ 60%  □ 70%  □ 80%  □ 90%  □ 100%

5. How confident are you that you can complete **30 MINUTES** of household chores at a **MODERATE INTENSITY** level on **TWO OR MORE** days of the week?

   □ 0%   □ 10%  □ 20%  □ 30%  □ 40%  □ 50%  □ 60%  □ 70%  □ 80%  □ 90%  □ 100%

6. How confident are you that you can complete **60 MINUTES** of household chores at a **MODERATE INTENSITY** level on **TWO OR MORE** days of the week?

   □ 0%   □ 10%  □ 20%  □ 30%  □ 40%  □ 50%  □ 60%  □ 70%  □ 80%  □ 90%  □ 100%
Leisure and Recreation Physical Activity

In answering the following questions think about how confident you are in performing the following physical activities during your free time. The word confident and the physical activity intensities (light, moderate, vigorous) are described on the first page of the questionnaire package.

Using the scale below, please check the appropriate response (0-100%) for each question.

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You may participate in sports or go to the gym during your free time. For example, you may play rugby, hockey, or soccer, dance, horseback ride, go for a run, lift weights, etc. Think about which activities you do specifically. These types of activities are typically performed at a moderate to vigorous intensity level.

1. How confident are you that you can complete **30 MINUTES** of these physical activities at a **MODERATE INTENSITY** level on **THREE OR MORE** days of the week?

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2. How confident are you that you can complete **60 MINUTES** of these physical activities at a **MODERATE INTENSITY** level on **THREE OR MORE** days of the week?

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3. How confident are you that you can complete **120 MINUTES** of these physical activities at a **MODERATE INTENSITY** level on **THREE OR MORE** days of the week?

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4. How confident are you that you can complete **15 MINUTES** of these physical activities at a **VIGOROUS INTENSITY** level on **THREE OR MORE** days of the week?

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- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100%

5. How confident are you that you can complete **30 MINUTES** of these physical activities at a **VIGOROUS INTENSITY** level on **THREE OR MORE** days of the week?

- 0%
- 10%
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- 30%
- 40%
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- 100%

6. How confident are you that you can complete **60 MINUTES** of these physical activities at a **VIGOROUS INTENSITY** level on **THREE OR MORE** days of the week?

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- 100%
Active video games (e.g., Wii, DanceDanceRevolution, EyeToy, Xbox360, etc.) are common activities you may enjoy during your free-time. These activities can be light to moderate in intensity level. If you do not play active video games please select don’t play.

1. How confident are you that you can complete **15 MINUTES** of active gaming at a **LIGHT INTENSITY** level **THREE OR MORE** days of the week?

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2. How confident are you that you can complete **30 MINUTES** of active gaming at a **LIGHT INTENSITY** level **THREE OR MORE** days of the week?

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3. How confident are you that you can complete **60 MINUTES** of active gaming at a **LIGHT INTENSITY** level **THREE OR MORE** days of the week?

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4. How confident are you that you can complete **15 MINUTES** of active gaming at a **MODERATE INTENSITY** level **THREE OR MORE** days of the week?

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5. How confident are you that you can complete **30 MINUTES** of active gaming at a **MODERATE INTENSITY** level **THREE OR MORE** days of the week?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%  
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐  Don’t play ☐

6. How confident are you that you can complete **60 MINUTES** of active gaming at a **MODERATE INTENSITY** level **THREE OR MORE** days of the week?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%  
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐  Don’t play ☐
Occupation Physical Activity

You may have a job that involves being physically active. This does not include a desk job where you are often seated. For example, activities may include babysitting young children, stocking shelves, waiting tables, serving customers, preparing foods, etc. These types of activities are typically light to moderate in intensity. The word confident and the physical activity intensities (light, moderate, vigorous) are described on the first page of the questionnaire package.

Using the scale below, please check the appropriate response (0-100%) for each question. Or select don’t work if you do not currently have a job.

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1. How confident are you that you can complete **30 MINUTES** of **LIGHT INTENSITY** physical activity at work on **THREE OR MORE** days of the week?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100% Don’t work

2. How confident are you that you can complete **60 MINUTES** of **LIGHT INTENSITY** physical activity at work on **THREE OR MORE** days of the week?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100% Don’t work

3. How confident are you that you can complete **120 MINUTES** of **LIGHT INTENSITY** physical activity at work on **THREE OR MORE** days of the week?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100% Don’t work
4. How confident are you that you can complete 30 MINUTES of MODERATE INTENSITY physical activity at work on THREE OR MORE days of the week?

0%  10%  20%  30%  40%  50%  60%  70%  80%  90%  100%  Don’t work

☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐

5. How confident are you that you can complete 60 MINUTES of MODERATE INTENSITY physical activity at work on THREE OR MORE days of the week?

0%  10%  20%  30%  40%  50%  60%  70%  80%  90%  100%  Don’t work

☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐

6. How confident are you that you can complete 120 MINUTES of MODERATE INTENSITY physical activity at work on THREE OR MORE days of the week?

0%  10%  20%  30%  40%  50%  60%  70%  80%  90%  100%  Don’t work

☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐  ☐
Appendix F

Calculating the domain-specific physical activity efficacy scores from
The Self-Efficacy for Daily Physical Activity Questionnaire (SEPAQ)
SEPAQ Item codes:

School physical activity items:
1. – SEPAQ1s
2. – SEPAQ2s
3. – SEPAQ3s
4. – SEPAQ4s
5. – SEPAQ5s
6. – SEPAQ6s
7. – SEPAQ7s
8. – SEPAQ8s
9. – SEPAQ9s

Transportation physical activity items:
1. – SEPAQ1t
2. – SEPAQ2t
3. – SEPAQ3t
4. – SEPAQ4t
5. – SEPAQ5t
6. – SEPAQ6t

Household physical activity items:
1. – SEPAQ1h
2. – SEPAQ2h
3. – SEPAQ3h
4. – SEPAQ4h
5. – SEPAQ5h
6. – SEPAQ6h

Leisure-time physical activity items:
1. – SEPAQ1l
2. – SEPAQ2l
3. – SEPAQ3l
4. – SEPAQ4l
5. – SEPAQ5l
6. – SEPAQ6l

Leisure-time active gaming items:
1. – SEPAQav1
2. – SEPAQav2
3. – SEPAQav3
4. – SEPAQav4
5. – SEPAQav5
6. – SEPAQav6

Occupation physical activity items:
1. – SEPAQ1o
2. – SEPAQ2o
3. – SEPAQ3o
4. – SEPAQ4o
5. – SEPAQ5o
6. – SEPAQ6o
Calculating domain-specific physical activity efficacy for Model 1 and Model 2.

**Model 1: 5 domain-specific physical activity efficacy scores**

1. Leisure-time physical activity efficacy

Calculate the mean efficacy score (0-100%) from each of the following items:

- SEPAQ1l
- SEPAQ2l
- SEPAQ3l
- SEPAQ4l
- SEPAQ5l
- SEPAQ6l

2. Household physical activity efficacy

Calculate the mean efficacy score (0-100%) from each of the following items:

- SEPAQ1h
- SEPAQ2h
- SEPAQ3h
- SEPAQ5h
- SEPAQ6h

3. Ambulatory transportation and school physical activity efficacy:

Calculate the mean efficacy score (0-100%) from each of the following items:

- SEPAQ1s
- SEPAQ2s
- SEPAQ3s
- SEPAQ1t
- SEPAQ2t
- SEPAQ3t

4. Transportation physical activity efficacy:

Calculate the mean efficacy score (0-100%) from each of the following items:

- SEPAQ4t
- SEPAQ5t
- SEPAQ6t

5. School physical activity efficacy:

Calculate the mean efficacy score (0-100%) from each of the following items:

- SEPAQ4s
- SEPAQ5s
- SEPAQ6s
- SEPAQ7s
- SEPAQ8s
- SEPAQ9s
Model 2: 7 domain-specific physical activity efficacy scores

1. Household physical activity efficacy

Calculate the mean efficacy score (0-100%) from each of the following items:

- SEPAQ1h
- SEPAQ2h
- SEPAQ3h
- SEPAQ4h
- SEPAQ5h
- SEPAQ6h

2. School physical activity efficacy

Calculate the mean efficacy score (0-100%) from each of the following items:

- SEPAQ4s
- SEPAQ5s
- SEPAQ6s
- SEPAQ7s

3. Active gaming physical activity efficacy

Calculate the mean efficacy score (0-100%) from each of the following items:

- SEPAQav1
- SEPAQav2
- SEPAQav3
- SEPAQav4
- SEPAQav5
- SEPAQav6

4. Ambulatory transportation and school physical activity efficacy

Calculate the mean efficacy score (0-100%) from each of the following items:

- SEPAQ1s
- SEPAQ2s
- SEPAQ1t
- SEPAQ2t
- SEPAQ3t

5. Occupation physical activity efficacy

Calculate the mean efficacy score (0-100%) from each of the following items:

- SEPAQ1o
- SEPAQ2o
- SEPAQ3o
- SEPAQ4o
- SEPAQ5o
- SEPAQ6o
6. Transportation physical activity efficacy

Calculate the mean efficacy score (0-100%) from each of the following items:

- SEPAQ4t
- SEPAQ5t
- SEPAQ6t

7. Leisure-time physical activity efficacy

Calculate the mean efficacy score (0-100%) from each of the following items:

- SEPAQ2l
- SEPAQ3l
- SEPAQ5l
- SEPAQ6l
Appendix G

The Self-Efficacy Scale
The Self-Efficacy Scale

In answering the following questions you will be asked to think about how confident you are that you can participate in physical activities that are described as light / moderate / hard. The word “confident” refers to the belief that you have in yourself that you can do something well. Please circle the appropriate percentage (%) indicating your response for each of the questions.

**Light activity:** You are moving around, but your heart rate and breathing do not increase very much. You probably will not be sweating doing these unless the weather is really hot. You would be able to talk easily through the activity.

Using the scale below, please check the appropriate response (0-100%) for each question.

<table>
<thead>
<tr>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all confident</td>
<td>Really not confident</td>
<td>Kind of confident</td>
<td>Reasonably confident</td>
<td>Almost confident</td>
<td>Completely confident</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. How confident are you that you can complete **10 minutes** of physical activity at a **light** intensity level **five** OR MORE days next week?

2. How confident are you that you can complete **30 minutes** of physical activity at a **light** intensity level **five** days next week?

3. How confident are you that you can complete **60 minutes** of physical activity at a **light** intensity level **five** days next week?
Moderate activity: Your breathing and heart rate increase. You may start to sweat, your legs might feel a little bit tired and you may feel out of breath. You may also find it hard to talk during the activity.

Using the scale below, please check the appropriate response (0-100%) for each question.

<table>
<thead>
<tr>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all confident</td>
<td>Really not confident</td>
<td>Kind of confident</td>
<td>Reasonably confident</td>
<td>Almost confident</td>
<td>Completely confident</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. How confident are you that you can complete **10 minutes** of physical activity at a **moderate** intensity level **five** days next week?

5. How confident are you that you can complete **30 minutes** of physical activity at a **moderate** intensity level **five** days next week?

6. How confident are you that you can complete **60 minutes** of physical activity at a **moderate** intensity level **five** days next week?
**Vigorous activity:** your heart beats very fast, your breathing is fast and you start sweating. You may feel exhausted and out of breath. Your legs would probably feel heavy. It would be very hard to talk during the activity.

Using the scale below, please check the appropriate response (0-100%) for each question.

<table>
<thead>
<tr>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all confident</td>
<td>Really not confident</td>
<td>Kind of confident</td>
<td>Reasonably confident</td>
<td>Almost confident</td>
<td>Completely confident</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. How confident are you that you can complete **10 minutes** of physical activity at a **hard** intensity level **five** OR **MORE** days next week?

0% □ 10% □ 20% □ 30% □ 40% □ 50% □ 60% □ 70% □ 80% □ 90% □ 100% □

8. How confident are you that you can complete **30 minutes** of physical activity at a **hard** intensity level **five** days next week?

0% □ 10% □ 20% □ 30% □ 40% □ 50% □ 60% □ 70% □ 80% □ 90% □ 100% □

9. How confident are you that you can complete **60 minutes** of physical activity at a **hard** intensity level **five** days next week?

0% □ 10% □ 20% □ 30% □ 40% □ 50% □ 60% □ 70% □ 80% □ 90% □ 100% □
Appendix H

The Physical Activity Questionnaire for Adolescents (PAQ-A)
Name: ___________________________  Age: __________

Sex: M____ F______  Grade: __________

Teacher: ___________________________

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

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

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

<table>
<thead>
<tr>
<th>Activity</th>
<th>1-2</th>
<th>3-4</th>
<th>5-6</th>
<th>7 times or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skipping</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Rowing/canoeing</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>In-line skating</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Tag</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Walking for exercise</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Bicycling</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Jogging or running</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Aerobics</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Swimming</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Baseball, softball</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Dance</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Football</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Badminton</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Skateboarding</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Soccer</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Street hockey</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Volleyball</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Floor hockey</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Basketball</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Ice skating</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Cross-country skiing</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Ice hockey/hockey</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

Other: ___________________________

| Other:                       |○    |○    |○    |○               |

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

- I don’t do PE .................................................. ○
- Hardly ever .................................................. ○
- Sometimes .................................................. ○
- Quite often .................................................. ○
- Always .................................................. ○

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

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

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

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

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

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

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

- None .......................................................... ○
- 1 time .......................................................... ○
- 2—3 times ........................................................ ○
- 4—5 times ........................................................ ○
- 6 or more times ................................................ ○
7. Which one of the following describes you best for the last 7 days? Read all five statements before deciding on the one answer that describes you.

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

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

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

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

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

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

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Little bit</th>
<th>Medium</th>
<th>Often</th>
<th>Very often</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Tuesday</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Wednesday</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Thursday</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Friday</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Saturday</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Sunday</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

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

Yes .................................................................○

No .................................................................○

If Yes, what prevented you? __________________________________________

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Appendix I

Letter of Information and Consent Form – Study 1
LETTER OF INFORMATION

Title: ASSESSING ENERGY EXPENDITURE IN ADOLESCENTS USING THE ACTIHEART™

Researchers: Nerissa Podolinsky and Harry Prapavessis

The pronouns you and your should be read as referring to the participant rather than the parent / guardian / next of kin who is signing the consent form for the participant.

You are being invited to participate in a health research study. The study looks to validate an objective measurement tool, call the Actiheart™ for measuring physical activity energy expenditure (PAEE). The Actiheart™ has been validated in both an adult and child population for structured treadmill walking and running, in addition to simulated real life activities such as washing windows and shoveling dirt. However, this device has yet to be validated as an accurate measure of PAEE for free-living activity, the volitional day to day activities individuals engage in throughout their daily lives. Without an accurate quantification of the energy expended from these types of activities, perceptions on what type of lifestyle (sedentary, moderately active, or active) a Canadian lives may be skewed. You have been selected as one of thirty-five students, to validate the Actiheart™ device for use in an adolescent population. In order to be eligible for this study you must be (a) between the age of 16-18 years (b) enrolled in an advanced physical education course (c) contactable throughout the full duration of the study (d) a non diabetic and (e) physical able (no contra-indication to being physically active). This research is completely voluntary and you do not have to take part in it.

The specific purpose of this study is to demonstrate the Acitheart™ device as an accurate measure of PAEE in an adolescent population for both structured lab-based activity as well as for a variety of activities adolescents partake in during their daily lives. During a one hour laboratory experience, the Acitheart™ PAEE measures will be compared to measures derived from indirect calorimetry for structured treadmill walking and running activities. In addition, the Acitheart™ total PAEE measures for daily activities over a 10 day period will be compared to PAEE measures derived from doubly labeled water (DLW). If the Acitheart™ PAEE measures show agreement with the PAEE measures calculated using indirect calorimetry and DLW methods, this tool will provide health researchers with a more precise instrument for quantifying the total energy that humans expend during daily lifestyle activities and behaviors.
The Actiheart™
The Actiheart™ is a device worn on the chest, attached by two adhesive electrodes. This device simultaneously collects data for real-time heart rate and movement counts. Movement counts are a quantification of the amount of acceleration an individual’s arms and legs produce. Heart rate and movement count data are collected every 15 seconds and is stored within the internal memory of the device. These data are downloaded from the Actiheart™ onto a computer. Then, using specific equations provided with the Actiheart computer software, an overall measure of an individual’s total PAEE is calculated. (See diagram below as to how the Actiheart™ attaches to an individual’s chest)

![Diagram showing how the Actiheart™ attaches to the chest](image)

The Actiheart™ attaches to the chest by two adhesive electrodes. One electrode is placed on the sternum at the level of the third intercostal space. While, the second electrode is placed adjacent to the first somewhere on the major Pectoralis muscle. Electrodes need to be replaced every couple days, or as they become unadhesive due to perspiration, being dampened in a shower, etc.

Indirect Calorimetry
Indirect calorimetry estimates energy expenditure via the measurement of oxygen consumption and carbon dioxide (CO2) production. For PAEE measurements using indirect calorimetry, an individual must be suited with a ventilation mask. The ventilation mask is hooked up to a gas analysis machine called a metabolic cart which will analyze the amount of oxygen an individual consumes, as well as the amount of CO2 an individual produces. The mask is worn for the full duration of time the individual engages in activity for. The more intense an activity is or the more active an individual is, the greater the amount of oxygen is consumed and the greater the amount of CO2 is produced. Thus, the more energy one will expend. (See diagram on how an individual is hooked up to indirect calorimetry machine).

![Diagram showing how an individual is hooked up to indirect calorimetry machine](image)

This is a picture of a COSMED Quark b2 indirect calorimeter ventilation mask. With indirect calorimetry, an individual is fitted with a similar rubberized gas mask as shown here. This mask is directly connected to a machine by tubing which will analyze the total amount of oxygen one consumes and the total amount of carbon dioxide one produces while performing a certain type of activity (e.g., treadmill walking).
**Doubly Labeled Water (DLW)**

DLW is a liquid mixture containing the two stable isotopes deuterium ($^2$H) and oxygen-18 (O18). Deuterium is an isotope of hydrogen (H2) and oxygen-18 an isotope of oxygen (O). Stable isotopes are not radioactive and only differ from the common elements (in this case hydrogen and oxygen) by having a slightly heavier atomic mass. Atomic mass is the total mass of all protons, neutrons and electrons bound together forming a single atom. (See diagram below). Both the stable isotopes deuterium and oxygen-18 are found in natural abundance in the earth’s oceans, as well as naturally in trace amounts within the human body.

![Diagram](attachment:image.png)

This diagram illustrates how a deuterium and oxygen-18 stable isotope differs with respect to the common elements hydrogen and oxygen. A typical hydrogen atom only possesses a single proton in its nucleus. Where as, a deuterium atom has the addition of a neutron along with a single proton in its nucleus. In a typical oxygen atom, there are eight protons and eight neutrons in the nucleus. The addition of two more neutrons into the nucleus of an oxygen atom makes the stable isotope oxygen-18. The difference in the number of neutrons between the isotopes and the elements still means that these isotope atoms have a similar electric charge to that of the hydrogen and oxygen atoms but differ with respect to atomic mass.

With using the DLW method for measuring energy expenditure, small doses of deuterium and oxygen-18 (comparable to an amount normally present in the human body) are required to be drunk by an individual. Once absorbed by the body, the DLW molecules stabilize and balance with existing total body water. Deuterium and oxygen-18 water molecules act as metabolic tracers. By tracking the elimination rate of deuterium and oxygen-18 from the body, one can calculate total carbon dioxide (CO2) production and thus can calculate the total amount of energy one has expended over a given time frame. The elimination rate of these two isotopes can be calculated from urine. Urine samples are analyzed by an isotope mass spectrometry machine. This machine quantifies how many DLW molecules have been metabolized by the body for a given time period. Urine samples are collected directly before and four hours following a DLW drink. By subtracting the amount of deuterium and oxygen-18 quantified in pre-DLW urine samples from those quantified in the five hour post DLW urine samples researchers can calculate how much deuterium and oxygen-18 remain in an individual’s body, in comparison to what occurs naturally following a DLW drink. In addition, urine samples are collected the following morning and evening, as well on days 5 and 9 of the study period. These additional urine samples are used to track the rate that deuterium and oxygen-18 are being metabolized and eliminated from the body. In total eight urine samples will be
required. By tracking the elimination rate of deuterium and oxygen-18, total CO2 production and thus total energy expenditure can be calculated. (Please see diagram below on how deuterium and oxygen-18 isotopes are utilized and eliminated by the human body).

\[ \text{\(^{18}\text{O elimination (water + CO}_2\)} - \text{\(^{2}\text{H}_{2}\) elimination (water)} = \text{CO}_2 \text{ Production} \]

The deuterium and oxygen-18 DLW molecules (\(^{2}\text{H}_2\) \(^{18}\text{O}\)) are drank and then equilibrate throughout an individual’s body water. Naturally, an individual’s body must brake down water (\(\text{H}_2\text{O} \rightarrow \text{H}_2 + \text{O}\)) to make the needed energy required for the body to function at rest and in addition to when engaging in activity. Once a water molecule (\(\text{H}_2\text{O}\)) is broken down, hydrogen (\(\text{H}_2\)) is predominately eliminated from the body through water (i.e., urine) and oxygen (\(\text{O}\)) through both carbon dioxide (\(\text{CO}_2\)) and water (i.e., urine). Similarly, as the body brakes down a DLW molecule (\(^{2}\text{H}_2\) \(^{18}\text{O} \rightarrow ^{2}\text{H}_2 + 18\text{O}\)) for energy use, the deuterium (\(^{2}\text{H}_2\)) like hydrogen is eliminated predominately through urine and the oxygen-18 (\(18\text{O}\)) through both \(\text{CO}_2\) and urine. By quantifying how much deuterium and oxygen-18 have been eliminated by the body through urine, total \(\text{CO}_2\) Production, and thus energy expenditure can be calculated. The more active an individual is, the more water ones body must metabolize and greater levels of \(\text{CO}_2\) are produced.

Currently, DLW is the gold standard for measuring energy expenditure for the activities humans engage in while at rest, as well as throughout their daily lives. It has been widely used by health researchers for calculating total energy expended in adult, adolescent, children, and infant populations.
Study Methods/Procedure

Upon consent, you will be asked to fill out a demographic information questionnaire and a Physical Activity Readiness – Questionnaire (PAR-Q). These questionnaires will be filled out during a regularly scheduled phys. Ed. Class at your secondary institution. The PAR-Q must be taken home signed by a parent or guardian and returned to your phys. Ed teacher. This will consent that you are able to take part in a walking and running treadmill fitness test. Upon completion of the questionnaires and signed consent, you will schedule a day and time for your first visit to the Exercise and Health Psychology Lab (EHPL) www.ehpl.uwo.ca (See attached map for directions to lab). All visits will be scheduled Monday to Friday between 6:30 and 8:30am with the availability of Saturday morning upon request. This ensures that absenteeism from school is minimum.

During the first visit to the EHPL, a record of your height and weight will be obtained using a standard weight and height scale in addition measures of lean body mass and fat mass percentage via dual-energy-xray-absorptiometry (DXA). A DXA scan is a quick and painless scan of your body which emits a dose of x-ray comparable or equal to the amount of radiation you would receive from sitting in front of a television watching your favorite shows in a day. Following, these measures you will be equipped with an Actiheart™ device and will perform a standard fitness test, where treadmill speed and incline increase incrementally over a 10 minute period or until you reach exhaustion. While performing this test, you will be hooked up to a COSMED Quark b² indirect calorimetry machine (see description provided previously). The COSMED Quarb b² will measure your respiratory data (O₂ inspired, CO₂ expired) throughout the test. Feelings of discomfort associated with physical activity, such as increased heart rate, sweating, and in some cases nausea, may be experienced. However, you will be supervised by researchers certified in first aid, standard CPR and defibrillation training. If at any time you wish to stop, the test will be terminated. Upon completion of the fitness test, you will undergo a short cool-down. You will be unhooked from the indirect calorimetry, the ventilation mask will be removed along with the Actiheart™. The Actihear™ data will be downloaded by a co-investigator of the study. Before leaving the lab you will rebook for your next visit to the EHPL where you commence part II for the study.

During your second visit to the EHPL you will be administered a DLW drink. The amount of water you will drink is based on your measures of height, weight, and fat free mass (consisting of 0.15g ²H2O and 0.3g H218O/kg estimated total body weight). This mixture will be prepared ahead of time by a pharmacist. The following morning you will return to the lab and be hooked up to the Quark b², indirect calorimetry machine again. You will be asked to lie quietly for 16min, well respiratory data is collected. This will measure the amount of energy your body expends when at rest. In order to obtain an accurate resting metabolic rate (RMR) you will be required to come to the lab in a 12 hour fasted state (no food or drink 12 hours prior).

Following the measurement of your RMR, required urine samples will be obtained and you will be re-equipped with the same Actiheart™ you wore during your first visit to the lab. You are required to wear the Actiheart™ for the next 10 days. You
will wear this device even when you are asleep. The only time you will take the Actiheart™ off is when you shower or go for a swim.

Over the next 10 days the device is worn, you will be required to replace electrodes as they become un-adhesive, or if the device needs to be removed for a short period of time (e.g., you take a shower or go for a swim). You will be given instructions on how to replace the electrodes of the Acitheart™ device. You also will be given a sheet to record each length of time you take off the Actiheart™. Lastly, before leaving the lab you will be given a list of the days that you are required to provide additional urine samples, for measuring the elimination of the DLW drink from your body.

A urine sample is required just prior to as well as four hours following the drinking of the DLW. In addition samples are required the following day (Day 1), Day 5, and Day 9 the Actheart™ is worn. These samples are to be collected from the second and last voids of those days. In total eight samples will be collected. You will be supplied with glass containers for the collection of these samples and bag to place the samples in. All samples are required to be stored in a refrigerator. You must record the exact time each sample was taken on a sheet provided. It will be arranged that a researcher will come to your house or school each morning following a sample day to collect the samples. All urine samples will be stored in a freezer at the EHPL until sent away for analysis. Analysis will take place at the Laboratory for Stable Isotope Science (LSIS) at the University of Western Ontario. The LSIS is part of the Earth’s Sciences Department and is not a medical laboratory. On day 10 (the morning following your last urine sample) you will return to the EHPL. The Acitheart™ will be removed and you will be asked to fill out a physical activity questionnaire. This questionnaire will assess how active you have been over the previous days you wore the Actiheart™. Following the completion of the questionnaire you will be thanked for your participation.

*Please see the attached Outline of Study Procedures for a clear brake down of what is expected of you at each lab visit as well as throughout the study.

The total time commitment for this study is 12 days. The time commitment starts with your first visit to the EHPL and lasts until you provide the final urine sample required, remove the Actiheart™, and fill out a final questionnaire. It is highly appreciated that if you decide to participate in this study, you will be committed to completing the full duration of the study. In particular, it is essential you will be contactable and able to meet on each one of the mornings a urine sample is to be collected.
Other Pertinent Information

Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time. This will have not effect to your academic status.

All computer data collected can be terminated at any time at the request of you or your parent/guardian. Recorded data will be retained for a period of five years in a secure place at the School of Kinesiology, University of Western Ontario, under the care of Dr. Harry Prapavessis. This data will be kept is a locked file and/or on a password protected computer, within the EHPL. The EHPL will be locked when no active members of the lab are present. Only the study investigators will have access to the data. All data will be destroyed after this period.

If you do not wish to participate in the study you can continue with personal school-work during the regularly scheduled phys. Ed class that the study information and initial data collection is done. Participation/non-participation will not affect school grades or the relationship you have with the school. All visits to the EHPL will be scheduled outside of school time, so no absenteeism from school is required. If you are late for school due to your visit at the EHPL running behind schedule. A researcher will call the school and explain for your lateness.

This research is not anticipated to cause you any stress or concern. Nor, is it associated with any direct benefits or risks. It is your own responsibility to get to and from the lab. Free parking will be available at the Alumni parking lot on campus (see attached map).

Thank you very much for considering participating in this study. This letter is yours to keep and you do not waive any legal rights by signing the consent form. If you have any questions about the conduct of this study or your rights as a research subject you may contact:

The Director
Office of Research Ethics
The University of Western Ontario

Please fill out the consent form on the following page. In addition, please feel free to address any questions or concerns to the investigators listed below.

Thank you.

Dr. Harry Prapavessis
Nerissa Podolinsky
Consent Statement

Please fill out and sign below in the space provided. Cut along the dotted line and return this form to your Phys. Ed teacher. A co-investigator will attend one of your regularly scheduled phys. Ed classes. to schedule a date and time for your first visit to the EHPL. This consent form must be returned before scheduling for participation in the study.

I have read the Information/Consent document, have had the nature of the study explained to me, and I agree to participate. All questions have been answered to my satisfaction.

Legally-Authorized Representative Name (please print clearly):

Legally-Authorized Representative Signature: ____________________ Date: _________________

Participant’s Name (please print clearly):

Participant’s Signature: ____________________ Date: _________________

Person Obtaining Informed Consent (please print clearly):

Person Obtaining Informed Consent Signature: ____________________ Date: _________________
Outline of Study Procedures

Exercise and Health Psychology Lab - Visit # 1(A.M.)

- Measures of height, weight, percent fat mass, and percent fat free mass will be obtained (using a standardized scale, BIA, and DXA respectively)
- Equipped with an Actiheart™ device
- Perform a standardized fitness test while hooked up to indirect calorimetry
- Following completion of the exercise test, you will be unhooked from indirect calorimetry and the Actiheart™ device removed
- Schedule a second visit to the EHPL

Exercise and Health Psychology Lab – Visit # 2 (P.M.)

- Provide pre-dose urine sample
- Administered a DLW drink

*Two enrichment urine samples are to be collected. The first sample is to be collected 4 hours following DLW dosage. The second sample is to be collected the following morning from your second void of the day

Exercise and Health Psychology Lab – Visit # 3 (A.M.)

- Bring enrichment urine samples to EHPL
- Arrive at lab in a 12 hour fasted state (no food or drink 12 hours before)
- Resting Metabolic Rate (RMR) will be obtained
  - Lie quietly while hooked up to indirect calorimetry for 30 minutes
- Equipped with an Actiheart™ device to be worn for the next 10 days
- Given a sheet to record Actiheart™ wear and non-wear time over the next 10 days
- Given a sheet indicating what day and at what time future urine samples are to be taken.
- Given the containers for which the urine samples are to be provided in

Ten Day Study Period the Actiheart™ is Worn

☆Subsequent urine samples are to be collected from:
  - your last void on Day 1 (first day Actiheart™ is worn for the 10 day duration)
  - your second and last voids on Day 5
  - your second and last voids on Day 9

- It will be arranged for a researcher to come to your house or school and pick up the urine samples each morning following a urine sample collection day (with the exception of urine samples collected on Day 9)

Exercise and Health Psychology Lab – Visit # 4 (A.M.)

- Bring your final two urine samples to the EHPL
- Actiheart™ device removed
- Fill out a physical activity questionnaire
Appendix J

Letter of Information and Consent Form – Study 2

(Physical Activity Survey: Sample 1, participants 14-17 years of age)
Letter of Information: Participants Ages 15-17
Assessing the Types of Regular Physical Activity Engaged in by Adolescents

Researchers: Dr. Harry Prapavessis & Nerissa Campbell
The University of Western Ontario

The pronouns “you” and “your” should be read as referring to the participant rather than the parent/guardian/next of kin who is signing the consent form for the participant.

Purpose
You are invited to participate in a survey study. The primary purpose of this study is to identify the most popular types of physical activity that individuals 15-18 years of age regularly engage in. The physical activity information collected will be used to develop a new scale for assessing physical self-efficacy (an individual’s judgment on whether or not he or she is capable of engaging in regular physical activity) in youth.

Procedures
Your participation in this study is your decision (of your own free choice). If you agree to participate a researcher will come to your school, sports/dance practice, or club meeting time, where you will be asked to fill out two short questionnaires. The first questionnaire will ask you information about yourself that include things like your age and gender. The second questionnaire will ask you to list all the different types of regular physical activity you engage in, within four distinct categories of physical activity: (1) transportation activities, (2) activities at school and/or work, (3) household activities, and (4) leisure time (free-time) activities. Together these questionnaires should take about 15 minutes to complete. If you choose not to participate in this study you may continue with your other activities while study participants are involved in research activities.

Confidentiality
Your participation in this study is completely confidential. No personal identifiers (i.e., name, initials, birth date, or full address) will be collected. The information that we collect from you will only be for the use of the study investigators. By participating in this research study you are agreeing that your results may be used for scientific purposes, including publication of the newly constructed scale in scientific journals.

Risks and Benefits
There are no known risks or benefits associated with participation in the current study.
Participation and Withdrawal

As mentioned above, participation in this study is your own decision to make. You may refuse to participate, refuse to answer any questions on the questionnaires, or withdraw from completing the questionnaires at any time with no consequences. You may not withdraw your completed questionnaires after they have been returned to the researcher as they will not be identifiable.

Consent

Written consent from both you and a parent/guardian/next of kin is required for participation in the current study. If you are eighteen years of age, completion of the questionnaires is evidence of consent. Therefore no formal written consent from you and your parent/guardian/next of kin is required.

INFORMATION ABOUT THE STUDY RESULTS

You may obtain information about the results of the study by asking the researcher when your participation has concluded. If you wish to be sent general research findings provide your name and address on a separate piece of paper and these will be mailed to you upon your request.

INFORMATION ABOUT PARTICIPATING AS A STUDY PARTICIPANT

If you have questions or require more information about the study itself, please contact Nerissa Campbell. This letter is for you to keep. If you have any concerns, please feel free to contact one of the researchers below. If you have any questions about the conduct of this study, or your rights as a participant, you may contact the Office of Research Ethics, The University of Western Ontario.

Dr. Harry Prapavessis

Nerissa Campbell
Consent Statement (Participant)

Please fill out and sign below in the space provided. Cut along the dotted line and return this form to your teacher, coach, or instructor. A researcher will attend one of your classes, practices or club meeting and distribute the questionnaires that are to be completed. This consent form must be returned before you can fill out the questionnaires.

I have read the Information/Consent document, have had the nature of the study explained to me, and I agree to participate. All questions have been answered to my satisfaction.

Participant's Name (please print clearly):
__________________________________________________________

Participant's Signature:
__________________________________________________________

Date:_________________________

Person Obtaining Informed Consent (please print clearly):
__________________________________________________________

Person Obtaining Informed Consent Signature:
__________________________________________________________

Date:_________________________
**Consent Statement (Parent/Guardian)**

Please fill out and sign below in the space provided. Cut along the dotted line and return this form to your teacher, coach, or instructor. A researcher will attend one of your classes, practices or club meeting and distribute the questionnaires that are to be completed. This consent form must be returned before you can fill out the questionnaires.

I have read the Information/Consent document, have had the nature of the study explained to me, and I agree to participate. All questions have been answered to my satisfaction.

Legally-Authorized Representative Name (please print clearly):

________________________________________

Legally-Authorized Representative Signature:

________________________________________

Date: _______________________

Person Obtaining Informed Consent (please print clearly):

________________________________________

Person Obtaining Informed Consent Signature:

________________________________________

Date:_________________
Appendix K
Letter of Information and Consent – Study 2

(Physical Activity Survey: Sample 1, participants 18 years of age)
Letter of Information: Participant’s 18 years of age

Assessing the Types of Regular Physical Activity Engaged in by Adolescents

Researchers: Dr. Harry Prapavessis & Nerissa Campbell
The University of Western Ontario

The pronouns “you” and “your” should be read as referring to the participant rather than the parent/guardian/next of kin who is signing the consent form for the participant.

Purpose

You are invited to participate in a survey study. The primary purpose of this study is to identify the most popular types of physical activity that individuals 15-18 years of age regularly engage in. The physical activity information collected will be used to develop a new scale for assessing physical self-efficacy (an individual’s judgment on whether or not he or she is capable of engaging in regular physical activity) in youth.

Procedures

Your participation in this study is your decision (of your own free choice). If you agree to participate a researcher will come to your school, sports/dance practice, or club meeting time, where you will be asked to fill out two short questionnaires. The first questionnaire will ask you information about yourself that include things like your age and gender. The second questionnaire will ask you to list all the different types of regular physical activity you engage in, within four distinct categories of physical activity: (1) transportation activities, (2) activities at school and/or work, (3) household activities, and (4) leisure time (free-time) activities. Together these questionnaires should take about 15 minutes to complete. If you choose not to participate in this study you may continue with your other activities while study participants are involved in research activities.
Confidentiality

Your participation in this study is completely confidential. No personal identifiers (i.e., name, initials, birth date, or full address) will be collected. The information that we collect from you will only be for the use of the study investigators. By participating in this research study you are agreeing that your results may be used for scientific purposes, including publication of the newly constructed scale in scientific journals.

Risks and Benefits

There are no known risks or benefits associated with participation in the current study.

Participation and Withdrawal

As mentioned above, participation in this study is your own decision to make. You may refuse to participate, refuse to answer any questions on the questionnaires, or withdraw from completing the questionnaires at any time with no consequences. You may not withdraw your completed questionnaires after they have been returned to the researcher as they will not be identifiable.

Consent

As you are eighteen years of age, completion of the questionnaires is evidence of consent. Therefore no formal written consent from you and your parent/guardian/next of kin is required.

INFORMATION ABOUT THE STUDY RESULTS

You may obtain information about the results of the study by asking the researcher when your participation has concluded. If you wish to be sent general research findings provide your name and address on a separate piece of paper and these will be mailed to you upon your request.
INFORMATION ABOUT PARTICIPATING AS A STUDY PARTICIPANT

If you have questions or require more information about the study itself, please contact Nerissa Campbell. This letter is for you to keep. If you have any concerns, please feel free to contact one of the researchers below. If you have any questions about the conduct of this study, or your rights as a participant, you may contact the Office of Research Ethics, The University of Western Ontario.

Dr. Harry Prapavessis        Nerissa Campbell
Appendix L

Letter of Information and Consent – Study 2 (SEPAQ data: Sample 2) and

Study 3 (Canadian participants)
Letter of Information: Participants Ages 13-18
Predicting Physical Activity Behaviour in Adolescents

Researchers: Dr. Harry Prapavessis & Nerissa Campbell
The University of Western Ontario

The pronouns “you” and “your” should be read as referring to the participant rather than the parent/guardian/next of kin who is signing the consent form for the participant.

**Purpose**
You are invited to participate in a research study. The primary purpose of this study is to determine whether physical activity efficacy (an individual’s judgment on whether or not he or she is capable of engaging in regular physical activity) predicts adolescents’ physical activity behaviour.

**Procedures**
Your participation in this study is your decision (of your own free choice). If you agree to participate a researcher will come to your school, where measures of height, weight, and body fat percentage will be collected. Height and weight will be measured using a standardized height and weight scale. Body composition will be measured using a Tanita bioelectrical impedance analyzer (BIA). The Tanita BIA looks just like a bathroom scale. You will be asked to stand on the scale. Electrodes in the foot pads will send a small safe electrical signal through your body. You will not be able to feel the electrical signal and measures of body fat percentage will be obtained in less than minute. (Please see page 2 for a description and more information on the Tanita BIA). Following measures of height, weight and body fat you will be asked to fill out three short questionnaires. The first questionnaire will ask you information about yourself that include things like your age and gender. The second and third questionnaires are very similar. They will ask you to rate on a scale from 0-100% how confident (0=not at all confident, 100%=completely confident) you feel in being able to engage in a bunch of different activities. The activities on the questionnaires will relate to activities you do: (1) for transportation purposes (e.g., getting to and from school, going to a friend’s house), (2) at school and/or at work, (3) at home, and (4) during your free-time. Together these questionnaires should take about 15-20 minutes to complete.

Once you have finished filling out the questionnaires a research assistant will set up an Actiheart™ for you to wear. The Actiheart™ is to be worn 24-hours a day for 8 days straight, expect when you are showering or engaging in water sports (please see the next page for a description and more information about the Actiheart™). Following the 8 days you use the Actiheart™, a research assistant will return to your school to collect the device and you will be asked to fill out one final questionnaire. The final questionnaire will involve you recalling the amount of physical activity you did over the previous 8 days you wore the Actiheart™ device. This questionnaire will take approximately 10 minutes to complete.

If you choose not to participate in this study you will not be penalized by your teacher in any way. Your teacher will provide you with something else to do.
**Description of the Tanita BIA:**
As described earlier, the Tanita BIA looks similar to a bathroom scale. The Tanita BIA is able to estimate your body fat percentage by measuring the resistance to the electrical signal as it passes through the water found in the muscle and fat of your body. Simply explained, the more muscle you have, the more water your body can hold. The greater amount of water one has in their body, the easier it is for the electrical current to travel through the body. The greater amount of fat you have, the harder it is for the signal to travel through your body.

**Description of the Actiheart™:**
The Actiheart™ is a device worn on the chest, attached by two adhesive electrodes. This device collects data on real-time heart rate and movement counts. Movement counts are a quantification of the amount of acceleration an individual’s body produces while moving. Heart rate and movement count data are collected every 15 seconds and is stored within the internal memory of the device. These data are downloaded from the Actiheart™ onto a computer. Then using specific equations, an overall measure of your total energy expended from activity is calculated for every day the device is worn. (See picture below on how the Actiheart™ attaches to an individual’s chest)

The Actiheart™ attaches to the chest by two adhesive electrodes. One electrode is placed on the sternum at the level of the third intercostal space. While, the second electrode is placed adjacent to the first somewhere on the major Pectoralis muscle. Electrodes need to be replaced every couple days, or as they become unadhesive due to perspiration, being dampened in a shower, etc.

**Potential Benefits to Participants and/or to Society**
The only benefit for you is that you may obtain insight into your physical activity patterns over a 1 week period. There are no other direct benefits for you as a participant in this research study. Scientists will benefit from this program by gaining knowledge about strategies to help youth become more physically active.

**Risks and Benefits**
In addition to the possibility of gaining insight into your physical activity patterns over a 1 week period, there are no known risks or benefits associated with participation in the current study. However, you may experience a minor skin irritation around the site(s) where the adhesive electrodes are placed on your chest. If this occurs, please contact a researcher so they can give you an alternative electrode brand to try. If the irritation persists you may wish to stop wearing the Actiheart™ device without penalty.
**Compensation for Participation**
There is no compensation for participation in this study.

**Confidentiality**
Your participation in this study is completely confidential. Any information that is obtained in connection with this program and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. The questionnaires that you complete will be kept in a locked filing cabinet in Dr. Harry Prapavessis' laboratory. The only people who will read the questionnaires are the two researchers listed above. By participating in this research study you are agreeing that your results may be used for scientific purposes. However, your personal identity will never be revealed in any reports regarding this program.

**Participation and Withdrawal**
As mentioned above, participation in this study is your own decision to make. You may refuse to participate, refuse to answer any questions on the questionnaires, or withdraw from completing the questionnaires or wearing the Actiheart™ at any time with no consequences.

**Consent**
Written consent from both you and a parent/guardian/next of kin is required for participation in the current study. If you are eighteen years of age, no formal written consent from your parent/guardian/next of kin is required.

**Information About the Study Results**
At the end of the study you will be given a one page print out containing your heart rate, activity, and energy expenditure data from the 8 days the Actiheart™ device was worn. If you wish to be sent the general research findings from the study as a whole, please provide your name and address on a separate piece of paper and these will be mailed to you upon your request.

**Information about Participating as a Study Participant**
If you have questions or require more information about the study itself, please contact Nerissa Campbell. This letter is for you to keep. If you have any concerns, please feel free to contact one of the researchers below. If you have any questions about the conduct of this study, or your rights as a participant, you may contact the Office of Research Ethics, The University of Western Ontario.

Dr. Harry Prapavessis

Nerissa Campbell
Consent Statement (Parent/Guardian)

Please fill out and sign below in the space provided. Cut along the dotted line and return this form to your teacher. This consent form must be returned before you can fill out the questionnaires.

I have read the Information/Consent document, have had the nature of the study explained to me, and I agree to participate. All questions have been answered to my satisfaction.

Legally-Authorized Representative Name (please print clearly):

________________________________________

Legally-Authorized Representative Signature:

________________________________________

Date: _______________________

Person Obtaining Informed Consent (please print clearly):

_______________________________________

Person Obtaining Informed Consent Signature:

________________________________________

Date: ___________________________
Assent/Consent Form: Participants Ages 13-18
Predicting Physical Activity Behaviour in Adolescents

Assent/Consent Statement

Please fill out and sign below in the space provided. Cut along the dotted line and return this form to your teacher. This assent/consent form must be returned before you can participate in the study.

I have read the Information and Assent/Consent document, have had the nature of the study explained to me, and I agree to participate. All questions have been answered to my satisfaction.

Participant’s Name (please print clearly):

________________________________________________________________________

Participant’s Signature:

________________________________________________________________________

Date:________________________

Person Obtaining Informed Consent (please print clearly):

________________________________________________________________________

Person Obtaining Informed Consent Signature:

________________________________________________________________________

Date:____________________
Appendix M

Participant Letter of Information and Consent Form(s) – Study 3
(New Zealand participants)
PARTICIPANT INFORMATION SHEET

You are being invited to take part in a research study that measures how confident you are to take part in physical activity and how much physical activity you actually do. To help you make a decision about participating in the study, we ask that you read this information sheet.

Why do we need this study?
It is important to be active when you are young, yet many young people don’t engage in a lot of activity. It is important that we try to understand the different reasons why some people are more active than others, in order to help inactive people become more active.

What do you need to do?
If after reading this information sheet, you decide that you would like to take part in the study, we will need you to give us permission in writing. To do this we ask that you read and sign the assent form. Over the 9 Day study period a researcher will come to your school two times. On Day 1, during the first visit measures of height and weight will be collected. You will also fill out three short questionnaires. The first questionnaire will ask for information about you that includes things like age and gender. The second and third questionnaires are very similar. They will ask you to rate how confident you feel in engaging in a variety of activities. The activities will relate to activities you do: (1) for transportation purposes (e.g., getting to and from school, going to a friend’s house), (2) at school and/or at work, (3) at home, and (4) during your free-time. Together these questionnaires should take about 15-30 minutes to complete.

Once you have finished filling out the questionnaires a researcher will set up an Actiheart™ device which will measure how much physical activity you do. The Actiheart™ collects data on real-time heart rate and body movement counts. The Actiheart™ is to be worn 24-hours a day for 8 days straight, expect when you shower or engage in water sports.

A researcher will return to your school a second time on Day 9 to collect the device and you will fill out one final questionnaire, which will ask you to recall the amount of physical activity you did during the previous week. This questionnaire should take 10-15 minutes to complete.

With the exception of wearing the Actiheart™ for 8 days, your total time involved with this study will be about 1.25 hour over the 9 Day study period.
Will the study help me?
We hope you will find this study fun and interesting. You will find out how much physical activity you do over a one week period. We cannot promise you will directly benefit from this study and you will not be paid for taking part in the study. However your participation will help us learn new strategies that will help people your age become more physically active. By participating in this study, your name will be entered into a draw for a chance to win an iPod shuffle. The draw will take place at the end of the study period (middle of July, 2011).

Will the study harm me in any way?
Doing this study will not harm you in any way. However, taking part in this study will take some of your time. There is a possibility that you may experience some minor skin irritation from the adhesive electrodes holding the Actiheart™ to your chest. The skin irritation will be similar to irritations that occur when band-aids are worn for an extended period of time. If this occurs and you find it very disconcerting you can remove the Actiheart™ with no affect to your academic progress.

Will my information be kept confidential?
We need to collect personal details such as your name, address and phone number, to allow us to communicate with you throughout the study. This information will be stored separately from any personal study information such your height, weight, and questionnaire data, and only linked to these data by a confidential unique identification code.

The study files and all your information will remain strictly confidential. No material that could personally identify you will be used in any reports on this study. Your information will be stored at Clinical Trials Research Unit for 10 years after you have reached age 16 years. All computer records will be password protected. All future use of the information collected will be strictly controlled in accordance with the Privacy Act, 1994.

During the study, ethics committee representatives, study personnel, and members of the research team may check your information. This will only be done to check the accuracy of the information collected for the study and the information will remain confidential.

When will the results be available?
There may be a delay between data collection and publication of results, since data collection is taking place in both New Zealand and Canada. However, we can provide you with a one page information sheet describing your activity level and energy expenditure for the 8 days the Actiheart™ was worn. Once the study is finished we will send you a summary of the main findings.
Has the study received ethical approval?
Yes, this study has received ethical approval from the Upper South B Regional Ethics Committee, ethics reference number URB/11/06/017.

What are my legal rights?
Your participation in this study is entirely voluntary (your choice). You do not have to take part. If you do not take part in this study you will not be affected in any way. You may withdraw from the study at any time, without having to give a reason. Your withdrawal will not affect on your future involvement with the University of Auckland or your academic progress. If you have any questions please ask a research assistant or contact:

Ralph Maddison
Study Co-ordinator,

Study Investigators
• Dr. Ralph Maddison, Miss Louise Foley
• Dr. Harry Prapavessis, Ms Nerissa Campbell

Please keep this sheet for your information.
Request for an interpreter

<table>
<thead>
<tr>
<th>Language</th>
<th>Request for an interpreter</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>I wish to have an interpreter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>E hiahia ana ahau ki tetahi kaiwhaka Māori/kaiwhaka Pakehā korero</td>
<td>Ae</td>
<td>Kao</td>
</tr>
<tr>
<td>Cook Island Māori</td>
<td>Ka inangaro au I tetai tangata uri reo</td>
<td>Ae</td>
<td>Kare</td>
</tr>
<tr>
<td>Fijian</td>
<td>Au gadreva me dua e vakadewa vosa vei au</td>
<td>Io</td>
<td>Sega</td>
</tr>
<tr>
<td>Niuean</td>
<td>Fia manako au ke fakaaoga e taha tagata fakahokohoko kupu</td>
<td>E</td>
<td>Nakaiai</td>
</tr>
<tr>
<td>Tokelaun</td>
<td>Ko au e fofou ki he tino ke fakaliliu te gagana Peletania ki gagama o na motu o te Pahefika</td>
<td>loe</td>
<td>Leai</td>
</tr>
<tr>
<td>Sāmoan</td>
<td>Oute mana ‘o ia iai se fa ‘amatala upu</td>
<td>loe</td>
<td>Leai</td>
</tr>
<tr>
<td>Tongan</td>
<td>‘Oku ou fiema ‘u ha fakatouleua</td>
<td>‘Io</td>
<td>‘Ikai</td>
</tr>
</tbody>
</table>

- I have read and I understand the information sheet dated ___________ for volunteers taking part in the study designed to examine if people’s confidence for being physically active predicts physical activity behaviour.
- I have had the opportunity to discuss this study. I am satisfied with the answers I have been given.
- I have had the opportunity to use whānau support or a friend to help me ask questions and understand the study.
- I understand that taking part in this study is voluntary (my choice), and that I may withdraw from the study at any time, and this will in no way affect my academic progress.
- I understand that my participation in this study is confidential and that no material that could identify me will be used in any reports on this study.
- I have had time to consider whether to take part in the study.
- I know who to contact if I have any questions about the study in general.
- I understand that there will be no personal details that identify me (such as my name, address) on the questionnaires.
- I understand that any data collected as part of this study will be stored securely for 10 years after the youngest participant turns 16 at the Clinical Trials Research Unit, The University of Auckland, in accordance with the Privacy Act, 1994. After this time the information will be safely destroyed.
- I understand that any information collected, as part of this study will not be used for any other purpose, without my permission and ethical approval, nor given to any other third party outside of the research team.
- I understand that there may be a significant delay between data collection and publication of the results.
- I wish to receive a copy of the results YES/NO
Child consent/assent

I ______________________________________ (print full name)
of ______________________________________ (print address)

________________________________________________________________________

________________________________________________________________________

hereby consent to take part in this study.

Signature: _________________________________

Date: ___/___/___
day/month/year

Parent consent on behalf of child

As a parent or Guardian I give consent on behalf of:

______________________________________ (print full name)

I agree that my son/daughter is to take part in this research.

Signature: _________________________________

Date: ___/___/___
day/month/year

Name: ______________________________________ (print full name)

Full name of researcher: ________________________________

Contact phone number for researcher: ________________________________

Project explained by: ________________________________

Project role: ______________________________________

Signature: ________________________________

Date: ___/___/___
day/month/year

Ethical Approval

This study has received ethical approval from the Upper South B Regional Ethics Committee, ethics reference number URB/11/06/017.
### PARTICIPANT CONSENT FORM
(Participants over 16 years of age)

<table>
<thead>
<tr>
<th>Request for an interpreter</th>
<th>English</th>
<th>Māori</th>
<th>Cook Island Māori</th>
<th>Fijian</th>
<th>Niuean</th>
<th>Tokelaun</th>
<th>Sāmoan</th>
<th>Tongan</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Participants over 16 years of age)</td>
<td>I wish to have an interpreter</td>
<td>E hiahia ana ahau ki tetahi kaiwhaka Māori/kaiwhaka Pakehā korero</td>
<td>Ka inangaro au I tetai tangata uri reo</td>
<td>Au gadreva me dua e vakadewa vosa vei au</td>
<td>Fia manako au ke fakaaga o e taha tagata fakahohokohoko kupu</td>
<td>Ko au e fofou ki he tino ke fakalili u te gagana Peletania ki gagama o na motu o te Pahefika</td>
<td>Oute mana ‘o ia iai se fa ‘amatala upu</td>
<td>‘Oku ou fiema ‘u ha fakatonulea</td>
</tr>
<tr>
<td>(Participants over 16 years of age)</td>
<td>Yes</td>
<td>Ae</td>
<td>Ae</td>
<td>lo</td>
<td>E</td>
<td>loe</td>
<td>loe</td>
<td>‘lo</td>
</tr>
<tr>
<td>(Participants over 16 years of age)</td>
<td>No</td>
<td>Kao</td>
<td>Kare</td>
<td>Sega</td>
<td>Nakai</td>
<td>Leai</td>
<td>Leai</td>
<td>‘Ikai</td>
</tr>
</tbody>
</table>

- I have read and I understand the information sheet dated ___________ for volunteers taking part in the study designed to examine if people’s confidence for being physically active predicts physical activity behaviour.
- I have had the opportunity to discuss this study. I am satisfied with the answers I have been given.
- I have had the opportunity to use whānau support or a friend to help me ask questions and understand the study.
- I understand that taking part in this study is voluntary (my choice), and that I may withdraw from the study at any time, and this will in no way affect my academic progress.
- I understand that my participation in this study is confidential and that no material that could identify me will be used in any reports on this study.
- I have had time to consider whether to take part in the study.
- I know who to contact if I have any questions about the study in general.
- I understand that there will be no personal details that identify me (such as my name, address) on the questionnaires.
- I understand that any data collected as part of this study will be stored securely for 10 years after the youngest participant turns 16 at the Clinical Trials Research Unit, The University of Auckland, in accordance with the Privacy Act, 1994. After this time the information will be safely destroyed.
- I understand that any information collected, as part of this study will not be used for any other purpose, without my permission and ethical approval, nor given to any other third party outside of the research team.
• I understand that there may be a significant delay between data collection and publication of the results.
• I wish to receive a copy of the results

YES/NO

Child consent

I ___________________________ (print full name)
of ___________________________ (print address)

____________________________________

hereby consent to take part in this study.

Signature: ___________________________

Date: ___/___/___

day/month/year

Full name of researcher: ___________________________

Contact phone number for researcher: ___________________________

Project explained by: ___________________________

Project role: ___________________________

Signature: ___________________________

Date: ___/___/___

day/month/year

Ethical Approval

This study has received ethical approval from the Northern X Regional Ethics Committee, ethics reference number URB/11/06/017.
Appendix N

Parental Letter of Information – Study 3 (New Zealand participants)
Your child is being invited to take part in a research study that measures their confidence for being physically active and how much they actually do. To help you make a decision about your child participating in the study, we ask that you read this information sheet.

Who is co-ordinating this study?
The study is co-ordinated by the Clinical Trials Research Unit (The University of Auckland).

What is the aim of this study?
The primary purpose of this study is to determine whether people’s confidence (self-efficacy) to be active predicts how much physical activity they do.

Why has my child been selected?
- Your child has been selected to take part in this study because he or she has indicated they are interested in taking part in the study. He or she also met the requirements below:
  - Between 14 to 18 years of age
  - Speaks and understands English

Where will the study take place?
The study will take place in Auckland, and the study procedure will take place in your child’s classroom at school.

How long will the study take?
Your child’s involvement with this study will take 9 days. Your child will be contacted at two times over the 9 days to collect information about him or herself and obtain some physical measures (such as height and weight). In addition, we will collect information about his or her confidence to be physically active (self-efficacy) and measure his or her physical activity behaviour.

How many people will be recruited into the study?
In total we are looking to recruit 120 adolescents to take part in this study. We will be recruiting 40 adolescents in Auckland, New Zealand and 80 adolescents in London, Canada.

What is involved if my child takes part?
Your child has the right to consent to participate in research when they are capable of understanding what the study involves and the risks. If you child is unable to fully understand, their assent must be obtained unless your child
is unable to communicate. On Day 1, during the first visit measures of height and weight will be collected. In addition, your child will fill out three short questionnaires. The first questionnaire will ask information about his or herself that include things like age and gender. The second and third questionnaires are very similar. They will ask your child to rate how confident he or she feels for engaging in a variety of activities. The activities will relate to activities he or she does: (1) for transportation purposes (e.g., getting to and from school, going to a friend’s house), (2) at school and/or at work, (3) at home, and (4) during his or her free-time. Together these questionnaires should take about 15-30 minutes to complete.

Once your child has finished filling out the questionnaires a researcher will set up an Actiheart™ device to measure how much activity your child does each day. This device collects data on real-time heart rate and body movement counts. The Actiheart™ is to be worn 24-hours a day for 8 days straight, expect when your child showers or engages in water sports. The Actiheart™ is a device worn on the chest, attached by two adhesive electrodes.

A researcher will return to the school on Day 9 to collect the device and your child will fill out one final questionnaire, which will ask them to recall the amount of physical activity they took part in during the previous week. This questionnaire should take 10-15 minutes to complete. With the exception of wearing the Actiheart™ for 8 days, your child’s total time involved will be about 1 hour over the 9 day study period.

**Will there be any costs involved?**
Taking part in this study will not cost you or your child any money.

**What are the risks and benefits of this study?**

**Possible benefits**
The study will provide your child with information and how much physical activity he or she does over a 1 week period. We cannot guarantee that your child will directly benefit from the study and you or your child will not be paid for taking part in the study. However your child’s participation will help us gain knowledge about strategies to help youth become more physically active.

**Possible risks**
We do not anticipate any risks to be associated with this study. However, taking part in this study will take some of your time and your child’s time. You and your child will be required to complete the consent and assent forms. Your child will complete physical measures and questionnaires and wear the Actiheart™ device. There is a possibility your child may experience a minor skin irritation around the site(s) where the adhesive electrodes are placed on his or her chest (for attachment of the Actiheart™). The skin irritation will be similar to irritations that occur when band-aids are worn for an extended period of time. If irritation occurs and causes your child
discomfort, he or she may stop wearing the Actiheart™ device, with no affect on your child’s academic progress.

**Compensation**

In the unlikely event of a physical injury as a result of your child’s participation in this study, your child may be covered by the Accident Compensation Corporation (ACC) legislation. ACC cover is not automatic and each case is assessed by ACC, according to the provisions of the 2001 Injury Prevention Rehabilitation and Compensation Act. If your child’s claim is accepted by ACC, your child still might not get any compensation. This depends on a number of factors such as whether you are a wage earner or non-earner. ACC usually provides only partial reimbursement of costs and expenses and there may be no lump sum compensation payable. There is no cover for mental injury unless it is a result of physical injury. If you have ACC cover, generally this will affect your child’s right to sue the investigators. If you have any questions about ACC, please contact your nearest ACC office or ask us for more information before your child agrees to take part.

**Will the information about my child be kept confidential?**

We need to collect personal details such as your child’s name, address and phone number, to allow us to communicate with you throughout the study. This information will be stored separately from any personal study data such as you and your child’s height, weight, and questionnaire data, and only linked to these data by a confidential unique identification code.

The study files and all information that your child provides will remain strictly confidential. No material that could personally identify your child will be used in any reports on this study. Information for your child will be stored at Clinical Trials Research Unit for 10 years after the child has reached age 16 years. All computer records will be password protected. All future use of the information collected will be strictly controlled in accordance with the Privacy Act, 1994.

During the study, ethics committee representatives, study personnel, and members of the research team may check your child’s records. This will only be done to check the accuracy of the information collected for the study and the information will remain confidential.

**When will the results be available?**

There may be a delay between data collection and publication of results, since data collection is taking place in both New Zealand and Canada, however we can provide you with a one page information sheet describing your child’s activity, and energy expenditure for the 8 days the Actiheart™ was worn. Once the study is finished we will send your child a summary of the main findings.

**Has the study received ethical approval?**

Yes, this study has received ethical approval from the Northern X Regional Ethics Committee, reference number: ________________
What are my legal rights?
Your child’s participation in this study is entirely voluntary (his or her choice). Your child does not have to take part. If he or she chooses not to take part in this study he or she will not be affected in any way. You or your child may withdraw from the study at any time, without having to give a reason. His or her withdrawal from the study will not affect to his or hers academic progress. If you or your child has any questions please ask a research assistant or contact:

Ralph Maddison
Study Co-ordinator,

If you have any queries or concerns regarding your rights as a participant in this study, you may wish to contact an independent health and disability advocate.

Study Investigators
- Dr. Ralph Maddison, Miss Louise Foley
- Dr. Harry Prapavessis, Ms Nerissa Campbell

Please keep this sheet for your information.
Thank you for taking the time to read about this study.
Appendix O

The University of Western Ontario Research Ethics Approval Notice – Study 1
Use of Human Subjects - Ethics Approval Notice

Principal Investigator: Dr. H. Prapavessis

Review Number: 15002E

Review Date: September 12, 2008

Review Level: Expedited

Protocol Title: Assessing Energy Expenditure in Adolescents Using the Actheart.

Department and Institution: Kinesthetics, University of Western Ontario

Sponsor:

Ethics Approval Date: December 31, 2008

Documents Reviewed and Approved: Revised study methodology and Letter of Information and Consent.

Documents Received for Information:

This is to notify you that the University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above. The membership of this REB also complies with the membership requirements for REBs as defined in Division 5 of the Food and Drug Regulations.

The ethics approval for this study shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the UWO Updated Approval Request Form.

During the course of the research, no deviations from, or changes to, the protocol or consent form may be initiated without prior written approval from the HSREB except when necessary to eliminate immediate hazards to the subject or when the changes(s) involve only logistical or administrative aspects of the study (e.g. change of monitor, telephone number). Expedited review of minor change(s) in ongoing studies will be considered. Subjects must receive a copy of the signed information/consent documentation.

Investigators must promptly also report to the HSREB:

a) changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) all adverse and unexpected experiences or events that are both serious and unexpected;
c) new information that may adversely affect the safety of the subjects or the conduct of the study.

If these changes/adverse events require a change to the information/consent documentation, and/or recruitment advertisement, the newly revised information/consent documentation, and/or advertisement, must be submitted to this office for approval.

Members of the HSREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

Chair of HSREB: Dr. Joseph Gilbert

Ethics Officer to Contact for Further Information

[Contact information]

This is an official document. Please retain the original in your files.
Appendix P

The University of Western Ontario Research Ethics Approval Notice – Study 2

(Physical activity survey data: Sample 1)
Use of Human Subjects - Ethics Approval Notice

Principal Investigator: Dr. H. Prapavessis
Review Number: 17296S
Review Date: August 06, 2010
Protocol Title: Construction of a physical activity self-efficacy scale for use in adolescents
Department and Institution: Kinesiology, University of Western Ontario
Sponsor:
Ethics Approval Date: September 20, 2010
Expired Date: December 31, 2010
Documents Reviewed and Approved: UWO Protocol, Letter of Information and Consent (15-17 year olds), Letter of Information and Consent (18+)

Documents Received for Information:

This is to notify you that The University of Western Ontario Research Ethics Board for Non-Medical Research Involving Human Subjects (NMREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the applicable laws and regulations of Ontario has granted approval to the above named research study on the approval date noted above.

This approval shall remain valid until the expiry date noted above assuming timely and acceptable responses to the NMREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the UWO Updated Approval Request Form.

During the course of the research, no deviations from, or changes to, the study or consent form may be initiated without prior written approval from the NMREB except when necessary to eliminate immediate hazards to the subject or when the change(s) involve only logistical or administrative aspects of the study (e.g. change of monitor, telephone number). Expedited review of minor change(s) in ongoing studies will be considered. Subjects must receive a copy of the signed information/consent documentation.

Investigators must promptly also report to the NMREB:
   a) changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
   b) all adverse and unexpected experiences or events that are both serious and unexpected;
   c) any new information that may adversely affect the safety of the subjects or the conduct of the study.

If these changes/adverse events require a change to the information/consent documentation, and/or recruitment advertisement, the newly revised information/consent documentation, and/or advertisement, must be submitted to this office for approval.

Members of the NMREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the NMREB.

Chair of NMREB: Dr. Riley Hinson
FDA Ref. #: IRB 00000941

Ethics Officer to Contact for Further Information:

- Grace Kelly (grace.kelly@uwo.ca)
- Janice Sutherland (jsuthair@uwo.ca)
- Elizabeth Wambolt (ewambolt@uwo.ca)
- Denise Grafton (dgraton@uwo.ca)

This is an official document. Please retain the original in your files.

UWO NMREB Ethics Approval - Initial
V.2007-10-12 (p/status=valid&Report=NMREB_Initial) 17296S

Page 1 of 1
Appendix Q

The University of Western Ontario Research Ethics Approval Notice

Study 2 (SEPAQ data: Sample 2) and Study 3 (Canadian participants)
Use of Human Participants - Ethics Approval Notice

Principal Investigator: Prof. Harry Papavasiliou

Review Number: 151012

Review Level: 3

Protocol Title: Does Physical Activity Efficiency Result from Objectively Assessed Physical Activity Behaviour in Adolescents?

Department & Institution: Kinesiology, University of Western Ontario

Sponsor: ethics.approval.dates:

Ethics Approval Date: July 27, 2011

Expiry Date: March 31, 2012

Documents Reviewed & Approved & Documents Received for Information:

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<th>Comments</th>
<th>Version Due</th>
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<td></td>
<td></td>
</tr>
<tr>
<td>Date of Enrollment: 1F and 14-18 y. old: 2011/07/01</td>
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</tr>
<tr>
<td>Other</td>
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<td>Parent-Parent</td>
</tr>
</tbody>
</table>

This is to certify that the University of Western Ontario's Research Ethics Board has reviewed and approved the study titled "Does Physical Activity Efficiency Result from Objectively Assessed Physical Activity Behaviour in Adolescents?" which is registered according to the University's Policy Statement on Ethical Conduct of Research Involving Humans and the Health Canada/CIHI (Joint Clinical Practice Guidelines), and all applicable laws and regulations of Ontario. The approved protocol is not available to the public.

The study adheres to the principles of the Declaration of Helsinki. The study is being conducted according to the principles of the World Medical Association Declaration of Helsinki. The study is also reviewed by the Research Ethics Board (REB). The REB has reviewed and approved the study. The REB has determined that the study does not meet the criteria for research involving human participants.

The Chair of the REB is Dr. Joseph Gilbert. The REB is registered with the Canadian Institutes of Health Research (CIHR) and has a CIHR registration number REB 190901.

Ethics Officer in Contact for Further Information:

[Signature]
[Name]
[Contact Information]

[Signature]
[Name]
[Contact Information]

This is an official document. Please retain this original in your files.
Appendix R

Upper South B Regional Ethics Committee, New Ministry of Health Approval Notice

Study 3 (New Zealand participants)
29 June 2011

Dr Ralph Maddison

Attention: Louise Foley

Dear Dr Maddison

Re: Ethics ref: URB/11/06/017 (please quote in all correspondence)
Study title: Does Physical Activity Self-Efficacy Predict Objectively Assessed Physical Activity Behaviour in Adolescents?
Investigators: Dr Ralph Maddison, Ms Louise Foley, Dr Harry Prapavessis, Ms Nerissa Campbell

This study was given ethical approval by the Upper South B Regional Ethics Committee on 29 June 2011. A list of members of the Committee is attached.

Approved Documents
— Study protocol V.1 dated 26 April 2011
— Participant Information Sheet. Exercise behaviour study PIS V.2.
— Parent Information Sheet. Exercise behaviour study PIS V.2.
— Information Sheet for schools. Exercise behaviour study school information sheet PIS V.2.
— Participant consent form. Exercise behaviour study IC V.2.
— Participant consent form (participants over the age of 16 years). Exercise behaviour study IC V.2.
— Principal consent form. Exercise behaviour study IC V.2.
— Questionnaires

This approval is valid until 30 July 2012, provided that Annual Progress Reports are submitted (see below).
Access to ACC
For the purposes of section 32 of the Accident Compensation Act 2001, the Committee is satisfied that this study is not being conducted principally for the benefit of the manufacturer or distributor of the medicine or item in respect of which the trial is being carried out. Participants injured as a result of treatment received in this trial will therefore be eligible to be considered for compensation in respect of those injuries under the ACC scheme.

Amendments and Protocol Deviations
All significant amendments to this proposal must receive prior approval from the Committee. Significant amendments include (but are not limited to) changes to:
- the researcher responsible for the conduct of the study at a study site
- the addition of an extra study site
- the design or duration of the study
- the method of recruitment
- information sheets and informed consent procedures.

Significant deviations from the approved protocol must be reported to the Committee as soon as possible.

Annual Progress Reports and Final Reports
The first Annual Progress Report for this study is due to the Committee by 30 July 2012. The Annual Report Form that should be used is available at www.ethicscommittees.health.govt.nz. Please note that if you do not provide a progress report by this date, ethical approval may be withdrawn.

A Final Report is also required at the conclusion of the study. The Final Report Form is also available at www.ethicscommittees.health.govt.nz.

Requirements for the Reporting of Serious Adverse Events (SAEs)
SAEs occurring in this study must be individually reported to the Committee within 7-15 days only where they:
- are unexpected because they are not outlined in the investigator’s brochure, and
- are not defined study end-points (e.g. death or hospitalisation), and
- occur in patients located in New Zealand, and
- if the study involves blinding, result in a decision to break the study code.

There is no requirement for the individual reporting to ethics committees of SAEs that do not meet all of these criteria. However, if your study is overseen by a data monitoring committee, copies of its letters of recommendation to the Principal Investigator should be forwarded to the Committee as soon as possible.

Please see www.ethicscommittees.health.govt.nz for more information on the reporting of SAEs, and to download the SAE Report Form.
Statement of compliance
The committee is constituted in accordance with its Terms of Reference. It complies with the Operational Standard for Ethics Committees and the principles of international good clinical practice.

The committee is approved by the Health Research Council’s Ethics Committee for the purposes of section 25(1)(c) of the Health Research Council Act 1990.

We wish you all the best with your study.

Yours sincerely

Mrs Diana Whipp
Administrator Upper South B Regional Ethics Committee
# CIRRICULUM VITAE

**Name:** Nerissa Campbell (*nee* Podolinsky)

**Post-secondary Education**

University of Western Ontario  
London, Ontario, Canada  

**Honours and Awards:**

Western Graduate Research Scholarship  
Ontario Graduate Scholarship  
2011-2012

**Work related Experience**

Research Assistant  
The University of Western Ontario  
2011  
Teaching Assistant  
The University of Western Ontario  
2007-2011

**Professional Development**

4th Annual Physical Activity Measurement Seminar  
The Medical Research Council: Epidemiology Unity  
Cambridge University  
Cambridge, United Kingdom

**Refereed Publications:**


Published Abstracts:


Other Publications:

Conference Presentations:


