THE CONCEPTUAL, OPERATIONAL, AND THEORETICAL BASIS OF YOUTH PHYSICAL ACTIVITY SELF-EFFICACY AMONG ADOLESCENT GIRLS

By

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ABSTRACT

THE CONCEPTUAL, OPERATIONAL, AND THEORETICAL BASIS OF
YOUTH PHYSICAL ACTIVITY SELF-EFFICACY AMONG ADOLESCENT GIRLS

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The purpose of this dissertation was to examine the conceptual, operational, and theoretical basis of physical activity (PA) self-efficacy among youth, and in particular adolescent girls. Manuscript one examined the conceptual basis of PA self-efficacy by conducting a concept analysis. A review of the literature identified 276 articles with 55 articles selected for review. Social cognitive theory (SCT) guided the analysis. Several conceptual definitions were found in the literature. Defining attributes of PA self-efficacy were personal cognition/perception, self-appraisal process, related action, and the power to choose PA. The concept was also found to be dynamic and bi-dimensional. Antecedents and consequences were consistent with SCT. This analysis provided clarification of the concept and identified the need to examine PA self-efficacy instruments for consistency between conceptual and operational definitions.

Manuscript two investigated the operational basis of PA self-efficacy by comparing the factorial validity, measurement invariance, and composite reliability of two PA self-efficacy instruments. A secondary analysis of data was conducted from Year 1 and 2 of a group randomized controlled trial (RCT) investigating the effect of a 17-week intervention on increasing PA among girls (*N*=1012) in the 5th-8th grades. Girls completed 6- and 7-item PA self-efficacy instruments at baseline and post-intervention. Confirmatory factor analyses were used to conduct invariance testing for intervention and control groups. Model fit was assessed using the model chi-square test, comparative fit index (CFI), and root mean square error of approximation (RMSEA). For simultaneous cross-group and longitudinal analysis, results demonstrated

configural invariance for both instruments but not metric invariance. The 6-item instrument achieved partial metric invariance with one indicator non-invariant (χ^2=170.224, *df*=112, p<.001, $\Delta\chi^2$=24.308, Δ*df*=18, p=.145, RMSEA=.032, CFI=.991, ΔCFI=-.001). Both instruments demonstrated longitudinal scalar invariance in the control group but not the intervention group. Composite reliability for the 6-item and 7-item instruments ranged from .772 - .842 and .719 - .800, respectively. Results suggest that the intervention influenced how girls responded to indicator items. Neither of the instruments achieved simultaneous metric invariance making it difficult to accurately examine mean differences in PA self-efficacy between groups.

Manuscript three examined the theoretical basis of PA self-efficacy. The purpose of the study was to test hypothesized relationships of the Health Promotion Model (HPM) between individual, interpersonal, and situational influences and moderate-to-vigorous PA (MVPA) among adolescent girls. Data from Year 3 of the same group RCT were collected from girls (*N*=512) in the 5^{th}-8^{th} grades. MVPA was measured using accelerometers. Study hypotheses were analyzed using structural equation modeling (SEM). Mean age of the girls was 11.8 years (*SD*=1.0). PA self-efficacy predicted commitment to PA (β=.524) and MVPA (β=.343). Commitment to PA suppressed the total effect of PA self-efficacy on MVPA (β=.279). Social support and options for PA were not significant predictors of MVPA. The model predicted 33.5% of the variance in commitment and 10.2% of the variance in MVPA. Consistent with other studies, PA self-efficacy continues to be a significant correlate of MVPA for adolescent girls. While this study is the first to examine HPM relationships using an objective measure of MVPA, the model predicted a small amount of the variance for this outcome. Future theory testing studies should involve longitudinal analyses and include reliable and valid measures based on well-defined concepts.

This work is dedicated to my parents, Leonard and Barbara Vander Velden. You were my first teachers and instilled in me a life-long passion for learning to which I will forever be indebted.

This work is also dedicated to my husband Jeff, daughter Olivia, and son Matthew. I could not have completed this journey without your constant encouragement, support, and patience.

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My dissertation committee members are also acknowledged for their advice and support. Dr. Barbara Smith, Dr. Manfred Stommel, Dr. Karin Pfeiffer, and Dr. Steven Pierce have all contributed in unique ways to my doctoral education. They have challenged me to think deeply about the research process and I have benefited greatly from their guidance. I would like to particularly acknowledge Dr. Pierce for his willingness to be a part of my committee and to share his statistical expertise with me. He embraced my passion for measurement science and advanced my knowledge of the subject in ways I did not think were possible.

I consider it a privilege to have been taught by outstanding research scientists during my doctoral education. Dr. Mildred Horodynski and Dr. Rebecca Lehto provided the foundation for this dissertation in the Knowledge Development and Nursing course where I learned the concept analysis process. Dr. Barbara Given and Dr. Bill Given shaped this dissertation in its early phase as I researched the concepts of self-efficacy and physical activity. Dr. Manfred Stommel introduced me to measurement science and related issues which led me to include a psychometric study as part of my dissertation.

Stacey Wesolek, former *Girls on the Move* Intervention project manager, and Kelly Bourne, current project manager, are both acknowledged for their support with various aspects of this dissertation. Dr. Dhruv Sharma, senior statistician with the Michigan State University Center for Statistical Training and Consulting, is acknowledged for his assistance with data management and imputation of missing data.

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Most importantly, my family is acknowledged for their emotional support, love, and sacrifice given to me over the past four years. They have witnessed this journey close up and I could not have done it without them. A special thanks to my husband Jeff who is always willing to listen to me, during times of joy and during times of difficulty. He is a faithful life partner and I benefit greatly from his humor and wisdom. To my children, Olivia and Matthew, two special gifts from God, who inspired me to complete this dissertation, it is truly an honor to be your mother. It is my hope that you continue to discover and reach your full potential academically, physically, socially, and spiritually and that you remain physically active throughout your lifetime.

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CHAPTER 1: INTRODUCTION

Introduction

Physical activity (PA) provides important physical and psychological health benefits for youth including increased physical fitness, improved academic performance, improved self-esteem, decreased risk for chronic disease, and improved mental health (Janssen & LeBlanc, 2010; Morrow et al., 2013; Ortega, Ruiz, Castillo, & Sjöström, 2007). Despite the known health benefits of PA (Bailey, Hillman, Arent, & Petitpas, 2012; Janssen & LeBlanc, 2010), the majority of adolescents are not meeting PA guidelines (Morrow et al., 2013). PA declines significantly with age and girls demonstrate a steeper decline than boys (Dumith, Gigante, Domingues, & Kohl, 2011). Furthermore, interventions designed to increase PA among adolescents have not been largely successful, particularly for increasing PA long-term (Craggs, Corder, van Sluijs, & Griffin, 2011; Metcalf, Henley, & Wilkin, 2012). A critical need exists for an improved understanding of adolescent PA, particularly among girls, to inform the design of effective, theory-based interventions that enable adolescents to engage in life-long PA (Plotnikoff, Costigan, Karunamuni, & Lubans, 2013).

Background and Significance

Physical Inactivity

PA among individuals of all age groups has continued to decline over the last few decades in the United States and globally (Kann et al., 2014; Ng & Popkin, 2012). This decline is particularly evident in adolescence (Belcher et al., 2010). In a recent systematic review of international studies, Dumith and colleagues (2011) reported a seven percent mean decline in PA per year among 10- to19-year-olds. In addition, PA levels were significantly lower among minority adolescents and females than those who were not of minority status and males, respectively. The United States Department of Health and Human Services PA guidelines (2008) recommended that all children 6 to 17 years of age obtain 60 minutes per day of moderate to vigorous physical activity (MVPA). Fakhouri and colleagues (2014) found that only 25% of youth ages 12-15 met PA guidelines according to self-report data. Using objectively measured PA, Troiano and colleagues (2008) reported that while 42 percent of children 6-11 years of age met PA guidelines, this percentage was lower among adolescents (8%), particularly for adolescent girls (3%).

Advances in technology, reductions in school physical education classes, and increased screen time have contributed to physical inactivity among adolescents (Owen, Healy, Matthews, & Dunstan, 2010). Physical inactivity has been linked to the development of obesity, metabolic syndrome, diabetes, and cardiac disease in adulthood (Ekelund et al., 2012; Kokkinos & Myers, 2010; Reilly & Kelly, 2010) as well as dyslipidemia, hypertension, and early signs of atherosclerosis during adolescence (Dhuper, Buddhe, & Patel, 2013). In order to decrease the risk for chronic disease, PA habits must be developed at a young age to promote an established pattern of PA into adulthood.

Theory-Based PA Interventions

Some evidence exists to support the use of a theoretical approach for the design and implementation of PA interventions among adolescents (Wilson et al., 2011) and more specifically for adolescent girls (Webber et al., 2008), but the research to date is limited. Effort in this area is particularly needed for adolescent girls, many of whom may require interventions that address their unique barriers related to PA (Bélanger et al., 2011; Hsu et al., 2011). Assessment and modification of theoretical models used in PA research are essential for developing effective theory-based interventions. Enhancing conceptual and operational clarity of constructs within theoretcial models, particularly those that have emerged as consistent correlates and determinants of PA, such as PA self-efficacy, may aid in refinement and integration of theoretical models used to explain adolescent PA (Plotnikoff et al., 2013).

PA Self-Efficacy

Bandura (1977) first described the concept of self-efficacy almost four decades ago. Self-efficacy is a concept emphasized in social cognitive theory (SCT). SCT focuses on reciprocal determinism, a dynamic relationship between individuals, the environment, and behavior. SCT has been incorporated into a number of health behavior models utilized to explain adolescent PA including the Health Promotion Model, Theory of Planned Behavior, and Self-Determination Theory (Plotnikoff et al., 2013).

Although a number of psychological, social, and environmental factors have been theorized to increase PA among adolescents, PA self-efficacy is a consistent correlate and determinant of PA (Bauman et al., 2012). In addition, in a review examining cognitive, behavioral, and interpersonal mediators of interventions, Lubans, Foster, and Biddle (2008) found that cognitive variables, such as self-efficacy, have the largest mediating effect between PA interventions and PA increases in adolescents. In longitudinal studies, higher levels of PA self-efficacy have been associated with both slower declines in PA with advancing age (Craggs et al., 2011) and greater increases in PA (Hearst, Patnode, Sirard, Farbakhsh, & Lytle, 2012) when measured over time. However, Perry and associates (2012) report inconclusive results for the mediating role of PA self-efficacy in intervention studies.

Current issues related to the construct of PA self-efficacy may partially explain this inconsistency. These include multiple conceptual definitions in the literature (Voskuil & Robbins, 2015), wide variability in measurement (Plotnikoff et al., 2013), social-cognitive construct overlap (Steele, Burns, & Whitaker, 2012), dispute over the dimensionality of PA self-efficacy (Dwyer et al., 2012; Pirasteh, Hidarnia, Asghari, Faghihzadeh, & Ghofranipour, 2008), and inadequate psychometric analysis of instruments designed to measure the construct (Dewar, Lubans, Morgan, & Plotnikoff, 2013). These knowledge gaps limit a true understanding related to the explanatory power of PA self-efficacy in theoretical models.

In addition, continued reliance on self-reported PA may impede a complete understanding of the role of PA self-efficacy in promoting PA among adolescents. When obtained via self-report, PA is consistently over-reported (LeBlanc & Janssen, 2010), particularly among inactive girls (Slootmaker, Schuit, Chinapaw, Seidell, & van Mechelen, 2009). Additional research is needed to explore the relationship between PA self-efficacy and accelerometer-measured PA.

Theoretical Framework

Using theoretical frameworks to guide nursing research and practice contributes to the advancement of nursing science by building the knowledge of the discipline (Fawcett, 2005). The Health Promotion Model (HPM) is a middle range theory that has been tested in nursing research and utilized in nursing practice to explain and predict a wide variety of health-promoting behaviors such as nutrition, hearing loss protection, stress management, and PA (McCullagh, 2013). The HPM is philosophically rooted in a reciprocal interaction world view that has a focus on the holistic nature of human beings in interaction with their environment (Pender, Murdaugh, & Parsons, 2015). The model is derived from two prominent psychological theories of human behavior, SCT (Bandura, 1986) and expectancy-value theory (Fishbein & Ajzen, 1975).

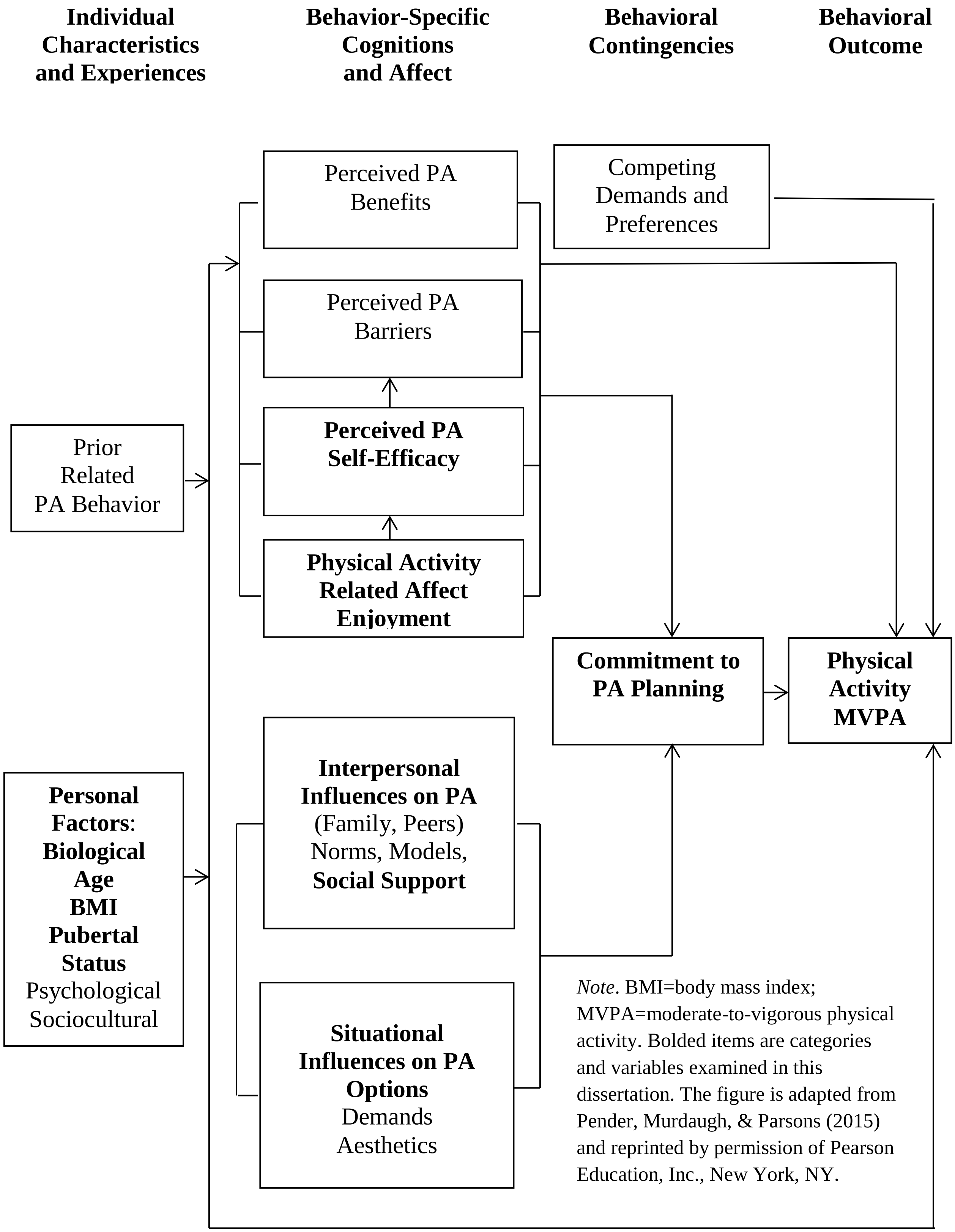
Description of the Health Promotion Model

The HPM focuses on the health-promoting behaviors of individuals and actions that people carry out with the intention of improving their health (McCullagh, 2013). The model is organized into three categories: individual characteristics and experiences, behavior specific cognitions and affect, and health-promoting behavior. Below is an overview of the elements of the model with examples using PA as the health-promoting behavior and definitions of model variables provided by Pender et al. (2015). Application of the Health Promotion Model to adolescent PA is presented in Figure 1.

Individual characteristics and experiences. Individual characteristics and experiences include prior-related behavior (past and current) and personal factors which are further categorized into biological (i.e. age, body mass index), psychological (i.e. self-esteem), and sociocultural factors (i.e. race, ethnicity, socioeconomic status). For example, high body mass index of an adolescent can have not only a direct effect on PA, but also an indirect effect through activity-related affect, such as PA enjoyment. Therefore, individual characteristics and experiences can directly affect a behavioral outcome or may act as a moderator on behavior-specific cognitions and affect.

Behavior-specific cognitions and affect. The behavior-specific cognitions and affect in the model are beliefs that include perceived benefits of action (positive or reinforcing consequences of behavior, such as increased energy related to PA), perceived barriers to action (blocks, hurdles, or costs of undertaking a behavior, such as lack of time for PA), perceived self-efficacy (judgment of personal capability to execute a particular health behavior, such as PA), and activity-related affect (subjective feeling states or emotions related to a health-promoting behavior, such as enjoyment of PA).

Figure 1. Application of the Health Promotion Model to Adolescent Physical Activity



Note. BMI=body mass index; MVPA=moderate-to-vigorous physical activity. Bolded items are categories and variables examined in this dissertation. The figure is adapted from Pender, Murdaugh, & Parsons (2015) and reprinted by permission of Pearson Education, Inc., New York, NY.

Also included in this category are interpersonal and situational influences. Interpersonal influences, including social norms, social support, and modeling, are described as behaviors, beliefs, or attitudes of relevant others (i.e. family, friends, health care providers). One example involves the modeling of PA among parents to their children. Situational influences are described as beliefs about the situation or context of a health-promoting behavior, such as options for PA in the neighborhood environment, which may be conducive to PA or limit PA options.

Two additional concepts in the model that are categorized as behavioral contingencies and proposed to influence health-promoting behavior include commitment to a plan of action (intentions to carry out a behavior and strategies for success) and immediate competing demands/preferences over which individuals may have high or low control. An example of commitment to a plan of action related to PA may be scheduling regular PA time periods during the week, and an immediate competing demand may be skipping scheduled PA for an alternative activity at the time of a planned PA event.

Behavioral outcome. Behavioral outcomes in the HPM include any health-promoting behavior. Examples include PA, nutrition, and stress management. The model does not include physiological (i.e. blood pressure, lower body fat) or psychological (i.e. quality of life, self-esteem) health outcomes. However, health behaviors, such as increased PA, are assumed to produce both physiological and psychological health benefits (Pender et al., 2015).

Model Relationships

The HPM relationships, or propositions among concepts, are explicitly stated. For example, prior-related behavior can directly influence a health behavior or have indirect effects through the behavior-specific cognitions and affect. There are also relationships among the behavior-specific cognitions and affect. For example, if PA was being examined in research, activity-related affect, such as PA enjoyment, is proposed to directly influence PA self-efficacy, but enjoyment can also have a direct effect or an indirect effect through commitment on the behavioral outcome.

The HPM is particularly applicable to the health promotion of adolescents, specifically for examining PA as a health behavior. The model has been used successfully in several research studies with this age group (Srof & Velsor-Friedrich, 2006). For example, Taymoori, Lubans, and Berry (2010) tested the model to explain PA among Iranian adolescent boys. Similarly, Wu and Pender (2002; 2005) have conducted tests of the model to explain PA among Taiwanese adolescents. Future tests of the model to explain PA among adolescent girls should include objectively-measured PA as an outcome to confirm relationships in the model. To date, no test of the model using an objective measure of PA was found in the literature for any age group. Furthermore, testing of model concepts and relationships in the HPM can be used to revise the theory resulting in a more parsimonious model.

Purpose

The objective of this dissertation is to examine the conceptual, operational, and theoretical basis of PA self-efficacy within the context of adolescent PA, and more specifically among adolescent girls. This dissertation project addresses three significant gaps in the literature. First, this dissertation focuses on issues related to the lack of conceptual clarity of PA self-efficacy among adolescents through a concept analysis process. Second, measurement issues related to PA self-efficacy are addressed by examining the psychometric properties of two PA self-efficacy instruments. Third, this project addresses the limitations of self-reported PA among adolescents by using accelerometer-measured PA as the behavioral outcome to test relationships in the HPM among adolescent girls. Improved understanding of PA behavior based on an objective measure of PA may provide a rationale for model revisions, such as integrating the model with other theoretical frameworks to better explain health behavior among adolescents (Plotnikoff et al., 2013).

Dissertation Format

A multiple manuscript format is used for this dissertation. Chapters 2, 3, and 4 each represent three separate manuscripts. The manuscripts for this dissertation include: 1) a concept analysis paper on PA self-efficacy; 2) a measurement study examining the reliability and validity of two PA self-efficacy instruments; and 3) a model testing study aimed at predicting PA among adolescent girls using several HPM constructs. Studies two and three are part of an ongoing parent study, a group randomized controlled trial (RCT), aimed at testing a multi-component theory-based intervention designed to increase MVPA among 5^{th} - 8^{th} grade girls (Robbins et al., 2013).

Chapter 2 consists of a concept analysis paper related to youth PA self-efficacy. This manuscript has been published in the *Journal of Advanced Nursing* (Voskuil & Robbins, 2015). Rodgers' (2000) evolutionary method was applied to conduct the concept analysis. This method uses a qualitative research approach to analyze and clarify concepts. A thorough literature review was conducted related to self-efficacy in the context of youth PA. Multiple conceptual definitions for PA self-efficacy were evident in the literature, and continued research is needed to clarify and advance knowledge related to this concept. In addition, the literature review conducted for this paper indicated the need for further analysis of PA self-efficacy instruments.

Chapter 3 builds on the concept analysis paper by examining operational definitions for PA self-efficacy among adolescent girls. This study examines the validity and reliability of two PA self-efficacy instruments currently being used in the parent study. This paper focuses specifically on assessment of factorial validity, cross-group and longitudinal measurement invariance, and composite reliability. Confirmatory factor analyses are used to examine the measurement properties of the two instruments.

Chapter 4 extends the research conducted in Chapter 2 and 3 by examining the theoretical basis of PA self-efficacy using an adapted version of the HPM in the context of adolescent girls' PA. This study examines the predictors of PA among adolescent girls using some of the proposed theoretical relationships within the HPM. A structural equation modeling approach is employed to test the HPM.

Chapter 5 provides a summary of the dissertation across all three papers. This chapter summarizes findings for each manuscript. Implications for nursing research, nursing practice, and policy are presented. The chapter ends with an overall conclusion statement.

APPENDIX

APPENDIX

Permission Letter to Reprint the Health Promotion Model

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Sep 7, 2016 PE Ref # 197044

Vicki R Voskuil
Michigan State University College of Nursing
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Dear Vicki R Voskuil,

You have our permission to include content from our text, ***HEALTH PROMOTION IN NURSING PRACTICE, 7th Ed. by PENDER, NOLA J.; MURDAUGH, CAROLYN L.;PARSONS, MARY ANN,*** in your dissertation or masters thesis at Michigan State University College of Nursing.

Content to be included is:
page 25 Figure 2- 3 Health Promotion Model

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Sincerely,
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CHAPTER 2: YOUTH PHYSICAL ACTIVITY SELF-EFFICACY: A CONCEPT ANALYSIS

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Abstract

Aim. To report an analysis of the concept of youth physical activity self-efficacy. **Background.** Physical activity self-efficacy is a concept that has been frequently examined as a key variable in research aimed at increasing physical activity among youth. Different conceptual definitions and empirical measures indicate the need for concept analysis to advance knowledge of the concept. **Design.** Rodger's evolutionary method of concept analysis was used to collect and analyze the data. Social cognitive theory guided the analysis. **Data Sources.** The PubMed, Cumulative Index of Nursing and Allied Health Literature, PsychInfo, Educational Resources Information Center and Sociological Abstracts databases were searched for publications from 1990-2013. Search terms included self-efficacy, physical activity, youth, children, adolescent and teen. **Review Methods.** A total of 276 articles were identified. Fifty-five articles meeting inclusion criteria were included in the review. Data were analyzed with particular focus on the attributes, antecedents and consequences of the concept. **Results.** Defining attributes of physical activity self-efficacy were identified as personal cognition/perception, self-appraisal process, related action, power to choose physical activity, dynamic state and bi-dimensional nature. Antecedents and consequences were consistent with social cognitive theory. Youth physical activity self-efficacy is defined as a youth's belief in his/her capability to participate in physical activity and to choose physical activity despite existing barriers. **Conclusions.** This concept analysis provided an in-depth analysis and clarification of youth physical activity self-efficacy. Future research should be aimed at establishing consistency in conceptual definitions and empirical measurement to further develop the concept across disciplines.

Keywords: concept analysis, nursing, physical activity, self-efficacy, youth, Bandura, Rodgers

Introduction

Self-efficacy is a concept that has been studied extensively across disciplines to explain behaviors across the lifespan (Bandura, 2004; Maibach & Murphy, 1995; Pajares, 2005; Resnick, 2013). Self-efficacy in research conducted by nurses has been examined in relationship to many topics including cancer, chronic illness, cultural competence, physical activity (PA) and weight loss (Lenz & Shortridge-Baggett, 2002). Self-efficacy has been the focus of concept analyses in nursing and other disciplines with application to sociocultural contexts such as adolescent smoking cessation, caregivers of cognitively impaired elderly, nursing education and diabetes care (Heale & Griffin, 2009; Liu, 2012; Mowat & Spence Laschinger, 1994; Townsend & Scanlan, 2011).

Several health behavior models identify self-efficacy as a variable in research aimed at improving health outcomes (Champion & Skinner, 2008; Montano & Kasprzyk, 2008; Pender, Murdaugh, & Parsons, 2011; Prochaska, Redding, & Evers, 2008). More specifically, self-efficacy is frequently cited in health behavior literature and included in interventions aimed at increasing youth PA (Perry, Garside, Morones, & Hayman, 2012). Self-efficacy has also been identified as a consistent mediator of intervention effects on PA among youth (Van Straalen et al., 2011).

Declines in PA from childhood to adolescence have generated increased research concerning the concept of PA self-efficacy. However, numerous conceptual definitions and empirical measures have been used with inconsistent effects on improving PA (Ashford, Edmonds, & French, 2010; Craggs, Corder, van Slujs, & Griffin, 2011; Perry et al., 2012; Williams & French, 2011). This paper builds on the current understanding of self-efficacy in the context of youth PA in the United States (U.S.) and globally. Through a review of the theoretical and empirical literature, this paper aims to report an analysis of the concept of youth PA self-efficacy through identification of its defining attributes, related concepts, antecedents and consequences.

Background

The increased emphasis on PA self-efficacy in health behavior research emanates from the disconcerting trends in PA among youth in the USA and globally. The United States Department of Health and Human Services (USDHHS) and the World Health Organization (WHO) recommend that youth, ages 5 or 6-17 years, attain at least 60 minutes of moderate to vigorous PA (MVPA) each day (U.S Department of Health and Human Services, 2008; World Health Organization, 2011). Participation in MVPA among youth has decreased while sedentary behavior has increased (Eaton et al., 2012; Pate & ONeill, 2008). Troiano and colleagues (2008) report that while 42% of 6-11 year olds meet current PA recommendations, the percentage drops to eight percent for adolescents. Dumith, Gigante, Domingues, and Kohl (2011) report a seven percent mean decline in PA per year among 10-19 year olds. Youth need to establish a habit of regular PA at a young age to decrease the risk for cardiovascular disease, diabetes and obesity (Daniels et al., 2005; Ekelund et al., 2012; Kokkinos & Myers, 2010).

Despite a range of interventions aimed at increasing PA among youth, few have been successful at sustaining increases in PA over time (Metcalf, Henley, & Wilkin, 2012). Oude Luttikhuis and colleagues (2009) emphasize the need to explain factors related to behavior change, but also underscore the importance of advancing understanding of the theoretical foundations of health behavior among youth. However, most of the variance in youth PA remains largely unexplained by theoretical models (Plotnikoff, Costigan, Karunamuni, & Lubans, 2013). Rhodes and Nigg (2011) highlight the importance of additional theory testing to advance the science of PA, specifically testing of social cognitive theory (SCT), pointing out that the concept of self-efficacy is one of the strongest correlates of PA.

Lubans, Foster, and Biddle (2008) demonstrate support for PA self-efficacy as a mediator between theory-based interventions and PA. Higher levels of PA self-efficacy have also been shown to result in significant increases in PA (Hearst, Patnode, Sirard, Farbakhsh, & Lytle, 2012) and less decline in PA over time (Craggs et al., 2011). Support for PA self-efficacy as a correlate and determinant of PA has been demonstrated in several studies (Bauman et al., 2012). However, Perry and associates (2012) report mixed results for the mediating role of PA self-efficacy and point to the heterogeneity of empirical measures as a possible explanation.

While theory-based interventions aimed at increasing youth PA self-efficacy may potentially increase PA, concepts in these theories need to be consistently defined and measured to determine their full explanatory power. Undertaking a concept analysis is an important first step to ensure that PA self-efficacy is closely aligned with empirical measures and adequately reflects the underlying theory. This process is critical for the development of effective theory-based interventions aimed at increasing youth PA and advancing theory related to PA.

Self-efficacy is a major concept in SCT. SCT is based on reciprocal determinism involving three major components: personal factors, environmental factors and behavior (Bandura, 1986, 1997, 2004). Given the reciprocal nature of these relationships, self-efficacy can influence youth PA, but PA also has the potential to impact self-efficacy. To impart structure and meaning to the concept and refine theoretical relationships, SCT provided the theoretical framework for this concept analysis (Bandura 1977a, 1986, 1997). Paley (1996) argues that concept analysis and clarification should occur in the context of relevant theories rather than in isolation and affords the opportunity for refinement of theoretical relationships.

Historical definitions of self-efficacy serve as a chronological context for the concept. Bandura first described self-efficacy as ‘the conviction that one can successfully execute the behavior required to produce the outcomes’ (1977b, p. 79) and later as ‘judgments of how well one can execute courses of action required to deal with prospective situations’ (1982, p. 122). The definition most often cited is ‘the belief in one’s capabilities to organize and execute courses of action required to produce given attainments’ (Bandura 1997, p. 2).

Central to the concept is the importance of maintaining a connection between the behavior of interest and the specific self-efficacy beliefs to be measured (Resnick, 2013). To analyze PA self-efficacy, defining PA is necessary. Adapted from Caspersen, Powell, and Christenson (1985), the following conceptual definition of PA by the USDHHS (2008) is one of the most frequently cited: any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above a basal metabolic rate. Gabriel, Morrow, and Woolsey (2012) offer an alternative definition describing PA as ‘the behavior that involves human movement, resulting in physiological attributes including increased energy expenditure and improved physical fitness’ (p. S15). For this concept analysis, these two statements are combined to define PA as a complex, multi-dimensional behavior that involves bodily movement produced by the contraction of skeletal muscle with resultant increases in physiological attributes, including energy expenditure above the basal metabolic rate and physical fitness.

Rodgers’ (2000) evolutionary method is ideal for examining concepts that change over time and vary across contextual situations. This method is also appropriate for guiding the analysis of the concept to determine how PA self-efficacy has evolved and how the concept may differ for youth according to age, health status, sex and culture. Table 1 includes the steps and results for the concept analysis.

Table 1. Evolutionary Method of Concept Analysis Applied to Physical Activity Self-Efficacy

Primary Activities	Concept Analysis Results
1. Identify the concept of interest and associated expressions (surrogate and related terms)	1. Concept: physical activity (PA) self-efficacy (competence, perceived competence, confidence)
2. Identify and select the setting and sample for data collection	2. Disciplines: education, kinesiology, psychology, medicine, nursing; Databases: PubMed CINAHL, PsychINFO, ERIC, Sociological Abstracts Time Period: 1990 – 2013
3. Collect data to identify the attributes and contextual basis of the concept including interdisciplinary, sociocultural, and temporal (antecedents and consequences) variations	3. Review of the literature and data coding process: 276 relevant articles were identified; 20 percent of these articles were chosen for review (n=55); each article was reviewed for attributes, contextual basis, antecedents, consequences, conceptual definitions, and empirical measures
4. Analyze data regarding the characteristics of the concept	4. Defining attributes: personal cognition/perception, self-appraisal process, related action, power to choose PA, dynamic state, and bi-dimensional nature; antecedents: theoretical sources of self-efficacy include enactive mastery, vicarious experience, verbal or social persuasion, and physiological or affective states; consequences: choice behavior (PA), PA effort expenditure and persistence, PA thought patterns, and PA emotional effects
5. Identify an exemplar of the concept	5. An exemplar from the literature was used to highlight the characteristics of the concept.
6. Identify implications and hypotheses for further development of the concept	6. Implications include development of a more consistent conceptual and operational definition, use of qualitative research to capture youth perspectives, improved understanding of the developmental nature of the concept, and additional investigation related to the theoretical sources of physical activity self-efficacy.

Note. CINAHL=Cumulative Index of Nursing and Allied Health Literature; ERIC=Educational Resources Information Center.

These steps do not need to be carried out chronologically, as some occur before others or transpire concurrently (Rodgers, 2000).

Data Sources

A review of the literature related to PA self-efficacy was conducted using the following data bases: PubMed, CINAHL, PsychINFO, ERIC and Sociological Abstracts. Keywords in the search were self-efficacy, physical activity, adolescent, youth and teen. The full concept 'physical activity self-efficacy' was also entered as a search phrase. A total of 838 abstracts were reviewed. Inclusion criteria were: peer-reviewed articles, including research articles, systematic reviews and theoretical articles; English language; time frame of 1990-2013; self-efficacy and PA as concepts; and age up to 18 years. Conference abstracts, dissertations, editorials, articles involving adults, and self-efficacy literature related to other health behaviors were excluded. After a review of the abstracts and eliminating duplicates, 276 articles were retained. Table 2 provides a summary of the literature search results by database.

Table 2. Literature Search Results

Database	Search Results	Excluded	Duplicates	Included
1. PubMed	393	200	NA	193
2. CINAHL	233	84	104	45
3. PsychINFO	137	20	91	26
4. ERIC	50	10	30	10
5. Sociological Abstracts	25	11	12	2
Totals	838	325	237	276
Sample chosen for full article review (20%):				55

Note. CINAHL=Cumulative Index of Nursing and Allied Health Literature; ERIC=Educational Resources Information Center.

Prior to 1990, few studies included the concepts of self-efficacy and PA. This outcome is likely due to two factors. First, conceptual distinctions were made between PA and exercise in the mid-1980s, which impacted the use of these terms in subsequent literature. Second, research generated on these concepts has increased exponentially over the last two decades. While self-efficacy studies certainly existed prior to 1990, research with youth was limited.

Using recommendations from Rodgers (2000), 20% of the 276 articles were chosen for review using stratified random sampling resulting in a total of 55 articles. While Rodgers (2000) recommends stratifying the sample by discipline, she also emphasizes that time is a unique contextual feature for concept analysis. Because of the interdisciplinary nature of the research involving PA self-efficacy and an increase in research involving the concept over the last two decades, a modified approach for sample selection using the following time periods was employed: 1990-1994, 1995-1999, 2000-2004, 2005-2009 and 2010-2013. This approach increased the comprehensiveness of the review and elucidated how the concept had evolved. A random number generator was used to select 20% of the articles from each time period as follows: one of four from 1990-1994; three of 17 from 1995-1999; nine of 46 from 2000-2004; 21 of 104 from 2005-2009; and 21 of 105 from 2010-2013.

The 55 selected articles represented a range of disciplines with the majority from kinesiology, public health and nursing ($n = 37$). A strong international focus was evident in the sample with 23 (42 %) of the selected articles representing 14 countries. The sample included quantitative ($n = 47$) and qualitative ($n = 2$) research, systematic reviews ($n = 4$) and theory-based articles ($n = 2$). Only four articles included youth with chronic conditions. Influential works by Bandura (1977, 1986, 1997, 2004, 2007) and self-efficacy concept analysis publications were also included as data sources.

Each article was coded according to attributes, antecedents, consequences, contextual basis, related/surrogate terms and conceptual/operational definitions. The coding process was based on explanations by Rodgers (2000), social cognitive theory (Bandura, 1986) and additional descriptions of the concept (Bandura 1997, 2004). Articles were read and re-read to ensure adequate coding of data. Information from each article was entered into an Excel spreadsheet using the above coding categories. As recommended by Rodgers (2000), thematic analysis was used to identify the attributes, antecedents and consequences from the literature. Because of the novel approach used for selection of the sample by time periods, data saturation was established by reviewing an additional five percent of the articles (n=14) after the themes for each category had been determined. This additional review supported saturation of the data with significant repetition related to the attributes, antecedents and consequences found in the selected sample.

Results

Conceptual definitions for PA self-efficacy were analyzed for similarities, differences, key words/phrases and consistency with Bandura's (1977a, 1986, 1997) descriptions of self-efficacy. The most notable finding was the variation in conceptual definitions and empirical measures for youth PA self-efficacy, supporting the need for concept analysis. As can be determined from Table 3, few conceptual definitions from the literature are similar and many lack key elements of Bandura's original conceptualization of self-efficacy.

Table 3. Conceptual Definitions for Physical Activity Self-Efficacy

Source (Year)	Conceptual Definition
Reynolds et al. (1990)	A person's belief in his/her ability to make changes with regard to physical activity
Pate et al. (1997)	Confidence in ability to be physically active
Nigg & Courneya (1998)	Situational confidence in the ability to persist with physical activity (exercise)
Allison, Dwyer, & Makin (1999)	Confidence to participate in physical activity despite external and internal barriers
Johnson et al. (2000)	An individual's confidence in ability to perform physical activity
Felton et al. (2002)	One's confidence in the ability to be physically active
Monge-Roias, Nunez, Garita, Chen-Mok (2002)	Capacity to make decisions related to the practice of physical activity in specific situations
Pender, Bar-Or, & Mitchell (2002)	Confidence in physical activity skills Level of perceived competence for physical activity
Nahas, Goldfine, & Collins (2003)	Perceptions of personal efficacy or confidence regarding one's ability to be active on a regular basis
Neumark-Sztainer, Story, Hannan, Tharp, Rex (2003)	Confidence to implement new activities and be active in different situations
Umeh (2003)	Ability to perform physical activity successfully
Deforche et al. (2004)	Confidence in ability to be physically active in a range of difficult situations
Robbins, Pender, Ronis, Kazanis (2004)	A sense of confidence in personal physical activity skills
Dishman et al. (2005)	Confidence in capability to be physically active
Fein, Plotnikoff, Wild, Spence (2005)	Confidence in a student's ability to engage in physical activity regardless of barriers
Norman, Sallis, & Gaskins (2005)	A person's confidence he or she can meet physical activity in situations that may represent barriers to physical activity
Petosa, Hortz, Cardina, & Suminski (2005)	Perceived ability to overcome barriers to physical activity
Wright, Ding, & Li (2005)	Perceived competency or effectiveness in performing a specific task
Annesi (2006)	Self-regulatory self-efficacy - individual's ability to utilize resources and persevere at physical activity Task self-efficacy - individual's assessment of own physical abilities to carry out a task
Foley et al. (2008)	Efficacious beliefs to perform activities and overcome obstacles to regular physical activity participation
Moola, Faulkner, Kirsh, Kilburn (2008)	Belief in capability to utilize skills in order to execute an action in a variety of situations

Table 3 (cont'd)

Source (Year)	Conceptual Definition
Shields et al. (2008)	Self-regulatory self-efficacy - individual's confidence in overcoming daily barriers to maintain activity levels Confidence in ability to manage physical activity
Taymoori & Lubans (2008)	Confidence in ability to be active in a variety of situations
Annesi, Tennant, Westcott, Faigenbaum, & Smith (2009)	Self-regulatory self-efficacy - confidence in completing greater amounts of exercise if wanted to exercise more
Dzewaltowski et al. (2009)	Confidence to be physically active 5-7 days per week Confidence to perform physical activity
Fawcett, Garton, & Dandy (2009)	Perceived ability in activity compared to peers
Maynard, Baker, Rawlins, Anderson, & Harding (2009)	Perceptions of confidence in the ability to do physical activity
Teerarungsikul et al. (2009)	Individual's belief in their ability to perform a course of action
Wenthe, Janz, & Levy (2009)	Overcoming barriers to physical activity
Annesi (2010)	Task self-efficacy - one's perception of his physical abilities Self-regulatory self-efficacy - one's perception of abilities to negotiate barriers
Buxbaum, Ponce, Saidi, & Michaels (2010)	Belief that one is capable of performing physical activity
Murray & Tenenbaum (2010)	Confidence in ability for physical activity
Taymoori, Rhodes, & Berry (2010)	Confidence for overcoming barriers to physical activity
Todd, Reid, & Butler-Kisber (2010)	Confidence in reaching a physical activity goal
Chen, Weiss, Heyman, Cooper, & Lustig (2011)	Adolescents' self-confidence in their ability to participate in various age-appropriate activities
Johnson, Kubik, & McMorris (2011)	Belief in one's ability to perform physical activity
Voorhees, Yan, Clifton, & Wang (2011)	Barriers self-efficacy - confidence in ability to be physically active regardless of barriers
Keats, Emery, & Finch (2012)	Perceived ability to successfully perform the behavior
Perry, Garside, Morones, & Hayman (2012)	Situation-specific belief regarding a person's competence to perform a certain skill or task (physical activity)
Silva et al. (2012)	Perceptions about confidence in overcoming barriers to being physically active
Peterson et al. (2013)	Confidence for overcoming barriers to physical activity
Roesch et al. (2013)	A person's confidence he or she can meet a behavioral criterion in situations that may present barriers to the behavior

Note. PA=physical activity.

Defining Attributes

PA self-efficacy attributes were explored through analysis of conceptual definitions, key words from the article review and an exploration of historical and theoretical sources. Data analysis indicated the following attributes: personal cognition and perception, self-appraisal process, PA-related action, power to choose PA, dynamic state and bi-dimensional nature. Characteristics, including supporting sources for each attribute, are listed in Table 4.

Personal cognition and perception. For youth, PA self-efficacy is determined individually and involves personal agency (Dzewaltowski et al., 2009). Perceptions and cognitions are used to form personal beliefs about PA. Luszczynska and colleagues (2010) refer to PA self-efficacy as individually perceived. Self-efficacy is also described as a cognitive concept that is specific to PA (Morgan, Saunders, & Lubans, 2012; Pender, Bar-Or, Wilk, & Mitchell, 2002).

Self-appraisal process. Youth PA self-efficacy involves a self-appraisal process that includes beliefs held by youth regarding their capability for PA. This evaluative process is referred to as an assessment (Annesi, 2006), judgment (Nigg & Courneya, 1998) and integrative appraisal (Bandura, 1997). Oettingen (1995) describes the formation of self-efficacy beliefs as a 'complex process of self-appraisal' (p. 151). Descriptors for belief vary and include behavioral belief (Keats, Emery, & Finch, 2012), domain-specific belief (Johnson et al., 2011) and situation-specific belief (Perry et al., 2012).

Bandura (1997) most often uses capability when referring to beliefs about self-efficacy. Ability and capability are used in definitions with similar frequency. Other terms include feeling able (Umeh, 2003), competence (Perry et al., 2012), perceived competence (Annesi, 2010; Nahas, Goldfine, & Collins, 2003,) and capacity (Monge-Rojas, Nunez, Garita, & Chen-Mok, 2002; Todd, Reid, & Butler-Kisber, 2010). Bandura (1986) points out that self-efficacy is less about actual skills and more about what a person believes he or she can do with those skills. PA self-efficacy is not merely a youth's actual PA ability, but rather the belief in his or her PA capability.

PA-related action. PA self-efficacy involves an action specifically related to PA. This attribute is similar to Bandura's (1997) use of the phrase 'execute courses of action' when defining self-efficacy (p. 2). Pender and colleagues (2002) equate execution in this definition with participation in PA, one of numerous behavioral descriptions used in the literature. Perform and participate are the most frequently used action terms in conceptual definitions respectively.

Power to choose PA. Bandura (2004) describes self-efficacy as the 'power to produce desired changes by one's actions' (p.144). Johnson and colleagues (2000) describe this attribute as controlling the choice to be physically active. Power is needed to carry out a particular behavior 'in the face of dissuading conditions' or 'impediments' despite having the capability for tasks or skills related to the behavior (Bandura, 2007, p.647). These impediments are most often referred to as barriers, competing activities, or positive alternatives (Buxbaum, Ponce, Saidi, & Michaels, 2010; Johnson, Kubik, & McMorris, 2011; Nigg & Courneya, 1998; Pate et al., 1997).

Barriers are categorized as environmental, personal and social (Annesi, 2010) and external or internal (Allison, Dwyer, & Makin, 1999). Other terms found in the literature include obstacles or difficult situations (Deforche, Bourdeaudhuij, Tanghe, Hills, & Bode, 2004; Reynolds et al., 1990; Umeh, 2003) and things that get in the way of PA (Roesch et al., 2013). Youth with high PA self-efficacy may be equipped with the power to choose PA over existing barriers. For purposes of this paper, barriers are conceptualized as encompassing competing activities or positive alternatives to PA, such as homework, and non-activities, such as inclement weather.

Dynamic state. Dynamic, changeable (Maibach & Murphy, 1995) and modifiable (Pender et al., 2002) are common descriptors of PA self-efficacy making the concept appealing for health promotion research because interventions can be directed at increasing self-efficacy. Amenable to change or having room for change also supports the dynamic state of PA self-efficacy (Keats et al., 2012; Neumark-Sztainer, Story, Hannan, Tharp, & Rex, 2003).

According to Bandura (1997), self-efficacy has a developmental context that begins in infancy and develops over the life course. Flammer (1995) states that young children tend to overrate their capabilities and underrate the difficulty of tasks. He considers the middle elementary age child to be about the earliest appropriate age to measure self-efficacy. PA self-efficacy develops over time (Murray & Tenenbaum, 2010; Todd et al., 2010) and for the most part, increases with advancing age (Allison et al., 1999; Monge-Rojas et al., 2002; Pate et al., 1997). However, Dishman and colleagues (2005) report higher PA self-efficacy among younger girls compared with older girls. While pubertal stage has been suggested as an explanation for this association, self-efficacy appears to be relatively stable across pubertal stages for both boys and girls (Gebremariam et al., 2012).

Bi-dimensional nature. Although identified as being multi-dimensional (Allison et al., 1999; Taymoori, Rhodes, & Berry, 2010), PA self-efficacy is most often portrayed as having the following two dimensions: task self-efficacy related to PA skills or ability (Annesi, 2006; Annesi, Tennant, Westcott, Faigenbaum, & Smith, 2009; Annesi, 2010; Driver, 2006; Foley et al., 2008; Petosa, Hortz, Cardina, & Suminski, 2005) and barrier self-efficacy or self-regulatory self-efficacy (Driver, 2006; Shields et al., 2008; Voorhees, Yan, Clifton, & Wang, 2011). The majority of conceptual definitions for PA self-efficacy include one of these dimensions but usually not both.

Table 4. Analysis of Defining Attributes of Physical Activity Self-Efficacy

Defining Attribute	Characteristics (Sources)
Personal concept that includes *cognitions* and *perceptions*	Expectation (Dzewaltowski et al., 2009) Individual, personal agency (Dzewaltowski et al., 2009) Perceived by individual (Luszczynska et al., 2010) Perceptual or perceptions (Fein, Plotnikoff, Wild, & Spence, 2005; Johnson et al., 2000; Maynard, Baker, Rawlins, Anderson, & Harding, 2009; Murray & Tenenbaum, 2010; Reynolds et al., 1990; Robbins Pender, Ronis, Kazanis, & Pis, 2004) Self-presentation (Wright, Ding, & Li, 2005) Cognitive or cognitions (Allison, Dwyer, & Makin, 1999; Fein, Plotnikoff, Wild, Spence, 2005; Neumark-Sztainer, Story, Hannan, Tharp, & Rex, 2002; Prins et al., 2011; Reynolds, et al., 1990; Robbins et al., 2004; Srof & Velsor-Friedrich, 2006; Taymoori & Lubans, 2008) Behavior specific cognition (Pender, Bar-Or, Mitchell, & 2002) Physical activity-related cognition (Morgan, Saunders, & Lubans, 2012) Social cognitive variable (Dishman et al., 2005; Lubans & Sylva, 2009; Ward et al., 2006)
Self-appraisal process that involves both *beliefs* and *capability*	Assess abilities (Annesi, 2006) Behavioral belief (Keats, Emery, & Finch, 2012) Belief (Annesi, Tennant, Westcott, Faigenbaum, & Smith, 2009; Buxbaum, Ponce, Saidi, & Michaels, 2010; Dzewaltowski et al., 2009; Foley et al., 2008; Lubans & Sylva, 2009; Moola, Faulkner, Kirsh, & Kilburn, 2008; Reynolds et al., 1990; Schaal, Peter, & Randler, 2010; Srof & Velsor-Friedrich, 2006; Teerarungsikul et al., 2009; Todd, Reid, & Butler-Kisber, 2010) Domain specific belief (Johnson, Kubik, & McMorris, 2011) Expectation (Dzewaltowski et al., 2009) Judgment (Nigg & Courneya, 1998) Situation-specific belief (Perry, Garside, Morones, & Hayman, 2012) Strength of belief (Foley et al., 2008) Confidence (Allison, Dwyer, Makin, 1999; Deforche et al., 2004; Annesi et al., 2009; Fein, Plotnikoff, Wild, & Spence, 2005; Maynard et al., 2009; Luszczynska et al., 2010; Moola et. al, 2012; Nigg & Courneya, 1998; Pender et al., 2002; Peterson et al., 2013; Prins et al., 2011; Reynolds et al., 1990; Sheilds et al., 2008; Silva et al., 2012; Todd, Reid, & Butler-Kisber, 2010; Voorhees et al., 2011; Wright, Ding, & Li, 2005)

Table 4 (cont'd)

Defining Attribute	Characteristics (Sources)
Self-appraisal process that involves both *beliefs* and *capability* (continued)	Level of confidence (Fawcett, Garton, & Dandy, 2009; Robbins et al., 2004; Taymoori, Rhodes, & Berry, 2010) Strength of self-efficacy determined by summing confidence ratings (Robbins et al., 2004) Self-confidence (Chen, Weiss, Heyman, Cooper, & Lustig, 2011) Being sure (Fein et al., 2005) How sure are you (Johnson et al., 2000; Neumark-Sztainer, Story, Hannan, Tharp, & Rex, 2003)
Belief is directed towards physical activity *capability*	Ability (Chen et al., 2011; Deforche et al., 2004; Fein et al., 2005; Maynard et al., 2009; Reynolds et al., 1990; Voorhees, Yan, Clifton, & Wang, 2011; Wright et al., 2005) Am I able? (Silva et al., 2012; Wenthe, Janz, & Levy, 2009) Feeling able (Umeh, 2003) Competence (Perry et al., 2012) Competency (Leary et al., 2013) Perceived competence (Annesi, 2010; Nahas, Goldfine, Collins, 2003) Perceived ability (Fawcett, Garton, & Dandy, 2009; Todd et al., 2010) Capacity (Monge-Roias, Nunez, Garita, & Chen-Mok, 2002) Capacity to know what one can do (Todd et al., 2010 Capable or capability (Allison et al., 1999; Buxbaum et al., 2010; Fein et al., 2005; Foley et al., 2008; Moola et al., 2008; Srof & Velsor-Friedrich, 2006; Umeh, 2003) Physical capability (Todd et al., 2010)
Involves an *action* related to physical activity	Achieve a PA goal (Todd et al., 2010) Challenging tasks (Pender et al., 2002) Engage in (Prins et al., 2011) Manage (Shields et al., 2008) Initiate (Teerarungsikul et al., 2009) Participation (Chen et al., 2011) Performance of tasks (Wright et al., 2005) Performance related to physical fitness (Johnson et al, 2000) Perform PA successfully (Umeh, 2003) Perform, performance, or performing (Buxbaum, Ponce, Saidi, & Michaels, 2010; Dzewaltowski et al., 2009; Fawcett, Garton, & Dandy, 2009; Johnson, Kubik, & McMorris, 2011) PA skills (Fawcett et al., 2009; Pender et al., 2002 Successful participation (execution) (Pender et al., 2002) Take action (Luszczynska et al., 2010)

Table 4 (cont'd)

Defining Attribute	Characteristics (Sources)
Involves *the power to choose* PA despite existing barriers	Barriers (Bergh et al., 2012) Barriers labeled as social, personal, or environmental (Annesi, 2010) Competing activities (Nigg & Courneya, 1998) Competing demands (Fein et al., 2005) Controlling the choice to be physically active (Johnson et al., 2000) External and internal barriers (Allison et al., 1999) External and internal obstacles (Deforche et al., 2004) Overcoming barriers (Annesi, 2006; Deforche et al., 2004; Dishman et al., 2005; Norman, Sallis, & Gaskins, 2005; Nigg & Courneya, 1998; Peterson et al., 2013; Shields et al., 2008; Silva et al., 2012; Taymoori, Rhodes, & Berry, 2010; Roesch et al., 2013; Voorhees et al., 2011; Wenthe, Janz, & Levy, 2009) Overcoming perceived barriers (Allison, Dwyer, Makin, 1999) Magnitude of behavior (Foley et al., 2008) Positive alternatives (Buxbaum et al., 2010; Johnson et al., 2011) Self-regulatory efficacy (Driver, 2006; Shields et al., 2008) Things that get in the way of PA (Roesch et al., 2013) Perceive few obstacles (Umeh, 2003)
Dynamic state developmental, changes over time	Change over time, modifiable variable (Pender et al., 2002) Amenable to change (Neumark-Sztainer, Story, Hannan, Tharp, & Rex, 2003) Develops over time (Murray & Tenenbaum, 2010) Developmental (Todd et al., 2010) Room for change in belief (Keats, Emery, & Finch, 2012)
Bi-dimensional – involves capability for PA but also capability for carrying out PA under difficult situations	Multi-dimensional (Allison et al., 1999) Multi-dimensional – barriers, support seeking, competing activities, environmental change (Taymoori et al., 2010) Self-efficacy skill/ability; self-efficacy for overcoming barriers (Petosa, Hortz, Cardina, & Suminski, 2005) Self-regulatory efficacy (Driver, 2006; Shields et al., 2008) Task self-efficacy (skill/ability), self-regulatory self-efficacy (overcome barriers) (Driver, 2006) Task and barrier efficacy, strength (of belief) and magnitude (of behavior) should be measured (Foley et al., 2008) Task self-efficacy (perceived physical competence), self-regulatory self-efficacy (managing perceived barriers) (Annesi et al., 2009) Dimensional construct, task self-efficacy (physical abilities), self-regulatory self-efficacy (ability to negotiate barriers) (Annesi, 2010)

Note. PA=physical activity.

Related Concepts/Surrogate Terms

Competence. Competence, and perceived competence, perceived competency and perceived physical competence are used as related and surrogate terms for PA self-efficacy (Annesi et al., 2009; Annesi, 2010; Driver, 2006; Fawcett, Garton, & Dandy, 2009; Nahas et al., 2003; Pender et al., 2002; Perry et al., 2012; Silva, Lott, Wickrama, Mota, & Welk, 2012; Srof & Velsor-Friedrich, 2006; Taymoori et al., 2010; Wright, Ding, & Li, 2005). Pender and colleagues (2002) equate PA self-efficacy with ‘level of perceived competence’ related to youth PA (p. 87). Maddux (2005) points out that Bandura, when first describing self-efficacy, referred to perceived competence and perceived self-efficacy as similar terms.

Perceived competence captures one dimension of PA self-efficacy because it relates specifically to personal assessment of capability, but lacks the dimension of the power to choose PA despite existing barriers. Annesi and colleagues (2009) associate perceived physical competence with task self-efficacy. Stanley, Boshoff, and Dollman (2013) report that children describe their perceived competency for PA as how good they are at a particular activity. While this description is based on perceptions, it refers more specifically to actual ability. Perceived competence for PA appears to be a related term that overlaps with PA self-efficacy.

Confidence. Confidence and belief are used interchangeably with confidence being the most frequently cited word in conceptual definitions. The strength of self-efficacy beliefs is described as a certain level of confidence (Fawcett et al., 2009; Robbins, Pender, Ronis, Kazanis, & Pis, 2004; Taymoori et al., 2010). Bandura (1997) states that confidence ‘refers to the strength of a belief but does not necessarily specify what the certainty is about’ and assessment of self-efficacy should include the ‘strength of the belief’ and ‘affirmation of a capability level’ (p. 382). Beliefs involve judgment and are essentially what youth perceive to be true regarding their capabilities for PA. However, beliefs may involve more than just confidence.

Confidence, when used in measures of PA self-efficacy, is most often stated as ‘how confident are you that you can be physically active’. However, similar phrases are also included in measures of PA self-efficacy such as ‘how sure are you’ or ‘how certain are you’ in place of ‘how confident are you’ (Fein, Plotnikoff, Wild, & Spence, 2005; Johnson et al., 2000; Leary, Lilly, Dino, Loprinzi, & Cottrell, 2013; Neumark-Sztainer et al., 2003). If the terms certainty or sure can be substituted for confidence, confidence is less likely to be a surrogate term for PA self-efficacy, but rather a term used to assess the strength of beliefs in PA capability.

Antecedents

According to Bandura (1986, 1997), four theoretical sources are critical for the formation of self-efficacy: enactive mastery, vicarious experience, verbal or social persuasion and physiological or affective states. A summary of antecedents from the literature is provided in Table 5.

Enactive mastery. Prior and current mastery of PA experiences (Allison et al., 1999; Annesi et al., 2009; Deforche et al., 2004; Keats et al., 2012; Lubans & Sylva, 2009; Pender et al., 2002; Todd et al., 2010) is an important antecedent of youth PA self-efficacy. Wright et al. (2005) capture the essence of this source by explaining that mastery experiences will foster PA self-efficacy best when they occur through PA successes gained through increasing difficulty.

Vicarious experience. Vicarious experience is expressed as imitation and role modeling of PA (Keats et al., 2012; Lubans & Sylva, 2009; Pender et al., 2002; Teerarungsikul et al., 2009). Examples of role models for youth are friends (Johnson et al., 2011; Silva et al., 2012) and family members (Shields et al., 2008). Modeling of PA by significant others provides youth with additional judgments of their own PA capabilities (Bandura, 1997).

Bandura (1997) highlights the importance of ‘attribute similarity’ of the role model for increasing an individual’s self-efficacy beliefs with age and sex similarities being the most important (p. 98). Murray and Tenenbaum (2010) report that youth PA self-efficacy increased when youth were exposed to peers who were competent but similar in ability. Bandura (1997) argues that highly competent role models have the greatest effect on increasing self-efficacy. Observations of others performing PA may be an important antecedent to consider when designing interventions to increase PA self-efficacy in youth.

Verbal or social persuasion. Increasing PA self-efficacy through verbal or social persuasion is another key antecedent (Driver, 2006; Lubans & Sylva, 2009; Murray & Tenenbaum, 2010; Pender et al., 2002). Social support is an example of positive social persuasion that can be provided from a variety of sources (Leary et al., 2013; Moola, Faulkner, Kirsh, & Kilburn, 2008; Neumark et al., 2003; Taymoori et al., 2010). Strong social support networks can contribute to higher levels of PA self-efficacy among youth (Peterson, Lawman, Wilson, Fairchild, & Van Horn, 2013).

Physiological or affective states. Physiological and affective responses can have negative or positive effects on PA self-efficacy (Driver, 2006; Murray & Tenenbaum, 2010). Fear (Annesi, 2010), pain (Lubans & Sylva, 2009), perceived exertion (Pender et al., 2002) and stress (Allison et al., 1999) can negatively impact PA self-efficacy. Deforche and colleagues (2004) emphasize the importance of gradually increasing PA to decrease the likelihood of negative emotions which can lower PA self-efficacy. Overall health can also impact PA self-efficacy (Buxbaum et al., 2010). Youth with chronic conditions such as congenital heart disease can experience fatigue that can decrease PA self-efficacy (Moola et al., 2008).

Positive responses to PA hold promise for increasing PA self-efficacy. Robbins and colleagues (2004) emphasize that positive feelings resulting from PA have the potential to increase PA self-efficacy. Enjoyment is the most frequently cited positive affective response (Fawcett et al., 2009; Lubans & Sylva, 2009; Perry et al., 2012; Teerarungsikul et al., 2009).

Table 5. Analysis of Antecedents of Physical Activity Self-Efficacy

Antecedents	Characteristics (Sources)
Enactive mastery (prior and current PA experiences)	Successful exercise experiences (Reynolds et al., 1990)
	Prior PA behavior levels (Pate et al., 1997)
	Mastery of PA (Allison, Dwyer, & Makin, 1999; Annesi et al., 2009)
	Mastery experiences (Keats et al., 2012; Pender et al., 2002; Todd et al., 2010; Wright & Ding, 2005)
	Successful mastery (Robbins et al., 2004)
	Current PA (Johnson et al., 2000)
	Past PA behavior (Umeh, 2003)
	PA behavior (Robbins et al., 2004)
	Past PA experiences (Murray & Tenenbaum, 2010)
	Performance of behaviors that lead to success (Deforche et al., 2004)
	Successes and failures of PA goals (Fein et al., 2005)
	Successes and failures (Petosa et al., 2005)
	Successes gained through increasing difficulty (Wright & Ding, 2005)
	Prior successes (Fawcett et al., 2009)
	Exercise skill development (Lubans & Sylva, 2009)
	Previous PA behavior (Johnson et al., 2011)
Vicarious experience	Observations of others (Pender et al., 2002)
	Modeling (Robbins et al., 2004)
	Peer modeling (Wright & Ding, 2005)
	PA modeling by friends (Johnson et al., 2011)
	Family participation in PA (Shields et al., 2008)
	Imitation and modeling (Lubans & Sylva, 2009)
	Modeling of PA (Murray & Tenenbaum, 2010)
	Role modeling of PA (Taymoori et al., 2010)
	Role modeling (Keats et al., 2012)
	Role modeling from friends (Silva et al., 2012)

Table 5 (cont'd)

Antecedents	Characteristics (Sources)
Verbal or social persuasion	Social persuasion (Pender et al., 2002) Social persuasion to be active (Murray & Tenenbaum, 2010) Social support (Deforche et al., 2004; Johnson et al., 2011; Shields et al., 2008) Social support from peers (Lubans & Sylva, 2009; Teerarungsikul et al., 2009) Peer and parent social support (Neumark-Sztainer et al., 2003) Parental support (Fawcett et al., 2009; Leary et al., 2013) Family and friend support (Wenthe et al., 2009) Friend support (Silva et al., 2012) Mother, father, and friend social support (Taymoori et al., 2010) Social support networks (Leary et al., 2013) Social persuasion (Pender et al., 2002) External feedback (Wright & Ding, 2005) Positive feedback (Teerarungsikul et al., 2009) Interpersonal influences (Srof & Velsor-Friedrich, 2006) Advice from health care provider or parent (Moola et al., 2008) Use of persuasion (Keats et al., 2012) Social encouragement (Keats et al., 2012)
Physiological or affective states	Life strain/stress (Allison, Dwyer, & Makin, 1999) Physiological arousal (Pender et al., 2002) Emotional states (Deforche et al., 2004) Pleasurable experiences (Robbins et al., 2004) Perceived exertion (Srof & Velsor-Friedrich, 2006) Fatigue (Moola et al., 2008) Satisfaction with activity (Fawcett et al., 2009) Enjoyment (Fawcett et al., 2009; Lubans & Sylva, 2009; Perry et al., 2012; Silva et al., 2012) Physiological symptoms of effort: pain (Lubans & Sylva, 2009) Feelings about PA such as fear and incompetence (Annesi, 2010) Affective responses to PA (Murray & Tenenbaum, 2010)

Note. PA=physical activity.

Consequences

Maibach and Murphy (1995) categorize self-efficacy consequences as choice behavior, effort expenditure and persistence, thought patterns and emotional effects. A summary of the data supporting PA self-efficacy consequences is provided in Table 6.

Choice behavior - PA. PA is a consequence of self-efficacy among youth. The majority of empirical studies report that higher levels of PA self-efficacy are significantly associated with higher reported PA among youth. However, Deforche and colleagues (2004) did not find PA to be an outcome of PA self-efficacy for obese adolescents. Additionally, Buxbaum and colleagues (2010) demonstrate an inverse relationship between self-efficacy and vigorous PA in a study of boys with hemophilia. Perhaps for youth with a long-time illness or health issue, PA self-efficacy is less likely to be related to or predict PA.

PA effort expenditure and persistence. Persistence and perseverance with PA are associated with PA self-efficacy (Annesi, 2006; Driver, 2006; Teerarungsikul et al., 2009). Others describe this consequence in terms of starting and maintaining PA or regularity of PA (Keats et al., 2012; Nigg & Courneya, 1998). PA effort and persistence are also described as maintaining PA despite potential barriers (Luszczynska et al., 2010), resisting relapse (Allison et al., 1999; Nahas et al., 2003) and being able to resume PA once stopped (Luszczynska et al., 2010). Bandura (1997) and Maddux (2005) describe this effort to overcome barriers as self-regulation. A concerted effort to overcome PA barriers can result in mastery of PA (Annesi et al. 2009; Fawcett et al., 2009).

PA thought patterns. PA thought patterns are referred to as decision-making for PA (Johnson et al., 2000), behavioral intentions (Foley et al., 2008, Luszczynska et al., 2010; Murray & Tenenbaum, 2010) and goal setting (Todd et al., 2010). Bandura (2004) diagrams a model of self-efficacy with goals listed as a consequence. Self-regulation and planning also fit with this cognitive process (Taymoori et al., 2010).

PA emotional effects. Less evidence exists for emotional patterns as a consequence of PA self-efficacy. Enjoyment of PA is the only emotional effect included in the literature (Driver, 2006; Petosa et al., 2005; Todd et al., 2010; Wright et al., 2005). Although enjoyment can be conceptualized as both an antecedent and consequence of PA self-efficacy, there is more support for enjoyment as an antecedent (Fawcett et al., 2009; Lubans & Sylva, 2009; Perry et al., 2012; Robbins et al., 2004; Teerarungsikul et al., 2009).

Table 6. Analysis of Consequences of Physical Activity Self-Efficacy

Consequences	Characteristics (Sources)
Choice behavior - PA	Exercise behavior (Reynolds et al., 1990)
	Exercise behavior change (Nigg & Courneya, 1998)
	Vigorous PA (Allison, Dwyer, & Makin, 1999; Pate et al., 1997)
	PA behavior (Johnson et al., 2000; Lubans & Sylva, 2009; Monge-Roias et al., 2002; Van Stralen et al., 2011)
	PA (Annesi, 2006; Berkowitz, 2008; Driver, 2006; Felton et al., 2002; Fein et al., 2005; Foley et al., 2008; Leary et al., 2013; Luszczynska et al., 2010; Maynard et al., 2009; Nahas et al., 2003; Norman et al., 2005; Pender et al., 2002; Perry et al., 2012; Peterson et al., 2013; Petosa et al., 2005; Shields et al., 2008; Schaal et al., 2010; Srof & Velsor-Friedrich, 2006; Teerarungsikul et al., 2009; Ward et al., 2006)
	PA participation (Moola et al., 2008)
	Sports team participation (Johnson et al., 2011)
	Successful participation (Pender et al., 2002)
	Moderate PA (Neumark-Sztainer et al., 2003)
	Self-initiated change in PA (Dishman et al., 2005)
	PA change (Murray & Tenenbaum, 2010)
	Physical leisure activities (Fawcett et al., 2009)
	Walking behavior (Voorhees et al., 2011)
	Moderate to vigorous PA (Lubans & Sylva, 2009; Prins et al., 2011; Voorhees et al., 2011; Wenthe et al., 2009)
	PA levels (Annesi, 2010)
	Level of performance for PA (Silva et al., 2012)
	Regular PA (Silva et al., 2012)

Table 6 (cont'd)

Consequences	Characteristics (Sources)
PA effort expenditure and persistence	Persistence or regularity over time (Nigg & Courneya, 1998) Ability to maintain PA (Nigg & Courneya, 1998) Perceived exertion (Pender et al., 2002; Robbins et al., 2004; Srof & Velsor-Friedrich, 2006) Persistence over time (Pender et al., 2002) Persist or persistence (Annesi, 2006; Driver, 2006) Effort (Annesi, 2006; Driver, 2006; Wright & Ding, 2005) Effort and persistence (Murray & Tenenbaum, 2010) Adoption and adherence (Driver, 2006) Motivation (Annesi, 2006; Annesi et al., 2009) Preventing relapse of PA(Shields et al., 2008) Recovery or ability to resume PA once stopped (Luszczynska et al., 2010) Maintain PA despite barriers (Luszczynska et al., 2010) Maintenance of PA (Murray & Tenenbaum, 2010) Starting and maintaining a behavior (Keats et al., 2012) Time and effort (Silva et al., 2012)
PA thought patterns	Decision making (Johnson et al., 2000; Monge-Roias et al., 2002) Behavioral intention (Foley et al., 2008; Luszczynska et al., 2010; Umeh, 2003) Intention formation (Murray & Tenenbaum, 2010) Planning (Luszczynska et al., 2010; Taymoori et al., 2010) Goal setting (Todd et al., 2010) Self-regulation (Taymoori et al., 2010) Outcome expectations (Driver, 2006; Taymoori et al., 2010)
PA emotional effects	Affect/enjoyment (Driver, 2006) Enjoyment (Todd et al., 2010; Wright & Ding, 2005)

Note. PA=physical activity.

Conceptual Definition

Based on the defining attributes, antecedents and consequences derived from the literature, youth PA self-efficacy is defined as a youth's belief in his/her capability to participate in PA and to choose PA despite existing barriers. PA self-efficacy is dynamic and bi-dimensional in nature.

Exemplar of the Concept

An exemplar of the concept, demonstrating the characteristics of PA self-efficacy, is present in a qualitative study examining perceptions related to the role of PA in the lives of 13 youth with congenital heart disease (Moola et al., 2008). The authors describe PA self-efficacy as a belief in the capability to use PA skills to participate in PA in different situations. The antecedents, defining attributes and consequences of PA self-efficacy are evident in the interview data from study participants.

Antecedents can influence PA self-efficacy in both negative and positive ways**.** For example, fatigue, a physiological state, results in both lower self-efficacy and lower PA participation. One girl states, 'I can't even walk up the stairs, so how am I going to run?' (p. 63). Similarly, when these youth observe their peers participating in sports, the antecedent of vicarious experience lowers PA self-efficacy by reinforcing the activity limitations of the cardiac defect. A participant commenting about track said, 'I knew that I physically wouldn't be able to finish…sometimes I get a little depressed if a lot of my friends are doing it and you'd like to be doing the events' (p. 61).

In contrast, positive mastery experiences from sports participation lead to increases in PA self-efficacy and result in continuation of PA over time. A participant states, 'I started hockey this year…it made me feel more confident and I could get more goals' (p. 62). Verbal persuasion also enhances youth PA self-efficacy when significant others provide positive feedback regarding athletic abilities. One youth describes his response stating, 'and then I want to show them that I can do it again and I keep playing' (p. 61). While this study is limited to youth with congenital heart disease, it provides evidence for the sources of self-efficacy which can lead youth to choose PA despite existing barriers, resulting in continued participation in PA over time.

Discussion

The rigorous evolutionary method outlined by Rodgers (2000) guided the analysis of PA self-efficacy from theoretical and empirical sources. SCT offered an organizing framework for data collection and analysis. While this analysis provides a conceptual definition for PA self-efficacy, future research should be directed at refining this definition. Consistency between conceptual and operational definitions should be evaluated in detail through continued examination of PA self-efficacy measures. Given the heterogeneity of instruments in the literature, future research should focus on refining instruments so they adequately reflect the defining attributes of PA self-efficacy. In addition, only two qualitative studies investigated PA self-efficacy among youth (Moola et al., 2008; Stanley et al., 2013). As demonstrated in the exemplar, future exploration of the concept using a qualitative approach may enhance understanding of PA self-efficacy by seeking out the youth perspective.

Congruency between Bandura's theoretical sources of self-efficacy and the antecedents of PA self-efficacy found in the empirical literature provides support for these sources as potential factors leading to increased youth PA self-efficacy. Expansion and refinement of health behavior models focused on these sources may be important for strengthening the development of effective theory-based interventions (Conn, Rantz, Wipke-Tevis, & Maas, 2001). Relationships in health behavior models may need revision and expansion to increase the explanatory power for increasing youth PA. For example, interventions directed at enjoyment of PA as an affective state and source of PA self-efficacy may result in higher PA self-efficacy and increased youth PA.

Examination of the development of PA self-efficacy as youth age is also warranted. The relationship between age and PA self-efficacy was not consistent across studies included in this concept analysis. Moreover, Van Stralen and colleagues (2011) report that research examining this relationship is lacking. Investigating how PA self-efficacy may differ by developmental stage can provide additional insight for developing interventions aimed at increasing PA self-efficacy (Deforche et al., 2004; Leary et al., 2013; Peterson et al., 2013). Future research should also examine sex differences related to self-efficacy, particularly because girls tend to report lower PA self-efficacy than boys. These efforts may lead to improvements in the tailoring of interventions for specific subgroups of youth.

Limitations

Use of a novel method for sampling a percentage of the literature by time periods may have resulted in missed data. Also, only two qualitative studies regarding PA self-efficacy in the final sample may limit information about the concept from a youth perspective. Finally, the data collection and analysis process was completed by the first author presenting the possibility of bias.

Conclusion

PA self-efficacy is an important concept for nurse scientists involved in research focused on increasing PA among youth in the U.S. and internationally. Because PA self-efficacy is a key concept in many theories aimed at health promotion, a consistent conceptual and operational definition is important for advancing the science related to the concept. Theory-based interventions designed to increase both the sources of self-efficacy and PA self-efficacy directly have the potential to promote PA among youth.

Middle range theories, such as nursing's Health Promotion Model (Pender et al., 2011), can be adapted, refined, tested and expanded based on evidence related to PA self-efficacy. For example, the Health Promotion Model (HPM) contains the theoretical sources of self-efficacy as key constructs in the model (Srof & Velsor-Friedrich 2006). Examination of how these sources serve as antecedents to PA self-efficacy may result in the need to revise or integrate theories to strengthen their explanatory power.

Nursing interventions that strengthen youth PA self-efficacy may be an important step toward assisting youth to develop an active lifestyle. This comprehensive analysis has resulted in a refined conceptual definition of youth PA self-efficacy and has enhanced the clarity of the concept. Continued theory-building involving PA self-efficacy is suggested with the ultimate goal of increasing PA and promoting a healthy lifestyle among youth worldwide.

APPENDIX

APPENDIX

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CHAPTER 3: RELIABILITY AND VALIDITY OF TWO PHYSICAL ACTIVITY SELF-EFFICACY INSTRUMENTS IN URBAN, ADOLESCENT GIRLS

MANUSCRIPT TWO

This manuscript will be submitted to *Frontiers in Psychology*. Author guidelines can be found at the journal home page: http://journal.frontiersin.org/journal/psychology. Planned authorship is as follows: Vicki R. Voskuil, PhD (c), RN, CPNP, doctoral candidate, Michigan State University College of Nursing, Steven J. Pierce, PhD, Associate Director, Center for Statistical Training & Consulting, Michigan State University, and Lorraine B. Robbins, PhD, RN, FNP-BC, FAAN, Associate Professor, Michigan State University College of Nursing.

Abstract

Aims. This study compared the psychometric properties of two physical activity self-efficacy (PASE) instruments. Factorial validity, cross-group and longitudinal invariance, and composite reliability were examined. **Methods.** Secondary analysis was conducted on data from a group randomized controlled trial (RCT) investigating the effect of a 17-week intervention on increasing moderate to vigorous physical activity among 5^{th} - 8^{th} grade girls (*N*=1,012). Participants completed 6-item (PASE-6) and 7-item (PASE-7) instruments at baseline and post-intervention. Confirmatory factor analyses for intervention and control groups were conducted with Mplus Version 7.4 using robust weighted least squares estimation. Model fit was evaluated with the chi-square index, comparative fit index (CFI), and root mean square error of - approximation (RMSEA). Composite reliability for ordinal indicators was conducted for measurement models with Mplus output using SAS 9.3. **Results.** Mean age of the girls was 12.2 years (*SD*=.96). One-third of the girls were obese. Girls represented a diverse sample with over 50% indicating black race and an additional 19% indicating mixed or other race. Both instruments demonstrated configural invariance for simultaneous analysis of cross-group and longitudinal invariance based on alternative fit indices: PASE-6 (χ^2=151.412, *df*=94, p<.001, RMSEA=.035, CFI=.992); PASE-7 (χ^2=138.445, *df*=66, p<.001, RMSEA=.047, CFI=.984). However, simultaneous metric invariance was not met for the PASE-6 (χ^2=186.943, *df*=116, p<.001, $\Delta\chi^2$=39.034, Δdf=22, p=.014, RMSEA=.035, CFI=.990, ΔCFI=-.002) or the PASE-7 (χ^2=163.702, *df*=76, p<.001, $\Delta\chi^2$=48.136, Δdf=18, p<.001, RMSEA=.048, CFI=.981, ΔCFI=-.006). Partial metric invariance for the simultaneous analysis was achieved for the PASE-6 with one factor loading identified as non-invariant (χ^2=170.224, *df*=112, p<.001, $\Delta\chi^2$=24.308, Δdf=18, p=.145, RMSEA=.032, CFI=.991, ΔCFI=-.001). Partial metric invariance was not met for the PASE-7. Longitudinal scalar invariance was achieved for both instruments in the control group but not the intervention group. PASE-6 composite reliability ranged from .772-.842. Reliability for the PASE-7 ranged from .719-.800 indicating higher reliability for the PASE-6. Reliability was more stable over time in the control group for both instruments. **Conclusions.** Results suggest that the intervention influenced how girls responded to indicator items. Neither of the instruments achieved simultaneous metric invariance making it difficult to assess mean differences in PA self-efficacy between groups.

Key Words: confirmatory factor analysis, girls, measurement invariance, physical activity, self-efficacy

Introduction

Despite the health benefits of physical activity (PA), less than 25% of adolescents meet recommended guidelines (Fakhouri et al., 2014; Kann et al., 2016) calling for 60 minutes or more per day of at least moderate-intensity PA (U.S. Department of Health and Human Services, 2008). Compared to boys, girls attain less PA and have greater declines in the behavior throughout adolescence (Dumith, Gigante, Domingues, & Kohl, 2011). An urgent need exists for an increased understanding of factors underlying this occurrence among adolescent girls, particularly given that the majority of interventions have not successfully increased PA in this population (Camacho-Minano, LaVoi, & Barr-Anderson, 2011).

While a number of psychosocial factors have been theorized to increase PA among adolescents, self-efficacy has been shown to be an important correlate and determinant of PA (Bauman et al., 2012; Craggs, Corder, van Sluijs, & Griffin, 2011) and mediator of PA intervention effects (Lubans, Foster, & Biddle, 2008). However, some researchers have reported contradictory findings regarding the relationships between self-efficacy and adolescent PA and have suggested that inadequate and varied measurement of the concept may explain the inconsistent results (Dewar, Lubans, Morgan, & Plotnikoff, 2013; Plotnikoff, Costigan, Karunamuni, & Lubans, 2013).

Establishing multi-group and longitudinal invariance of PA self-efficacy instruments in intervention studies is necessary to determine if the same construct is measured over time with the same metric (Widaman, Ferrer, & Conger, 2010). Unfortunately, evaluation of the psychometric properties of PA self-efficacy instruments is rarely undertaken and reported in the literature (Brown, Hume, & Chinapaw, 2009). This study aims to decrease this gap by comparing the factorial validity, measurement invariance, and reliability of two PA self-efficacy instruments used in a large-scale study to test a PA intervention with urban, adolescent girls. The results of this study may contribute to improved understanding of PA self-efficacy and its role in fostering PA for girls.

Background

The concept of PA self-efficacy has its origins within social cognitive theory (Bandura, 1986). Bandura (1997) defines self-efficacy as 'the belief in one's capabilities to organize and execute courses of action required to produce given attainments' (p. 2). When this definition is applied to PA, self-efficacy is defined as a belief in one's capability to participate in PA and to choose PA over existing barriers (Voskuil & Robbins, 2015). PA self-efficacy has been incorporated into a number of health behavior models used to develop theory-based interventions and explain PA in adolescents (Plotnikoff et al., 2013).

While several studies have included PA self-efficacy as a key construct in theory-based interventions with youth (Bauman et al., 2012), psychometric assessment of PA self-efficacy instruments has been insufficient. Following examination of the reporting of validity and reliability in 15 studies that included a PA self-efficacy instrument, Brown and colleagues (2009) noted that while the majority of studies included acceptable internal consistency with Cronbach's alpha (n=12), fewer than half reported reliability over time (n=7), only two reported acceptable factor analysis, and none reported criterion validity. Furthermore, psychometric analysis of PA self-efficacy instruments utilized with specific populations, such as girls, has been limited (Dewar et al., 2013).

Of interest in this study is the potential for interventions to alter the way in which participants understand and respond to a PA self-efficacy instrument. In the Trial of Activity for Adolescent Girls (TAAG), Lytle and colleagues (2009) reported that girls in the intervention group had lower self-efficacy scores at the end of the study compared to girls in the control group. These authors hypothesized that exposure to the intervention likely heightened girls' awareness of their difficulties related to PA. Dunton and colleagues (2007) reported declines in scores for PA self-efficacy among an intervention group of adolescent girls over the course of the study. Other researchers have noted similar findings for self-efficacy among youth, reporting lower PA self-efficacy after exposure to an intervention (Bergh et al., 2012; Haerens et al., 2008). Reporting mean differences in PA self-efficacy between an intervention and control group may be inaccurate if researchers assume measurement invariance without actually confirming it through invariance testing (Dishman et al., 2010).

Few studies have demonstrated support for the factorial validity and measurement invariance of PA self-efficacy instruments (Dishman et al., 2002; 2010; Motl et al., 2000; Roesch Norman, Merz, Sallis, & Patrick, 2013) with only the TAAG study demonstrating satisfactory cross-group and longitudinal invariance between intervention and control groups (Dishman et al., 2010). Roesch and colleagues (2013) established longitudinal invariance of a PA self-efficacy instrument measured in 11- to 15-year old adolescents; however, the analysis was not conducted by separating the intervention and control groups. Additional investigation of longitudinal invariance of self-efficacy measures in intervention studies is warranted to better understand changes in the concept over time, influences by intervention effects, and effect on PA among adolescent girls.

An additional concern regarding the measurement of PA self-efficacy is that researchers often adapt established instruments without conducting additional psychometric analysis to confirm that these changes have not affected the measurement properties (Bergh et al., 2012; Dewar et al., 2013; Johnson, Kubik, & McMorris, 2011). Deleting items, changing item wording, and altering the number of response choices may have a significant impact on the reliability and validity of these instruments and can change the meaning of the underlying concept. For example, Sherwood et al. (2004) adapted a PA self-efficacy instrument for use with 8- to 10-year old girls by changing the main stem of item questions from *how sure are you* to *how hard do you think it would be.* The authors point out that the items may have more accurately reflected perceived behavioral control than self-efficacy.

This study also aims to improve upon current reliability analysis for self-efficacy measures. Although frequently reported in psychometric studies (Brown et al., 2009), alpha may underestimate the true reliability for scales with a limited number of items (Furr & Bachrach, 2014). Furthermore, Cronbach's alpha assumes that items are tau-equivalent in which factor loadings of items are equal to each other, which is often not the case (Thurber & Bonynge, 2011). Assessment of composite reliability using confirmatory factor analysis (CFA) may provide better support for internal consistency (Raykov, 2004) and be more accurate for multi-dimensional instruments than alpha (Barbaranelli, Lee, Vellone, & Riegel, 2015). Composite reliabilty is also most appropriate for categorical, Likert-type scales with few response options (Yang & Green, 2011) that are typically used to assess self-efficacy among adolescents.

Purpose

The purpose of this study was to compare the psychometric properties of two PA self-efficacy instruments used with urban 5^{th}-8^{th} grade girls in the "Girls on the Move" group randomized controlled trial (RCT; Robbins et al., 2013). The specific aims were to examine: 1) the factorial validity; 2) multi-group and longitudinal invariance; and 3) the composite reliability of the self-efficacy instruments in the group RCT's control and intervention groups.

Methods

Design

The psychometric properties of two PA self-efficacy instruments were examined using secondary analysis of data from the first two years of the "Girls on the Move" group RCT. The group RCT was conducted to examine the effect of a 17-week multi-component intervention on increasing MVPA among racially diverse, underserved 5^{th}-8^{th} grade girls (Robbins et al., 2013). The group RCT included 24 urban schools in the Midwestern U.S. over three intervention years from 2012-2015. To examine the current study's aims, data collected during intervention years one and two of the group RCT were used. At baseline and again at the end of the 17-week intervention, girls completed an iPad-delivered survey that included the PA self-efficacy instruments.

Sample and Setting

Sample. A total of 1,012 girls participated during the first two intervention years of the group RCT that included fall 2012-spring 2013 and fall 2013-spring 2014. Inclusion criteria for the group RCT participants were: 1) 5^{th}-7^{th} grade girls (ages 10-14; 8^{th} grade girls in schools with only 7^{th} and 8^{th} grades); 2) able to participate in a PA club 3 days a week after school; 3) anticipated availability to complete 9-month post-intervention follow-up measures; and 4) able to read, understand, and speak English. Girls were excluded if they had a health condition that prevented safe PA or were involved in after-school sports or a community program that included PA.

Setting. For this study, data were collected in 16 schools. Eight schools, half of which served as controls, were involved in each of the two intervention years. School-level data indicated that the majority of girls in each school were black and of low socioeconomic status

(SES), the latter of which was determined based on participation in the free or reduced-price lunch program. After baseline data were collected, schools were randomly assigned to receive either the intervention or control condition. All school administrators, parents/guardians, and participants agreed to this randomization procedure.

Measures

Demographics. Demographic information was collected from single items listed on the consent form completed by the girls' parents/guardians. These items were used to obtain information on each girl's age, grade, ethnicity, race, and participation in a free or reduced-price lunch program.

Body mass index (BMI). BMI was included in this study for use in describing the sample. Each girl's measured weight and height were used to calculate body mass index (BMI). Girls' weight was measured to the nearest 0.1 kg using a foot-to-foot bioelectric impedance scale (Tanita Corporation, Tokyo, Japan). Girls' height without shoes was measured to the nearest 0.1 cm using a Shorr Board (www.weighandmeasure.com). Weight and height were used to calculate body mass index (BMI) based on the formula of $kg/meters^2$. BMI percentiles for age were calculated using the 2000 Centers for Disease Control (CDC) interpretation of BMI for children and teens (CDC, 2015). Weight status was classified as: 1) underweight ($<5^{th}$ percentile); 2) healthy weight (5^{th} percentile to $<85^{th}$ percentile); 3) overweight ($\geq 85^{th}$ to $<95^{th}$ percentile); and 4) obese ($\geq 95^{th}$ percentile).

PA self-efficacy. PA self-efficacy was measured using two instruments. The first instrument was developed by Saunders et al. (1997) as a 17-item scale with three factors: support-seeking, barriers, and positive alternatives. Additional psychometric testing using confirmatory factor analysis (CFA) of the instrument resulted in a unidimensional 8-item scale that has demonstrated multi-group and longitudinal invariance (Dishman et al., 2002; Dishman et al., 2010; Motl et al., 2000). The revised instrument included items from each of the three factors identified by Saunders et al. (1997) with five response options ranging from 1) *disgaree a lot* to 5) *agree a lot* that replaced the dichotomous *yes/no* used initially.

This instrument was further modified to 6-items for use in the group RCT. Two items focusing on social support were eliminated: 1) "*I can ask my parent or other adult to do physically active things with me"*; and 2) "*I can ask my best friend to be physically active with me during my free time on most days"*. In addition, the response choices were reduced from five to four to avoid a neutral response option: 0) *disagree a lot* to 3) *agree a lot*. Previous research has shown that elimination of a neutral response and offering four response choices may be optimal when surveying youth (Borgers, Sikkel, & Hox, 2004). A sample item is "*I can be physically active in my free time on most days even when I am busy*". In this study, the 6-item scale is referred to as PA self-efficacy (PASE)-6.

The second self-efficacy instrument was originally developed as a 12-item Self-Efficacy for Exercise Behaviors Scale for use with adults (Sallis, Pinski, Grossman, Patterson, & Nader, 1988). Exploratory factor analysis (EFA) resulted in two factors, a 5-item resisting-relapse factor and a 7-item making-time-for exercise factor. This instrument was further modified to a 10-item scale for use with adolescents and demonstrated adequate predictive validity (Wilson et al., 2002) and reliability (Wilson et al., 2008). Neither factorial validity or measurement invariance testing of the instrument was found in the peer-reviewed literature. However, in an unpublished study, CFA did not support a unidimensional scale and showed inadequate fit to the data (Lawman, Wilson, Van Horn, & Resnicow, 2011). One item, "*How sure are you that you can* *stick to your exercise program when you are alone and no one is watching you*?" was found to be non-invariant between boys and girls and was deleted resulting in a 9-item scale.

In the group RCT, this instrument was revised further to a 7-item scale with four response choices ranging from 0) *not at all sure* to 3) *very sure*. Two items were removed to reduce response burden and increase the relevance of items for adolescent girls: 1) "*How sure are you that you can stick to your exercising when you have guests staying in your home*?" and 2) "*How sure are you that you can stick to exercising even when you have limited amounts of time*? A sample item from the scale is "*How sure are you that you can stick to your exercise program even when your friends want to hang out*?" In this study, the 7-item scale is referred to as PA Self-Efficacy (PASE)-7.

Procedures

Recruitment. The Michigan State University Institutional Review Board and school administrators gave permission for data collection for the group RCT. Data collectors visited each school and community center to share information about the study with girls. Recruitment packets with study information, assent and consent forms, and an eligibility screening tool were provided to girls interested in participating. Girls were asked to share information in the packets with their parents or guardians and return completed packets in one or two days to the researchers present at their school.

Data collection. Eligible girls with signed consent and assent forms completed an iPad-delivered survey, including the PASE-6 and PASE-7, at their school at baseline and after the 17-week intervention. Trained research assistants measured height and weight behind privacy screens. Details of the group RCT procedures have been reported elsewhere (Robbins et al., 2013).

Data Analysis

Data analysis was performed using Stata 14 (StataCorp, College Station, TX), Mplus 7.4 (Muthén & Muthén, Los Angeles, CA), and SAS 9.3 (SAS Institute Inc., Cary, NC). Stata was used to calculate descriptive statistics of the sample, review characteristics of the PASE-6 and PASE-7 items, conduct a missing data analysis, and assess for non-independence of the data. In addition, t-tests and chi-square analysis were used to check for baseline differences between intervention and control groups. A single regression imputation with the self-efficacy items as model predictors was used to handle missing data. This decision was based on the fact that both instruments had < 1% missing data at baseline and < 10% missing data post-intervention, and this proportion was not likely to result in biased results (Dong & Peng, 2013).

The potential for a clustering effect existed due to the group RCT multi-level structure with girls nested in schools. Intra-class correlation coefficients (ICCs) of all items for the PASE-6 and PASE-7 were used to assess for non-independence of the data to ensure that a single-level CFA was appropriate for data analysis. Brown (2015) states that ICC values below .05 likely indicate that a multi-level CFA model may not be warranted. However, Musca et al. (2011) caution that even with ICC values as low as .01, Type I error rates can be greater than 5%. Of the 26 ICC values, the majority were close to zero. Only three items had ICCs ≥.01. The highest ICC value was .013 for one of the PASE-7 items at baseline. Given the low ICC values overall for both instruments at both time points, the decision was made to conduct invariance testing using single-level CFA.

Confirmatory factor analyses were conducted using Mplus to determine factorial validity and measurement invariance of the PASE-6 and PASE-7 instruments. Parameters were estimated using weighted least squares with mean and variance adjustment (WLSMV) with delta parameterization in which data are fitted to a polychoric correlation matrix. This estimation method is recommended for ordinal indicators with fewer than five response choices and is also robust to skewness and kurtosis of items (Brown, 2015; Flora and Curran, 2004; Flora, Labrish, & Chalmers, 2012). Scaling of each latent factor was achieved by fixing the factor loading for the first indicator to 1. Referent indicators for each instrument were chosen based on item-level descriptive statistics and carefully selecting items with the greatest variability and satisfactory standardized parameter estimates (Johnson, Meade, & DuVernet, 2009).

The general approach taken for invariance testing began with an assessment of separate single group models for the intervention and control groups at each time point for both instruments. Analysis then proceeded to cross-group measurement invariance between the intervention and control groups as well as longitudinal invariance for each group from baseline to post-intervention. The last step in the analysis involved combining cross-group and longitudinal invariance testing in which factor loadings, and thresholds if appropriate, were constrained simultaneously. Invariance analysis included: 1) configural (equal form) invariance; 2) metric (equal factor loadings) invariance; and 3) scalar (equal thresholds) invariance (Brown, 2015; Milfont & Fischer, 2011; Roesch et al., 2013).

Because invariant factor loadings are considered vital for construct validity (Brown, 2015), partial metric invariance was not undertaken with the cross-group and longitudinal invariance models. Instead, if the metric model resulted in non-invariant factor loadings, the model was re-specified. However, for the final simultaneous invariance models, partial metric invariance was pursued in an attempt to discover which factor loading(s) were non-invariant. In the case of scalar non-invariance, partial invariance was explored by examining threshold differences between groups or time points as well as suggested modification indices (MIs).

Dimitrov (2010) has suggested that partial invariance can be deemed satisfactory if <20% of parameters are non-invariant.

The model chi-square test was used to evaluate initial fit in single group models. Because this test is sensitive to large sample sizes, alternative fit indices were also used for model evaluation including the comparative fit index (CFI) and the root mean square of approximation (RMSEA). Recommendations from Kline (2016) and Brown (2015) were used to interpret the CFI and RMSEA using the following values as a guide to assessing model fit: CFI ≥.95; RMSEA ≤.05 for close fit, ≤.08 for approximate fit, >.08 to <.1.0 for marginal fit, and ≥1.0 for poor fit, and evaluation of lower- and upper-bound RMSEA 90% confidence intervals.

Although the chi-square test is sensitive to sample size, model results should still be closely evaluated for areas of strain including correlated residuals (≥.10) and modification indices (Kline, 2016). For this study, when the majority of correlated residuals were <.10 and modification indices were small but alternative fit indices indicated marginal fit, measurement invariance continued based on the fact that these models were considered plausible (Bryne, Shavelson, & Muthén, 1989; Raykov, Marcoulides, & Li, 2012).

After single group models were evaluated, measurement invariance evaluation was based on chi-square difference testing between baseline and nested models. A corrected chi-square difference test was used because the differences are not distributed as chi-square using WLSMV. RMSEA and CFI fit indices were also evaluated at each step of invariance testing. Change in CFI was also used to evaluate measurement invariance results. Cheung & Rensvold (2002) recommend using a change in CFI between models ≥ -.01 as potentially indicating non-invariance. Changes in CFI were used with caution for this study because the guideline established by these researchers was based on a simulation study using maximum likelihood estimation with normally distributed data. Whether or not this value can be used with WLSMV estimation has not yet been established.

Composite reliability of the instruments was ascertained by calculating nonlinear structural equation modeling (SEM) reliability coefficients using a parallel-forms definition of reliability (Green & Yang, 2009; Yang & Green, 2014). Computation of composite reliability was conducted using a three step approach: 1) estimation of thresholds and polychoric correlations; 2) fitting the CFA model to the polychoric correlation matrix using WLSMV; and 3) inputting factor loadings and thresholds into the equation using a SAS program to calculate the reliability of the scale scores. Steps one and two were conducted in Mplus along with the creation of separate data files that were then transferred to SAS to carry out step 3.

Results

Demographics

The sample included 1,012 girls ranging in age from 10- to 15-years (*M*=12.2; *SD*=.96). Girls represented a diverse population with 526 (52.0%) blacks, 256 (25.3%) whites, and 133 (13.1%) mixed race with 108 (81.2%) of these girls selecting black as part of a mixed race. Of the 962 participants that reported ethnicity (Hispanic or not), 113 (11.7%) were Hispanic. Based on BMI percentiles, 438 (43.3%) were at a healthy weight, 338 (33.3%) were obese, 226 (22.3%) were overweight, and 10 (1.0%) girls were underweight. No significant differences between groups were found with the exception of race (χ^2=6.385, p = 0.01) with more black girls in the control group. Table 7 includes additional sample characteristics.

Table 7. Sample Characteristics at Baseline

	Total Sample (*N*=1012)		Intervention (*N*=510)		Control (*N*=502)	
Characteristic	*n*	%	*n*	%	*n*	%
Age (years)						
10	90	8.9	48	9.4	42	8.4
11	373	36.9	180	35.3	193	38.4
12	343	33.9	184	36.1	159	31.7
13	163	16.1	78	15.3	85	16.9
14	43	4.2	20	3.9	23	4.6
15	4	0.4	2	0.4	2	0.4
Grade						
Fifth	69	6.8	34	6.7	35	7.0
Sixth	415	41.0	205	40.2	210	41.8
Seventh	412	40.7	214	42.0	198	39.4
Eighth	116	11.5	57	11.2	59	11.8
Hispanic ethnicity						
Yes	113	11.2	421	82.5	428	85.3
No	849	83.9	61	12.0	52	10.4
Not reported	50	0.5	28	5.5	22	4.4
Race						
Black*	526	52.0	245	48.0	281	56.0
White	256	25.3	140	27.5	116	23.1
Mixed	133	13.1	68	13.3	65	12.9
Other	64	6.3	38	7.5	26	5.2
Not reported	33	3.3	19	3.7	14	2.8
Free/reduced-price lunch[a]						
Yes	804	79.4	392	76.9	412	82.1
No	136	13.4	75	14.7	61	12.2
Not reported	72	7.1	43	8.4	29	5.8
Weight status						
Underweight	10	1.0	4	0.8	6	1.2
Healthy weight	438	43.3	236	46.3	202	40.2
Overweight	226	22.3	115	22.5	111	22.1
Obese	338	33.3	155	30.4	183	36.5

Note. Percentages may not add to 100 due to rounding error.
[a]Free/reduced-price lunch program used as an indicator of socioeconomic status.
*$p<.05$

Descriptive Statistics of Items

Item-level analysis was conducted for each indicator of the PASE-6 and PASE-7 instruments at baseline and post-intervention for the full sample and separately in intervention and control groups. Descriptive statistics and polychoric correlations are presented in Appendix A. Table 8 includes item descriptions for the PASE-6 and PASE-7.

Overall, the PASE-6 items demonstrated a tendency for girls to choose agreeable response options (i.e. *agree a lot* or *agree a little*) with skewed distributions and evidence of a ceiling effect for items. The exception was the item, "*I can be active in my free time on most days even when I am busy*" in which girls' responses had greater variability. Mean inter-item polychoric correlations for the full sample were .44 (min-max: .38-.58) and .52 (min-max: .46-.63) at baseline and post-intervention respectively. Mean scores for the PASE-6 for the full sample were 2.20 (SD=.59) at baseline and 2.17 (SD=.59) post-intervention.

Compared to the PASE-6, the PASE-7 items had lower mean scores and were less skewed with girls being more likely to endorse the 0 and 1 response options (i.e. *not at all sure* or *not very sure*). However, one item, "*How sure are you that you can stick to participating in activities that include exercise?*" had over 50% of girls endorsing the highest response option of *very sure* at baseline. This item had the highest mean score of all the PASE-7 items with limited variance and marked skewness and kurtosis. Mean inter-item polychoric correlations for the full sample were .39 (min-max: .30-.51) and .41 (min-max: .29-.57) at baseline and post-intervention respectively. For the full sample, the PASE-7 mean score at baseline was 1.90 (SD=.59) and 1.82 (SD=.60) at post-intervention.

Table 8. PASE-6 and PASE-7 Item Descriptions

Item	PASE-6 Item Description
P6-1	I can be active in my free time on most days.
P6-2	I can be active in my free time on most days instead of watching TV or playing video games.
P6-3	I can be active or play active games or sports in my free time on most days when it is hot or cold out.
P6-4	I can be active in my free time on most days when I have to stay home.
P6-5	I have the skills I need to be active in my free time on most days.
P6-6	I can be active in my free time on most days even when I am busy.
Item	**PASE-7 Item Description**
P7-1	How sure are you that you can stick to your exercise program when your family is demanding more time from you?
P7-2	How sure are you that you can stick to your exercise program when you have household chores?
P7-3	How sure are you that you can stick to your exercising when you're feeling lazy?
P7-4	How sure are you that you can stick to participating in activities that include exercise?
P7-5	How sure are you that you can stick to your exercise program even when your friends want to hang out?
P7-6	How sure are you that you can stick to making exercise a top priority?
P7-7	How sure are you that you can stick to your exercise program when you have a lot of demands at school?

Measurement Invariance

Cross-group invariance. Cross-group measurement invariance began with analysis of single group CFA models for the intervention and control groups at baseline and post-intervention using pre-specified fit criteria. Configural, metric, and scalar invariance tests were conducted following this analysis. Figures 2 and 3 show the hypothesized path diagrams for the PASE-6 and PASE-7. Diagrams include the latent factor, underlying latent response variables indicated by an *, and observed indicators. Small arrows denote disturbance and error variances for the latent response variables and observed indicators, respectively. Parameter estimates, including factor loadings, thresholds, and r-square values for each instrument, are summarized in Appendices B and C. Model results are presented in Table 9.

Figure 2. PASE-6 Hypothesized Path Diagram

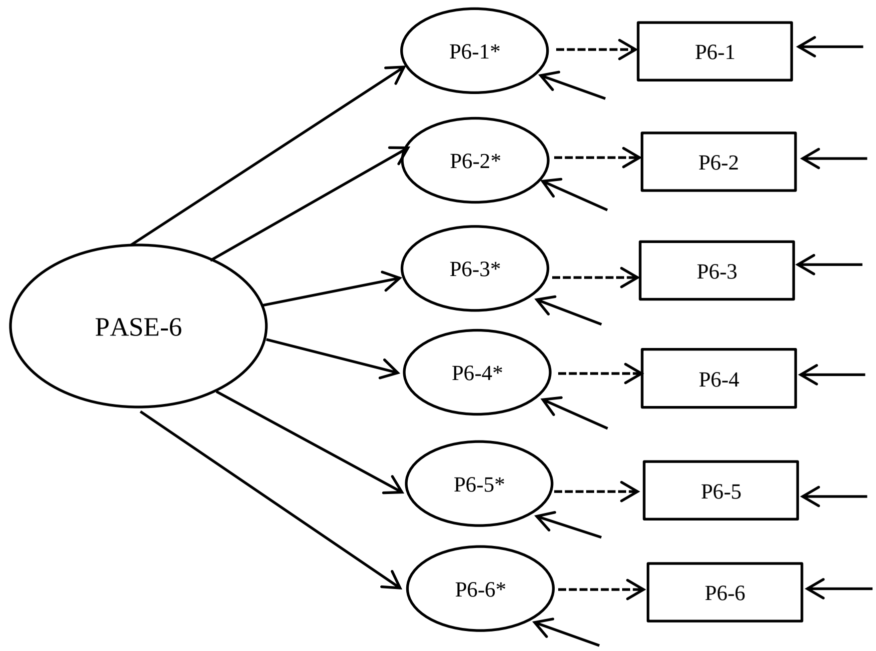
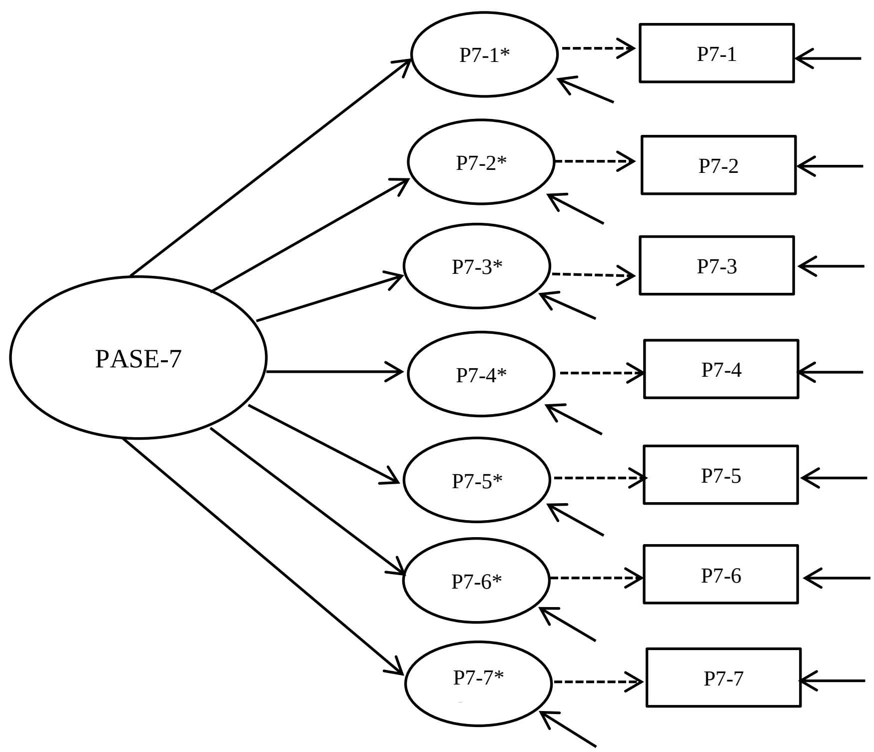


Figure 3. PASE-7 Hypothesized Path Diagram



PASE-6. CFA models for the intervention group demonstrated an excellent fit to the data at baseline (χ^2=8.091, *df*=9, p=.525, RMSEA=.000, CFI=1.000) and post-intervention (χ^2=10.660, *df*=9, p=.300, RMSEA=.019, CFI=.999). Based on RMSEA values, model fit for the control group was acceptable at baseline (χ^2=32.503, *df*=9, p<.001, RMSEA=.072, CFI=.984) and marginal at post-intervention (χ^2=39.893, *df*=9, p<.001, RMSEA=.083, CFI=.978).

Given the significant chi-square and higher RMSEA values in the control group, model results were analyzed for areas of strain at both time points. All residual correlations at baseline were <.10, but at post-intervention one residual correlation >.10 was noted between P6-3 and P6-4 (-.106). Suggested modification indices at both time points were low in value, not substantively justifiable, and not indicated in the intervention group. Therefore, cross-group invariance testing continued because the models appeared plausible. Others have suggested that baseline models may not need to entirely meet pre-determined fit criteria if the model appears reasonable (Bowen & Masa, 2015; Byrne et al., 1989; Raykov et al., 2012).

Evaluation of fit indices, with the exception of the model chi-square test, supported configural invariance between groups at both time points (baseline: χ^2=39.438, *df*=18, p=.003, RMSEA=.049, CFI=.993; post-intervention: χ^2=53.591, *df*=18, p<.001, RMSEA=.063, CFI=.991). All residual correlations were <.10 for both groups at both time points with the exception of the previously mentioned correlated residual. Metric invariance between intervention and control groups was supported at baseline ($\Delta\chi^2$=7.849, Δ*df*=5, p=.165, RMSEA=.042, CFI=.993, ΔCFI=.000) and post-intervention ($\Delta\chi^2$=6.933, Δ*df*=5, p=.226, RMSEA=.052, CFI=.992, ΔCFI=.001).

Scalar invariance between groups was not supported at either time point indicating non-invariant thresholds across groups (baseline: $\Delta\chi^2$=35.009, Δ*df*=11, p<.001, RMSEA=.050, CFI=.986, ΔCFI= -.007; post-intervention: $\Delta\chi^2$=30.008, Δdf=11, p=.002, RMSEA=.053, CFI=.987, ΔCFI= -.005). Partial scalar invariance was conducted by examining modification indices and expected parameter change (EPC) values to see which threshold might be freed in an attempt to achieve partial scalar invariance. Scalar invariance models were then re-analyzed by freeing these thresholds one at a time starting with the threshold with the largest modification index, and freeing additional thresholds if scalar invariance was not achieved (Coertjens, Donche, De Maeyer, Vanthournout, & Van Petegem, 2012; Dimitrov, 2010).

At baseline, partial scalar invariance testing began by freeing the third threshold (going from *agree a little* to *agree a lot)* for P6-3. However, this action did not improve model fit enough to achieve invariance ($\Delta\chi^2$=25.850, Δdf=10, p=.004, RMSEA=.046, CFI=.988, ΔCFI= -.005). This process was repeated by freeing the first threshold of P6-1 (going from *disagree a lot* to *disagree a little*), but invariance was still not met ($\Delta\chi^2$=18.472, Δdf=9, p=.030, RMSEA=.043, CFI=.990, ΔCFI= -.003). After freeing the third threshold of P6-2, partial scalar invariance was met ($\Delta\chi^2$=12.840, Δdf=8, p=.118, RMSEA=.040, CFI=.992, ΔCFI= -.001). Thus 3 of 18 thresholds were non-invariant (16.7%) with 3 of 6 items still having fully invariant thresholds.

Post-intervention scalar invariance proceeded in the same manner. The process began by freeing the third threshold for the P6-2 item. This action still resulted in scalar non-invariance ($\Delta\chi^2$=19.969, Δdf=10, p=.030, RMSEA=.049, CFI=.990, ΔCFI= -.002). Modification indices and EPC values indicated that the second threshold (going from *disagree a little* to *agree a little*) for the P6-6 item should also be freed. Doing so resulted in improved model fit and partial scalar invariance ($\Delta\chi^2$=13.456, Δdf=9, p=.143, RMSEA=.046, CFI=.991, ΔCFI= -.001).

PASE-7. Initial models for the intervention group (χ^2=74.255, *df*=14, p<.001, RMSEA=.092, CFI=.967) and control group (χ^2=58.828, *df*=14, p<.001, RMSEA=.080, CFI=.966) at baseline showed a marginal fit to the data. Model fit was poor in the intervention group (χ^2=124.709, *df*=14, p<.001, RMSEA=.125, CFI=.951) and control group (χ^2=84.340, *df*=14, p<.001, RMSEA=.100, CFI=.952) at post-intervention.

Consistent areas of strain across groups and time points indicated the need to add a residual covariance between P7-1 and P7-2. Adding a residual covariance for these two items was theoretically justifiable given the connection to family responsibilities for each of these items. Another area of strain in the control group at baseline and post-intervention was a residual correlation between P7-2 and P7-6. However, this residual correlation was not present in the intervention group at either time point.

The adjusted models improved fit: 1) intervention group at baseline: χ^2=26.042, *df*=13, p=.017, RMSEA=.044, CFI=.993; 2) control group at baseline: χ^2=41.407, *df*=13, p<.001, RMSEA=.066, CFI=.978; 3) intervention group post-intervention: χ^2=66.676, *df*=13, p<.001, RMSEA=.090, CFI=.976 and 4) control group post-intervention: χ^2=46.905, *df*=13, p<.001, RMSEA=.072, CFI=.977). Areas of strain were as follows: 1) control group at baseline: a residual correlation >.10 between P7-2 and P7-5 (-.113); and 2) intervention group post-intervention: a residual correlation >.10 between P7-4 and P7-6 (-.104).

Compared to the PASE-6 in which intervention group models fit better than control group models, the PASE-7 models fit the data better in both groups at baseline versus post-intervention. Although the chi-square values were all statistically significant, none of the models indicated poor fit according to the pre-specified RMSEA and CFI criteria. Therefore, cross-group measurement invariance was undertaken given that these models appeared plausible. The results confirmed invariant factor loadings ($\Delta\chi^2$=5.495, Δdf=6, p=.482, RMSEA=.064, CFI=.983, ΔCFI=.006) and thresholds ($\Delta\chi^2$=21.967, Δdf=13, p=.056, RMSEA=.056, CFI=.981, ΔCFI= -.002) post-intervention across groups, but factor loadings were not invariant at baseline ($\Delta\chi^2$=14.636, Δdf=6, p=.023, RMSEA=.054, CFI=.985, ΔCFI= -.002).

Model results were examined to determine which factor loadings were non-invariant at baseline. Each item was tested for non-invariance one at a time to determine which factor loadings were problematic. When the factor loading for the P7-3 item, "*How sure are you that you can stick to exercising when you're feeling lazy*", was unconstrained, metric invariance was achieved. For this study, partial metric invariance was not considered acceptable because it was assumed to be a fundamental requirement for determining that the same construct is being measured across groups and over time.

Several re-specifications of the initial hypothesized model were attempted. First, single group models were re-specified by dropping the above non-invariant item. It is worth noting that the P7-3 item was not part of the original psychometric development study for this scale (Sallis et al., 1988). This item also had consistently lower factor loadings than the other items. Therefore, single group models with this item deleted were analyzed. Again, model fit was acceptable for the intervention group (χ^2=14.906, df=8, p=.060, RMSEA=.041, CFI=.996) and control group (χ^2=20.779, df=8, p=.008, RMSEA=.056, CFI=.988) at baseline but indicated marginal fit at post-intervention for both groups: 1) intervention: χ^2=43.522, df=8, p<.001, RMSEA=.093, CFI=.983; and 2) control: χ^2=46.723, df=8, p<.001, RMSEA=.098, CFI=.968.

While a one-factor model was hypothesized for this study, the original psychometric development study had shown a two-factor structure in a sample of adults (Sallis et al., 1988). An EFA using principal factor analysis was conducted in Mplus to explore the factor structure for this sample. Although the eigenvalues and scree plot supported a single-factor model, the suggested two-factor model showed the P7-3 item cross-loading on factors with loadings less than .40. In addition, the P7-1 and P7-2 items together loaded on one factor. The correlation between the two factors was .760. Based on these findings, the PASE-7 was still hypothesized as unidimensional, but this information was used to guide decision-making regarding further re-specifications of the model.

A 5-item model was hypothesized by dropping both the P7-2 and P7-3 items. Rationale for this model was based on the fact that both of these items demonstrated residual correlations >.10 with other items. These items also consistently had the lowest factor loadings and r-square values across models, particularly at post-intervention for both groups. Dropping the P7-2 item also eliminated the need for the residual covariance between P7-1 and P7-2.

Single group results for this 5-item model improved fit in the control (χ^2=6.855, *df*=5, p=.232, RMSEA=.027, CFI=.998) and intervention (χ^2=10.525, *df*=5, p=.062, RMSEA=.047, CFI=.995) groups at baseline. Overall fit post-intervention was still inferior to the fit at baseline, but this model provided an improvement compared to previous models with lower overall chi-square values, lower RMSEA values approaching acceptable model fit, higher CFI values, and no residual correlations >.10 in the control group (χ^2=24.990, *df*=5, p<.001, RMSEA=.089, CFI=.979) or intervention group (χ^2=22.103, *df*=5, p<.001, RMSEA=.082, CFI=.990).

Configural invariance at baseline demonstrated a good fit to the data (χ^2=17.234, *df*=10, p=.069, RMSEA=.038, CFI=.996). Both metric invariance ($\Delta\chi^2$=6.046, Δ*df*=4, p=.196, RMSEA=.034, CFI=.996, ΔCFI=.000) and scalar invariance ($\Delta\chi^2$=12.791, Δ*df*=9, p=.172, RMSEA=.032, CFI=.994, ΔCFI= -.002) were established across groups. Thus, the factor loadings and thresholds for the 5-item model were both invariant at baseline.

Fit indices for the post-intervention configural model provided some support for equal form across groups but did not fit the data as well as the baseline model: χ^2=47.181, *df*=10, p<.001, RMSEA=.086, CFI=.986. Model results demonstrated that all residual correlations were <.10. A modification index of 19.795 for a residual covariance between P7-1 and P7-4 was recommended but not theoretically justified and was not indicated at baseline. Because the RMSEA approached acceptable fit and the CFI was acceptable, metric and scalar invariance were also assessed at post-intervention. The metric model indicated invariant factor loadings when compared to the configural model ($\Delta\chi^2$=2.184, Δ*df*=4, p=.702, RMSEA=.056, CFI=.992, ΔCFI=.006). However, scalar invariance of thresholds was not met ($\Delta\chi^2$=18.974, Δ*df*=9, p=.025, RMSEA=.052, CFI=.988, ΔCFI= -.004).

Partial scalar invariance was investigated using the same process as the PASE-6. Modification indices and EPC values pointed to the thresholds for the P7-4 item, "*How sure are you that you can stick to participating in activities that include exercise*", as potentially non-invariant. The third threshold (going from *agree a little* to *agree a lot)* had the largest difference between groups so this threshold was freed and the model was reassessed. Partial scalar invariance was met by freeing this threshold: $\Delta\chi^2$=5.650, Δ*df*=8, p=.686, RMSEA=.041, CFI=.993, ΔCFI=.001. One of 15 thresholds was non-invariant (6.7%) with 4 of 5 items still having fully invariant thresholds.

Table 9. PASE-6 and PASE-7 Cross-Group Measurement Invariance Results

PASE-6 Baseline								
Model	χ^2 (*df*)	*p*	χ^2_{diff}	Δdf	*p*	RMSEA [90% CI]	CFI	ΔCFI
INT	8.091 (9)	.525	------	------	------	.000 [.000,.046]	1.000	------
CON	32.503 (9)	<.001	------	------	------	.072 [.046,.100]	.984	------
MI								
M1	39.438 (18)	.003	------	------	------	.049 [.028,.069]	.993	------
M2	43.780 (23)	.006	7.849	5	.165	.042 [.022,.061]	.993	.000
M3	76.490 (34)	<.001	35.009	11	<.001	.050 [.035,.065]	.986	-.007
M4	67.642 (33)	<.001	25.850	10	.004	.046 [.030,.061]	.988	-.005
M5	61.474 (32)	.001	18.472	9	.030	.043 [.026,.059]	.990	-.003
M6	55.945 (31)	.004	12.840	8	.118	.040 [.022,.056]	.992	-.001
PASE-6 Post-Intervention								
Model	χ^2 (*df*)	*p*	χ^2_{diff}	Δdf	*p*	RMSEA [90% CI]	CFI	ΔCFI
INT	10.660 (9)	.300	------	------	------	.019 [.000,.055]	.999	------
CON	39.893 (9)	<.001	------	------	------	.083 [.058,.110]	.978	------
MI								
M1	53.591 (18)	<.001	------	------	------	.063 [.044,.082]	.991	------
M2	54.132 (23)	<.001	6.933	5	.226	.052 [.034,.070]	.992	.001
M3	82.580 (34)	<.001	30.008	11	.002	.053 [.039,.068]	.987	-.005
M4	72.345 (33)	<.001	19.969	10	.030	.049 [.033,.064]	.990	-.002
M5	65.702 (32)	<.001	13.456	9	.143	.046 [.030,.061]	.991	-.001
PASE-7[a] Baseline								
Model	χ^2 (*df*)	*p*	χ^2_{diff}	Δdf	*p*	RMSEA [90% CI]	CFI	ΔCFI
INT	10.525 (5)	.062	------	------	------	.047 [.000,.086]	.995	------
CON	6.855 (5)	.232	------	------	------	.027 [.000,.072]	.998	------
MI								
M1	17.234 (10)	.069	------	------	------	.038 [.000,.067]	.996	------
M2	22.225 (14)	.074	6.046	4	.196	.034 [.000,.060]	.996	.000
M3	34.651 (23)	.056	12.791	9	.172	.032 [.000,.052]	.994	-.002
PASE-7[a] Post-Intervention								
Model	χ^2 (*df*)	*p*	χ^2_{diff}	Δdf	*p*	RMSEA [90% CI]	CFI	ΔCFI
INT	22.103 (5)	.001	------	------	------	.082 [.049,.118]	.990	------
CON	24.990 (5)	<.001	------	------	------	.089 [.056,.125]	.979	------
MI								
M1	47.181 (10)	<.001	------	------	------	.086 [.062,.111]	.986	------
M2	36.543 (14)	.001	2.184	4	.702	.056 [.034,.079]	.992	.006
M3	54.144 (23)	<.001	18.974	9	.025	.052 [.034,.070]	.988	-.004
M4	40.958 (22)	.008	5.650	8	.686	.041 [.021,.061]	.993	.005

Note. χ^2_{diff} =adjusted χ^2 difference test used to compare models; *df*=degrees of freedom; RMSEA=root mean square error of approximation; 90% CI=90% confidence interval for RMSEA; CFI=comparative fit index; ΔCFI=change in comparative fit index; INT=intervention group; CON=control group; MI=measurement invariance models; M1=configural model; M2=metric model; M3=scalar model; M4, M5, M6=partial scalar models.

[a]PASE-7 model results from modified 5-item scale without P7-2 and P7-3.

Longitudinal invariance. Longitudinal invariance was assessed for each instrument over time. Error covariances for each item across time points were built into the model to account for expected methods effects with repeated measures (Brown, 2015). Figures 4 and 5 show the hypothesized longitudinal measurement models for the PASE-6 and PASE-7. Figure 5 is based on the 5-item revised measurement model. Parameter estimates for the CFA models are provided in Appendices B and C. Fit indices are shown in Table 10.

PASE-6. The PASE-6 configural model for the intervention group over time demonstrated excellent fit to the data (χ^2=52.418, *df*=47, p=.272, RMSEA=.015, CFI=.999). The metric model also fit the data well and indicated invariant factor loadings over time (χ^2=64.074, *df*=52, p=.122, $\Delta\chi^2$=10.398, Δ*df*=5, p=.065, RMSEA=.021, CFI=.997, ΔCFI= -.002). Scalar invariance was not supported (χ^2=89.557, *df*=63, p=.016, $\Delta\chi^2$=28.693, Δ*df*=11, p=.003, RMSEA=.029, CFI=.993, ΔCFI= -.004). Partial scalar invariance was pursued with the same process used in the cross-group measurement models. The third threshold for P6-5 was freed at both time points. This approach resulted in partial scalar invariance (χ^2=77.903, *df*=62, p=.084, $\Delta\chi^2$=14.845, Δ*df*=10, p=.138, RMSEA=.022, CFI=.996, ΔCFI= -.001).

The configural model for the control group resulted in a significant chi-square value (χ^2=98.550, *df*=47, p<.001). There were two correlated residuals >.10, P6-61 with P6-32 (.118) and P6-32 with P6-42 (-.111). The decision to proceed with metric invariance was based on the following rationale: 1) areas of strain were not present in the intervention group; 2) freeing the parameters with large modification indices was not theoretically justified; and 3) alternative fit indices supported adequate fit.

Figure 4. PASE-6 Hypothesized Longitudinal Measurement Model

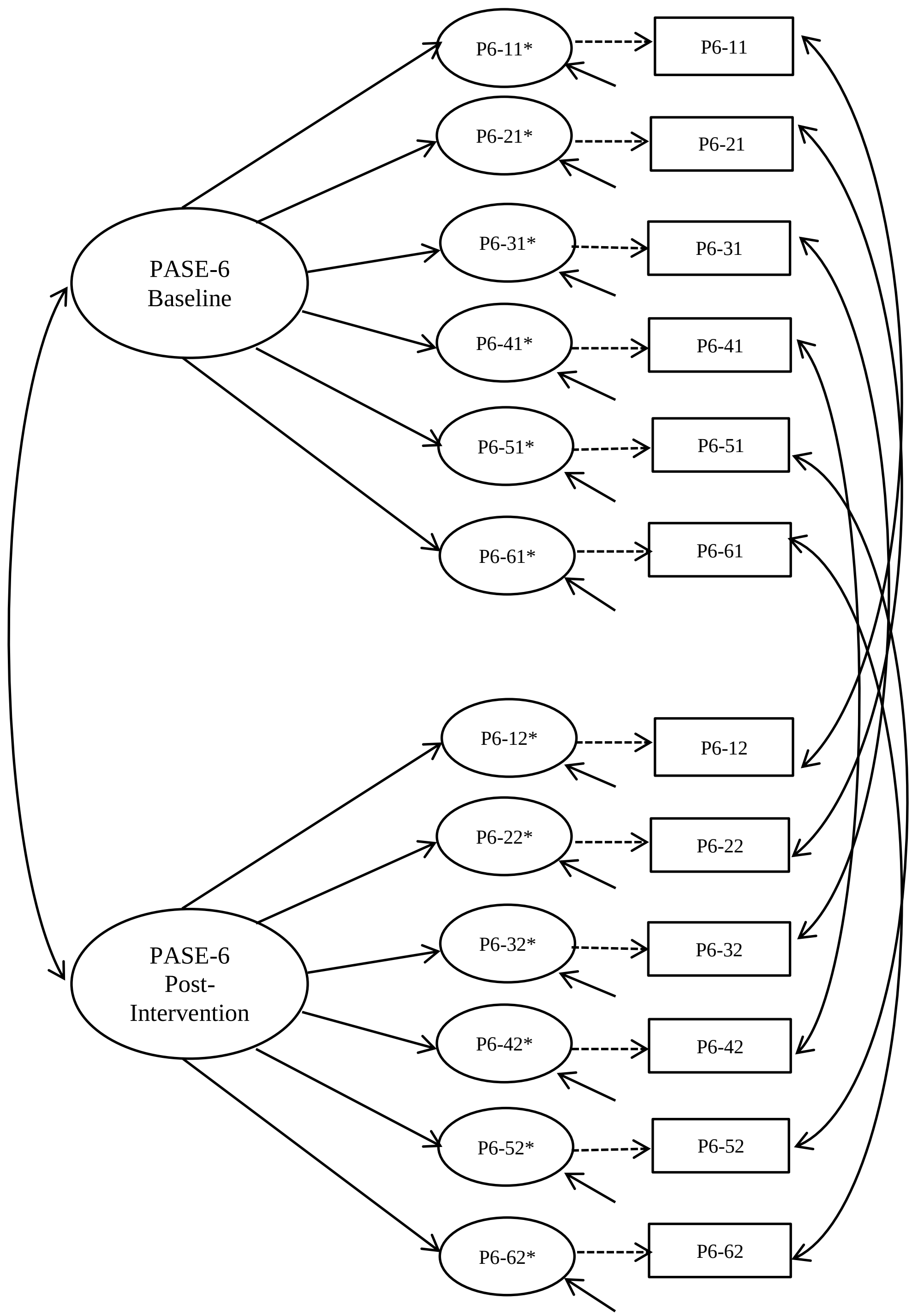
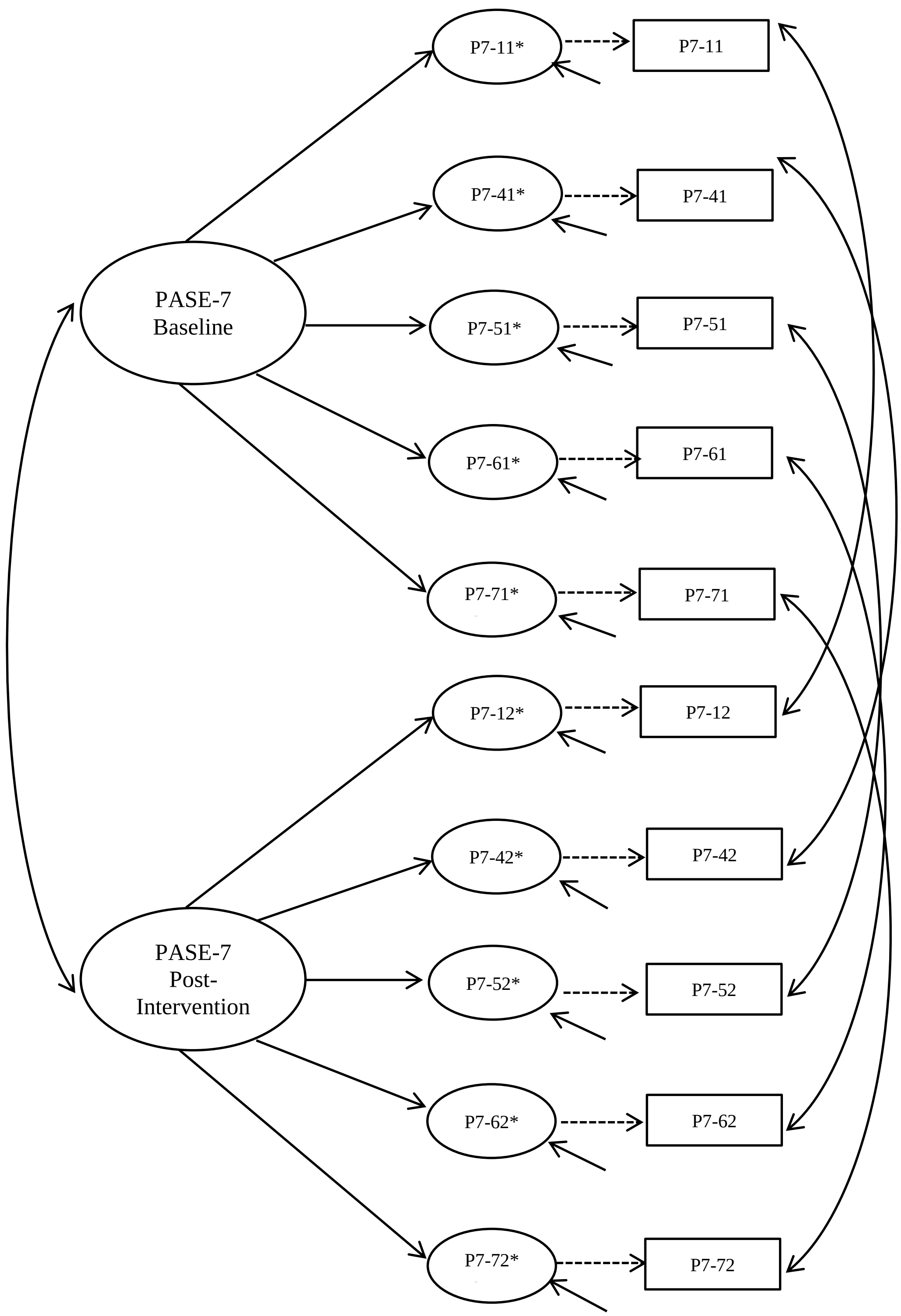


Figure 5. PASE-7 Hypothesized Longitudinal Measurement Model



Results for the metric model denoted invariant factor loadings over time in the control group ($\Delta\chi^2$=7.128, Δdf=5, p=.211, RMSEA=.044, CFI=.984, ΔCFI=.000). Scalar invariance was also supported in the control group indicating invariant thresholds over time ($\Delta\chi^2$=18.306, Δdf=11, p=.075, RMSEA=.042, CFI=.982, ΔCFI= -.002).

PASE-7. Similar to the PASE-6 longitudinal results, the configural models for both the intervention and control groups resulted in significant model chi-square values (see Table 10). Areas of strain were assessed in both groups at both time points. For the control group, there was one correlated residual >.10: P7-41 with P7-52 (-.102). Results for the intervention group also indicated one residual correlation >.10, P7-41 with P7-52 (.106). Alternative fit indices demonstrated an adequate fit to the data with RMSEA values <.08 and CFI values >.95. Based on this information, the decision was made to proceed to the metric model.

Metric invariance was supported for the intervention group over time ($\Delta\chi^2$=7.194, Δdf=4, p=.126, RMSEA=.046, CFI=.987, ΔCFI=.000). However, scalar invariance was not supported ($\Delta\chi^2$=34.267, Δdf=9, p<.001, RMSEA=.052, CFI=.979, ΔCFI= -.008). Evaluation of the modification indices and EPC values as well as examination of the differences in threshold values again indicated that the P7-4 third threshold may be invariant. Partial scalar invariance was met by freeing this threshold over time ($\Delta\chi^2$=.929, Δdf=8, p=.999, RMSEA=.038, CFI=.988, ΔCFI=.001). Metric and scalar invariance were supported for the control group over time: 1) metric: $\Delta\chi^2$=.655, Δdf=4, p=.957, RMSEA=.032, CFI=.991, ΔCFI=.004; and 2) scalar: $\Delta\chi^2$=12.653, Δdf=9, p=.179, RMSEA=.031, CFI=.990, ΔCFI= -.001.

Table 10. PASE-6 and PASE-7 Longitudinal Invariance Results

Model	χ^2 (*df*)	*p*	χ^2_{diff}	Δdf	*p*	RMSEA [90% CI]	CFI	ΔCFI
PASE-6								
Intervention Group								
M1	52.418 (47)	.272	------	------	------	.015 [.000,.034]	.999	------
M2	64.074 (52)	.122	10.398	5	.065	.021 [.000,.037]	.997	-.002
M3	89.557 (63)	.016	28.693	11	.003	.029 [.013,.042]	.993	-.004
M4	77.903 (62)	.084	14.845	10	.138	.022 [.000,.037]	.996	-.001
Control Group								
M1	98.550 (47)	<.001	------	------	------	.047 [.034,.060]	.984	------
M2	103.012 (52)	<.001	7.128	5	.211	.044 [.032,.057]	.984	.000
M3	119.830 (63)	<.001	18.306	11	.075	.042 [.031,.054]	.982	-.002
PASE-7[a]								
Intervention Group								
M1	62.631 (29)	<.001	------	------	------	.048 [.031,.064]	.987	------
M2	68.819 (33)	<.001	7.194	4	.126	.046 [.031,.061]	.987	.000
M3	98.944 (42)	<.001	34.267	9	<.001	.052 [.038,.065]	.979	-.008
M4	71.630 (41)	.002	.929	8	.999	.038 [.023,.053]	.988	.001
Control Group								
M1	52.819 (29)	.004	------	------	------	.040 [.022,.058]	.987	------
M2	49.598 (33)	.032	.655	4	.957	.032 [.010,.049]	.991	.004
M3	61.749 (42)	.025	12.653	9	.179	.031 [.011,.046]	.990	-.001

Note. χ^2_{diff} =adjusted χ^2 difference test; *df*=degrees of freedom; RMSEA=root mean square error of approximation; 90% CI=90% confidence interval for RMSEA; CFI=comparative fit index; ΔCFI=change in comparative fit index; M1=configural model; M2=metric model; M3=scalar model; M4=partial scalar model.

[a]PASE-7 model results from modified 5-item scale without P7-2 and P7-3.

Simultaneous cross-group and longitudinal invariance. For each instrument, invariance testing continued by combining the cross-group and longitudinal models so that tests for invariant factor loadings and thresholds could be assessed simultaneously. For example, to test metric invariance, factor loadings at baseline and post-intervention were constrained to be equal in the control group model, and these same constraints were applied to the intervention group model. Results for both instruments are presented in Table 11. Parameter estimates from the PASE-6 and PASE-7 CFA models are provided in Appendices B and C, respectively.

PASE-6. The configural model demonstrated adequate fit based on alternative fit indices (χ^2=151.412, *df*=94, p<.001, RMSEA=.035, CFI=.992). Given the large chi-square value, the residual correlations and modification indices were examined for potential problem areas. All of the residual correlations for the intervention group were <.10. For the control group, residual correlations >.10 were the same as those reported for the configural model. Metric model results did not support invariant factor loadings across group and time simultaneously (χ^2=186.943, *df*=116, p<.001, $\Delta\chi^2$=39.034, Δ*df*=22, p=.014, RMSEA=.035, CFI=.990, ΔCFI= -.002).

Although a partial metric invariance solution was not considered acceptable for this study, an attempt was made to identify if there was a single non-invariant factor loading. In order to investigate which item(s) might be problematic, subsequent models were analyzed by freeing each loading one at a time. This procedure showed that when the P6-1 item, "*I can be active in my free time on most days*", was freed, partial metric invariance was met (χ^2=170.224, *df*=112, p<.001, $\Delta\chi^2$=24.308, Δ*df*=18, p=.145, RMSEA=.032, CFI=.991, ΔCFI= -.001).

PASE-7. The configural model demonstrated adequate fit based on alternative fit indices (χ^2=138.445, *df*=66, p<.001, RMSEA=.047, CFI=.984). Areas of strain included a residual correlation of -.102 between P7-41 and P7-52 in the control group and a residual correlation of

.106 between P7-71 and P7-62. All other residual correlations were <.10. Similar to the PASE-6, the metric model indicated that factor loadings were not invariant across group and time periods simultaneously (χ^2=163.702, *df*=76, p<.001, $\Delta\chi^2$=48.136, Δ*df*=18, p<.001, RMSEA=.048, CFI=.981, ΔCFI= -.006). Each variable was assessed using the same process that was implemented for the PASE-6. No single variable was identified as non-invariant indicating that multiple factor loadings may be non-invariant for the PASE-7.

Table 11. PASE-6 and PASE-7 Simultaneous Cross-Group and Longitudinal Invariance Results

			PASE-6					
Model	χ^2 (*df*)	*p*	χ^2_{diff}	*p*	Δ*df*	RMSEA [90% CI]	CFI	ΔCFI
M1	151.412 (94)	<.001	------	------	------	.035 [.024,.045]	.992	------
M2	186.943 (116)	<.001	39.034	<.001	22	.035 [.025,.044]	.990	-.002
M3	170.224 (112)	<.001	24.308	.145	18	.032 [.022,.041]	.991	-.001
			PASE-7[a]					
Model	χ^2 (*df*)	*p*	χ^2_{diff}	*p*	Δ*df*	RMSEA [90% CI]	CFI	ΔCFI
M1	115.659 (58)	<.001	------	------	------	.044 [.032,.056]	.987	------
M2	163.702 (76)	<.001	48.136	.<.001	18	.048 [.038,.058]	.981	-.006

Note. χ^2_{diff} =adjusted χ^2 difference test; *df*=degrees of freedom; RMSEA=root mean square error of approximation; 90% CI=90% confidence interval for RMSEA; CFI=comparative fit index; ΔCFI=change in comparative fit index; M1=configural model; M2=metric model; M3=partial metric model.
[a]PASE-7 model results from modified 5-item scale without P7-2 and P7-3.

Reliability

PASE-6. Non-linear SEM reliability coefficients for the PASE-6 invariance models ranged from .772-.842. For the control group, reliability was quite consistent from baseline to post-intervention with minor differences in coefficients (range of Δ=–.001–.003). On the other hand, changes in reliability coefficients for the intervention group from baseline to post-intervention were greater than those in the control group and all increased over time (range of Δ=.042–.059).

PASE-7. For the PASE-7 invariance models, reliability coefficients ranged from .719–.800. Similar to the PASE-6, the reliability coefficients appeared to be more stable in the control group than the intervention group over time. From baseline to post-intervention, changes in coefficients for the control group (range of Δ=.009–.018) were smaller than those for the intervention group (range of Δ=.035–.042). Reliability coefficients were higher at post-intervention than at baseline. Overall, reliability estimates for the PASE-7 were slightly lower than those for the PASE-6. Reliability coefficients for invariance models are summarized in Table 12.

Table 12. Composite Reliability Estimates for PASE-6 and PASE-7

	Composite Reliability Estimates			
Instrument and Model	Intervention Group		Control Group	
PASE-6	Time 1	Time 2	Time 1	Time 2
Cross Group Configural Model	.798	.842	.795	.797
Cross Group Metric Model	.772	.831	.795	.798
Cross Group Scalar Model	.793	.840	.795	.798
Longitudinal Configural Model	.797	.836	.795	.798
Longitudinal Metric Model	.797	.842	.795	.794
Longitudinal Scalar Model	.798	.840	.796	.795
Simultaneous Configural Model	.797	.842	.795	.798
Simultaneous Metric Model	.779	.828	.797	.798
PASE-7	Time 1	Time 2	Time 1	Time 2
Cross Group Configural Model	.762	.800	.720	.736
Cross Group Metric Model	.758	.800	.719	.736
Cross Group Scalar Model	.761	.799	.719	.736
Longitudinal Configural Model	.761	.800	.719	.737
Longitudinal Metric Model	.761	.799	.719	.732
Longitudinal Scalar Model	.762	.797	.719	.733
Simultaneous Configural Model	.761	.800	.719	.737
Simultaneous Metric Model	.761	.799	.724	.733

Note. Results computed using standardized factor loadings and thresholds; Time 1=baseline; Time 2=post-intervention.

Discussion

This study investigated the factorial validity, cross-group and longitudinal invariance, and composite reliability of two PA self-efficacy instruments used in the “Girls on the Move” group RCT. The findings regarding the measurement of PA self-efficacy are important for advancing the science of adolescent PA research, particularly because invariance testing for psychosocial constructs proposed to influence PA is not routinely conducted.

The PASE-6 single factor model supported the unidimensional factor structure hypothesized in this study. These findings are similar to those reported by earlier researchers for the 8-item instrument (Dishman et al., 2002; Dishman et al., 2010; Motl et al., 2000). In addition, Steele, Burns, and Whitaker (2013) reported a unidimensional factor structure with the same 6-item instrument used in the current study. The fact that the intervention group demonstrated better fit at both time periods than the control group was not anticipated as comparability of groups should be expected in a group RCT. While significant differences emerged in the racial composition between groups, with significantly more black girls in the control group, researchers have reported racial invariance for the 8-item version of this instrument with black and white girls of similar age (Dishman et al., 2010).

The PASE-7 factor structure as hypothesized did not fit the data well and required a number of model re-specifications with the deletion of two items. This instrument was first created and tested among adults resulting in a 12-item two-factor instrument, including a 5-item resisting-relapse factor and a 7-item making-time-for-exercise factor (Sallis et al., 1988). In subsequent psychometric studies in which the current PASE-7 was adapted, researchers mention the use of a resisting-relapse factor, but items from both factors were utilized to measure PA self-efficacy among adolescents (Lawman et al, 2011; Peterson, Lawman, Wilson, Fairchild, & Van Horn, 2013).

The PASE-6 exhibited equal factor loadings between intervention and control groups at baseline and post-intervention but only partial scalar invariance. Longitudinal metric invariance was achieved for both groups separately with the control group also demonstrating scalar invariance. However, the factor loadings were not fully invariant when constraints were applied simultaneously across groups and time indicating non-equivalent measurement of PA self-efficacy.

Partial metric invariance was investigated for the PASE-6 for the simultaneous invariance analysis with one item found to be non-invariant: "*I can be active in my free time on most days*". This finding has important implications for the measurement of the concept as the deletion of this item may better reflect the conceptual definition of PA self-efficacy used for this study. Of the six items in the instrument, this item is the only one that does not relate specifically to overcoming a barrier to PA or having the needed skills to participate in PA, which are theorized to be two dimensions of the concept (Voskuil & Robbins, 2015). Bandura (2004) stresses that self-efficacy should be assessed in the context of the challenges related to completing a particular behavior in order to maintain conceptual precision.

The modified 5-item PASE-7 exhibited cross-group metric and scalar invariance at baseline, invariant thresholds at baseline, and partial scalar invariance post-intervention. Similar results were found for longitudinal invariance with factor loadings invariant over time in both groups. In the control group, the modified PASE-7 demonstrated complete scalar invariance and only one threshold was found to be non-invariant in the intervention group over time. Similar to the PASE-6, the factor loadings were not invariant for the simultaneous invariance analysis. Unlike the PASE-6, partial metric invariance was not met, with no one item found to be non-invariant, implying that at least two of the five items had non-invariant factor loadings.

While neither of the instruments achieved scalar invariance for the simultaneous analysis, both measures demonstrated longitudinal scalar invariance for the control group but only partial scalar invariance for the intervention group. Additionally, reliability coefficients demonstrated less stability over time in the intervention group compared to the control group for both instruments. These findings, along with the absence of equal factor loadings for the simultaneous invariance analysis, offer support for the theory that the intervention itself may influence how girls' respond to the self-efficacy items and imply that the same concept is not being measured in the same way across groups and time.

Evaluation of group differences for adolescent girls' PA self-efficacy should be interpreted with caution due to the possibility of confounding from non-equivalent measurement. For example, if self-efficacy mean scores for girls in the intervention group were significantly higher or lower compared to the control group, these differences could be related to systematic response bias rather than the effect of the intervention on longitudinal change in self-efficacy. Likewise, conclusions regarding the mediational effects of PA self-efficacy in the "Girls on the Move" intervention study may be misleading in the absence of equivalent measurement across groups and time.

Results from this study underscore the importance of assessing the psychometric properties of adapted instruments rather than assuming that a revised version will be equally reliable and valid as the original instrument. The PASE-6 was created by deleting two items that were closely related to social support for PA, specifically questions about parental support and friend support, from an existing 8-item PA self-efficacy instrument. Steele, Burns, and Whitaker (2013) reported lower factor loadings for these two items in a sample of 6^{th} - 8^{th} grade youth: .267 for parental support; .444 for friend support. Dewar and colleagues (2013) point out that the original 8-item instrument also had some lower factor loadings in earlier psychometric studies. For example, Motl et al. (2000) reported factor loadings ranging from .390 to .610 indicating the possibility that some items may have been weakly related to the self-efficacy latent construct.

While these adaptations appear justified, the absence of simultaneous metric invariance for the PASE-6 may have been a consequence of these changes. For example, in the original psychometric development study, three factors were described: support seeking, barriers, and positive alternatives (Saunders et al., 1997). The 8-item version of this instrument was found to be unidimensional when items from each of these three factors were included. Deleting the items of parental and friend support, which represented the support seeking factor, may have led to this lack of invariance. Reducing response burden for adolescent girls is certainly a worthy endeavor, but may come at the expense of diminished reliability and validity.

Use of the PASE-7 may have been a poor fit for the girls in this study given that they were enrolled in the group RCT only if they did not meet national guidelines for PA and were not involved in sports or after school community programs involving PA. Hence, asking girls questions about sticking to an exercise program if none exists may have contributed to the non-invariance of the instrument in this study. Items in the PASE-6 specifically asked about PA which is not limited to a structured exercise regimen.

Interestingly, the PASE-7 items demonstrated more variability in responses and were less skewed compared to the PASE-6 items. The PASE-6 items resulted in ceiling effects with the majority of girls choosing *agree a lot* for most items. Bandura (2006) has recommended increasing the difficulty level for endorsing items when the majority of the sample selects the highest efficacy category. For the PASE-6, how the item stem is phrased and what response choices are provided could use revision. Given that the PASE-7 achieved better distribution of responses using the wording *how sure are you* in the item stem, changing the item stems for the PASE-6 from *I can…* to *How sure are you that you can…* should be examined in a future study. This recommendation is consistent with Bandura's (1997) instruction to include 'degrees of assurance' using words such as how certain, how confident, or how sure when rating indicator items (p. 43). Additionally, having girls rate their PA self-efficacy on a scale of 1-10, as recommended by Bandura, could also decrease overall ceiling effects for these instruments.

Strengths and Limitations

A major strength of this study was the simultaneous cross-group and longitudinal assessment of invariance of an intervention and control group from a large, group RCT. Very few studies have conducted this level of invariance analysis for self-efficacy instruments between intervention and control groups in adolescent PA intervention research.

An added strength was the use of an appropriate estimator for ordinal categorical data by using the WLSMV estimation method. A frequently encountered issue in psychometric studies has been the application of the maximum likelihood estimator to Likert-type scales, particularly when ≤ 4 response options are used to assess a latent construct (Flora & Curran, 2004). This approach leads to biased parameter estimates such as lower factor loadings and elevated standard errors compared to parameter estimates using WLSMV estimation or other appropriate estimators for handling non-normal data (Brown, 2015).

This study conducted invariance testing in a rigorous manner using recent recommendations by Kline (2016) in which chi-square tests and chi-square difference testing are not simply disregarded as inflated based on sample size, but rather used as a guide to evaluate potential areas of strain in a model. Relying only on changes in CFI between models to establish levels of invariance may not provide sufficient evidence of measurement invariance. While

Cheung and Rensvold (2002) recommend using CFI changes <.10 as confirmation of invariance, their simulation study was conducted using normally distributed data and maximum likelihood estimation. Additional simulation studies are needed to confirm these recommendations including simulation with the WLSMV estimation method (Brown, 2015; Dimitrov, 2010).

Data for this study came from a large sample of 5^{th}-8^{th} grade girls who were racially and ethnically diverse. Previous psychometric studies that have conducted invariance testing of PA self-efficacy instruments have not always included a diverse sample. In addition, invariance testing of these instruments has not previously included girls as young as the fifth grade.

A limitation of this study was the use of a single regression imputation approach to missing data. Although overall the amount of missing data for this study was small, this method may have reduced variability in the data, particularly at post-intervention when missing data increased due to attrition. While this study contributes to the understanding of factorial validity and reliability for self-efficacy measures, it did not address other important aspects of validity such as convergent, discriminant, and criterion-related validity. Another limitation is that the sample included only urban, adolescent girls, and findings from this study cannot be generalized to other populations, such as boys. Finally, while partial invariance was assessed in this study, the process for doing so with WLSMV estimation has not been fully investigated and remains an ongoing issue for structural equation modeling research (Brown, 2015; Dimitrov, 2010).

Conclusion

The results of this study provide important information regarding the factorial validity, measurement invariance, and reliability of two PA self-efficacy instruments. This study indicated that neither of the adapted instruments achieved full metric invariance implying that these instruments did not measure the same concept equally between groups at both time points. These findings offer some support for the notion that participation in a PA intervention changes girls' perceptions about a psychological construct such as self-efficacy. Perhaps as girls participated in various components of the intervention (Robbins et al., 2013), their enhanced understanding of the challenges related to PA may have altered the meaning of the construct over time and changed how they responded to the indicator questions.

These findings have important implications for the measurement of PA self-efficacy in the "Girls on the Move" group RCT. Because neither of the instruments achieved scalar invariance with the simultaneous analysis, drawing accurate conclusions regarding group differences becomes more challenging given that these differences could be attributed to the effect of the intervention, developmental change over time, or systematic response bias (Roesch et al., 2013).

Several implications for future research are noted from this study. Investigators are encouraged to conduct invariance analysis when adapting instruments that have previously been confirmed as valid and reliable. Essentially an adapted measure is an entirely different measure, and these alterations can potentially undermine the psychometric properties of an instrument. Assessing simultaneous group and longitudinal invariance in intervention studies involving girls could help to clarify whether decreases in self-efficacy are real or can be attributed to measurement problems.

Qualitative research using focus groups of adolescent girls may be one way to revise the items in these PA self-efficacy instruments. This approach may help to ensure that items accurately reflect current challenges to PA in this population, particularly given technological advances and changes over the last decade. The items in the instruments used for this study did not incorporate use of computers, cell phones, iPads, or other devices that may interfere with an adolescent's capability to be physically active. Other researchers have pointed out this deficit and have revised items on psychosocial measures to reflect current technology use among adolescents (Dewar et al., 2013).

Adequate psychometric evaluation of scales used to measure psychosocial constructs, such as self-efficacy, has been identified as a significant gap in the literature (Brown et al., 2009). This study contributes to an increased understanding of the psychometric properties of PA self-efficacy instruments. Continued assessment of the reliability and validity of PA self-efficacy instruments will help to ensure that this concept is being measured appropriately. Building the science of adolescent PA research depends on a solid measurement foundation. Effort in this area is critical for furthering understanding of the role of PA self-efficacy in health behavior and how the concept might influence or be influenced by interventions designed for adolescent girls.

APPENDICES

APPENDIX A

Polychoric Correlations and Descriptive Statistics of Items

Table A1. PASE-6 Items Pooled Across Groups

	Baseline						Post-Intervention					
Items	P6-1	P6-2	P6-3	P6-4	P6-5	P6-6	P6-1	P6-2	P6-3	P6-4	P6-5	P6-6
P6-1	1.00						1.00					
P6-2	.47	1.00					.59	1.00				
P6-3	.41	.43	1.00				.55	.49	1.00			
P6-4	.54	.58	.48	1.00			.63	.55	.47	1.00		
P6-5	.49	.46	.47	.52	1.00		.52	.50	.51	.51	1.00	
P6-6	.38	.43	.45	.49	.46	1.00	.50	.46	.52	.53	.46	1.00
Mean	2.29	2.34	2.17	2.32	2.20	1.86	2.26	2.32	2.18	2.25	2.23	1.82
SD	.78	.85	.85	.80	.80	.97	.76	.78	.84	.80	.78	.95
Variance	.61	.71	.72	.65	.64	.95	.58	.61	.71	.63	.61	.91
Skewness	-1.00	-1.18	-.81	-1.11	-.76	-.36	-.88	-.90	-.74	-.95	-.76	-.35
Kurtosis	3.65	3.64	2.97	3.77	3.01	2.06	3.54	3.10	2.81	3.56	3.05	2.17
RSP-0	35	48	49	42	34	99	31	23	43	42	28	106
RSP-1	97	104	146	92	143	261	102	130	62	102	136	252
RSP-2	419	317	400	383	423	331	457	363	394	437	432	377
RSP-3	461	543	417	495	412	321	422	496	413	431	416	277
ICC[a]	.000	.000	.009	.000	.009	.003	.000	.002	.000	.003	.000	.010
95% UB	.000	.000	.060	.000	.060	.260	.000	.810	.000	.210	.000	.060

Note. ICC=intra-class correlation coefficient; PASE=physical activity self-efficacy; RSP=response option with counts presented for each item (0=disagree a lot; 1=disagree a little; 2=agree a little; 3=agree a lot). SD=standard deviation. UB=upper bound for ICC confidence interval (lower bound was 0 for all items).

[a]Intra-class correlation coefficients were used to examine non-independence in the data due to clustered sampling design by schools.

Table A2. PASE-6 Items by Treatment Group

	Baseline						Post-Intervention					
Control	P6-1	P6-2	P6-3	P6-4	P6-5	P6-6	P6-1	P6-2	P6-3	P6-4	P6-5	P6-6
P6-1	1.00						1.00					
P6-2	.47	1.00					.55	1.00				
P6-3	.45	.41	1.00				.48	.45	1.00			
P6-4	.55	.58	.42	1.00			.63	.52	.36	1.00		
P6-5	.54	.51	.51	.55	1.00		.49	.47	.47	.46	1.00	
P6-6	.34	.35	.46	.45	.49	1.00	.44	.42	.51	.45	.43	1.00
Mean	2.31	2.35	2.17	2.36	2.25	1.93	2.26	2.40	2.16	2.30	2.23	1.89
SD	.81	.82	.83	.80	.80	.95	.78	.76	.82	.76	.76	.94
Variance	.65	.68	.69	.63	.64	.90	.60	.58	.67	.58	.57	.88
Skewness	-1.15	-1.22	-.83	-1.20	-.81	-.47	-.93	-1.11	-.65	-.95	-.71	-.48
Kurtosis	3.94	3.90	3.18	4.01	2.94	2.23	3.54	3.60	2.69	3.54	3.01	2.35
Intervention	P6-1	P6-2	P6-3	P6-4	P6-5	P6-6	P6-1	P6-2	P6-3	P6-4	P6-5	P6-6
P6-1	1.00						1.00					
P6-2	.48	1.00					.62	1.00				
P6-3	.38	.46	1.00				.62	.53	1.00			
P6-4	.53	.59	.54	1.00			.63	.58	.56	1.00		
P6-5	.44	.40	.43	.48	1.00		.56	.52	.54	.55	1.00	
P6-6	.43	.50	.44	.53	.42	1.00	.55	.48	.54	.58	.48	1.00
Mean	2.27	2.32	2.17	2.27	2.15	1.80	2.25	2.23	2.17	2.18	2.21	1.75
SD	.75	.87	.87	.81	.80	.99	.74	.79	.87	.83	.80	.97
Variance	.56	.75	.76	.66	.64	.99	.55	.63	.76	.69	.64	.93
Skewness	-.82	-1.13	-.78	-1.02	-.73	-.26	-.83	-.72	-.81	-.94	-.79	-.23
Kurtosis	3.29	3.41	2.78	3.58	3.10	1.94	3.54	2.78	2.89	3.48	3.05	2.05

Note. SD=standard deviation.

Table A3. PASE-7 Items Pooled Across Groups

	Baseline							Post-Intervention						
Items	P7-1	P7-2	P7-3	P7-4	P7-5	P7-6	P7-7	P7-1	P7-2	P7-3	P7-4	P7-5	P7-6	P7-7
P7-1	1.00							1.00						
P7-2	.50	1.00						.54	1.00					
P7-3	.36	.37	1.00					.36	.29	1.00				
P7-4	.31	.38	.30	1.00				.43	.39	.38	1.00			
P7-5	.34	.41	.36	.44	1.00			.42	.32	.35	.41	1.00		
P7-6	.36	.37	.33	.49	.50	1.00		.41	.32	.37	.47	.57	1.00	
P7-7	.38	.40	.32	.36	.49	.51	1.00	.43	.42	.36	.34	.53	.50	1.00
Mean	1.79	1.89	1.62	2.34	1.93	1.97	1.78	1.73	1.79	1.68	2.19	1.83	1.87	1.64
SD	.89	.94	1.05	.79	.90	.86	.92	.90	.92	.98	.80	.91	.86	.95
Variance	.80	.88	1.10	.62	.81	.73	.84	.80	.84	.96	.64	.82	.74	.89
Skewness	-.37	-.47	-.21	-1.05	-.51	-.45	-.28	-.32	-.41	-.22	-.78	-.40	-.37	-.20
Kurtosis	2.43	2.32	1.86	3.48	2.50	2.47	2.23	2.38	2.38	2.04	3.10	2.39	2.48	2.14
RSP-0	95	96	197	30	79	53	94	105	109	142	36	93	67	138
RSP-1	245	219	229	111	208	227	279	261	227	275	137	236	249	286
RSP-2	448	399	347	353	429	428	396	445	442	364	436	431	449	391
RSP-3	224	298	239	518	296	304	243	201	234	231	403	252	247	197
ICC[a]	.001	.013	.000	.007	.000	.010	.008	.000	.004	.000	.008	.000	.000	.005
95% UB	.980	.060	.000	.070	.000	.060	.060	.000	.120	.000	.060	.000	.000	.090

Note. ICC=intra-class correlation coefficient; PASE=physical activity self-efficacy; RSP=response option with counts presented for each item (0=disagree a lot; 1=disagree a little; 2=agree a little; 3=agree a lot); SD=standard deviation. UB=upper bound for ICC confidence interval (lower bound was 0 for all items).

[a]Intra-class correlation coefficients were used to examine non-independence in the data due to clustered sampling design by schools.

Table A4. PASE-7 Items by Treatment Group

	Baseline							Post-Intervention						
Control	P7-1	P7-2	P7-3	P7-4	P7-5	P7-6	P7-7	P7-1	P7-2	P7-3	P7-4	P7-5	P7-6	P7-7
P7-1	1.00							1.00						
P7-2	.44	1.00						.50	1.00					
P7-3	.36	.37	1.00					.36	.23	1.00				
P7-4	.30	.34	.27	1.00				.47	.38	.36	1.00			
P7-5	.31	.39	.34	.44	1.00			.37	.26	.38	.37	1.00		
P7-6	.35	.25	.30	.48	.45	1.00		.37	.25	.37	.44	.52	1.00	
P7-7	.33	.37	.33	.35	.46	.47	1.00	.39	.38	.36	.32	.42	.44	1.00
Mean	1.78	1.91	1.62	2.33	1.96	2.05	1.82	1.73	1.77	1.68	2.25	1.79	1.88	1.61
SD	.91	.92	1.08	.78	.88	.81	.92	.91	.94	1.01	.79	.94	.85	.95
Variance	.83	.84	1.16	.61	.77	.66	.84	.83	.88	1.01	.62	.88	.73	.91
Skewness	-.42	-.50	-.23	-1.00	-.52	-.41	-.32	-.32	-.41	-.23	-.84	-.34	-.39	-.14
Kurtosis	2.43	2.44	1.80	3.41	2.55	2.39	2.23	2.33	2.33	1.98	3.15	2.22	2.53	2.10
Intervention	P7-1	P7-2	P7-3	P7-4	P7-5	P7-6	P7-7	P7-1	P7-2	P7-3	P7-4	P7-5	P7-6	P7-7
P7-1	1.00							1.00						
P7-2	.56	1.00						.58	1.00					
P7-3	.36	.37	1.00					.35	.35	1.00				
P7-4	.32	.42	.34	1.00				.40	.40	.40	1.00			
P7-5	.36	.42	.37	.45	1.00			.48	.39	.32	.46	1.00		
P7-6	.38	.47	.37	.50	.54	1.00		.44	.38	.37	.50	.63	1.00	
P7-7	.42	.42	.32	.37	.52	.54	1.00	.48	.47	.36	.37	.64	.56	1.00
Mean	1.80	1.87	1.62	2.36	1.91	1.89	1.74	1.74	1.81	1.68	2.13	1.87	1.85	1.67
SD	.88	.96	1.02	.80	.92	.89	.91	.88	.90	.95	.81	.87	.87	.94
Variance	.77	.92	1.04	.63	.84	.80	.83	.77	.81	.91	.65	.76	.75	.88
Skewness	-.32	-.44	-.19	-1.10	-.50	-.43	-.24	-.32	-.40	-.20	-.72	-.46	-.34	-.25
Kurtosis	2.41	2.22	1.92	3.56	2.44	2.42	2.23	2.43	2.43	2.11	3.07	2.57	2.43	2.20

Note. SD=standard deviation.

APPENDIX B

Model Parameter Estimates for PASE-6 Items by Treatment Group

Table B1. PASE-6 Cross Group Measurement Invariance: Configural Model Estimates

Group/Item	Baseline			Post-Intervention		
Intervention	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P6-1	.974 (.064)	.655 (.035)	.429 (.046)	1.164 (.051)	.816 (.023)	.665 (.037)
P6-2	1.070 (.064)	.720 (.031)	.518 (.045)	1.050 (.049)	.735 (.026)	.541 (.038)
P6-3	.969 (.062)	.652 (.032)	.425 (.042)	1.072 (.046)	.751 (.024)	.564 (.037)
P6-4	1.202 (.067)	.809 (.028)	.654 (.045)	1.119 (.046)	.784 (.022)	.615 (.035)
P6-5	.924 (.067)	.622 (.035)	.387 (.044)	1.003 (.050)	.703 (.028)	.494 (.040)
P6-6	1.000	.673 (.031)	.453 (.042)	1.000	.701 (.027)	.491 (.038)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P6-1	-1.986 (.121)	-1.102 (.070)	.183 (.056)	-1.920 (.114)	-1.139 (.071)	.248 (.056)
P6-2	-1.654 (.094)	-.967 (.066)	-.103 (.056)	-1.986 (.121)	-.929 (.065)	.168 (.056)
P6-3	-1.654 (.094)	-.807 (.063)	.178 (.056)	-1.617 (.092)	-.835 (.063)	.198 (.056)
P6-4	-1.715 (.098)	-1.066 (.069)	.098 (.056)	-1.599 (.091)	-1.007 (.067)	.264 (.056)
P6-5	-1.760 (.101)	-.921 (.065)	.346 (.057)	-1.834 (.107)	-.952 (.066)	.213 (.056)
P6-6	-1.238 (.074)	-.264 (.056)	.508 (.058)	-1.207 (.073)	-.258 (.056)	.653 (.060)
Control	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P6-1	1.155 (.080)	.693 (.031)	.480 (.043)	1.221 (.067)	.780 (.026)	.609 (.041)
P6-2	1.135 (.078)	.681 (.032)	.464 (.044)	1.097(.062)	.701 (.031)	.492 (.043)
P6-3	1.075 (.075)	.645 (.033)	.416 (.043)	1.018 (.061)	.650 (.031)	.423 (.041)
P6-4	1.269 (.083)	.761 (.028)	.579 (.043)	1.136 (.063)	.726 (.028)	.527 (.041)
P6-5	1.283 (.079)	.770 (.026)	.592 (.040)	1.032 (.058)	.659 (.032)	.435 (.043)
P6-6	1.000	.600 (.034)	.360 (.041)	1.000	.639 (.030)	.409 (.039)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P6-1	-1.687 (.097)	-1.148 (.072)	.040 (.056)	-1.827 (.107)	-1.101 (.070)	.171 (.056)
P6-2	-1.687 (.097)	-1.110 (.070)	-.080 (.056)	-2.016 (.125)	-1.148 (.072)	-.120 (.056)
P6-3	-1.666 (.096)	-.933 (.066)	.268 (.057)	-1.854 (.110)	-.830 (.064)	.268 (.057)
P6-4	-1.753 (.102)	-1.167 (.072)	-.045 (.056)	-1.913 (.115)	-1.138 (.071)	.110 (.056)
P6-5	-1.913 (.115)	-.949 (.066)	.125 (.056)	-2.016 (.125)	-1.022 (.068)	.237 (.057)
P6-6	-1.355 (.079)	-.482 (.058)	.444 (.058)	-1.307 (.077)	-.499 (.059)	.551 (.059)

Note. λ =factor loading; τ =unstandardized threshold; Std=standardized ; SE=standard error; P6=PASE-6 items.

Table B2. PASE-6 Cross Group Measurement Invariance: Metric Model Estimates

Group/Item		Baseline			Post-Intervention	
Intervention	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P6-1	1.086 (.062)	.674 (.031)	.455 (.042)	1.195 (.055)	.826 (.022)	.682 (.036)
P6-2	1.120 (.063)	.714 (.029)	.509 (.041)	1.090 (.053)	.739 (.024)	.547 (.036)
P6-3	1.053 (.061)	.649 (.029)	.421 (.038)	1.049 (.052)	.742 (.023)	.551 (.035)
P6-4	1.248 (.068)	.804 (.026)	.591 (.039)	1.160 (.052)	.778 (.022)	.605 (.034)
P6-5	1.229 (.064)	.633 (.031)	.574 (.037)	1.042 (.053)	.701 (.027)	.491 (.037)
P6-6	1.000	.660 (.029	.380 (.037)	1.000	.703 (.026)	.494 (.036)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P6-1	-1.794 (.087)	-1.208 (.082)	-.210 (.110)	-1.940 (.093)	-1.343 (.092)	-.099 (.127)
P6-2	-1.640 (.083)	-1.095 (.075)	-.441 (.097)	-2.068 (.109)	-1.142 (.089)	-.140 (.116)
P6-3	-1.648 (.083)	-.973 (.078)	-.202 (.107)	-1.753 (.095)	-1.013 (.081)	-.109 (.113)
P6-4	-1.710 (.086)	-1.202 (.081)	-.330 (.116)	-1.833 (.091)	-1.244 (.085)	-.069 (.127)
P6-5	-1.992 (.104)	-1.261 (.093)	-.074 (.136)	-1.988 (.108)	-1.158 (.089)	-.084 (.115)
P6-6	-1.269 (.069)	-.505 (.059)	.047 (.114)	-1.323 (.067)	-.498 (.059)	.307 (.136)
Control	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P6-1	1.086 (.062)	.669 (.030)	.448 (.038)	1.195 (.055)	.761 (.024)	.578 (.036)
P6-2	1.120 (.063)	.690 (.029)	.476 (.040)	1.090 (.053)	.694 (.028)	.481 (.039)
P6-3	1.053 (.061)	.649 (.029)	.421 (.038)	1.049 (.052)	.667 (.028)	.445 (.037)
P6-4	1.248 (.068)	.769 (.026)	.591 (.039)	1.160 (.052)	.738 (.025)	.545 (.037)
P6-5	1.229 (.064	.757 (.025)	.574 (.037)	1.042 (.053)	.663 (.030)	.440 (.039)
P6-6	1.000	.616 (.030)	.380 (.037)	1.000	.636 (.027)	.405 (.035)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P6-1	-1.794 (.087)	-1.148 (.072)	.040 (.056)	-1.940 (.093)	-1.101 (.070)	.171 (.056)
P6-2	-1.640 (.083)	-1.110 (.070)	-.080 (.056)	-2.068 (.109)	-1.148 (.072)	-.120 (.056)
P6-3	-1.648 (.083)	-.933 (.066)	.268 (.057)	-1.753 (.095)	-.830 (.064)	.268 (.057)
P6-4	-1.710 (.086)	-1.167 (.072)	-.045 (.056)	-1.833 (.091)	-1.138 (.071)	.110 (.056)
P6-5	-1.992 (.104)	-.949 (.066)	.125 (.056)	-1.988 (.108)	-1.022 (.068)	.237 (.057)
P6-6	-1.269 (.069)	-.505 (.059)	.444 (.058)	-1.323 (.067)	-.498 (.059)	.551 (.059)

Note. λ =factor loading; τ =unstandardized threshold; Std=standardized ; SE=standard error; P6=PASE-6 items.

Table B3. PASE-6 Cross Group Measurement Invariance: Scalar Model Estimates

Group/Item		Baseline			Post-Intervention	
Intervention	λ (SE)	Std. λ (SE)	R^2	λ (SE)	Std. λ (SE)	R^2
P6-1	1.061 (.059)	.680 (.030)	.463 (.040)	1.159 (.051)	.831 (.021)	.691 (.035)
P6-2	1.102 (.061)	.708 (.028)	.501 (.039)	1.084 (.051)	.737 (.023)	.544 (.035)
P6-3	1.037 (.059)	.642 (.028)	.413 (.036)	1.024 (.048)	.741 (.023)	.549 (.034)
P6-4	1.230 (.065)	.800 (.025)	.641 (.040)	1.139 (.050)	.778 (.021)	.605 (.033)
P6-5	1.175 (.060)	.657 (.029)	.431 (.038)	1.018 (.049)	.701 (.026)	.492 (.036)
P6-6	1.000	.647 (.028)	.419 (.036)	1.000	.698 (.025)	.487 (.035)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P6-1	-1.809 (.088)	-1.143 (.062)	.061 (.047)	-1.909 (.092)	-1.165 (.062)	.156 (.049)
P6-2	-1.675 (.085	-1.056 (.059)	-.141 (.047)	-2.091 (.107)	-1.104 (.062)	-.025 (.047)
P6-3	-1.693 (.083)	-.908 (.056)	.173 (.049)	-1.748 (.089)	-.871 (.053)	.182 (.047)
P6-4	-1.731 (.087)	-1.133 (.063)	-.030 (.049)	-1.823 (.089)	-1.143 (.061)	.140 (.048)
P6-5	-1.969 (.099)	-1.023 (.059)	.192 (.051)	-1.995 (.102)	-1.047 (.058)	.183 (.047)
P6-6	-1.298 (.069)	-.402 (.046)	.415 (.050)	-1.312 (.065)	-.424 (.048)	.562 (.052)
Control	λ (SE)	Std. λ (SE)	R^2	λ (SE)	Std. λ (SE)	R^2
P6-1	1.061 (.059)	.667 (.030)	.445 (.038)	1.159 (.051)	.751 (.024)	.564 (.036)
P6-2	1.102 (.061)	.693 (.029)	.480 (.040)	1.084 (.051)	.702 (.028)	.493 (.039)
P6-3	1.037 (.059)	.652 (.029)	.425 (.038)	1.024 (.048)	.664 (.027)	.440 (.036)
P6-4	1.230 (.065)	.773 (.026)	.598 (.040)	1.139 (.050)	.738 (.025)	.545 (.037)
P6-5	1.175 (.060)	.739 (.025)	.546 (.037)	1.018 (.049)	.660 (.029)	.435 (.038)
P6-6	1.000	.629 (.030)	.395 (.037)	1.000	.648 (.027)	.420 (.035)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P6-1	-1.809 (.088)	-1.143 (.062)	.061 (.047)	-1.909 (.092)	-1.165 (.062)	.156 (.049)
P6-2	-1.675 (.085)	-1.056 (.059)	-.141 (.047)	-2.091 (.107)	-1.104 (.062)	-.025 (.047)
P6-3	-1.693 (.083)	-.908 (.056)	.173 (.049)	-1.748 (.089)	-.871 (.053)	.182 (.047)
P6-4	-1.731 (.087)	-1.133 (.063)	-.030 (.049)	-1.823 (.089)	-1.143 (.061)	.140 (.048)
P6-5	-1.969 (.099)	-1.023 (.059)	.192 (.051)	-1.995 (.102)	-1.047 (.058)	.183 (.047)
P6-6	-1.298 (.069)	-.402 (.046)	.415 (.050)	-1.312 (.065)	-.424 (.048)	.562 (.052)

Note. λ =factor loading; τ =unstandardized threshold; Std=standardized ; SE=standard error; P6=PASE-6 items.

Table B4. PASE-6 Longitudinal Invariance: Configural Model Estimates

Group/Item	Baseline			Post-Intervention		
Intervention	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P6-1	1.006 (.067)	.671 (.035)	.450 (.047)	1.166 (.052)	.819 (.024)	.670 (.039)
P6-2	1.074 (.071)	.716 (.032)	.513 (.046)	1.033 (.050)	.726 (.027)	.526 (.039)
P6-3	.973 (.065)	.649 (.034)	.421 (.044)	1.065 (.048)	.748 (.025)	.559 (.038)
P6-4	1.205 (.069)	.804 (.028)	.646 (.045)	1.123 (.047)	.789 (.023)	.622 (.036)
P6-5	.930 (.072)	.626 (.028)	.392 (.046)	1.005 (.053)	.706 (.029)	.498 (.041)
P6-6	1.000	.667 (.033)	.445 (.044)	1.000	.702 (.027)	.493 (.038)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P6-1	-1.986 (.121)	-1.102 (.070)	.183 (.056)	-1.920 (.114)	-1.139 (.071)	.248 (.056)
P6-2	-1.654 (.094)	-.967 (.066)	-.103 (.056)	-1.986 (.121)	-.929 (.065)	.168 (.056)
P6-3	-1.654 (.094)	-.807 (.063)	.178 (.056)	-1.617 (.092)	-.835 (.063)	.198 (.056)
P6-4	-1.715 (.098)	-1.066 (.069)	.098 (.056)	-1.599 (.091)	-1.007 (.067)	.264 (.056)
P6-5	-1.760 (.101)	-.921 (.065)	.346 (.057)	-1.834 (.107)	-.952 (.066)	.213 (.056)
P6-6	-1.238 (.074)	-.264 (.056)	.508 (.058)	-1.207 (.073)	-.258 (.056)	.653 (.060)
Control	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P6-1	1.134 (.084)	.689 (.034)	.474 (.047)	1.190 (.068)	.772 (.029)	.597 (.045)
P6-2	1.131 (.079)	.686 (.033)	.471 (.046)	1.044 (.066)	.678 (.034)	.459 (.046)
P6-3	1.053 (.077)	.639 (.035)	.409 (.045)	1.030 (.064)	.669 (.033)	.447 (.044)
P6-4	1.266 (.084)	.768 (.030)	.590 (.046)	1.100 (.065)	.714 (.030)	.510 (.043)
P6-5	1.253 (.079)	.761 (.027)	.579 (.042)	1.045 (.062)	.678 (.033)	.460 (.045)
P6-6	1.000	.607 (.035)	.368 (.042)	1.000	.649 (.031)	.422 (.040)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P6-1	-1.687 (.097)	-1.148 (.072)	.040 (.056)	-1.827 (.107)	-1.101 (.070)	.171 (.056)
P6-2	-1.687 (.097)	-1.110 (.070)	-.080 (.056)	-2.016 (.125)	-1.148 (.072)	-.120 (.056)
P6-3	-1.666 (.096)	-.933 (.066)	.268 (.057)	-1.854 (.110)	-.830 (.064)	.268 (.057)
P6-4	-1.753 (.102)	-1.167 (.072)	-.045 (.056)	-1.913 (.115)	-1.138 (.071)	.110 (.056)
P6-5	-1.913 (.115)	-.949 (.066)	.125 (.056)	-2.016 (.125)	-1.022 (.068)	.237 (.057)
P6-6	-1.355 (.079)	-.482 (.058)	.444 (.058)	-1.307 (.077)	-.499 (.059)	.551 (.059)

Note. λ =factor loading; τ =unstandardized threshold; Std=standardized ; SE=standard error; P6=PASE-6 items.

Table B5. PASE-6 Longitudinal Invariance: Metric Model Estimates

Group/Item	Baseline			Post-Intervention		
Intervention	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P6-1	1.030 (.060)	.688 (.030)	.473 (.042)	1.030 (.060)	.810 (.023)	.656 (.037)
P6-2	1.037 (.060)	.692 (.029)	.479 (.040)	1.037 (.060)	.741 (.026)	.549 (.038)
P6-3	.988 (.057)	.660 (.030)	.435 (.039)	.988 (.057)	.742 (.024)	.551 (.036)
P6-4	1.201 (.062)	.802 (.026)	.644 (.042)	1.201 (.062)	.790 (.022)	.625 (.034)
P6-5	.938 (.062)	.626 (.032)	.392 (.040)	.938 (.062)	.705 (.028)	.497 (.040)
P6-6	1.000	.668 (.030)	.446 (.040)	1.000	.702 (.026)	.493 (.036)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P6-1	-1.853 (.101)	-1.102 (.070)	.183 (.056)	-1.853 (.101)	-1.039 (.082)	.230 (.103)
P6-2	-1.782 (.087)	-.967 (.066)	-.103 (.056)	-1.782 (.087)	-.932 (.087)	.172 (.103)
P6-3	-1.596 (.080)	-.807 (.063)	.178 (.056)	-1.596 (.080)	-.796 (.078)	.192 (.098)
P6-4	-1.730 (.088)	-1.066 (.069)	.098 (.056)	-1.730 (.088)	-1.099 (.093)	.291 (.123)
P6-5	-1.756 (.085)	-.921 (.065)	.346 (.057)	-1.756 (.085)	-.908 (.083)	.206 (.098)
P6-6	-1.236 (.065)	-.263 (.056)	.508 (.058)	-1.236 (.065)	-.263 (.056)	.672 (.129)
Control	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P6-1	1.126 (.072)	.700 (.030)	.491 (.042)	1.126 (.072)	.763 (.028)	.583 (.042)
P6-2	1.087 (.067)	.676 (.030)	.457 (.041)	1.087 (.067)	.688 (.031)	.473 (.042)
P6-3	1.032 (.065)	.641 (.033)	.412 (.042)	1.032 (.065)	.667 (.030)	.445 (.041)
P6-4	1.223 (.072)	.760 (.027)	.578 (.041)	1.223 (.072)	.721 (.028)	.520 (.040)
P6-5	1.212 (.068)	.753 (.026)	.568 (.039)	1.212 (.068)	.686 (.031)	.471 (.043)
P6-6	1.000	.622 (.032)	.387 (.040)	1.000	.636 (.030)	.404 (.038)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P6-1	-1.616 (.083)	-1.148 (.072)	.040 (.056)	-1.616 (.083)	-.979 (.084)	.039 (.129)
P6-2	-1.749 (.085)	-1.110 (.070)	-.080 (.056)	-1.749 (.085)	-1.079 (.083)	-.197 (.109)
P6-3	-1.656 (.089)	-.933 (.066)	.268 (.057)	-1.656 (.089)	-.786 (.089)	.135 (.128)
P6-4	-1.807 (.093)	-1.167 (.072)	-.045 (.056)	-1.807 (.093)	-1.153 (.092)	-.005 (.139)
P6-5	-1.972 (.106)	-.949 (.066)	.125 (.056)	-1.972 (.106)	-1.084 (.102)	.122 (.148)
P6-6	-1.265 (.073)	-.500 (.059)	.444 (.058)	-1.265 (.073)	-.500 (.059)	.383 (.149)

Note. λ =factor loading; τ =unstandardized threshold; Std=standardized ; SE=standard error; P6=PASE-6 items.

Table B6. PASE-6 Longitudinal Invariance: Scalar Model Estimates

	Longitudinal Invariance: Scalar Model Estimates					
Group/Item	Baseline			Post-Intervention		
Intervention	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P6-1	1.046 (.057)	.693 (.028)	.480 (.039)	1.046 (.057)	.807 (.023)	.652 (.037)
P6-2	1.047 (.060)	.694 (.028)	.481 (.039)	1.047 (.060)	.741 (.025)	.550 (.038)
P6-3	.997 (.054)	.660 (.028)	.436 (.038)	.997 (.054)	.742 (.024)	.551 (.036)
P6-4	1.204 (.058)	.797 (.025)	.636 (.040)	1.204 (.058)	.794 (.022)	.631 (.034)
P6-5	.954 (.059)	.632 (.031)	.399 (.039)	.954 (.059)	.700 (.028)	.491 (.040)
P6-6	1.000	.662 (.029)	.439 (.038)	1.000	.706 (.026)	.499 (.036)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P6-1	-1.851 (.095)	-1.084 (.059)	.166 (.046)	-1.851 (.095)	-1.084 (.059)	.166 (.046)
P6-2	-1.782 (.087)	-.963 (.056)	.000 (.046)	-1.782 (.087)	-.963 (.056)	.000 (.046)
P6-3	-1.591 (.076)	-.817 (.054)	.145 (.044)	-1.591 (.076)	-.817 (.054)	.145 (.044)
P6-4	-1.720 (.084)	-1.090 (.061)	.145 (.050)	-1.720 (.084)	-1.090 (.061)	.145 (.050)
P6-5	-1.759 (.081)	-.932 (.056)	.232 (.048)	-1.759 (.081)	-.932 (.056)	.232 (.048)
P6-6	-1.232 (.062)	-.289 (.049)	.537 (.052)	-1.232 (.062)	-.289 (.049)	.537 (.052)
Control	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P6-1	1.143 (.070)	.709 (.030)	.503 (.042)	1.143 (.070)	.757 (.027)	.573 (.042)
P6-2	1.085 (.064)	.674 (.029)	.454 (.040)	1.085 (.064)	.689 (.030)	.475 (.042)
P6-3	1.047 (.062)	.650 (.032)	.423 (.041)	1.047 (.062)	.658 (.029)	.433 (.039)
P6-4	1.222 (.069)	.759 (.026)	.576 (.040)	1.222 (.069)	.724 (.027)	.524 (.039)
P6-5	1.195 (.064)	.742 (.026)	.551 (.039)	1.195 (.064)	.698 (.030)	.487 (.042)
P6-6	1.000	.621 (.031)	.386 (.038)	1.000	.637 (.029)	.405 (.037)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P6-1	-1.657 (.082)	-1.067 (.061)	.060 (.047)	-1.657 (.082)	-1.067 (.061)	.060 (.047)
P6-2	-1.763 (.086)	-1.099 (.061)	-.132 (.046)	-1.763 (.086)	-1.099 (.061)	-.132 (.046)
P6-3	-1.699 (.086)	-.864 (.057)	.217 (.049)	-1.699 (.086)	-.864 (.057)	.217 (.049)
P6-4	-1.822 (.091)	-1.165 (.062)	-.006 (.050)	-1.822 (.091)	-1.165 (.062)	-.006 (.050)
P6-5	-1.967 (.102)	-1.007 (.062)	.141 (.051)	-1.967 (.102)	-1.007 (.062)	.141 (.051)
P6-6	-1.280 (.071)	-.495 (.050)	.435 (.049)	-1.280 (.071)	-.495 (.050)	.435 (.049)

Note. λ =factor loading; τ =unstandardized threshold; Std=standardized ; SE=standard error; P6=PASE-6 items.

Table B7. PASE-6 Simultaneous Cross-Group and Longitudinal Invariance: Configural Model Estimates

Group/Item	Baseline			Post-Intervention		
Intervention	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P6-1	1.006 (.067)	.671 (.035)	.450 (.047)	1.166 (.052)	.819 (.024)	.670 (.039)
P6-2	1.074 (.071)	.716 (.032)	.513 (.046)	1.033 (.050)	.726 (.027)	.526 (.039)
P6-3	.973 (.065)	.649 (.034)	.421 (.044)	1.065 (.048)	.748 (.025)	.559 (.038)
P6-4	1.205 (.069)	.804 (.028)	.646 (.045)	1.123 (.047)	.789 (.023)	.622 (.036)
P6-5	.930 (.072)	.626 (.028)	.392 (.046)	1.005 (.053)	.706 (.029)	.498 (.041)
P6-6	1.000	.667 (.033)	.445 (.044)	1.000	.702 (.027)	.493 (.038)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P6-1	-1.986 (.121)	-1.102 (.070)	.183 (.056)	-1.920 (.114)	-1.139 (.071)	.248 (.056)
P6-2	-1.654 (.094)	-.967 (.066)	-.103 (.056)	-1.986 (.121)	-.929 (.065)	.168 (.056)
P6-3	-1.654 (.094)	-.807 (.063)	.178 (.056)	-1.617 (.092)	-.835 (.063)	.198 (.056)
P6-4	-1.715 (.098)	-1.066 (.069)	.098 (.056)	-1.599 (.091)	-1.007 (.067)	.264 (.056)
P6-5	-1.760 (.101)	-.921 (.065)	.346 (.057)	-1.834 (.107)	-.952 (.066)	.213 (.056)
P6-6	-1.238 (.074)	-.264 (.056)	.508 (.058)	-1.207 (.073)	-.258 (.056)	.653 (.060)
Control	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P6-1	1.134 (.084)	.689 (.034)	.474 (.047)	1.190 (.068)	.772 (.029)	.597 (.045)
P6-2	1.131 (.079)	.686 (.033)	.471 (.046)	1.044 (.066)	.678 (.034)	.459 (.046)
P6-3	1.053 (.077)	.639 (.035)	.409 (.045)	1.030 (.064)	.669 (.033)	.447 (.044)
P6-4	1.266 (.084)	.768 (.030)	.590 (.046)	1.100 (.065)	.714 (.030)	.510 (.043)
P6-5	1.253 (.079)	.761 (.027)	.579 (.042)	1.045 (.062)	.678 (.033)	.460 (.045)
P6-6	1.000	.607 (.035)	.368 (.042)	1.000	.649 (.031)	.422 (.040)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P6-1	-1.687 (.097)	-1.148 (.072)	.040 (.056)	-1.827 (.107)	-1.101 (.070)	.171 (.056)
P6-2	-1.687 (.097)	-1.110 (.070)	-.080 (.056)	-2.016 (.125)	-1.148 (.072)	-.120 (.056)
P6-3	-1.666 (.096)	-.933 (.066)	.268 (.057)	-1.854 (.110)	-.830 (.064)	.268 (.057)
P6-4	-1.753 (.102)	-1.167 (.072)	-.045 (.056)	-1.913 (.115)	-1.138 (.071)	.110 (.056)
P6-5	-1.913 (.115)	-.949 (.066)	.125 (.056)	-2.016 (.125)	-1.022 (.068)	.237 (.057)
P6-6	-1.355 (.079)	-.482 (.058)	.444 (.058)	-1.307 (.077)	-.499 (.059)	.551 (.059)

Note. λ =factor loading; τ =unstandardized threshold; Std=standardized ; SE=standard error; P6=PASE-6 items.

Table B8. PASE-6 Simultaneous Cross-Group and Longitudinal Invariance: Metric Model Estimates

Group/Item		Baseline			Post-Intervention	
Intervention	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P6-1	1.132 (.047)	.699 (.029)	.489 (.041)	1.132 (.047)	.820 (.022)	.673 (.036)
P6-2	1.078 (.046)	.692 (.027)	.479 (.037)	1.078 (.046)	.740 (.025)	.548 (.037)
P6-3	1.045 (.043)	.654 (.028)	.428 (.037)	1.045 (.043)	.737 (.023)	.543 (.034)
P6-4	1.183 (.047)	.796 (.025)	.633 (.040)	1.183 (.047)	.785 (.021)	.616 (.033)
P6-5	1.131 (.046)	.631 (.030)	.398 (.038)	1.131 (.046)	.708 (.027)	.501 (.038)
P6-6	1.000	.665 (.028)	.442 (.038)	1.000	.699 (.025)	.489 (.035)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P6-1	-1.850 (.068)	-1.287 (.084)	-.169 (.105)	-1.850 (.068)	-1.235 (.075)	-.136 (.104)
P6-2	-1.807 (.073)	-1.123 (.073)	-.399 (.087)	-1.807 (.073)	-1.094 (.077)	-.177 (.100)
P6-3	-1.699 (.067)	-.996 (.074)	-.150 (.099)	-1.699 (.067)	-.987 (.068)	-.146 (.098)
P6-4	-1.758 (.067)	-1.196 (.073)	-.264 (.102)	-1.758 (.067)	-1.220 (.074)	-.120 (.111)
P6-5	-1.996 (.081)	-1.216 (.087)	.006 (.116)	-1.996 (.081)	-1.206 (.081)	-.137 (.108)
P6-6	-1.304 (.054)	-.264 (.056)	.508 (.058)	-1.304 (.054)	-.499 (.048)	.242 (.116)
Control	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P6-1	1.132 (.047)	.717 (.024)	.514 (.035)	1.132 (.047)	.718 (.023)	.515 (.033)
P6-2	1.078 (.046)	.683 (.024)	.467 (.033)	1.078 (.046)	.683 (.025)	.467 (.034)
P6-3	1.045 (.043)	.662 (.025)	.438 (.033)	1.045 (.043)	.662 (.024)	.438 (.032)
P6-4	1.183 (.047)	.750 (.022)	.562 (.034)	1.183 (.047)	.750 (.024)	.562 (.035)
P6-5	1.131 (.046)	.716 (.024)	.513 (.035)	1.131 (.046)	.716 (.025)	.513 (.036)
P6-6	1.000	.633 (.025)	.401 (.032)	1.000	.634 (.025)	.402 (.032)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P6-1	-1.850 (.068)	-1.148 (.072)	.040 (.056)	-1.850 (.068)	-1.101 (.070)	.171 (.056)
P6-2	-1.807 (.073)	-1.110 (.070)	-.080 (.056)	-1.807 (.073)	-1.148 (.072)	-.120 (.056)
P6-3	-1.699 (.067)	-.933 (.066)	.268 (.057)	-1.699 (.067)	-.830 (.064)	.268 (.057)
P6-4	-1.758 (.067)	-1.167 (.072)	-.045 (.056)	-1.758 (.067)	-1.138 (.071)	.110 (.056)
P6-5	-1.996 (.081)	-.949 (.066)	.125 (.056)	-1.996 (.081)	-1.022 (.068)	.237 (.057)
P6-6	-1.304 (.054)	-.499 (.048)	.444 (.058)	-1.304 (.054)	-.499 (.048)	.551 (.059)

Note. λ =factor loading; τ =unstandardized threshold; Std=standardized ; SE=standard error; P6=PASE-6 items.

APPENDIX C

Model Parameter Estimates for PASE-7 Items by Treatment Group

Table C1. PASE-7 Cross Group Measurement Invariance: Configural Model Estimates

Group/Item	Baseline			Post-Intervention		
Intervention	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P7-1	.747 (.057)	.534 (.036)	.286 (.039)	.817 (.053)	.611 (.034)	.373 (.042)
P7-4	.847 (.062)	.606 (.039)	.367 (.047)	.786 (.052)	.587 (.035)	.345 9.041)
P7-5	.999 (.060)	.715 (.032)	.511 (.045)	1.104 (.045)	.825 (.022)	.680 (.036)
P7-6	1.070 (.058)	.766 (.028)	.587 (.043)	1.030 (.048)	.770 (.026)	.592 (.040)
P7-7	1.000	.716 (.030)	.512 (.042)	1.000	.747 (.026)	.558 (.039)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P7-1	-1.402 (.081)	-.404 (.057)	.767 (.062)	-1.304 (.077)	-.362 (.057)	.863 (.064)
P7-4	-1.861 (.109)	-1.084 (.069)	-.069 (.056)	-1.737 (.100)	-.899 (.064)	.367 (.057)
P7-5	-1.352 (.078)	-.541 (.059)	.559 (.059)	-1.416 (.081)	-.536 (.058)	.690 (.061)
P7-6	-1.429 (.082)	-.508 (.058)	.599 (.059)	-1.486 (.085)	-.458 (.058)	.703 (.061)
P7-7	-1.293 (.076)	-.294 (.056)	.767 (.062)	-1.129 (.070)	-.258 (.056)	.849 (.063)
Control	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P7-1	.739 (.072)	.484 (.041)	.234 (.039)	.981 (.082)	.599 (.037)	.359 (.044)
P7-4	.963 (.078)	.631 (.039)	.398 (.049)	1.010 (.086)	.617 (.040)	.380 (.049)
P7-5	1.019 (.081)	.688 (.036)	.446 (.048)	1.097 (.083)	.670 (.035)	.449 (.047)
P7-6	1.100 9.083)	.721 (.035)	.519 (.050)	1.177 (.086)	.719 (.033)	.517 (.047)
P7-7	1.000	.655 (.037)	.429 (.048)	1.000	.611 (.035)	.373 (.043)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P7-1	-1.240 (.075)	-.444 (.058)	.768 (.062)	-1.218 (.074)	-.346 (.057)	.830 (.064)
P7-4	-1.913 (.115)	-1.083 (.070)	.010 (.056)	-1.883 (.112)	-1.005 (.068)	.150 (.056)
P7-5	-1.493 (.086)	-.604 (.060)	.534 (.059)	-1.250 (.075)	-.373 (.057)	.665 (.061)
P7-6	-1.913 (.115)	-.684 (.061)	.449 9.058)	-1.524 (.087)	-.522 (.059)	.684 (.061)
P7-7	-1.355 (.079)	-.378 (.057)	.647 (.060)	-1.065 (.069)	-.150 (.056)	.873 (.064)

Note. λ =factor loading; τ =unstandardized threshold; Std=standardized ; SE=standard error; P7=PASE-7 items.

Table C2. PASE-7 Cross Group Measurement Invariance: Metric Model Estimates

Group/Item	Baseline			Post-Intervention		
Intervention	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P7-1	.708 (.055)	.551 (.033)	.303 (.036)	.934 (.064)	.622 (.031)	.387 (.038)
P7-4	.935 (.061)	.622 (.035)	.387 (.036)	.976 (.068)	.592 (.031)	.351 (.037)
P7-5	1.032 (.064)	.712 9.029)	.507 (.041)	1.083 (.067)	.823 (.020)	.677 (.034)
P7-6	1.170 (.071)	.740 (.026)	.548 (.038)	1.163 (.071)	.767 (.023)	.589 (.036)
P7-7	1.000	.720 (.027)	.519 (.039)	1.000	.740 (.025)	.548 (.037)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P7-1	-1.284 (.068)	-.443 (.065)	.590 (.122)	-1.258 (.066)	-.312 (.080)	.977 (.160)
P7-4	-1.975 (.103)	-1.233 (.094)	-.185 (.096)	-1.907 (.099)	-.966 (.093)	.495 (.125)
P7-5	-1.481 (.075)	-.664 (.079)	.429 (.140)	-1.238 (.067)	-.415 (.075)	.716 (.148)
P7-6	-1.775 (.101)	-.693 (.093)	.507 (.161)	-1.509 (.079)	-.401 (.090)	.831 (.164)
P7-7	-1.355 (.071)	-.391 (.058)	.609 (.151)	-1.029 (.060)	-.161 (.057)	.877 (.153)
Control	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P7-1	.708 (.055)	.459 (.033)	.211 (.030)	.934 (.064)	.582 (.031)	.339 (.036)
P7-4	.935 (.061)	.607 (.033)	.368 (.039)	.976 (.068)	.608 (.034)	.369 (.042)
P7-5	1.032 (.064)	.670 (.030)	.449 (.041)	1.083 (.067)	.674 (.030)	.455 (.041)
P7-6	1.170 (.071)	.759 (.030)	.577 (.046)	1.163 (.071)	.724 (.029)	.524 (.042)
P7-7	1.000	.649 (.031)	.421 (.040)	1.000	.623 (.031)	.388 (.038)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P7-1	-1.284 (.068)	-.444 (.058)	.768 (.062)	-1.258 (.066)	-.346 (.057)	.830 (.064)
P7-4	-1.975 (.103)	-1.083 (.070)	.010 (.056)	-1.907 (.099)	-1.005 (.068)	.150 (.056)
P7-5	-1.481 (.075)	-.604 (.060)	.534 (.059)	-1.238 (.067)	-.373 (.057)	.665 (.061)
P7-6	-1.775 (.101)	-.684 (.061)	.449 (.058)	-1.509 (.079)	-.522 (.059)	.684 (.061)
P7-7	-1.355 (.071)	-.391 (.058)	.647 (.060)	-1.029 (.060)	-.161 (.057)	.873 (.064)

Note. λ =factor loading; τ =unstandardized threshold; Std=standardized ; SE=standard error; P7=PASE-7 items.

Table C3. PASE-7 Cross Group Measurement Invariance: Scalar Model Estimates

Group/Item		Baseline			Post-Intervention	
Intervention	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P7-1	.724 (.052)	.542 (.031)	.293 (.034)	.917 (.056)	.624 (.030)	.389 (.037)
P7-4	.911 (.057)	.629 (.034)	.396 (.043)	.957 (.061)	.595 (.030)	.354 (.036)
P7-5	1.031 (.061)	.709 (.028)	.503 (.040)	1.067 (.058)	.825 (.020)	.680 (.034)
P7-6	1.161 (.066)	.745 (.025)	.555 (.038)	1.152 (.063)	.767 (.023)	.588 (.035)
P7-7	1.000	.720 (.027)	.518 (.038)	1.000	.736 (.024)	.542 (.036)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P7-1	-1.305 (.064)	-.436 (.044)	.718 (.052)	-1.253 (.062)	-.352 (.046)	.843 (.055)
P7-4	-1.940 (.097)	-1.126 (.059)	-.060 (.046)	-1.882 (.094)	-.990 (.058)	.263 (.047)
P7-5	-1.475 (.072)	-.615 (.050)	.519 (.053)	-1.241 (.064)	-.425 (.047)	.629 (.051)
P7-6	-1.751 (.094)	-.662 (.053)	.507 (.053)	-1.513 (.076)	-.492 (.050)	.698 (.054)
P7-7	-1.346 (.069)	-.367 (.047)	.666 (.053)	-1.047 (.057)	-.197 (.045)	.820 (.055)
Control	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P7-1	.724 (.052)	.471 (.031)	.222 (.030)	.917 (.056)	.578 (.029)	.334 (.034)
P7-4	.911 (.057)	.594 (.032)	.352 (.038)	.957 (.061)	.603 (.033)	.364 (.040)
P7-5	1.031 (.061)	.672 (.030)	.452 (.040)	1.067 (.058)	.672 (.028)	.452 (.037)
P7-6	1.161 (.066)	.756 (.029)	.572 (.044)	1.152 (.063)	.726 (.027)	.527 (.040)
P7-7	1.000	.652 (.030)	.425 (.038)	1.000	.630 (.028)	.397 (.035)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P7-1	-1.305 (.064)	-.436 (.044)	.718 (.052)	-1.253 (.062)	-.352 (.046)	.843 (.055)
P7-4	-1.940 (.097)	-1.126 (.059)	-.060 (.046)	-1.882 (.094)	-.990 (.058)	.263 (.047)
P7-5	-1.475 (.072)	-.615 (.050)	.519 (.053)	-1.241 (.064)	-.425 (.047)	.629 (.051)
P7-6	-1.751 (.094)	-.662 (.053)	.507 (.053)	-1.513 (.076)	-.492 (.050)	.698 (.054)
P7-7	-1.346 (.069)	-.367 (.047)	.666 (.053)	-1.047 (.057)	-.197 (.045)	.820 (.055)

Note. λ =factor loading; τ =unstandardized threshold; Std=standardized ; SE=standard error; P7=PASE-7 items.

Table C4. PASE-7 Longitudinal Invariance: Configural Model Estimates

Group/Item		Baseline			Post-Intervention	
Intervention	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P7-1	.747 (.061)	.520 (.037)	.271 (.039)	.817 (.053)	.613 (.034)	.376 (.042)
P7-4	.924 (.069)	.644 (.040)	.414 (.051)	.775 (.054)	.582 (.035)	.339 (.041)
P7-5	.999 (.064)	.696 (.032)	.484 (.045)	1.099 (.046)	.826 (.023)	.682 (.037)
P7-6	1.125 (.064)	.783 (.027)	.614 (.043)	1.021 (.047)	.767 (.025)	.588 (.039)
P7-7	1.000	.697 (.031)	.485 (.044)	1.000	.751 (.027)	.564 (.040)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P7-1	-1.402 (.081)	-.404 (.057)	.767 (.062)	-1.304 (.077)	-.362 (.057)	.863 (.064)
P7-4	-1.861 (.109)	-1.084 (.069)	-.069 (.056)	-1.737 (.100)	-.899 (.064)	.367 (.057)
P7-5	-1.352 (.078)	-.541 (.059)	.559 (.059)	-1.416 (.081)	-.536 (.058)	.690 (.061)
P7-6	-1.429 (.082)	-.508 (.058)	.599 (.059)	-1.486 (.085)	-.458 (.058)	.703 (.061)
P7-7	-1.293 (.076)	-.294 (.056)	.767 (.062)	-1.129 (.070)	-.258 (.056)	.849 (.063)
Control	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P7-1	.731 (.068)	.491 (.040)	.241 (.040)	.980 (.081)	.612 (.037)	.374 (.046)
P7-4	.902 (.069)	.606 (.038)	.367 (.046)	1.033 (.083)	.645 (.039)	.416 (.050)
P7-5	.980 (.075)	.658 (.037)	.433 (.049)	1.053 (.085)	.658 (.039)	.432 (.051)
P7-6	1.085 (.076)	.728 (.034)	.530 (.049).	1.103 (.082)	.689 (.034)	.474 (.047)
P7-7	1.000	.671 (.034)	.451 (.045)	1.000	.624 (.035)	.390 (.044)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P7-1	-1.240 (.075)	-.444 (.058)	.768 (.062)	-1.218 (.074)	-.346 (.057)	.830 (.064)
P7-4	-1.913 (.115)	-1.083 (.070)	.010 (.056)	-1.883 (.112)	-1.005 (.068)	.150 (.056)
P7-5	-1.493 (.086)	-.604 (.060)	.534 (.059)	-1.250 (.075)	-.373 (.057)	.665 (.061)
P7-6	-1.913 (.115)	-.684 (.061)	.449 (.058)	-1.524 (.087)	-.522 (.059)	.684 (.061)
P7-7	-1.355 (.079)	-.378 (.057)	.647 (.060)	-1.065 (.069)	-.150 (.056)	.873 (.064)

Note. λ =factor loading; τ =unstandardized threshold; Std=standardized ; SE=standard error; P7=PASE-7 items.

Table C5. PASE-7 Longitudinal Invariance: Metric Model Estimates

Group/Item		Baseline			Post-Intervention	
Intervention	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P7-1	.759 (.052)	.541 (.032)	.292 (.035)	.759 (.052)	.600 (.032)	.360 (.038)
P7-4	.884 (.057)	.629 (.034)	.396 (.043)	.884 (.057)	.593 (.031)	.352 (.037)
P7-5	.984 (.053)	.700 (.029)	.490 (.040)	.984 (.053)	.822 (.021)	.675 (.035)
P7-6	1.070 (.051)	.761 (.025)	.580 (.037)	1.070 (.051)	.781 (.023)	.609 (.036)
P7-7	1.000	.712 (.028)	.507 (.040)	1.000	.743 (.025)	.552 (.038)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P7-1	-1.336 (.072)	-.404 (.057)	.767 (.062)	-1.336 (.072)	-.381 (.069)	.789 (.131)
P7-4	-1.927 (.096)	-1.084 (.069)	-.069 (.056)	-1.927 (.096)	-1.053 (.091)	.371 (.116)
P7-5	-1.338 (.072)	-.541 (.059)	.559 (.059)	-1.338 (.072)	-.530 (.071)	.578 (.133)
P7-6	-1.503 (.074)	-.508 (.058)	.599 (.059)	-1.503 (.074)	-.524 (.084)	.677 (.151)
P7-7	-1.241 (.068)	-.302 (.056)	.767 (.062)	-1.241 (.068)	-.302 (.056)	.816 (.160)
Control	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P7-1	.750 (.054)	.501 (.033)	.251 (.033)	.750 (.054)	.605 (.034)	.366 (.041)
P7-4	.897 (.058)	.598 (.032)	.358 (.039)	.897 (.058)	.651 (.035)	.423 (.045)
P7-5	.985 (.062)	.658 (.031)	.432 (.041)	.985 (.062)	.658 (.035)	.433 (.046)
P7-6	1.095 (.066)	.731 (.030)	.534 (.044)	1.095 (.066)	.687 (.032)	.472 (.044)
P7-7	1.000	.667 (.031)	.445 (.041)	1.000	.627 (.032)	.393 (.041)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P7-1	-1.213 (.069)	-.444 (.058)	.768 (.062)	-1.213 (.069)	-.457 (.064)	.540 (.125)
P7-4	-1.942 (.104)	-1.083 (.070)	.010 (.056)	-1.942 (.104)	-1.141 (.087)	-.054 (.097)
P7-5	-1.493 (.074)	-.604 (.060)	.534 (.059)	-1.493 (.074)	-.596 (.078)	.466 (.146)
P7-6	-1.904 (.098)	-.684 (.061)	.449 (.058)	-1.904 (.098)	-.807 (.088)	.506 (.151)
P7-7	-1.367 (.073)	-.380 (.059)	.647 (.060)	-1.367 (.073)	-.380 (.059)	.733 (.160)

Note. λ =factor loading; τ =unstandardized threshold; Std=standardized ; SE=standard error; P7=PASE-7 items.

Table C6. PASE-7 Longitudinal Invariance: Scalar Model Estimates

Group/Item	Baseline			Post-Intervention		
Intervention	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P7-1	.764 (.049)	.544 (.031)	.296 (.034)	.764 (.049)	.597 (.031)	.356 (.037)
P7-4	.885 (.053)	.630 (.032)	.397 (.041)	.885 (.053)	.599 (.030)	.359 (.036)
P7-5	.985 (.050)	.701 (.028)	.492 (.039)	.985 (.050)	.820 (.021)	.672 (.035)
P7-6	1.063 (.048)	.757 (.024)	.573 (.036)	1.063 (.048)	.782 (.023)	.611 (.036)
P7-7	1.000	.712 (.027)	.507 (.039)	1.000	.742 (.025)	.551 (.036)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P7-1	-1.342 (.068)	-.412 (.046)	.743 (.054)	-1.342 (.068)	-.412 (.046)	.743 (.054)
P7-4	-1.911 (.091)	-1.072 (.060)	.098 (.048)	-1.911 (.091)	-1.072 (.060)	.098 (.048)
P7-5	-1.346 (.070)	-.559 (.050)	.524 (.050)	-1.346 (.070)	-.559 (.050)	.524 (.050)
P7-6	-1.504 (.073)	-.537 (.051)	.589 (.053)	-1.504 (.073)	-.537 (.051)	.589 (.053)
P7-7	-1.249 (.065)	-.328 (.048)	.745 (.056)	-1.249 (.065)	-.328 (.048)	.745 (.056)
Control	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P7-1	.773 (.053)	.514 (.033)	.264 (.033)	.773 (.053)	.587 (.032)	.344 (.037)
P7-4	.897 (.054)	.595 (.031)	.355 (.037)	.897 (.054)	.651 (.033)	.424 (.044)
P7-5	.998 (.062)	.663 (.031)	.440 (.041)	.998 (.062)	.653 (.033)	.427 (.043)
P7-6	1.086 (.063)	.721 (.030)	.520 (.043)	1.086 (.063)	.697 (.030)	.486 (.042)
P7-7	1.000	.664 (.030)	.441 (.040)	1.000	.636 (.031)	.405 (.039)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P7-1	-1.242 (.065)	-.450 (.047)	.683 (.053)	-1.242 (.065)	-.450 (.047)	.683 (.053)
P7-4	-1.930 (.098)	-1.100 (.058)	-.006 (.048)	-1.930 (.098)	-1.100 (.058)	-.006 (.048)
P7-5	-1.494 (.070)	-.589 (.050)	.526 (.054)	-1.494 (.070)	-.589 (.050)	.526 (.054)
P7-6	-1.864 (.090)	-.719 (.054)	.487 (.054)	-1.864 (.090)	-.719 (.054)	.487 (.054)
P7-7	-1.344 (.071)	-.363 (.051)	.696 (.056)	-1.344 (.071)	-.363 (.051)	.696 (.056)

Note. λ =factor loading; τ =unstandardized threshold; Std=standardized ; SE=standard error; P7=PASE-7 items.

Table C7. PASE-7 Simultaneous Cross-Group and Longitudinal Invariance: Configural Model Estimates

Group/Item	Baseline			Post-Intervention		
Intervention	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P7-1	.747 (.061)	.520 (.037)	.271 (.039)	.817 (.053)	.613 (.034)	.376 (.042)
P7-4	.924 (.069)	.644 (.040)	.414 (.051)	.775 (.054)	.582 (.035)	.339 (.041)
P7-5	.999 (.064)	.696 (.032)	.484 (.045)	1.099 (.046)	.826 (.023)	.682 (.037)
P7-6	1.125 (.064)	.783 (.027)	.614 (.043)	1.021 (.047)	.767 (.025)	.588 (.039)
P7-7	1.000	.697 (.031)	.485 (.044)	1.000	.751 (.027)	.564 (.040)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P7-1	-1.402 (.081)	-.404 (.057)	.767 (.062)	-1.304 (.077)	-.362 (.057)	.863 (.064)
P7-4	-1.861 (.109)	-1.084 (.069)	-.069 (.056)	-1.737 (.100)	-.899 (.064)	.367 (.057)
P7-5	-1.352 (.078)	-.541 (.059)	.559 (.059)	-1.416 (.081)	-.536 (.058)	.690 (.061)
P7-6	-1.429 (.082)	-.508 (.058)	.599 (.059)	-1.486 (.085)	-.458 (.058)	.703 (.061)
P7-7	-1.293 (.076)	-.294 (.056)	.767 (.062)	-1.129 (.070)	-.258 (.056)	.849 (.063)
Control	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P7-1	.731 (.068)	.491 (.040)	.241 (.040)	.980 (.081)	.612 (.037)	.374 (.046)
P7-4	.902 (.069)	.606 (.038)	.367 (.046)	1.033 (.083)	.645 (.039)	.416 (.050)
P7-5	.980 (.075)	.658 (.037)	.433 (.049)	1.053 (.085)	.658 (.039)	.432 (.051)
P7-6	1.085 (.076)	.728 (.034)	.530 (.049).	1.103 (.082)	.689 (.034)	.474 (.047)
P7-7	1.000	.671 (.034)	.451 (.045)	1.000	.624 (.035)	.390 (.044)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P7-1	-1.240 (.075)	-.444 (.058)	.768 (.062)	-1.218 (.074)	-.346 (.057)	.830 (.064)
P7-4	-1.913 (.115)	-1.083 (.070)	.010 (.056)	-1.883 (.112)	-1.005 (.068)	.150 (.056)
P7-5	-1.493 (.086)	-.604 (.060)	.534 (.059)	-1.250 (.075)	-.373 (.057)	.665 (.061)
P7-6	-1.913 (.115)	-.684 (.061)	.449 (.058)	-1.524 (.087)	-.522 (.059)	.684 (.061)
P7-7	-1.355 (.079)	-.378 (.057)	.647 (.060)	-1.065 (.069)	-.150 (.056)	.873 (.064)

Note. λ =factor loading; τ =unstandardized threshold; Std=standardized ; SE=standard error; P7=PASE-7 items.

Table C8. PASE-7 Simultaneous Cross-Group and Longitudinal Invariance: Metric Model Estimates

Group/Item		Baseline			Post-Intervention	
Intervention	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P7-1	.822 (.043)	.556 (.030)	.310 (.034)	.822 (.043)	.615 (.029)	.379 (.036)
P7-4	.952 (.045)	.638 (.032)	.407 (.040)	.952 (.045)	.598 (.029)	.358 (.035)
P7-5	1.024 (.050)	.698 (.027)	.487 (.038)	1.024 (.050)	.820 (.021)	.672 (.034)
P7-6	1.124 (.050)	.745 (.023)	.555 (.035)	1.124 (.050)	.770 (.022)	.592 (.034)
P7-7	1.000	.713 (.027)	.508 (.038)	1.000	.743 (.024)	.551 (.036)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P7-1	-1.282 (.050)	-.396 (.068)	.791 (.132)	-1.282 (.050)	-.380 (.068)	.796 (.129)
P7-4	-1.927 (.076)	-1.094 (.086)	-.055 (.090)	-1.927 (.076)	-1.066 (.089)	.382 (.114)
P7-5	-1.340 (.053)	-.528 (.073)	.579 (.127)	-1.340 (.053)	-.522 (.067)	.579 (.126)
P7-6	-1.590 (.065)	-.507 (.080)	.639 (.140)	-1.590 (.065)	-.525 (.082)	.693 (.145)
P7-7	-1.183 (.051)	-.270 (.046)	.754 (.137)	-1.183 (.051)	-.270 (.046)	.781 (.139)
Control	λ (SE)	Std. λ (SE)	R^2 (SE)	λ (SE)	Std. λ (SE)	R^2 (SE)
P7-1	.822 (.043)	.528 (.026)	.279 (.028)	.822 (.043)	.535 (.025)	.286 (.027)
P7-4	.952 (.045)	.612 (.026)	.374 (.032)	.952 (.045)	.619 (.027)	.384 (.033)
P7-5	1.024 (.050)	.658 (.026)	.433 (.034)	1.024 (.050)	.666 (.026)	.444 (.035)
P7-6	1.124 (.050)	.723 (.026)	.522 (.037).	1.124 (.050)	.731 (.026)	.535 (.038)
P7-7	1.000	.643 (.026)	.413 (.033)	1.000	.651 (.025)	.423 (.033)
	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)	τ_1 (SE)	τ_2 (SE)	τ_3 (SE)
P7-1	-1.282 (.050)	-.444 (.058)	.768 (.062)	-1.282 (.050)	-.346 (.057)	.830 (.064)
P7-4	-1.927 (.076)	-1.083 (.070)	.010 (.056)	-1.927 (.076)	-1.005 (.068)	.150 (.056)
P7-5	-1.340 (.053)	-.604 (.060)	.534 (.059)	-1.340 (.053)	-.373 (.057)	.665 (.061)
P7-6	-1.590 (.065)	-.684 (.061)	.449 (.058)	-1.590 (.065)	-.522 (.059)	.684 (.061)
P7-7	-1.183 (.051)	-.270 (.046)	.647 (.060)	-1.183 (.051)	-.270 (.046)	.873 (.064)

Note. λ =factor loading; τ =unstandardized threshold; Std=standardized ; SE=standard error; P7=PASE-7 items.

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CHAPTER 4: PREDICTING PHYSICAL ACTIVITY AMONG URBAN ADOLESCENT GIRLS: A TEST OF THE HEALTH PROMOTION MODEL

MANUSCRIPT THREE

This manuscript will be submitted to the *American Journal of Health Promotion*. Author guidelines can be found on the journal website at http://www.healthpromotionjournal.com/

Abstract

Purpose. To test hypothesized relationships of the Health Promotion Model (HPM) between individual, interpersonal, and situational influences and moderate-to-vigorous physical activity (MVPA) among urban, adolescent girls. **Design.** A secondary analysis of baseline data from a group randomized controlled trial was conducted. **Sample and Setting.** The sample included girls (*N*=512) in the 5th-8th grades from eight urban schools in the Midwestern United States. **Measures.** Data were collected on age, body mass index, pubertal status, enjoyment, self-efficacy, social support, options for PA, and commitment to PA. Girls wore an accelerometer to measure MVPA. **Analysis.** Structural equation modeling was used to analyze study aims. **Results.** Mean age of the sample was 11.8 years (SD=1.0). Girls attained a daily average of 40.2 (SD=18.3) minutes of MVPA. Self-efficacy had a positive direct (β=.343; $p<.001$) and total effect (β=.279; $p<.001$) on MVPA. Commitment to PA had a negative direct effect (β= -.123; p=.048) on MVPA. The model predicted 10.2% of the variance in MVPA. Limitations include lack of longitudinal analysis and inability to generalize the results to other populations such as boys. **Conclusion.** PA self-efficacy continues to emerge as a significant predictor of MVPA in the HPM. Continued theory testing is needed to better understand the correlates and determinants of PA among adolescent girls prior to designing theory-based interventions to promote PA.

Keywords: Health Promotion Model, theory, adolescent, girls, physical activity, structural equation modeling, self-efficacy

Introduction

In a recent systematic review, physical inactivity has been linked to increases in obesity rates among adolescents in the United States, resulting in a dramatic rise in hypertension, dyslipidemia, and pre-clinical atherosclerosis (Dhuper, Buddhe, & Patel, 2013). Despite well-established health benefits of PA (Janssen & LeBlanc, 2010), including a decreased risk for the development of cardiovascular disease and diabetes (Daniels et al., 2005; Ekelund et al., 2012; Kokkinos & Myers, 2010), the majority of adolescents do not meet guidelines recommending 60 minutes of moderate to vigorous physical activity (MVPA) each day (United States Department of Health and Human Services, 2008; World Health Organization, 2011; Fakhouri et al., 2014).

Adolescent girls engage in less PA than boys, a difference that increases with age (Dumith, Gigante, Domingues, & Kohl, 2011). By the 9^{th} grade, only 20% of girls report meeting recommendations for PA with percentages being lower for black and Hispanic girls compared to white girls (Kann et al., 2016). When PA is measured with accelerometers, the percentage of girls meeting PA guidelines has been found to be as low as 3% (Troiano et al., 2008). Efforts are urgently needed before girls enter high school to reverse these disconcerting trends that are linked to an increasing chronic disease burden worldwide (Durstine, Gordon, Wang, & Luo, 2013).

Systematic reviews examining the effects of PA interventions for adolescent girls have reported some intervention success for improving PA (Brown, 2009; Camacho-Minano, LaVoi, & Barr-Anderson, 2011; Clemens & Hayman, 2004). However, a major limitation consistent across these reviews is that studies employing objective outcome measures of PA have not confirmed the effectiveness of PA interventions (Craggs, Corder, van Sluijs, & Griffin, 2011; Metcalf, Henley, & Wilkin, 2012; Voskuil, Frambes, & Robbins, 2016).

Evidence of intervention success based on self-reported PA may be misleading. PA measured by self-report has been shown to be inaccurate with adolescents over-reporting PA (Chinapaw, Lidwine, van Poppel, van Mechelen, & Terwee, 2010). Among adolescents, self-reported PA and objectively-measured PA are not highly correlated, and inactive adolescents over-report PA more so than their active peers (LeBlanc & Janssen, 2010). Discrepancies between self-reported and accelerometer-measured PA are greater for adolescent girls than boys (Adamo, Prince, Tricco, Connor-Gorber, & Tremblay, 2009; Slootmaker, Schuit, Chinapaw, Seidell, & van Mechelen, 2009). Reliance on self-reported measurement inhibits a full understanding of PA among adolescents, particularly among girls.

Given the declines in PA across adolescence, especially for girls, coupled with the limited success of interventions to increase PA, testing and refinement of theoretical models may be critically needed as an initial step toward developing effective theory-based interventions (Buchan, Ollis, Thomas, & Baker, 2012; Rhodes & Nigg, 2011). Several theoretical models have been used to explain adolescent PA including social cognitive theory and ecological models (Perry, Garside, Morones, & Hayman, 2012), yet adolescent PA remains largely unexplained by any single theory (Plotnikoff, Costigan, Karunamuni, & Lubans, 2013). A major limitation of model testing has been the reliance on self-reported PA. Given that measurement error of an outcome variable can impact effect sizes (Burchinal, 2008), additional theory testing based on accelerometer-measured PA must be conducted to ensure that these explanations are accurate.

Few studies have tested a theoretical model of PA among adolescent girls using accelerometer-measured PA. Of these studies, three tested a social-cognitive model of PA. One study, including 8^{th} grade girls from the Trial of Activity for Adolescent Girls (TAAG), showed that self-efficacy had a direct effect on accelerometer-measured MVPA and moderated the relationship between social support and perceived barriers (Dishman et al., 2010a). The second study, involving 8th grade Australian girls participating in the Girls in Sport group randomized trial, showed that self-efficacy, school environment, and physical self-worth had direct effects on accelerometer-measured MVPA (Lubans et al., 2012). In the third study, self-efficacy was the only variable in the model that was associated with MVPA at 12 months among Australian, adolescent girls participating in the Nutrition and Enjoyable Activity for Teens trial (Dewar et al., 2013). Recommendations for future research from these studies included testing different models of PA in more diverse samples of adolescent girls and using an ecological framework with assessment of the PA environment in future model testing.

Theoretical Framework

The Health Promotion Model (HPM) has been used to explain health-promoting behaviors in a variety of populations (Pender, Murdaugh, & Parsons, 2015). The HPM includes three groups of variables that influence behavior: 1) individual characteristics; 2) behavior-specific cognitions and affect; and 3) behavioral contingencies including commitment to a plan of action. Individual characteristics include personal factors such as age and race. Behavior-specific cognitions and affect include benefits, barriers, self-efficacy, activity-related affect, interpersonal influences, such as social support; and situational influences, such as the physical environment. The model indicates that behavior-specific cognitions and affect influence health-promoting behavior both directly and indirectly through commitment to a plan of action. The HPM features multi-level factors, including individual, social, and environmental components which may impact health behavior.

The HPM has been tested specifically with PA as a health-promoting behavior among adolescents in a number of studies (Ammouri, Kaur, Neuberger, Gajewski, & Choi, 2007; Garcia et al., 1995; Mohamadian & Arani, 2014; Taymoori, Lubans, & Berry, 2010a; Wu & Pender, 2002; Wu & Pender, 2005; Wu, Pender, & Noureddine, 2003). Self-efficacy has emerged as the most consistent predictor of PA in previous studies testing the HPM (Plotnikoff et al., 2013; Wu & Pender, 2002). In addition, commitment and enjoyment were predictive of PA among adolescent boys (Taymoori et al., 2010a). Additional research is needed to confirm these relationships among adolescent girls. Relationships between PA and perceived barriers to and benefits of PA have been non-significant among adolescent girls with self-efficacy fully mediating the relationship between perceived barriers and PA (Wu et al., 2003). Results from previous studies examining the effect of social support on PA have been inconsistent (Taymoori et al., 2010a; Wu & Pender, 2002), indicating the need to test this variable as a predictor of PA among adolescent girls.

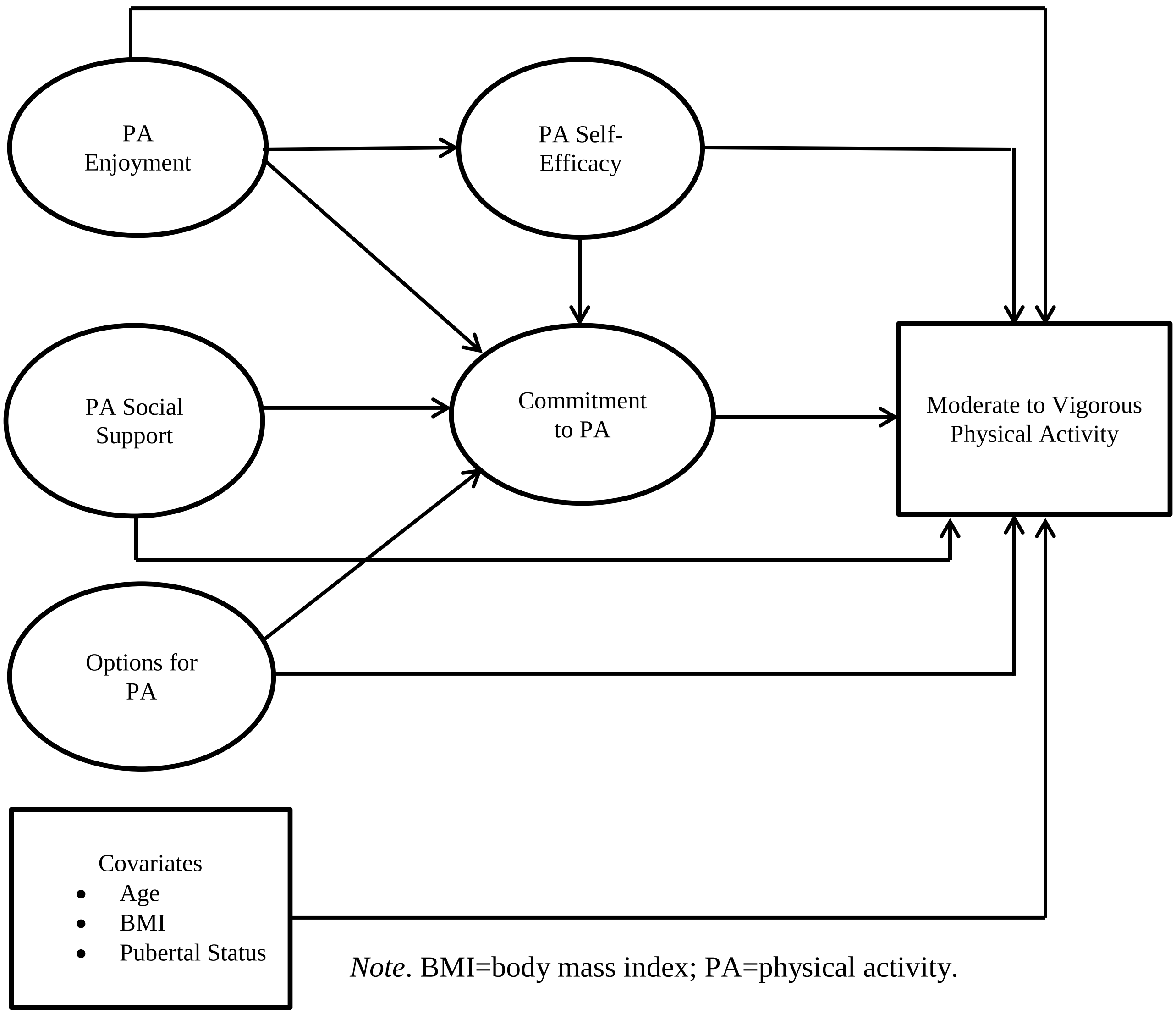
Only one study was found in the literature that tested the HPM variable of situational influences among adolescents (Ammouri et al., 2007). Situational influences related to PA include: 1) environmental aesthetics and safety; 2) environmental options for PA including accessibility and availability of resources; and 3) environmental demands or cues that can influence PA (Pender et al., 2015). Although some studies of the perceived neighborhood environment among youth have provided support for the association between environmental options and PA, evidence has been limited due to self-reported PA, lack of theory-based studies, and inadequate measurement of the perceived environment (Ding, Sallis, Kerr, Lee, & Rosenberg, 2011). Examination of options for PA would incorporate recommendations from researchers to test multi-level influences in theoretical models (Buchan et al., 2012; Dewar et al., 2013). Further research is needed to confirm these relationships in the HPM.

Two major limitations have limited explanatory power of the HPM. First, no studies have tested the model using an objective measure of PA. Given the limitations of self-reported PA, model testing with accelerometer-measured PA is warranted. Second, some HPM constructs have not been included in model testing with adolescent girls. For example, if situational influences or commitment to a plan of action are key explanatory variables but not included in model testing, then a complete understanding of how well the model predicts PA is not fully known. In addition, some variables may not be adequate predictors of PA, and theory-testing may lead to a more parsimonious model.

Purpose

The purpose of this study was to test hypothesized relationships of the HPM as a means of predicting accelerometer-measured PA in a sample of urban 5^{th}-8^{th} grade girls. The primary study aims were to: 1) examine the direct effects of PA self-efficacy, PA enjoyment, PA social support, options for PA, and commitment to PA on accelerometer-measured MVPA; 2) examine the indirect effects of PA self-efficacy, PA enjoyment, PA social support, and options for PA on accelerometer measured MVPA through commitment to PA; 3) examine the indirect effect of PA enjoyment on commitment to PA through PA self-efficacy; 4) examine the indirect effect of PA enjoyment on accelerometer-measured MVPA through PA self-efficacy; 5) determine the variance in commitment to PA and accelerometer-measured PA explained by these HPM variables. Age, body mass index (BMI), and pubertal status were included as covariates. Figure 6 shows the hypothesized path diagram of HPM relationships examined in this study.

Figure 6. Hypothesized Path Diagram of Health Promotion Model Variables



Note. BMI=body mass index; PA=physical activity.

Methods

Design

The study aims rely on a secondary analysis of baseline data collected from 5^{th}-8^{th} grade girls (*N*=512) from Year 3 of a group randomized controlled trial (RCT) which examined the effect of a PA intervention on MVPA (Robbins et al., 2013). Girls in eight racially diverse, urban middle schools completed an iPad-delivered survey. All study procedures have been described elsewhere (Robbins et al., 2013). The group RCT and the current study were approved by the Institutional Review Board at Michigan State University.

Setting and Sample

Schools for the group RCT were selected based on the following inclusion criteria: ≥50% non-white students, ≥ 50% of students participating in a free or reduced-price lunch program, and agreement by the school to be randomized to intervention or control condition. Girls were excluded if they were involved in school or community sports or other organized PA ≥ 3 days per week, had a health condition that prevented or limited PA, knew that they would not be available for follow-up, or could not read and write English (Robbins et al., 2013).

Measures

Participant demographics, personal factors, behavior-specific cognitions and affect, and the behavioral outcome of MVPA were assessed.

Demographics. Single items on the consent form were used to assess age, grade, ethnicity, race, and enrollment status in the free or reduced-price lunch program. Age, BMI, pubertal status, and MVPA were modeled as observed variables. PA self-efficacy, PA enjoyment, PA social support, options for PA, and commitment to PA were modeled as latent variables. Factorial validity and composite reliability are presented for each latent construct using results from the current study. Item wording and response choices for the indicators of the latent variables are presented in Table 13.

Personal factors (biological).

Age. Age at baseline was calculated from reported birthdate and measured in years.

Body mass index. Body mass index (BMI) was calculated from weight and height (kg/m^2). Height and weight were measured at girls' respective schools. BMI z-scores were computed using a SAS program for the 2000 Centers for Disease Control and Prevention (CDC) Growth Charts (CDC, 2015) from the National Center for Chronic Disease Prevention and Health Promotion website. BMI z-scores were used in the structural equation modeling (SEM) analysis. BMI percentiles for age were used to determine weight status as follows: underweight ($<5^{th}$ percentile); 2) healthy weight (5^{th} percentile to $<85^{th}$ percentile); 3) overweight ($\geq 85^{th}$ to $<95^{th}$ percentile); and 4) obese ($\geq 95^{th}$ percentile).

Pubertal status. Pubertal status, defined as the level of pubertal development at a specific time point (Coelho-e-Silva, Valente-dos-Santos, Figueiredo, Sherar, & and Malina, 2013), was measured with the Pubertal Developmental Scale (Petersen, Crockett, Richards, & Boxer, 1988), adapted for use with adolescents (Carskadon & Acebo, 1993). Correlations between physician and self-reported ratings were high (r=0.87, p<.001) during initial development of the scale (Carskadon & Acebo, 1993). In the group RCT, girls completed a pencil and paper survey related to five areas of pubertal development including growth spurt, body hair, skin changes, breast growth, and menarche. The first four items were scored on a 1-4 scale with 1) *no development* to 4) *development complete*. Additionally, girls were asked if they had started their period. Yes on menstruation was scored as 4, and no was scored as 1. Pubertal status was calculated using the mean score of the five items. Higher scores indicated more advanced development. Because this instrument was meant to be used as a proxy for physician observation of pubertal development in research settings where non-invasive measures are needed (Carskadon & Acebo, 1993), pubertal status was treated as an observed variable.

Behavior-specific cognitions and affect.

***PA self-efficacy*.** PA self-efficacy was assessed using an adapted 6-item version of an 8-item instrument that has established reliability and validity (Bartholomew, Loukas, Jowers, & Allua, 2006; Dishman et al., 2002; Dishman et al., 2010b; Motl et al., 2000). Initial confirmatory factor analysis (CFA) showed an adequate model fit with the exception of a significant model chi-square value (χ^2=28.484, *df*=9, p=<.001, RMSEA=.065, CFI=.987). One item, "*I can be physically active in my free time on most days"*, was removed, as this item was found to have a non-invariant factor loading from simultaneous cross-group and longitudinal invariance testing (Voskuil, Pierce, & Robbins, 2016). The revised 5-item measure demonstrated improved fit (χ^2=10.709, *df*=5, p=.058, RMSEA=.047, CFI=.994). Composite reliability was .737.

PA enjoyment. PA enjoyment was assessed with an adapted 6-item version of the 16-item Physical Activity Enjoyment Scale (PACES; Kendzierski & DeCarlo, 1991) which has established reliability and validity (Dishman et al., 2005b; Motl et al., 2001; Paxton et al., 2008). The 6-item scale included three positively-worded and three negatively-worded items. Negatively-worded items were reverse scored. A sample item is "*When I do physical activity, it's fun".* Four response choices were used ranging from 0) *not at all true* to 3) *very true*. Initial CFA results showed a poor fit to the data (χ^2=218.133, *df*=9, p<.001, RMSEA=.213, CFI=.957). Issues with multi-collinearity were evident among the three positively-worded items. In addition, there were several residual correlations >.10. A 4-item scale using one positively-worded item and three negatively-worded items reversed scored resulted in a good fit to the data (χ^2=1.772, *df*=2, p=.412, RMSEA=.000, CFI=1.000). The composite reliability was .743.

PA social support. PA social support was measured using an 8-item Social Support Scale (Robbins et al., 2013). Exploratory factor analysis from a previous study indicated a single factor (Ling, Robbins, Resnicow, & Bakhoya, 2014). The CFA model for this 8-item scale indicated a significant model chi-square value and marginal fit to the data based on alternative fit indices (χ^2=94.009, *df*=20, p<.001, RMSEA=.085, CFI=.977). Using guidelines provided by Beets et al. (2010), the scale was reduced to four items representing instrumental (*n*=1), conditional (*n*=1), and motivational (*n*=2) aspects of social support for PA. The revised measurement model indicated a good fit to the data (χ^2=2.760, *df*=2, p=.257, RMSEA=.027, CFI=.999). The composite reliability coefficient was .781.

Options for PA. The variable, options for PA, was measured using a 5-item subscale from a 12-item multidimensional measure of situational influences related to PA, the Perceived Environment Scale for Youth (PES-Y), a measure developed for this study by the first author from existing instruments in the literature (Evenson et al., 2006; Mota, Almeida, Santos, & Ribeiro, 2005; Timperio, Crawford, Telford, & Salmon, 2004). The variable, options for PA, measures perceptions of availability and accessibility of PA resources in the neighborhood environment. CFA indicated a good fit to the data (χ^2=4.828, *df*=5, p=.437, RMSEA=.000, CFI=1.000) with a composite reliability of .660.

Commitment to PA. Commitment to PA was measured using the Commitment to Physical Activity Scale for Adolescents (CPASA), an 11-item instrument developed from existing scales in the literature (Debate, Huberty, & Pettee, 2009; Dishman et al., 2005a; Pender, Garcia, & Ronis, 2014). In the initial development of the scale, exploratory and confirmatory factor analysis indicated a single factor for the CPASA (Robbins et al., 2016). In the current study, initial CFA results (χ^2=138.784, *df*=44, p<.001, RMSEA=.065, CFI=.942) demonstrated a marginal fit to the data with a significant model chi-square value, CFI <.950, and several residual correlations >.10. A revised measurement model, using four items originally from the Commitment to PA Scale (Debate et al., 2009), showed a good fit to the data in the current study (χ^2=3.224, *df*=2, p=.200, RMSEA=.035, CFI=.998). Composite reliability was .724.

Behavioral outcome.

MVPA. MVPA was measured via ActiGraph GT3X-plus, a small, lightweight accelerometer (www.ActiGraph.com) that is reliable and valid for assessing MVPA (Hänggi, Phillips, & Rowlands, 2013; Robbins et al., 2013; Trost, 2007; Warren et al., 2010). Accelerometers were set to begin data collection at 5:00 am on the day that the devices were distributed at each school. Girls were instructed to wear the monitor on their right hip via an elastic belt starting from the time they got up in the morning to the time they went to bed, except for when they were showering or swimming. The accelerometer was worn for seven consecutive days at baseline including weekday and weekend days. Girls received reminders by telephone each morning during the week to wear their monitor.

Determination of MVPA was calculated by measuring activity intensity based on established count cut-points (15-second epochs) resulting in the following count thresholds: sedentary activity ≤ 100 counts per minute; light PA 101 to ≤ 2,295 count per minute; moderate PA 2,296 to ≤ 4,011 counts per minute; vigorous PA ≥ 4,012 counts per minute (Evenson, Catellier, Gill, Ondrak, & McMurray, 2008). Minutes of MVPA were estimated from recordings of acceleration counts and were aggregated for the hour as a number between 0 to 60 minutes, with missing data recorded accordingly.

Table 13. Item Descriptions for Health Promotion Model Latent Variable Indicators

	PA Self-Efficacy	Response Choices
EFF1	I can be active in my free time on most days even when I am busy.	0=disagree a lot 1=disagree a little 2=agree a little 3=agree a lot
EFF2	I can be active in my free time on most days instead of watching TV or playing video games.	
EFF3	I can be active or play active games or sports in my free time on most days when it is hot or cold outside.	
EFF4	I can be active in my free time on most days when I have to stay home.	
EFF5	I have the skills I need to be active in my free time on most days.	
	PA Enjoyment	
ENJ1	When I do physical activity it's fun.	0=not at all true 1=not very true 2=sort of true 3=very true
ENJ2	When I do physical activity I feel upset or frustrated.	
ENJ3	When I do physical activity I feel bored.	
ENJ4	When I do physical activity I feel as if I would rather be doing something else.	
	PA Social Support	
SS1	Someone encourages me to exercise.	0=never 1=rarely 2=sometimes 3=often
SS2	Someone watches me exercise, play active games, or do sports.	
SS3	Someone congratulates or tells me I am doing well with my exercise, physical activity, or sports.	
SS4	Someone buys clothes or equipment for me so I can be physically active or do sports.	
	Options for PA	
OPT1	Where I live, I have gyms or indoor spaces where I can be physically active.	0=disagree a lot 1=disagree a little 2=agree a little 3=agree a lot
OPT2	Where I live, I have places that I can be physically active.	
OPT3	Where I live, there are bike and walking trails that I can use to be physically active.	
OPT4	Where I live, there are parks and playgrounds where I can be physically active.	
OPT5	Where I live, it is easy to get to places where I can be physically active.	
	Commitment to Physical Activity	
COM1	I like thinking about doing physical activity.	0=never 1=rarely 2=sometimes 3=often
COM2	Physical activity is one of the best parts of my day.	
COM3	I would change my schedule to participate in physical activity.	
COM4	My day is better when I am physically active.	

Note. EFF=self-efficacy indicators; PA=physical activity; SS=social support indicators; OPT=options for physical activity indicators; COM=commitment to physical activity indicators.

For model testing, mean minutes of MVPA per day were converted to weekly mean minutes of MVPA per hour to keep scaling properties similar to the latent constructs.

Data Analysis

Descriptive statistics were performed using Stata 14 (StataCorp, College Station, TX). Mplus 7.4 (Muthén & Muthén, Los Angeles, CA) was used to conduct SEM. SAS 9.3 (SAS Institute Inc., Cary, NC) was used to compute reliability coefficients. Assumptions of multivariate analysis were assessed prior to examination of the study aims. In addition, all scale items were evaluated for non-independence of the data using the intra-class correlation coefficient (ICC). ICC values ranged from 0-.03. Because ICC values < .05 most often indicate that multi-level SEM is not warranted (Brown, 2015), single-level SEM models were used.

Missing data for the latent variables in the study were minimal with one missing case (0.2%) for the options for PA variable. In addition, there were nine missing cases (1.8%) for BMI z-score and four missing cases (0.8%) for pubertal status. A single regression imputation was used to impute missing data for these variables. Missing data were also present in MVPA hourly measures. Of a total of 90 potential hours for the week, the mean percentage of missing hours was 13.3%. When girls did not wear the accelerometer for a complete 60 minutes, the data for the hour were considered missing and then imputed. To adequately address the bias inherent in missing data (Enders, 2010), multivariate imputation by chained equations (Van Buuren, Brand, Groothuis-Oudshoorn, & Rubin, 2006; Van Buuren, 2007; Van Buuren & Groothuis-Oudshoorn, 2010) was implemented to impute the missing accelerometer data. Specifically, hourly MVPA readings were imputed and the average MVPA for the week was calculated from the imputed data based on 14 hours for each weekday and 10 hours for each weekend day, which is comparable to imputation procedures from other studies involving adolescent girls (Catellier et al., 2005; Pate et al., 2006).

Power for this secondary analysis was considered adequate based on recommendations in the literature. MacCallum, Browne, and Sugawara (1996) demonstrated that hypothesized models with ≥ 100 degrees of freedom (*df*) should achieve power estimates greater than 0.8 with a sample size of at least 200. A recent study that evaluated sample size requirements for SEMs using simulation techniques, demonstrated that sample sizes larger than 450 were adequate for most SEMs (Wolf, Harrington, Clark, & Miller, 2013).

The aims of the study were analyzed using a two-step SEM approach (Kline, 2016) that first fitted a measurement model, and then added regression paths to produce a structural regression (SR) model. Models were analyzed with weighted least squares means and variance (WLMSV) estimation using a polychoric correlation matrix. This robust estimation method is recommended for latent variables with ordinal indicators and can be used in conjunction with continuous outcome variables (Muthén & Muthén, 2015). The metric of each factor was set by fixing a factor loading to one. Reliability of the latent factors was estimated with nonlinear structural equation modeling (SEM) reliability coefficients using a parallel-forms version of reliability (Green & Yang, 2009; Yang & Green, 2014). Factor loadings and thresholds from Mplus were inputted into an equation using a SAS program to obtain the reliability coefficient.

The model chi-square test was used to evaluate overall model fit. Recognizing that this test is sensitive to large samples, alternative fit indices were also used to evaluate model fit including the comparative fit index (CFI) and root mean square error of approximation (RMSEA). In cases where the model chi-square test was significant, residual correlations and modification indices were examined for evidence of poor model fit (Kline, 2016). Based on recommendations by Brown (2015) and Kline (2016), the following guidelines for fit indices were used to evaluate model fit: 1) CFI >.95; 2) RMSEA <.05 (close fit), <.08 (approximate fit), ≥ .08 and <1.0 marginal fit, and ≥1.0 (poor fit); and 3) lower and upper bound RMSEA 90% confidence intervals. Direct, indirect, and total effects were assessed for each relationship being tested. Paths in the SR model were significant if $|t|>1.96$.

Results

Sample Characteristics

The sample included 512 girls with a mean age of 11.8 years (SD: 1.02; min-max: 9.6-14.9). Girls were evenly distributed among fifth through seventh grades but not eighth grade (*n*=18; 3.5%). The sample represented a diverse group of girls with 231 (45.1%) indicating black race, 56 (10.9%) indicating mixed race with 47 (83.9%) of those girls selecting black as part of a mixed race, 144 (28.1%) indicating white race, and 86 (16.3%) indicating Hispanic ethnicity. Approximately 80% of girls participated in the free or reduced-price lunch program at their school. Table 14 provides a summary of sample characteristics.

Measurement Model

The initial combined measurement model with factor structures for the latent constructs indicated a poor fit to the data (χ^2=430.614, *df*=199, p<.001, RMSEA=.048, CFI=.951). The enjoyment items had several residual correlations >.10 with other items. Attempts to attain adequate fit for the full measurement model with this latent variable were unsuccessful. Therefore, enjoyment was dropped from the hypothesized path diagram.

The revised combined measurement model indicated a good fit to the data with the exception of a significant chi-square value (χ^2=189.643, *df*=129, p<.001, RMSEA=.030, CFI=.983). Inspection of the residuals indicated the need to add two error covariances: 1) EFF2 with COM3; 2) EFF4 with COM2. The adjusted chi-square difference test showed a significantly improved model fit with the error covariances added ($\Delta\chi^2$=37.060, Δdf=2, p<.001). This decision was also supported by Marsh and colleagues (2014) who argue that most item-level CFA models used in SEM are too restrictive because they do not allow for small cross loadings with other psychological constructs.

Table 14. Characteristics of the Sample

Characteristic	*M*	(SD)
Age (years)	11.76	(1.02)
BMI (kg/m^2)	22.19	(5.63)
BMI z-score	0.83	(1.08)
Pubertal status (1-4)	2.20	(0.62)
MVPA (mean minutes/day)	40.20	(18.33)
MVPA (mean weekly minutes/hour)	3.13	(1.43)
Grade	*n*	(%)
Fifth	159	(31.05)
Sixth	165	(32.23)
Seventh	170	(33.20)
Eighth	18	(3.52)
Hispanic ethnicity		
Yes	86	(16.80)
No	389	(75.98)
Missing	37	(7.23)
Race		
Black	231	(45.12)
White	144	(28.13)
Mixed	56	(10.94)
Other	81	(15.82)
Free or reduced-price lunch[a]		
Yes	382	(74.61)
No	98	(19.14)
Missing	32	(6.25)
Weight status		
Underweight	9	(1.76)
Healthy weight	258	(50.39)
Overweight	91	(17.77)
Obese	145	(28.32)
Missing	9	(1.76)

Note. *N*=512. Percentages may not add to 100 due to rounding error.
[a]Free/reduced-price lunch program used as an indicator of socioeconomic status.

Structural Regression Model

Table 15 includes the model-based correlation estimates among the study variables. The latent factors were all significantly correlated with each other. Age, BMI and pubertal status demonstrated negative, weak, and non-significant correlations with MVPA. Self-efficacy, social support, and options for PA were all positively and significantly correlated with MVPA, but these correlations were weak. The correlation between commitment to PA and MVPA was small and not significant. The majority of indicators were positively skewed indicating an overall ceiling effect. MVPA was also positively skewed. Descriptive statistics and polychoric correlations for latent variable indicators used in the final SR model are provided in Table 16.

Table 15. Model-Based Correlations for Study Variables

	Variables	1	2	3	4	5	6	7	8
1	Age								
2	BMI	.092*							
3	PUB	.415**	.252**						
4	EFF	-.178**	-.015	-.087					
5	SS	-.228**	-.039	-.072	.589**				
6	OPT	-.083	-.006	-.024	.526**	.543**			
7	COM	-.232**	-.153**	-.122*	.425	.302	.193		
8	MVPA	-.003	-.055	-.037	.292**	.166**	.182**	.090	

Note. Correlations reported from measurement model estimates; BMI=body mass index (z-score); PUB=pubertal status; EFF=self-efficacy; SS=social support; OPT=options for physical activity; COM=commitment to physical activity; MVPA=moderate to vigorous physical activity. *p<.05; **p<.01

Table 16. Polychoric Correlations and Descriptive Statistics for Indicator Variables

	Items	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	EFF1																		
2	EFF2	.337																	
3	EFF3	.412	.380																
4	EFF4	.417	.520	.484															
5	EFF5	.423	.367	.400	.505														
6	SS1	.281	.266	.301	.364	.315													
7	SS2	.296	.257	.285	.276	.335	.501												
8	SS3	.268	.223	.271	.314	.304	.574	.595											
9	SS4	.193	.148	.215	.216	.277	.438	.493	.593										
10	OPT1	.221	.219	.184	.221	.205	.286	.281	.372	.304									
11	OPT2	.201	.222	.189	.200	.270	.225	.291	.288	.237	.385								
12	OPT3	.097	.172	.069	.116	.123	.206	.185	.177	.237	.328	.278							
13	OPT4	.140	.227	.219	.268	.239	.121	.148	.213	.169	.273	.368	.330						
14	OPT5	.234	.222	.183	.247	.317	.220	.191	.248	.195	.429	.402	.324	.425					
15	COM1	.260	.288	.170	.236	.191	.206	.216	.207	.099	.104	.130	.076	.054	.143				
16	COM2	.326	.325	.206	.175	.230	.171	.279	.248	.141	.177	.209	.089	.109	.139	.497			
17	COM3	.299	.381	.243	.301	.217	.239	.139	.170	.146	.083	.132	.087	.105	.145	.426	.398		
18	COM4	.273	.229	.224	.265	.206	.201	.218	.208	.149	.116	.162	.116	.094	.150	.446	.527	.373	
	Mean	1.89	2.29	2.17	2.28	2.23	2.02	1.86	2.09	1.89	1.85	2.36	2.02	2.39	2.17	2.07	1.83	2.05	2.19
	SD	.95	.86	.81	.81	.77	.94	1.01	.96	1.08	1.11	.81	1.09	.93	.94	.80	.88	.83	.77
	RC 0	46	25	18	21	14	44	61	40	83	89	19	76	39	40	18	34	24	14
	RC 1	124	62	76	52	65	89	121	93	80	93	50	73	43	71	91	145	90	70
	RC 2	184	164	218	200	223	191	161	160	159	136	172	130	107	161	238	206	233	232
	RC 3	158	261	200	239	210	188	169	219	190	194	271	233	323	240	165	127	165	196

Note. EFF=self-efficacy indicators; SS=social support indicators; OPT=options for physical activity indicators; COM=commitment to physical activity indicators; SD=standard deviation; RC=response choice. Values for response choices indicate frequency for each category

The SR model indicated a good fit with the exception of a significant chi-square value (χ^2=319.296, *df*=195, p<.001, RMSEA=.035, CFI=.966). Results for the SR model are presented in Figure 7. Table 17 summarizes the direct, indirect, and total effects for study hypotheses. PA self-efficacy demonstrated a significant, modest direct effect on MVPA (β=.343, 95% CI=[.211, .475]). Commitment to PA had a significant negative effect (β= -.123, 95% CI=[-.245, -.001]) on MVPA but this effect was small and potentially trivial. The indirect effect through commitment (β= -.064, 95% CI=[-.134, .005]) suppressed the total effect of PA self-efficacy on MVPA (β=.279, 95% CI=[165, .392]).

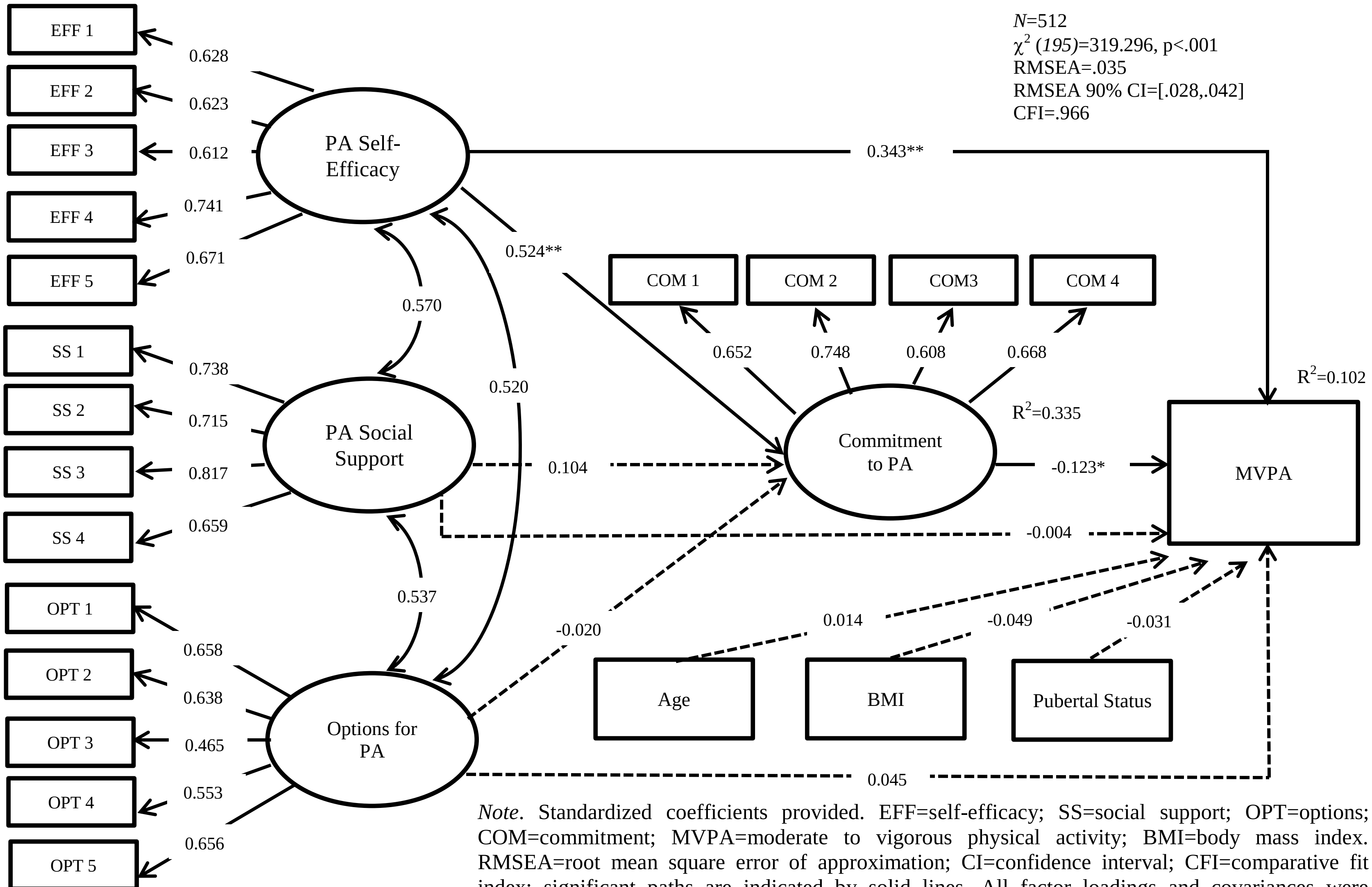
Social support was not a significant predictor of commitment (β=.104, 95% CI=[-.051, .258]) or MVPA (β= -.004, 95% CI=[-.138, .129]). Similarly, the options for PA variable was not a significant predictor of commitment (β=-.020, 95% CI=[-.183, .144]) or MVPA (β=.045, 95% CI=[-.082, .173]). None of the covariates were significant predictors of MVPA: age (β=.014, 95% CI=[-.086, .114]); BMI (β= -.049, 95% CI=[-.142, .045]); pubertal status (β= -.031, 95% CI=[-.132, .071]). PA self-efficacy, social support, and options for PA predicted 33.5% of the variance in commitment with 27.5% predicted by self-efficacy (β=.524, 95% CI=[.379, .669]). Overall, the model predicted 10.2% of the variance in objectively-measured MVPA. PA self-efficacy demonstrated the largest total effect (β=.279, 95% CI=[.165, .392]) predicting 7.8% of the variance in MVPA.

Table 17. Direct, Indirect, and Total Effects for Study Hypotheses

	Unstandardized Estimates				Standardized Estimates			
Type of Effect	*b*	SE	*t*	95% CI	β	SE	*t*	95% CI
Direct Effects								
EFF →COM	.544**	.089	6.141	[.371, .718]	.524**	.074	7.084	[.379, .669]
EFF →MVPA	.778**	.161	4.824	[.462,1.094]	.343**	.067	5.102	[.211, .475]
SS →COM	.092	.070	1.306	[-.046, .229]	.104	.079	1.316	[-.051, .258]
SS →MVPA	-.008	.132	-.064	[-.267, .250]	-.004	.068	-.064	[-.138, .129]
OPT →COM	-.020	.083	-.238	[-.182, .143]	-.020	.083	-.238	[-.183, .144]
OPT →MVPA	.098	.141	.697	[-.178, .375]	.045	.065	.699	[-.082, .173]
COM →MVPA	-.269	.138	-1.942	[-.540, .003]	-.123*	.062	-1.977	[-.245,-.001]
AGE →MVPA	.020	.071	.278	[-.120, .159]	.014	.051	.278	[-.086, .114]
BMI →MVPA	-.065	.063	-1.025	[-.192, .049]	-.049	.048	-1.027	[-.142, .045]
PUB →MVPA	-.071	.119	-.594	[-.304, .163]	-.031	.052	-.593	[-.132, .071]
Indirect Effects								
EFF→COM →MVPA	-.146	.081	-1.811	[-.304, .012]	-.064	.035	-1.820	[-.134, .005]
SS→ COM →MVPA	-.025	.022	-1.128	[-.067, .018]	-.013	.011	-1.083	[-.035, .009]
OPT→ COM →MVPA	.005	.022	.236	[-.039, .049]	.002	.010	.236	[-.018, .023]
Total Effects								
EFF→ COM, EFF→COM →MVPA	.632**	.139	4.560	[.360, .903]	.279**	.058	4.813	[.165, .392]
SS → COM, SS → COM → MVPA	-.033	.131	-.251	[-.290, .224]	-.017	.068	-.251	[-.150,. 116]
OPT→ COM, OPT→ COM→MVPA	.104	.138	.748	[-.168, .375]	.048	.064	.751	[-.077,.173]

Note. *b*=unstandardized estimate; SE=standard error; *t*=estimate/SE; CI=confidence interval; β=standardized estimate; EFF=self-efficacy; SS=social support; OPT=options for physical activity; COM=commitment to physical activity; MVPA=moderate to vigorous physical activity; BMI=body mass index; PUB=pubertal status. MVPA based on mean minutes/hour for the week.
*p<.05, **p<.01

Figure 7. Structural Regression Model Results



Note. Standardized coefficients provided. EFF=self-efficacy; SS=social support; OPT=options; COM=commitment; MVPA=moderate to vigorous physical activity; BMI=body mass index. RMSEA=root mean square error of approximation; CI=confidence interval; CFI=comparative fit index; significant paths are indicated by solid lines. All factor loadings and covariances were significant at p<.001.
*p<.05; **p<.001

Discussion

This study examined theoretical relationships of the HPM on accelerometer-measured MVPA among urban, adolescent girls and is the first to test HPM relationships using an objective measure of PA. Examination of the regression paths demonstrated some noteworthy findings. First, while the direct paths to MVPA from self-efficacy and commitment were both statistically significant, they demonstrated contrasting effects. The positive, direct effect of PA self-efficacy on MVPA was modest in size with a one unit increase in PA self-efficacy associated with an increase of .343 [95% CI: .211, .475] mean minutes/hour of MVPA per week (4.41 mean minutes of MVPA per day). However, the negative, direct effect of commitment to PA on MVPA of -.123 [95% CI: -.245, -.001] was small and potentially trivial. Second, social support and options for PA were not significant predictors of commitment or MVPA with point estimates and confidence intervals suggesting negligible effects. Third, none of the indirect paths through commitment to PA were significant. Finally, the majority of the variance in objectively measured MVPA remains unexplained by the model.

The positive, direct effect of PA self-efficacy on MVPA is consistent with other studies that have tested the HPM among adolescents (Wu & Pender, 2002; Wu et al., 2003; Wu & Pender, 2005; Taymoori et al., 2010a; Taymoori et al., 2010b; Mohamadian & Arani, 2014). While these studies have reported effects (β=.21 - .61) that support self-efficacy as a predictor of self-reported PA, none reported confidence intervals making it difficult to determine the magnitude of the effects across studies. Overall, the findings of the current study add to the body of knowledge regarding the association between PA self-efficacy and accelerometer-measured MVPA, which has not been extensively studied.

The positive, modest effect of self-efficacy on MVPA in this study may be partially related to the timing of data collection. Bandura (1997) argues that the relationship between efficacy beliefs and behavior will be most accurate ‘when they are measured in close temporal proximity’ (p. 67). MVPA data was collected in the week following data collection of self-efficacy beliefs. Moreover, this situation may explain why PA self-efficacy has not been a consistent determinant of MVPA over time in some studies (Bauman et al., 2012; Hearst, Patnode, Sirard, Farbakhsh, & Lytle, 2012), particularly if past efficacy beliefs decrease over time. On the other hand, Dewar and colleagues (2013) reported a positive, direct effect (β=.26) of baseline PA self-efficacy on accelerometer-measured MVPA at 12 months when testing a social cognitive theory among adolescent girls. These differences indicate a need to examine the relationship of PA self-efficacy and objectively-measured MVPA over time in future studies and with different samples of girls.

Social support was not a significant predictor of commitment to PA or MVPA. Social support has been included in the majority of studies testing the HPM, but results have demonstrated inconsistent relationships with adolescent PA. For example, some researchers have analyzed social support, norms, and modeling together as indicators of interpersonal influences in SEM analysis making it difficult to determine the effect of social support alone (Wu & Pender, 2002; Wu et al., 2003). These inconsistencies could also be related to methodological and population differences.

Issues of inadequate conceptual clarity have also contributed to significant variations in the measurement of social support (Beets, Cardinal, & Alderman, 2010). In this study, social support items did not reference a specific person, but instead referred to type of support such as instrumental support (i.e. buying equipment). Ling et al. (2014) reported slightly lower correlations with objectively measured MVPA (r=.13) for the 8-item version of the instrument, compared to other measures specifically assessing parent (r=.22) and peer (r=.28) support

(Reimers, Jekauc, Mess, Mewes, & Woll, 2012). Lack of significant relationships in this study may be related to how social support was measured. Social network analysis (Macdonald-Wallis, Jago, & Sterne, 2012) could be considered in future tests of the HPM to assess social influences related to MVPA among adolescents.

Options for PA did not have a significant direct or indirect effect on MVPA. Ammouri and colleagues (2007) examined environmental opportunities for PA and found a significant direct effect on self-reported PA among female adolescents (β=.18). Likewise, Duncan, Strycker, Chaumeton, and Cromley (2016) reported significant direct effects for perceived accessibility to neighborhood facilities on accelerometer-measured MVPA (β=.22) among female adolescents in the U.S. These findings are in contrast to a systematic review by Ding et al. (2011) which reported no association between perceived environmental attributes and objectively-measured PA. It is worth noting that none of these studies reported confidence intervals for the estimates, making it difficult to compare effects of these studies to the current study. Therefore, it is hard to draw definitive conclusions regarding the relationships between perceived environmental variables and objectively-measured MVPA. Future refinement of perceived environmental measures may contribute to an enhanced understanding of this relationship in the HPM.

Commitment to PA had a negative effect on MVPA which was not expected. However, it is difficult to determine whether this effect was trivial or modest (β = -.123, 95% CI= [-.245, -.001]). Taymoori et al. (2010a) found that commitment had positive, direct (β =.13) and indirect effects on self-reported PA among Iranian adolescent boys. Conversely, self-regulation strategies, a similar construct to commitment, did not have a direct effect on the self-reported PA of Iranian adolescent girls (Taymoori et al., 2010b). However, Dishman et al. (2005a) reported that self-management strategies had a significant, positive, direct effect on self-reported PA among 6th (β =.22) and 8th (β =.19) grade girls as well as an indirect effect between self-efficacy and self-reported PA for both samples. Similarly, Grant, Young, and Wu (2015) found that self-management strategies predicted objectively-measured MVPA from 8th-11th grade among a diverse group of girls (β=.12, 95% CI=[.0002, .25]), but this effect was small. Inconsistencies among these studies might be explained by variations in the samples. Additionally, commitment to PA may not be similar enough to self-management strategies to make this comparison.

The correlation between commitment and MVPA was weak in this study (r=.09). Robbins et al. (2016) also reported a low correlation (r=.11) between commitment and MVPA using data from Year 2 of the same group RCT. Pandey and Elliot (2010) point out that variables weakly correlated with outcomes but moderately correlated with other predictor variables may be more likely to suppress total effects for other predictors. Future research should be directed towards clarification of this concept as well as continued evaluation of measures used to operationalize commitment to determine its theoretical relevance in the HPM.

None of the covariates demonstrated significant associations with MVPA. Surprisingly, age was not a significant predictor of MVPA. With decreases in MVPA among girls evident as early as age 10 and continued declines throughout adolescence (Dumith et al., 2011; Nader, Bradley, Houts, McRitchie, & O'Brien, 2008; Troiano et al., 2008) this finding was not expected. Patnode and colleagues (2010) found that age was a significant predictor of MVPA for adolescent boys, but not for girls. One explanation could be that the decline in MVPA is greater in later adolescence. Another reason may be the lack of variability in age in this sample, which would attenuate the relationship between age and MVPA (Goodwin & Leach, 2006). Additionally, this study examined cross-sectional data, and the sample was described as being inactive.

BMI was inversely related to MVPA consistent with other studies (Chung, Skinner, Steiner, & Perrin, 2012; Page et al., 2005). However, BMI was weakly and negatively correlated with MVPA and was not a significant predictor in the SEM analysis. Van der Horst and colleagues (2007) also reported a lack of association between BMI and PA in children and adolescents. Similarly, Patnode et al. (2010) found that BMI was not a significant predictor of accelerometer-measured PA among girls. Racial and ethnic differences may account for some of these inconsistencies as Kelly et al. (2010) found significant inverse correlations between BMI and MVPA for black and white girls, but not Hispanic girls.

Pubertal status was not a significant predictor of MVPA. However, some evidence suggests the timing of pubertal development may impact MVPA among girls (Hearst et al., 2012; Hunter Smart et al., 2012). Baker and colleagues (2007) found that early maturing girls had lower self-reported and accelerometer-measured MVPA than later maturing girls. Similarly, Davison et al. (2007) found that advanced pubertal development at age 11 was associated with lower accelerometer-measured MVPA at age 13. Use of a self-report measure of pubertal status in this study may have contributed to the lack of association.

This study has several strengths. First, research was conducted with a large, diverse sample of adolescent girls in the U. S. Most theory testing studies of the HPM have been conducted in Iran and Taiwan, so little is known regarding application of the model to girls in other countries. Second, the analysis for this study employed latent variable SEM, which corrects estimates of regression coefficients for measurement error in the constructs. Use of this analytic approach is important because the majority of studies that have tested the HPM have utilized path analysis which assumes that variables are measured without error (Kelloway, 2015). Finally, MVPA in this study was measured objectively with accelerometers. Prior studies of the

HPM have been conducted using self-reported PA, which has been shown to be inaccurate among adolescents (Chinapaw et al., 2010; Slootmaker et al., 2009).

Despite these strengths, several limitations are worth noting. The cross-sectional design of the study precludes making causal inferences regarding theoretical relationships in the HPM. Also, this study did not test alternative models which may have fit the data equally well. Reduction of the number of items for the latent constructs may not have adequately represented the constructs of interest, potentially contributing to the lack of significant relationships with MVPA. Additionally, lack of sufficient measurement for PA enjoyment did not permit this construct to be tested in the model. Self-report bias and ceiling effects for indicators of several latent variables likely impacted the ability to detect an effect on MVPA. Also, important covariates, such as race and socioeconomic status, were not included in the analysis for this study. Finally, the results of this study cannot be generalized to girls of other ages or boys.

These limitations provide a number of suggestions for future research. Clearly, more longitudinal research is needed to better understand the determinants of PA among adolescent girls. Newer analytic methods, such as exploratory structural equation modeling (ESEM), could be used in future studies which would allow researchers to test more complex models (Marsh et al., 2014). Currently, the majority of theoretical models have been examined using recursive modeling strategies which assume linear relationships between variables. Studies examining non-recursive paths between constructs could advance theoretical understanding of PA among adolescents. Objective measures for HPM constructs such as biomarkers for pubertal status or global positioning systems for environmental variables should be considered. Finally, ongoing model testing with other populations and settings would increase generalizability.

Conclusion

In summary, the findings of this study support PA self-efficacy as an important correlate of objectively-measured MVPA among adolescent girls. This finding is consistent with previous studies that have tested the HPM relationships in the context of adolescent PA using self-reported PA. Additional research regarding commitment to PA is warranted to determine if this construct is essential in the HPM. Overall, the majority of variance in PA among adolescent girls remains unexplained. Future research should focus on improving the measurement properties of instruments used to operationalize theoretical constructs so that they are reliable and valid. Increasing PA among adolescent girls will require innovative approaches guided by theoretical models that are evidence-based. Theoretical revisions to the HPM, as well as the use of alternative theoretical models, may be necessary to account for the complexity of health behavior among adolescent girls.

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CHAPTER 5: CONCLUSION

The purpose of this dissertation was to study the conceptual, operational, and theoretical basis of PA self-efficacy within the context of adolescent PA, specifically adolescent girls. The dissertation, which included three manuscripts, was designed to address three significant gaps in the literature. The first manuscript centered on clarifying issues related to the conceptual foundation of PA self-efficacy among youth by conducting a concept analysis. The second manuscript examined the operational basis of PA self-efficacy by comparing the psychometric properties of two PA self-efficacy instruments designed for adolescents. Very few studies have examined the reliability, validity, and measurement invariance of psychological concepts such as PA self-efficacy. Finally, the third manuscript investigated the theoretical implications of PA self-efficacy within the framework of the Health Promotion Model (Pender, Murdaugh, & Parsons, 2015) using accelerometer-measured MVPA among urban, adolescent girls. This latter study addressed the limitations of using self-reported PA in theory testing studies involving adolescent populations.

Summary of Manuscript One

The first manuscript advanced the conceptual understanding of youth PA self-efficacy by focusing on a concept analysis. The need for this analysis was based on the fact that several conceptual definitions have been used in the literature, resulting in conceptual confusion and disagreement about the dimensionality of the concept. Rodger's (2000) evolutionary method for concept analysis provided a rigorous approach to reviewing the literature and identifying defining attributes, related concepts, antecedents, and consequences. The analysis was also guided by social cognitive theory (Bandura, 1986). A conceptual definition resulted that provided support for the bi-dimensional nature of PA self-efficacy in which youth judge their capability to: 1) participate in PA; and 2) choose PA despite existing barriers. This bi-dimensional nature indicated that instruments capturing the task or skill component of self-efficacy as well the barrier component of self-efficacy may be the most accurate in linking conceptual and operational definitions. The analysis also provided support for the dynamic nature of PA self-efficacy, meaning the concept changes over time and is amenable to interventions. It was apparent from the literature that the lack of conceptual clarity has led to wide variations in how the concept has been operationalized for use in research, with very few studies examining the measurement properties of self-efficacy instruments. Addressing this gap was the focus of the second manuscript.

Summary of Manuscript Two

Manuscript two focused on comparing the composite reliabilty, factorial validity, and measurement invariance of two PA self-efficacy instruments that were included in the "Girls on the Move" group RCT, utilizing data from Year 1 and Year 2 which involved 1,102 5^{th}-8^{th} grade urban, adolescent girls. One unique aim of this study was to examine the cross-group and longitudinal measurement invariance of the two instruments simultaneously between intervention and control groups. Establishing this level of invariance is necessary to ensure that PA self-efficacy is being measured with the same metric, allowing for accurate comparison of mean scores as well as mediation of intervention effects. Furthermore, some authors have suggested that interventions aimed at increasing girls' self-efficacy for PA may actually change the meaning of the construct, resulting in the lack of invariance over time (Lytle et al., 2009). This proposition was also explored in this manuscript.

Results from this study demonstrated unidimensional factor structures for both instruments. Composite reliability was moderate for both instruments with higher overall values for the PASE-6 instrument compared to the PASE-7 instrument. Metric invariance (i.e. equal factor loadings) for both instruments was evident across groups and longitudinally. Full scalar invariance was not achieved for either instrument. Simulatenous cross-group and longitudinal invariance evaluation showed that factor loadings were not fully invariant for either instrument. The PASE-6 was found to have one non-invariant factor loading, demonstrating that a 5-item version of this instrument resulted in partial metric invariance. However, partial metric invariance was not met for the PASE-7.

Worth noting is that the 5-item version of the PASE-6, demonstrating simultaneous metric invariance, is consistent with the bi-dimensional conceptual definition provided in the first manuscript. Items on this instrument reflect having the requisite skills to participate in PA as well as the capability to choose PA over exisiting barriers, such as having to stay at home, being too busy, or wanting to play video games or watch television. The item that was not invariant, "*I can be physically active in my free time on most days"*, does not address choosing PA over existing barriers. Based on these findings, the PASE-6 is recommended over the PASE-7 for use in research with this population.

Interestingly, both instruments achieved the level of scalar invariance for the control group but only partial scalar invariance for the intervention group. In addition, the lack of equal factor loadings in the simultaneous analysis lends support for the theory that the intervention itself may change how girls think about the concept of PA self-efficacy, and suggests that the concept is not being measured in the same way at both timepoints. Unfortunately, this occurrence precludes the ability to make mean group comparisons for this construct.

While the use of the same metric may be obvious for some observed measures, such as weight (i.e. researchers would not use kilograms in one group versus pounds in another), this issue is not routinely investigated with psychosocial measures (Brown et al., 2009). This study has advanced the science related to measurement invariance of latent constructs, such as PA self-efficacy among adolescent girls. This study also points out the importance of assessing reliablity and validity for adapted instruments, rather than relying on past psychometric analyses of original instruments. Researchers should routinely carry out evaluation of measurement invariance for study measures when making group comparisons.

Summary of Manuscript Three

The purpose of manuscript three was to examine PA self-efficacy within the context of a theoretical framework by testing proposed relationships in the Health Promotion Model (HPM). Variables for this study were selected based on prior theory-testing research involving adolescents. While PA self-efficacy has been shown to predict self-reported PA in prior research that tested HPM relationships (Wu & Pender, 2002; Wu et al., 2003; Wu & Pender, 2005; Taymoori et al., 2010a; Taymoori et al., 2010b; Mohamadian & Arani, 2014), studies testing the HPM with objectively-measured PA among adolescents were not found in the literature. Furthermore, no study was found that examined HPM relationships with a diverse group of girls in the United States.

This study was designed to include individual (PA self-efficacy; commitment to PA), social (social support), and environmental (options for PA) factors that have the potential to influence MVPA. These variables were selected to incorporate recommendations of other researchers that have called for integration of ecological components when testing theoretical models for adolescents, and in particular for adolescent girls (Dewar et al., 2013). In addition, biological factors (age, BMI, and pubertal status) were included as covariates in model testing.

Results of the structural equation modeling analysis showed that PA self-efficacy had the largest direct effect on accelerometer-measured MVPA among adolescent girls, confirming results of previous studies among adolescents (Bauman et al., 2012; Plotnikof et al., 2013). Social support and options for PA were not significant predictors of either commitment to PA or MVPA. Furthermore, commitment to PA demonstrated an unexpected negative relationship with MVPA. The negative indirect effect of commitment to PA resulted in suppression of the total effect of self-efficacy on MVPA. None of the covariates were significant predictors of MVPA.

A major limitation of this study was the inability to obtain adequate measurement models for some of the instruments in the study, necessitating a reduction in overall items used for some of the latent constructs. In addition, due to poor measurement properties of the 6-item enjoyment scale, this variable was dropped from model testing. These measurement issues may have impacted the overall results, as self-efficacy had undergone rigorous psychometric evaluation in the second manuscript, and also emerged as the strongest predictor of MVPA.

A number of studies have reported low correlations between self-reported psychosocial variables and accelerometer-measured MVPA among adolescents (Dewar et al., 2013; Dishman et al., 2010; Robbins et al., 2016), theorizing that common method bias over-inflates the relationship between self-reported variables and underestimates the relationship between self-reported and objective measures (Conway and Lance, 2010). This study also demonstrated low correlations between self-reported HPM constructs and objectively-measured MVPA. However, self-efficacy had the strongest relationship with MVPA (r=.292) and the largest, positive direct effect on MVPA (β=.343, 95% CI=[.211, .475]).

Dewar and colleagues (2013) found that baseline PA self-efficacy was the only significant predictor of accelerometer-measured MVPA across one year for adolescent girls. Worth noting is that the self-efficacy instrument in this study included specific instructions to ensure congruency between the questions and study outcome. Girls were provided with a referent of participating in MVPA a total of 60 minutes on most days of the week when answering items. Making sure that questionnaires are closely aligned with study outcomes may help to diminish the impact of this measurement issue.

Overall, this study adds to the body of knowledge related to the HPM in the context of adolescent PA by using an objective outcome measure for MVPA with a diverse group of adolescent girls. This study also utilized full SEM compared to prior studies testing the HPM which have primarily relied on path analysis, thus not accounting for measurement error. Given that some HPM relationships were not confirmed in this study, additional testing with psychometrically sound instruments is needed to confirm the importance of various factors in the model and make needed revisions.

Implications

The three manuscripts in this dissertation have made a significant contribution to the literature related to PA self-efficacy and advanced the conceptual, operational, and theoretical understanding of the concept specifically among urban, adolescent girls. At the conceptual level, a thorough literature review for PA self-efficacy in manuscript one resulted in an improved conceptual definition for PA self-efficacy. This definition was utilized to inform the aims and interpret the findings of the remaining two manuscripts. At the operational level, results from manuscript two demonstrated that the 5-item PASE-6 achieved the strongest level of measurement invariance and was most closely aligned with the conceptual definition provided in manuscript one. This 5-item instrument was then incorporated into the final manuscript which tested relationships among HPM variables including PA self-efficacy. At the theoretical level, findings from manuscript three supported a direct relationship between PA self-efficacy and MVPA in the HPM. This dissertation demonstrated the importance of having a strong conceptual and operational foundation before drawing conclusions related to factors that might assist adolescent girls to increase their PA.

Furthermore, the aims of this dissertation, specifically those from manuscript two and three, were met using data from a diverse sample of urban, low active adolescent girls, among whom a high percentage were either overweight or obese. Thus, the results of this dissertation have important implications related to the understanding of PA self-efficacy among low active, overweight or obese adolescent girls. Findings from manuscript two suggested that the "Girls on the Move" intervention may have altered how girls conceptualized the concept of PA self-efficacy from baseline to post-intervention. This possibility has been proposed by authors in earlier studies (Dunton et al., 2007; Lytle et al., 2009). Results from manuscript three demonstrated that while PA self-efficacy did have a direct effect on MVPA, the majority of the variance in MVPA remains unexplained.

Intervention studies with adults have demonstrated that barrier identification lowers PA self-efficacy levels (Ashford, Edmunds, & French, 2010) and that PA self-efficacy may not be an important factor for increasing PA among low active, obese adults (Olander et al., 2013). Additional research, including the use of qualitative methods, is needed to examine if these findings are also true for overweight or obese adolescent girls and to discover other salient factors that may have a greater impact on increasing MVPA. Use of alternative theoretical models should be considered, as they may be more appropriate for explaining MVPA in this unique population.

Nursing Research Implications

The concept analysis process underscored several important areas for future research. First, while evidence supports that PA self-efficacy is dynamic and changes over time, specifically how this construct changes as youth develop is not fully known, as the relationship between age and self-efficacy was not consistent across studies (Van Stralen et al., 2011). Second, more research is needed that examines how PA self-efficacy may differ between girls and boys, as some studies have shown that girls demonstrate lower levels of PA self-efficacy than boys (Voskuil & Robbins, 2015). Third, very few qualitative studies have explored the concept from a youth's perspective. Engaging youth in participatory research in which they have an active voice in sharing their viewpoint (Jacquez, Vaughn, & Wagner, 2013) may aid in our understanding of the concept and how it relates to PA among adolescent girls.

Future research should focus on conceptual clarification of concepts such as commitment, social support, and options for PA. Additionally, measurement invariance testing across groups and time for the instruments used to measure other HPM variables is needed. This endeavor will be necessary in order to accurately test theoretical models and understand the relationships between these factors, PA self-efficacy, and MVPA among adolescent girls. More studies examining HPM relationships longitudinally would also be beneficial. Using emerging statistical approaches such as exploratory structural equation modeling or testing alternative models with non-recursive relationships may be effective approaches for advancing the science of PA behavior among adolescent girls.

Although PA self-efficacy continues to be viewed as a significant predictor of MVPA for adolescents, and girls in particular, less reliance could be placed on psychological constructs and more on integration of biological factors in health behavior models. For example, the HPM includes genetic influences as a biological factor, but this component has not been incorporated into theory-testing. Including genetic factors in theory testing studies has the potential to advance the science of PA by explaining health behavior from not only a psychological perspective but also a biological framework (Herring, Sailors, & Bray, 2014). It is also possible that genetic predispositions to PA may moderate the relationship of PA self-efficacy and MVPA. In addition, the influence of genetic factors and PA, while understudied, has almost exclusively been conducted using self-reported PA (Moore-Harrison & Lightfoot, 2010). More studies are needed that examine the influence of genetic factors on objectively-measured PA.

Nursing Practice Implications

Pediatric nurses, nurse practitioners, and school nurses can play a vital role in enhancing self-efficacy as well as promoting MVPA among adolescent girls by raising awareness regarding the benefits of life-long PA, increasing girls' autonomy to be physically active, and assisting them to develop PA goals and plans (Golsäter, Fast, Bergman-Lind, & Enskar, 2015). The role of the school nurse in promoting PA may be especially important for underserved, urban adolescent girls who may not have the opportunities or resources for PA compared to their economically advantaged peers.

Policy Implications

While this dissertation has advanced the conceptual, operational, and theoretical understanding of PA self-efficacy, continued emphasis on psychosocial variables and individual health behavior is unlikely to result in population-level increases in PA. Achieving the Healthy People 2020 (U.S. Department of Health and Human Services, 2010) goal of 31.6% of adolescents meeting PA guidelines, a 10% improvement, will require population-level strategies. Given that less than 25% of adolescents meet guidelines of 60 minutes or more of MVPA on most days and the percentages are lower for adolescent girls (Kann et al., 2016), interventions aimed at implementing PA policies may provide a more effective approach.

In a global review of policies related to PA, Pate, Trilk, Byun, and Wang (2011) reported that those with the strongest evidence for increasing PA among youth were aimed at physical education in school, school environmental policy support, and mass media or advertising campaigns. These findings support recommendations put forth in *Educating the Study Body: Taking Physical Activity and Physical Education to School* (Kohl & Cook, 2013), in which policies should be put forth requiring schools to provide PA opportunities for youth of all ages. For some adolescent girls, this opportunity may be their only one to be physically active in a safe, supportive environment. Nurses can also advocate for school PA policies to help girls, particularly those that are not involved in sports, to become and remain physically active for life.

Concluding Remarks

Over a decade ago, the Tucker Center for Research on Girls and Women in Sport (2007) published, *Developing Physically Active Girls: An Evidence-Based Multidisciplinary Approach*. What was clear from this report was that girls' PA behavior is influenced by many factors including psychological, sociological, environmental, and physiological dimensions. Unfortunately, the report also confirmed that girls are less likely to be active than boys, approximately two out of every three girls are not involved in sports, less than 30% of adolescent girls participate in physical education at school, and girls living in poverty face the greatest barriers to PA.

Despite intervention efforts aimed at increasing PA among adolescent girls, effects have been modest, reinforcing the fact that changing behavior in this population is difficult (Pearson, Braithwaite, & Biddle, 2015). However, evidence from this review suggests that theory-based, multi-component interventions aimed at increasing PA produce the strongest effects for girls. Therefore, in order to determine components to target in PA interventions, ongoing research investigating theoretical frameworks, such as the HPM, is warranted. Ongoing testing and revisions of PA theories should be based on conceptually clear constructs that are measured with validity and precision. Advancing the science of adolescent PA requires nothing less.

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