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Social and Ecological Determinants of Physical Activity for Youth with Cerebral Palsy

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Walden University
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Abstract

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George E. Gorton, III

MS, Walden University, 2013

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Submitted in Partial Fulfillment

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Abstract

Physical inactivity is a leading cause of morbidity and mortality, increasing risk for noncommunicable disease and compromised physical, social, and mental health. However, fewer than 20% of U.S. youth meet physical activity guidelines; youth with disabilities are even less active. Physical activity is influenced by personal, family, social, organizational, community, and environmental factors acting within a social-ecological framework. To what extent is not well understood. The purpose of this study was to determine the extent to which social and ecological factors are associated with participation of youth with cerebral palsy in physical activity. The research design was a cross-sectional, quantitative approach with online survey methodology employing validated questionnaires using a nationally representative sample of 465 dyads of parents and youth with cerebral palsy age 12-17 years. Using exploratory and confirmatory factor analysis, latent constructs explained 5-88% of the variance in the indicators. Using structural equation modeling, the final model explained 53.1% of the variance in participation. Physical activity stage ($\beta = .632$), activity capacity ($\beta = .168$), and parent activity level ($\beta = .126$) exhibited direct effects. Self-confidence ($\beta = .631$), physical activity stage ($\beta = .632$), persistence ($\beta = .387$), athletic competence ($\beta = .348$), activity capacity ($\beta = .256$), and positive friendship experiences ($\beta = .215$) exhibited the strongest total effects. The findings support the importance of personal, family, and social factors for increasing participation in a health behavior that promotes health and well-being in a population at risk for social exclusion, stigma, and chronic health conditions.

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Chapter 1: Introduction to the Study

Physical inactivity is a leading cause of morbidity and mortality across all age, sex, race, and socioeconomic strata according to the Centers for Disease Control and Prevention (CDC, 2020) and the World Health Organization (WHO, 2009). There is a clear dose-response relationship between physical activity (PA) and reduced risk of cardiovascular disease and other chronic health conditions (Arem et al., 2015; Kyu et al., 2016; Lee et al., 2012). PA is critical during childhood and adolescence to promote the development of strong bones and muscles, enhance well-being, build social skills, and lead to healthy adult behaviors (Janssen & Leblanc, 2010; Murphy, Carbone, & American Academy of Pediatrics Council on Children With Disabilities, 2008; Shikako-Thomas, Kolehmainen, Ketelaar, Bult, & Law, 2014).

However, fewer than 20% of adolescents meet public health recommendations for being physically active during work, play, for transportation such as walking to school, or in daily life (CDC, 2016). The least active youth have more than twice the risk for cardiovascular disease and other chronic health conditions as adults compared to the most active youth (Jiménez-Pavón et al., 2013). Youth with disabilities are even less likely than those without disabilities to be involved in PA (Bjornson, Belza, Kartin, Logsdon, & McLaughlin, 2007; Bratteby Tollerz, Forslund, Olsson, Lidström, & Holmbäck, 2015), further increasing their risk for developing chronic conditions.

The extent to which youth with disabilities participate in PA is influenced by the complex interaction among personal, family, social, organizational, community, and environmental factors that operate within a social-ecological framework (Bedell et al., 2013; Feehan et al., 2012). However, to what extent these factors influence participation in PA is only partially understood (Bedell et al., 2013; Woodmansee, Hahne, Imms, & Shields, 2016). This research fills this gap in understanding by identifying the relationships among factors within a social-ecological framework that influence participation of youth with disabilities in PA.

In this chapter, I will briefly review the background of physical inactivity in youth, with and without disabilities, and its link to increased risk of chronic illness later in life. I will describe the gap in the literature that my research is designed to answer. I will describe my basic methodological approach to answering my research question. Finally, I will briefly discuss the social change implications of my study.

Background

Kohl et al. (2012) and Trost, Blair, and Khan (2014) have argued that lack of PA is a critical public health problem because of increased risk for cardiovascular disease, diabetes, high blood pressure, and other chronic illness. Kantomaa, Tammelin, Ebeling, Stamatakis, and Taanila (2015) have shown that high levels of PA are associated with high levels of health in adolescents. These studies establish the context for the importance of my research problem.

Murphy et al. (2008) and Verschuren, Peterson, Balemans, and Hurvitz (2016) provided perspective from health care providers on why it is important for youth with disabilities to be involved in PA and thus promote physical, social, and mental health.

They argued that it is critically important to identify and reduce barriers to participation. Additionally, Wiart, Darrah, Kelly, and Legg (2015) provided a family perspective that parents want their youth with disabilities to participate in PA, but the community resources are not available. Despite laws and national guidelines promoting access for those with disabilities, only 35% of fitness facilities had adequate training to support participation; only 4% had adequate equipment and none had specific policies to support involvement of those with disabilities (Rimmer, Padalabalanarayanan, Malone, & Mehta, 2017). These studies demonstrate that despite knowledge of why PA is important and a desire to be physically active, the physical, social, and attitudinal world does not support PA for those most at risk of low levels of PA.

Bedell et al. (2013), Bjornson et al. (2007), Ryan, Forde, Hussey, and Gormley (2015), and Shields, Synnot, and Kearns (2015) have each shown that youth with cerebral palsy (CP) and other childhood-onset physical disabilities participate less frequently, and when they do participate, they are less involved in moderately vigorous leisure, recreational, and sport PA than their peers without disabilities, creating the circumstances for increased risk of developing chronic illness (Kohl et al., 2012).

However, Woodmansee et al. (2016) challenged the belief that youth with disabilities participate less in all types of PA than youth without disabilities, expanding the concept of participation to include diversity, frequency, location, companionship, enjoyment, and preference. Using an age-matched survey, they showed that youth with disabilities demonstrated higher levels of participation with respect to preference, enjoyment, and frequency for some activities, despite lower or same levels of participation in other activities. This study exposed a gap in the literature on what conditions determine whether a youth with a disability, such as CP, will participate in PA. Furthering this perspective, Feehan et al. (2012), Kanagasabai, Mulligan, Mirfin-Veitch, and Hale (2014), and others have proposed that participation is the result of a complex interaction among personal, family, social, and environmental factors.

Many researchers, including Bauman et al. (2012); Bedell et al. (2013); Bloemen, Backx, et al. (2015); Bloemen, Verschuren, et al. (2015); Buffart, Westendorp, van den Berg-Emons, Stam, and Roebroeck (2009); Bult, Verschuren, Jongmans, Lindeman, and Ketelaar (2011); Shields and Synnot (2016); Shields, Synnot, and Barr (2012); Verschuren, Wiart, Hermans, and Ketelaar (2012) have used qualitative studies to identify the personal, family, social, and environmental factors that influence participation of youth with disabilities, including those with CP, in leisure, recreational, and sport PA.

Several theoretical frameworks have conceptualized how personal and environmental factors help to explain the relationship between having the capability to be involved in life situations—such as PA—and actually participating in them (King et al., 2003; van der Ploeg, van der Beek, van der Woude, & van Mechelen, 2004). These conceptual models provided the foundation for my question of how social, economic, and environmental factors affect the relationship between function and participation in PA for youth with CP.

Irwin et al. (2012) and others developed the NIH Patient-Reported Outcome Measurement Information System (PROMIS) and operationalized physical, mental, and social health in pediatric and parent self-report survey instruments, such as physical function, pain interference, emotional distress, and social peer relationships. Availability of previously validated questionnaires relevant to my target population provides the methodologic basis for collecting valid information on the constructs in this study.

Longo, Badia, and Orgaz (2013) and Shikako-Thomas et al. (2013) used the conceptual model of King et al. (2003) to examine the association of child, family, and environment factors with diversity, intensity, and enjoyment of participation for youth with CP using child self-report and parent proxy-report. Their findings supported the use of an ecological framework as the conceptual basis for examining the participation of youth with CP. However, neither of these studies examined PA from the perspective of participating at sufficient levels for health benefit.

Based on these previous studies, the physical, social, and attitudinal world does not support PA for those most at risk of low levels of PA. Information regarding the determinants of PA for youth with CP and others who are not sufficiently active is needed to address programmatic, organizational, and policy changes that empower people and enable environments.

Problem Statement

PA is a critical public health issue and an important, modifiable risk factor for promoting and maintaining physical, mental, and social health. People who are physically active have stronger bones and muscles, better physical health and well-being, and fewer mental health problems than those who are inactive (CDC, 2020). Conversely, physical inactivity is a leading cause of morbidity and mortality worldwide across all age, sex, race, and socioeconomic strata, and contributes to 19 million disability-adjusted life-years, three million deaths, and $117 billion in healthcare costs annually (Ding et al., 2016; Kohl et al., 2012; U.S. Department of Health and Human Services, 2018b). Because of its global prevalence and a health impact equivalent to that of smoking or obesity (Lee et al., 2012), PA is an essential part of a public health strategy to reduce noncommunicable diseases.

Involvement in PA is crucial at all ages. From as young as 6 years, the least active have two to seven times the risk for future cardiovascular disease compared to the most active (Jiménez-Pavón et al., 2013). Youth with disabilities, such as CP, often do not achieve healthy PA levels (Bratteby Tollerz et al., 2015). The extent to which youth with CP participate in PA is influenced by the complex interaction among personal, family, social, organizational, community, and environmental factors that operate within a social-ecological framework (Bedell et al., 2013; Feehan et al., 2012). However, to what extent these factors influence participation in PA is only partially understood (Bedell et al., 2013; Woodmansee et al., 2016). What is needed is to understand to what extent personal, family, social, organizational, community, and environmental factors influence participation in PA for youth with CP to recommend programmatic, organizational and policy changes to increase their ability to participate in PA.

Purpose of the Study

The purpose of this quantitative study was to determine the extent to which personal, family, social, organizational, community, and environmental factors are associated with participation of youth, age 12 to 17 years, with CP in health-enhancing PA. This age range is particularly important because the determinants of participation in PA for adolescents with CP have not been sufficiently explored and this is a critical transition age—from childhood to adulthood—during which participation in PA decreases (Majnemer, Shikako-Thomas, Schmitz, Shevell, & Lach, 2015; Shikako-Thomas et al., 2013). To address this knowledge gap, I used a quantitative approach with online survey research methodology; I used the following validated self- and parent-reported outcome questionnaires as measures for physical, social, and cognitive function and peer relations: the Child and Adolescent Scale of Environment (Bedell, 2004), Child and Adolescent Factors Inventory (Bedell, 2004), Self-Perception Profile for Adolescents (Wichstraum, 1995), Stages of Change for PA (Marcus, Selby, Niaura, & Rossi, 1992), Dimensions of Mastery Questionnaire (Morgan, Busch-Rossnagel, Barrett, & Wang, 2009), Youth Risk Factor Behavior Surveillance Survey (CDC, 2017), International PA Questionnaire (The IPAQ Group, 2003), and several of the NIH Patient-Reported Outcome Measurement Information System (PROMIS) (Health Measures, 2017).

Research Question(s) and Hypotheses

My research explores one research question and 15 associated hypotheses to address the gap in the literature I identified.

RQ: What is the extent to which personal, family, social, organizational, community, and environmental factors are associated with participation of youth with CP age 12-17 years in health-enhancing levels of PA, controlling for age, sex, and level of gross motor function?

$H1_0$: Gross motor function level, pain, strength and associated conditions will not be significant indicators of a latent construct reflecting body structure and function.

$H1_A$: Gross motor function level, cognitive function, pain, strength and associated conditions will be significant indicators of a latent construct reflecting body structure and function.

$H2_0$: Mobility and upper extremity function will not be significant indicators of a latent construct reflecting activity capacity.

$H2_A$: Mobility and upper extremity function will be significant indicators of a latent construct reflecting activity capacity.

$H3_0$: Age, sex, grade, ethnicity, race, height, weight, intention, general competence, gross motor persistence, global self-worth, social competence, athletic competence, behavioral conduct, and close friendship will not be significant indicators of a latent construct reflecting personal factors.

$H3_A$: Age, sex, grade, ethnicity, race, height, weight, intention, general competence, gross motor persistence, global self-worth, social competence, athletic competence, behavioral conduct, and close friendship will be significant indicators of a latent construct reflecting personal factors.

$H4_0$: Socioeconomic status, parent physical health, parent PA level, parent mental health, parent physical function, parent anxiety, parent depression, parent fatigue, parent pain interference, parent social support, parent emotional support, parent instrumental support, parent informational support, parent social isolation, family finances, and family stress will not be significant indicators of a latent construct reflecting family factors.

$H4_A$: Socioeconomic status, parent physical health, parent PA level, parent mental health, parent physical function, parent anxiety, parent depression, parent fatigue, parent pain interference, parent social support, parent emotional support, parent instrumental support, parent informational support, parent social isolation, family finances, and family stress will be significant indicators of a latent construct reflecting family factors.

$H5_0$: Bullying, peer relationships, close friendships, peer social support, social attitudes, and assistance will not be significant indicators of a latent construct reflecting social factors.

$H5_A$: Bullying, peer relationships, close friendships, peer social support, social attitudes, and assistance will be significant indicators of a latent construct reflecting social factors.

H6_0: Safety, violent crime rate, children living in poverty, high school graduation rate, severe housing problems, social association participation rate, physical inactivity, and urban/rural location will not be significant indicators of a latent construct reflecting community factors.

H6_A: Safety, violent crime rate, children living in poverty, high school graduation rate, severe housing problems, social association participation rate, physical inactivity, and urban/rural location will be significant indicators of a latent construct reflecting community factors.

H7_0: Institutional policies, services, and resources, programs and services, and devices and equipment will not be significant indicators of a latent construct reflecting organizational factors.

H7_A: Institutional policies, services, and resources, programs and services, and devices and equipment will be significant indicators of a latent construct reflecting organizational factors.

H8_0: Physical design and access, transportation, access to exercise facilities, air pollution, rainy days, snowy days, hot days, and cold days will not be significant indicators of a latent construct reflecting physical environmental factors.

H8_A: Physical design and access, transportation, access to exercise facilities, air pollution, rainy days, snowy days, hot days, and cold days will be significant indicators of a latent construct reflecting physical environmental factors.

$H9_0$: More positive family factors will not be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H9_A$: More positive family support will be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H10_0$: More positive social factors will not be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H10_A$: More positive social factors will be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H11_0$: More positive community factors will not be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H11_A$: More positive community factors will be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H12_0$: More positive organizational factors will not be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H12_A$: More positive organizational factors will be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H13_0$: More positive physical environment factors will not be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H13_{\text{A}}$: More positive physical environment factors will be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H14_0$: Intention will not mediate the positive effects of personal, family, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

$H14_{\text{A}}$: Intention will mediate the positive effects of personal, family, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

$H15_0$: Family support will not moderate the positive effects of personal, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

$H15_{\text{A}}$: Family support will moderate the positive effects of personal, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

Theoretical Framework for the Study

The theoretical framework for this study was a social-ecological theory (SET) of factors affecting the participation of children and youth with disabilities (van der Ploeg et al., 2004). SETs such as those described by McLeroy, Bibeau, Steckler, and Glanz (1988) and Bronfenbrenner (1977) emphasize the reciprocal relationship of physical, mental, and social health with influences at the intrapersonal, interpersonal, institutional, community, and public policy levels. SETs are fundamental theoretical frameworks for public health promotion activities applied broadly in drug abuse programs, chronic disease risk-factor reduction, adolescent pregnancy prevention, and community action research to promote empowerment through social change (McLeroy et al., 1988), but this is the first time it was applied in a theoretical manner to PA for children with CP. King et al. (2003), Burton, Turrell, Oldenburg, and Sallis (2005), and others have applied a general socioecological perspective to disability research. They sought to explain the frequency and diversity of participation of children with disabilities, including those with CP, in recreation and leisure activities based upon prior research in the fields of rehabilitation, psychology, sports, and recreation.

The PA for People With a Disability Model (PAPDM) proposed by van der Ploeg et al. (2004) integrates important conceptual foundations, such as the WHO International Classification of Functioning, Disability and Health (ICF), SET, and the transtheoretical model (TTM). The ICF expands the understanding of the causes of health and disability away from a biomedical model to incorporate social and psychosocial perspectives that are consistent with SET. Incorporation of the TTM adds an evaluative component in which the influence of others, personal values, and motivations combine to drive action. While the PAPDM predicts direct and indirect effects of personal and environmental factors on PA, the PAPDM has not been widely operationalized or tested. The PAPDM provides a conceptual basis for understanding why people with disabilities do or do not participate in important health behaviors. I provide a more detailed analysis in Chapter 2.

Nature of the Study

This quantitative survey used a sample of youth, aged 12 to 17 years, with CP and one parent taken from the electronic medical record of a specialty children’s hospital system within the continental United States. Quantitative research is consistent with the goals of testing theory that has been conceptualized through literature review, expert opinion, and prior qualitative research, and establishing direct and indirect relationships among variables, controlling for the effects of other variables (Creswell, 2009).

I used survey research to quantify abstract concepts such as physical and institutional barriers, supportive relationships, time and financial impact, family preference, child self-perception, function, and participation using existing, validated self- and parent-report scales. Data collection instruments included NIH Patient-Reported Outcome Measurement Information System (PROMIS) measures for physical, social, and cognitive function and peer relations (Health Measures, 2017), Gross Motor Function

Classification System (Rosenbaum, Palisano, Bartlett, Galuppi, & Russell, 2008), stages of change for exercise behavior (Marcus et al., 1992), Youth Perception Profile for Adolescents (Harter, 2012), Dimensions of Mastery Questionnaire (Morgan et al., 2018), Child and Adolescent Scale of Environment (Bedell, 2011b), Child and Adolescent Factor Inventory (Bedell, 2011a), and International PA Questionnaire (The IPAQ Group, 2003). Additionally, ecological data were obtained from existing secondary datasets including the American Community Survey and County Health Rankings to provide a social and environmental context for participation. The IPAQ, SPPA, and PROMIS instruments surveys were available free of charge from the developer's website. The stages of change for exercise behavior was freely available from the published manuscript. Permission to use the CASE, CAFI, and DMQ-18 were obtained from the developers and are included in Appendix B.

The dependent variable was a youth participation in PA. Independent variables included measures of personal, social, family, institutional, community, and environmental environment that could influence participation in PA. Data were analyzed using exploratory and confirmatory factor analyses and structural equation modeling.

Definitions

Cerebral palsy

Cerebral palsy is defined as

> a group of permanent disorders of the development of movement and posture, causing activity limitations that are attributed to non-progressive disturbances that

> occurred in the developing fetal or infant brain. The motor disorders of cerebral palsy are often accompanied by disturbances of sensation perception, cognition communication, and behavior, by epilepsy, and by secondary musculoskeletal problems. (Rosenbaum et al., 2007).

Physical Activity

PA is defined as any bodily movement produced by skeletal muscles that requires energy expenditure (Caspersen, Powell, & Christenson, 1985). It includes exercise as well as other activities that occur as a part of playing, working, active transportation, doing chores, and participating in recreational activities (WHO, May 22, 2004).

Participation

Participation is defined as involvement in life situations including physical, social, and self-engagement (WHO, 2001). Barriers to participation are factors that decrease the likelihood of participation in PA. Facilitators are factors that increase the likelihood of participation in PA.

PA participation

PA participation is defined as a multidimensional construct for which participation is one dimension. Ross, Bogart, et al. (2016) describe “experiences in physically demanding movement, sport, game, or recreational play that results in energy expenditure and perceptions of communal involvement.” It can be qualified by level (frequency, intensity), quality of experience (enjoyment, self-efficacy, satisfaction), and overall profile (extent to which participation matches expectations).

Determinants of Participation

Child factors are the personal characteristics, including physical body structures and functions, that may be primary or secondary impairments and psychological function encompassing attitudes and knowledge about, preferences, motivation, and perceived self-efficacy toward PA (Jirikowic & Kerfeld, 2016; WHO, 2001).

Family factors are the demographics (income, education, resources, socioeconomic status), family structure, and parental attitudes, beliefs, values, and knowledge about child participation in PA and the impact participation has on health (Jirikowic & Kerfeld, 2016; WHO, 2001).

Environmental factors are the characteristics and qualities of the physical, social, and attitudinal environment in the home, school, and community that influence opportunities for participation in PA and may include access to programs, physical barriers in the built environment, availability of specialized services, social supports, and adaptive equipment (Jirikowic & Kerfeld, 2016; WHO, 2001).

Social factors are the characteristics of the attitudinal world that provide social support and assistance, create the potential for fun, or create negative attributes that restrict involvement (WHO, 2001).

Organizational factors are the characteristics of organizations such as the programs or services they offer, rules and policies, or availability of devices and equipment to promote equal involvement of people with disability (McLeroy et al., 1988).

Community factors are the characteristics of neighborhoods that promote or restrict participation in PA. These can include values toward social participation or PA, crime and violence, urban or rural location, poverty, education, housing, or others commonly found as social determinants of health (McLeroy et al., 1988).

Physical environmental factors are the features of physical world that may promote or restrict participation in PA. These could include heat, precipitation, presence of parks or outdoor recreation areas, transportation, or accessibility of the built environment (McLeroy et al., 1988).

Assumptions

The primary assumption underlying this study was that health is an interaction of individuals with the physical, social, and attitudinal worlds in which they live, consistent with a socially constructed model of disability. The association between capacity—what a person can do—and participation—involvement in life experiences—is mediated by impairments in body structures and body functions. Translation of capacity into participation in health-enhancing PA is moderated by intention, which is driven by modifiable personal factors, such as having confidence in one’s abilities (self-efficacy), having a positive attitude toward participation in PA, individual preferences for being active, body mass index (BMI), and fixed personal factors, such as race, ethnicity, sex, and age. These primary drivers are moderated and mediated by more distal influences, such as family supports and resources; societal attitudes; organizations with staff, equipment, and programs appropriate for people with disabilities; communities with features that make PA accessible and enjoyable; weather and temperature; and the built environment, among others. A path model describing the complex interactions is shown in Figure 1 in Chapter 2. Further details regarding the proposed determinants of participation in health-enhancing PA are shown in the measurement models of Figures 2 and 3 in Chapter 2.

Scope and Delimitations

My study takes a broad approach to understanding the characteristics of the physical, social, and attitudinal world that promote health. I focus on health-enhancing PA as my dependent variable because it is a personal passion, and one of the most important health behaviors linked to long-term health (Lee et al., 2012). I focus on disability because nearly 20% of the general population has some form of disability (Carroll et al., 2014). The laws and international guidelines supporting those with disabilities are recent in comparison to other forms of advocacy. The 2006 Convention on the Rights of Persons with Disabilities (UN General Assembly, January 24, 2007) provides the social impetus for promoting equal access to care, education, employment, and participation.

I focus on youth because that is the critical timeframe when values are formed and adult health behaviors are initiated. I focus on CP because it is the most common childhood physical disability, affecting nearly 1 in 300 children (Christensen et al., 2014; Oskoui, Coutinho, Dykeman, Jette, & Pringsheim, 2013). Additionally, it is a population I have worked with for many years, to study movement patterns associated with this condition. It is also a substantial part of the population served by the organization I work for, and where recruitment for the study took place.

Within my research, I narrowed the focus to youth with CP, aged 12-17 years. This age range is important developmentally and represents the time when the family does not drive involvement in PA and individual preferences and values become important. Adolescence is a time when social influences of peers are strong, affecting willingness to participate in activities with others (Lindsay & McPherson, 2012). For adolescents with CP, strength declines in relation to body mass as they age, making it increasingly difficult to remain engaged in PA (Davids, Oeffinger, Bagley, Sison-Williamson, & Gorton, 2015).

I focused on understanding participation in health-enhancing PA from a social-ecological perspective. A misperception is that people with disabilities do not participate in PA because they cannot or do not want to. In fact, people with substantial physical impairments can participate at high levels of PA when they have assistance (Gannotti, Fuchs, Roberts, Hobbs, & Cannon, 2015). Youth with disabilities and their parents identify preferences and priorities for participation in PA (Shikako-Thomas et al., 2015; Shimmell, Gorter, Jackson, Wright, & Galuppi, 2013). Involvement in PA is restricted by barriers in the physical, social, and attitudinal world (Bloemen, Backx, et al., 2015; Buffart et al., 2009; Bult et al., 2011; Mitchell, Ziviani, & Boyd, 2015a; Shields & Synnot, 2016). Based on the fundamental right to optimal health and equal access to participation, restriction of participation based on characteristics of the physical, social, and attitudinal world equates to health inequities based on disability status. The social change implication inherent in this research is that of equal access to characteristics of the physical, social, and environmental world that promote optimal health for all people, regardless of disability status.

I selected youth with CP, aged 12-17, years as the target population for my study. Generalizability of the study findings are limited by my choice of study population. While it is likely that other youth with physical or intellectual disabilities will encounter many of the same problems that youth with CP encounter, this study is not designed to address differences in patterns of family, social, or physical environment factors toward participation in health-enhancing PA. Also, young adults or young children may have different patterns of factors that influence participation. Young children may be more influenced by family, while young adults may be more influenced by personal factors or the environment. Thus, my study findings will be limited in generalizability to the study population. Further discussion of generalizability will be provided in Chapter 3.

Limitations

My study was a cross-sectional, quantitative study using a survey administered through a web-based interface. Cross-sectional studies are limited in their ability to measure change across time as well as their ability to determine causality (Campbell & Stanley, 1963; Frankfort-Nachmias, Nachmias, & DeWaard, 2015; Salazar, Crosby, & DiClemente, 2015a). My findings using survey methodology could have been affected by information bias, inadequate response rate, questionnaire reliability and validity, and common source bias. Information bias was minimized by using an anonymous survey to reduce the likelihood of obtaining socially desirable responses. Response rate was maximized by reducing the number of questions and providing compensation for completing the questionnaires. Internal validity was maximized by using questionnaires with strong psychometric properties that provided information on well-defined scales. Common source bias was limited by obtaining responses from both the youth and a parent, and using ecological information to support the context of the physical, social, and attitudinal world. Other biases could have come from omitting important variables that could have influenced the outcome of participation in health-enhancing PA. This bias was limited by a comprehensive literature review to identify all potential factors. More details on bias are provided in Chapter 3; more details on the factors that influence participation in PA are included in Chapter 2.

Significance of the Study

Social change is about changing the social, political, economic, and physical environments that support health and well-being of all people, regardless of who they are or where they live, so that they can live the healthiest lives possible. My study focused on understanding how personal, social, economic, and environmental factors within a socioecological framework facilitate or restrict youth with CP from participating in the recommended amounts of health-enhancing PA. Participation in adequate amounts of PA is important for developing and maintaining optimal physical, social, and mental health (Murphy et al., 2008). It is also critically important to reduce risk of future chronic illness such as obesity, cardiovascular disease, high blood pressure, and diabetes (Hallal et al., 2012; Kohl et al., 2012).

The findings from my study support the development of organizational, community, and national policies that empower people and lead to an enabling physical and social environment. The results of this study are important for promoting health, well-being, and positive social change in a population at risk for physical and social exclusion, stigma, and chronic health conditions. Involvement in PA provides opportunities for social interaction, builds self-efficacy and self-esteem, and improves quality of life (Maher, Toohey, & Ferguson, 2016). Promoting participation in PA prior to the development of chronic illness may decrease the prevalence and severity of health conditions linked to inactivity, decrease national healthcare costs, and promote public health (Carroll et al., 2014; Das & Horton, 2016; Ding et al., 2016). Understanding to what extent personal, family, social, and environmental factors influence the participation of youth with CP in PA provides information that may be used to address social and structural barriers that limit the involvement of youth with disabilities in important opportunities for leisure and social recreation (Feehan et al., 2012; Wiart et al., 2015). Organizational, community, and national policies to promote PA for youth with CP would encourage life habits that contribute to physical, mental, and social health, and that support happiness and quality of life (Murphy & Carbone, 2008).

Summary

In Chapter 1, I provided an overview of my research topic to explain the personal, family, social, community, organizational, and physical environment factors that influence the participation of youth with disabilities in health-enhancing PA. Physical inactivity is a leading cause of morbidity and mortality, increasing risk for noncommunicable disease and compromised physical, social, and mental health. However, fewer than 20% of U.S. youth meet physical activity guidelines; youth with disabilities are even less active. The purpose of my study was to determine the extent to which social and ecological factors are associated with participation of youth with cerebral palsy in physical activity.

Physical activity is influenced by personal, family, social, organizational, community, and environmental factors acting within a social-ecological framework. To what extent is not well understood. Built upon SET as the supporting theoretical framework, I presented the PAPDM as the conceptual framework for a structural equation model employing latent constructs. I outlined one research question and 15 hypotheses that build upon the PAPDM to validate it as a framework for understanding participation. I described and operationalized key concepts such as PA, participation, determinants of participation with SET, and cerebral palsy. I examined the scope of my research, its delimitations, assumptions, and the limitations that result from my choice of methods.

The research design was a cross-sectional, quantitative approach with online survey methodology employing validated questionnaires using a nationally representative sample of 465 dyads of parents and youth with cerebral palsy age 12-17 years. Using exploratory and confirmatory factor analysis, latent constructs explained 5-88% of the variance in the indicators. Using structural equation modeling, the final model explained 53.1% of the variance in participation. Physical activity stage ($\beta = .632$), parent activity level ($\beta = .126$), and activity capacity ($\beta = .168$) exhibited direct effects. Self-confidence ($\beta = .631$), physical activity stage ($\beta = .632$), persistence ($\beta = .387$), athletic competence ($\beta = .348$), activity capacity ($\beta = .256$), and positive friendship experiences ($\beta = .215$) exhibited the strongest total effects. The findings support the importance of personal, family, and social factors for increasing participation in a health behavior that promotes health and well-being in a population at risk for social exclusion, stigma, and chronic health conditions.

In Chapter 2, I explore the literature on the theoretical and conceptual foundations of my research, the health benefits and consequences of PA and CP, and the determinants of participation in health-enhancing PA for those with CP. In Chapter 3, I outline my methodological approach to answering my research question about the extent to which personal, family, social, organizational, community, and environmental factors influence participation of youth, age 12 to 17 years, with CP in health-enhancing PA. I describe my population, sampling, instrumentation, and data analysis plan in Chapter 3. In Chapter 4, I present my findings in detail and interpret my findings, discuss conclusions, recommendations, and social change implications in Chapter 5.

Chapter 2: Literature Review

Introduction

PA is a critical public health issue and a principal, modifiable personal behavior for maintaining and promoting physical, mental, and social health. People who are physically active have stronger bones and muscles, better physical health and well-being, and fewer mental health problems than those who are inactive (CDC, 2020). Conversely, physical inactivity is a leading cause of morbidity and mortality worldwide across all age, sex, race, and socioeconomic strata. Physical inactivity contributes to 19 million disability-adjusted life-years, 3 million deaths, and $117 billion in health care costs annually (Ding et al., 2016; Kohl et al., 2012; U.S. Department of Health and Human Services, 2018b). Because of its global prevalence and health impact (Lee et al., 2012), PA is an essential part of a public health strategy to reduce noncommunicable disease and promote health.

Involvement in PA is crucial for all ages and all people. From as young as 6 years, the least active youths have 2–7 times the risk of developing future cardiovascular disease compared to the most active (Jiménez-Pavón et al., 2013). Youth with disabilities such as CP often do not achieve healthy PA levels (Bratteby Tollerz et al., 2015). The extent to which youth with CP participate in PA is influenced by a complex interaction among personal, family, social, and environmental factors that operate within a social–ecological framework (Bedell et al., 2013; Feehan et al., 2012). However, to what extent these factors influence participation in PA is only partially understood (Bedell et al., 2013; Woodmansee et al., 2016). What is needed is to understand to what extent personal, family, social, and environmental factors influence participation in PA for youths with CP to recommend programmatic, organizational, and policy changes to empower them as individuals and improve their physical, social, and attitudinal environments to increase their ability to participate in PA.

The purpose of this study was to improve understanding of the extent to which personal, family, social, and environmental factors influence the participation in PA of youth with CP, aged 12–17 years, by examining the paths of influence of these factors. This age range is particularly important because it is a critical transition age from childhood to adulthood, when adult behaviors form, yet participation in PA typically decreases (Majnemer et al., 2015; Shikako-Thomas et al., 2013).

In this chapter, I review the literature. I employed a systematic search strategy focused on peer-reviewed publications in the English language from 2012 through 2017, using multiple databases with keywords relevant to four primary concepts of public health, PA, CP, and adolescence, including qualitative, quantitative, and mixed methods approaches. I review the theoretical foundations for the transition from a medical model to a social model to an integrated model of the health and behavior of people with disabilities. Change in the framework of health has evolved with changes in legislation and understanding of the role of the social determinants of health. I focus on the recently developed WHO International Classification of Functioning, Disability, and Health (ICF) model of health, the life course health development (LCHD) model, and the PAPDM, which includes components of social cognitive theory and the theory of planned behavior.

I review the literature from the perspective of the concepts of public health, PA, CP, and the determinants of PA. I review early studies establishing the importance of PA as a critical health behavior, the prevalence of PA, its association with morbidity and mortality outcomes, the population attributable fraction of morbidity and mortality accounted for by PA, and the minimum levels of PA recommended for different age groups.

Next, I review CP, the most common cause of physical disability in childhood, and the link between reduced motor control, decreased strength, and spasticity with reduced likelihood of meeting PA recommendations to establish youths with CP as a group vulnerable to the effects of reduced PA. I review the pathophysiology, etiology, and prevalence of CP as well as classification systems and societal costs of the health condition. Finally, I discuss factors that are identified in the literature as proposed determinants of participation in PA for adolescents with CP using the PAPDM. I review factors related to body structures and body functions; capacity to perform activities; and those acting at the personal, family, social, organizational, community, and physical environment levels.

Literature Search Strategy

I searched the existing literature for the years 2012–2017 for full-text, peer-reviewed articles written in the English language using the following databases: CINAHL

Plus with Full Text, MEDLINE Plus With Full Text, Google Scholar, PubMed, ProQuest Central, and PsycINFO. I employed a systematic search strategy using these four primary concepts: CP, PA, public health, and adolescence. I performed Boolean searches using combinations of the key words “cerebral palsy AND PA AND (youth OR adol* OR pedi* OR child* OR teen*) AND public health,” with additional terms including “adolescent health,” “cognition,” “exercise,” “quality of life,” “social,” “socioeconomic OR socio-economic OR economic,” “determinant OR pattern OR predictor,” “environment,” “transportation,” “preference,” “participation,” “epidemiology OR etiology,” and “psychosocial.” By manually searching reference lists of included studies and through citation tracking in Google Scholar, I identified additional relevant studies.

I included original, peer-reviewed research studies using qualitative, quantitative, or mixed methods; expert reviews; and systematic reviews with or without meta-analysis. I included studies written in English; included children or adolescents with CP or physical disabilities between 12 and 17 years of age; and examined relationships among the primary concepts within the home, school, or community setting. I excluded studies that focused primarily on adults or people with intellectual disabilities, unless they contained relevant material not found in published studies on children or adolescents. I also excluded studies of program effectiveness that focused on leisure activities that were not physical and studies on the development or validation of measurement tools.

Theoretical Foundation

Participation in PA is an individual health behavior that fits within the behavioral constructs of the health belief model (HBM), social cognitive theory (SCT), theory of planned behavior (TPB), and transtheoretical model (Buchan, Ollis, Thomas, & Baker, 2012). However, more contemporary studies on PA, especially those relevant to people with a disability, include a social–ecological perspective from social-ecological theory (McLeroy et al., 1988) as conceptualized through the International Classification of Functioning, Disability, and Health (WHO, 2001). Integrated theories combine the ecological and individual perspectives and may be most relevant to the study of PA for people with disabilities, such as work on the PAPDM (van der Ploeg et al., 2004).

Health Belief Model

The HBM (Houchbaum, 1958) was one of the first widely applied theories of health behavior, developed to explain why some people chose to be screened for tuberculosis while others did not. According to the HBM, behavior will change when someone perceives that he or she is susceptible to a health condition that has serious consequences and that the benefits of acting outweigh the costs or barriers to acting. People with disabilities must overcome many personal, family, social, and environmental barriers to join a gym, participate on a school athletic team, or use a national park. These include lack of interest, parental concerns for a child’s safety, stigma resulting from peer attitudes, and accessibility, among others. Numerous qualitative studies have defined the barriers to participation in PA for youths with disabilities (Barr & Shields, 2011; Bult et al., 2011; Conchar, Bantjes, Swartz, & Derman, 2016; Kang, Hsieh, Liao, & Hwang, 2017; Shields & Synnot, 2016). However, the HBM has several limitations as it applies to PA. The benefits to PA occur in the future through reduction of chronic disease risk, while the costs accrue in the present, unbalancing the assessment of perceived risk and perceived benefit.

Social Cognitive Theory

SCT (Bandura, 1986) posits that human behavior is the result of the dynamic interplay among personal, social, and environmental influences. Through self-efficacy (Bandura, 1977), a primary component of SCT, people who are confident about their ability to do something are more likely to persevere when confronted by personal or environmental barriers. SCT theory includes the theorem that psychological influences such as past performance, vicarious experiences, verbal persuasion, and emotional arousal influence the magnitude, strength, and generality of the relationship between self-efficacy and behavior (Bandura, 1977). Self-efficacy has relevance for participation in PA, especially for people with disabilities, who may have physical, cognitive, or other limitations that challenge their social and physical involvement. Self-efficacy is a crucial driver of participation in PA (King et al., 2003).

Theory of Planned Behavior/Theory of Reasoned Action

The TRA (Ajzen & Fishbein, 1980) posits that the best predictor of behavior is one’s intention, which is influenced by beliefs and attitudes about the person’s behavior and the perception of how important others would feel about this behavior (subjective norms). Within disability, subjective norms present issues of social isolation, segregation, stigma, and exclusion (Gaskin, Andersen, & Morris, 2012) that become significant barriers to participation. The TPB (Ajzen, 1985, 1991) extends the TRA to include the perceived level of behavioral control as an intervening construct between intention and behavior. Attitudes and subjective norms predict and drive intention when it is perceived that behavior is under volitional control. Intention is similar to the construct of self-efficacy (Bandura, 1977) in that it refers to the perception of capability for controlling the outcome of an attempted behavior. The TPB incorporates the HBM construct of perceived costs and benefits and defines as instrumental beliefs that drive intention and also include affective beliefs that are positive or negative feelings about a behavior (Ajzen, 1991). Youths with CP have reported that they dislike participating in sports because they are not good at them (DeFazio & Porter, 2016). While the TRA/TPB provide insight into PA behavior, they do not conceptualize the pathways of action for distal influences, and studies using the TRA/TPB have left large amounts of unexplained variance, suggesting that additional factors are present (Buchan et al., 2012).

Transtheoretical Model

The TTM (DiClemente & Prochaska, 1983; Prochaska & DiClemente, 1982) was initially developed to explain how behavior change happens over time in stages that indicate readiness for change. The stages include precontemplation, contemplation, preparation, action, maintenance, and termination. Self-efficacy is included as a construct from the TPB; the TTM construct of decisional balance is equivalent to the assessment of risk and benefit from the HBM. The TTM has been used to examine behavior change related to smoking, alcohol and substance abuse, medication compliance, HIV/AIDS prevention, teen pregnancy, bullying, eating disorders, obesity, sedentary behavior, and other relevant public health issues (Glanz, Rimer, & Viswanath, 2008). However, several authors have suggested that the TTM is a surrogate for intention, as it correlates highly with intention, and that the TTM is not a strong predictor of change in PA behavior (Glanz et al., 2008).

Integrated Theories

While the HBM, SCT, TRA/TPB, and TTM offer individual- and interpersonal-level constructs that are relevant for understanding PA, more recent work has explained PA behavior using socioecological theories that include the influences of public policy, environment, organizations, communities, and social factors. de Vries, Dijkstra, and Kuhlman (1988) combined the psychosocial constructs of attitude, social influence (subjective norms), and self-efficacy of the SCT and TPB with the stages of change influence from the TTM to create the attitude, social influence, and self-efficacy (ASE) model.

Social–Ecological Theory

SET (McLeroy et al., 1988) is adapted from the work of Bronfenbrenner (1977) on how individual behavior results from the dynamic interaction between people and the physical and social environments in which they live. SET proposes that multiple levels of influence on behavior interact across levels. The individual level contains factors such as attitudes, beliefs, biology, psychology, and development (McLeroy et al., 1988). The interpersonal level refers to social, cultural, formal, and informal social networks and support systems (McLeroy et al., 1988). The organizational or institutional level contains policies, rules, regulations, and social institutions (McLeroy et al., 1988). The community level includes relationships between organizations or institutions and formal and informal networks (McLeroy et al., 1988). Finally, the public policy level includes local, state, and national laws, policies, rules, and regulations (McLeroy et al., 1988). While SET identifies a bidirectional association among constructs, it does not have a well-defined path model. However, later integrated models use SET as an underlying conceptual framework.

Life Course Health Development Theory

The LCHD framework explains how positive and negative influences affect an individual’s health trajectory over a lifetime (Halfon & Hochstein, 2002). LCHD combines theory from public health, medicine, human development, and social sciences. LCHD posits that health is the cumulative effect of determinants from genetic, behavioral, biological, social, and economic contexts that change with time and have different consequences at different times during an individual’s life (Halfon & Hochstein, 2002). The unique attributes of LCHD are related to timing and accumulation of positive and negative exposures as influences on health. LCHD introduces concepts such as genetics, perinatal birth characteristics such as prematurity and low birth weight, and the effect of social isolation and discrimination during childhood as factors that influence self-confidence and participation in PA during adolescence. LCHD explains the influence of adverse childhood experiences with PA, such as pain, wearing leg braces, being excluded from gym classes, and feeling socially isolated, which contributed to feelings of inferiority and decreased motivation to participate in PA in the life of a woman with CP (Gaskin et al., 2012).

International Classification of Functioning, Disability, and Health

SET is the foundation for integrated theoretical frameworks such as the ICF (WHO, 2001). The ICF creates language to describe disability and health. The ICF is considered a biopsychosocial model; it posits that impairment and disability form through the dynamic interaction between a person's ability and his or her physical, social, and attitudinal environments. Within the ICF, *body functions* are the physiological and psychological functions of body systems; *body structures* are the anatomic organs and systems that support body functions. *Impairments* are problems with body structures or body functions. *Activity* is the execution of a task, subdivided into a person's *capacity* to function in a standard environment and his or her *performance* within the person's current environment. *Participation* is involvement in a life situation. *Activity limitations* are difficulties in performing activities, while *participation restrictions* are problems with involvement in life situations. Activity limitations and participation restrictions are influenced by *personal factors*, internal influences, and *external environmental factors* from the physical, social, and attitudinal worlds. Internal influences include the concepts of self-efficacy and behavioral intention from SCT and the TPB as well as the ecological constructs of the environment from SET. While the ICF is a standard language for discussing health and disability, the framework is conceptual rather than causal. It does not model the process through which body structures and functions lead to disability under the influence of personal and environmental factors.

PA for People With a Disability Model

Additional work toward an integrated path model specific to PA and people with a disability was done by van der Ploeg et al. (2004) in the PAPDM. The PAPDM extends the ICF by expanding personal factors to include facilitators and barriers such as energy, time, money, motivation, and skills as well as self-efficacy, intention, and attitude. The PAPDM includes external facilitators and barriers such as transportation availability and access to facilities, equipment, and other factors from the HBM and social influence from the TPB and SCT as environmental factors. It also includes the influence of personal attitudes, beliefs, self-efficacy, and biological and pathophysiological factors on intention as personal factors. The PAPDM hypothesizes a bidirectional relationship between personal and environmental factors, consistent with SET, and uses intention as a mediator between having the capacity to be active and achieving participation in PA. It includes the influence of the health condition and its interaction with self-efficacy on determining intention to participate.

The PAPDM predicts that someone with a severe motor impairment, resilient attitude, and strong desire to be active may find creative ways to become and remain active despite his or her impairment, as demonstrated in the work of Gannotti et al.

(2015). This model was used as the conceptual framework for understanding the barriers to and facilitators of participation in PA for children and adolescents with physical disabilities based on both qualitative and quantitative studies that included a majority of youths with CP (Bloemen, Backx, et al., 2015). Bloemen, Backx, et al. (2015) recommended more research to understand strengths of association and to confirm the paths of action for this model to provide a guide for future policy and intervention.

King and colleagues (King, Law, Hanna, et al., 2006; King et al., 2003) proposed an alternative conceptual framework grounded in SET based on a review of the literature on participation of people with disabilities, risk and resilience, determinants of participation, and factors influencing PA. The conceptual model includes direct and indirect effects at the child, family, and environmental levels. The model was tested using the first wave of data from a prospective, longitudinal cohort study of 427 youths aged 6–8, 9–11, and greater than 12 years with a range of disabilities, including amputation, CP, stroke, congenital anomalies, orthopedic conditions, spina bifida, and other conditions.

Using self-administered questionnaires for the parent and child, King and her colleagues used structural equation modeling (SEM) to validate direct and indirect pathways to predict the intensity of formal and informal participation. Child functional ability, child preferences for informal activities, and family participation in social and recreational activities explained 30% of the variance in intensity of informal participation. Family intellectual and cultural orientation, child preferences for formal activities, child functional ability, and family participation in social and recreational activities explained 18% of the variance in intensity of formal participation. Additionally, family income; unsupportive physical, social, and attitudinal environments; family cohesion; and supportive relationships for the child indirectly influenced intensity of formal or informal participation. This work showed that participation is a complex construct influenced by multiple factors acting within a social–ecological framework. However, the work of King and her colleagues did not focus on participation in health-enhancing PA.

Conceptual Framework of the Study

The conceptual framework for my dissertation is grounded in the PAPDM (van der Ploeg et al., 2004), an extension of WHO's ICF biopsychosocial framework (WHO, 2001) that includes a life course health perspective (Halfon & Hochstein, 2002). The primary constructs include body structures and functions, activities and participation, and personal and environmental (physical, social, attitudinal) factors from the ICF, integrated with intention, attitude, and self-efficacy from the TPB (Ajzen, 1991) and SCT (Bandura, 1977). These theories are derived from SET (McLeroy et al., 1988), expanding the personal and environmental factors to include effects from personal, family, social, organizational, community, and physical environmental levels.

The primary assumptions include that health is an interaction of individuals with the physical, social, and attitudinal worlds in which they live. The association between capacity, what a person can do, and participation and involvement in life experiences is mediated by impairments in body structures and body functions. Intention moderates the translation of functional capacity into participation in health-enhancing PA. Intention is influenced by modifiable personal factors such as having confidence in one's abilities (self-efficacy); having a positive attitude toward participation in PA; individual preferences for PA; body mass index; and fixed personal factors such as race/ethnicity, sex, and age. These primary drivers are moderated and mediated by more distal influences such as family supports and resources; societal attitudes; organizations with staff, equipment, and programs appropriate for people with disabilities; communities with features that make PA both possible and enjoyable; weather and temperature; and the built environment, among others. Figure 1 illustrates a path model describing the complex interactions. Further details regarding the proposed determinants of PA are shown in the measurement models in Figures 2 and 3.

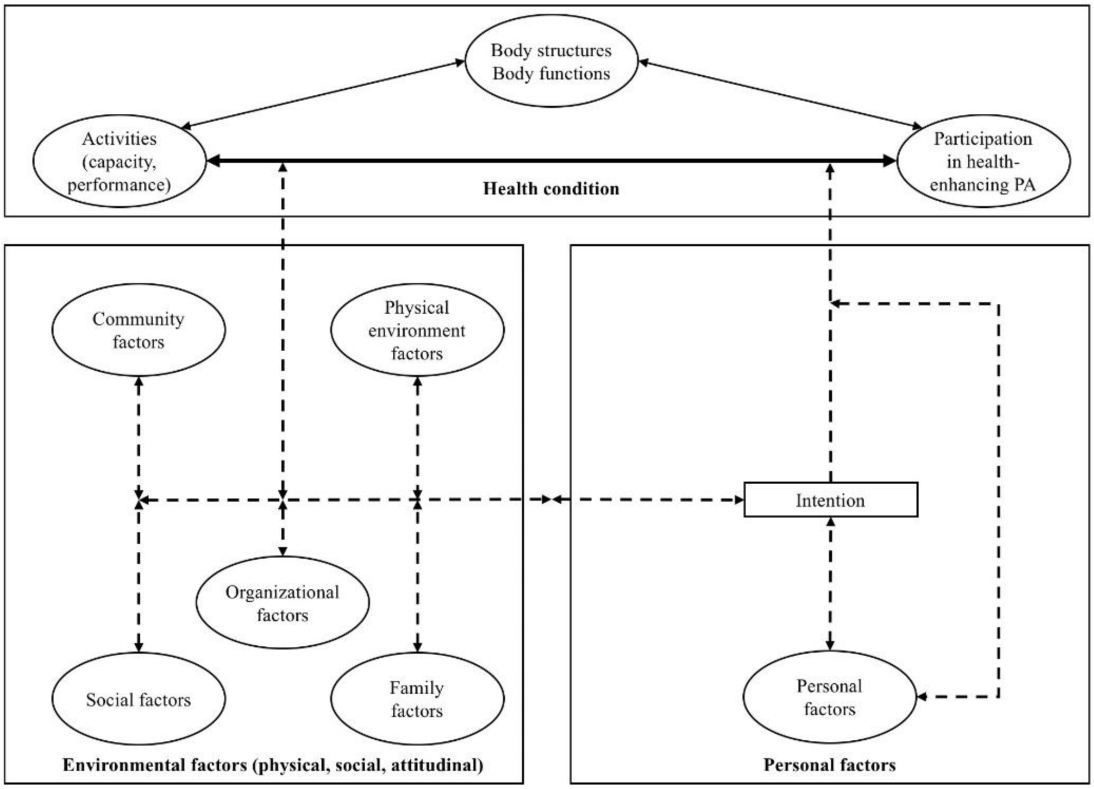

Figure 1. Path model of factors influencing PA.

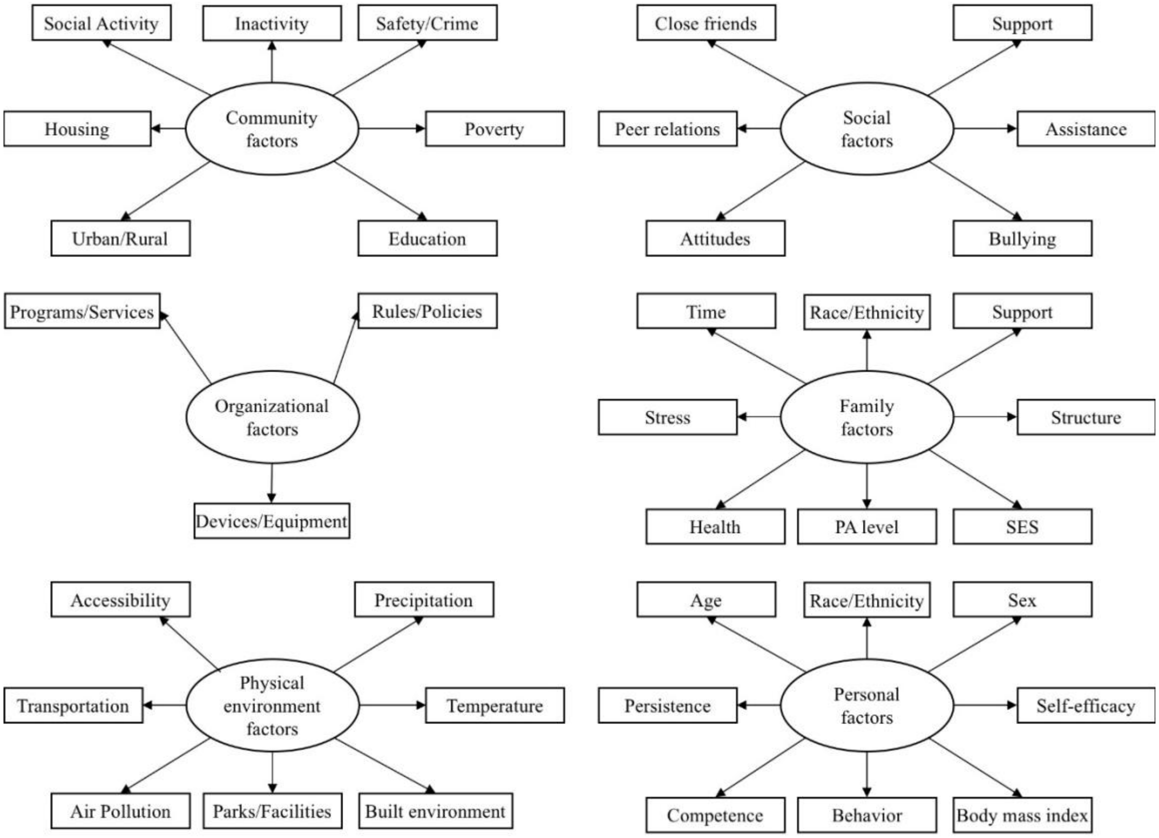

Figure 2. Measurement model of social and ecological factors influencing PA.

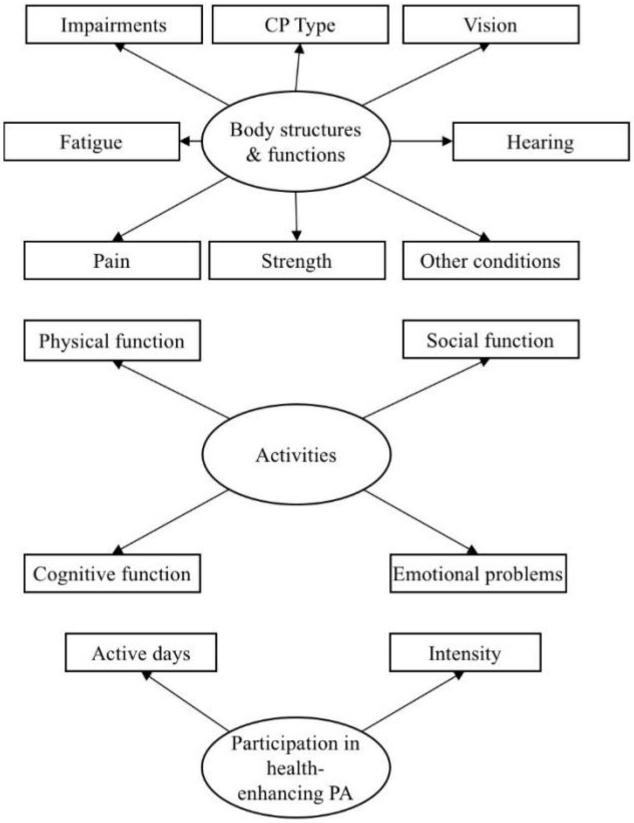

Figure 3. Measurement model of health-related factors influencing PA.

Literature Review Related to Key Variables and Concepts

The key constructs within my research question include PA, CP, participation, and factors influencing the participation of youths with CP in health-enhancing levels of PA. I review the literature surrounding each of these factors in the context of my research question and within a social–ecological framework as conceptualized through the PAPDM and ICF, my selected conceptual frameworks.

Physical Activity

PA is any bodily movement produced by the muscles that expends more energy than sitting (WHO, 2010). It can take place at home, at school, in the workplace, or in the community as part of leisure, recreation, occupation, or transportation through informal or organized activities. For children and adolescents, PA takes place in the home, school, and community environments during chores, play, sports, transportation, leisure recreation, and physical education (WHO, 2010). Participation in adequate amounts of PA is essential for achieving and maintaining individual health and is a crucial population-based public health strategy for prevention of noncommunicable diseases. In the United States, two of the Healthy People 2020 objectives are to “reduce the proportion of people with disabilities who report physical or program barriers to local health and wellness programs” and to “increase the proportion of adolescents who meet current Federal PA guidelines for aerobic PA” (U.S. Department of Health and Human Services, 2018b). Only 28.7% of adolescents met this guideline in 2011 (U.S. Department of Health and Human Services, 2018a). Comparatively, 2%–7% of adolescents with CP met this guideline (Verschuren et al., 2016), providing the basis for this dissertation proposal.

Early studies. While PA is now universally recognized as important for health, the evidence supporting its relationship with health is relatively recent. Morris, Heady, Raffle, Roberts, and Parks (1953) published the earliest epidemiological investigation of PA and its relation to coronary heart disease by examining the PA levels in mail carriers and bus conductors in London; they showed a 50% reduced risk of heart disease for having a physically active job. During the 1970s through 1990s, the findings from large epidemiological investigations on Harvard alumni illustrated that being more active reduced risk of death from coronary heart disease by 50% (Paffenbarger & Hale, 1975). Beginning moderately vigorous PA reduced the risk of death by 23% compared to remaining inactive for men aged 45–84 years (Paffenbarger et al., 1993). These early studies were foundational for the creation of public health PA recommendations.

In 1995, the CDC made the first national recommendation that all adults should accumulate at least 30 min of moderate to vigorous PA (MVPA) on most days of the week (Office of Disease Prevention and Health Promotion, 2007). Accumulating evidence on the link between PA and multiple health outcomes led the WHO to recommend in 2004 that all countries create national plans and policies for increasing PA through safe transportation to schools and workplaces and access to recreational environments (WHO, 2010). In 2008 and 2018, the CDC updated the national strategy on health promotion and prevention of chronic disease to include PA and muscle and bone strengthening for all adults and youth ages 6 years and older, regardless of disability status (U.S. Department of Health and Human Services, 2008, 2018b).

The WHO advocates that participation in adequate amounts of PA is vital for all people at all stages of their lives to maintain physical, social, and mental health and to prevent diabetes and certain forms of cancer (WHO, 2010). The WHO “Global Recommendations on PA for Health” emphasize primary prevention of coronary heart disease, cardiovascular disease, stroke, hypertension, diabetes, obesity, osteoporosis, breast and colon cancer, functional health, and depression through promotion of PA for all people of all ages, regardless of gender, race, ethnicity, or income level (WHO, 2010). The 2008 CDC and 2010 WHO guidelines recommend that all children and adolescents get at least 60 min of MVPA every day (WHO, 2010).

Prevalence of physical inactivity. Despite knowledge of the importance of being physically active, the prevalence of meeting PA recommendations varies by country, race, sex, and age. Globally, 31.1% of adults and 80.3% of adolescents do not attain recommended weekly PA levels (Hallal et al., 2012). While PA is a personal health behavior, it is influenced by multiple environmental, social, and economic factors. In a cross-sectional study by Hunter, Boeri, Tully, Donnelly, and Kee (2015), among adults in Ireland, the likelihood of participating in sufficient amounts of PA varied from 3% (95% CI [1, 6]) for single, unemployed males aged 55 years or older with a high school education, no children, no disability, no car, poor health, and living in the most deprived neighborhood to 38% (95% CI [29, 47]) for healthy, employed, single women aged 16–34 years with no children, no disability, good health, access to a motor vehicle, and living in the least deprived neighborhoods. Ability to meet PA recommendations varies by the factors within a social–ecological framework.

Population attributable fraction of PA for health outcomes. PA is essential for maintaining health for everyone. The overall health benefits from participation in PA accumulate to all people, regardless of age, race, sex, or disability status at any time it is started and at any dose above no involvement (Manini, 2015). Physical inactivity has an influence on health equivalent to that of smoking, diet, or alcohol (Kohl et al., 2012), influencing multiple body systems and organs (Kohl et al., 2012). As a result, participation in PA is one of the most significant public health preventive strategies and has a high level of return on investment. Using secondary analysis of the 2002 global observatory data, the WHO estimated the mortality and burden of disease attributable to selected major chronic health conditions and concluded that physical inactivity was the fourth leading cause of death, contributing to 6%, or 3.2 million, of all deaths globally in 2002, behind hypertension (11%), smoking (9%), and diabetes (WHO, 2009). Physical inactivity was attributable for 21%–25% of breast and colon cancer, 27% of diabetes, and 30% of heart disease (WHO, 2009). Furthermore, Lee et al. (2012) found that physical inactivity accounted for 6%–10% of all noncommunicable diseases, including 6% of deaths from cardiovascular disease, 7% of deaths from type 2 diabetes, 10% of deaths from breast and colon cancers, and 9% of premature deaths from other causes. Lack of PA causes poor health.

Being physically inactive also increases the costs of health care. Carlson, Fulton, Pratt, Yang, and Adams (2015) estimated that 11.1% (95% CI [7.3, 14.9]), or $117 billion in health care costs, or $1,313 per inactive person, was attributable to being physically inactive. Using secondary data from the WHO global observatory, Pratt, Norris, Lobelo, Roux, and Wang (2014) concluded that physical inactivity is attributable for 1.0%–2.6% of national direct health care costs for adults in developed countries and

2.5%–3.3% in developing countries. Because of the prevalence of inactivity, its link to the development of noncommunicable disease, and the resulting economic impact, PA is a critically important public health topic.

Association of PA with morbidity and mortality. The evidence supporting a causal association between participation in PA and health is strong for adults. Multiple cross-sectional and longitudinal studies have identified a *U*-shaped dose–response relationship between PA and health for adults (Almeida et al., 2014; Arem et al., 2015; Carlson et al., 2015; Carroll et al., 2014; Ekelund et al., 2016). Reiner, Niermann, Jekauc, and Woll (2013) completed a systematic review of 15 longitudinal cohort studies published between 1980 and 2012 that followed 288,724 adults aged 18–85 years for 6–60 years to review the long-term association between participation in PA and obesity, coronary heart disease, type 2 diabetes, and dementia. They concluded that participation in MVPA reduced the risk of all disease outcomes and followed a dose–response relationship. Other studies have shown that participating in adequate amounts of PA decreased risk of mortality by 12%–39% (Almeida et al., 2014; Ekelund et al., 2016) and risk of many noncommunicable diseases by up to 50% (Carroll et al., 2014), including risk of breast cancer by 3%–6%, colon cancer by 10%–21%, diabetes by 14%–28%, heart disease by 10%–25%, and stroke by 10%–26% (Kyu et al., 2016). However, the health benefits of PA are present even if people do not meet recommended levels. The minimum dose of PA to achieve health benefits is not known.

Several studies have examined the health benefit of partially achieving recommended levels of PA. In a secondary data analysis of 1999–2004 NHANES data on 10,535 U.S. adults, Zhao et al. (2014) found a 36% (HR .64, 95% CI [.52, .79]) decreased risk for all-cause mortality among those who fully met recommendations for participation in more than 150 min of MVPA weekly compared to those who did not meet the recommendation. The findings of this study also demonstrated a 28% (HR .72, 95% CI [.54, .97]) decreased risk for those who were active but did not fully meet recommendations. In a large cohort of adults from Europe and the U.S., Arem et al. (2015) found that adults who participated in at least some PA, even if less than the recommended amount, decreased their risk of mortality from any cause (HR 0.80, 95% CI [.78, .82]). Those who participated in more than the recommended amount increased their protection (1–2 times: HR 0.69, 95% CI [.67, .70]; 2–3 times: HR 0.63, 95% CI [.62, .65]; 3–5 times: HR 0.61, 95% CI [.59, .62]). Those who had the highest amount of PA had less incremental benefit from increasing levels of PA but had no increased harm (HR 0.69, 95% CI [.59, .78]).

Additionally, the benefit derived from PA mediated the increased risk of mortality and morbidity from 3–5 hours of sitting (Ekelund et al., 2016). In a prospective study of 1,794 adults aged 45–79 years with or at risk of knee osteoarthritis, Sun et al. (2014) estimated that participation in recommended amounts of PA increased quality-adjusted life-years by 6%–10%. Achieving at least some PA has a substantial health benefit for adults and can improve quality of life.

The benefits of PA for children and adolescents mirror those of adults. Several large systematic reviews have generated high-level evidence supporting the role of PA on health for youth. Based on a systematic review of 86 papers from 1980 to 2008 evaluating the association between PA and health outcomes in school-aged youth, Janssen and Leblanc (2010) concluded that participation in PA was linked to decreased risk of cardiovascular disease, high cholesterol, metabolic syndrome, high blood pressure, obesity, decreased bone mineral density, depression, and injuries. In 'Identification and Prevention of Dietary- and Lifestyle-induced Health Effects in Children and Infants (IDEFICS),' a cross-sectional study in Spain of 16,224 children aged 2–9 years, the least active youths had increased risk of cardiovascular disease compared to the most active youths (boys OR 3.26, 95% CI [1.74, 6.10]; girls OR 2.54, 95% CI [1.33, 4.86]; (Jiménez-Pavón et al., 2013). Most recently, based on a systematic review of 162 studies of 204,171 youths aged 5–17 years from 21 countries, Poitras et al. (2016) concluded that participation in PA for any duration and at any intensity is associated with better physical, social, and mental health in school-aged children. Involvement in PA is critical for the development of physical, social, and mental health among youths.

Construct of participation in PA. Within the reviewed literature, the scope of the construct of participation differs between the fields of public health and disability studies and rehabilitation. Participation in health-enhancing PA is defined by the number of days meeting minimum guidelines of MVPA. It is operationalized in survey tools, such as the Global PA Questionnaire (Cleland et al., 2014) and the International PA

Questionnaire (Guedes, Lopes, & Guedes, 2005), used in large epidemiological studies. Some investigators have converted the frequency of participation to dose using scaling factors to estimate metabolic equivalents (METs; (Arem et al., 2015). METs of PA have been estimated for adults (Ainsworth et al., 2011) and youths (Harrell et al., 2005; Ridley, Ainsworth, & Olds, 2008) but not for youths with disabilities.

Within the fields of disability studies and rehabilitation, participation has a broader context that includes dimensions of enjoyment, socialization, and activity (Kang, Palisano, King, & Chiarello, 2014; King et al., 2004; King et al., 2003). This conceptualization reflects the dynamic interaction between the person and the physical, social, and attitudinal worlds; through involvement in life situations, individuals derive physical, social, and mental health benefits. Within this context, participation in PA is multidimensional, influenced by the type of PA (active, recreational, social, skill based, or self-improvement), personal and family preferences for type of activity, intensity (frequency, type, time), diversity, location (home, school, community), level of organization (organized, informal), companionship (with family or friends, or alone), and enjoyment, measured by parental or self-report in many of the reviewed studies (Bult et al., 2011; King et al., 2014; King, Law, Hurley, Petrenchik, & Schwellnus, 2010; King, Law, Petrenchik, & Hurley, 2013; King, Petrenchik, et al., 2010; Longo et al., 2013; Majnemer et al., 2015; Orlin et al., 2010; Palisano et al., 2011; Raghavendra, Virgo, Olsson, Connell, & Lane, 2011; Shields et al., 2015; Shikako-Thomas et al., 2013; Woodmansee et al., 2016). Participation in PA is measured through subjective parent or self-report using surveys and questionnaires such as the Children's Assessment of Participation and Enjoyment (King et al., 2004), Participation and Environment Measure for Children and Youth (Coster et al., 2011; Coster et al., 2012), Activities Scale for Kids – Performance version (Young, Williams, Yoshida, & Wright, 2000), and Assessment of Life Habits (Noreau, Fougeyrollas, & Vincent, 2002). However, other studies have employed objective measurement of PA using accelerometers (Bjornson et al., 2007; Mitchell et al., 2015a; Mitchell, Ziviani, & Boyd, 2015b).

Cerebral Palsy

CP is one of the most common motor disabilities among children and adolescents in developed countries (Eunson, 2016). Rather than a specific diagnosis, CP is a descriptor term for a group of nonprogressive injuries to the developing brain that occur during the prenatal, perinatal, or postnatal period up to about age 2 years, caused by environmental, social, genetic, and medical risk factors (Blair & Watson, 2006). The secondary effects of the injury, including spasticity, weakness, and poor motor control, affect gross motor function throughout life and are often accompanied by additional impairments, such as vision, hearing, communication, nutrition, and other significant comorbidities (Eunson, 2016). While CP is nonprogressive, gross motor function deteriorates with age, resulting in decreasing levels of PA, social isolation, and discrimination that contribute to increased risk of CVD as adults (Peterson, Gordon, & Hurvitz, 2013; Peterson, Ryan, Hurvitz, & Mahmoudi, 2015).

Prevalence and risk factors. The prevalence of CP has been estimated at 3.1 (95% CI [2.8, 3.4]) per 1,000 live births and is higher for male newborns (3.6/1,000, 95% CI [3.2, 4.1]) and mothers of Black non-Hispanic race and ethnicity (3.9/1,000, 95% CI [3.3, 4.5]; (Christensen et al., 2014). Eunson (2016) and Solaski, Majnemer, and Oskoui (2014) have found that mothers in the lowest socioeconomic stratum were 30%–80% more likely to have an infant with CP than mothers in the highest socioeconomic stratum. The prevalence of CP has been supported by secondary analysis of national surveys in the U.S. at 2.6/1,000 live births (95% CI [2.1, 3.1]; (Maenner et al., 2016); at 3.5/1,000 live births (95% CI [3.2, 3.0]) through a U.S. regional monitoring system (Durkin et al., 2016); and at 2.11/1,000 live births (95% CI [1.98, 2.25]) through systematic review and meta-analysis of 49 studies from multiple countries from 1985 to 2011 (Oskoui et al., 2013).

The most significant risk factors include low birth weight and prematurity; prevalence increases to 59.28 per 1,000 live births for infants with birth weights between 1,000 and 1,499 g and to 111.80 per 1,000 live births for those born before 28 weeks' gestation (Oskoui et al., 2013). Additional preconception, prenatal, perinatal, and neonatal risk factors include major birth defects (HR 4.8, 95% CI [2.7, 8.5]; (Blair & Nelson, 2015), maternal age under 18 years (HR 2.1, 95% CI [1.1, 4.2]), maternal fever at time of delivery (HR 5.4, 95% CI [2.0, 15.0]), maternal syphilis during pregnancy (HR 10.2, 95% CI [1.4, 76.0]; (Pan, Deroche, Mann, McDermott, & Hardin, 2014), maternal hypertension (HR 4.8, 95% CI [2.7, 8.5]; (Blair & Nelson, 2015), maternal urinary tract infection (HR 2.1, 95% CI [1.4, 3.2]) or use of nitrofurantoin-based antibiotics during the first trimester (HR 1.7, 95% CI [1.1, 2.8]; (Miller et al., 2013), neonatal sepsis (HR 2.1, 95% CI [1.8, 2.5]; (Alkaikh, Yusuf, & Sauve, 2013), severe maternal obesity (HR 2.0, 95% CI [1.0, 4.0]; (Pan et al., 2014), birth asphyxia (HR 108.7, 95% CI [97.7, 120.9]; (Villamor et al., 2017), breech or Cesarean delivery, and placental dysfunction (McIntyre et al., 2013). McIntyre et al. (2013)additionally found that low birth weight and prematurity increased the risk of CP through a dose–response relationship in the presence of other risk factors. McMichael et al. (2015) identified novel gene mutations that could interact with social, physical, economic, and environmental factors to trigger the injury that causes CP and estimated that genetic factors could explain 14%–30% of CP cases. The risk factors for CP are myriad and act at different times from just after conception to during the early childhood years and through different exposure routes.

Few factors have been found to be protective against risk of CP. Immigrant status was found to be protective against CP in one study performed in Canada (HR .77, 95% CI [.67, .88]) after adjusting for other risk factors (Ray et al., 2014). Injection of a bolus dose of magnesium sulfate during birth was found to be neuroprotective with a moderately reduced risk of developing CP (RR .69, 95% CI [.55, .88]); (Conde-Agudelo & Romero, 2009). At this point, there is no known cure or prevention for CP.

Classification of cerebral palsy. CP is characterized according to the site and extent of injury to the developing brain and by physiological, topographical, and functional severity classification systems (Pakula, Van Naarden Braun, & Yeargin-

Allsopp, 2009). Physiologic classifications divide CP into those with pyramidal involvement (85%), characterized by the presence of spasticity, and nonpyramidal involvement (15%), characterized by abnormality in tone or motor control, such as chorea, athetosis, dystonia, or ataxia (Pakula et al., 2009). Topographical classification divides CP into hemiplegia, involving unilateral upper and lower extremities; diplegia, involving bilateral lower extremities; triplegia, involving three extremities; and quadriplegia, involving all four extremities (Pakula et al., 2009). Functional severity is characterized by scales such as the Gross Motor Function Classification System, which rates mobility on a 5-point scale from least impaired (Level I, able to keep up with peers) to most impaired (Level V, uses a motorized wheelchair for mobility; (Pakula et al., 2009). Based on U.S. population-based national surveillance data, Christensen et al. (2014) found that 40.4% of 8-year-olds with CP functioned at GMFCS Level I, 15.2% at Level II, 12.3% at Level III, 16.8% at Level IV, and 15.2% at Level V.

Societal costs of cerebral palsy. While CP is not progressive, the motor impairments create increasing challenges for participation in social and economic roles with growth and age (Oskoui et al., 2013). The total direct costs for persons with cerebral palsy born in 2000 were estimated at $11.5 billion in 2003 dollars by the CDC or an estimated $1 million in lifetime costs for care per person with CP (Oskoui et al., 2013). Indirect costs from physical impairments that limit the ability to fulfill social and economic roles were estimated at 2–5 times the direct costs, highlighting the cost to society for a prevalent condition affecting physical functioning (CDC, 2004).

The expectation of a long life magnifies the prevalence and economic impact of CP. Brooks et al. (2014) estimated that the life expectancy of a 15-year-old with CP who can walk without assistance (GMFCS Level I–II) is 55 years for females compared to 66.2 years in the general population and 52 years for males compared to 61.4 years in the general population. The combination of prevalence, long life, and substantial physical disability creates a high impact of this population on health care systems that are important for allocation of health care dollars, policy development, and health care planning.

PA Levels of People With Cerebral Palsy

Disability is the result of the interaction between the individual and his or her physical, social, and attitudinal environments. It is necessary to empower people and enable access to all environments and activities (Rimmer & Rowland, 2008).

Combining findings from the literature on PA in children with CP, Verschuren et al. (2016) reported that youths with CP spent 76% (GMFCS Level I) to 99% (GMFCS Level V) of their day sedentary; that 2% (GMFCS Level V) to 18% (GMFCS Level I) consistently engage in leisure-time PA (LPA), and that 2% (GMFCS Level III) to 7% (GMFCS Level I) consistently engage in MVPA. Only those in GMFCS Levels I–III participated in any MVPA. Despite recommendations for involvement in at least 60 min of MVPA on at least 5 days each week, few youths with CP meet these guidelines. Comparing youths with disabilities to those without, Bedell et al. (2013) reported that 87% of youths with disabilities never participated in organized physical activities, compared to 24% of youths without disabilities, and that 55% of youths with disabilities never engaged in unstructured physical activities, compared to 5% of youths without disabilities.

People with CP of all ages accumulate lower levels of PA than their age- and sex-matched peers. In a cross-sectional study of 81 ambulatory (GMFCS Levels I–III) youths with CP aged 10–13 years, Bjornson et al. (2007) used accelerometers to compare the steps, total active time, and time spent in moderate to vigorous PA with a matched typically developing (TD) population. Youths with CP achieved an average of 4,222 steps/day compared to 6,739 for the TD group. Additionally, youths with CP had less overall active time (40.2% vs. 29.6%) and less time in moderate to vigorous activity (5.6% vs. 9.7%). These findings were supported in similar studies by Capio, Sit, Abernethy, and Masters (2012) and Bratteby Tollerz et al. (2015) for primary school children and by Maher, Williams, Olds, and Lane (2007) for adolescents aged 11–17 years with and without CP. In a cross-sectional cohort study with matched controls, Maher, Kernot, and Olds (2013) used a multimedia activity recall survey for adolescents aged 11–17 years with CP and determined that youths with CP spent less time in PA (91 vs. 147 min per day), less time in active transport (28 vs. 52 min per day), less time in MVPA (79 vs. 131 min per day), more sedentary time (116 vs. 80 min per day), and less time socializing with friends (6 vs. 20 min per day).

In a further cross-sectional study in Australia, Mitchell et al. (2015b) used accelerometers to measure the daily PA patterns of 102 ambulatory children and youths with unilateral CP (hemiplegia, GMFCS Levels I and II) and found that only 25% met recommended PA guidelines. Mitchell et al. (2015b) found that youths with CP were inactive for 43 min of every hour and achieved MVPA for only 3.7 min each hour. Boys attained these recommendations more often than girls, and younger children achieved them more often than adolescents or adults. Youths with CP were more active on weekdays than on weekends.

In a cross-sectional postal survey of 159 adults, aged 17–74 years, Hamrah Nedjad, Jansson, and Bartonek (2013) found that only 14% achieved the recommended levels of PA, although 34% achieved at least 150 min of light PA weekly. In a cross-sectional study of 45 ambulatory adolescents aged 15–20 years with CP functioning at GMFCS Levels II and III, Bania et al. (2014) reported 20 hours per day of sedentary time, achieving daily step counts of 4,992 and an average of 32 METs per day of energy expenditure. Within this group of more involved adolescents, only 4% met weekly recommended PA levels. The studies using accelerometers are limited by not being worn during swimming, which has been found to be the most common PA for youths with CP (Badia, Orgaz, Verdugo, & Ullan, 2013; Longo et al., 2013; Shikako-Thomas et al., 2015; van Eck et al., 2008; Woodmansee et al., 2016). The evidence is consistent and clear that young children, adolescents, and adults with CP are less active, have more sedentary time, and generally do not meet recommended levels of PA.

Risk from reduced PA for people with cerebral palsy. Because of their decreased levels of PA, people with CP have higher levels of cardiovascular risk than their age- and sex-matched peers without CP. Ryan, Crowley, et al. (2014) completed a cross-sectional study of 41 ambulatory adults aged 18–62 years with CP to determine the association of participation in PA with markers of cardiovascular disease. They found that level of physical functioning was related to time spent in MVPA. Of those functioning at GMFCS Level I, 53.8% participated in the recommended 150 min of PA weekly, while 16.7% of those at GMFCS Level II and 0% of those at GMFCS Level III met the recommended standards for PA. Furthermore, duration of participation in MVPA was negatively related to cardiometabolic risk factors, including waist-height ratio, $r = -.538$, $p < .05$, waist circumference, $r = -.518$, $p < .05$, systolic blood pressure, $r = -.592$, $p < .05$, and diastolic blood pressure, $r = -.636$, $p < .05$.

In a second cross-sectional study, Ryan, Hensey, McLoughlin, Lyons, and Gormley (2014) examined the association between PA, overweight/obesity, and high blood pressure in 90 ambulatory youths aged 6–17 years with CP. They found that 18.9% of the participants were obese, 22% were hypertensive or prehypertensive, and participation in vigorous PA reduced risk of high blood pressure (OR .6, 95% CI [.37, .99]). Because of decreased ability to meet recommended levels of PA, people with CP experience higher risk of obesity, hypertension, diabetes, cardiovascular disease, and other chronic illness.

Factors Influencing Participation in Health-Enhancing PA

Both qualitative and quantitative studies have provided evidence of a diverse array of factors acting at multiple levels that influence whether a youth with a physical disability, such as CP, will participate in PA. Evidence from these studies suggests that participation in PA is determined within a social–ecological framework that includes intrapersonal, interpersonal, organizational, and environmental levels as embodied with the ICF framework (Bauman et al., 2012; Bedell et al., 2013; Bloemen, Backx, et al., 2015; Bloemen, Verschuren, et al., 2015; Buffart et al., 2009; Bult et al., 2011; Chang et al., 2014; Colver et al., 2012; Dahan-Oliel et al., 2014; Di Marino, Tremblay, Khetani, & Anaby, 2017; King, Law, Hanna, et al., 2006; Law, Petrenchik, King, & Hurley, 2007; Li et al., 2016; Shields & Synnot, 2016; Shields et al., 2012; Shimmell et al., 2013; Tseng, Chen, Shieh, Lu, & Huang, 2011; Verschuren et al., 2012). Investigators have used different approaches to understand barriers and facilitators and have conceptualized participation in multiple ways.

In seminal work following the introduction of the ICF and PAPDM frameworks and national recommendations for participation in PA, King, Law, Hanna, et al. (2006) performed a quantitative, longitudinal cohort study using home interview and self-administered questionnaires to examine the patterns and predictors of participation in recreational and leisure activities for 427 youths, aged 6–14 years, with complex physical disabilities, of whom 50% had CP. Using SEM, they determined that significant paths to informal participation included child functional ability, *r* = .39, child preference for activities, *r* = .31, and family participation in social and recreational activities, *r* = .28. Factors at the personal and family levels had weak to moderate correlation with participation. However, the authors did not include additional variables to measure more about the home, school, and community environments.

In another study focusing on the interaction of proximal barriers with the home, school, and community environments, Law et al. (2007) indicated that age, socioeconomic status, level of physical function, and behavioral difficulties moderated the impact of the physical, social, and attitudinal environments on participation for youths with disabilities. This work was extended by Imms (2008) through a systematic review of studies on the involvement of youths with CP in PA. She concluded that participation is (a) a complex construct that varies in meaning across perspectives; (b) influenced by interpersonal, organizational, and environmental factors that act directly and indirectly through personal factors; and (c) most commonly affected by social attitudes and the physical environment. Further work through systematic review by Shikako-Thomas, Majnemer, Law, and Lach (2009) identified child, environment, and family factors as determinants of participation, consistent with the conceptual framework proposed by King et al. (2003). There is agreement in the literature that the influences of participation in PA act from different levels through a social–ecological framework. However, the definition of participation continues to be refined, the construct of participation in health-enhancing PA is not widely utilized, and how different levels interact to promote or restrict participation is not well known. The influence of factors at different levels has been conceptualized using the ICF framework of body structure and function, activity, and participation influenced by a combination of personal and environmental factors.

Body structures and functions. *Body functions* are the physiological and psychological functions of body systems; *body structures* are the anatomic organs and systems that support body functions (WHO, 2001). Pain, fatigue, muscle power, motor control, spasticity, and comorbid conditions influence participation at the level of body structure and function (Barnett, Dawes, & Wilmut, 2013; Bloemen, Backx, et al., 2015; Bult et al., 2011; Shimmell et al., 2013; Verschuren et al., 2012). As the levels of impairment, pain, spasticity, and fatigue increase, participation in PA is likely to decrease. With increasing motor control and muscle power, participation is likely to increase.

Quantitative studies have built on early qualitative knowledge to characterize the strength and direction of the relationship between factors acting at the body and structure levels with participation outcomes. Dang et al. (2014) examined a multinational longitudinal sample of 594 adolescents aged 13–17 years with CP to determine childhood factors that predicted participation as an adolescent. They concluded that frequency and severity of pain during childhood restricted adolescent participation across all domains after adjusting for level of impairment, sex, region, and age.

Oeffinger et al. (2014) examined the influence of measures of body structure and function on activity and participation in 377 ambulatory youths with CP aged 8–18 years using linear regression. The findings from this study suggested that strength, body composition, and magnitude of gait impairment explain 11%–50% of the variance in measures of activity and participation. Furthermore, Raghavendra et al. (2011) compared the involvement of youths aged 10–15 years with CP without communication problems and those with complex communication needs to TD peers. They found that youths with complex communication needs participated in activities closer to home rather than in the community and participated in fewer social activities. Their findings suggest that communication impairment may challenge participation. In both studies, higher levels of impairment were associated with lower levels of activity and participation, validating that impairment of body function and structure has a moderately strong relationship with PA. However, the large amount of unexplained variance suggests that other factors are involved.

Additionally, the authors did not examine factors at other levels or examine participation in health-enhancing PA. Some literature on severely involved individuals with CP has demonstrated that people can accommodate their limitations in body structure and function to find ways to participate in PA at very high levels (Gannotti et al., 2015). These findings present an opportunity to understand better what factors act, how strong the influence is, and by what pathways they either restrict or promote participation in health-enhancing PA.

Activities. The *activities* construct of the ICF includes the concepts of *capacity* and *performance*. Capacity is what someone *can* do without the influence of personal and environmental barriers, while performance is what someone *does* do, given his or her capacity, in the person’s unique environment (Alghamdi, Chiarello, Palisano, & McCoy, 2017; WHO, 2001). The differences between capacity and performance operationalize the influences of personal and environmental factors on the gap between what someone can do and how involved he or she is in his or her life. Factors within the capacity domain include physical, social, emotional, and cognitive functioning.

Greater functional capacity is associated with more participation, although personal and environmental factors mediate and moderate this relationship (Imms et al., 2017; King, Imms, et al., 2013; Lee, Kim, & Jeong, 2015; Orlin et al., 2010; WHO, 2001). Different domains of function, such as physical and communication functions, interact in their effect on participation. For example, manual function affects the relationship between gross motor function and participation (Lee, Chung, & Lee, 2015), and the effect of physical impairment on participation is more pronounced for people with communication difficulties (Raghavendra et al., 2011).

In a large quantitative, cross-sectional survey examining the influence of gross motor function on the frequency of participation in family and recreational activities for youths with CP across all GMFCS levels, (Alghamdi et al., 2017) found that gross motor function and communication function explained 28% of the frequency of participation. Their findings confirmed earlier work by Kerr, McDowell, and McDonough (2007) in which gross motor function explained 27% of the variance in participation in ambulatory youths with CP. However, neither of these studies accounted for other personal or environmental barriers that could also have influenced participation, and neither examined participation in health-enhancing PA as the dependent variable.

Meanwhile, Bjornson, Zhou, Stevenson, and Christakis (2013) examined the role of performance on mediating the pathway between capacity and participation and found that performance mediates 75% of the effect of capacity on participation, confirming that important physical, social, and attitudinal factors affect whether youths will participate given their intrinsic physical abilities. Huang, Tseng, Chen, Shieh, and Lu (2013) examined the determinants of participation in PA in the school setting for 167 school-aged children with CP in China using multiple linear regression. They found that receiving therapy in school, having a helper, typology of CP, level of gross motor function, and level of manual function explained 83% of the variance in PA performance. PA performance was negatively affected by manual and gross motor function, receiving in-school therapy, and having a helper. However, it is likely that severity confounded the results of this study. Those who had more severe physical, behavioral, and cognitive function required more in-school therapy and personal assistance. However, this study did not account for other personal or environmental barriers that could have influenced participation and did not examine participation in health-enhancing PA.

Personal factors. The literature on factors influencing participation in PA has focused on four sources of personal factors: demographic factors, such as age, sex, and race/ethnicity; factors related to a health condition, such as type of CP and associated secondary conditions; factors related to attitudes, such as preference for PA, enjoyment, concerns, feelings, mastery motivation, and persistence; and factors related to self-concept, such as self-esteem, self-worth, self-confidence, perceived athletic competence, and athletic identity. Combinations of these personal factors have been used to explain significant amounts of the variance in participation in PA. In a study on 427 school-aged youths with physical disabilities, King, Law, et al. (2013) estimated that personal factors accounted for 7.3% of the variance in participation in active PA. Additionally, the combination of athletic competence, level of physical functioning, age, and family income explained 26% of the variance. Within a social–ecological framework, personal factors impact and are also impacted by influences at other levels.

Demographic factors. Age has a significant effect on participation in PA in TD youth, decreasing participation with increasing age (Katzmarzyk et al., 2016). In a systematic review of participation in leisure activities for youths with CP, Shikako-Thomas et al. (2009) found that increasing age was associated with decreased diversity and intensity of participation, but they did not perform a meta-analysis to quantify the magnitude of the association. In a large cross-sectional survey, Orlin et al. (2010) found that overall participation in all activities differed by age in youths with CP; those younger than 12 years participated more frequently and in more types of activities than those over 12 years. Their findings were supported in a survey study by Badia et al. (2013), in which younger people with physical or intellectual disabilities participated in more PA than older respondents for most activities. Through secondary data analysis of the 2006 Participation and Activity Limitation Survey in Canada, Mâsse, Miller, Shen, Schiariti, and Roxborough (2013) identified that children aged 5–7 or 8–11 years were 1.52 and 1.69 times more likely to be active in supervised school-based activities than those aged

12–14 years. Using accelerometers in a cross-sectional approach, Mitchell et al. (2015a) estimated that participation in MVPA decreased by 24 steps per day with each year of increasing age. Majnemer et al. (2015) performed a prospective, longitudinal cohort study with a group of 38 children with CP and followed them from age 6–12 years for 5 years. The effect size of age on participation in active PA was small, η = .07; comparatively, the effect size of age on participation in recreational activities was large, η = 1.11. While age influences participation, the magnitude of its effect is uncertain and likely depends on the outcome of interest.

The evidence regarding the influence of sex on participation in PA is inconsistent. In a survey of adults with disabilities aged 17–65 years, Badia et al. (2013) did not find a main effect due to sex on any participation outcome but did identify a significant interaction between sex and type of activity. This finding further supports the work of Shikako-Thomas et al. (2009) with youth; men and boys preferred and participated in more physical activities, while women and girls preferred social and leisure activities at home. However, in a systematic review of systematic reviews of the determinants of PA in TD youths, Bauman et al. (2012) identified male sex as positively correlated with increased PA in 7 of 11 (64%) studies that included sex as a construct. Additionally, through secondary analysis of the 2006 Participation and Activity Limitation Survey in Canada, Mâsse, Miller, Shen, Schiariti, and Roxborough (2013) identified that boys were 1.25 time more likely to be physically active than girls. Furthermore, using accelerometers, Mitchell et al. (2015a) estimated that participation in MVPA decreased by 56 steps per day for being female. While sex appears to influence participation, the magnitude of its effect is uncertain and may also depend on the outcome of interest.

No studies reviewed examined the influence of race or ethnicity on participation in PA in youths with CP. However, among TD youths, differences have been found in time spent in sedentary time and level of health-related fitness (Katzmarzyk et al., 2016).

Health condition. Factors related to the type and severity of a health condition have a significant effect on participation in PA in youths with disabilities, including CP. Through secondary data analysis of the 2006 Participation and Activity Limitation Survey in Canada, Mâsse et al. (2013) identified that those with a mild or moderate disability were 8.6 and 2.54 times as likely to be active than those with severe disability. Using a custom questionnaire focused around the TPB, Kwan, Cairney, Hay, and Faught (2013) estimated that health condition explained 11% of the variance in participation for youths with developmental coordination disorder.

Combining demographic and health condition factors, Shields et al. (2015) identified younger age, being male, and having fewer disabilities as the best predictors of being active, explaining 19% of the variance. Palisano et al. (2011) explored how personal factors acted on participation in leisure and recreational PA for adolescents with CP. Using SEM, the investigators modeled age and sex as direct effects on participation; increasing age and female sex predicted decreasing PA. Utilizing the CAPE, Longo et al. (2013) explained 43% of the variance in the diversity of participation using sex, age, intellectual impairment, and level of gross motor function. The authors concluded that child and environmental factors influenced participation more than family factors based on the size of the beta coefficients using multiple linear regression. Additional factors at other levels could explain more of the variance.

Attitudes. Factors related to attitudes, such as preference for PA, enjoyment, concerns for safety or wellness, feelings, mastery motivation, and persistence, affect willingness to participate in PA. Attitude influences participation through its link to intention in PAPDM (van der Ploeg et al., 2004). In a quantitative cross-sectional survey exploring the leisure activity preferences of 127 ambulatory adolescents with CP in Canada, Shikako-Thomas et al. (2015) concluded that youths with CP had diverse preferences, mostly in the domains of social and active physical activities. They found that there was discordance between what youths with CP wanted to do and what youths did when physical, attitudinal, or environmental barriers were present. Playing computer or video games, going to the movies, doing snow sports, playing a musical instrument, and going shopping were the top preferred activities, but these varied by sex. What youths do is influenced by a complex interaction between their preferences, their environments, and their ages.

Shikako-Thomas et al. (2013) identified that persistence, level of gross motor function, and social function were the best predictors of being physically active. In a systematic review of the determinants of PA in youths with physical disabilities, Bloemen, Backx, et al. (2015) identified increasing age, lack of time, the physical demands of activity, lack of skill, poor motivation, preference for sedentary activities, feeling like an outsider, feeling embarrassed, and having female sex as factors restricting participation in PA. While the authors organized the determinants within the framework of the PAPDM model, they did not perform a meta-analysis. Therefore, the magnitude, paths of action, and directionality of the associations are not known.

Further analyzing the strength of the relationship between preferences and participation, Dahan-Oliel et al. (2014) examined the influence of child and environmental characteristics on leisure participation of 128 adolescents born prematurely using multiple linear regression. They found that while male sex, $\beta = .325$, motor competence, $\beta = .055$, PA preferences, $\beta = .548$, and maternal education, $\beta = .348$, explained 52% of the variance in participation in active physical activities, PA preference was the strongest predictor, suggesting that PA preference may outweigh the influence of other factors.

Using a convenience sample of 153 parents and 112 adolescents with CP across all GMFCS levels, Majnemer et al. (2013) used a multitude of measures, including the Dimensions of Mastery Questionnaire, Leiter IQ scale, Gross Motor Function Measure, GMFCS, Manual Ability Classification System, Vineland Adaptive Behavior Scale, Strengths and Difficulties Questionnaire, Family Environment Scale, and Self-Perception Profile for Adolescents, to better understand the factors associated with motivation of adolescents to participate in a wide range of physical and social activities. The authors concluded that youths with CP persist less than their TD peers in challenging motor, cognitive, or social tasks but derive the same level of satisfaction in accomplishing those tasks when they are successful.

Youths with more severe involvement may give up more quickly than those who are less involved. Majnemer et al. (2013) found that age, $r = -.17$, hyperactivity, $r = -.22$, prosocial behavior, $r = .42$, self-competence, $r = .22$, athletic competence, $r = .49$, social acceptance, $r = .24$, and romantic appeal, $r = .25$, influenced gross motor persistence. However, variables acting at other levels also influenced gross motor persistence. At the family level, family active recreational orientation, $r = .42$, influenced gross motor persistence. At the level of activities, physical function level, $r = .52$, daily living skills, $r = .42$, and communication ability, $r = .42$, influenced gross motor persistence; and at the interpersonal level, socialization, $r = .49$, influenced gross motor persistence. While motivation is an individual-level construct, it is affected by influences at distal levels.

Self-concept. Factors related to self-concept, such as self-esteem, self-worth, self-confidence, perceived athletic competence, and athletic identity, affect participation in PA. Self-concept affects participation through its link to intention in PAPDM (van der Ploeg et al., 2004). In an early study examining the influence of physical disability on perceptions of self-worth and competence in youths with CP compared to their peers without CP in Holland, Schuengel et al. (2006) found that global self-worth and perceived self-competence of youths did not differ based on having CP. However, athletic competence differed between groups and correlated strongly with motor competence, *r* = .63, confirming that self-perceptions become more critical when impairments are more significant.

Motivation, perceived athletic competence, and preferences for PA were supported in a systematic review by Li et al. (2016), who proposed that these factors may be universal drivers of participation not related to disability status. Having higher motivation, higher athletic competence, and stronger preferences for PA make it more likely for participation to occur. In a cross-sectional survey of 576 parents of children age 5–17 years with and without disabilities using the PEM-CY, Bedell et al. (2013) found that personal factors commonly reported that affected motivation to participate included the physical (47%), cognitive (33%), and social (46%) demands of the activity. These findings were further supported in a study by Schutte and McNeil (2015) on TD adults, which found that a positive athletic identity mediated the relationship between motivation and frequency of exercise. When preferences (what they wanted to do) and motivations (why they wanted to do it) aligned with access, people exercised more.

Family factors. Family factors identified in the literature with regard to participation in PA included physical, social, and emotional support; lack of time; knowledge; family preferences for PA; doubts and fears; energy; resources; availability of child care; available transportation; and socioeconomic status (Shikako-Thomas et al., 2009). In a qualitative study on adult women with CP reflecting on the importance of family in their lives, Freeborn and Knafl (2014) identified four themes related to family support: being and teaching to be an advocate, promoting inclusion and acceptance, integrating therapy into daily life, and the importance of sibling as friends and mentors. This study emphasized that the family is the primary social support system when growing up with CP. Family fills the roles of friend, teacher, and caregiver. Siblings serve as friends when a youth does not have other friends at school.

In a quantitative, longitudinal cohort study performed by King et al. (2006) regarding participation of children with physical disabilities, the authors concluded that children participated most when they had high levels of functioning and stronger personal preferences for PA, when their families participated more in social and recreational activities, when environmental barriers were lower, and when they had a more supportive family. In a systematic review of the determinants of PA among youths with disabilities, Bloemen, Backx, et al. (2015) identified being reliant on parents for transportation, lack of parental support, concern for safety or acceptance, and low maternal level of education as family-level barriers to participation in PA. Additionally, family resilience, preference for PA, and support were facilitators of participation in PA. As in the qualitative study by Freeborn and Knafl (2014), support from family was an essential moderating factor that could overcome barriers at other levels.

Family income was identified as a significant predictor of engagement in active PA, with higher income predicting higher levels of involvement (King, Law, et al., 2013; Mâsse et al., 2013; Shields et al., 2015; Shikako-Thomas et al., 2013). This finding was further supported in a cross-sectional survey of 576 parents of children age 5–17 years with and without disabilities using the PEM-CY, wherein Bedell et al. (2013) found that time (19%) and money (24%) were barriers commonly reported by families of youths with disabilities.

Children and youths with disabilities from families earning above the median income were 58% more likely to be involved in supervised PA than those from families earning below the median income within another study (Mâsse et al., 2013). Longo et al. (2013) examined caregiver age, sex, educational level, family cohesion, and the number of siblings as factors, but only explained 2% of the variance in the diversity of participation using these variables for adolescents with CP. Palisano et al. (2011) included family structure and relationships in their SEM model of participation; they identified a low correlation, $r = .24$, with measures of processes of care, but this did not have a significant association with the intensity of participation. In a systematic review of systematic reviews of the determinants of PA in TD youths, Bauman et al. (2012) identified parental support for PA as positively correlated with increased PA in five of eight (63%) studies reviewed that included this construct. Similarly, through systematic review, Shikako-Thomas et al. (2009) found that socioeconomic status, parent education level, and family functioning were primary determinants of participation in children and youths with physical disabilities. Lower family income and lower parental education predicted lower levels of participation, and family functioning affected leisure activity preferences and level of support. In a quantitative, cross-sectional survey of 187 adolescents with CP in Canada, Shikako-Thomas et al. (2013) found that family activity orientation, family independence, and family income were more prominent than personal-level factors for predicting participation.

In a quantitative survey examining parental priorities for activity and participation of youths with CP in Canada, Chiarello et al. (2010) found that parental priorities varied based on the age and gross motor function level of the youths. For children under age 12 years, developing independence in daily activities was the priority, while for adolescents, independent mobility was the priority. However, the priority for physical recreation decreased with GMFCS level, to 16% at GMFCS Level I, 11% at Levels II–III, and 5% at Levels IV–V. Family priorities may act in conjunction with age and motor involvement as factors that create a supportive family environment to encourage participation in PA.

Overall, the predictive power of family-level factors was lower than it was for personal-level factors. There is some suggestion that while personal-level factors may act directly on participation in PA, family-level factors may act indirectly or be moderators or mediators of personal and environmental factors. However, few studies have quantified the direction, magnitude, or path of action of family factors on participation in PA for youths with CP. While Di Marino et al. (2017) explained 18% of the involvement of young children in community activities, it is likely that the role of the family varies with age. Adolescents may have more independence and be less influenced by parental support than young children.

Social factors. Social factors identified in the literature reviewed included the influence of friends, professionals, and others through their physical support and friendship and through their attitudes regarding people with disabilities. Social isolation, exclusion, and stigma are primary social barriers that restrict participation. Facilitators included getting physical or social support from friends and professionals as well as social opportunities to develop friendships and information regarding activities and resources in the local community. Few studies examined how social factors affected participation in PA for children and youths with CP or the magnitude of the association.

In one systematic review, Shikako-Thomas et al. (2009) identified characteristics of the attitudinal world, including bullying, staring, lack of peer support, and segregation, as primary social determinants of participation of youths and children with physical disabilities. In another systematic review, Bloemen, Backx, et al. (2015) identified social exclusion, bullying, lack of support from teachers, lack of role models, and lack of professionals who could teach adaptive activities as social barriers to participation in PA. Skilled helpers and help from teachers and friends were facilitators of participation in PA. The findings of both of these studies were validated by Gaskin et al. (2012), who portrayed lack of participation in PA as the result of a life of social exclusion, feelings of inferiority, and lack of being wanted for an adult woman with CP.

Through these studies, it appears that social influences act through intention and motivation to participate. Negative social experiences reduce motivation, which decreases persistence to try when faced with barriers from a medical condition or the physical environment. However, the magnitude, path of action, and directionality of the association of social influences with participation in PA for adolescents with CP are not known.

Organizational factors. Organizational-level factors influencing participation in PA identified in the literature reviewed included factors related to programs such as staff, equipment, resources, and knowledge as well as rules and restrictions for the participation of children and youths with disabilities in PA at organizations. Facilitators included having adaptive programs and equipment, accessible and adapted environments, and inclusive programs.

Knowledge about organizational-level barriers and facilitators came primarily through the qualitative research as comments from children and youths with disabilities or their families regarding the challenges of accessing programs. Wiart et al. (2015) surveyed fitness facilities and community programs to identify organizational-level barriers. The authors found that 46% of facilities had modified or adapted equipment available and that 25% of programs lacked wheelchair accessibility. Only 10% of programs provided training for their staff regarding people with disabilities; 3% of community centers had an assistant available to help a person with a disability; and no programs had a frequency of programs of two to three times weekly, the recommended level of PA to improve fitness. These findings were supported in a mixed methods study by Feehan et al. (2012) that found that 73% of the parents of children with special needs surveyed felt that their children needed more supervision than was usually available in a community program.

In a systematic review of the determinants of PA in youths with disabilities, Bloemen, Backx, et al. (2015) identified a lack of professional training in disability, lack of opportunities, lack of equipment, and lack of facilities as organizational-level barriers to participation in PA. Trained staff, accessible programs and facilities, and integrated physical education programs in school were facilitators of participation in PA. This study supported the findings from earlier work, such as that by Shikako-Thomas et al. (2009), that identified lack of equipment, structural barriers, lack of information, and organizational policies as primary determinants of participation of youths with physical disabilities.

Supporting the findings of (Wiart et al., 2015) regarding the status of accessibility and preparedness of organizations to help those with disabilities, Rimmer et al. (2017) surveyed 227 fitness facilities across 10 U.S. states to examine their usability by people with disabilities. They found that parking, signage, locker rooms, bathrooms, showers, pools, and equipment were all limited in their accessibility and convenience. The built environment within organizations continues to be a problem, despite legislation, such as the American With Disabilities Act, intended to promote universal design.

Despite the finding that organizational-level barriers such as accessibility and availability of programs were common themes, no studies examined the strength of association of organizational-level variables with participation in PA for children and youths with disabilities.

Community factors. Community factors related to participation in PA identified in the literature reviewed included lack of community-level programs, such as recreation and sporting activities. When programs and activities were available, families did not know about them because there was little advertising. Community safety and community design were mentioned but not measured beyond a comparison of rural and urban residential location as descriptive statistics. In one study, children and youths with disabilities living in urban areas were 10%–25% more likely to participate in PA than those from rural areas, although this relationship had a wide 95% confidence interval that included the possibility of no effect (Mâsse et al., 2013). In a large nationally representative sample of noninstitutional adolescents from the 1994–1995 National Longitudinal Study on Adolescent Health, Gordon-Larsen, Nelson, Page, and Popkin (2006) found that the number of recreation facilities in a community was inversely related to community-level socioeconomic status and positively associated with the level of PA. A small potential effect size was confirmed by Shields et al. (2015), who identified community-level socioeconomic status as a weak but significant predictor of participation in PA. Additionally, in a quantitative, cross-sectional survey of 21 parents of children with special health care needs, including several youths with CP, Feehan et al. (2012) found that only 35% of parents reported having parks, 16% recreation centers, 11% gyms, and 5% pools or playgrounds available and accessible for their children to use. No studies examined used community-level barriers or facilitators in structural models to explore the path through which community-level barriers or facilitators act or the strength of the association with participation in PA.

Physical environmental factors. Characteristics of the physical environment identified through review of the literature in PA included weather, temperature, geographic location, parks and facilities, safety, transportation, and attributes of the built environment (Anaby et al., 2013; Anaby et al., 2014; Eisenberg, Vanderbom, & Vasudevan, 2017; Gordon-Larsen et al., 2006; Kang, Zhu, Ragan, & Frogley, 2007; King, Imms, et al., 2013; Law et al., 2007; Powell, Slater, Chaloupka, & Harper, 2006; Rimmer et al., 2017; Rosenberg, Ratzon, Jarus, & Bart, 2012).

King, Imms, et al. (2013) examined geographic patterns in recreation and leisure participation of youths with CP. They found that region (U.S., Canada, Australia), $\beta = .08$, affected participation nearly as strong as the level of gross motor function, $\beta = .12$, and was a stronger influence than age group, $\beta = .01$, sex, income level, or parental education. However, this study looked at the region at the national level and did not examine state-, community-, or zip code–based differences.

In a cross-sectional survey of 576 parents of children aged 5–17 years with and without disabilities using the PEM-CY, Bedell et al. (2013) found that characteristics of the physical, social, and attitudinal environments were identified as barriers more often than personal factors, including physical layout (29%); sensory quality (19%); physical (47%), cognitive (33%), and social (46%) demands of the activity; relations with peers (29%); weather conditions (34%); access to public transportation (29%); information

(22%); equipment and supplies (22%); and programs and services (36%). In a large study employing SEM to analyze multiple levels of influence on the participation of 818 European children with CP aged 8–12 years, Colver et al. (2012) explained up to 52% of the variance in participation using measures of the physical, social, and attitudinal environments.

In a recent systematic review of 15 qualitative and quantitative studies performed since the Americans With Disabilities Act was passed in 1990, Eisenberg et al. (2017) concluded that design factors in the built environment moderate the relationship between having a disability and being involved in PA by decreasing motivation and intention to participate in PA.

Anaby et al. (2013) performed a scoping review to map the extent of the effect of the environment on out-of-school participation of youths with physical disabilities. They reported that the most common supports come from family and friends and that geographic location, transportation, access to a vehicle, parking, availability of mobility equipment, and built environment characteristics all influence participation. Positive personal attitudes and adequate support from family and friends permit people to participate in PA despite negative attributes of the physical environment. In a further cross-sectional quantitative survey of 576 parents of children and youths with and without disabilities, Anaby et al. (2014) reported that the environment had a direct impact on participation in the home, school, and community settings and that it mediated the effect of income and health conditions. Higher income reduced the influence of environmental barriers, while more severe health conditions increased the influence. This finding was further supported in a cross-sectional survey of 90 young children with disabilities by Di Marino et al. (2017) examining the effect of child, family, and environmental factors on the participation of young children with disabilities in home, school, and community environments. The findings illustrate that environmental resources and supports consistently explain participation in all settings and for all outcomes.

Summary and Conclusions

The literature review provided evidence of the importance of participation in PA as a lifestyle behavior to attain and maintain physical, social, and mental health. Among people with disabilities, personal, family, social, organizational, community, and environmental factors influence participation in PA both directly and indirectly through motivation. As a transitional period during which adult behaviors form, adolescence is a critical time for people to develop patterns of participation in PA; however, negative social influences, lack of family support, lack of opportunity, and other barriers intercede to restrict participation.

Summary of Main Findings

The reviewed literature supports the concept that participation of children and youths with disabilities, such as CP, in PA is a complex integration among personal, family, social, organizational, community, and environmental factors. Most of the existing research comes from the fields of rehabilitation medicine, psychology, child development, and public health. Much research has been accomplished using qualitative methods to obtain the perceptions of children and youths with disabilities with different health conditions and their parents regarding the primary barriers to and facilitators of participation in PA. King's conceptual model of factors affecting participation in PA of children and youths with disabilities and the PAPDM have incorporated many of these barriers and facilitators into theoretical frameworks that can be used to organize and measure the concepts.

Some well-validated tools are in use, such as the Children's Assessment of Participation and Enjoyment and Preferences for Activities of Children and the Participation and Environment Measure for Children and Youth. More recently, the Measure of Environmental Qualities of Activity Settings, Self-Reported Experiences of Activity Settings, and Craig Hospital Inventory of Environmental Factors (CHIEF) have been developed and validated. These instruments measure the impact of environmental factors on participation in PA; additionally, the CHIEF includes information on organizational and policy-level barriers.

What is known is that children and youths with disabilities including CP participate in PA at lower levels than do youths without disabilities. As they age, participation in PA tends to decrease. Boys tend to participate more in PA than girls do. Having a health condition that affects physical, social, or cognitive functioning affects participation in proportion to level of severity. Family income, level of support, and preferences for activity may affect participation, but the level of association appears low.

The extent to which organizational, policy, and broad environmental factors influence participation has been reported through qualitative research, but the magnitude of association is unknown based on the literature reviewed. The consensus is that children and youths with CP and other disabilities are less active than their TD peers and that they and their families need resources, positive support, adaptive equipment, adaptive environments, and policies supporting universal access to promote participation in PA.

How the Present Study Fills Gaps in the Literature

Gaps identified in the literature include information on how factors at different levels interact with one another, the magnitude of their influence, and whether they act directly or indirectly on participation. Additionally, while participation of adolescents in PA has been studied extensively, the focus has been on participation in structured or unstructured activity, recreation or leisure activity, school activity, and formal or informal activity. The dependent variables studied have included intensity, enjoyment, and frequency of participation in school, home, and community contexts. However, no studies examined included participation in health-enhancing PA from an epidemiological perspective, such as would be measured in national surveys to evaluate whether a youth with CP met the recommended levels of 60 minutes of PA on at least 5 days each week.

PA is critically important for people with disabilities. However, youths with CP and other disabilities remain a vulnerable population at risk for low levels of PA at a critical time in their lives. The present study will fill a gap in knowledge by defining the strength of association, paths of influence, and interactions among personal, family, social, community, and environmental factors that influence participation in health-enhancing PA using primary data collected from a representative sample of adolescents with CP and their families.

This study is expected to extend current knowledge, which focuses on identifying what array of factors influence participation, but not on how or how strong the associations are. This knowledge will lead to better ability to create programs that address the population-level health of adolescents with disabilities. Chapter 3 will describe the methodology and research design to explore the research question and hypotheses mentioned in Chapter 1 by examining the effects of personal, family, social, organizational, community, and environmental factors on the participation of youths with CP, aged 12–17 years, in health-enhancing levels of PA.

Chapter 3: Research Method

Introduction

People who are physically active have stronger bones and muscles, better physical health and well-being, and fewer mental health problems than those who are inactive (CDC, 2020). Conversely, physical inactivity is a leading cause of morbidity and mortality worldwide across all age, sex, race, and socioeconomic strata, contributing to 19 million disability adjusted life-years, three million deaths, and $53.8 billion in healthcare costs annually (Ding et al., 2016; Kohl et al., 2012). National and international guidelines recommend that all adults and youth of all ages, including those with disabilities, participate in minimum levels of moderate to vigorous PA (Haskell et al., 2007; U.S. Department of Health and Human Services, 2018a; Verschuren et al., 2016; WHO, 2010). However, fewer than 20% youth meet current PA guidelines (Kohl et al., 2012; U.S. Department of Health and Human Services, 2018a). Ability to participate in health-enhancing levels of PA is an essential part of a long-term strategy to promote health and improve quality of life, and is considered a fundamental right for all people, regardless of disability status (Lee et al., 2012; U.S. Department of Health and Human Services, 2018a; UN General Assembly, January 24, 2007; WHO, 2010).

However, youth with disabilities such as CP are half as likely to achieve healthy PA levels as their typically developing peers (Bjornson et al., 2007; Bratteby Tollerz et al., 2015; Carlon, Taylor, Dodd, & Shields, 2013; Lauruschkus, Westbom, Hallstrom, Wagner, & Nordmark, 2013; Maher et al., 2007; van Eck et al., 2008). The extent to which they participate in leisure, recreational, and active physical activities is influenced by a complex interaction among personal, family, social, and environmental factors within a social-ecological framework (Badia et al., 2013; Bloemen, Backx, et al., 2015; Buffart et al., 2009; Bult et al., 2011; Di Marino et al., 2017; Feehan et al., 2012; King, Law, Hanna, et al., 2006; Li et al., 2016; Longo et al., 2013; Mâsse et al., 2013; Ortiz-Castillo, 2011; Rimmer, Riley, Wang, Rauworth, & Jurkowski, 2004; Shields & Synnot, 2016; Shikako-Thomas et al., 2013; van Eck et al., 2008; Verschuren et al., 2012; Yazdani, Yee, & Chung, 2013). To what extent and how these factors influence participation in PA is only partially understood (Anaby et al., 2013; Anaby et al., 2014; Bauman et al., 2012; Dentro et al., 2014; Eisenberg et al., 2017; Law, King, King, Kertoy, Hurley, Rosenbaum, Young, & Hanna, 2006; Shikako-Thomas et al., 2009). What is needed is to understand to what extent personal, family, social, and environmental factors influence participation in PA for youth with CP to drive programmatic, organizational, and policy changes that empower people and enable environments.

In this chapter, I review the long-term goal of my research as well as the purpose of this study and its research question and hypotheses. I then review the research design I used to answer the research question and the rationale for my research. I review the methodology used, including my population, sample, sampling procedures, and recruitment. I describe the survey instruments I used and the operationalization of the constructs defined within my study. I then present my data analysis plan in detail. Finally

I present the threats to internal and external validity, the ethical procedures involved in study design and conduct, and conclude with a summary of the chapter.

The long-term goal of my research is to create a physical, social, and attitudinal environment that supports the ability of all people, including those with disabilities, to participate in life experiences on an equal basis. The overall objectives of this study were to determine which personal, family, social, and environmental factors were the most influential determinants of participation in PA, and how they interacted with other factors. The central hypothesis of this proposal was that personal, family, social, and environmental factors act as both facilitators and barriers to participation in health-enhancing PA in a complex inter-relationship that can be modeled using structural equation modeling.

Extensive prior qualitative and quantitative research identified personal, family, social, and environmental factors that act as facilitators and barriers to participation (Badia et al., 2013; Bloemen, Backx, et al., 2015; Buffart et al., 2009; Bult et al., 2011; Chang et al., 2014; Dahan-Oliel et al., 2014; Dang et al., 2014; Di Marino et al., 2017; Feehan et al., 2012; Jaarsma, Dijkstra, de Blecourt, Geertzen, & Dekker, 2015; King, Imms, et al., 2013; King, Law, Hanna, et al., 2006; King, Law, et al., 2013; Law, King, King, Kertoy, Hurley, Rosenbaum, Young, Hanna, et al., 2006; Li et al., 2016; Mihaylov, Jarvis, Colver, & Beresford, 2004; Morress, 2015; Ortiz-Castillo, 2011; Palisano et al., 2011; Rimmer et al., 2004; Shields & Synnot, 2016; Shields et al., 2012; Shikako-Thomas et al., 2009; Shikako-Thomas et al., 2013; Tseng et al., 2011; Verschuren et al., 2012; Yazdani et al., 2013). Prior studies have examined the complex interrelationships among combinations of these factors on involvement in leisure, recreation, mobility, relationships, formal and informal activities, and functional capacity and have explained 14-90% of the variance in the outcome (Colver et al., 2012; Dang et al., 2014; Kang et al., 2014; King, Law, Hanna, et al., 2006; Palisano et al., 2011; Park & Kim, 2013). However, there remains a lack of understanding on what factors influence participation in health-enhancing levels of PA (Bedell et al., 2013; Woodmansee et al., 2016). This knowledge is essential to building the policy and programmatic infrastructure that will support participation on an equal basis. The rationale for this work was based on extending the qualitative and quantitative contributions of prior research to further the understanding of participation as it relates to physical health. I tested the central hypothesis by pursuing one research question with 15 associated hypotheses:

RQ: What is the extent to which personal, family, social, organizational, community, and environmental factors are associated with participation of youth with CP age 12-17 years in health-enhancing levels of PA, controlling for age, sex, and level of gross motor function?

$H1_0$: Gross motor function level, pain, strength and associated conditions will not be significant indicators of a latent construct reflecting body structure and function.

$H1_A$: Gross motor function level, cognitive function, pain, strength and associated conditions will be significant indicators of a latent construct reflecting body structure and function.

$H2_0$: Mobility and upper extremity function will not be significant indicators of a latent construct reflecting activity capacity.

$H2_A$: Mobility and upper extremity function will be significant indicators of a latent construct reflecting activity capacity.

$H3_0$: Age, sex, grade, ethnicity, race, height, weight, intention, general competence, gross motor persistence, global self-worth, social competence, athletic competence, behavioral conduct, and close friendship will not be significant indicators of a latent construct reflecting personal factors.

$H3_A$: Age, sex, grade, ethnicity, race, height, weight, intention, general competence, gross motor persistence, global self-worth, social competence, athletic competence, behavioral conduct, and close friendship will be significant indicators of a latent construct reflecting personal factors.

$H4_0$: Socioeconomic status, parent physical health, parent PA level, parent mental health, parent physical function, parent anxiety, parent depression, parent fatigue, parent pain interference, parent social support, parent emotional support, parent instrumental support, parent informational support, parent social isolation, family finances, and family stress will not be significant indicators of a latent construct reflecting family factors.

$H4_A$: Socioeconomic status, parent physical health, parent PA level, parent mental health, parent physical function, parent anxiety, parent depression, parent fatigue, parent pain interference, parent social support, parent emotional support, parent instrumental support, parent informational support, parent social isolation, family finances, and family stress will be significant indicators of a latent construct reflecting family factors.

$H5_0$: Bullying, peer relationships, close friendships, peer social support, social attitudes, and assistance will not be significant indicators of a latent construct reflecting social factors.

$H5_A$: Bullying, peer relationships, close friendships, peer social support, social attitudes, and assistance will be significant indicators of a latent construct reflecting social factors.

$H6_0$: Safety, violent crime rate, children living in poverty, high school graduation rate, severe housing problems, social association participation rate, physical inactivity, and urban/rural location will not be significant indicators of a latent construct reflecting community factors.

$H6_A$: Safety, violent crime rate, children living in poverty, high school graduation rate, severe housing problems, social association participation rate, physical inactivity, and urban/rural location will be significant indicators of a latent construct reflecting community factors.

$H7_0$: Institutional policies, services, and resources, programs and services, and devices and equipment will not be significant indicators of a latent construct reflecting organizational factors.

$H7_A$: Institutional policies, services, and resources, programs and services, and devices and equipment will be significant indicators of a latent construct reflecting organizational factors.

$H8_0$: Physical design and access, transportation, access to exercise facilities, air pollution, rainy days, snowy days, hot days, and cold days will not be significant indicators of a latent construct reflecting physical environmental factors.

$H8_A$: Physical design and access, transportation, access to exercise facilities, air pollution, rainy days, snowy days, hot days, and cold days will be significant indicators of a latent construct reflecting physical environmental factors.

$H9_0$: More positive family factors will not be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H9_A$: More positive family support will be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H10_0$: More positive social factors will not be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H10_A$: More positive social factors will be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H11_0$: More positive community factors will not be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H11_A$: More positive community factors will be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H12_0$: More positive organizational factors will not be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H12_A$: More positive organizational factors will be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H13_0$: More positive physical environment factors will not be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H13_A$: More positive physical environment factors will be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H14_0$: Intention will not mediate the positive effects of personal, family, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

$H14_A$: Intention will mediate the positive effects of personal, family, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

$H15_0$: Family support will not mediate the positive effects of personal, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

$H15_A$: Family support will mediate the positive effects of personal, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

I answered this research question and examined its hypotheses using a quantitative approach with online survey research methodology employing validated self- and parent-reported questionnaires with a representative sample of youth with CP treated by a national specialty children's hospital system with locations throughout the continental U.S. The findings will promote health, well-being, and positive social change in a population at risk for physical and social exclusion, stigma, and chronic health conditions. Understanding to what extent personal, family, social, organizational, community, and environmental factors influence participation of youth with CP in PA will provide information that can be used to address the social, attitudinal, and structural barriers that restrict participation of youth with disabilities in essential opportunities for leisure and social recreation (Feehan et al., 2012; Wiart et al., 2015).

The hypotheses were structured to first examine the measurement model. Hypotheses 1–8 tested the construct validity of the latent variables representing body structure and function, activity capacity, personal factors, family factors, social factors, community factors, organizational factors, and physical environment factors, respectively. Hypotheses 9–13 tested the strength and directionality of the relationships between the latent constructs and the dependent variable, participation in health-enhancing PA. In Hypothesis 14, intention was be examined as a mediating variable for the influence of other factors. Finally, in hypothesis 15, the role of the family was examined as a variable that could change the influence of variables at other levels. A more supportive family may be able to promote participation even when other factors are present as barriers.

Purpose of the Study

The purpose of this study was to determine the extent to which personal, family, social, organizational, community, and environmental factors influence participation of youth, age 12 to 17 years, with CP in health-enhancing PA. I examined the paths of influence of relevant factors using structural equation modeling. This age range is relevant because the determinants of participation in PA for adolescents with CP have not been sufficiently explored, this is a critical transition age from childhood to adulthood during which adult health behaviors form, yet participation in PA typically decreases (Verschuren et al., 2012; Wen et al., 2011). The findings from this study could have a significant impact on promoting health, well-being, and positive social change in a population at risk for physical and social exclusion, stigma, and chronic health conditions. Understanding how personal, family, social, organizational, community, and environmental factors influence participation of youth with CP in health-enhancing levels of PA will provide information that addresses the social, attitudinal, and structural barriers that limit the involvement of youth with disabilities in essential opportunities for leisure and social recreation. This information could help drive programmatic, organizational and policy changes to increase the ability to participate in PA, decrease the risk of future chronic illness, decrease lifetime costs, reduce inequities based on disability status, and enhance quality of life.

Research Design and Rationale

The research design was a cross-sectional, quantitative approach using online survey research methodology. The methods employed validated self- and parent-reported outcome questionnaires from a sample of adolescents, age 12 to 17 years, with CP, taken from a sample frame defined by the electronic medical record of a national children's hospital system within the continental United States. The constructs within the research questions are components of a social-ecological conceptual model defined by van der Ploeg et al. (2004) to explain participation in PA for people with disabilities. The research design determined the extent to which personal, family, social, organizational, community, and environmental factors facilitated or impeded participation of youth with CP, age 12-17 years, in health-enhancing levels of PA.

The research design was cross-sectional. Cross-sectional studies are hypothesis-generating; they are appropriate when knowledge on a topic is incomplete and it is not feasible to perform experimental studies (Salazar et al., 2015a). Knowledge from the existing literature on participation in health-enhancing PA for youth with CP is early in its development. Qualitative knowledge exists on what the barriers and facilitators to participation in health-enhancing PA are (Buffart et al., 2009; Shields & Synnot, 2016). Quantitative studies have explored limited numbers of relationships among the constructs from personal, family, and environmental levels in populations that include youth to adults with CP and other disabilities (Anaby et al., 2014; Di Marino et al., 2017; Mitchell et al., 2015a; van Eck et al., 2008). Several research groups have proposed conceptual frameworks for how the relevant constructs work together to promote or restrict participation in physical and social activities in disabled and typically developing populations (Buchan et al., 2012; King et al., 2003; van der Ploeg et al., 2004). A few studies have tested these frameworks to explore the causal structure of the relationships influencing participation (Anaby et al., 2014; Burton et al., 2005; Dang et al., 2014; Di Marino et al., 2017; King, Law, Hanna, et al., 2006).

Yet much remains unknown about which factors are most influential and how they act to restrict participation (Mitchell et al., 2015a). There is no agreed upon theoretical model explaining what factors restrict youth with CP from participating in adequate amounts of health-enhancing PA (Jirikowic & Kerfeld, 2016). The observational design is appropriate to collect information from a snapshot in time across a cohort of youth with CP to determine the strength of relationships among many potential influences at the same time (Frankfort-Nachmias et al., 2015; Salazar et al., 2015a).

Survey methodology is used to describe key patterns within a population that can inform policy (Salazar, Crosby, & DiClemente, 2015c). Survey studies typically start with a large sampling frame from which a representative sample can be selected using probability-based techniques (Salazar et al., 2015c). Survey administration can be by interview-assist, computer-assist, self-, or proxy-response using paper, computer, or other recording media (Salazar et al., 2015c). Online survey studies can be quick to complete, accessing large numbers of individuals within a short time frame.

This study used a representative sample using probability techniques based on a sample frame constructed from all eligible youth in the electronic medical record of a national children’s hospital system in the continental United States. While the sample frame did not include all youth with CP in the United States, there is no national registry of people with CP available. The children’s hospital system provides orthopedic care regardless of a family’s ability to pay. The charity model of treating any child reduced the likelihood of sample selection bias based on socioeconomic status.

My study used self- and parent proxy-response for the questionnaires. Parents responded about family structure, financial and time constraints, available emotional, informational, and instrumental support, and the environment. Youth responded about pain, fatigue, cognition, peer relationships, athletic self-esteem, bullying, and other personal factors. I used county of residence to access ecological data on violent crime, rurality, poverty level, weather, housing, and other community and policy level factors. All responses were anonymous.

The dependent variable was participation in health-enhancing PA, defined in the Youth Risk Factor Surveillance System as the number of days in a week in which the youth is physically active for a total of at least 60 minutes per day (CDC, 2017). Health-enhancing PA includes any activity that increases heart rate and breathing hard some of the time.

The independent variables act at the levels of body structure and function, activities, personal, family, social, organizational, community, and physical environment. Independent variables at the level of body structure and function include type of CP, comorbid conditions, strength, pain, fatigue, and seizures. Activities included levels of physical, social, and cognitive functioning. Family factors included parental level of PA, family relationships, parental levels of physical, mental, and social health, depression, stress, access to social support, and socioeconomic status. Social factors included peer relationships, bullying, and social support within the home, school, and community environment. Organizational factors included access to adaptive equipment, trained personnel, programs, rules and polices, and cost. Community factors included rurality, levels of violent crime, rurality, percent children living at or under poverty level, median household income, percent participation in social associations, levels of physical inactivity, high school graduation rate, and housing. Physical environment factors included access to recreational facilities, average air pollution (PM20), access to the built environment, and number of poor health days in the past 30 days.

Methodology

Population

The study population was a geographically diverse sample of youth with CP. I aimed to recruit a sample size of 500 dyads including youth with CP of any gross motor function level and one parent living in the same household. Participating youth and parents answered questionnaires anonymously on a web-based survey interface.

Inclusion criteria. Eligible participants were 12 to 17 years, had a diagnosis of CP, spoke English, and had a parent who speaks English.

Exclusion criteria. Exclusion criteria included youth with a cognitive deficit that restricted their ability to respond to written questions. Youth and parents speaking languages other than English were excluded because of the availability of all questionnaires only in English.

Sampling and Sampling Procedures

The primary sampling strategy was based on a stratified random sample from a sampling frame defined by eligible youth receiving specialty medical care at a national children’s hospital system with 19 locations in 14 states across the continental United States. While registries are available in Sweden, Australia, Canada, and the United Kingdom, no national registry of people with CP is currently available in the United States (Hurley et al., 2011). Therefore, using the electronic medical record of a national specialty healthcare system was a good available alternative because patients receiving care at hospitals are systematically registered. Another option was convenience sampling using advertisements on Facebook and on list serves for families with CP. However, convenience sampling has known issues with sampling bias that affect representativeness and generalizability (Salazar, Crosby, & DiClemente, 2015b).

The sampling frame was constructed using a query of all patients in the electronic medical record who were between the ages of 12 and 17 years on the date the query was run, expressed a language preference of English, and who had CP. CP was determined based on the presence of an International Classification of Diseases (ICD-10) code of G80.0-G80.9 for any inpatient or outpatient encounter within the past 60 months. The information requested from the query included patient name, parent name, street address, city, county, state, zip code, date of birth, and parent email address.

The sample was taken using a stratified random sample procedure. Stratification was performed by state of residence. The percentage of the sampling frame taken for each state was equal to the percentage of the population represented by the estimated 2017 U.S. Census (U.S. Census Bureau, 2010b). Only states with more than 30 patients included within the sampling frame were used to ensure a probability sample is possible. With a target sample size of 500, only California, Texas, and Florida required samples larger than 30 based on estimated 2017 Census population. These states each had a specialty care hospital in them which created a larger availability of patients for those states based on ease of access to the facility. For other states, the target sample size was smaller than 30 and was not anticipated to be a problem.

Power analysis. Sample size estimation in SEM is affected by model complexity, distribution of variables, missing data, reliability, and the variance-covariance structure of variables (Schumacker & Lomax, 2010). In prior studies (Dang et al., 2014; King, Law, Hanna, et al., 2006; Park & Kim, 2013), the effect of gross motor function on intensity of participation was moderate ($R_2 = .39$); the effect of physical, social, and attitudinal supports was moderate and inverse ($R_2 = -.48$); the effect of family support was weak ($R_2 = .09$); the effect of child preferences for PA were weak ($R_2 = .10$); and the effect of the environment was weak ($R_2 = .09$). Assuming moderate strength relationships, an empirical assessment of sample size using the bias-corrected bootstrap technique with 80% power required a sample size of at least 400 (Fritz & MacKinnon, 2007). Using an alternative method of multiple linear regression, and assuming a small effect size, with Cohen's $f_2 \geq .05$, an alpha level of .107-, and ten predictor variables in the regression equation, a sample size of at least 335 was necessary (Selya, Rose, Dierker, Hedeker, & Mermelstein, 2012). However, this method is known to underestimate sample size because it considers only direct and not indirect effects (Fritz & MacKinnon, 2007). A sample size of 500 was targeted for this study because of the number of constructs included, complex relationships among the constructs, and moderate to low anticipated correlations expected. The influence of low effect size was partially compensated by the high reliability anticipated for test measures because of the inclusion of multiple items per factor (Iacobucci, 2010).

Procedures for Recruitment, Participation, and Data Collection

Recruitment procedures. I used email and postal addresses from the electronic medical record to send invitations to the stratified random sample of eligible youth to obtain the necessary sample size. Participants responded to their choice of a web-based or a paper-based survey containing the same questions. There are approximately 10,000 youth with CP treated at the specialty healthcare system each year [Ron King, personal communication]. Email and postal addresses are collected as part of the standard intake process when a youth becomes a patient at the children’s hospital and are available for most current patients. Families sign a notice of privacy practices that includes permission to contact them for relevant research. Prior studies in this population using similar methods from registries achieved response rates of 63-67% (Colver et al., 2012; Dang et al., 2014; Yazdani et al., 2013). Systematic review of response rates for mail and internet response surveys revealed an average response rate of 52.7% (Baruch & Holtom, 2008). A mixed mode design using web and paper response in a large-scale survey of adolescents about their health behaviors achieved an 86.5% response rate (Larson et al., 2011). Conservatively anticipating a response rate of 33%, I sent emails and post cards to 1,500 youth and parents inviting them to participate to achieve my sample size of 500.

Informed consent. I collected data using an anonymous survey with no link to the sample frame. The survey did not collect names, e-mail addresses, postal addresses, or any of the other 18 forms of information that could be used to identify the youth or parent respondent with the exception of county of residence (U.S. Department of Health and Human Services, 2015). The final dataset was consistent with an expert determination that there is no reasonable basis for identification based on the information in the dataset (U.S. Department of Health and Human Services, 2015).

Because of the low risk and anonymous nature of this survey study, I requested and received a waiver of consent documentation from the IRB for this study. A waiver of consent documentation is permissible when a study is of low risk and the only link would be the consent form (U.S. Department of Health and Human Services, 2016).

While documentation of consent was not collected, the information for consent was provided. At the beginning of the online survey, and in the first section of the paper survey, participants were provided with the following elements of consent: a definition of what research is; a description of the specific purpose of my dissertation research; possible risks and likelihood of occurrence; potential benefits of this research; rights of people who choose to participate in research; and a statement of the voluntary nature of participation in research. Participants were free to stop answering questions at any time.

Only participants who completed the survey received compensation for their participation.

Data collection. Prior studies demonstrated low levels of mode effects between paper and web-based administration for self- and parent-reported pediatric PROMIS scales (Magnus et al., 2016). Multiple administration modes were used to maximize the likelihood of achieving the desired sample size. The web-based survey was administered through Assessment Center®, the web-based administration platform for PROMIS housed at the Northwestern University Research Data Center. The system architecture and computing environment were 21 CFR 11 and HIPAA compliant (Northwestern University Research Data Center, 2017). Assessment Center can manage consent, randomize the order of test measure administration to minimize bias from test fatigue, and automate scoring of all PROMIS test measures (Northwestern University Research Data Center, 2017).

Exiting the study. Once the youth and one parent completed answering the questions on the online survey, their participation in the study was complete. Once the youth and one parent mailed the alternative paper forms in the addressed, stamped envelope provided, their participation in this research was complete. Online survey data resided on 21CFR11 compliant servers at the Statistical Consulting Center at Northwestern University. This location is the data center for all NIH PROMIS studies. Data were downloaded in encrypted Excel files upon study completion for data analysis.

Follow-op procedures. There was no requirement for a return for follow-up or interview following completion of the surveys in this study. No attempt was made to contact participants regarding their responses or the results of this study.

Instrumentation

Dependent variable. The dependent variable was participation in health-enhancing levels of PA, which I measured using a direct interpretation of national and international PA recommendations included in the 2009-2017 Youth Risk Behavior Surveillance System (CDC, 2017). This question explored the number of days each week that youth participated in at least 60 minutes of PA that included sweating or breathing hard. It is valid, reliable, and responsive for youth, age 12 to 17 years (CDC, 2017). The PROMIS Pediatric PA Short Form (Tucker et al., 2014a, 2014b) was used as a supplementary measure of participation in health-enhancing PA. It was measured on a continuous rather than an ordinal scale, provided better resolution of PA level, and is population normed (mean = 50; standard deviation = 10). It uses the same conceptual definition as the YRBSS and is valid, reliable, and responsive for youth, age 12 to 17 years (Tucker et al., 2014b).

Independent variables. Independent variables included measured and latent variables at the personal, family, social, organizational, community, and physical environmental levels. Personal demographics, gross motor function (Palisano, Rosenbaum, Bartlett, & Livingston, 2008), cognitive function (Lai, Butt, et al., 2011), fatigue (Lai et al., 2013), pain interference (Varni et al., 2010), strength impact (Tucker et al., 2014a, 2014b), upper and lower extremity physical function (Rose et al., 2014), peer relationships (DeWalt et al., 2013), family relationships (Bevans et al., 2017), self-perceptions (Harter, 2012), and persistence (Morgan et al., 2009) were examined by youth self-report. Family demographics, perceived parental stress (Cyranowski et al., 2013), parental physical and mental health (Hays, Schalet, Spritzer, & Cella, 2017), companionship and emotional support (Hahn et al., 2014), instrumental and informational support (Hahn et al., 2014), social isolation (Hahn et al., 2014), and youth behavior (Goodman, 1997, 2001) were measured by parental report. Presence, magnitude and impact of a youth's impairments and the influence of the physical, social, and attitudinal world (Bedell, 2004; Coster et al., 2011) were measured by parental report. All scales were previously subjected to rigorous psychometric evaluation, had evidence of acceptable levels of validity, reliability, and responsiveness, and had been used in prior studies by the intended respondent. Questionnaires are listed in Tables 1 and 2. A description of how questionnaire scales map to relevant personal, family, social, community, organization, and environmental constructs is provided in Appendix A in Tables 27 through 34.

Table 1

List of Questionnaires for Youth Respondent

Questionnaire	Items
2017 Youth Risk Behavior Surveillance Survey	10

Gross Motor Function Classification System	1
PROMIS Pediatric PA - Short Form 8a	8
PROMIS Pediatric Cognitive Function - Short Form 7a	7
PROMIS Pediatric Fatigue - Short Form 10a	10
PROMIS Pediatric Pain Interference - Short Form 8a	8
PROMIS Pediatric Strength Impact - Short Form 8a	8
PROMIS Pediatric Mobility - Short Form 8a	8
PROMIS Pediatric Upper Extremity - Short Form 8a	8
PROMIS Pediatric Peer Relationships - Short Form 8a	8
PROMIS Pediatric Family Relationship - Short Form 4a	4
Stages of Change for PA	1
Self-Perception Profile for Adolescents	45
Dimensions of Mastery Questionnaire	41
Total Questions	167

Table 2

List of Questionnaires for Parent Respondent

Questionnaire	Items
Demographics	7
International PA Questionnaire	7
PROMIS-29 Adult Profile	29
PROMIS Adult Global Physical Health Short Form	2
PROMIS Adult Global Mental Health Short Form	2
PROMIS Adult Companionship Short Form	4
PROMIS Adult Emotional Support Short Form	4
PROMIS Adult Instrumental Support Short Form	4
PROMIS Adult Informational Support Short Form	4
PROMIS Adult Social Isolation Short Form	4
Child and Adolescent Factors Inventory (CAFI)	17
Child and Adolescent Scale of Environment (CASE)	18
Total Questions	102

2017 Youth Risk Behavior Survey. The Youth Risk Behavior Surveillance System (YRBSS) is an biannual, national, population-representative survey system for youth in grades 8, 10, and 12 to monitor health-risk behaviors in all 50 states and seven

U.S. territories (CDC, 2018). The questionnaires are intended to be self-administered by the non-institutionalized general population of youth in grades 9-12 (Brener et al., 2013). Content validity has been validated by expert review, including representatives from the CDC’s Division of Adolescent and School Health, The Society of State Directors of Health, Physical Education, and Recreation, state educational agencies, and the National Center for Health Statistics (Brener et al., 2013).

Each survey is field tested with high school students prior to administration (Brener et al., 2013). Test-retest reliability was evaluated in 1992 in a convenience sample of 1,679 students, revealing kappa coefficients of .61 or higher for 75% of questions (Brener et al., 2013). Test-retest was re-evaluated in 1999 in a convenience sample of 4,619 high school students; all except 10 question had kappa coefficients greater than .61 (Brener et al., 2013). The cognitive and situational factors that could affect the validity of the YRBS have been previously examined (Brener, Billy, & Grady, 2003). In 2000, the validity of the YRBS questions on height and weight were examined and found that respondents overreported height by an average of 2.7 inches and under-reported weight by an average of 3.5 pounds, underestimating prevalence of overweight and obesity (Brener, McManus, Galuska, Lowry, & Wechsler, 2003). The questions from three sections of the 2017 National YRBS questionnaire were included as written, including seven questions from the demographics section, two on bullying, and five on PA. The YRBS questionnaires are in the public domain; no permission is required to use the questionnaires or individual questions from the questionnaires (CDC, 2018). The

YRBS has been used extensively for surveillance of risk behaviors in the general population of youth (Brener et al., 2013) related to obesity, teen pregnancy, tobacco use, alcohol use, sexual behaviors, PA, violence, and injury (CDC, 2018).

Gross Motor Function Classification System (GMFCS). The GMFCS is an objective 5-level classification of sitting and walking ability for children with CP from age 2 to 18 (Palisano et al., 2008; Rosenbaum et al., 2008; Wood & Rosenbaum, 2000). Children in GMFCS Level I have the most independent function and those in Level V have the least independent function (Wood & Rosenbaum, 2000). Content validity (Palisano et al., 2008), discriminant validity (Oeffinger et al., 2014) and test-retest reliability (Wood & Rosenbaum, 2000), r = .79, have been tested in youth with CP. The GMFCS has been widely used to classify gross motor function in youth with CP since its introduction in 2000 (Bania et al., 2014; Bjornson et al., 2013; Oeffinger et al., 2014; Palisano et al., 2011). The expanded and revised version published in 2008 was used for this study (Palisano et al., 2008). Permission has been granted by the authors for noncommercial use (CanChild, 2016).

Patient Reported Outcome Measurement Information System (PROMIS). PROMIS is a roadmap initiative of the National Institutes of Health (NIH) intended to increase the accuracy and reliability of patient reported questionnaires in NIH-funded research (Reeve et al., 2007). PROMIS is grounded in a health framework that considers physical, social, and mental health using a population rather than disease specific reference (Health Measures, 2017).

PROMIS instrument development methodology is rigorous. Development starts with a comprehensive review of the literature to catalog items used in previous instruments on a domain of interest to form an item pool consisting of all of the items (Health Measures, 2017). Focus groups and thematic analysis are used to ensure full coverage of a domain, leading to item refinement, adding, combining, and removing items as necessary to reduce the item pool to an item bank (Health Measures, 2017). Cognitive interviews are performed to ensure items are understood as intended across genders, race, ethnic groups, geographic locations, cultures, and educational levels (Health Measures, 2017). Large scale field testing is then performed to calibrate items and item banks using item response theory (Health Measures, 2017). Items are ranked from easiest to hardest and respondents are ranked from least to most able on the domain of interest (Health Measures, 2017). Factor analysis is used to ensure unidimensionality (Health Measures, 2017). Differential item functioning is performed to determine whether items perform differently for different groups on age, gender, race, ethnicity, diagnostic groups, and other factors (Health Measures, 2017). The best subset of items in an item bank are selected to make a short form, retaining most of the power of the full item bank, but with a substantially reduced response burden. The final item banks and short forms are validated using general population and chronic disease groups compared to legacy instruments to assess their construct, criterion, and content validity; test-retest and content range reliability; precision; response burden; and responsiveness (Health Measures, 2017). Each domain is scored as a T-score with a population mean of 50 and standard deviation of 10 (Health Measures, 2017). Forms are available as self-report for youth aged 8-17 years, proxy report by parents for youth, age 5-17 years, and for adults. (Health Measures, 2017). Forms are available in English, Spanish, and some additional languages (Health Measures, 2017). PROMIS forms are in the public domain and available to all researchers at no cost; no permission is required to use any of the PROMIS forms (Health Measures, 2017).

Pediatric PA Short Form. The pediatric PA item bank consists of 80 items related to the theoretical conceptualization of PA as any bodily movement produced by skeletal muscles that results in energy expense above resting levels (Tucker et al., 2014a, 2014b). Through cognitive interviews and focus groups of youths, aged 8 -17 years, the developers refined the items to include the purpose of the activity, physical environment, and companionship during the activity (Tucker et al., 2014a). Strong evidence of content validity was confirmed during item bank development (Tucker et al., 2014b). The 8-item short form selected for this study performs better, with better reliability and lower standard errors than the 4-item short form, with internal consistency >0.95 across much of the relevant content range (Health Measures, 2017). The current version of the PA short form was released in March 2017 (Health Measures, 2017). Standard errors are 2.3 on a T-score across the content range from 41.4-58.4 and falls off only in the extremity scores (Health Measures, 2017). The PA short form is appropriate for use with general populations of youth and those with chronic conditions such as CP; it is centered on a general pediatric population sample with a median of 50 and standard deviation of 10

(Health Measures, 2017).

Pediatric Cognitive Function Short Form. The pediatric cognitive function item bank contains 45 items; it assesses perceived cognitive deficits related to mental awareness, concentration, memory, verbal fluency, and changes in cognitive functions (Lai, Butt, et al., 2011). The item bank has been validated and centered on a general population sample of 1,409 children, aged 7-17 years, of whom 319 had a neurological diagnosis (Lai, Zelko, et al., 2011). The items are hierarchical, unidimensional, and locally independent, and discriminate based on cognitive symptoms (Lai, Zelko, et al., 2011). The resulting scales have been validated for parent proxy- or self-report in the general population of youth, aged 7-17 years, with or without chronic health conditions (Health Measures, 2017). The current version of the 7-item cognitive function short form was released in December 2016 (Health Measures, 2017). The scale has internal consistency >0.95 with standard errors +/- 2.3 across the content range from 30.0-53.02 and falls off only in the extremity scores (Health Measures, 2017). The scale has been previously used for children with leukoencephalopathy, brain tumors, epilepsy, traumatic brain injury, and cerebral palsy (Lai et al., 2017; Lai, Butt, et al., 2011).

Pediatric Fatigue Short Form. The pediatric fatigue item bank contains 39 items related to tiredness (23 items) and lack of energy (11 items) that have been tested in a population representative sample of 3,048 youth, aged 8-17 years, with and without chronic health conditions (Lai et al., 2013). Tiredness focuses on the impact of fatigue on restricting participation in physical, mental, and social activities (Health Measures, 2017).

The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (DeWalt et al., 2015; DeWitt et al., 2011; Irwin et al., 2010; Lai et al., 2013; Varni et al., 2014). The 10-item short form consists of the questions with the highest information content and demonstrate a correlation 0.98 with the full item bank (Health Measures, 2017; Varni et al., 2014). The short form demonstrates internal consistency of 0.87 and test-retest reliability of 0.80 (Varni et al., 2014) with standard errors +/- 3.7 across the content range from 44-84 and falls off only in the extremity scores (Health Measures, 2017). The current version of the fatigue short form was released in July 2016 (Health Measures, 2017). The fatigue scale is valid for parent proxy- or self-report in the general population of youth, aged 8-17 years, with or without chronic health conditions (Health Measures, 2017). The fatigue short form has been used previously with attention deficit disorder, asthma, epilepsy, intestinal disorder, overweight, premature birth, mental health disorders, and rheumatic disease (Varni et al., 2014).

***Pediatric Pain Interference Short Form*.** The pediatric pain interference item bank contains 13 items that measure the extent to which pain interferes with daily activities (Irwin et al., 2012; Varni et al., 2010). The items have been tested in a population representative sample of 3,048 youth, aged 8-17 years, with and without chronic health conditions (Varni et al., 2010). The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (DeWalt et al., 2015; DeWitt et al., 2011;

Irwin et al., 2010; Varni et al., 2014). The 8-item short form consists of the questions with the highest information content and has a correlation of 0.98 with the full item bank administered by computer adaptive test, test-retest reliability of .66, and internal consistency of 0.88 (Varni et al., 2014). The item bank and short form demonstrate internal reliability >.90 across the T-score scale from approximately 45-70 (Varni et al., 2010) with standard errors of 3.2 across the content range from 47.1-70.1 and falls off only in the extremity scores (Health Measures, 2017). The current version of the pain interference short form was released in July 2016 (Health Measures, 2017). The pain interference scale is valid for parent proxy- or self-report in the general population of youth, age 8-17 years, with or without chronic health conditions (Health Measures, 2017). The pain interference short form has been used previously for youth with attention deficit disorder, asthma, epilepsy, intestinal disorder, overweight, premature birth, mental health disorders, and rheumatic disease (Irwin et al., 2012; Varni et al., 2010).

***Pediatric Strength Impact Short Form*.** The pediatric strength impact item bank contains 15 items that measure the extent to which strength interferes with activities on a daily basis (Tucker et al., 2014b). The items have been extensively tested through cognitive interviews and focus groups of youths, aged 8 -17 years (Tucker et al., 2014a). Strong evidence of content validity was confirmed during item bank development (Tucker et al., 2014b). The 8-item short form consists of the questions with the highest information content, has a correlation of 0.94 with the full item bank, and demonstrates internal consistency >.90 across the relevant content range (Health Measures, 2017).

Standard errors are 2.0 on a T-score across the content range from 27.1-38.3 and falls off only in the extremity scores (Health Measures, 2017). The current version of the strength impact short form was released by the PROMIS initiative in March 2017 (Health Measures, 2017). The strength impact scale is valid for parent proxy- or self-report in the general population of youth, aged 8-17 years, with or without chronic health conditions (Health Measures, 2017). It is centered on a general pediatric population sample with a mean of 50 and standard deviation of 10 (Health Measures, 2017).

***Pediatric Physical Function Mobility Short Form*.** The pediatric physical function mobility item bank contains 32 items that measure the amount of difficulty someone has performing daily physical activities such as getting out of bed or running (DeWitt et al., 2011; Health Measures, 2017). The items have been tested in a population representative sample of 3,048 youth, aged 8-17 years, with and without chronic health conditions (DeWitt et al., 2011). The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (DeWalt et al., 2015; DeWitt et al., 2011; Irwin et al., 2010; Varni et al., 2014). The 8-item short form consists of the questions with the highest information content and has a correlation of 0.95 with the full item bank administered by computer adaptive test, test-retest reliability of 0.73, and internal consistency of 0.74 (Varni et al., 2014). The item bank and short form demonstrate internal reliability >.90 across the T-score scale from approximately 20-45 with standard errors of 3.2 across the content range from 15.2-40.1 and falls off only in the extremity scores (Health Measures, 2017). The current version of the physical function mobility short form was released by the PROMIS initiative in July 2016 (Health Measures, 2017). The scale is valid for parent proxy- or self-report in the general population of youth, aged 8-17 years, with or without chronic health conditions (Health Measures, 2017). The short form has been used previously for youth with attention deficit disorder, asthma, epilepsy, intestinal disorder, overweight, premature birth, mental health disorders, and rheumatic disease (DeWitt et al., 2011; Irwin et al., 2012; Varni et al., 2010).

***Pediatric Physical Function Upper Extremity Short Form*.** The pediatric physical function upper extremity item bank contains 38 items that measure the amount of difficulty someone has performing daily physical activities that require the use of the shoulders, arms or hands (DeWitt et al., 2011; Health Measures, 2017). The items have been tested in a population representative sample of 3,048 youth aged 8-17 years with and without chronic health conditions (DeWitt et al., 2011). The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (DeWalt et al., 2015; DeWitt et al., 2011; Irwin et al., 2010; Varni et al., 2014). The 8-item short form consists of the questions with the highest information content and has a correlation of 0.95 with the full item bank administered by computer adaptive test, test-retest reliability of .71, and internal consistency of 0.63 (Varni et al., 2014). The item bank and short form demonstrate internal reliability >.90 across the T-score scale from approximately 20-40 with standard errors of 3.2 across the content range of T-scores from 14-34 and falls off only in the extremity scores (Health Measures, 2017). The current version of the physical function upper extremity short form was released by the PROMIS initiative in July 2016 (Health Measures, 2017). The physical function upper extremity scale is valid for parent proxy- or self-report in the general population of youth, aged 8-17 years, with or without chronic health conditions (Health Measures, 2017). The upper extremity short form has been used previously for youth with attention deficit disorder, asthma, epilepsy, intestinal disorder, overweight, premature birth, mental health disorders, and rheumatic disease (DeWitt et al., 2011; Irwin et al., 2012; Varni et al., 2010).

***Pediatric Peer Relationships Short Form*.** The pediatric peer relationships item bank contains 38 items that measure the quality of relationships with friends and others (DeWalt et al., 2013; Health Measures, 2017). The items have been tested in a population representative sample of 3,048 youth, aged 8-17 years, with and without chronic health conditions (Varni et al., 2014). The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (DeWalt et al., 2015; DeWitt et al., 2011; Irwin et al., 2010; Varni et al., 2014). The 8-item short form consists of the questions with the highest information content and has a correlation of 0.95 with the full item bank administered by computer adaptive test, test-retest reliability of 0.81, and internal consistency of 0.84 (Varni et al., 2014). The item bank and short form demonstrate standard errors of 3.5 across the content range of T-scores from 25.7-48.0 and falls off only in the extremity scores (Health Measures, 2017). The current version of the peer relationships short form was released by the PROMIS initiative in July 2016 (Health Measures, 2017). The scale is valid for parent proxy- or self-report in the general population of youth, aged 8-17 years, with or without chronic health conditions (Health Measures, 2017). The short form has been used for youth with attention deficit disorder, asthma, epilepsy, intestinal disorder, overweight, premature birth, mental health disorders, and rheumatic disease (DeWitt et al., 2011; Irwin et al., 2012; Varni et al., 2010).

Pediatric Family Relationships Short Form. The pediatric family relationships item bank contains 38 items that measure the quality of relationships with friends and others (Bevans et al., 2017; Health Measures, 2017). The items have been tested in a population representative sample of 2,846 youth, aged 8-17 years, with and without chronic health conditions (Bevans et al., 2017). The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (Bevans et al., 2017). The 8-item short form consists of the questions with the highest information content and has a correlation of 0.95 with the full item bank administered by computer adaptive test, test-retest reliability of 0.81, and internal consistency of 0.98 (Bevans et al., 2017; Health Measures, 2017). The item bank and short form demonstrate standard errors of 3.2 across the content range of T-scores from 19.2-53.2 and falls off only in the extremity scores (Health Measures, 2017). The current version of the family relationships short form was released by the PROMIS initiative in September 2017 (Health Measures, 2017). The scale is valid for parent proxy- or self-report in the general population of youth aged 8-17 years with or without chronic health conditions (Health Measures, 2017).

***Adult Global Physical Health Short Form*.** The global physical health 2-item short form is designed to be a brief survey tool that provides information about overall health status, predictive of health care utilization and mortality (Hays et al., 2017). The two items were selected as those best reflecting the underlying construct from a larger 10-item bank based on their discrimination ability (Hays et al., 2017). The 2-item physical health short form was validated in a general population sample of 21,133 adults (Hays et al., 2017). The global physical health item bank is hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (Hays, Bjorner, Revicki, Spritzer, & Cella, 2009). The 2-item short form demonstrates a correlation of 0.94 with the longer 4-item form, test-retest reliability of 0.70, and internal consistency of 0.73 (Hays et al., 2009). The short form demonstrates standard errors of 5.1 across the content range of T-scores from 29-45 and falls off in the extremity scores (Health Measures, 2017). The current version of the 2-item global physical health short form was released by the PROMIS initiative in September 2016 (Health Measures, 2017). The scale is valid for self-report in the general adult population (Health Measures, 2017).

***Adult Global Mental Health Short Form*.** The global mental health 2-item short form is designed to be a brief survey tool that provides information about overall quality of life (Hays et al., 2017). The two items were selected as those best reflecting the underlying construct from a larger item bank based on their discrimination ability (Hays et al., 2017). The 2-item mental health short form was validated in a general population sample of 21,133 adults (Hays et al., 2017). The global mental health item bank is hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (Hays et al., 2009). The 2-item mental health short form demonstrates a correlation of 0.97 with the longer 4-item form, test-retest reliability of 0.86, and internal consistency of 0.81 (Hays et al., 2009). The short form demonstrates standard errors of 4.3 across the content range of T-scores from 32.0-52.8 and falls off in the extremity scores (Health Measures, 2017). The current version of the 2-item global mental health short form was released by the PROMIS initiative in September 2016 (Health Measures, 2017). The scale is valid for self-report in the general adult population (Health Measures, 2017).

PROMIS-29 Adult Profile. The PROMIS-29 Adult Profile consists of short forms for physical function, anxiety, depression, fatigue, sleep disturbance, ability to participate in social roles and activities, pain interference, and pain intensity. The current version of the PROMIS-29 Profile, version 2.1, was released by the PROMIS initiative in February 2018 (Health Measures, 2017). The details for each form follow.

Adult Physical Function Short Form. The adult physical function item bank contains 124 items related to upper and lower extremity function, trunk control, and activities of daily living (Rose et al., 2014). The items have been tested in a population representative sample of 16,065 adults with and without chronic health conditions (Rose et al., 2014). The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (Rose et al., 2014). The 4-item short form included in the PROMIS-29 Profile consists of the 4 questions with the highest information content and has a correlation of 0.83 with the full item bank administered by computer adaptive test (Health Measures, 2017). The item bank and short form demonstrate internal reliability >.98 across the T-score scale from four standard deviations below to two standard deviations above the population mean and falls off only in the extremity scores (Cella et al., 2010; Health Measures, 2017). The scale is valid for self-report in the general adult population (Cella et al., 2010; Health Measures, 2017).

Adult Anxiety Short Form. The adult anxiety item bank contains 29 items related to emotional distress from fear, worry, or nervousness (Cella et al., 2010). The items have been tested in a population representative sample of 21,133 adults with and without chronic health conditions (Cella et al., 2010). The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (Cella et al., 2010). The 4-item short form included in the PROMIS-29 Profile consists of the 4 questions with the highest information content and has a correlation of 0.96 with the full item bank administered by computer adaptive test (Health Measures, 2017). The item bank and short form demonstrate internal reliability >.93 across the T-score scale from four standard deviations below to two standard deviations above the population mean and falls off only in the extremity scores (Cella et al., 2010; Health Measures, 2017). The scale is valid for self-report in the general adult population (Cella et al., 2010; Health Measures, 2017).

Adult Depression Short Form. The adult depression item bank contains 28 items related to emotional distress from negative mood, loss of interest, self-criticism, and loneliness (Cella et al., 2010). The items have been tested in a population representative sample of 21,133 adults with and without chronic health conditions (Cella et al., 2010). The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (Cella et al., 2010). The 4-item short form included in the PROMIS-29 Profile consists of the 4 questions with the highest information content and has a correlation of 0.96 with the full item bank administered by computer adaptive test (Cella et al., 2010; Health Measures, 2017). The item bank and short form demonstrate internal reliability >.92 across the T-score scale from two standard deviations below to three standard deviations above the population mean and falls off only in the extremity scores (Cella et al., 2010; Health Measures, 2017). The scale is valid for self-report in the general adult population (Cella et al., 2010; Health Measures, 2017).

Adult Fatigue Short Form. The adult fatigue item bank contains 95 items related to exhaustion that decreases the ability to participate in daily activities or roles (Cella et al., 2010). The items have been tested in a population representative sample of 21,133 adults with and without chronic health conditions (Cella et al., 2010). The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (Cella et al., 2010). The 4-item short form included in the PROMIS-29 Profile consists of the 4 questions with the highest information content and has a correlation of 0.76 with the full item bank administered by computer adaptive test (Cella et al., 2010; Health Measures, 2017). The item bank and short form demonstrate internal reliability >.91 across the T-score scale from two standard deviations below to four standard deviations above the population mean and falls off only in the extremity scores (Cella et al., 2010; Health Measures, 2017). The scale is valid for self-report in the general adult population (Cella et al., 2010; Health Measures, 2017).

Adult Sleep Disturbance Short Form. The adult sleep disturbance item bank contains 27 items related to feeling satisfied with the amount and quality of nightly sleep (Cella et al., 2010). The items have been tested in a population representative sample of 21,133 adults with and without chronic health conditions (Cella et al., 2010). The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (Cella et al., 2010). The 4-item short form included in the PROMIS-29 Profile consists of the 4 questions with the highest information content and has a correlation of 0.96 with the full item bank administered by computer adaptive test (Cella et al., 2010; Health Measures, 2017). The item bank and short form demonstrate internal reliability >.92 across the T-score scale from one standard deviation below to three standard deviations above the population mean and falls off only in the extremity scores (Cella et al., 2010; Health

Measures, 2017). The scale is valid for self-report in the general adult population (Cella et al., 2010; Health Measures, 2017).

Adult Ability to Participate in Social Roles and Activities Short Form. The adult satisfaction with participation in social roles and activities item bank contains 95 items related to exhaustion that decreases the ability to participate in daily activities or roles (Cella et al., 2010). The items have been tested in a population representative sample of 21,133 adults with and without chronic health conditions (Cella et al., 2010). The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (Cella et al., 2010). The 4-item short form included in the PROMIS-29 Profile consists of the 4 questions with the highest information content and has a correlation of 0.96 with the full item bank administered by computer adaptive test (Cella et al., 2010; Health Measures, 2017). The item bank and short form demonstrate internal reliability >.96 across the T-score scale from two standard deviations below to one standard deviation above the population mean and falls off only in the extremity scores (Cella et al., 2010; Health Measures, 2017). The scale is valid for self-report in the general adult population (Cella et al., 2010; Health Measures, 2017).

Adult Pain Interference Short Form. The adult pain interference item bank contains 41 items related to the impact of perceived pain on performing daily activities and roles (Cella et al., 2010). The items have been tested in a population representative sample of 21,133 adults with and without chronic health conditions (Cella et al., 2010).

The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (Cella et al., 2010). The 4-item short form included in the PROMIS-29 Profile consists of the 4 questions with the highest information content and has a correlation of 0.95 with the full item bank administered by computer adaptive test (Cella et al., 2010; Health Measures, 2017). The item bank and short form demonstrate internal reliability >.97 across the T-score scale the population mean to three standard deviations above the population mean (Cella et al., 2010; Health Measures, 2017). The scale is valid for self-report in the general adult population (Cella et al., 2010; Health Measures, 2017).

Adult Pain Intensity Short Form. The adult pain intensity item bank consists of 1 item related to the average severity of pain in the past seven days on a 0-10 scale (Cella et al., 2010).

Adult Companionship Short Form. The adult companionship item bank contains 32 items related to having someone to be social with to visit, talk, or share (Hahn et al., 2010; Health Measures, 2017). The items have been tested in a nationally representative sample of 14,931 adults with and without chronic health conditions (Health Measures, 2017). The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (Cyranowski et al., 2013; Health Measures, 2017). The 4-item short form consists of the 4 questions with the highest information content and has a correlation of 0.94 with the full item bank administered by computer adaptive test. The item bank and short form demonstrate internal reliability >.90 across the T-score scale from two standard deviations below to four standard deviations above the population mean (Health Measures, 2017). The scale is valid for self-report in the general adult population (Health Measures, 2017). The current version of the companionship short form was released by the PROMIS initiative in June 2016 (Health Measures, 2017).

***Adult Emotional Support Short Form*.** The adult emotional support item bank contains 16 items related to having someone to be social with to visit, talk, or share (Hahn et al., 2010; Health Measures, 2017). The items have been tested in a nationally representative sample of 1,008 English-speaking adults, 644 Spanish-speaking adults, ad 1,200 adults with chronic health conditions (Hahn et al., 2014) as well as with 692 community-dwelling adults (Cyranowski et al., 2013). The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (Cyranowski et al., 2013; Hahn et al., 2014; Health Measures, 2017). The 4-item short form consists of the 4 questions with the highest information content and has a correlation of 0.96 with the full item bank administered by computer adaptive test (Health Measures, 2017). The item bank and short form demonstrate internal reliability >.90 across the T-score scale from two standard deviations below to four standard deviations above the population mean (Health Measures, 2017). The scale is valid for self-report in the general adult population (Health Measures, 2017). The current version of the emotional support short form was released in June 2016 (Health Measures, 2017).

***Adult Informational Support Short Form*.** The adult informational support item bank contains 10 items related to having someone available for information and advice (Hahn et al., 2010; Health Measures, 2017). The items have been tested in a nationally representative sample of 1,008 English-speaking adults, 644 Spanish-speaking adults, and 1,200 adults with chronic health conditions (Hahn et al., 2014) as well as with 692 community-dwelling adults (Cyranowski et al., 2013). The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (Cyranowski et al., 2013; Hahn et al., 2014; Health Measures, 2017). The 4-item short form consists of the 4 questions with the highest information content and has a correlation of 0.97 with the full item bank administered by computer adaptive test (Health Measures, 2017). The item bank and short form demonstrate internal reliability >.90 across the T-score scale from two standard deviations below to one standard deviation above the population mean (Health Measures, 2017). The scale is valid for self-report in the general adult population (Health Measures, 2017). The current version of the informational support short form was released in June 2016 (Health Measures, 2017).

***Adult Instrumental Support Short Form*.** The adult instrumental support item bank contains 11 items related to having someone to assist when help is needed such as transportation to a doctor’s appointment or daily chores (Hahn et al., 2010; Health Measures, 2017). The items have been tested in a nationally representative sample of 1,008 English-speaking adults, 644 Spanish-speaking adults, and 1,200 adults with chronic health conditions (Hahn et al., 2014) as well as with 692 community-dwelling adults (Cyranowski et al., 2013). The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (Cyranowski et al., 2013; Hahn et al., 2014; Health Measures, 2017). The 4-item short form consists of the 4 questions with the highest information content and has a correlation of 0.97 with the full item bank administered by computer adaptive test (Health Measures, 2017). The item bank and short form demonstrate internal reliability >.90 across the T-score scale from two standard deviations below to one standard deviation above the population mean (Health Measures, 2017). The scale is valid for self-report in the general adult population (Health Measures, 2017). The current version of the instrumental support short form was released in June 2016 (Health Measures, 2017)..

***Adult Social Isolation Short Form*.** The adult social isolation support item bank contains 14 items related to feeling isolated, alone, or left out (Hahn et al., 2010; Health Measures, 2017). The items have been tested in a nationally representative sample of 1,008 English-speaking adults, 644 Spanish-speaking adults, ad 1,200 adults with chronic health conditions (Hahn et al., 2014). The items are hierarchical, unidimensional, locally independent, demonstrate uniform performance across genders and ages, and discriminate among chronic health groups (Hahn et al., 2014; Health Measures, 2017). The 4-item short form consists of the 4 questions with the highest information content and has a correlation of 0.97 with the full item bank administered by computer adaptive test (Health Measures, 2017). The item bank and short form demonstrate internal reliability >.90 across the T-score scale from one standard deviation below to three standard deviations above the population mean (Health Measures, 2017). The scale is valid for self-report in the general adult population (Health Measures, 2017). The current version of the social isolation support short form was released in June 2016 (Health Measures, 2017).

Stages of Change Questionnaire. Marcus et al. (1992) adapted a stages of change questionnaire for exercise behavior change in adults from earlier work on smoking and addiction behavior (DiClemente & Prochaska, 1983). The questionnaire was validated in adults, 1,063 government employees and 429 hospital employees, demonstrating discrimination by levels of self-efficacy toward exercise across all stages, with test-retest reliability of .90, and inter-rater reliability of .78 (Marcus et al., 1992). Cardinal (1997) further examined the stages of change questionnaire in 235 adults and Nigg and Courneya (1998) examined the questionnaire in 819 high school students aged 13-19 years to provide further evidence of content and construct validity. Leslie, Johnson-Kozlow, Sallis, Owen, and Bauman (2003) examined test-retest reliability in a sample of 123 Australian and 105 U.S. undergraduate students and found a kappa coefficient of .50 with moderately vigorous and .76 with vigorous PA.

Self-Perception Profile for Adolescents (SPPA). The SPPA (Harter, 2012) contains 45 questions that define a multidimensional construct relevant to understanding self-esteem and self-concept in youth aged 13-18 years. The dimensions include scholastic competence, social competence, athletic competence, physical appearance, job competence, romantic appeal, behavioral conduct, close friendships, and global self-work. Items are presented in a structure alterative format with 5 question per domain. Domains can be administered together or individually (Harter, 2012). The instrument is available to use freely (Harter, 2012). Internal validity, face validity, factorial validity, convergent validity, discrimination, and construct validity have been described (Harter, 2012). Test-retest reliability is .74-.93 in all domains based on four samples of students in grades 8-11 in the U.S.; the instrument differentiates those with typical development from those with learning or behavioral difficulties (Harter, 2012). Wichstraum (1995) further validated the instrument in a nationally representative sample of 11,315 Norwegian youth aged 13-20 years and found evidence for construct validity, convergent validity, discriminative validity, factorial validity, and internal consistency. The scale is valid for self-report in the general youth population aged 13-18 years (Harter, 2012) and has been extensively used for youth with disabilities including cerebral palsy (King, Shultz, Steel, Gilpin, & Cathers, 1993; Russo et al., 2008; Shields, Loy, Murdoch, Taylor, & Dodd, 2007; Verschuren et al., 2007). The current version was released in 2012 (Harter, 2012).

Dimensions of Mastery Questionnaire (DMQ). The DMQ is an inventory that measures a person’s efforts to master challenging tasks and the gratification received from these efforts (Morgan, Wang, Liao, & Xu, 2013). Originally developed in the 1980’s, the most recent revision released in 2016, the DMQ-18 includes four persistence scales related to persistence in mastering a skill, and two expressive scales related to whether the person feels pleasure or distress from attempting to master challenging tasks (Morgan et al., 2018). Persistence scales include persistence at object or cognitive tasks, gross motor persistence, social mastery motivation with adults, and social master motivation with peers/children (Morgan et al., 2018). Expressive scales include mastery pleasure and negative reactions in mastery situations. Each scale contains 5-6 items that can be answered by self- or proxy-report (Morgan et al., 2018). The DMQ has been previously used for youth with CP to measure whether a youth with a physical disability will attempt tasks that are challenging despite their disability (Majnemer et al., 2013).

The original version of the DMQ was validated in 149 mothers of typically developing, 60 mothers of children with intellectual or physical disabilities, and 18 preschool teachers (Morgan et al., 2018). Since its initial release for young children, the DMQ has been revised, expanded, rescored, and further expanded and revised to its current version, the DMQ-18, which includes 41 items along 7 scales (Morgan et al., 2018). The DMQ has been validated in more than 7,000 children in a geographically diverse sample from the U.S., United Kingdom, Israel, Australia, and Hungary (Morgan et al., 2018). The DMQ has been normed using responses from 633 parents, 217 teachers or caregivers, and 183 elementary and high school students (Morgan et al., 2018). Construct validity was supported through a factorial structure that identified independent factors of general mastery motivation and dependence in mastery situations, as well as moderate correlations with parallel measures, *r* = .37-.41 (Morgan et al., 2018). The factorial structure is supported with strong loadings greater than .40 with limited cross-factor loadings for each scale based on principal component analysis with Varimax rotation, accounting for 52% of the variance (Morgan et al., 2018). Internal consistency is .77-.85 for the persistence scales and .70-.83 for the expressive scales (Morgan et al., 2018). Test-retest reliability is .70-.79 for each scale over a one month retest time and good correlation with prior versions of the DMQ, *r* = .70-.91 (Morgan et al., 2018). The DMQ has been previously used for youth with CP (Majnemer et al., 2008; Majnemer, Shevell, Law, Poulin, & Rosenbaum, 2010; Majnemer, Shevell, Rosenbaum, Law, & Poulin, 2007; Majnemer et al., 2013; Miller, Marnane, Ziviani, & Boyd, 2014; Morgan et al., 2009; Morgan et al., 2018; Shikako-Thomas et al., 2013). The authors provide permission to use the scales freely upon completion of a user agreement; and request sharing the results of studies that use the DMQ-18 as well as raw data (Morgan et al., 2018). The signed user agreement is attached in Appendix D.

Children and Adolescent Scale of Environment (CASE). The CASE (Bedell, 2011b; Bedell & McDougall, 2015) is an 18-item inventory intended to measure the impact of environmental barriers within the physical, social, and attitudinal environment for youth with disabilities. The CASE was adapted from the Craig Hospital Inventory of Environmental Factors for adults (Whiteneck et al., 2004). The CASE was validated in a sample of 60 youth with traumatic brain injury in the inpatient rehabilitation setting (Bedell, 2004; Bedell & Dumas, 2004) and further validated in a longitudinal study of 430 youth, aged 11-17 years, with chronic conditions, including 135 with CP (Bedell & McDougall, 2015). The CASE has evidence of internal consistency, $\alpha = .89$, and construct validity, 55% of the variance is explained by three factors related to community and home resources, school resources, and physical design and access (Bedell & McDougall, 2015). The factors are supported by strong loading within and low loading between factors with minimal evidence of cross–loading (Bedell & McDougall, 2015). Internal reliability of the factors was .85 for community and home resources, .85 for school resources, and .76 for physical design and access (Bedell & McDougall, 2015). Test-retest reliability is good with ICC = .75 (Bedell & McDougall, 2015). Convergent validity was supported by positive correlations between CASE and CAFI scores for youth with greater impairments and negative correlations between the CASE and CASP for youth with fewer impairments (Bedell & McDougall, 2015). Discriminant validity was demonstrated by significant between group differences based on chronic condition (Bedell & McDougall, 2015). No evidence of differential item functioning was found for age or sex (Bedell & McDougall, 2015). The CASE has been previously used to measure the impact of environmental factors on participation of youth with CP (Hunter et al., 2015; Law et al., 2007; McCauley et al., 2013). The CASE is available to freely use as cited on the author's website; a letter of permission from the author is included in Appendix D.

Children and Adolescent Functional Inventory (CAFI). The CAFI (Bedell, 2011b; Bedell & McDougall, 2015) is a 15-item inventory intended to measure the presence of cognitive, behavioral, psychological, and physical impairments. The CAFI has evidence of internal consistency, α = .86, test-retest reliability, ICC = .68, construct validity, and discriminative validity; higher scores on the CAFI are associated with more restricted participation, *r* = -.58 (Bedell, 2011a; Bedell, 2004; Bedell & Dumas, 2004). The CAFI is an inventory of impairment rather than a unidimensional construct (Bedell & McDougall, 2015). The CASE has been previously used to measure the impact of environmental factors on participation of youth with CP (Bedell & McDougall, 2015). The CASE is available to freely use as cited on the author's website; a letter of permission from the author is included in Appendix D.

County Health Rankings. County Health Rankings is an initiative of the Robert Wood Johnson Foundation and the University of Wisconsin Public Health Institute to bring together secondary data from multiple public, private, and governmental sources to analyze and understand the influence of social determinants of health (Robert Wood Johnson Foundation, 2018). Aggregated secondary data from County Health Rankings will be used at the county level with respect to violent crime rate, children in poverty, high school graduation rate, air pollution, housing problems, access to recreational facilities, participation in social associations, and physical inactivity. Data from County Health Rankings are freely available (Robert Wood Johnson Foundation, 2018).

Operationalization of Constructs

Health-enhancing PA. Health-enhancing PA is defined as the self-reported number of days in each week that a youth is physically active for at least 60 minutes, as defined in the 2017 YRBSS (CDC, 2017). Physically active is defined as increasing heart rate, sweating or breathing hard some of the time. This was a single question that read

"During the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day? (Add up all the time you spent in any kind of PA that increased your heart rate and made you breathe hard some of the time.)" This measure was on an ordinal scale with 8 levels ranging from A to H, coded as 0 to 7 days per week.

I collected a secondary measure of PA with a similar conceptualization related to participation in PA that increases heart rate, sweating, breathing hard, or becoming tired using the PROMIS PA Short Form (Tucker et al., 2014b). From this instrument, PA is measured on a ratio scale with a population mean of 50 and standard deviation of 10 based on youth response to 8 questions with a time frame of the past seven days (Health Measures, 2017). An example of one question is "In the past 7 days, how many days did you exercise or play so hard that your body got tired?" (Health Measures, 2017). The response structure was "no days; 1 day; 2-3 days; 4-5 days; 6-7 days" coded as 1-5 and converted to a T-score using either a lookup table or an automated online scoring system; both provide the T-score and its standard error (Health Measures, 2017). Higher scores indicate greater amounts of participation in PA.

Measures of health. Measures of general health of the youth with CP were included to provide context of their medical condition on participation in PA.

CP subtype. CP subtype was operationalized by level of gross motor functioning. It will be measured by parent proxy report using the GMFCS (Rosenbaum et al., 2008). The GMFCS is a 5-level ordinal scale measuring gross motor function ranging from near normal, GMFCS level I, to highly impaired and non-ambulatory using a wheelchair for short and long distances, GMFCS V.

Comorbid conditions**.** Comorbid conditions was operationalized by the presence of conditions related to health and cognitive, physical, and sensory functioning (Bedell, 2011a). It was measured using the CAFI, a 15-item index of conditions that could restrict participation in daily life activities beyond a diagnosis of CP (Bedell, 2011a). Examples include paying attention or concentrating, problem solving or judgement, speech, hearing, or vision. The response structure is a 3-level Likert scale consisting of “no problem; little problem; and big problem.” Scoring assigns scores of 1, 2, and 3, for each level, respectively, sums the totals of all items, and expresses as a percentage. The final score was at the interval level.

Cognitive function**.** Cognitive function was operationalized as perceived deficits related to mental awareness, concentration, memory, verbal fluency, and changes in cognitive functions (Lai, Butt, et al., 2011). Cognitive function was measured based on youth responses to the 7 statements on the PROMIS Pediatric Cognitive Function Short Form within the time frame of the past four weeks (Health Measures, 2017). An example of one statement is “In the past 4 weeks, I have trouble keeping track of what I am doing if I get interrupted” (Health Measures, 2017). The response structure is “None of the time; a little of the time; some of the time; most of the time; all of the time” coded as 5-1 and converted to a T-score using either a lookup table or an automated online scoring system; both provide the T-score and its standard error (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as greater perceived cognitive deficits.

Fatigue. Fatigue was operationalized as the extent to which being tired or lacking energy restricts participation in physical, mental, and social activities over the past seven days (Health Measures, 2017). Fatigue will be measured based on youth responses to the 10 statements on the PROMIS Pediatric Fatigue Short Form (Health Measures, 2017). An example of one statement is “In the past 7 days, being tired made it hard for me to play or go out with my friend as much as I’d like.” (Health Measures, 2017). The response structure was “never; almost never; sometimes; often; almost always” coded as 1-5 and converted to a T-score using either a lookup table or an automated online scoring system; both provide the T-score and its standard error (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as greater perceived impact of fatigue on PA.

Pain interference. Pain interference was operationalized as the extent to which pain restricts participation in physical, mental, and social activities over the past seven days (Health Measures, 2017). Pain interference was measured based on youth responses to the 8 statements on the PROMIS Pediatric Pain Interference Short Form (Health Measures, 2017). An example of one statement is “In the past 7 days, it was hard for me to walk one block when I had pain.” (Health Measures, 2017). The response structure was “never; almost never; sometimes; often; almost always” coded as 1-5 and converted to a T-score using either a lookup table or an automated online scoring system; both provide the T-score and its standard error (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as greater perceived impact of pain on PA.

Strength impact. Strength impact was operationalized as the extent to which a youth has enough strength to participate in physical activities over the past seven days (Health Measures, 2017). Strength impact was measured based on youth responses to the 8 questions on the PROMIS Pediatric Strength Impact Short Form (Health Measures, 2017). An example of one question is “In the past 7 days, how many days were you strong enough to jump up and down.” (Health Measures, 2017). The response structure was “no days; 1 day; 2-3 days; 4-5 days; 6-7 days” coded as 1-5 and converted to a T-score using either a lookup table or an automated online scoring system; both provide the T-score and its standard error (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as more frequently having adequate strength to participate in physical activities.

Physical function – mobility. Physical function mobility was operationalized as the amount of difficulty someone has performing daily physical activities such as getting out of bed or running over the past seven days (Health Measures, 2017). Mobility was measured based on youth responses to the 8 statements on the PROMIS Pediatric Mobility Short Form (Health Measures, 2017). An example of one statement is “In the past 7 days, I could keep up when I played with other kids.” (Health Measures, 2017). The response structure was “with no trouble; with a little trouble; with some trouble; with a lot of trouble; not able to do” coded as 5-1 and converted to a T-score using either a lookup table or an automated online scoring system; both provide the T-score and its standard error (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as greater ability to perform daily physical activities.

Physical function – upper extremity. Physical function upper extremity was operationalized as the amount of difficulty someone has performing daily physical activities that require the use of the shoulder, arms, or hands (Health Measures, 2017). Upper extremity was measured based on youth responses to the 8 statements on the PROMIS Pediatric Upper Extremity Short Form (Health Measures, 2017). An example of one statement is “In the past 7 days, I could put on shoes by myself.” (Health Measures, 2017). The response structure was “with no trouble; with a little trouble; with some trouble; with a lot of trouble; not able to do” coded as 5-1 and converted to a T-score using either a lookup table or an automated online scoring system; both provide the T-score and its standard error (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as greater ability to perform daily physical activities.

Measures of personal factors. Personal factors considered included age, sex, race, ethnicity, educational level, height, weight, intention to participation in PA, and psychological factors that could influence participation in PA.

Age. Age was operationalized as the integer number of years lived since birth and was measured using the question “How old are you?” with seven response options “12 years old; 13 years old; 14 years old; 15 years old; 16 years old; 17 years old; 18 years old.” No manipulation of the variable was performed. The score represents age, with larger values representing older age. For comparison purposes 12 was the reference age.

Sex. Sex was operationalized as a biological rather than a social indicator based on self-report. It was collected using one question “What is your sex?” with two categorical response options “female; male.” Female was coded as 1 and male was coded as 0. For comparison purposes, male was the reference category.

Educational grade level. Educational grade level was operationalized as the grade level the youth was in, or most recently completed based on self-report at the time of study participation. It was collected on an ordinal scale using one question “In what grade are you?” with five response options “9th grade; 10th grade; 11th grade; 12th grade; ungraded or other grade.” Responses were coded 9, 10, 11, 12, and missing respectively. Larger values represented higher levels of completed school. For comparison purposes, 9 was the reference category.

Ethnicity. Ethnicity was operationalized as the self-reported affiliation with the Hispanic or Latino social group, consistent with the definition within the U.S. Census (U.S. Census Bureau, 2017). Ethnicity was collected using the question “Are you Hispanic or Latino?” with two categorical response options “Yes; No” and was coded 0 for no and 1 for yes, indicating whether the respondent self-affiliated with the Hispanic or Latino social group or not. For comparison purposes, non-Hispanic was the reference category.

Race. Race was operationalized as the youth’s self-reported affiliation with social groups based on region of origin, consistent with the U.S. Census definition (U.S. Census

Bureau, 2017). Race was collected using the question “What is your race?” with five categorical response options “American Indian or Alaska native; Asian; Black or African American; Native Hawaiian or other Pacific Islander; White.” Race was coded White = 1; American Indian or Alaska Native = 2; Asian = 3; Black or African American = 4; and Native Hawaiian or other Pacific Islander = 5. For comparison purposes, White was the reference category.

Height. Height was operationalized as the youth’s self-reported height in feet and inches, consistent with the methods of the 2017 YRBS using the question “How tall are you without your shoes on?” (CDC, 2017). The response in feet and inches was converted to meters on a ratio scale.

Weight. Weight was operationalized as the youth’s self-reported weight in pounds, consistent with the methods of the 2017 YRBS using the question “How much do you weigh without your shoes on?” (CDC, 2017). The response in pounds was converted to kilograms on a ratio scale.

Intention. Intention was operationalized as whether a youth self-reports that they exercise or intend to exercise regularly. Exercise is defined as spending at least 10 minutes in any kind of PA that increases heart rate and makes the youth breathe hard some of the time. Regularly is defined as doing it at least three times a week. Intention will be collected using one statement “Please check the description that best applies to whether you exercise or intend to exercise regularly.” The response options were “I currently do not exercise and do not intend to start exercising in the next 6 months (precontemplation); I currently do not exercise but I am thinking about starting to exercise regularly in the next 6 months (contemplation); I currently exercise sometimes but not regularly (preparation); I currently exercise regularly but I have only begun doing so within the last 6 months (action); and I currently exercise regularly and have done so for more than 6 months (maintenance).” Responses were coded as precontemplation = 1; contemplation = 2; preparation = 3; action = 4; and maintenance = 5, and were considered to be on an ordinal scale with higher numbers demonstrating greater levels of intention to be physically active (Marcus et al., 1992).

General competence compared to peers. General competence compared to peers was operationalized as a youth’s perceived ability to master challenging general tasks in comparison to peers of the same age (Morgan et al., 2018). General competence was measured by youth self-report using the 5-item general competence scale on the DMQ. An example statement was “I do things that are difficult for kids my age” with a 5-level Likert response structure on an ordinal scale ranging from “not at all like me” (1) to “exactly like me” (5). The scale score was the average of the responses on five items. Higher levels correspond to greater perceived competence compared to peers.

Gross motor persistence. Gross motor persistence was operationalized as a youth’s perceived ability to master physical tasks that may be challenging (Morgan et al., 2018). Gross motor persistence was measured by youth self-report using the gross motor persistence scale on the DMQ. An example statement was “I try to do well in physical activities even when they are challenging” with a 5-level Likert response structure on an ordinal scale ranging from “not at all like me” (1) to “exactly like me” (5). The scale score was the average of the responses on five items. Higher scores correspond to greater perceived gross motor persistence.

Global self-worth. Global self-worth was operationalized as a youth’s general perception of self-esteem (Harter, 2012). It was measured using the global self-worth scale of the SPPA, which consisted of 5 items presented as contrasting statements about a topic. Two items related to negative aspects of self-esteem and two related to positive aspects. An example is “Some teenagers are happy with themselves most of the time BUT Other teenagers are often not happy with themselves.” The response structure relied on the respondent to select which of the two statements was most like them, and then to select whether it was “Really true for me” or “Sort of true for me.” Scoring was based on a 4-level Likert scale with the lowest score, 1, reflecting the strongest response on the negatively worded portion to 4, representing the strongest response on the positively worded portion. The final scale score was the average of the responses on each of the five items. Higher scores correspond to higher levels of perceived general self-worth.

Social competence. Social competence was operationalized as a youth’s perceived ability to make friends and have others accept them for who they are (Harter, 2012). Social competence was measured using the social competence scale of the SPPA, which consists of 5 items presented as contrasting statements about a topic. Two items related to negative aspects of social competence and two related to positive aspects. An example is “Some teenagers find it pretty hard to make friends BUT Other teenagers find it pretty easy to make friends." The response structure relied on the respondent to select which of the two statements was most like them, and then to select whether it was "Really true for me" or "Sort of true for me." Scoring was based on a 4-level Likert scale with the lowest score, 1, reflecting the strongest response on the negatively worded portion to 4, representing the strongest response on the positively worded portion. The final scale score was the average of the responses on each of the five items. Higher scores correspond to higher levels of perceived social competence.

Athletic competence. Athletic competence was operationalized as a youth's perceived ability to do well at sports and outdoor games (Harter, 2012). Athletic competence was measured using the athletic competence scale of the SPPA, which consisted of 5 items presented as contrasting statements about a topic related to athletic ability. Two items related to negative aspects of athletic competence and two related to positive aspects. An example is "Some teenagers do very well at all kinds of sports BUT Other teenagers don't feel they are very good when it comes to sports." The response structure relied on the respondent to select which of the two statements was most like them, and then to select whether it was "Really true for me" or "Sort of true for me." Scoring was based on a 4-level Likert scale with the lowest score, 1, reflecting the strongest response on the negatively worded portion to 4, representing the strongest response on the positively worded portion. The final scale score was the average of the responses on each of the five items. Higher scores correspond to higher levels of perceived athletic competence.

Behavioral conduct. Behavioral conduct was operationalized as a youth's perceived ability to do the right thing and avoid getting into trouble (Harter, 2012). Behavioral conduct was measured using the behavioral conduct scale of the SPPA, which consisted of 5 items presented as contrasting statements about a topic related to behavior. Two items related to negative aspects of behavioral conduct and two related to positive aspects. An example is "Some teenagers usually do the right thing BUT Other teenagers often don't do what they know is right." The response structure relied on the respondent to select which of the two statements was most like them, and then to select whether it was "Really true for me" or "Sort of true for me." Scoring was based on a 4-level Likert scale with the lowest score, 1, reflecting the strongest response on the negatively worded portion to 4, representing the strongest response on the positively worded portion. The final scale score was the average of the responses on each of the five items. Higher scores correspond to higher levels of perceived behavioral conduct.

Close friendship. Close friendship was operationalized as a youth's perceived ability to make close friends (Harter, 2012). Close friendship was measured using the close friendship scale of the SPPA, which consisted of 5 items presented as contrasting statements about a topic related to making friends. Two items related to negative aspects of friendship and two related to positive aspects. An example is "Some teenagers are able to make really close friends BUT Other teenagers find it hard to make really close friends." The response structure relied on the respondent to select which of the two statements was most like them, and then to select whether it was "Really true for me" or

"Sort of true for me." Scoring was based on a 4-level Likert scale with the lowest score, 1, reflecting the strongest response on the negatively worded portion to 4, representing the strongest response on the positively worded portion. The final scale score was the average of the responses on each of the five items. Higher scores correspond to higher levels of perceived ability to make close friends.

Measures of family factors. Family factors included features of the economic, social, and health-related context of the family or parent.

Income. Income was conceptualized as total annual income over the past 12 months and was collected using one question with 11 response options "Less than $5,000" to "$150,000 or more." Income was measured on an ordinal scale by parental report and was coded 1 through 11 corresponding to increasing reported levels of income. Higher values reflect higher total annual income over the past 12 months.

Education level. Education level was conceptualized as the highest level of education attained by the responding parent. Response options included "Did not complete high school; graduated high school or received GED; graduated from two-year college or university; graduated from four-year college or university; graduate degree." Responses were coded from 0 to 4, respectively, corresponding to the highest level of education attained by the responding parent.

Family structure. Family structure was conceptualized by whether there is a one-parent or multi-parent home. It was collected by parent report using the question "What is your family situation at home?" with three response options "married or living together;

single parent; or other." Responses were coded as 1, 2, or missing corresponding to the number of parents in the home.

Parent PA level. Parental PA was operationalized as the intensity of parental involvement in moderate and vigorous physical activities. This was collected by parent report using the International PA Short Form (The IPAQ Group, 2003), which consisted of seven questions related to the number of days and number of minutes or hours of vigorous, moderate, and light activity and the number of hours spent sitting. Scoring was performed using the automated algorithm distributed by the authors (The IPAQ Group, 2003) and reported as a categorical score of low, medium, or high weekly PA.

Family relationships. Family relationships was operationalized as the extent to which a youth was involved with and felt like an important member of the family (Health Measures, 2017). Family relationships were measured based on parent responses to the 4 questions on the PROMIS Parent Proxy Family Relationships Short Form (Health Measures, 2017). An example of one question is "In the past 4 weeks, my child felt he/she really belonged in our family." (Health Measures, 2017). The response structure was "never; rarely; sometimes; often; always" coded as 1-5 and converted to a T-score using an automated online scoring system (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as having stronger family relationships.

Parental physical health. Parental physical health was operationalized as the extent to which an adult felt they had good physical health (Health Measures, 2017). Physical health was measured based on parent responses to the 2 questions on the

PROMIS Adult Global Physical Health Short Form 2a (Health Measures, 2017). An example of one question is “In general, how would you rate your physical health?” (Health Measures, 2017). The response structure was “excellent; very good; good; fair; poor” coded as 1-5 and converted to a T-score using an automated online scoring system; (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as having better physical health.

Parental mental health. Parental mental health was operationalized as the extent to which an adult felt they had good mental health (Health Measures, 2017). Mental health was measured based on parent responses to the 2 questions on the PROMIS Adult Global Mental Health Short Form 2a (Health Measures, 2017). An example of one question is “In general, how would you rate your mental health, including your mood and your ability to think?” (Health Measures, 2017). The response structure was “excellent; very good; good; fair; poor” coded as 1-5 and converted to a T-score using an automated online scoring system (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as having better mental health.

Parental physical function. Parental physical function was operationalized as the extent to which an adult were able to do physical tasks easily (Health Measures, 2017). Physical health was measured based on parent responses to the 4 questions on the PROMIS-29 Profile v2.1 pertaining to physical function (Health Measures, 2017). An example of one question is “Are you able to go for a walk of at least 15 minutes?”

(Health Measures, 2017). The response structure was “without any difficulty; with a little difficulty; with some difficulty; with much difficulty; unable to do” coded as 5-1 and converted to a T-score using an automated online scoring system (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as having better physical function.

Parental anxiety. Parental anxiety was operationalized as how often a parent felt emotional distress from fear, worry, or nervousness (Health Measures, 2017). Anxiety was measured based on parent responses to the 4 statements on the PROMIS-29 Profile v2.1 pertaining to anxiety (Health Measures, 2017). An example of one statement is “In the past 7 days, my worries overwhelmed me.” (Health Measures, 2017). The response structure is “never; rarely; sometimes; often; always” coded as 1-5, respectively, and converted to a T-score using an automated online scoring system that provided the T-score and its standard error (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as having higher levels of anxiety.

Parental depression. Parental depression was operationalized as how often a parent felt emotional distress from negative mood, loss of interest, self-criticism, or loneliness (Health Measures, 2017). Depression was measured based on parent responses to the 4 statements on the PROMIS-29 Profile v2.1 pertaining to depression (Health Measures, 2017). An example of one statement is “In the past 7 days, I felt helpless.” (Health Measures, 2017). The response structure was “never; rarely; sometimes; often; always” coded as 1-5, respectively, and converted to a T-score using an automated online scoring system that provided the T-score and its standard error (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as having higher levels of depression.

Parental fatigue. Parental fatigue was operationalized as the extent to which a parent felt being tired prevents them from doing things they want to do (Health Measures, 2017). Fatigue was measured based on parent responses to the 4 statements on the PROMIS-29 Profile v2.1 pertaining to fatigue (Health Measures, 2017). An example of one statement is “In the past 7 days, I had trouble starting things because I am tired.” (Health Measures, 2017). The response structure was “not at all; a little bit; somewhat; quite a bit; very much” coded as 1-5, respectively, and converted to a T-score using an automated online scoring system that provided the T-score and its standard error (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as having higher levels of fatigue.

Parental ability to participate in social roles and activities. Parental ability to participate in social roles and activities was operationalized as how often a parent felt they were able to do the things they wanted to do (Health Measures, 2017). Ability to participate was measured based on parent responses to the 4 statements on the PROMIS-29 Profile v2.1 pertaining to this construct (Health Measures, 2017). An example of one statement is “I have trouble doing all of the family activities that I want to do.” (Health Measures, 2017). The response structure was “never; rarely; sometimes; usually; always” coded as 5-1, respectively, and converted to a T-score using an automated online scoring system that provided the T-score and its standard error (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as having higher levels of ability to participate in social roles and activities.

Parental pain interference. Parental pain interference was operationalized as the extent to which a parent felt pain interfered with their ability to do things (Health Measures, 2017). Pain interference was measured based on parent responses to the 4 questions on the PROMIS-29 Profile v2.1 pertaining to this construct (Health Measures, 2017). An example of one question is “In the past 7 days, how much did pain interfere with your day to day activities?” (Health Measures, 2017). The response structure was “not at all; a little bit; somewhat; quite a bit; very much” coded as 1-5, respectively, and converted to a T-score using an automated online scoring system that provided the T-score and its standard error (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as having higher impact of pain on participation in activities.

Parental social support. Parental social support was operationalized as how often a parent felt they had someone to do things with (Health Measures, 2017). Social support was measured based on parent responses to the 4 questions on the PROMIS Adult Companionship Short Form (Health Measures, 2017). An example of one question is “Do you have someone with whom you can do something enjoyable?” (Health Measures, 2017). The response structure was “never; almost never; sometimes; fairly often; very often” coded as 1-5, respectively, and converted to a T-score using an automated online scoring system that provided the T-score and its standard error (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as having stronger social support.

Parental emotional support. Parental emotional support was operationalized as how often a parent felt they had someone to confide in (Health Measures, 2017). Emotional support was measured based on parent responses to the 4 statements on the PROMIS Adult Emotional Support Short Form (Health Measures, 2017). An example of one statement is "I have someone who will listen to me when I need to talk." (Health Measures, 2017). The response structure was "never; almost never; sometimes; fairly often; very often" coded as 1-5, respectively, and converted to a T-score using an automated online scoring system that provided the T-score and its standard error (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as having stronger emotional support.

Parental instrumental support. Parental instrumental support was operationalized as how often a parent felt they had someone to help them when they needed help (Health Measures, 2017). Instrumental support was measured based on parent responses to the 4 questions on the PROMIS Adult Instrumental Support Short Form (Health Measures, 2017). An example of one question is "Do you have someone to help you with your daily chores if you are sick?" (Health Measures, 2017). The response structure was "never; almost never; sometimes; fairly often; very often" coded as 1-5, respectively, and converted to a T-score using an automated online scoring system that provided the T-score and its standard error (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as having stronger instrumental support.

Parental informational support. Parental informational support was operationalized as how often a parent felt they had someone to get advice from when they needed it (Health Measures, 2017). Informational support was measured based on parent responses to the 4 statements on the PROMIS Adult Informational Support Short Form (Health Measures, 2017). An example of one statement is "I have someone to give me information if I need it." (Health Measures, 2017). The response structure was "never; almost never; sometimes; fairly often; very often" coded as 1-5, respectively, and converted to a T-score using an automated online scoring system that provided the T-score and its standard error (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as having stronger informational support.

Parental social isolation. Parental social isolation was operationalized as how often a parent felt left out or alone (Health Measures, 2017). Social isolation was measured based on parent responses to the 4 statements on the PROMIS Adult Social Isolation Short Form (Health Measures, 2017). An example of one statement is "I feel that people barely know me." (Health Measures, 2017). The response structure was "never; almost never; sometimes; fairly often; very often" coded as 1-5, respectively, and converted to a T-score using an automated online scoring system that provided the T-score and its standard error (Health Measures, 2017). The T-score is a ratio level score. Higher scores are interpreted as feeling more isolated.

Family finances. Family finances was operationalized by the extent to which lack of money created problems for a youth's experience with the physical or social aspects of the home or community, or availability of needed services or equipment (Bedell, 2011b). It was measured using one question from the CASE related to inadequate or lack of family finances. The response structure was a 4-level Likert scale "no problem; little problem; big problem; not applicable" and was coded 1, 2, 3, and missing, respectively. Higher scores are interpreted as more impact of financial problems.

Family stress. Family stress was operationalized by the extent to which family stress created problems for a youth's experience with the physical or social aspects of the home or community, or availability of needed services or equipment (Bedell, 2011b). It was measured using one question from the CASE related to family stress. The response structure was a 4-level Likert scale "no problem; little problem; big problem; not applicable" coded 1, 2, 3, and missing, respectively. Higher scores are interpreted as more impact of family stress.

Measures of social factors. Social factors included those that reflected or influenced relationships between the youth and peers.

Bullying. Bullying was operationalized by teasing, threatening, hitting, shoving, or hurting repeatedly. It was measured based on youth report to two questions from the 2017 YRBS Survey (CDC, 2017). An example of one question is "During the past 12 months, have you ever been bullied on school property?" Both questions used a dichotomous response structure "yes; no" coded no = 0 and yes = 1. The bullying variable was scored as the sum of the two responses, with 0 reflecting no bullying, 1 reflecting some bullying, and 2 reflecting a lot of bullying.

Peer relationships. Peer relationships was operationalized as the quality of relationships with friends and other peers (Health Measures, 2017). Peer relationships was measured based on youth self-responses to the 8 statements on the PROMIS Pediatric Peer Relationship Short Form 8a (Health Measures, 2017). An example of one statement is “In the past 7 days, I felt accepted by other kids.” (Health Measures, 2017). The response structure was “never; almost never; sometimes; fairly often; very often” coded as 0-4, respectively, and converted to a T-score using an automated online scoring system that provided the T-score and its standard error (Health Measures, 2017). The T-score is a ratio level score. Higher scores were interpreted as having better relationships.

Support. Support was operationalized by the extent to which lack of support and encouragement at school or in the community created problems for a youth’s experience with the physical or social aspects of the home or community, or availability of needed services or equipment (Bedell, 2011b). It was measured using two statements from the CASE related to support. An example of one statement is “lack of support and encouragement for your child in the community or neighborhood.” The response structure was a 4-level Likert scale “no problem; little problem; big problem; not applicable,” coded 1, 2, 3, and missing, respectively. The average of the scores on the two items was used as the score for support. Higher scores were interpreted as more impact of lack of support.

Social attitudes. Social attitudes was operationalized by the extent to which people's attitudes at school or in the community created problems for a youth's experience with the physical or social aspects of the home or community, or availability of needed services or equipment (Bedell, 2011b). It was measured using two statements from the CASE related to attitudes. An example of one statement is "problems with people's attitudes toward your child in the community or neighborhood." The response structure was a 4-level Likert scale "no problem; little problem; big problem; not applicable," coded 1, 2, 3, and missing, respectively. The average of the scores on the two items was used as the score for attitudes. Higher scores were interpreted as more impact of negative attitudes.

Assistance. Assistance was operationalized by the extent to which lack of assistance at school or in the community created problems for a youth's experience with the physical or social aspects of the home or community, or availability of needed services or equipment (Bedell, 2011b). It was measured using two statements from the CASE related to assistance. An example of one statement is "inadequate or lack of assistance from people at home or in the community or neighborhood." The response structure was a 4-level Likert scale "no problem; little problem; big problem; not applicable," coded 1, 2, 3, and missing, respectively. The average of the scores on the two items was used as the score for assistance. Higher scores were interpreted as more impact of lack of assistance.

Measures of community factors. Community factors included those that characterized the nature of neighborhood, measured at the level of the self-reported county of residence by the parent.

Violent crime rate. Violent crime rate was operationalized as the number of violent crimes reported by law enforcement per 100,000 population within the county of residence (Robert Wood Johnson Foundation, 2018). Violent crime rate was calculated based on data from the Federal Bureau of Investigation through the Uniform Crime Reporting Program for the period 2012-2014 (Robert Wood Johnson Foundation, 2018). Higher values indicated higher violent crime rates.

Percent children in poverty. Percent children in poverty was operationalized as the number of children under age 18 years living below 100% of the Federal Poverty Level per 100 population within the county of residence (Robert Wood Johnson Foundation, 2018). Percent children in poverty was calculated based on data from the 2016 American Community Survey (ACS) and aggregated by 2010 census tract boundaries (Robert Wood Johnson Foundation, 2018). Higher values indicated more children living in poverty.

High school graduation rate. High school graduation rate was operationalized as the percentage of ninth grade students graduating from high school within four years (Robert Wood Johnson Foundation, 2018). High school graduation rate was calculated based on data from the National Center for Education Statistics for the years 2014-2015 and aggregated by county (Robert Wood Johnson Foundation, 2018). Higher values indicated a greater percentage of ninth graders graduating from high school within four years.

Percent with severe housing problems. Percent with severe housing problems was operationalized as the number of households per 100 population with problems with kitchen, plumbing, more than 1.5 persons per room, or costing more than 50% of monthly income (Robert Wood Johnson Foundation, 2018). Percent with severe housing problems was calculated based on Comprehensive Housing Affordability Strategy (CHAS) data for the years 2010-2014 and aggregated by county (Robert Wood Johnson Foundation, 2018). Higher values indicated a greater percentage of households living with severe housing problems.

Social association participation rate. Social association participation rate was operationalized as the number of people per 10,000 population with memberships to civic, business, fitness, or professional organizations (Robert Wood Johnson Foundation, 2018). Social association participation rate was calculated based on County Business Patterns data for the year 2015 and aggregated by county (Robert Wood Johnson Foundation, 2018). Higher values indicated a greater social participation rate.

Physical inactivity percentage. Physical inactivity percentage was operationalized as the number of adults over 20 years per 100 population who reported being involved in no leisure time PA (Robert Wood Johnson Foundation, 2018). Physical inactivity percentage was calculated based on data from the National Diabetes Surveillance System for the year 2014 aggregated by county (Robert Wood Johnson Foundation, 2018).

Higher values indicated a greater percentage of inactive adults.

Percent urban. Percent urban was operationalized by the number of areas of 50,000 people or more and clusters of at least 2,500 and less than 50,000 as defined by the (U.S. Census Bureau, 2010a). Percent urban was calculated based on the percentage of the population living in urban areas based on census data from the year 2010 aggregated by county. Higher values indicated a greater percentage of the population of a county living in urban areas.

Measures of organizational factors. Organizational factors represented effects stemming from agencies, policies, programs, services, or rules.

Government agencies and policies. Government agencies and policies was operationalized by the extent to which they created problems for a youth's experience with the physical or social aspects of the home or community, or availability of needed services or equipment (Bedell, 2011b). It was measured using one statement from the CASE "problems with government agencies and policies." The response structure was a 4-level Likert scale "no problem; little problem; big problem; not applicable" and was coded 1, 2, 3, and missing, respectively. Higher scores were interpreted as more impact by government agencies and policies.

Programs and services. Programs and services was operationalized by the extent to which lack of access to programs and services at school or in the community created problems for a youth's experience with the physical or social aspects of the home or community, or availability of needed services or equipment (Bedell, 2011b). It was measured using two statements from the CASE related to access. An example of one statement is “inadequate or lack of programs and services in the community or neighborhood.” The response structure was a 4-level Likert scale “no problem; little problem; big problem; not applicable,” coded 1, 2, 3, and missing, respectively. The average of the scores on the two items were used as the score for assistance. Higher scores were interpreted as more impact of lack of access to programs and services.

Devices and equipment. Devices and equipment was operationalized by the extent to which lack of access to devices and equipment created problems for a youth’s experience with the physical or social aspects of the home or community, or availability of needed services or equipment (Bedell, 2011b). It was measured using one statement from the CASE “inadequate or lack of assistive devices or equipment.” The response structure was a 4-level Likert scale “no problem; little problem; big problem; not applicable,” coded 1, 2, 3, and missing, respectively. A higher score was interpreted as more impact by lack of access to devices or equipment.

Measures of physical environment factors. Environmental factors included the features of the built and natural environment.

Physical design and access. Physical design and access was operationalized by the extent to which problems with design and layout of building features at school or in the community created problems for a youth’s experience with the physical or social aspects of the home or community, or availability of needed services or equipment (Bedell, 2011b). It was measured using three statements from the CASE related to design and layout. An example of one statement is "problem with design and layout of buildings and places your child uses in the community or neighborhood." The response structure was a 4-level Likert scale "no problem; little problem; big problem; not applicable" and was coded 1, 2, 3, and missing, respectively. The average of the scores on the three items was used as the score for assistance. Higher scores were interpreted as more impact of features of the built environment.

Transportation. Transportation was operationalized by the extent to which lack of transportation created problems for a youth's experience with the physical or social aspects of the home or community, or availability of needed services or equipment (Bedell, 2011b). It was measured using one statement from the CASE "inadequate or lack of transportation." The response structure was a 4-level Likert scale "no problem; little problem; big problem; not applicable," coded 1, 2, 3, and missing, respectively. A higher score was interpreted as more impact by lack of access to transportation.

Percent access to exercise opportunities. Percent access to exercise opportunities was operationalized as the percentage of the population living in a census block within a half mile of a park, in an urban census block within a mile of a recreation facility, or in a rural census block within three miles of a recreation facility (Robert Wood Johnson Foundation, 2018). Access to exercise was calculated based on combined data from Business Analyst, Delorme map data, ESRI, and US Census Tigerline files for the year 2016 aggregated by county (Robert Wood Johnson Foundation, 2018). Higher values indicated a greater percentage of the population with access to recreational opportunities.

Air pollution. Air pollution was operationalized as the average daily density of fine particulate matter, PM2.5, in micrograms per cubic meter (Robert Wood Johnson Foundation, 2018). Air pollution was calculated based on data from the Environmental Public Health Tracking Network for the year 2012 aggregated by county (Robert Wood Johnson Foundation, 2018). Higher values indicated higher levels of air pollution.

Unhealthy days. Unhealthy days was operationalized as the number of days in the past 30 in which it was unhealthy to exercise outdoors (Robert Wood Johnson Foundation, 2018). Unhealthy days was calculated based on data from the Environmental Public Health Tracking Network for the year 2012 aggregated by county (Robert Wood Johnson Foundation, 2018). Higher values indicated higher levels of unhealthy days.

Data Analysis Plan

Research questions and hypotheses. The research question and specific hypotheses I addressed in my research were as follows:

RQ: What is the extent to which personal, family, social, organizational, community, and environmental factors facilitate or impede participation of youth with CP age 12-17 years in health-enhancing levels of PA, controlling for age, sex, and level of gross motor function?

$H1_0$: Gross motor function level, pain, strength and associated conditions will not be significant indicators of a latent construct reflecting body structure and function.

$H1_A$: Gross motor function level, cognitive function, pain, strength and associated conditions will be significant indicators of a latent construct reflecting body structure and function.

$H2_0$: Mobility and upper extremity function will not be significant indicators of a latent construct reflecting activity capacity.

$H2_A$: Mobility and upper extremity function will be significant indicators of a latent construct reflecting activity capacity.

$H3_0$: Age, sex, grade, ethnicity, race, height, weight, general competence, gross motor persistence, global self-worth, social competence, athletic competence, behavioral conduct, and close friendship will not be significant indicators of a latent construct reflecting personal factors.

$H3_A$: Age, sex, grade, ethnicity, race, height, weight, general competence, gross motor persistence, global self-worth, social competence, athletic competence, behavioral conduct, and close friendship will be significant indicators of a latent construct reflecting personal factors.

$H4_0$: Socioeconomic status, parent physical health, parent PA level, parent mental health, parent physical function, parent anxiety, parent depression, parent fatigue, parent pain interference, parent social support, parent emotional support, parent instrumental support, parent informational support, parent social isolation, family finances, and family stress will not be significant indicators of a latent construct reflecting family factors.

$H4_A$: Socioeconomic status, parent physical health, parent PA level, parent mental health, parent physical function, parent anxiety, parent depression, parent fatigue, parent pain interference, parent social support, parent emotional support, parent instrumental support, parent informational support, parent social isolation, family finances, and family stress will be significant indicators of a latent construct reflecting family factors.

$H5_0$: Bullying, peer relationships, close friendships, peer social support, social attitudes, and assistance will not be significant indicators of a latent construct reflecting social factors.

$H5_A$: Bullying, peer relationships, close friendships, peer social support, social attitudes, and assistance will be significant indicators of a latent construct reflecting social factors.

$H6_0$: Safety, violent crime rate, children living in poverty, high school graduation rate, severe housing problems, social association participation rate, physical inactivity, and urban/rural location will not be significant indicators of a latent construct reflecting community factors.

$H6_A$: Safety, violent crime rate, children living in poverty, high school graduation rate, severe housing problems, social association participation rate, physical inactivity, and urban/rural location will be significant indicators of a latent construct reflecting community factors.

$H7_0$: Institutional policies, services, and resources, programs and services, and devices and equipment will not be significant indicators of a latent construct reflecting organizational factors.

$H7_A$: Institutional policies, services, and resources, programs and services, and devices and equipment will be significant indicators of a latent construct reflecting organizational factors.

$H8_0$: Physical design and access, transportation, access to exercise facilities, air pollution, and unhealthy days will not be significant indicators of a latent construct reflecting physical environmental factors.

$H8_A$: Physical design and access, transportation, access to exercise facilities, air pollution, and unhealthy days will be significant indicators of a latent construct reflecting physical environmental factors.

$H9_0$: More positive family factors will not be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H9_A$: More positive family support will be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H10_0$: More positive social factors will not be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H10_{A}$: More positive social factors will be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H11_{0}$: More positive community factors will not be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H11_{A}$: More positive community factors will be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H12_{0}$: More positive organizational factors will not be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H12_{A}$: More positive organizational factors will be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H13_{0}$: More positive physical environment factors will not be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H13_{A}$: More positive physical environment factors will be associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H14_0$: Intention will not mediate the positive effects of personal, family, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

$H14_A$: Intention will mediate the positive effects of personal, family, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

$H15_0$: Family support will not mediate the positive effects of personal, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

$H15_A$: Family support will mediate the positive effects of personal, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

The overall analytic design included data cleaning, exploratory and confirmatory factor analysis to establish latent constructs that describe personal, family, social, organizational, community, and physical environmental factors, and structural equation modeling to examine the strength of relationships among the latent constructs. SPSS Version 25.0 (IBM Corporation, 2017) was used for data cleaning and general univariate, bivariate, and multivariate statistical analyses. Mplus Version 8.1 (Muthén & Muthén, 2018) was used for exploratory and confirmatory factor analysis and structural equation modeling.

Data cleaning. Data cleaning consisted of a systematic examination of the characteristics of the variables to establish whether there were influential outliers, missing data, multivariate normal distributions, linear relationships among constructs, and independence, the basic assumptions for structural equation modeling (Schumacker & Lomax, 2010). Outliers were identified as data points that fell beyond a standardized z-score of 1.96 for each variable (Field, 2013). The distribution of z-scores was examined for quantitative variables; it was expected that 67% of values would be within 1 standard deviation, 95% within 2 standard deviations, and 97.5% within 3 standard deviations based on a standard normal distribution (Field, 2013; Gerstman, 2015). Values that were clearly outside normal ranges were converted to missing values.

Descriptive and distributional characteristics of each variable were examined to assess whether the variables met the assumption of a normal distribution and whether data transformation or normalization were necessary (Field, 2013). Mean, median, standard deviation, range, quartiles, skewness, and kurtosis were examined for quantitative variables, excluding missing cases pairwise (Pallant, 2016). Normality was assessed by examining the ratio of skewness to kurtosis, through Q-Q normality plots, box and whisker plots, and the Shapiro-Wilk and Kolmogorov-Smirnov tests, excluding missing cases pairwise (Pallant, 2016). Linearity was examined using Pearson correlations and by examining bivariate graphs (Pallant, 2016). Frequencies and bar graphs were examined for categorical variables (Pallant, 2016).

Missing data were treated using maximum likelihood and multiple imputation techniques in MPlus during factor analysis and structural equation modeling (Allison, 2003). Whether data were missing completely at random, missing at random, or missing not at random was assessed using analysis of variance, with age, sex, and GMFCS level as the factors.

Data analysis. Data analysis was divided into two phases, examination and confirmation of the measurement model and evaluation of the structural model.

Measurement model. Exploratory (EFA) and confirmatory factor analysis (CFA) was used to establish dimensionality of the constructs, factor loadings, and variance structures (Brown, 2014; Iacobucci, 2010) using Mplus (Muthén & Muthén, 2018). Orthogonal rotation was used during EFA to reflect relationships among factors and to increase the likelihood of good model fit in CFA (Brown, 2014). Dimensionality was examined using the scree test and focused on factors with Eigenvalues greater than 1 (Brown, 2014). Factors were interpreted based on the meaning of the scales and items included. Poorly defined factors, including those with loadings <0.3, only 2-3 items loading, or loadings >0.5 on multiple factors were eliminated (Brown, 2014). EFA was repeated until stable factors with good fit were identified. Final factors included at least three indicators, a minimum for examining goodness of fit (Brown, 2014). Once a stable factor structure was established, CFA was used to confirm fit. Model parameters were established using full information maximum likelihood or weighted least squares maximum value to minimize the difference between model and sample (Brown, 2014). Goodness of fit was established through examination of multiple fit indices. Overall goodness of fit was evaluated using $\chi 2$; statistically significant $\chi 2$ indicated that the model did not fit the data well (Brown, 2014; Iacobucci, 2010). Standardized root mean square residual (SRMR) less than .10; root mean square error of approximation (RMSEA) less than .08; comparative fit index (CFI) greater than or about .90; and Tucker-Lewis index (TLI) greater than or about .95 indicated acceptable model fit (Brown, 2014; Iacobucci, 2010).

Structural model. Structural equation modeling (SEM) was used to examine the relationships among the constructs using Mplus (Muthén & Muthén, 2018). The general approach proceeded successively through model specification, model identification, model estimation, model testing, and model modification (Schumacker & Lomax, 2010). Model specification started with the proposed structural model (Figure 1) and measurement models (Figures 2-3) based on extant literature (Anaby et al., 2014; Bloemen, Backx, et al., 2015; Dang et al., 2014; Di Marino et al., 2017; Jirikowic & Kerfeld, 2016; King, Law, Hanna, et al., 2006; King et al., 2003; Mitchell et al., 2015a; Mitchell et al., 2015b; Nooijen et al., 2014; Ross, Bogart, et al., 2016; Ross, Case, & Leung, 2016; Sallis, Prochaska, & Taylor, 2000; van Eck et al., 2008) and a unified model linking the PAPDM (van der Ploeg et al., 2004), ICF (WHO, 2007), and SET (McLeroy et al., 1988). Model identification was intended to lead to an over-identified model because of the number of factors included (Schumacker & Lomax, 2010). Model identification started from a parsimonious model with few factors, adding factors based on the anticipated strength of relationships through review of the literature. Model estimation was based on a full information maximum likelihood estimator assuming multivariate normality is confirmed; alternatively a weighted-least-squares approach was because it has fewer assumptions but requires a larger sample size (Schumacker & Lomax, 2010). The overall model fit was evaluated using χ^2; statistically significant χ^2 indicated that the model does not fit the data well (Brown, 2014; Iacobucci, 2010). Standardized root mean square residual (SRMR) less than .10; root mean square error of approximation (RMSEA) less than .08; comparative fit index (CFI) greater than or about .90; and Tucker-Lewis index (TLI) greater than or about .95 will indicate acceptable model fit (Brown, 2014; Iacobucci, 2010). Incremental models were compared using chi-square difference tests proceeded until no significant difference was found in successive models (Brown, 2014; Byrne, 2013; Schumacker & Lomax, 2010). Model modification was based on the size of reported modification indices and theoretical value of the proposed modification within the theoretical and conceptual framework (Muthén & Muthén, 2018; Schumacker & Lomax, 2010).

Interpretation. Results of the study include the factor loadings; explained variance, R^2; model fit statistics for the measurement models; pathway strengths, R; explained variance, R^2; and model fit statistics for the structural model. Pathways with higher strength had larger correlations and were interpreted as having more influence on the dependent variable. Pathways with non-significant correlation strength were not displayed. The final model was interpreted within the context of existing literature and the initial conceptual model.

Threats to Validity

Threats to Internal Validity

Internal validity refers to whether the findings of a study can be trusted, that all viable alternative explanations have been excluded (Frankfort-Nachmias et al., 2015). Threats to internal validity come from biases in selection, information, and instrumentation (Frankfort-Nachmias et al., 2015). Within a cross-sectional study, the primary threats are from data being from a single group at a single point in time (Campbell & Stanley, 1963). Lack of a control group provides no basis for comparison (Campbell & Stanley, 1963). Lack of a time course provides no information on whether the phenomenon of interest is stable, and provides no context for determining causation (Campbell & Stanley, 1963). The research questions are based upon how a theoretical model relevant to youth with disabilities is supported by the data from a primary survey.

Sample size. Recruitment of an adequate sample size is a potential threat to internal validity of a study. This was mitigated through a multistage mail and email strategy, monetary compensation for both the youth and the parent for their time upon completion of the survey, and by including an alternative recruitment strategy.

Instrumentation. Validity and reliability of test instruments is a threat to internal validity (Frankfort-Nachmias et al., 2015). All questionnaires included in this survey were previously tested for multiple forms of validity and reliability and have been used previously in research on the population included in this study. I included multiple dimensions of each primary social-ecological variable. For example, at the level of the family, I collected information on race and ethnicity, age, socioeconomic status, time availability, stress, health, structure, social support, and PA level. Each represented a different facet of the role of the family in providing support for a youth with CP to participate in health-enhancing PA. This employed the principle of triangulation to collect multiple dimensions of a construct (Frankfort-Nachmias et al., 2015).

Common source bias. Within survey studies, collecting information on the independent and dependent variables from the same person may inflate correlations among variables (George & Pandey, 2017). I minimized this likelihood by using information from the youth, a parent, and ecological level data regarding the physical, social, and attitudinal world to examine their effects on participation in PA.

Question construction and construct validity. Within survey research, how questions are constructed and asked determines the understandability, validity, and reliability of the responses (Frankfort-Nachmias et al., 2015). The questionnaires included in this study relied heavily on those developed through the NIH PROMIS initiative. PROMIS questionnaires undergo rigorous development that includes formal definition of the construct of interest, exhaustive literature review to identify the scope and dimensions of the construct, cognitive interviews, assessment of culture, literacy, and understandability effects, psychometric evaluation using item response theory methods, calibration using large scale testing, population norms, and intensive testing of construct validity, criterion validity, content validity, responsiveness, and reliability (Health Measures, 2017).

Response bias. Response bias, or survey bias, is a systematic error in which responses are inaccurate or false because of desire to give an expected answer, not understanding a question, or becoming fatigued during the survey (Frankfort-Nachmias et al., 2015). If parents or youth consistently over-report or under-report their level of PA to try to conceal how inactive they really are, a form of social desirability bias, the results could be erroneous. The anonymous nature of the study was intended to decrease risk of this type of bias. The questionnaires were administered in a random order to prevent fatigue during survey completion from biasing the responses to questions always asked at the end of the survey. Understandability was extensively tested for all questionnaires, reducing the risk for guessing or arbitrary selection of answers. The response burden was been considered and reduced to no more than an estimated 30 minutes to complete the surveys. Most questions used a five-level Likert response scale with the same response structure to make answering the questions consistent across multiple questionnaires.

Recall bias. Recall bias is a systematic error relevant to self-report questionnaires when people may not remember the frequency or difficulty of different behaviors or traits (Crosby, Salazar, Clayton, & DiClemente, 2015). Questions used in this survey study employed a short time-frame for questions, generally within the past seven days to reduce the risk of recall bias.

Model failure. Failure to converge on an acceptable fit for the SEM model was a possible threat. An alternative analytic strategy would have used multiple linear regression, which can be used in a moderation-mediation analysis to test similar structures to SEM, but in separate models that do not include indirect effects or modeled errors (Schumacker & Lomax, 2010). An additional threat was that the use of modification indices to iteratively develop a model can be controversial; failure to converge may be considered the end of the SEM analytic framework (Tarka, 2018). In this study, modification indices were used only to the extent that they were consistent with theory; models beyond the initial hypothesized model were considered exploratory rather than confirmatory.

Causation. Because this study was cross-sectional in nature, causation cannot be inferred (Field, 2013). While structural equation modeling proposes pathways that are sometimes interpreted as causal pathways, the pathways represent associations rather than causal pathways (Tomarken & Waller, 2005). Only experimental designs can determine causality (Campbell & Stanley, 1963).

Omitted variables. Structural equation modeling (SEM) is a technique that determines how well data fit a specified model (Schumacker & Lomax, 2010). Fit indices test the null hypothesis that there is no difference between the model and the data. However, the fit indices are sensitive to important omitted variables (Tomarken & Waller, 2005). Therefore, omission of some important variable could have created a Type 2 error.

Threats to External Validity

External validity refers to the ability to generalize the findings of a study to the population it was drawn from or to other populations with similar people, places, or times (Campbell & Stanley, 1963). Generalizability of this study was limited by the characteristics of the final sample that is selected. The setting was a national pediatric healthcare system. A nationally representative sample of youth with CP age 12-18 was intended. Youth receiving care at other hospitals were part of the sample frame. Youth from other countries were not part of the sample frame. The study findings may not be generalizable to those who have other types of disabilities, or who are of different ages. Data will be collected during the spring and summer of 2019. Weather or other events that took place during this time could have affected the responses of all participants, which could affect generalizability.

Selection bias. Selection bias is a systematic error due to non-random selection of individuals included in a study (Frankfort-Nachmias et al., 2015). Selection bias was controlled in this study by randomly selecting participants from a large sample frame containing all youth with CP treated at one of 14 sites of a national pediatric healthcare system. It is possible that the final sample was representative because of geographic locations of the hospital sites, or because of lack of access to treatment at the hospitals based on some demographic socioeconomic characteristic. While not all youth with CP are treated at this hospital system, no national registry exists that would contain a complete list of all youth with CP. Representativeness of the final sample was compared to national demographic characteristics.

Ethical Procedures

Access to Participants

The setting for my research was a national pediatric specialty healthcare system with sites in the U.S., Canada, and Mexico. I drew a random sample of eligible participants from the electronic medical record of this healthcare system from patients treated in the U.S. only. I requested names, addresses, and email addresses from the electronic medical record to use for mailing invitations to participate in the study. As an employee of one hospital within the system, and a member of the scientific staff, I was permitted to perform research in the system. I followed institutional policies regarding research, including protection of confidential information, storage of research data, and approval by the institutional IRB before beginning any research activities.

Treatment of Human Research Participants

My research involved interaction with human research participants by collecting information through a web-based survey administered to dyads consisting of a child aged 12-17 years and one parent. Thus, both the youth and the parent were research participants.

Involvement in the study was limited to completion of the anonymous survey, which was expected to take less than 30 minutes for each of the youth and the parent. Once the survey was complete, there was no further interaction or follow-up. Names and addresses from the electronic medical record were used only for mailing or emailing invitations to participate. No other information was taken from the electronic medical record. There was no link between the names and addresses and the survey submitted.

Institutional permissions. Recruitment started with a stratified random sample of youth receiving care at any hospital in the healthcare system. To gain access to the population, I needed institutional IRB approval and approval from the Walden IRB. The institution outsourced IRB processes to Western IRB, a nationally recognized independent IRB that provides services to academic and non-academic institutions. The Federalwide Assurance for the institution participating with Western IRB was last updated on 1/3/2018. I worked closely with Western IRB and Walden IRB to coordinate the necessary submissions to receive approvals from both prior to commencing any research activities. Following approval by the institutional IRB, Walden IRB approved the study with oversight of recruitment, data collection, and data analysis assigned to the institutional IRB and preparation and quality of the dissertation to the Walden IRB.

Ethical concerns related to recruitment. I am a senior level administrator at one site of the healthcare system I used for recruitment. Because of my role, coercion was a potential ethical issue. I addressed this by using a national rather than a local sample from the U.S.-based sites for my hospital system. I work at one hospital, but the sample reflected all of them, which decreased any influence I might have over recruitment.

Collecting the sample required access to a list of patients drawn from the electronic medical record for the purposes of recruitment for research. Since I was already on the scientific staff and the institution's notice of privacy practice (NOPP) notified all patients that their records could be reviewed preparatory to research, this was not an issue.

Recruitment took place by postal or email invitation to one parent of the youth, as found in the electronic medical record. Basic information about purpose of the research, inclusion and exclusion criteria, study procedures, time commitment, compensation, the name and address of the investigator and institutions involved, and contact information for questions. My approach was straightforward and honest, not emphasizing unrealistic benefits or financial compensation.

Personalized letters were sent to all selected participants describing and announcing the opportunity to participate in this study. An initial email was sent to all selected participants who had email addresses available describing and announcing the opportunity to participate in the study. One week later, a second email was sent to all selected participants with information on how they could access the study website to participate. Two weeks later, a reminder email was sent to all participants regarding the study. Finally, two weeks later, a second reminder email was sent to all participants regarding participation in the study. Any study participant who did not want to participate using the web-based interface was mailed a package of forms upon request to complete with paper and pen and a stamped, self-addressed return envelope was included.

Both the youth and the parent were research subjects in my study. Youth were under the age of majority and unable to provide consent. The parent participating in the study would usually provide consent for their own participation, permission for their child to participate, and the youth would provide their assent to participation. However, because the survey was anonymous, I requested a waiver of documentation of consent from the IRB. This is acceptable when a study is low risk and the only link between study results and the participant is the consent form (U.S. Department of Health and Human Services, 2016).

The youth involved in the study were minor youth with disabilities, which makes them more vulnerable than other participants. I needed to justify the use of this population to the IRB and obtained their permission to involve them. I have 33 years' experience working with this population in clinical and research capacities. The survey results were anonymous. No one, not even I, would know or be able to know who completed the surveys and who did not.

Ethical concerns related to data collection. Participation in this research was voluntary. The only interaction with participants was through a web survey interface. If the participant did not want to answer any question or wanted to stop answering questions, they could simply exit the survey interface. The primary issues related to surveys are those of confidentiality and privacy. I addressed the issue of confidentiality of the data by making the survey anonymous. No name or other identifier linked the data to the list of eligible participants within the sampling frame. I addressed the issue of privacy by having the survey on a web interface that the participants could complete at their own home.

Treatment of Data

Data were collected using the NIH Assessment Center survey interface. The following are from the Assessment Center User Manual (Northwestern University Research Data Center, 2017) related to security and confidentiality of data:

All data collected in Assessment Center including confidential, personal health information were maintained and secured at Northwestern University Research Data Center in Chicago, IL. The following text provides information about security measures at Northwestern University Research Data Center which ensure all data collected, stored, and maintained in Assessment Center are protected.

> We observe high standards of data security practices. Our approach to security consists of a collection of policies, procedures, and practices that are designed to balance the following three characteristics for critical resources: confidentiality, integrity, and availability. Secure communication lines are set in place to prevent the interception of data transmission by utilizing various data encryption technologies, such as Secured Socket Layer (SSL) and digital certificates; signatures may be used to encrypt data, validate data integrity, and authenticate the parties in a transaction. An infrastructure for confidential data management that includes the sophisticated use of firewall technologies, dedicated database and application servers, automatic failover design, real-time monitoring and related technological capabilities has been established.

Comprehensive Information Systems (IS) operating procedures and guidelines which include descriptions of system architecture, delivery platform, data sharing plan, privacy, security and issues of ADA/Accessibility has been developed. Each is presented below in greater detail.

System Architecture

Our web-based research application, Assessment Center, has been developed using ASP.NET technology in the C# programming language. C# offers rapid development and true object-oriented programming. While C# is a Microsoft proprietary language, Microsoft, HP, and Intel co-sponsored submission of the language specifications to the ECMA for standardization, and is currently ratified under the ECMA-334 standard. It is also ratified under the ISO/IEC 23270 standard.

Centralized databases commonly used in data collection have been constructed using Microsoft SQL Server 2008 R2. Direct data access will be allowed only through views and stored procedures, and all data changes will be logged. In compliance with FDA 21 CFR Part 11, all data will be time-stamped and no data will be overwritten, thus preserving an audit trail. All data transfers will occur through XML files, defined by published XML schemas.

Delivery Platform

The internet will provide the primary delivery platform. Expertise lies with the Microsoft line of software, which will be used to develop the website GUI and backend. Study websites will be accessible only through a SSL encryption layer, ensuring the confidentiality of the data transferred. Study websites will comply with the accessibility guidelines outlined by the World Wide Web Consortium (“Web Content Accessibility Guidelines 1.0” – http://www.w3.org/TR/1999/WAI-WEBCONTENT-19990505/). These guidelines help promote accessibility by people with disabilities. See also “ADA Issues” below.

Data Sharing

XML is an industry standard method of data sharing. The application will implement a standard set of XML schemas for data transfer. These XML schemas will be publicly published, outlining the format of the data. The XML files containing the data itself will be encrypted prior to transport.

Privacy

HIPAA requirements will drive the privacy of data. The PHI will be stored separately from the individual’s other data (e.g., survey responses). Other data associated with an individual will be

> indexed only by a generic ID. Encryption will also be used wherever data is transferred (SSL for webpages, etc.).
>
> Security
>
> The importance for confidentiality of the participant's PHI is recognized. PHI will be collected and transferred only where necessary. Where possible, participants will be identified only by generic ID's. SSL encryption will be used with all internet web pages to ensure confidential form submission. For data files that need to be transferred electronically, the information will be encrypted prior to transport.

The web servers and associated database servers are housed on dedicated hardware housed at Northwestern University Research Data Center. These are physically protected from intrusion as well as natural disasters. The secure facilities are protected electronically by hardware and software firewalls, intrusion detection software, anti-virus scans, and 24x7 monitoring by onsite professionals.

Northwestern University Research Data Center is completely fitted with redundancy for HVAC, power and fire detection/suppression systems.

Once data collection was complete, data were downloaded from Assessment Center in Excel spreadsheet format and stored on a password-protected computer system with a routine backup strategy. Data will be kept for a minimum of five years after completion of the study. Access to data was limited to those directly involved in the study and those who oversee research. These included myself, my committee members, and the research staff at the institution and the IRBs involved in approving the study.

Incentives

To increase the likelihood of obtaining the necessary sample size, I compensated my participants for their participation. While paying a little is acceptable because it respects the time necessary to complete the surveys, paying too much would be considered coercive. Consistent with IRB approval, I compensated $20 for the youth and $20 for the parent involved in the study. I received a grant from my workplace that covered the costs of mailing, compensation, and licensing for the survey administration software.

Summary

The purpose of this study was to determine the extent to which personal, family, social, organizational, community, and environmental factors influence participation of youth, age 12 to 17 years, with CP in health-enhancing PA. The research design was a cross-sectional, quantitative approach using online survey research methodology. The methods employed validated self- and parent-reported outcome questionnaires from a sample of adolescents, age 12 to 17 years, with CP taken from a sampling frame defined by the electronic medical record of a national children’s hospital system within the continental United States. Anonymous responses were obtained from the youth and one parent. The constructs within the research questions were components of a social-ecological conceptual model defined by van der Ploeg et al. (2004) to explain participation in PA for people with disabilities.

The hypotheses were structured to first examine the validity of the measurement model. Hypotheses 1–8 examined the construct validity of latent variables representing body structure and function, activity capacity, personal factors, family factors, social factors, community factors, organizational factors, and physical environment factors, respectively. Hypotheses 9–13 examined the strength and directionality of the relationships between the latent constructs and the dependent variable, participation in health-enhancing PA. In Hypothesis 14, intention was examined as a mediating variable for the influence of other factors. Finally, in Hypothesis 15, the role of the family was examined as a variable that could change the influence of variables at other levels. A more supportive family could promote participation when other barriers are present.

The methods included data cleaning, looking for outliers, missing data, normal distributions linear relationships among constructs, and independence. I then used exploratory and confirmatory factor analysis to examine the construct validity of the latent variables in Hypotheses 1–8. Next, I used SEM to link the latent constructs together to test the structure of the PAPDM. The model was built successively by starting with a basic framework and adding paths until an optimized model is obtained. This stage of the analysis tested Hypotheses 9–13, which revealed the strength and directionality of the relationships among the constructs. Additionally, the role of the family and intention were examined in greater detail to understand their roles in mediating other pathways.

In Chapter 4, I will present the results of data cleaning, exploratory and CFA, and SEM. Each hypothesis will be carefully examined and results presented. The results will be displayed in table form to reflect the models tested, and the final model will be displayed as a path diagram.

Chapter 4: Results

Introduction

The purpose of this study was to determine the extent to which personal, family, social, organizational, community, and environmental factors were associated with participation of youth, age 12 to 17 years, with CP, in health-enhancing PA. This quantitative, descriptive, cross-sectional study used primary survey data, collected between March 4, 2019 and July 25, 2019, with an online questionnaire. The dataset included responses from 465 parent–youth dyads to 335 questions from previously validated test instruments and scales. The dependent variable was self-reported PA level performed by youth with CP. Independent variables, listed in Tables 27-34 in Appendix A, included personal, family, social, organizational, community, and environmental factors. The theoretical framework included the International Classification of Functioning, Disability, and Health (WHO, 2001), the PAPDM (van der Ploeg et al., 2004), and social-ecological theory (Bronfenbrenner, 1977). The analytical strategy included EFA, CFA, and SEM.

Chapter 4 includes a description of the IRB approval process, recruitment and data collection, scoring of my test instruments, data cleaning, and statistical analyses conducted to address my research questions. Tables and figures that help in data interpretation are included. The research question and hypotheses addressed in my research were as follows:

RQ: What is the extent to which personal, family, social, organizational, community, and environmental factors facilitate or impede participation of youth with CP, age 12-17 years, in health-enhancing levels of PA, controlling for age, sex, and level of gross motor function?

$H1_0$: Gross motor function level, pain, strength, fatigue and associated conditions are not significant indicators of a latent construct reflecting body structure and function.

$H1_A$: Gross motor function level, cognitive function, pain, strength, fatigue, and associated conditions are significant indicators of a latent construct reflecting body structure and function.

$H2_0$: Mobility and upper extremity function are not significant indicators of a latent construct reflecting activity capacity.

$H2_A$: Mobility and upper extremity function are significant indicators of a latent construct reflecting activity capacity.

$H3_0$: Age, sex, grade, ethnicity, race, height, weight, general competence, gross motor persistence, global self-worth, social competence, athletic competence, behavioral conduct, and close friendship are not significant indicators of a latent construct reflecting personal factors.

$H3_A$: Age, sex, grade, ethnicity, race, height, weight, general competence, gross motor persistence, global self-worth, social competence, athletic competence, behavioral conduct, and close friendship are significant indicators of a latent construct reflecting personal factors.

$H4_0$: Socioeconomic status, parent physical health, parent PA level, parent mental health, parent physical function, parent anxiety, parent depression, parent fatigue, parent pain interference, parent social support, parent emotional support, parent instrumental support, parent informational support, parent social isolation, family finances, and family stress are not significant indicators of a latent construct reflecting family factors.

$H4_A$: Socioeconomic status, parent physical health, parent PA level, parent mental health, parent physical function, parent anxiety, parent depression, parent fatigue, parent pain interference, parent social support, parent emotional support, parent instrumental support, parent informational support, parent social isolation, family finances, and family stress are significant indicators of a latent construct reflecting family factors.

$H5_0$: Bullying, peer relationships, close friendships, peer social support, social attitudes, and assistance are not significant indicators of a latent construct reflecting social factors.

$H5_A$: Bullying, peer relationships, close friendships, peer social support, social attitudes, and assistance are significant indicators of a latent construct reflecting social factors.

$H6_0$: Safety, violent crime rate, children living in poverty, high school graduation rate, severe housing problems, social association participation rate, physical inactivity, and urban/rural location are not significant indicators of a latent construct reflecting community factors.

$H6_A$: Safety, violent crime rate, children living in poverty, high school graduation rate, severe housing problems, social association participation rate, physical inactivity, and urban/rural location are significant indicators of a latent construct reflecting community factors.

$H7_0$: Institutional policies, services, and resources, programs and services, and devices and equipment are not significant indicators of a latent construct reflecting organizational factors.

$H7_A$: Institutional policies, services, and resources, programs and services, and devices and equipment are significant indicators of a latent construct reflecting organizational factors.

$H8_0$: Physical design and access, transportation, access to exercise facilities, air pollution, rainy days, snowy days, hot days, and cold days are not significant indicators of a latent construct reflecting physical environmental factors.

$H8_A$: Physical design and access, transportation, access to exercise facilities, air pollution, rainy days, snowy days, hot days, and cold days are significant indicators of a latent construct reflecting physical environmental factors.

$H9_0$: More positive family factors are not associated with higher levels of health enhancing PA, controlling for age, sex, and level of gross motor function.

$H9_A$: More positive family support is associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

H10_0: More positive social factors are not associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

H10_A: More positive social factors are associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

H11_0: More positive community factors are not associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

H11_A: More positive community factors are associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

H12_0: More positive organizational factors are not associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

H12_A: More positive organizational factors are associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

H13_0: More positive physical environment factors are not associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

H13_A: More positive physical environment factors are associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

H14_0: Intention does not mediate the positive effects of personal, family, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

$H14_{A}$: Intention mediates the positive effects of personal, family, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

$H15_{0}$: Family support does not mediate the positive effects of personal, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

$H15_{A}$: Family support mediates the positive effects of personal, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

Data Collection

Study Timeline

Table 3 displays a detailed timeline of study events, including IRB approvals, amendments, study initiation, recruitment progress, and closure of the study website.

IRB Approval

Following administrative review and approval by the research department of the sponsoring organization, I received formal IRB approval from Western IRB, the central IRB providing services to the organization. I forwarded approval documents to the Walden University IRB and received final approval to initiate data collection (Approval No. 03-01-19-0298593). IRB approval included a waiver of consent documentation and a determination that this study represented minimal risk. All participants were presented

Table 3

Detailed Study Recruitment Timeline

Study task	Date
Submitted IRB materials to sponsor organization for administrative review	1/17/19
Received comments from administrative review	1/27/19
Completed revision of protocol materials from administrative review	1/30/19
Submitted IRB materials to Western IRB for review	1/31/19
IRB application approved by Western IRB	2/14/19
Received notification of approval by Western IRB	2/19/19
Submitted Western IRB approval materials to Walden IRB	2/20/19
Received confirmation of final approval from Walden IRB	3/1/19
Launched survey website	3/4/19
Received master eligibility list from sponsor organization	3/8/19
Sent letters to chiefs of staff and administrators at sponsor organization	3/10/19
Sent Wave 1 of 1,500 recruitment letters to eligible youth	3/12/19
Received first response from Wave 1	3/13/19
Sent first email follow-up reminder to Wave 1 participants (702/1,500)	3/19/19
59/702 email reminders returned undeliverable	3/19/19
Received inquiry from parent via site administrator about study	3/26/19
Discussion with sponsor organization attorney about inquiry	3/27/19
Received recommended edits to recruitment letters from attorney	4/1/19
Submitted amendment to Western IRB	4/3/19
Received request for revisions to amendment	4/9/19
Submitted revised amendment to Western IRB	4/9/19
Amendment approved by Western IRB	4/12/19
Received approval of amendment from Western IRB	4/17/19
Sent second email follow-up reminder to Wave 1 participants	4/17/19
Sent Wave 2 of 1,500 recruitment letters	4/26/19
Received first response from Wave 2	4/30/19
Sent third email follow-up reminder to Wave 1 participants	5/4/19
Sent first email follow-up reminder to Wave 2 participants (690/1,500)	5/4/19
63/690 email reminders returned undeliverable	5/4/19
Sent second email follow-up reminder to Wave 2 participants	5/16/19
Sent Wave 3 of 1,500 recruitment letters	6/5/19
Received first response from Wave 3	6/8/19
Sent third email follow-up reminder to Wave 2 participants	6/9/19
Sent first email follow-up reminder to Wave 3 participants (691/1,500)	6/13/19
90/691 email reminders returned undeliverable	6/13/19
Sent second email follow-up reminder to Wave 3 participants	6/21/19

(table continues)

Study task	Date
Sent third email follow-up reminder to Wave 3 participants	7/1/19
Sent Wave 4 of 1,438 recruitment letters	6/12/19
Received first response from Wave 4	6/19/19
Sent first email follow-up reminder to Wave 4 participants (588/1,438)	6/19/19
72/588 email reminders returned undeliverable	5/4/19
Sent second email follow-up reminder to Wave 4 participants	7/1/19
Sent third email follow-up reminder to Wave 4 participants	7/9/19
Closed study website to enrollment	7/19/19

Note. IRB = Institutional Review Board.

with a study information sheet at the start of the electronic survey. Respondents needed to click a positive response button to proceed to the study questions.

Sample Frame

I obtained the names, mailing addresses, and, when available, email addresses of 6,054 eligible youth and a parent of each youth from the electronic medical records of a children's specialty hospital system with locations throughout the United States with the assistance of the sponsoring organization's corporate research and information services staff. All youth were between the ages of 12 and 17 years and had a diagnosis of CP with an ICD-10 code of G80.0-G80.9 for any inpatient or outpatient encounter in the 3 years prior to IRB approval documented in the electronic medical record. Source verification of age and diagnosis of a random sample of 10% of the final respondents to the survey confirmed their eligibility. After excluding 16 youth from Alaska, 160 from Hawaiʻi, 3 from Puerto Rico, and 19 with no address, 5,856 eligible youth within the continental United States remained. This was my master sample frame.

Recruitment

My recruitment plan included taking a stratified random sample of 1,500 eligible youth from the master sample frame to invite participation in the study, anticipating a response rate of 33% to achieve a final sample size of 500. While selecting the initial stratified random sample, eight states had insufficient numbers in the sample frame to select a random sample and participants from these states were initially excluded from the study. I initiated data collection with a mailing to the parents of 1,500 youth, representing a stratified random sample matching the proportion of youth with CP in each state based on 2018 U.S Census data for population between 12 and 18 years, using a prevalence of 3.11 youth with CP per 1,000 population from the literature (Oskoui et al., 2013). Random selection was made using the SPSS select cases function on a state-by-state basis. I followed this postal mailing a week later with emails to the 702 parents of youth who had email addresses available; 59 emails (8.4%) were returned as undeliverable.

On March 26, 2019 I received a phone call and email from one of the administrators of the sponsoring organization regarding a letter received from a parent. The parent questioned the recruitment process and challenged the eligibility of their youth based on their understanding of the youth’s diagnosis. The youth’s eligibility was confirmed based on data within the electronic medical record; the recruitment process followed the protocol approved by the IRB. An attorney for the sponsoring organization reviewed the recruitment materials and made recommendations for slight changes to the wording. These changes were included in an amendment submitted to the institutional IRB on April 3, 2019 and approved on April 12, 2019. After approval of the amendment, two additional emails using the revised recruitment language were sent to each parent at weekly intervals to remind them of the survey opportunity.

During data monitoring after 3 weeks of data collection, I determined that the rate of survey completion was unlikely to be achieved within the study timeframe. Two factors motivated this decision. The number of responses received within the first several weeks indicated a lower response rate than expected. The proportion of eligible names on the master sample frame with email addresses was 45.6%, lower than expected. Based on these factors, I submitted a request with the April 3 IRB amendment to expand recruitment beyond the random sample to include up to 100% of the eligible youth identified in the master sample frame. Following IRB approval of the amendment, two additional waves of 1,500 recruitment letters were sent on April 26, 2019 and June 5, 2019. A final wave of 1,356 recruitment letters was sent on June 12, 2019. Three emails were sent at weekly intervals following postal mailing of the recruitment letters for those who had email addresses available.

I closed the online survey and downloaded the final dataset and PROMIS scores from Assessment Center on July 25, 2019. The final dataset contained 568 responses from parent youth dyads. Of these, 46 were identified as duplicates by exactly matching responses on parent age, sex, relationship situation, annual household income, state, and three-digit ZIP code and having identical or nearly identical responses for all other questions answered. The final number of respondents was 522 from the 5,856 eligible youth, for an overall response rate of 8.9%.

Additionally, 57 responses were excluded from the final dataset for providing insufficient information, answering fewer than 30 question, less than 10% of the 335 possible questions. The questions answered for this group were limited to parent demographic information, parent PA, and parent global physical and mental health; no responses from youth were received. The final dataset for analysis included 465 respondents. As approved by the IRB, all respondents who requested compensation were sent two $20 gift cards for the time they spent answering the questionnaires, about 30 min for each parent and 30 min for each youth. Figure 4 is a recruitment flowchart

Scoring

The 23 PROMIS short forms, International PA Questionnaire (IPAQ), Youth Self-Perception Profile for Adolescents (SPPA), Dimensions of Mastery Questionnaire (DMQ), Child and Adolescent Factors Inventory (CAFI), and Child and Adolescent Scale of Environment (CASE) each contained responses to multiple items that needed to be scored prior to analysis. All parent- and youth-reported PROMIS short forms were scored automatically through Assessment Center using calibration results from test instrument construction by the developers. The scoring algorithm resulted in a *T*-score with a mean of 50 and standard deviation of 10, normalized to the U.S. adult and pediatric general populations, respectively. Larger values indicated more of the concept being measured.

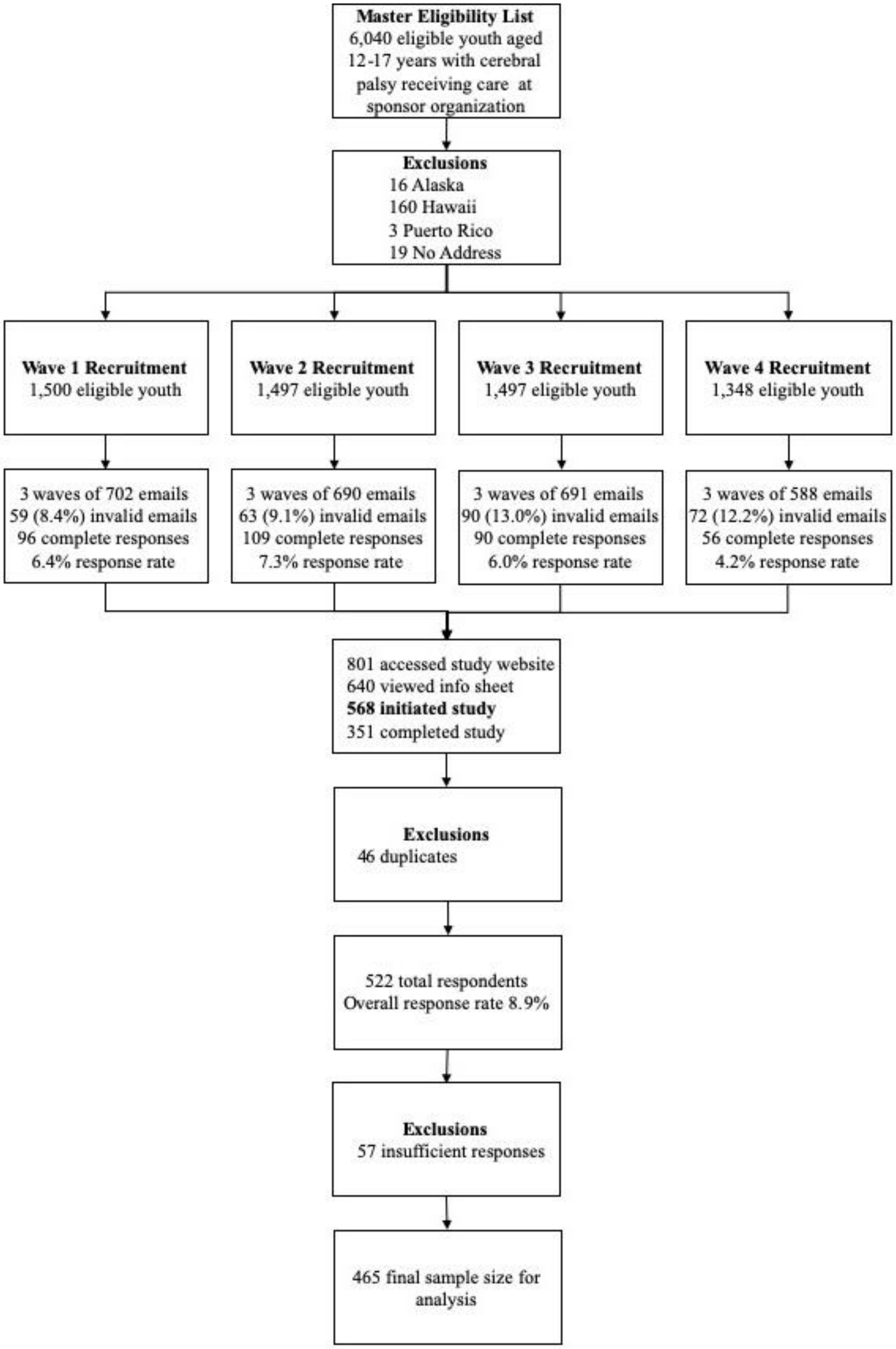

Figure 4. Recruitment flowchart.

The IPAQ was scored using an Excel spreadsheet from the developers (The IPAQ Group, 2003). Self-reported moderate, vigorous, and walking activity were each capped at 180 min/day with a minimum floor of 10 min/day. The developers used a conversion of 8 METs/min for vigorous activity, 4 METs/min for moderate activity, and 3.3 METs/min for walking activity. Total MET-minutes of activity per week was calculated as the sum of self-reported vigorous, moderate, and walking activity. Self-reported daily hours spent sitting was not included in calculations. Activity level was categorized as high if participants self-reported a minimum of 3 days of vigorous activity and at least 1,500 MET-minutes of total activity weekly or if participants self-reported any level of activity on 7 days with at least 3,000 MET-minutes of total weekly activity. Activity level was categorized as moderate if participants self-reported a minimum of 3 days of vigorous activity for at least 20 min daily, 5 days of moderate or walking activity for at least 30 min daily, or 5 days of any level of activity with at least 600 MET-minutes of total activity weekly. Participants who did not meet criteria for either moderate or high-level activity were categorized as low activity.

The SPPA was scored according to developer recommendations (Harter, 2012). For each test item, the youth graded two statements about self-perception of scholastic competence, social competence, athletic competence, physical appearance, job competence, romantic appeal, behavioral conduct, close friendships, or global self-worth. Each subscale score was formed by the mean of responses to five items. Within each subscale, two or three of the five items highlighted each of the first or the second statement. Youth were asked first to choose which of the two statements they most agreed with and then to choose magnitude of agreement: really true or sort of true. The final score, ranging from 1 to 4, was created as the sum of the statement choice, scored as 0 or 2, and the magnitude, scored as 1 or 2. Larger scores indicated higher levels of the trait.

The DMQ was scored according to guidelines published by the developer (Morgan et al., 2018). For each test item, the youth rated how much like them each statement was within domains of cognitive/object persistence, gross motor persistence, social persistence with adults, social persistence with children, mastery pleasure, negative reactions, and general competence. Each subscale score was formed by the mean of responses to five or six items, each scored on a 5-point Likert scale ranging from 1 (*least like me*) to 5 (*most like me*). A score for total persistence was created from the average of the first four domains. Larger scores indicated higher levels of the trait.

The CAFI was scored according to guidelines published by the developer (Bedell, 2011a). For each of the 15 items, the parent rated how much of a problem each was on a 3-point ordinal scale ranging from 1 (*no problem*) to 3 (*big problem*). Subscores were created for cognitive and communication, psychological, physical, and medical. A total score was created from the sum of all responses. Scores were created by dividing the sum of responses for items within the subscale by the maximum possible score, that is, for all 15 items × 3 = 45, and then multiplying by 100 to create a percentage. Larger scores indicated a greater extent of impairment.

The CASE was scored according to guidelines published by the developer (Bedell, 2011b). For each of the 18 items, the parent rated how much of a problem each was on a 3-point ordinal scale ranging from 1 (*no problem*) to 3 (*big problem*). Items had a context of home, school, community, neighborhood, or work and a theme of design and layout, attitudes, support and encouragement, equipment, transportation, programs and services, stress, crime, or information. Items were used individually in this analysis and grouped by their context within the social-ecological framework. Larger scores indicated a greater extent of environmental problem.

Data Cleaning

I reviewed all responses for missing and out-of-range data. When county of residence was missing, three-digit ZIP code was used to identify county. I examined responses for height that were out of range, defined as less than 4 feet or more than 7 feet tall. When possible, the response was used to correct the value entered. For example, a response for height in feet of 510 was interpreted as 5 feet 10 inches and coded as 70 inches. Responses that could not be clearly interpreted were coded as missing. Body mass index was calculated from weight in pounds divided by inches squared and multiplying by a conversion factor of 703. A reported parent age of less than 25 years was coded as missing. Two parents entered a birth year rather than age; this was converted to age in years. Missing data for youth demographics for four respondents were completed by cross-checking other information provided in the survey. For example, sex was determined by parent response to an open text question in which the parent used *he* or *she* as a pronoun to describe their youth.

I examined all continuous variables for influential outliers by reviewing box plots and *z*-scores. With a sample size of 465, I expected that 23 values for each variable could exceed a *z*-score of 2.0 and two values could exceed a *z*-score of 3.0 (Gerstman, 2015). All variables met the distributional assumptions for *z*-scores; there were no extreme outliers.

I examined all continuous variables for skewness and kurtosis by inspecting histograms and using the explore command in SPSS. Statistically significant skewness was indicated by a ratio of skewness to its standard error greater than 1.96 (Field, 2013). Statistically significant kurtosis was indicated by a ratio of kurtosis to its standard error greater than 1.96 (Field, 2013). No variables exhibited significant skewness, with skewness values between −1.1 and 1.1. No variables exhibited significant kurtosis, with skewness values between −1.0 and 1.1.

I examined all continuous variables for normality by observing the normal Q-Q plots using the explore command in SPSS. Several variables showed a moderate departure from normality, including parental physical function, pediatric strength impact, pediatric upper extremity function, pediatric family relationships, behavioral conduct, total persistence, and mastery pleasure. With a sample size of 465, the data set met criteria for a large sample size according to the central limit theorem (Field, 2013). Based on large sample size, all variables were assumed to meet the assumption of normality.

Missing Data

Missing data by scored instrument are shown in Table 4. The proportion of missing data ranged from 0% for parent demographic questions and ecological variables to 24.1% for the DMQ, the last question in the survey administration package. All questions were completed by 249 youth–parent dyads, 53.6% of all respondents. The overall missing response rate was 10.2%; 19 variables had no missing data, whereas 83 variables had at least one missing value.

Table 4

Missing Data by Survey Instrument

Instrument name	Missing, *n* (%)
Dimensions of Mastery Questionnaire	112 (24.1)
Youth Perception Profile for Adolescents	95 (20.4)
PROMIS Pediatric Peer Relationships	80 (17.2)
PROMIS Pediatric Strength Impact	80 (17.2)
PROMIS Pediatric Family Relationships	79 (17.0)
PROMIS Pediatric Upper Extremity Function	78 (16.8)
Stage of Change for PA	77 (16.6)
PROMIS Pediatric Mobility	77 (16.6)
PROMIS Pediatric Pain Interference	77 (16.6)
PROMIS Pediatric Fatigue	77 (16.6)
PROMIS Pediatric Cognitive Function	76 (16.3)
PROMIS Pediatric PA	75 (16.1)
Gross Motor Function Classification	58 (12.5)
Child and Adolescent Scale of Environment	37 (8.0)
Child and Adolescent Factors Inventory	23 (4.9)
International PA Questionnaire	23 (4.9)
PROMIS Parental Social Isolation	17 (3.7)
PROMIS Parental Informational Support	17 (3.7)
PROMIS Parental Instrumental Support	17 (3.7)
PROMIS Parental Emotional Support	13 (2.8)
PROMIS Parental Companionship	11 (2.4)
PROMIS Parental Pain Interference	7 (1.5)
PROMIS Parental Ability to Participate in Social Roles	5 (1.1)

Options for managing missing data include pairwise and listwise deletion; imputation based on mean, median, mode, or random sample; linear interpolation; linear regression; and multiple imputation. Pairwise and listwise deletion reduces sample size and power and creates the potential for biased parameter estimated resulting from selection bias (Chen, Toma-Drane, Valois, & Drane, 2005; Laaksonen, 2016). Imputation based on mean, median, mode, and random sample maintains sample size but reduces the variability of the data, leading to underestimates of variance and standard deviation estimates (Muthén, Kaplan, & Hollis, 1987). Linear interpolation is good for data that vary with a linear trend based on other observations from the same individual; however, multiple variables were missing for each individual, making this problematic. Therefore, I used multiple imputation using a Markov chain Monte Carlo method with linear regression for scale variables and ordinal regression for categorical variables to create five imputed data sets. Using MI retained my sample size of 465, preserved power, and reduced the likelihood of bias from my sample selection. The final analysis was based on the pooled average of the five imputed data sets.

Statistical Results

Descriptive Statistics

The results in Table 5 summarize the demographics of parent respondents to my survey. Most responding parents (89.7%) were female. The age of the responding parent ranged from 30 to 80 years; 78.1% were married or living together; 7.9% were single parents. Annual household income skewed right, with more parents reporting earning higher wages than lower; 37.9% of parents reported earning less than $50,000 annually, while 20% reported earning less than $25,000. Half of all parents (51.1%) reported high levels of weekly PA, 29.9% reported moderate levels, and 19% reported low levels of weekly PA.

Table 5

Parent Respondent Characteristics

	Frequency	Percentage
Sex		
Female	417	89.7
Male	48	10.3
Total	465	100.0
Relationship status		
Married or living together	357	78.1
Single parent	82	17.9
Other	18	3.9
Missing	8	–
Total	465	100.0
Income category (USD)		
<5,000	15	3.2
$5,000–9,999	19	4.2
$10,000–14,999	16	3.5
$15,000–19,999	15	3.3
$20,000–24,999	26	5.7
$25,000–34,999	35	7.7
$35,000–49,999	47	10.3
$50,000–74,999	79	17.3
$75,000–99,999	77	16.9
$100,000–149,999	77	16.9
≥150,000	50	11.0
Missing	9	–
Total	465	100.0
Activity category		
Low	84	19.0
Moderate	132	29.9
High	226	51.1
Missing	23	–
Total	465	100.0

My study sample reflects parents and youth living in 44 of the 50 U.S. states. The results in Table 6 detail the state of residence reported by parent respondents and the corresponding proportion of the U.S. population, age 12-17 years, who live in each state. The sample distribution closely matches the U.S. population distribution by state with some oversampling from California, Florida, Illinois, South Carolina, Kentucky, Oregon, and Utah, states where the sponsor organization has health care facilities with strong CP programs. Other states were within 1-2% of the U.S. population distribution, supporting a nationally representative sample.

Table 6

Parent and Youth State of Residence

State	Frequency	Percentage	Percentage of U.S.[a]
Alabama	6	1.3	1.5
Arizona	5	1.1	2.2
Arkansas	5	1.1	1.0
California	41	8.8	12.2
Connecticut	2	0.4	1.1
Delaware	1	0.2	0.3
Florida	46	9.9	5.7
Georgia	5	1.1	3.5
Idaho	5	1.1	0.6
Illinois	29	6.2	4.0
Indiana	5	1.1	2.2
Iowa	4	0.9	1.0
Kansas	2	0.4	1.0
Kentucky	17	3.7	1.4
Louisiana	20	4.3	1.5
Maryland	1	0.2	1.8
Massachusetts	10	2.2	2.0
Michigan	5	1.1	3.1

(table continues)

State	Frequency	Percentage	Percentage of U.S.[a]
Minnesota	6	1.3	1.7
Mississippi	2	0.4	1.0
Missouri	12	2.6	1.9
Montana	1	0.2	0.3
Nebraska	6	1.3	0.6
Nevada	4	0.9	0.9
New Hampshire	3	0.6	0.4
New Jersey	6	1.3	2.8
New Mexico	2	0.4	0.7
New York	9	1.9	5.6
North Carolina	17	3.7	3.2
North Dakota	5	1.1	0.2
Ohio	8	1.7	3.6
Oklahoma	12	2.6	1.3
Oregon	29	6.2	1.2
Pennsylvania	19	4.1	3.7
South Carolina	29	6.2	1.5
South Dakota	1	0.2	0.3
Tennessee	8	1.7	2.1
Texas	23	4.9	9.9
Utah	22	4.7	1.2
Virginia	8	1.7	2.5
Washington	17	3.7	2.2
West Virginia	3	0.6	0.5
Wisconsin	1	0.2	1.8
Wyoming	3	0.6	0.2
Missing	0	–	–
Total	465	100.0	97.4

[a] Percentage of U.S. population aged 12–17 years based on U.S. Census estimate for July 1, 2017.

The results in Table 7 summarize the demographic characteristics of youth respondents. My study sample included 57.2% boys and 42.8% girls, consistent with the epidemiology of CP being more prevalent in boys (Durkin et al., 2016). The sample reflects a flat distribution by age with 11%–20% at each age from 12 to 17 years. The sample proportion of youth self-identifying with Hispanic or Latino ethnicity was 16.0%, consistent with the 17.6% reported by the U.S. Census, 2013–2017 American Community Survey (ACS) 5-Year Estimates (U.S. Census Bureau, 2018). Similarly, the proportions of self-reported race were comparable to the 2013–2017 ACS 5-Year Estimates with 78.4% reported as White, compared to the Census estimate of 75.7%; 8.0% Black or African American, compared to a 13.9% Census estimate; 4.3% Asian, compared to a 6.3% Census estimate; 1.5% American Indian or Alaska Native, compared to a 1.7% Census estimate; and 1.5% Native Hawaiian or Other Pacific Islander, compared to a 0.4% Census estimate. White youth were slightly oversampled, while Black or African American and Asian youth were slightly undersampled. Table 8 summarizes the height and weight of youth respondents.

Table 7

Youth Respondent Characteristics

	Frequency	Percentage
Sex		
Female	181	42.8
Male	242	57.2
Missing	42	–
Total	465	100.0
Age (years)		
12	45	11.1
13	81	19.9
14	59	14.5
15	64	15.7
16	78	19.2
17	80	19.7
Missing	58	–
Total	465	100.0
Ethnicity		
Hispanic or Latino	65	16.0
Not Hispanic or Latino	340	84.0
Missing	60	–
Total	465	100.0
Race		
American Indian or Alaska Native	6	1.5
Asian	17	4.3
Black or African American	32	8.0
Native Hawaiian or Other Pacific Islander	6	1.5
White	312	78.4
Multiracial	25	6.3
Missing	67	–
Total	465	100.0

Table 8

Youth-Reported Physical Characteristics

	n	Min.	Max.	*M*	*SD*
Height (inches)	391	43.0	78.0	62.0	5.9
Weight (pounds)	394	26	296	118.3	40.9

The findings in Table 9 summarize the parent self-reported PROMIS measures of physical, mental, and social health. The mean scores for each measure were close to the population mean, consistent with the parents being a representative population. The distributions included minimum scores up to 3 standard deviations and maximum scores up to 2 standard deviations from the population mean of 50, demonstrating variability in different measures of physical, social, and mental health, a characteristic necessary for successful use of regression-based approaches.

The results in Table 10 summarize the youth self-reported PROMIS measures of physical, mental, and social health. The mean sample scores for pain interference, fatigue, and family relationships were near 50, the population mean for youth. However, the mean scores for strength impact, mobility, and upper extremity function were 34–37, or more than 2 standard deviations lower than the population mean. The maximum scores reported for youth for these measures was 54–57, demonstrating the magnitude of impairment present in the CP population. Despite the magnitude of functional impairment, the mean PA score was only 0.5 standard deviations lower than the population mean with a range from 28.8 to 71.7. While family relationships had an overall mean near the population mean, the mean for peer relationships was lower than the population mean, demonstrating some of the challenges with social situations faced by youth with CP.

Table 9

Parent Self-Reported Physical, Mental, and Social Health

	n	Min.	Max.	*M*	*SD*
PROMIS physical function	465	22.6	57.0	50.4	9.0
PROMIS anxiety	465	40.3	81.4	52.9	8.1
PROMIS fatigue	464	33.7	75.8	51.0	8.6
PROMIS depression	465	41.0	79.3	48.6	8.2
PROMIS sleep disturbance	463	32.0	73.3	49.3	8.6
PROMIS ability to participate in social roles	460	27.5	64.2	51.4	9.0
PROMIS pain interference	458	41.6	75.6	50.3	9.0
PROMIS global physical health	464	23.4	63.3	49.4	8.3
PROMIS global mental health	465	25.8	64.6	50.2	8.9
PROMIS companionship	454	25.2	63.1	51.6	8.6
PROMIS emotional support	452	25.8	62.0	52.0	8.7
PROMIS instrumental support	448	29.4	63.3	52.9	9.2
PROMIS informational support	448	29.8	65.6	55.0	8.9
PROMIS social isolation	446	34.8	74.2	48.7	8.7

Table 10

Youth Self-Reported Physical, Mental, and Social Health

	n	Min.	Max.	*M*	*SD*
PROMIS PA	390	28.8	71.7	44.0	8.8
PROMIS cognitive function	389	24.1	63.1	45.3	8.6
PROMIS fatigue	388	30.3	84.0	50.4	11.9
PROMIS pain interference	388	34.0	78.0	51.9	12.0
PROMIS strength impact	385	22.1	54.3	37.3	11.2
PROMIS mobility	388	15.2	58.5	35.3	11.4
PROMIS upper extremity function	387	12.6	56.7	34.8	16.1
PROMIS peer relationships	385	17.7	64.4	44.1	11.5
PROMIS family relationships	386	20.4	61.1	54.1	7.9

The parent-reported influences of various physical, social, and attitudinal environmental characteristics of the home, school, and community are shown in Table 11. Approximately 50% of parent respondents reported that each environmental characteristic posed no problem, while about 30% reported each was a little problem and about 15% reported each was a big problem. Environmental characteristics most often ranked as a big problem included community programs and services, characterized as a big problem by 24% of respondents, family finances by 21.5%, family stress by 20.8%, school programs and services by 18.3%, and assistive equipment by 18.3%. Environmental characteristics that were least often ranked as a big problem included community crime and violence by 2.9% of respondents, school assistance by 7.7%, and school support by 8.6%. Characteristics that were most often reported as no problem included community crime and violence by 83.6% of respondents and transportation by 68%.

The findings in Table 12 summarize the magnitude of parent-reported youth impairments. Higher scores reflect more severe levels of impairment for cognitive and communication, psychological, physical, and medical problems. The highest mean score was for physical problems, consistent with CP being a disorder affecting gross motor functioning through its effects of weakness, spasticity, and poor motor control. Medical problems were the least reported source of impairment, with a mean score of 43.1.

Table 11

Parent-Reported Environmental Characteristics From CASE

	Frequency	Percentage
Home: Physical design		
No problem	228	54.7
Little problem	136	32.6
Big problem	53	12.7
Missing	48	–
Total	465	100.0
Community: Physical design		
No problem	186	45.4
Little problem	162	39.5
Big problem	62	15.1
Missing	55	–
Total	465	100.0
School: Physical design		
No problem	205	50.5
Little problem	163	40.1
Big problem	38	9.4
Missing	59	–
Total	465	100.0
Community/home: Support		
No problem	202	49.5
Little problem	140	34.3
Big problem	66	16.2
Missing	57	–
Total	465	100.0

(table continues)

	Frequency	Percentage
School: Support		
No problem	224	54.8
Little problem	150	36.7
Big problem	35	8.6
Missing	56	–
Total	465	100.0
School: Attitudes		
No problem	190	45.9
Little problem	168	40.6
Big problem	56	13.5
Missing	51	–
Total	465	100.0
Community: Attitudes		
No problem	232	55.8
Little problem	143	34.4
Big problem	41	9.9
Missing	49	–
Total	465	100.0
Assistive equipment		
No problem	198	48.9
Little problem	133	32.8
Big problem	74	18.3
Missing	60	–
Total	465	100.0
Community/home: Assistance		
No problem	249	61.0
Little problem	113	27.7
Big problem	46	11.3
Missing	57	–
Total	465	100.0
School: Assistance		
No problem	239	59.0
Little problem	135	33.3
Big problem	31	7.7
Missing	60	–
Total	465	100.0
Transportation		
No problem	280	68.0
Little problem	90	21.8
Big problem	42	10.2
Missing	53	–
Total	465	100.0

(table continues)

	Frequency	Percentage
School: Programs/services		
No problem	197	48.8
Little problem	133	32.9
Big problem	74	18.3
Missing	61	–
Total	465	100.0
Community: Programs/services		
No problem	168	41.5
Little problem	140	34.6
Big problem	97	24.0
Missing	60	–
Total	465	100.0
Family finances		
No problem	185	43.7
Little problem	147	34.8
Big problem	91	21.5
Missing	42	–
Total	465	100.0
Family stress		
No problem	153	36.1
Little problem	183	43.2
Big problem	88	20.8
Missing	41	–
Total	465	100.0
Community: Crime/violence		
No problem	351	83.6
Little problem	57	13.6
Big problem	12	2.9
Missing	45	–
Total	465	100.0
Government agencies/policies		
No problem	224	54.9
Little problem	127	31.1
Big problem	57	14.0
Missing	57	–
Total	465	100.0
Information		
No problem	246	58.4
Little problem	124	29.5
Big problem	51	12.1
Missing	44	–
Total	465	100.0

Table 12

Parent-Reported Child Impairment Severity From CAFI

	n	Min.	Max.	*M*	*SD*
Total score	442	20.0	100.0	61.4	14.5
Cognitive and communication problems	442	26.7	100.0	62.6	20.1
Psychological problems	442	16.7	100.0	59.8	18.0
Physical problems	439	33.3	100.0	72.5	18.1
Medical problems	440	8.3	83.3	43.1	13.4

Severity of self-reported motor impairment for youth with CP is characterized by the Gross Motor Function Classification System (GMFCS), with Level 1 being the least and Level 5 the most impaired. While youth functioning at Level I may have slight difficulty keeping up with peers and may have reduced quality of movement, youth functioning at Level V do not walk even for short distances, instead using a wheelchair for even short distances. Table 13 summarizes the distribution of motor impairment for the study sample. The study sample included all GMFCS levels, with 34.9% at Level I, 24.3% at Level II, 12.3% at Level III, 10.8% at Level IV, and 17.7% at Level V. The distribution of CP reported through worldwide registries was reported by Reid, Carlin, and Reddihough (2011) with 34.2% Level I, 25.6% Level II, 11.5% Level III, 13.6% Level IV, and 15.6% Level V. The distribution of motor severity levels in this study is consistent with that reported in worldwide registries.

Table 13

Youth-Reported Gross Motor Function Classification System Levels

GMFCS level	Frequency	Percentage
I	142	34.9
II	99	24.3
III	50	12.3
IV	44	10.8
V	72	17.7
Missing	58	–
Total	465	100.0

The youth in this sample reported being bullied more, being less physically active, and watching TV more frequently than the general population of youth aged 12–17 years through the 2017 Youth Risk Behavior Surveillance System (CDC, 2018). The findings in Table 14 summarize youth-reported social, activity, and function characteristics; 27% of youth reported experiencing bullying at school, higher than the 19% reported for students in the 2017 YRBSS. Similarly, 22.1% of youth reported not being physically active on even 1 day during the week, while 8.9% reported being physically active on all 7 days, compared to 15.4% and 26.1%, respectively, in the 2017 YRBSS. Additionally, 33.4% of youth in this sample reported watching at least 3 hours of TV daily, compared to 20.7% in the YRBSS. Finally, 35.4% of the sampled youth reported participating on at least one sports team, compared to 54.3% of youth in the 2017 YRBSS. Being less physically active and experiencing higher levels of bullying are consistent with prior literature.

Table 14

Youth-Reported Social, Activity, and Function Characteristics

	Frequency	Percentage
Bullying at school		
No	276	70.4
Yes	106	27.0
Prefer not to answer	10	2.6
Missing	73	–
Total	465	100.0
Electronic bullying		
No	333	85.2
Yes	49	12.5
Prefer not to answer	9	2.3
Missing	74	–
Total	465	100.0
Physically active days		
0	87	22.1
1	46	11.7
2	53	13.5
3	66	16.8
4	35	8.9
5	54	13.7
6	17	4.3
7	35	8.9
Missing	72	–
Total	465	100.0
TV hours per day		
0	49	12.5
≤1	106	27.0
2	107	27.2
3	66	16.8
4	36	9.2
≥5	29	7.4
Missing	72	–
Total	465	100.0

(table continues)

	Frequency	Percentage
Computer hours per day		
0	68	17.3
≤1	85	21.7
2	100	25.5
3	63	16.1
4	39	9.9
≥5	37	9.4
Missing	73	–
Total	465	100.0
Gym days per week		
0	144	36.7
1	37	9.4
2	45	11.5
3	66	16.8
4	9	2.3
5	91	23.2
Missing	73	–
Total	465	100.0
Sports teams		
0	251	64.5
1	79	20.3
2	41	10.5
3	18	4.6
Missing	76	–
Total	465	100.0

The PAPDM posits that a youth's PA behavior can be described through a stage approach. The results in Table 15 detail the proportion of youth in each PA stage, from "I currently do not exercise and do not intend to start exercising in the next 6 months" to "I currently exercise regularly and have done so for more than 6 months." Approximately 25% of youth reported that they did not currently exercise; 42% reported that they exercise, but not regularly; and 32% reported that they exercise regularly. This is consistent with the 22% reporting no PA and 25% reporting being active 5 or more days per week in Table 14, providing internal consistency for PA stage.

Table 15

Youth Self-Reported PA Stage

PA stage	Frequency	Percentage
I currently do not exercise and do not intend to start exercising in the next 6 months.	56	14.4
I currently do not exercise but I am thinking about starting to exercise regularly in the next 6 months.	44	11.3
I currently exercise sometimes but not regularly.	161	41.5
I currently exercise regularly but I have only begun doing so within the last 6 months.	28	7.2
I currently exercise regularly and have done so for more than 6 months.	99	25.5
Missing	77	–
Total	465	100.0

The PAPDM proposes that self-esteem and persistence are predictors of PA stage (van der Ploeg et al., 2004). Youth-reported self-esteem was measured through the SPPA. The findings in Table 16 summarize the subscores for the eight domains of self-esteem. Subscores for behavioral conduct, global self-worth, and physical appearance were consistent with published norms for high school age peers (Harter, 2012). Subscores for romantic appeal, close friendships, scholastic competence, athletic competence, job competence, and social competence were lower for the youth with CP in this sample, compared to the general population of youth without CP according to published norms (Harter, 2012).

Table 16

Youth-Reported Self-Perception

	n	Min.	Max.	*M*	*SD*
Romantic appeal	369	0.0	4.0	2.1	0.7
Behavioral conduct	372	1.0	4.0	3.0	0.6
Close friendships	373	0.0	4.2	2.8	0.9
Global self-worth	370	1.0	4.0	3.1	0.7
Scholastic competence	376	0.0	4.0	2.6	0.9
Social competence	375	1.0	4.0	2.4	0.8
Athletic competence	374	0.5	3.8	1.9	0.7
Physical appearance	374	1.0	4.4	2.8	0.8
Job competence	373	0.8	4.0	2.3	0.8

The results in Table 17 summarize the subscores for youth-reported mastery and persistence as reported through the DMQ. All domains showed a range of scores across the full scale of the DMQ from 1 to 5. Overall, the subscores for this sample population of youth with CP were similar to those reported by Morgan et al. (2018), with the exception of gross motor persistence, which was substantially lower for the sample of youth with CP (*M* = 2.8) compared to the population mean (*M* = 3.7). This supports that while the magnitude of impairment may impact gross motor persistence, this does not necessarily imply an effect on other forms of persistence, ability to derive pleasure from successes, reaction to failure, or general competence toward peers.

Table 17

Youth-Reported Mastery and Persistence

	n	Min.	Max.	*M*	*SD*
Cognitive persistence	355	1.0	5.0	3.2	1.1
Gross motor persistence	355	1.0	5.0	2.8	1.3
Social persistence with adults	353	1.0	5.0	3.4	1.0
Social persistence with children	354	1.0	5.0	3.5	1.0
Total persistence	355	1.0	5.0	3.2	0.9
Mastery pleasure	354	1.0	5.0	4.3	0.8
Negative reaction to failure	354	1.0	5.0	3.1	0.8
General competence toward peers	355	1.0	5.0	2.9	1.0

The findings in Table 18 summarize the economic, physical, social, and environmental characteristics based on county of residence reported by parents. The study sample includes families from 231 distinct counties across the continental U.S. and include a range of community characteristics. Median household income ranged from $28,077 to $117,989. High school graduation rates ranged from 50% to 100%. Rurality ranged from 0% to 100%; and the proportion of non-Hispanic Whites ranged from 6.2% to 97.7%. The findings indicate a wide range of diversity was present in all characteristics.

Table 18

County-Level Economic, Physical, Social, and Environmental Characteristics

	n	Min.	Max.	*M*	*SD*
Physically unhealthy days (of past 30)	465	2.5	5.6	3.9	0.5
Food environment index (0–10)	465	4.4	9.7	7.6	0.8
Physically inactive (%)	465	11.5	37.4	22.9	5.1
Access to exercise opportunities (%)	465	64.0	100.0	80.6	17.5
High school graduation rate (%)	464	50.0	98.7	85.3	6.6
Children in poverty (%)	465	5.6	42.0	19.8	7.3
Income inequality (ratio 80th/20th percentile)	465	3.2	8.2	4.6	0.6
Social association rate (%)	465	1.7	45.6	10.1	4.5
Violent crime rate (per 100,000 population)	465	0.0	1,566	371.9	218.1
Average daily $PM_{2.5}$ (micrograms/cc)	465	3.0	19.7	9.8	2.0
Severe housing problems (%)	465	5.8	33.8	16.9	4.4
Median household income ($)	465	$28,077	$117,989	$56,840	$13,280
Non-Hispanic White (%)	465	6.2	97.7	67.8	18.8
Rural (%)	465	0.0	100.0	23.6	25.3

Note. cc = cubic centimeter.

Statistical Assumptions

SEM is an advanced form of linear regression. The basic statistical assumptions in SEM include no influential outliers, multivariate normality, linear relationships between observed variables and constructs, linear relationships among constructs, and no missing data. I examined the data for influential outliers during data cleaning through evaluation of *z*-scores and box plots. All variables met the distributional assumptions for *z*-scores; there were no extreme outliers. I examined all continuous variables for normality by observing Q-Q and P-P plots. While several variables showed a mild departure from normality, based on a large sample size, all variables were assumed to meet the assumption of normality. No variables had significant skewness or kurtosis. I used robust estimators in Mplus to reduce or eliminate bias resulting from mild nonnormality, skewness, and kurtosis (Muthén & Muthén, 2018). I addressed missing data using MI and robust full information maximum likelihood estimators in Mplus that automatically impute missing data during analysis (Muthén & Muthén, 2018).

Statistical Analysis Findings

In the following sections, I present the results of bivariate correlations of all independent variables with the dependent variable pediatric PA. I present the results of exploratory and confirmatory factor analysis of Hypotheses 1–8 to define latent constructs for personal, family, social, community, organizational, and environmental factors. I present the findings from SEM analysis of Hypotheses 9–13 to test for bivariate relationships of the latent constructs with the dependent variable. Finally, I present the findings from SEM analysis of Hypotheses 14 and 15 to examine the relationships and effect sizes of the latent constructs on the dependent variable.

Bivariate correlations with pediatric PA. I calculated bivariate correlations of all independent variables with the dependent variable pediatric PA. I used Pearson’s product moment correlations for interval and ratio level variables and Spearman’s rank order correlations for ordinal variables (Field, 2013). Because of the large number of variables, I adjusted the significance threshold to report only relationships with $p < .005$, in accordance with recommendations from Bonferroni to reduce the likelihood of a Type

1 error in which a false positive finding is reported (Field, 2013). Results are grouped by the social-ecological level of the variable's effect.

At the personal level, 22 of the 34 variables shown in Table 19 had significant, $p < .005$, relationships with pediatric PA. Self-reported physically active days, $r = .652$, $p < .001$, and stage of change for PA, $r = .613$, $p < .001$, had strong positive relationships with PA. Five variables had moderate relationships with PA. Gross motor function level, $r = -.378$, $p < .001$, had an inverse relationship, while strength impact, $r = .354$, $p < .001$, mobility, $r = .389$, $p < .001$, upper extremity function, $r = .332$, $p < .001$, and total persistence, $r = .318$, $p < .001$, demonstrated positive relationships. Variables with weak relationships included hours spent watching TV; number of weekly days attending gym class; participation on sports teams; athletic, social, and general competence; and physical, medical, and cognitive impairments.

At the family level, 2 of the 17 variables shown in Table 20 had significant, $p < .005$, relationships with pediatric PA. Parent PA level, $r = .134$, $p < .001$, and parent mental health, $r = .156$, $p < .001$, both had weak positive relationships with pediatric PA.

At the social level, two of the six variables shown in Table 21 had significant, $p < .005$, relationships with pediatric PA. Participation on sports teams, $r = .354$, $p < .001$, had a weak positive relationship, $r = .297$, $p < .001$, and quality of peer relationships, $r = .139$, $p < .001$, had a weak positive relationship.

Table 19

Correlations of Personal/Youth Variables With Pediatric PA

	Correlation	*p*-Value
Age	.046	.320
Body mass index	.061	.191
Physically active days	.652	.000
TV hours	−.217	.000
Computer hours	.014	.758
Gym days	.219	.000
GMFCS	−.378	.000
Cognitive function	.001	.979
Fatigue	−.055	.233
Pain interference	−.079	.090
Strength impact	.354	.000
Mobility	.389	.000
Upper extremity function	.332	.000
Stage of change for PA	.613	.000
Romantic appeal	.108	.019
Behavioral conduct	−.081	.081
Self-worth	.023	.620
Scholastic competence	.080	.083
Social competence	.142	.002
Athletic competence	.170	.000
Physical appearance	−.005	.921
Job competence	.241	.000
General competence toward peers	.263	.000
Cognitive persistence	.185	.000
Gross motor persistence	.277	.000
Social persistence with adults	.282	.000
Social persistence with children	.235	.000
Total persistence	.318	.000
Mastery pleasure	.164	.000
Negative reaction to failure	.185	.000
Cognitive and communication problems	−.234	.000
Psychological problems	−.100	.031
Physical problems	−.204	.000
Medical problems	−.245	.000

Table 20

Correlations of Parent/Family Variables With Pediatric PA

	Correlation	*p*-Value
Parent age	−.007	.874
Annual household income	.074	.111
Parent PA category	.134	.004
Parent physical function	−.002	.969
Parent anxiety	.026	.575
Parent fatigue	−.014	.761
Parent depression	−.025	.594
Parent sleep disturbance	.033	.481
Parent ability to participate in social roles	.044	.340
Parent pain interference	.014	.758
Parent physical health	.095	.041
Parent mental health	.156	.001
Parent companionship	.094	.042
Parent emotional support	.028	.550
Parent instrumental support	.127	.006
Parent informational support	.012	.795
Parent social isolation	−.007	.874

Table 21

Correlations of Social Variables With Pediatric PA

	Correlation	*p*-Value
Bullying in school	.028	.549
Electronic bullying	.042	.366
Participation on sport teams	.297	.000
Peer relationships	.139	.003
Family relationships	−.122	.008
Close friendships	.091	.050

At the community and organization levels, 2 of the 18 variables shown in Table 22 had significant, $p < .005$, relationships with pediatric PA. Barriers resulting from design features of the home, $r = -.149$, $p < .001$, and barriers due to lack of assistance at home and in the community, $r = -.172$, $p < .001$, both had weak negative relationships.

Table 22

Correlations of Community/Organizational Variables With Pediatric PA

	Correlation	*p*-Value
Home: Physical design	−.149	.001
Community: Physical design	−.085	.066
School: Physical design	−.066	.152
Community/home support	−.061	.187
School support	−.015	.746
School attitudes	.100	.031
Community attitudes	.024	.604
Assistive equipment	−.108	.020
Community/home assistance	−.172	.000
School assistance	−.017	.708
Transportation	−.055	.235
School programs and services	−.087	.062
Community programs and services	−.111	.017
Family finances	−.139	.003
Family stress	−.118	.011
Community crime/violence	.027	.559
Government agencies/policies	−.078	.092
Information	−.019	.689

At the environmental level, none of the variables shown in Table 23 and none of the county-level ecological variables reported in Table 24 had significant, $p < .005$, relationships with pediatric PA.

Table 23

Correlations of Environment Variables With Pediatric PA

	Correlation	*p*-Value
Total environmental problems	−.081	.082
Problems with home and community resources	−.094	.043
Problems with school resources	.006	.894
Problems with physical design and access	−.102	.028

Table 24

Correlation of Ecological Variables With Pediatric PA

	Correlation	*p*-Value
Physically unhealthy days	−.057	.224
Food environment index	−.004	.923
Physically inactive	−.053	.258
Access to exercise opportunities	−.036	.440
High school graduation rate	.024	.612
Children in poverty	−.036	.434
Income inequality	−.033	.474
Social association rate	.088	.059
Violent crime rate	−.063	.172
Average daily particulate matter	.059	.202
Severe housing problems	−.064	.166
Household income	.010	.834
Non-Hispanic White	.013	.777
Rural	.061	.193

Structural equation modeling. The findings are presented in four steps based on the hypotheses. Hypotheses 1–8 develop the measurement model by defining each of the latent constructs. Hypotheses 9–13 examine the relationships of the latent constructs with pediatric PA. Hypotheses 14–15 define the direct and indirect effects among the latent constructs through the structural model. Acceptable fit was judged using multiple fit statistics including a nonsignificant chi-square, $p>.5$, CFI ≥.90, TLI ≥.95, RMSEA ≤0.08 and SRMR ≤0.10.

Measurement model. The measurement model consists of eight hypotheses that define latent constructs for body structure and function, activity capacity, personal factors, family factors, social factors, community factors, organizational factors, and environmental factors from measured variables. The general structure of each latent construct was tested using EFA in SPSS and then finalized using CFA in Mplus.

Hypothesis 1. In Hypothesis 1, I examine the construct of activity capacity from measured variables reflecting the impairments a person experiences and the impact of sensations like pain and fatigue on body function.

$H1_0$: Gross motor function level, pain, strength, fatigue, and associated conditions are not significant indicators of a latent construct reflecting body structure and function.

$H1_A$: Gross motor function level, cognitive function, pain, strength, fatigue, and associated conditions are significant indicators of a latent construct reflecting body structure and function.

EFA was performed in SPSS using the measured variables gross motor function level, PROMIS cognitive function, PROMIS pain interference, PROMIS strength impact, and associated conditions including cognitive impairments, physical impairments, medical impairments, and psychological impairments reported through the CAFI. Using a maximum likelihood (ML) estimator and orthogonal rotation, EFA revealed a scree plot suggestive of two factors. The first two eigenvalues were 3.707 and 1.160, explaining

50.0% of the variance in the two-factor latent construct. The Kaiser–Meyer–Olkin measure of sampling adequacy indicated that 81.1% of the variance in the measured variables could be related to the underlying latent construct. Bartlett's test of sphericity was used to test the hypothesis that the variables were unrelated, $\chi_2 = (28, N = 465) = 1{,}108.140$, $p < .001$, indicating the results of the factor analysis differed from an identity matrix and yielded meaningful results.

Physical impairments, medical impairments, psychological impairments, and cognitive impairments composed the first factor, body structure. Strength impact, fatigue, pain interference, and cognitive function formed the second factor, body function. All factor loadings were greater than .5, indicating strong loadings of the measured variables on the latent factors.

CFA supported two factors, body structure and body function. I selected cognitive impairments to set the scale of body structure and fatigue for the scale of body function; I fixed the corresponding loading factors to 1. Using an ML estimator, the two-factor model with 1 group and 465 observations with 9 dependent measured variables supported 2 continuous latent variables, $\chi_2(15, N = 465) = 33.160$, $p < .005$ (CFI = .979; TLI = .961; RMSEA = .051; SRMR = .031).

While the chi-square did not meet criteria demonstrating a nonsignificant difference between the sample and the model, all other criteria indicated adequate goodness of fit. Since chi-square is known to be sensitive to sample size, and this study included a large sample size, adequate fit of the model was accepted. The two-factor model is shown in Figure 5 and demonstrates loading factors greater than .5 for all factors. Body structure explained 49% of the variance in the measured variables cognitive impairments, physical impairments, medical impairments, and psychological impairments. Body function explained 24% of the variance in fatigue, pain interference, and cognition. As a result, I rejected the null hypothesis and accepted the alternative hypothesis that cognitive function, pain, strength, fatigue, and associated conditions are significant indicators of a two-factor latent construct reflecting body structure and function.

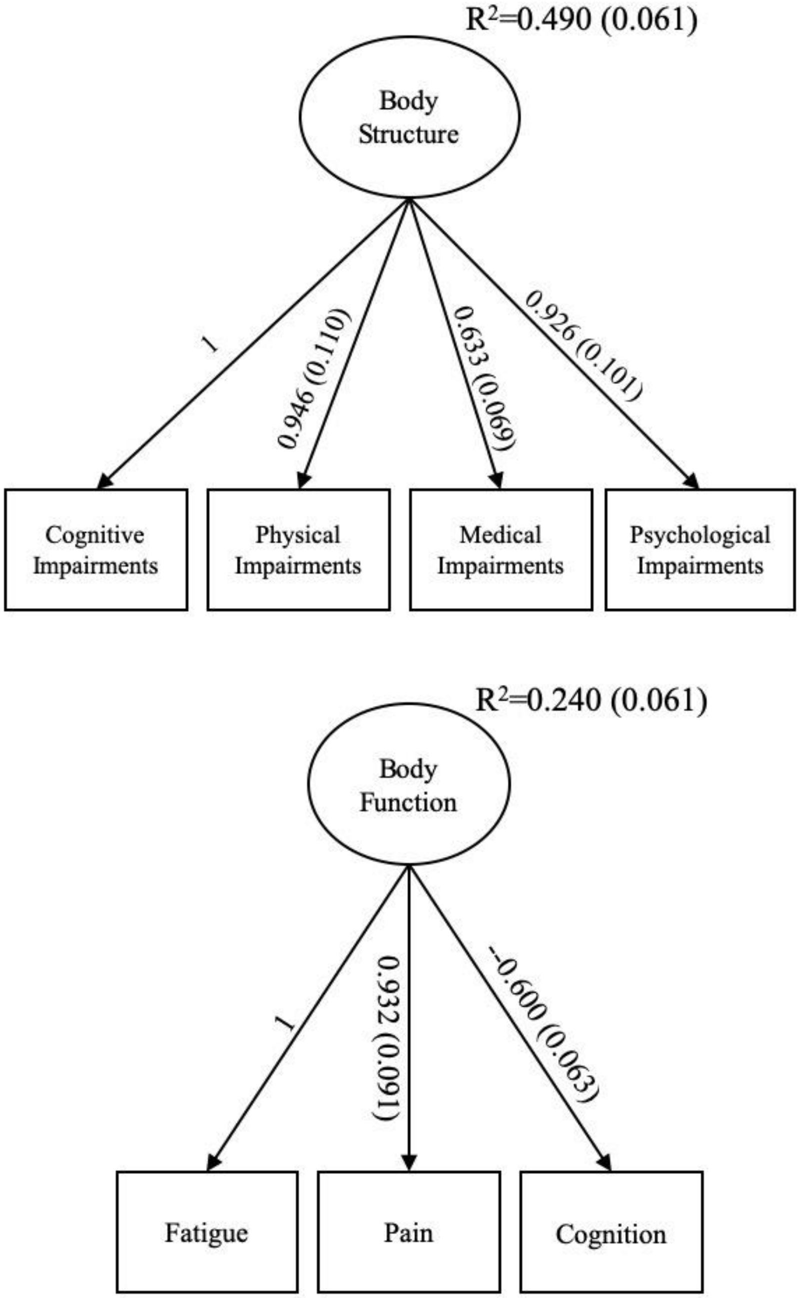

Figure 5. Measurement models for latent constructs of body structure and body function function.

Hypothesis 2. In Hypothesis 2, I examine the construct of activity capacity from measured variables reflecting what a person is physically able to do.

$H2_0$: Mobility and upper extremity function are not significant indicators of a latent construct reflecting activity capacity.

$H2_A$: Mobility and upper extremity function are significant indicators of a latent construct reflecting activity capacity.

EFA was performed using the measured variables PROMIS mobility, PROMIS upper extremity function, and Gross Motor Function Classification. Gross Motor Function Classification was added following my proposal because it more clearly fits within the activity capacity domain than the function domain. Using an ML estimator and an orthogonal rotation, EFA revealed a scree plot indicative of one primary factor. The first eigenvalue was 2.602, explaining 58.0% of the variance in the latent construct. The Kaiser–Meyer–Olkin measure of sampling adequacy indicated that 72.7% of the variance in the measured variables could be related to the underlying latent construct. Using Bartlett's test of sphericity to test the hypothesis that the variables were unrelated, $\chi_2(6, N = 465) = 935.73$, $p < .001$, the results of the factor analysis differed from an identity matrix and yielded meaningful results.

Mobility, upper extremity function, and Gross Motor Function Classification composed the latent factor activity capacity. All factor loadings were greater than .5, indicating strong loadings of the measured variables on the latent factors.

In CFA, I selected upper extremity dexterity to set the scale of activity capacity and fixed the loading factor at 1. Using an ML estimator, the model with 1 group and 465 observations with 4 dependent measured variables supported 1 continuous latent variable with $\chi_2(2, N = 465) = 6.791$, $p < .005$ (CFI = .988; TLI = .964; RMSEA = .072; SRMR = .016).

While the chi-square did not meet criteria demonstrating a nonsignificant difference between the sample and the model, all other criteria indicated adequate goodness of fit. Since chi-square is known to be sensitive to sample size, adequate fit of the model was accepted. The model of activity capacity is shown in Figure 6 and demonstrates loading factors greater than .5 for all factors.

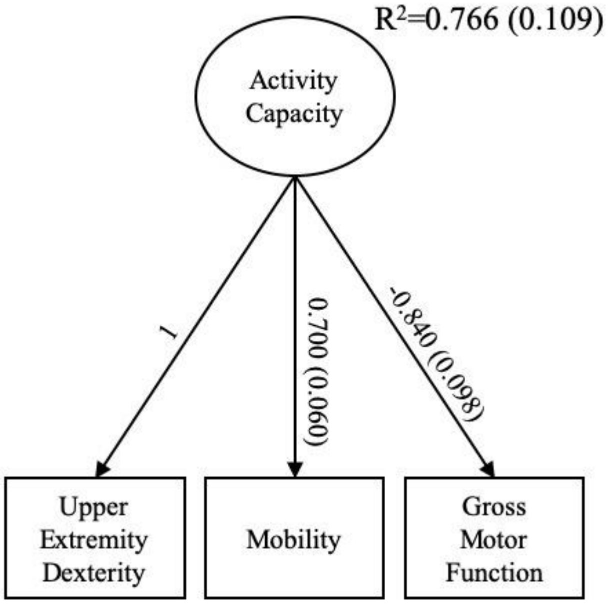

Figure 6. Measurement model for latent construct of activity capacity.

Activity capacity explained 76.6% of the variance in the measured variables upper extremity dexterity, mobility, and Gross Motor Function Classification Level. On the basis of these results, I rejected the null hypothesis and accepted the alternative hypothesis that mobility and upper extremity function are significant indicators of a latent construct reflecting activity capacity.

Hypothesis 3. In Hypothesis 3, I examine the construct of personal factors from measured variables reflecting identity, physical, and psychological characteristics of the person.

$H3_0$: Age, sex, grade, ethnicity, race, height, weight, general competence, gross motor persistence, global self-worth, social competence, athletic competence, behavioral conduct, and close friendship are not significant indicators of a latent construct reflecting personal factors.

$H3_A$: Age, sex, grade, ethnicity, race, height, weight, general competence, gross motor persistence, global self-worth, social competence, athletic competence, behavioral conduct, and close friendship are significant indicators of a latent construct reflecting personal factors.

EFA was performed using the measured variables age, sex, grade, ethnicity, race, height, weight, general competence, gross motor persistence, global self-worth, social competence, athletic competence, behavioral conduct, and close friendship. Using an ML estimator and orthogonal rotation, EFA revealed a scree plot suggestive of four factors. The first four eigenvalues were 3.352, 1.967, 1.305, and 1.143, explaining 46.4% of the variance in the construct. The Kaiser–Meyer–Olkin measure of sampling adequacy indicated that 69.8% of the variance in the measured variables could be related to the underlying latent construct. Using Bartlett's test of sphericity to test the hypothesis that the variables were unrelated, $\chi_2(78, N = 465) = 1{,}195.682$, $p < .001$, the results of the factor analysis differed from an identity matrix and yielded meaningful results.

Age, sex, grade, ethnicity, race, height, weight, and behavioral conduct did not have a factor loading greater than .4 on any factor and were discarded from further factor analysis. Close friendship was moved to the social factor because it more clearly aligned with the theoretical construct of social interaction than personal characteristics. Social persistence with peers, social persistence with adults, and gross motor persistence composed the first factor, persistence. Social competence, athletic competence, physical appearance, and self-worth composed the second factor, self-confidence. All factor loadings were above .5, indicating strong loadings of the measured variables on the latent factors.

CFA supported two factors, self-confidence and persistence. I selected social persistence with peers to set the scale of persistence and social competence to set the scale of self-confidence; I fixed the corresponding loading factors to 1. Using an ML estimator, the two-factor model with 1 group and 465 observations with 8 dependent measured variables supported 2 continuous latent variables with $\chi_2(9, N = 465) = 21.313$, $p < .005$ (CFI = .979; TLI = .951; RMSEA = .054; SRMR = .042).

While the chi-square did not meet criteria demonstrating an insignificant difference between the sample and the model, all other criteria indicated adequate goodness of fit. Since chi-square is known to be sensitive to sample size, adequate fit of the model was accepted. The two-factor model is shown in Figure 7 and demonstrates loading factors above .4 for all factors. Persistence explained 11.5% of the variance in the measured variables social persistence with adults, social persistence with peers, and gross motor persistence. Self-confidence explained 21.7% of the variance in social competence, athletic competence, physical appearance, and self-worth.

On the basis of these results, I accepted the null hypothesis for the variables age, sex, grade, ethnicity, race, height, weight, and behavioral conduct. For the remaining variables, I rejected the null hypothesis and accepted the alternative hypothesis that social persistence with peers, social persistence with adults, gross motor persistence, social competence, athletic competence, physical appearance, and self-worth are significant indicators of a two-factor latent construct reflecting personal factors.

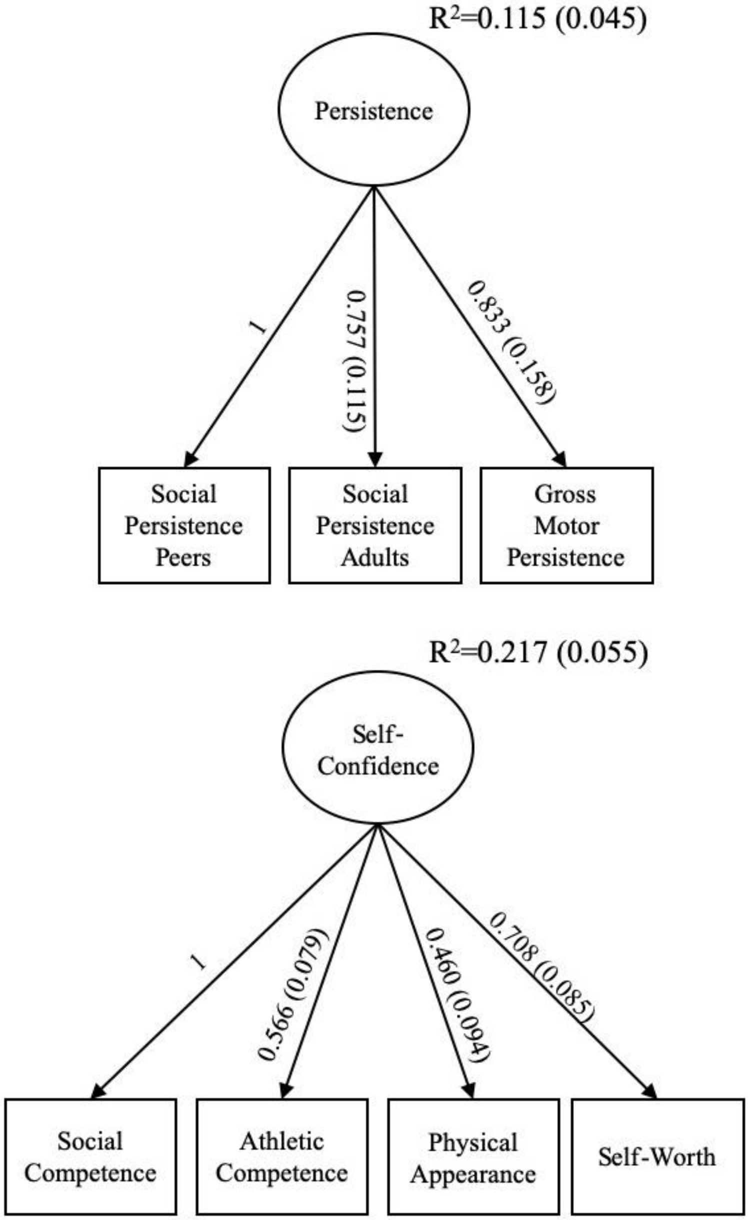

Figure 7. Measurement model for latent construct of personal factors.

Hypothesis 4. In Hypothesis 4, I examine the construct of family factors from measured variables about parent physical and social health.

$H4_0$: Socioeconomic status, parent physical health, parent PA level, parent mental health, parent physical function, parent anxiety, parent depression, parent fatigue, parent pain interference, parent social support, parent emotional support, parent instrumental support, parent informational support, parent social isolation, family finances, and family stress are not significant indicators of a latent construct reflecting family factors.

$H4_A$: Socioeconomic status, parent physical health, parent PA level, parent mental health, parent physical function, parent anxiety, parent depression, parent fatigue, parent pain interference, parent social support, parent emotional support, parent instrumental support, parent informational support, parent social isolation, family finances, and family stress are significant indicators of a latent construct reflecting family factors.

I performed EFA using the measured variables annual household income, PROMIS parent physical health, parent PA level, PROMIS parent mental health, PROMIS parent physical function, PROMIS parent anxiety, PROMIS parent depression, PROMIS parent fatigue, PROMIS parent pain interference, PROMIS parent social support, PROMIS parent emotional support, PROMIS parent instrumental support, PROMIS parent informational support, PROMIS parent social isolation, family finances, and family stress. Using an ML estimator and orthogonal rotation, EFA revealed a scree plot suggestive of four factors. The first four eigenvalues were 5.980, 2.020, 1.393, and 1.032, explaining 56.8% of the variance in the construct. The Kaiser–Meyer–Olkin measure of sampling adequacy indicated that 86.7% of the variance in the measured variables could be related to the underlying latent construct. Using Bartlett's test of sphericity to test the hypothesis that the variables were unrelated, $\chi_2(120, N = 465) = 2{,}953.522$, $p < .001$, the results of the factor analysis differed from an identity matrix and yielded meaningful results.

Annual household income, parent PA category, and family stress did not have a factor loading greater than .4 on any factor and were discarded from further factor analysis. Family finances was the only indicator loading on one factor and was removed from further factor analysis. Parent PA was considered as an independent variable because of its role in modeling behavior within the theory of planned behavior, a central theory in my research. Parent fatigue, parent physical health, parent physical function, parent pain interference, and sleep disturbance composed the first factor, parent physical health. Companionship, informational support, emotional support, instrumental support, and social isolation composed the second factor, parent social health. All factor loadings were greater than .5, indicating strong loadings of the measured variables on the latent factors.

CFA supported two factors, parent physical health and parent social health. I selected fatigue to set the scale of parent physical health and companionship to set the scale of parent social health, fixing the corresponding loading factors to 1. Using an ML estimator, the two-factor model with 1 group and 465 observations with 10 dependent measured variables supported 2 continuous latent variables with χ_2(27, N = 465) = 78.211, $p < .005$ (CFI = .976; TLI = .960; RMSEA = .064; SRMR = .036).

While the chi-square did not meet criteria demonstrating an insignificant difference between the sample and the model, all other criteria indicated adequate goodness of fit. Since chi-square is known to be sensitive to sample size, adequate fit of the model was accepted. The two-factor model is shown in Figure 8 and demonstrates loading factors above .4 for all factors. Parent physical health explained 31.3% of the variance in the measured variables parent fatigue, parent physical health, parent physical function, parent pain interference, and sleep disturbance. Parent social health explained 34.3% of the variance in companionship, informational support, emotional support, instrumental support, and social isolation.

On the basis of these results, I accepted the null hypothesis for the variables annual household income, parent PA category, family finances, and family stress. For the remaining variables, I rejected the null hypothesis and accepted the alternative hypothesis that parent physical health, parent physical function, parent anxiety, parent depression, parent fatigue, parent pain interference, parent social support, parent emotional support, parent instrumental support, parent informational support, and parent social isolation are significant indicators of a two-factor latent construct reflecting family factors.

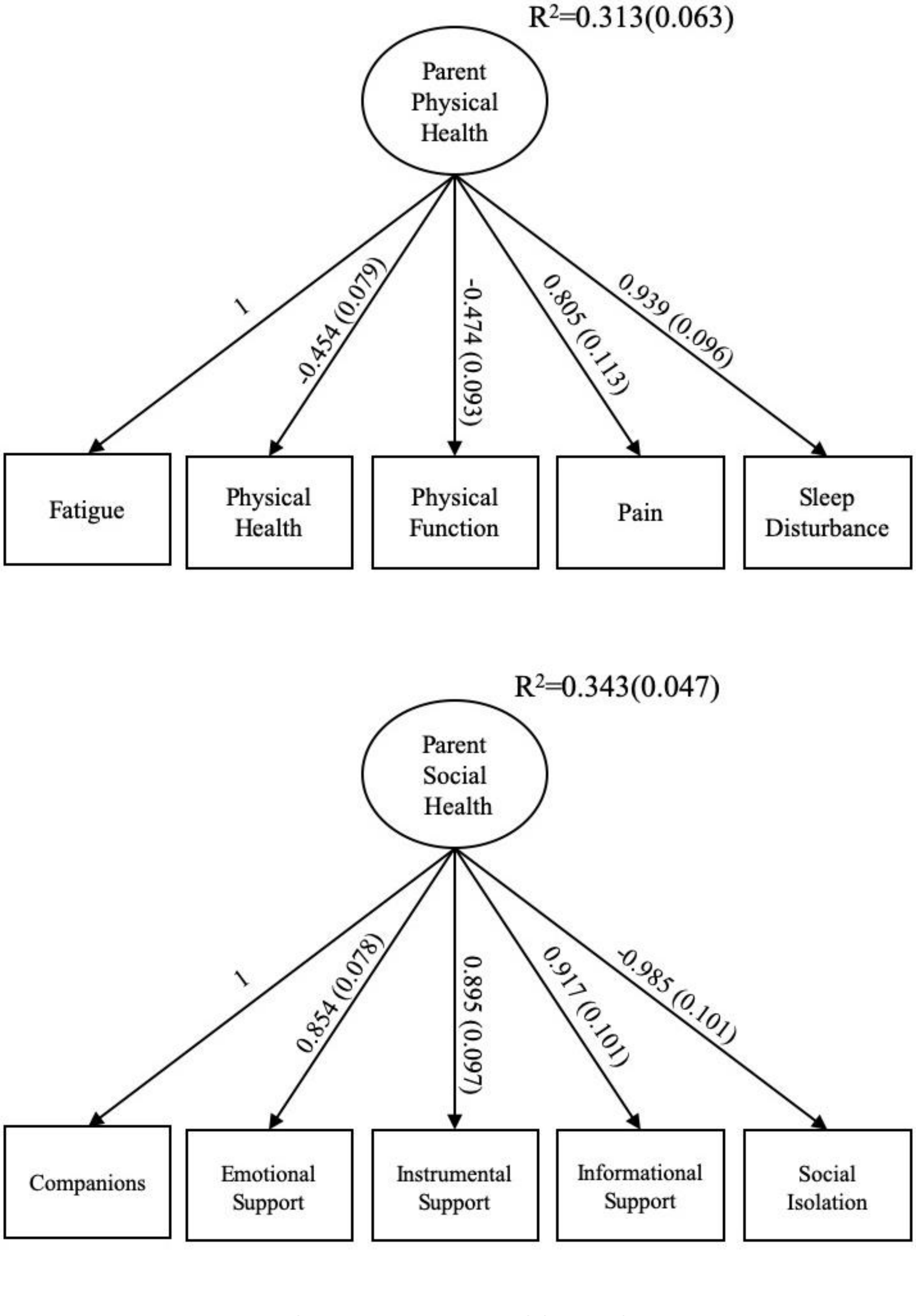

Figure 8. Measurement model for latent construct of family factors.

Hypothesis 5. In Hypothesis 5, I examine the construct of the social factors from measured variables about bullying, peer relationships, friendships, and attitudes.

$H5_0$: Bullying, peer relationships, close friendships, peer social support, social attitudes, and assistance are not significant indicators of a latent construct reflecting social factors.

$H5_A$: Bullying, peer relationships, close friendships, peer social support, social attitudes, and assistance are significant indicators of a latent construct reflecting social factors.

I performed EFA using the measured variables for electronic and school-based bullying, PROMIS peer relationships, the close friendships domain of the SPPA, and peer support and social attitudes from five questions on the CASE measuring support and attitudes at home, school, and in the community. Using an ML estimator and an orthogonal rotation, EFA revealed a scree plot suggestive of three factors. The first three eigenvalues were 4.412, 1.463, and 1.220, explaining 61.5% of the variance in the construct. The Kaiser–Meyer–Olkin measure of sampling adequacy indicated that 81.5% of the variance in the measured variables could be related to the underlying latent construct. Using Bartlett’s test of sphericity to test the hypothesis that the variables were unrelated, $\chi_2(45, N = 465) = 1,546.652$, $p < .001$, the results of the factor analysis differed from an identity matrix and yielded meaningful results.

School assistance, school support, school attitudes, community/home support, community/home attitudes, and community/home assistance composed the first factor, attitudes and support. Close friendships and peer relationships composed the second factor, friendships. Electronic bullying and school bullying composed the third factor, bullying. All factor loadings were greater than .5, indicating strong loadings of the measured variables on the latent factors.

CFA supported two factors, attitudes and friendships. The bullying construct was not supported through CFA, as the analysis would not converge during parameter estimation when bullying was included. I selected community/home support to set the scale of attitudes and peer relationships to set the scale of friendships, fixing the corresponding loading factors to 1. Using an ML estimator, the two-factor model with 1 group and 465 observations with 8 dependent measured variables supported 2 continuous latent variables with $\chi_2(14, N = 465) = 22.137$, $p < .005$ (CFI = .997; TLI = .995; RMSEA = .035; and SRMR = .024).

While the chi-square did not meet criteria demonstrating an insignificant difference between the sample and the model, all other criteria indicated adequate goodness of fit. Since chi-square is known to be sensitive to sample size, adequate fit of the model was accepted. The two-factor model is shown in Figure 9 and demonstrates moderately strong loading factors above .3 for all factors except school assistance. This indicator was kept in the model as it fit the theoretical construct of social attitudes. Attitudes explained 28.5% of the variance in the measured variables school assistance, school support, school attitudes, community/home support, community/home attitudes, and community/home assistance. Friendships explained 88.2% of the variance in close friendships and peer relationships.

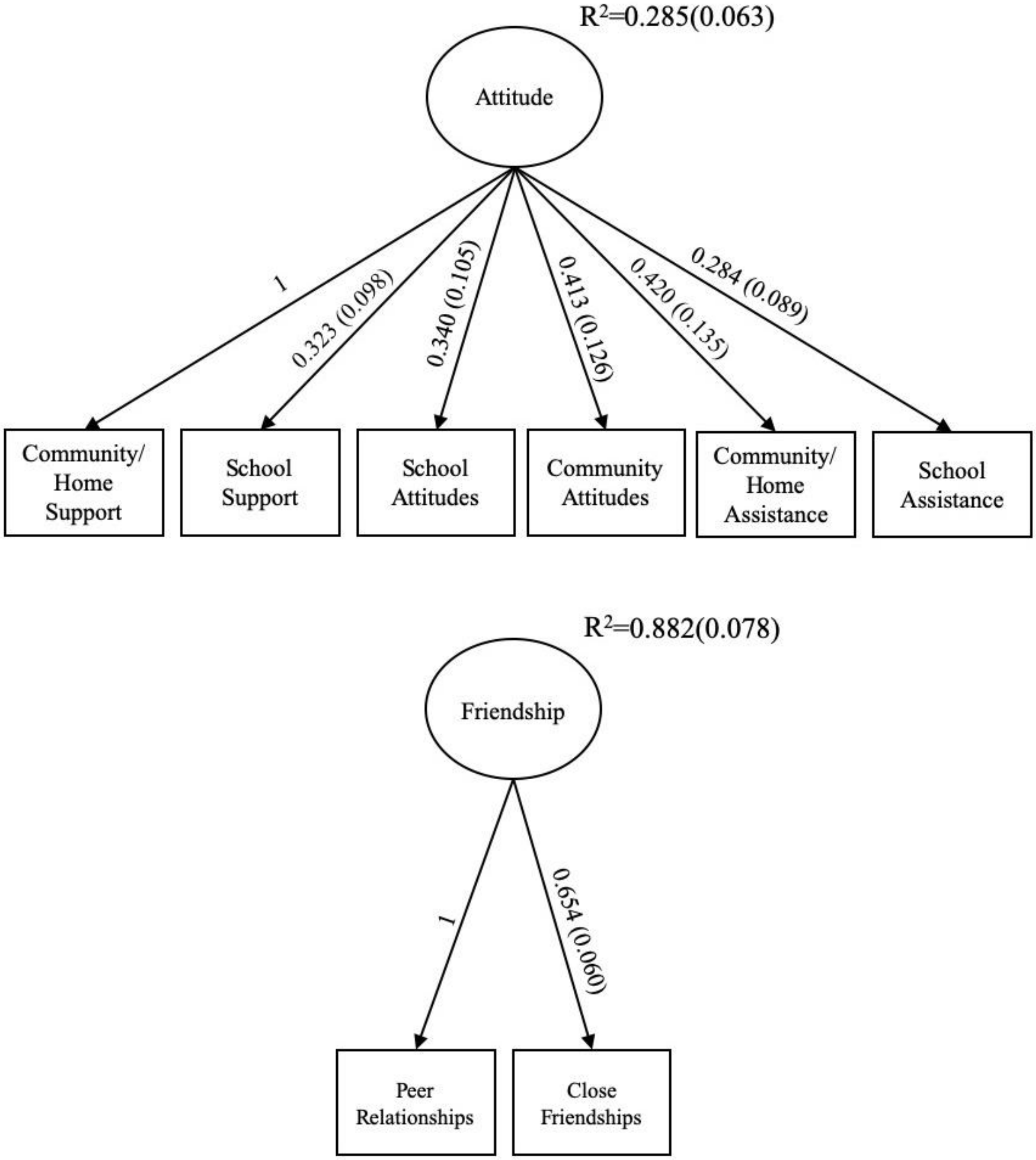

Figure 9. Measurement model for latent construct of social factors.

On the basis of these results, I accepted the null hypothesis for the bullying variables. For the remaining variables, I rejected the null hypothesis and accepted the alternative hypothesis that peer relationships, close friendships, peer social support, social attitudes, and assistance are significant indicators of a two-factor latent construct reflecting social factors.

Hypothesis 6. In Hypothesis 6, I examine the construct of the community from measured variables about crime, poverty, graduation rates, housing, access to exercise, and urban/rural location.

$H6_0$: Safety, violent crime rate, children living in poverty, high school graduation rate, severe housing problems, social association participation rate, access to exercise opportunities, and urban/rural location are not significant indicators of a latent construct reflecting community factors.

$H6_A$: Safety, violent crime rate, children living in poverty, high school graduation rate, severe housing problems, social association participation rate, access to exercise opportunities, and urban/rural location are significant indicators of a latent construct reflecting community factors.

I performed EFA using the measured variables for parent perception of safety from community crime/violence from the CASE, and violent crime rate, children living in poverty, high school graduation rate, severe housing problems, social association participation rate, percentage with access to exercise opportunities, and urban/rural location based on county of residence. Using an ML estimator and orthogonal rotation, EFA revealed a scree plot suggestive of two factors. The first two eigenvalues were 2.842 and 1.659, explaining 53.7% of the variance in the construct. The Kaiser–Meyer–Olkin measure of sampling adequacy indicated that 65.5% of the variance in all measured variables could be related to the underlying latent construct. Using Bartlett's test of sphericity to test the hypothesis that the variables were unrelated, $\chi^2(21, N = 465) = 1{,}271.658$, $p < .001$, the results of the factor analysis differed from an identity matrix and yielded meaningful results.

High school graduation rate did not load on any of the factors and was removed from further analysis. Percentage with severe housing problems and percentage children in poverty cross-loaded on both factors. As a result, the construct was reduced to one factor that included percentage children in poverty, access to exercise opportunities, percentage rural, percentage living with severe housing problems, and violent crime rate. All factor loadings were greater than .5, indicating strong loadings of the measured variables on the latent factor, community.

CFA supported one factor that included percentage rural, housing conditions, social association participation rate, and access to PA facilities. Percentage children living in poverty was not supported in the construct through CFA, as the analysis would not converge during parameter estimation when this indicator was included. I selected rurality to set the scale of the latent construct community, fixing the corresponding loading factor to 1 during model specification. Using an ML estimator, the one-factor model with 1 group and 465 observations with 4 dependent measured variables supported

1 continuous latent variable with $\chi_2(2, N = 465) = 9.376$, $p < .05$ (CFI = .982; TLI = .947; RMSEA = .089; SRMR = .023).

While the chi-square did not meet criteria demonstrating an insignificant difference between the sample and the model, all other criteria indicated adequate goodness of fit. Since chi-square is known to be sensitive to sample size, adequate fit of the model was accepted. The two-factor model is shown in Figure 10 and demonstrates moderately strong loading factors above .4 only for rurality and access to exercise opportunities. Housing conditions and social association participation rate were retained in the model because they fit the theoretical construct of community. The final latent construct of community explained 4.5% of the variance in the measured variables percentage rural, housing conditions, social association participation rate, and access to PA facilities.

On the basis of these results, I accepted the null hypothesis for the parent perception of safety and high school graduation rate. For the remaining variables, I rejected the null hypothesis and accepted the alternative hypothesis that severe housing problems, social association participation rate, access to exercise opportunities, and urban/rural location are significant indicators of a latent construct reflecting community factors. However, this construct explained a low amount of variance, indicating that the measured indicators did not share a large amount in common related to a single construct explained by community.

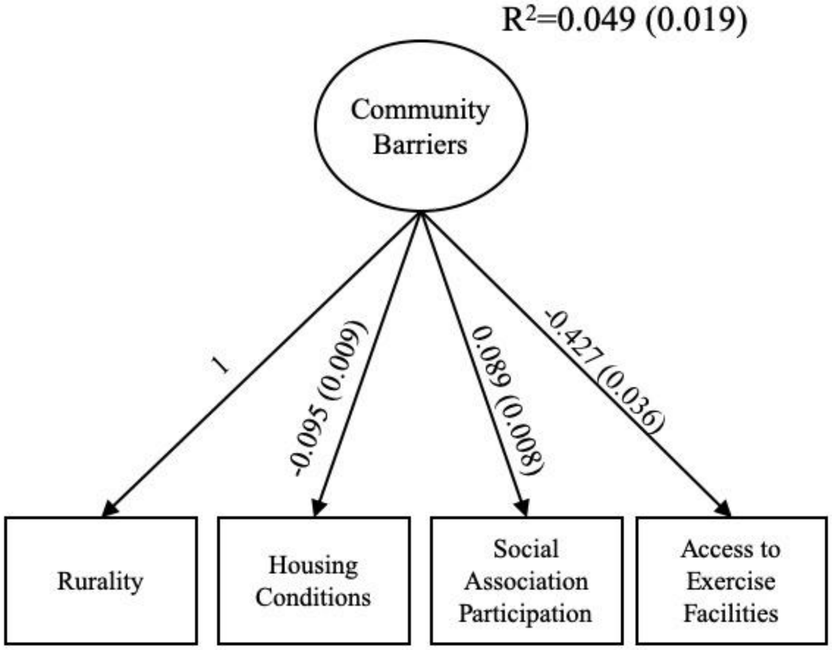

Figure 10. Measurement model for latent construct of community factors.

Hypothesis 7. In Hypothesis 7, I examine the construct of organization from measured variables about policies, program, services, and availability of assistive devices and equipment.

*H*7₀: Institutional policies, services, and resources, programs and services, and devices and equipment are not significant indicators of a latent construct reflecting organizational factors.

*H*7ᴀ: Institutional policies, services, and resources, programs and services, and devices and equipment are significant indicators of a latent construct reflecting organizational factors.

I performed EFA using the measured variables for parent perception of the magnitude of barriers from institutional policies, community programs/services, school programs/services, and assistive equipment from the CASE. Using an ML estimator and orthogonal rotation, EFA revealed a scree plot suggestive of one factor with an eigenvalue of 2.458, explaining 49.4% of the variance in the construct. The Kaiser–Meyer–Olkin measure of sampling adequacy indicated that 75.9% of the variance in the measured variables could be related to the underlying latent construct. Using Bartlett's test of sphericity to test the hypothesis that the variables were unrelated, $\chi_2(6, N = 465) = 446.037, p < .001$, the results of the factor analysis differed from an identity matrix and yielded meaningful results. All factor loadings were greater than .5, indicating strong loadings of the measured variables on the latent factor, organization.

CFA supported one factor that included institutional policies, community programs/services, school programs/services, and assistive equipment. I selected community programs/services to set the scale of the latent construct organization, fixing the corresponding loading factor to 1 during model specification. Using an ML estimator, the one-factor model with 1 group and 465 observations with 4 dependent measured variables supported 1 continuous latent variable with $\chi_2(1, N = 465) = 2.615, p > .05$ (CFI = .998; TLI = .990; RMSEA = .057; SRMR = .011).

All criteria met thresholds for adequate goodness of fit. The latent construct is shown in Figure 11 and demonstrates loading factors greater than .4 for all factors, indicating strong loading on the latent construct. The final latent construct of organization explained 84.6% of the variance in the measured variables. On the basis of these results, I rejected the null hypothesis and accepted the alternative hypothesis that institutional policies, services, and resources; programs and services; and devices and equipment are significant indicators of a latent construct reflecting organizational factors.

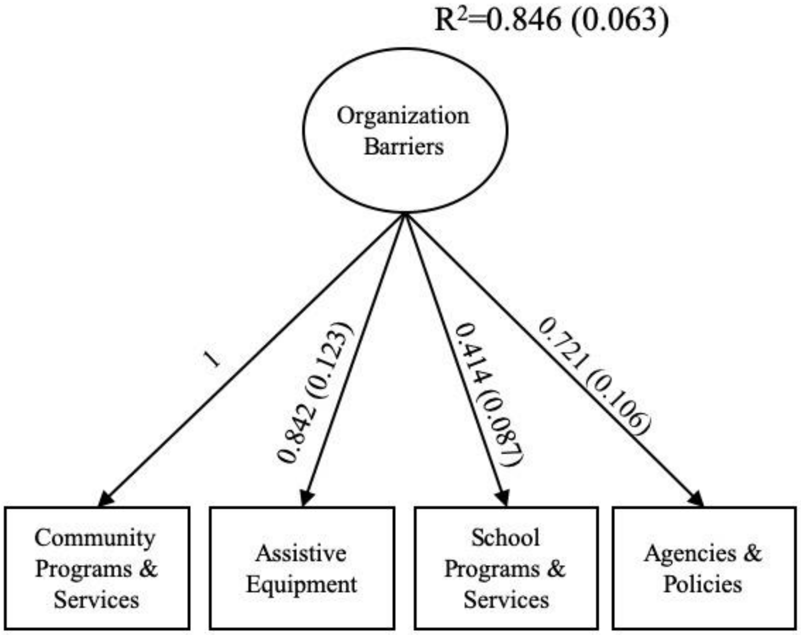

Figure 11. Measurement model for latent construct of organizational factors.

Hypothesis 8. In Hypothesis 8, I examine the construct of physical environment from measured variables about physical design transportation air pollution, food access, and weather.

H8_0: Physical design and access, transportation, air pollution, food environment index, and unhealthy days are not significant indicators of a latent construct reflecting physical environmental factors.

*H*8A: Physical design and access, transportation, air pollution, food environment index, and unhealthy days are significant indicators of a latent construct reflecting physical environmental factors.

I performed EFA using the measured variables for parent perception of the magnitude of barriers from physical design of the home, community, and school, and transportation from the CASE and physically unhealthy days, food environment index, and air pollution based on county of residence. I had intended to obtain separate indicators for rainy days, snowy days, hot days, and cold days from NOAA based on county of residence. However, the data set did not provide information in a consistent manner to permit all measurements to be within county of residence within a recent time frame. Thus an alternative approach was used based on a single indicator of unhealthy days from County Health Rankings based on county of residence.

Using an ML estimator and orthogonal rotation, EFA revealed a scree plot suggestive of two factors with eigenvalues of 2.458 and 2.162, explaining 52.6% of the variance in the construct. The Kaiser–Meyer–Olkin measure of sampling adequacy indicated that 73.4% of the variance in the measured variables could be related to the underlying latent construct. Using Bartlett’s test of sphericity to test the hypothesis that the variables were unrelated, $\chi_2(28, N = 465) = 1{,}076.581$, $p < .001$, the results of the factor analysis differed from an identity matrix and yielded meaningful results.

Unhealthy days, percentage physically inactive, percentage with access to exercise opportunities, and food environment index composed the first factor, physical environment. Physical design of the home, school, and community and transportation composed the second factor, built environment. All factor loadings were greater than .5, indicating strong loadings of the measured variables on the latent factors.

CFA supported two factors, physical environment and built environment. I selected access to exercise opportunities to set the scale of physical environment and home design to set the scale of built environment, fixing the corresponding loading factors to 1. The final model did not converge with transportation included, and this was excluded from further analysis. With the remaining variables, using an ML estimator, the two-factor model with 1 group and 465 observations with 8 dependent measured variables supported 2 continuous latent variables with $\chi_2(19, N = 465) = 61.499, p < .001$ (CFI = .956; TLI = .935; RMSEA = .069; SRMR = .050).

While the chi-square did not meet criteria demonstrating an insignificant difference between the sample and the model, all other criteria indicated adequate goodness of fit. Since chi-square is known to be sensitive to sample size, adequate fit of the model was accepted. The two-factor model is shown in Figure 12 and demonstrates moderately strong loading factors greater than .5 for built environment factors. The loading factors for physical environment were weak for bad health days and food environment index. However, these indicators were kept in the model as they fit the theoretical construct of physical environment. Built environment explained 51.5% of the variance in the measured variables.

On the basis of these results, I accepted the null hypothesis for transportation. I rejected the null hypothesis and accepted the alternative hypothesis that physical design and access, air pollution, food environment index, rainy days, snowy days, hot days, and cold days are significant indicators of a latent construct reflecting physical and built environment factors.

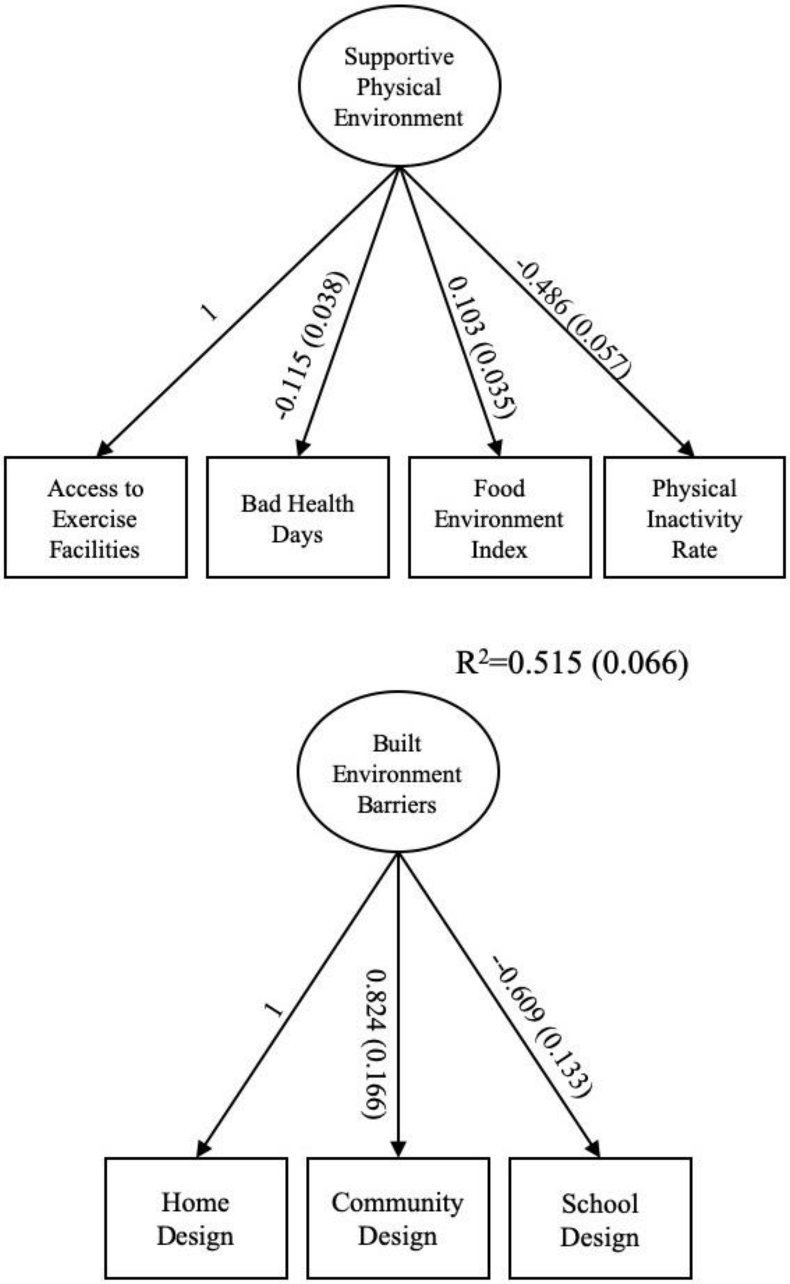

Figure 12. Measurement model for latent construct of physical and built environmental factors.

Hypothesis 9. In Hypothesis 9, I examine the bivariate relationship between the physical and social health dimensions of the latent construct for family factors and pediatric PA, controlling for age, sex, and level of gross motor function.

$H9_0$: More positive family factors are not associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

$H9_A$: More positive family support are associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

I examined the correlation between the latent construct for family factors and pediatric PA using Mplus, including the variables for age, sex, and level of gross motor function as independent factors. Regression in Mplus calculates a parameter that is equivalent to a Pearson product moment correlation (Muthén & Muthén, 2018). Neither parent physical health nor parent social health was significantly correlated with pediatric PA, $\rho = -.064$, $p > .05$ and $\rho = -.043$, $p > .05$, respectively. I therefore accepted the null hypothesis that more positive family factors are not associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function. While no correlation was found in the bivariate relationship, it is possible that there is an indirect effect of family factors on pediatric PA as proposed in the PAPDM. Indirect factors will be tested in Hypothesis 15.

Hypothesis 10. In Hypothesis 10, I examine the bivariate relationship between the attitude and friendship dimensions of the latent construct for social factors and pediatric PA, controlling for age, sex, and level of gross motor function.

$H10_0$: More positive social factors are not associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

$H10_A$: More positive social factors are associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

I examined the correlation between the latent construct for social factors and pediatric PA using Mplus, including the variables for age, sex, and level of gross motor function as independent factors. The presence of supportive social attitudes was positively and weakly correlated with pediatric PA, $\rho = .120$, $p < .05$. However, the presence of supportive friendships was not significantly associated with pediatric PA, $\rho = .134$, $p > .05$. I therefore accepted the null hypothesis that more supportive friendships are not associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function, and accepted the alternative hypothesis that more supportive social attitudes is associated with higher levels of PA. While no correlation was found in a bivariate relationship for supportive friendships, it is possible that there is an indirect effect on pediatric PA as proposed in the PAPDM. Indirect factors will be tested in Hypothesis 14.

Hypothesis 11. In Hypothesis 11, I examine the bivariate relationship between the latent construct for community factors and pediatric PA, controlling for age, sex, and level of gross motor function.

$H11_0$: More positive community factors are not associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

*H*11A: More positive community factors are associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

I examined the correlation between the latent construct for community factors and pediatric PA using Mplus, including the variables for age, sex, and level of gross motor function as independent factors in the regression. The presence of supportive community characteristics was not significantly associated with pediatric PA, $\rho = -.007$, $p > .05$. I therefore accepted the null hypothesis that more supportive community factors are not associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function. While no correlation was found in a bivariate relationship for supportive community factors, it is possible that there is an indirect effect on pediatric PA as proposed in the PAPDM. Indirect factors will be tested in Hypothesis 14.

Hypothesis 12. In Hypothesis 12, I examine the bivariate relationship between organizational factors and pediatric PA, controlling for age, sex, and level of gross motor function.

*H*120: More positive organizational factors are not associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

*H*12A: More positive organizational factors are associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

I examined the correlation between the latent construct for organizational factors and pediatric PA using Mplus, including the variables for age, sex, and level of gross motor function as independent factors in the regression. The presence of supportive organizational characteristics was not significantly associated with pediatric PA, ρ = .463, $p > .05$. I therefore accepted the null hypothesis that more supportive organizational factors are not associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function. While no correlation was found in a bivariate relationship for supportive organizational factors, it is possible that there is an indirect effect on pediatric PA as proposed in the PAPDM. Indirect factors will be tested in Hypothesis 14.

Hypothesis 13. In Hypothesis 13, I examine the bivariate relationship between the physical and built dimensions of the latent construct for environmental factors and pediatric PA, controlling for age, sex, and level of gross motor function.

$H13_0$: More positive environmental factors are not associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

$H13_A$: More positive environmental factors are associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function.

I examined the correlation between the latent construct for organizational factors and pediatric PA using Mplus, including the variables for age, sex, and level of gross motor function as independent factors in the regression. Neither physical nor built environment was significantly correlated with pediatric PA, ρ = .046, $p > .05$ and ρ = .051, $p > .05$, respectively. I therefore accepted the null hypothesis that more positive environmental factors are not associated with higher levels of health-enhancing PA, controlling for age, sex, and level of gross motor function. While no correlation was found in a bivariate relationship, it is possible that there is an indirect effect of environmental factors on pediatric PA as proposed in the PAPDM. Indirect factors will be tested in Hypothesis 14.

Structural model. The structural model consists of two hypotheses that define the relationships among the latent constructs of body structure and function, activity capacity, personal factors, family factors, social factors, community factors, organizational factors, and environmental factors. The structural model was tested using SEM in Mplus Version 8.3. All continuous variables were centered around the grand mean of each variable. Centering around the grand mean is recommended when the value of the variable at 0 is not meaningful (Muthén & Muthén, 2018). Since the population mean of all of the PROMIS variables is set at 50 by design, this is an appropriate choice. Centering affects the calculation of intercepts, but not of slopes (Muthén & Muthén, 2018). Within my analysis, only the slopes are interpreted. Because the final model includes both continuous and ordinal-level variables, a weighted least squares maximum value (WLSMV) estimator was used. As a robust estimator, WLSMV does not assume normally distributed variables, providing the best option for modeling samples combining ordinal and continuous data (Brown, 2014). Results presented are average values across five imputed data sets.

Nested models were tested, starting with a reduced model that contained only the ICF components of body structure and function, activity capacity, PA stage, and pediatric PA. In successive models, one latent construct was added at a time based on the theoretical framework of the PAPDM. Personal factors were added first, then family social, community, organizational, and finally environmental factors. Modification indices were used to guide model design within the constraints of the theoretical framework. Improved model performance was confirmed using a chi-square difference test, comparing the difference in the chi-square test of model fit between the reduced and alternative models with degrees of freedom equal to the difference in degrees of freedom between models (Brown, 2014). All alternative models demonstrated statistically significant improvement, with $p < .05$. The final structural model is shown in Figure 13. The final model had adequate fit as reflected by multiple fit indices with $\chi_2(1{,}365, N = 465) = 1{,}832.598$, $p < .001$ (CFI = .928; TLI = .922; RMSEA = .027; SRMR = .061). While the chi-square did not meet criteria demonstrating an insignificant difference between the sample and the model, all other criteria indicated adequate goodness of fit. Since chi-square is known to be sensitive to sample size, adequate fit of the model was accepted. Ellipses in the figure represent latent constructs; rectangles represent measured variables. Standardized and unstandardized parameter estimates for the measurement model are shown in Table 25.

Table 25

Standardized and Unstandardized Parameter Estimates

Latent construct/indicator	Estimate		*SE*	*p*-Value
	Unstandardized	Standardized		
Body structure				
Cognitive impairments	1.000	.662	.041	.000
Physical impairments	.946	.676	.041	.000
Medical impairments	.633	.610	.042	.000
Psychological impairments	.926	.696	.045	.000
Body function				
Fatigue	1.000	.780	.040	.000
Pain interference	.932	.704	.045	.000
Cognition	−.600	−.645	.051	.000
Capacity				
Upper extremity dexterity	1.000	.888	.039	.000
Mobility	.700	.888	.025	.000
Sport team participation	.135	.162	.069	.000
Gross motor function level	−.840	−.804	.041	.000
Community and home assistance	−.482	−.363	.043	.000
Strength	.664	.839	.040	.000
Persistence				
Social persistence with peers	1.000	.774	.061	.000
Social persistence with adults	.757	.546	.072	.000
Gross motor persistence	.833	.493	.067	.000
Self-confidence				
Social competence	1.000	.781	.041	.000
Athletic competence	.566	.491	.063	.000
Physical appearance	.460	.352	.063	.000
Self-worth	.708	.594	.056	.000
Attitude				
Community and home support	1.000	.942	.028	.000
School support	.323	.666	.040	.000
School attitudes	.340	.695	.049	.000
Community attitudes	.413	.749	.039	.000
Community and home assistance	.420	.635	.044	.000
School assistance	.284	.619	.051	.000
Friendship				
Peer relationships	1.000	.849	.040	.000
Close friendships	.654	.690	.046	.000

(table continues)

Latent construct/indicator	Estimate		*SE*	*p*-Value
	Unstandardized	Standardized		
Parent physical health				
Fatigue	1.000	.732	.043	.000
Global physical health	−.454	−.349	.049	.000
Physical function	−.474	−.336	.052	.000
Pain interference	.805	.568	.050	.000
Sleep disturbance	.939	.689	.048	.000
Parent social health				
Companionship	1.000	.782	.036	.000
Emotional support	.854	.661	.042	.000
Instrumental support	.895	.654	.047	.000
Informational support	.917	.694	.041	.000
Social isolation	−.985	−.771	.037	.000
Community				
Rurality	1.000	1.056	.027	.000
Housing conditions	−.095	−.564	.036	.000
Social association participation	.089	.522	.033	.000
Access to exercise opportunities	−.427	−.647	.045	.000
Organization				
Community programs and services	1.000	.775	.041	.000
Assistive equipment	.842	.682	.041	.000
School programs and services	.414	.336	.062	.000
Agencies and policies	.721	.615	.044	.000
Physical environment				
Access to exercise facilities	1.000	.311	.063	.000
Bad health days	−.115	−1.156	.170	.000
Food environment index	.103	.727	.118	.000
Physical inactivity rate	−.486	−.511	.092	.000
Built environment				
Home design	1.000	.468	.065	.000
Community design	.824	.850	.046	.000
School design	.609	.686	.046	.000

Hypothesis 14. In Hypothesis 14, I examine whether intention, as measured by the stage of PA readiness reported by the youth, mediates the positive effects of the personal, family, social, community, organizational, and physical latent constructs.

H14_0: Intention does not mediate the positive effects of personal, family, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

H14_A: Intention mediates the positive effects of personal, family, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

Mediation effects in SEM are reflected in a variable exhibiting both direct and indirect effects on a dependent variable (Muthén & Muthén, 2018). Direct effects act directly on the dependent variable, while indirect effects act through one or more other variables. Total effect size is calculated as the sum of the products of all coefficients in series and the direct effects (Muthén & Muthén, 2018). In this manner, it is possible for a variable to have an effect through multiple indirect pathways in addition to a direct effect. As an example, in Figure 13, self-confidence has indirect effects through athletic competence, positive friendship experiences, body structure, and body function. Direct, indirect, and total effect sizes of the study variables within the PAPDM are shown in Table 26.

Direct effects on PA in the model are from PA stage, capacity, and parent PA level. The direct effect from PA stage had a moderate effect size of .632, while the direct effects from parent PA and activity capacity had weak effect sizes of .126 and .168, respectively. Activity capacity also exerted an indirect influence through PA stage for a total effect size of .256.

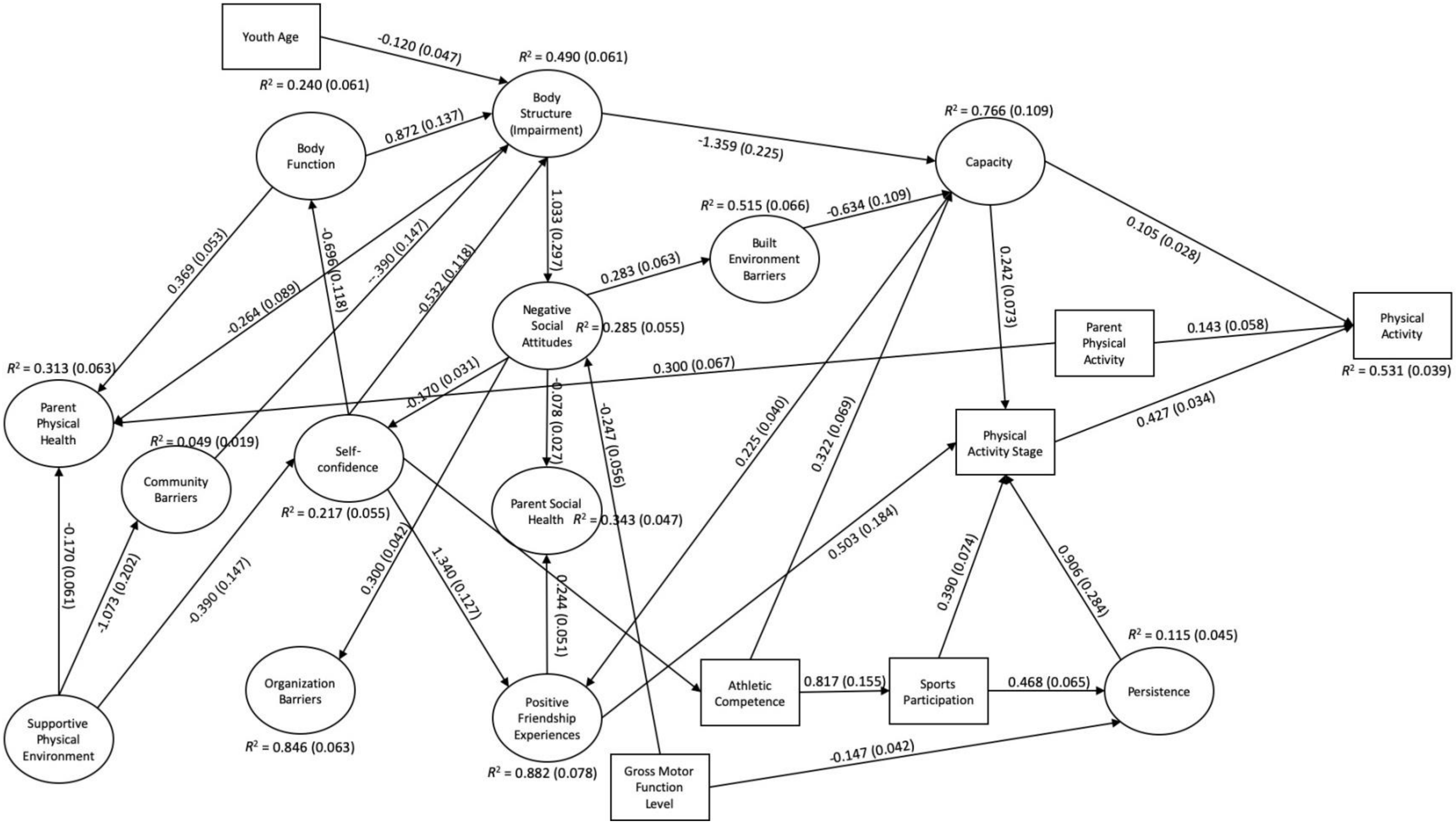

Figure 13. Final structural model of personal, family, social, community, organizational, and environmental factors on physical activity – unstandardized paramater estimates.

Table 26

Direct, Indirect, and Total Effect Sizes of Study Variables on Pediatric PA

	Effect size			
	Direct	Indirect	Total	*p*-Value
Personal				
Body structure		.143	.143	.000
Body function		.125	.125	.000
Activity capacity	.168	.151	.256	.000
Sports participation		.348	.348	.000
PA stage	.632		.632	.000
Persistence		.387	.387	.000
Self-confidence		.631	.631	.000
Athletic competence		.318	.318	.000
Age		.017	.017	.000
GMFCS level		.062	.062	.000
Family				
Parent PA	.126		.143	.000
Parent physical health			[a]	
Parent social health			[a]	
Social				
Social attitudes		.019	.019	.000
Close friendships		.215	.215	.000
Organizational barriers			[a]	
Community barriers		.056	.056	.000
Environment				
Physical environment		.060	.060	.000
Built environment		.067	.067	.000

Note. GMFCS = Gross Motor Function Classification System.
[a]No modeled direct or indirect effect on pediatric PA.

The largest total effect sizes were from self-confidence, PA stage, persistence, athletic competence and sports participation, activity capacity, and positive friendship experiences. Self-confidence exerted indirect effects through athletic competence/sports participation, positive friendship experiences, body structure, and body function for the largest total effect size of .631. PA stage exerted a direct effect size of .632. Persistence acted indirectly through PA stage for a total effect size of .387. Sports participation and athletic competence were measured indicators that exerted independent effects in the model through PA stage and activity capacity for total effect sizes of .348 and .318, respectively. Activity capacity acted directly on PA and indirectly through PA stage for a total effect size of .256. Positive friendship experiences exerted an indirect effect through PA stage for a total effect size of .215. The strongest effect sizes were at the personal and social levels.

The weakest total effect sizes were from family factors, community factors, environmental factors, and organizational factors. Only parent PA was modeled as having an indirect effect on youth PA. Parent physical health and parent mental health were dependent variables, with pathways from latent constructs exerting influence on them but exerting no influence on youth PA. Likewise, perception of the influence of organizational barriers was a dependent effect of negative social attitudes but did not exert an effect on youth PA. Social attitudes exerted a weak indirect effect through perceived barriers of the built environment and activity capacity, with a total effect size of .019. The physical and built environments exerted indirect influence through self-confidence and activity capacity, with weak total effect sizes of .060 and .067, respectively. Factors acting at the distal levels of the social-ecological model had weaker effects than those at the proximal levels.

PA stage mediated pathways from activity capacity, persistence, sports participation, and positive friendship experiences, effects at the personal and social levels. PA stage did not mediate pathways that included family factors, organizational factors, community factors, or environmental factors.

On the basis of these findings, I accepted the null hypothesis that intention does not mediate the positive effects of family, community, organizational, and physical environmental factors on participation in health-enhancing PA. I rejected the null hypothesis in favor of the alternative hypothesis that intention mediates the positive effects of personal and social factors on participation in health-enhancing PA.

Hypothesis 15. In Hypothesis 15, I examine whether family support, as measured by the role modeling of parent PA, mediates the positive effects of the personal, family, social, community, organizational, and physical latent constructs.

$H15_0$: Family support does not mediate the positive effects of personal, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

$H15_A$: Family support mediates the positive effects of personal, social, community, organizational, and physical environmental factors on participation in health-enhancing PA, controlling for age, sex, and level of gross motor function.

On the basis of the final model in Figure 13, parent PA had a direct effect on youth PA and did not mediate pathways from any latent construct. On the basis of this finding, I accepted the null hypothesis that family support, as measured by the role modeling of parent PA, does not mediate the positive effects of personal, social, community, organizational, and physical environmental factors on participation in health-enhancing PA.

Summary

In Chapter 4, I presented the details of data collection, representativeness of the final sample, data cleaning, and statistical analysis of each of the hypotheses of my overall research question. I used descriptive statistics to characterize demographic information of my sample population and the distributions and characteristics of each of my study variables. I used EFA and CFA to construct eight latent constructs defined through Hypotheses 1–8. I used SEM to test Hypotheses 9–13, testing the bivariate effects of my latent variables on my dependent variable, controlling for my covariates age, sex, and gross motor function level. I used SEM to test Hypotheses 14 and 15 to examine the direct and indirect effects of the latent constructs on my dependent variable and to calculate the effect sizes of my independent variables on my dependent variable.

The purpose of my study was to determine the extent to which personal, family, social, organizational, community, and environmental factors are associated with participation of youth age 12–17 years with CP in health-enhancing PA. My study sample was a large, nonrandom sample that was closely representative of the national distribution of youth with CP age 12–17 years in 44 states. In the analyses for Hypotheses 1–8, I successfully created eight latent constructs representing personal, family, social, organizational, community, and environmental factors with acceptable measurement models for each. The results from analyses conducted for Hypotheses 9–13 demonstrated that there was not a significant bivariate relationship between any of the family, social, community, organizational, or environmental factors in my study, except community attitudes, which had a weak positive correlation with health-enhancing PA.

The findings for Hypotheses 14 and 15 demonstrated that while there were not significant bivariate relationships, personal, family, and social factors, the proximal effects within the social-ecological model, had stronger total effects on participation in health-enhancing PA than factors at the distal levels, organizational, community, and environmental factors. The final structural model supported the theoretical construct of the PAPDM. Intention, measured by youth-reported PA stage, was a key determinant of participation in PA and mediated pathways from other personal and social factors. The International Classification of Functioning, Disability, and Health provided additional structure to the theoretical framework through its definitions of body structure and function, activity, and participation.

The study findings illustrate a complex relationship among the latent constructs that creates a network of direct and indirect effects on participation in health-enhancing PA. Self-confidence, PA stage, and persistence had the strongest effects on participation in health-enhancing PA. They had moderate to strong effect sizes of .631, .632, and .387, respectively.

In Chapter 5, I interpret these findings in the context of the theoretical framework and prior research. I also discuss the limitations of my study and recommendations for further research and practice, and I describe the potential impact for positive social change.

Chapter 5: Discussion

Introduction

The purpose of this study was to determine the extent to which personal, family, social, organizational, community, and environmental factors are associated with participation of youth, age 12 to 17 years, with cerebral palsy in PA. Understanding to what extent personal, family, social, and environmental factors restrict participation of youth with disabilities will provide information that may help address the social, attitudinal, and structural barriers that restrict involvement of youth with disabilities in essential opportunities for leisure and social recreation through programs, policy, and advocacy.

PA is a critical public health issue because it is a modifiable risk factor for promoting and maintaining physical, mental, and social health in people of all ages. People who are physically active have stronger bones and muscles, better physical health and well-being, and fewer mental health problems than those who are inactive (CDC, 2020). Conversely, physical inactivity is a leading cause of morbidity and mortality worldwide across all age, sex, race, and socioeconomic strata (Ding et al., 2016; Kohl et al., 2012). Because of its global prevalence and health impact, PA is an essential part of a public health strategy.

Involvement in PA is crucial for all people of all ages. From as young as six years of age, the least active have increased risk for future cardiovascular disease compared to the most active (Jiménez-Pavón et al., 2013). Youth with disabilities such as CP are even more at risk and often do not achieve healthy PA levels (Bratteby Tollerz et al., 2015). The findings of this study may have a significant impact on promoting health, well-being, and positive social change in a population at risk for physical and social exclusion, stigma, and increased risk of chronic health conditions.

This study used a cross-sectional, quantitative approach with online survey research methodology employing validated self- and parent-reported questionnaires using a nationally representative sample of dyads of youth with CP and one parent. The results of this study are based upon a sample of 465 youth with CP, age 12-17 years, from 44 U.S. states that is nationally representative with respect to sex (Durkin et al., 2016), age, race, ethnicity, and geographic distribution (U.S. Census Bureau, 2018), and gross motor function level (Reid et al., 2011). The findings of this study include the following:

- In this sample, 22% of the youth reported not being physically active on any days during the week compared to 15% of a historical population-based sample (CDC, 2018).
- The barriers most commonly reported as big problems restricting participation of youth with CP in PA were community programs and services (24%), family finances (22%), family stress (21%), school programs and services (18%), and access to assistive equipment (18%).
- Factors at the personal level had moderate bivariate correlations with participation in PA, including self-reported stage of readiness to participate in PA (r = .613), GMFCS level (r = -.378), strength impact (r = .354), mobility

(*r* = .389), upper extremity dexterity (*r* = .332), and total persistence (*r* = .318).

- Factors at family level had weak bivariate correlations with participation in PA including parent PA level (*r* = .134), parent mental health (*r* = .156), family finances (*r* = -.139), family stress (*r* = -.118), family relationships (*r* = -.122), and instrumental support (*r* = .127).
- Factors at the social level had weak bivariate correlations with participation in PA, including participation on sports teams (*r* = .297) and peer relationships (*r* = .139).
- Factors at the community and organization levels had weak bivariate correlations with participation in PA, including community and home assistance (*r* = -.172) and community programs and services (*r* = -.111).
- None of the variables at the physical or built environment level had significant correlations with participation in PA.
- Latent constructs for personal, family, social, community, organizational, and environmental factors exhibited good model fit, explaining 5% (community) to 88% (social/friendship) of the shared variance using 2 to 6 indicators for each construct.
- Bivariate relationships between the latent constructs and participation in PA were weak (social/attitudes) or non-significant (family, social/friendship, community, organization, environment).

- An SEM of the direct and indirect effects among the latent constructs on the dependent variable participation in PA met the criteria for good model fit and explained 53% of the variance in participation in PA.
- PA stage ($\beta = .632$), parent PA level ($\beta = .126$), and activity capacity ($\beta = .168$) had direct effects on participation in PA.
- Self-confidence ($\beta = .631$), PA stage ($\beta = .632$), persistence ($\beta = .387$), athletic competence ($\beta = .348$), activity capacity ($\beta = .256$), and positive friendship experiences ($\beta = .215$) had the strongest total effects on participation in PA.
- The strongest influences on participation in PA occurred through factors at the personal and social levels.
- Effects from family, community, organization, and environment level factors had weak influence on participation in PA.
- After controlling for other factors, GMFCS level ($\beta = .061$) and age ($\beta = .017$) had weak effects on participation in PA.
- At every GMFCS level, some youth reported being highly engaged in PA, with a higher PA score than the population norm.

Interpretation of Findings

Regular participation in PA is one of the most important health behaviors for all people of all ages, regardless of disability, to promote physical, mental, and social health (CDC, 2020). However, those with physical disabilities, including youth with CP, are often less physically active, putting them at risk for compromised health and development of chronic illness (Peterson et al., 2015; Ryan, Crowley, et al., 2014; Ryan, Hensey, McLoughlin, Lyons, & Gormley, 2015). Much is known from the research literature about what factors affect participation in PA for youth with CP (Bloemen, Backx, et al., 2015; Bult et al., 2011; Koldoff & Holtzclaw, 2015). The extent to which youth with disabilities are physically active is influenced by the complex interaction among personal, family, social, organizational, community, and environmental factors that operate within a social-ecological framework (Bedell et al., 2013; Feehan et al., 2012). However, how and to what extent these factors influence PA is only partially understood (Bedell et al., 2013; Woodmansee et al., 2016).

For the current study, I used survey responses from a nationally representative sample of 465 youth with CP-parent dyads from 44 U.S. states regarding the personal, family, social, community, organizational, and environmental factors that facilitated or restricted participation of the youth in PA. I used EFA and CFA to construct latent variables at each level of the social-ecological framework. I used SEM to develop a model, based on the PAPDM, exploring the relationships among the latent constructs to explain participation of youth with CP in PA.

Comparison with Previous Studies

Previous studies have shown that youth with CP are involved in less PA than their peers without CP. In the current study, 9% of youth with CP reported participating in at least 60 minutes of PA daily, meeting PA guidelines. This is consistent with the finding from Verschuren et al. (2016) that 7% of youth functioning at GMFCS level I were consistently involved in moderate to vigorous PA. Hamrah Nedjad et al. (2013) reported that 14% of the youth with CP in their study met PA guidelines, while only 4% met PA guidelines in another study by Bania et al. (2014). Comparatively, 26% of youth from the general population without CP reported meeting PA guidelines in the 2017 Youth Risk Behavior Surveillance Survey (CDC, 2018). The findings from my study confirm the finding of decreased PA for youth with CP.

My final structural model is consistent with underlying theory explaining how multiple factors affect the participation youth with CP in PA. Factors that had a direct effect on participation included a youth's capacity for participation, parent PA level, and a youth's intent to participate regularly in PA. Capacity was affected by a youth's athletic competence; presence of barriers in the built environment; and the magnitude of a youth's physical, medical, psychological, and cognitive impairments. Intent to participate in PA was influenced by a youth's level of persistence, participation in sporting activities, and positive friendship experiences. Effects of organizational and physical environment barriers were more distal and appeared to influence parental physical health and youth self-confidence, which was also affected by negative attitudes within the community. My model explained 53.1% of the variance in a youth's self-reported level of participation in PA and met the criteria for acceptable fit of a structural equation model.

Previous studies have used similar theoretical frameworks. In a study by King, Law, Hanna, et al. (2006), the authors used structural equation modeling to examine the relationships among child, family, and environmental factors with intensity of participation in leisure and recreational activities of 427 youth age 6-14 years with physical disabilities. The authors found three factors with direct effects on intensity of participation, including parent involvement in PA, $\beta = .18$, child functional ability, $\beta = .13$, and child preference for activities, $\beta = .28$. These findings mirror those from my study with notable similarities in the magnitude of effect sizes. Child preference was similar to my construct of intention to participate in PA, $\beta = .632$, and had the strongest direct effect on participation. Child functional ability measured as a latent construct reflecting mobility, upper extremity dexterity, and gross motor function level, $\beta = .105$, had weak effect sizes in both studies. Family participation in PA, measured using the IPAQ in the current study, had a similarly weak effect size, $\beta = .142$. These findings corroborate the results of both studies and increase their generalizability.

Additionally, in the study by King, Law, Hanna, et al. (2006), the authors identified indirect factors that affected participation that included supportive relationships for the child, unsupportive physical, social, and attitudinal environments, and other family factors such as income and cohesion. These had small effect sizes and acted indirectly on participation through their influence on family participation, child preference, and functional ability. These findings support those of my current study where built environment factors influenced participation through their effects on activity capacity with an effect size of $\beta = .067$. Negative social attitudes acted indirectly through their influence on the built environment with an effect size of $\beta = .019$. Positive friendship experiences acted indirectly through their influence on intention to participate in PA with an effect size of β = .215. These findings further corroborate the results of both studies and add to their generalizability and validity.

The findings from my study indicated that persistence, β = .387, and self-confidence, β = .631, were important indirect determinants of participation in PA. The latent construct for persistence included the concept of gross motor persistence social persistence with peers, and social persistence with adults. A study by Shikako-Thomas et al. (2013) found a bivariate correlation between gross motor persistence and intensity of participation in active-PA, *r* = .44, consistent with the magnitude of association found in my study.

The latent construct for self-confidence included self-worth, social competence, physical appearance, and athletic competence. The current study found that athletic competence was an important indirect determinant of participation in PA. In a study to validate the CAPE, King, Law, King, et al. (2006) found a bivariate correlation of *r* = .29 between athletic competence and intensity of participation in active-PA, a similar magnitude to the β = .318 found in the current study. Shikako-Thomas et al. (2013) found a similar bivariate correlation between athletic competence and intensity of participation in active-PA, *r* = .36 in a study of 187 adolescents age 12-19 years with CP in Canada. In another study examining the psychosocial determinants of participation in PA, King, Law, et al. (2013) found effect sizes of β = .158 for athletic competence, further supporting the importance of this construct. They also found an effect size β = .137 for support from friends, similar to the β = .215 for close friendships found in my study. These findings further support the validity and generalizability of the findings from my study.

The studies by King, Law, Hanna, et al. (2006) were based upon a representative sample of youth age 6 to 14 years recruited through 14 rehabilitation centers across Canada. Their population included a broad cross-section of youth with CP, amputations, stroke, congenital anomalies, arthritis, and other pediatric conditions affecting physical ability. Similarly, the current study is a representative sample of youth with CP age 11 to 17 years recruited through pediatric specialty hospitals from 44 U.S. states. The survey instruments used in each study were different but had similar underlying conceptual definitions.

Surprisingly, neither age nor gross motor function level (GMFCS) had a direct role in participation in PA after inclusion of the latent constructs. GMFCS classifies the severity of functional involvement of a youth with CP. Based on the findings from my study, personal, social, and environmental factors played a larger role in promoting PA than severity of functional involvement. Self-confidence, persistence with gross motor activities, athletic competence, and having positive friendships were key attributes linked to participation in PA in this population. These characteristics may all be influenced by a youth’s participation, or exclusion, from inclusion in activities such as gym class in school or other community-based programs.

Findings in the Context of Theory

The findings from my study highlight the complexity of interactions amongst variables at different levels that influence participation in PA. This is a finding consistent with previous studies such as those by King, Law, Hanna, et al. (2006) and Imms (2008) and with the theoretical foundations of SET (McLeroy et al., 1988), the ICF (WHO, 2001), and the PAPDM (van der Ploeg et al., 2004). Null hypotheses one and two were rejected, confirming the fit of two latent constructs reflecting body structure, body function, and capacity, supporting the utility of the corresponding definitions from the ICF. Null hypotheses three through eight were all rejected, confirming the fit of latent constructs supporting SET as a mechanism to organize the influence of sets of factors for influences of person, family, social, community, organization, and environment. The PAPDM was used to guide construction of the final model. This model successfully confirmed intention and self-esteem as key attributes that lead to increased participation in PA. Additionally, effects from the personal and social levels had stronger influence on participation than those from the family, community, organization, and environmental levels.

Self-confidence had the strongest influence of all the factors, acting through multiple indirect pathways. This is consistent with the construct of self-efficacy (Bandura, 1977), a key factor within the PAPDM, in that it refers to the perception of capability for controlling the outcome of an attempted behavior. This study suggests that the most important factor predicting participation in PA is that youth with CP believe in their ability to participate because of close friendships, a supportive family, availability of assistive resources, and environments that are conducive to participation. The findings from this study validate the PAPDM.

Limitations of the Study

The purpose of this quantitative, cross-sectional study was to determine the extent to which social and ecological factors are associated with participation of youth, age 12 to 17 years, with PA in PA using primary data collection through an online, self- and parent-report survey.

Limitations Affecting Internal Validity

As a cross-sectional, descriptive study, the findings demonstrate association, but cannot be interpreted as causal relationships among the latent constructs, despite the structure of the final model. The model contained multiple latent constructs which were each derived from 2-6 measured variables. The latent constructs explained 4-88% of the shared variance in the measured variables. Additional, or different sets of measured variables could have resulted in different amounts of shared variance and could have fit together in the final model in different ways. In particular, the constructs of community barriers and physical environment did not explain large amounts of shared variance, suggesting these constructs were not well-defined along the dimensions they represented. Additional research to more fully explore the dimensions of these variables could help future research. The final sample size of 465 parent-youth dyads was adequate for EFA, CFA, and SEM statistical techniques. However, the number of latent constructs included in the final model was large for the sample size and may have overfitted the final model. The final model explained 53% of the variance in the dependent variable, suggesting there could be additional latent constructs or measured variables that could help to explain more of the variance.

The questionnaires administered were well-validated and population referenced. However, all of the variables were measured using Likert scales by either parent report or self-report. It is possible that either the parent or the youth could have responded in ways that were socially acceptable rather than responding with factual choices. Responses could also have been exaggerated by selective memory over the short timeframe of the 7-day recall period. None of the measures, including the dependent variable, participation in PA, were directly measured. Use of a PA monitor could have resulted in different outcomes compared to self-reported measures of PA.

The survey was administered between March and July, which could have created response bias depending on the area of the country and weather patterns. Since the responses for many questions were based on a 7-day recall timeframe, short term changes could have affected the findings. With more time to collect data, it is possible that seasonality could have been included as a study variable. The study also included information based on the county of residence to access ecological variables about socioeconomic status, violence, graduation rate, air pollution, and other aspects of the community. Since these were based on county, they did not reflect smaller area fluctuations that could have been present based on address.

Limitations Affecting Generalizability

The sample was derived from a master list of all eligible youth with CP treated by a national pediatric specialty healthcare system and contained a representative sample of youth from 44 U.S. states. However, not all eligible youth with CP were treated at that healthcare system, it was not a probability-based sample, and fewer than 10% of those invited to participate chose to, leading to the potential for selection bias. The recruitment strategy included sending physical letters and emails to eligible youth. However, email addresses were available for less than 50% of families from the electronic medical record, another potential source of selection bias. Those with email addresses were more likely than those without to respond to the study invitation. Another limitation of the study was that the survey was available only in English. Therefore, the study did not include youth or families for whom English was not the primary language.

Recommendations

The conceptualization for PA used in this study was bodily movement that increased energy expenditure above that of sitting (Health Measures, 2017). Participation in PA was measured as frequency or intensity and did not capture elements of the dimension of participation as an experience taking place in a certain context that could be shared with others, the quality of the experience, or how the experience matches preferences or expectations (Ross, Bogart, et al., 2016). Intention to participate in PA was used as a component from TPB (Ajzen, 1985, 1991) within PAPDM (van der Ploeg et al., 2004). In this study, the importance of experience was reflected in the strength of the effect by positive friendship experiences on intention. Future research utilizing more robust measures that capture participation in PA as a life experience rather than a frequency or intensity could offer additional insight into the influence of social characteristics that promote or restrict participation.

Within this study, PA was measured by self-report. Previous studies have demonstrated that self-report PA is exaggerated compared to directly measured PA (Bratteby Tollerz et al., 2015). Future studies using directly measured PA using accelerometers as PA monitors could extend the validity of my study findings.

While the sample size of this study was large, and included a nationally representative sample of youth with CP with respect to age, race, ethnicity, geographic location, sex, and gross motor function level, it did not include youth or families that did not speak English and did not include a localized assessment of the impact of social and economic factors. Future research on populations that do not speak English could add to the generalizability of the findings from the current study.

This was a cross-sectional study; therefore, the findings demonstrate association, not causation. Understanding the relationships among constructs within a social-ecological framework is important for determining the most effective ways to intervene to change behavior. Within this study, the largest effect size was seen for self-confidence, which acted indirectly on participation in PA through multiple pathways. Associated with self-confidence, athletic competence, gross motor persistence, and sports participation were key characteristics that predicted increased participation in PA. The findings of this study would predict that programs focusing on increasing self-confidence, especially related to athletic competence, gross motor persistence, and sports team participation could be effective in increasing participation in PA. Future prospective studies should examine the effectiveness of programs designed to increase participation in PA that incorporate these characteristics as key program features. Additionally, future studies could examine the validity of the final study model for predicting participation in PA in a new sample.

The final model in this study explained 53% of the variance in participation in PA of youth with CP, age 12 to 17 years. The latent construct for community barriers explained only 4% of the variance in the measured indicators, suggesting that there are multiple or additional dimensions that were not captured by the measured indicators included in this study. The latent construct for physical environment did not converge in the final model with the inclusion of ecological variables regarding bad health days, air pollution, and physically inactive days. Because of the lack of availability of consistent data for weather patterns such as rainy, snowy, hot, or cold days, I was not able to include weather patterns in the analysis. Future studies could focus more closely on developing and validating latent constructs for community and environment level factors. Future studies could also extend the scope of the variables included to increase the explained variance. These could include the role of family stress and finances, which have been shown to be related to participation outcomes in previous studies (King, Law, Hanna, et al., 2006).

Implications

The findings from this study have potential implications for positive social change, theory, and public health practice.

Potential Impact for Positive Social Change

Positive social change is about influencing the personal, social, and physical environments that promote health and well-being of all people to live the healthiest lives possible. Promoting participation in health-enhancing levels of PA is an essential part of a long-term public health strategy to promote health and improve quality of life and is considered a fundamental right for all people, regardless of disability status (UN General Assembly, January 24, 2007; WHO, May 22, 2004). My study focused on understanding how physical, social, and ecologic factors facilitate or restrict youth with CP from participating in health-enhancing PA. Participation in PA is important for developing and maintaining physical, social, and mental health (Murphy et al., 2008) and critically important for preventing chronic illness such as obesity, cardiovascular disease, high blood pressure, and diabetes (Hallal et al., 2012; Kohl et al., 2012).

The findings from this study support the development of organizational, community, and national programs and policies that empower people and enable the physical and social environments in which they live. Empowering people includes providing accessible and inclusive opportunities to participate in sports and leisure activities that help develop positive friendship experiences and self-confidence, key determinants of participation in PA identified in this study. Enabling environments includes reducing barriers within the built environment and providing accessible facilities, trained staff, and appropriate assistive technology and devices identified as facilitators within this study.

The results of this study identify determinants of PA that may be important for promoting health, well-being, and positive social change in a population at risk for physical and social exclusion, stigma, and chronic health conditions. Involvement in PA provides opportunities for social interaction, builds self-efficacy and self-esteem, and improves quality of life (Maher et al., 2016). Promoting participation in PA prior to development of chronic illness may decrease the prevalence and severity of health conditions linked to inactivity, decrease national healthcare costs, and promote public health (Carroll et al., 2014; Das & Horton, 2016; Ding et al., 2016). Organizational, community, and national policies to promote PA for youth with CP would encourage life habits that contribute to physical, mental, and social health, support happiness and raise quality of life (Murphy & Carbone, 2008).

Theoretical and Empirical Implications

The theoretic framework of this study was grounded in the PAPDM. The study findings empirically validated the relationships within the PAPDM. Consistent with TPB within PAPDM, intention to participate was a key direct factor that was influenced by positive friendship experiences, athletic competence, participation on sports teams, persistence, and self-confidence. Consistent with the ICF, another component of the PAPDM, body function was strongly correlated with body structure and activity capacity.

The social and built environment indirectly influenced participation in PA through the direct factors of activity capacity parental involvement in PA, and intention to participate in PA.

Recommendations for Practice

The findings from this study suggest that the strongest facilitators for participation PA are at the personal and social levels. At the personal level, these include self-confidence, especially as it relates to gross motor persistence, athletic competence, and participation on sports teams. These findings suggest that intentional positive feedback to promote aspects of self-confidence could be an effective characteristic to include in future program development. Personal narratives such as that by Gaskin et al. (2012) highlight participation in PA as adverse childhood experiences that decrease self-confidence, especially athletic competence and instill feelings of inferiority that lead to premature declines in PA and physical functioning. The school setting could be particularly influential for strengthening athletic competence with supportive, inclusive athletic programs and disability-specific education to reduce peer social exclusion.

Conclusion

The purpose of this study was to determine the extent to which social and ecological factors are associated with participation of youth CP, age 12 to 17 years, in PA. Using primary data collection, a nationally representative sample of 465 parent-youth dyads responded through an online, self- and parent-report survey to questions exploring personal, family, social, community, organizational, and environmental barriers and facilitators to youth participation in health-enhancing PA. Using EFA, CFA, and SEM, 8 latent constructs were derived from measured variables and a final path model was developed explaining the associations among the latent constructs on participation in health-enhancing PA. The final model met criteria for adequate fit and explained 53% of the variance and supported the theoretical framework of the PAPDM. Direct effects on youth participation in PA included those from parental involvement in PA, youth activity capacity, and youth intention to participate in PA. The strongest effect sizes included those from youth self-confidence, persistence, activity capacity, athletic competence, participation on sports teams, and close friendship experiences. These factors acted indirectly on participation in PA through the direct factors.

The findings from this study demonstrate complex relationships among multiple latent constructs that interact within a social-ecological framework to influence the level of participation of a youth with CP in health-enhancing PA. Personal, family, and social level factors self-confidence, persistence, athletic competence, parental participation in PA, and close friendship experiences are modifiable factors that can be incorporated into public health, community, and organizational programs to promote increased participation in PA. Consistent with international conventions on the rights of people with disabilities, all people, regardless of their disability status have the right to participate, to the greatest extent possible, in leisure and recreation activities that promote health and well-being. The findings from this study provide evidence supporting the importance of personal, family, and social level factors for promoting participation in a health behavior that promotes health, well-being, and positive social change in a population at risk for physical and social exclusion, stigma, and chronic health conditions. Understanding the barriers and facilitators of PA for children and adolescents with CP is essential for designing effective interventions to promote participation in this group.

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Appendix A: List of Measures by Conceptual Domain

Table 27

Measures of Health-Enhancing PA

Construct	Questionnaire	Scale	Items	Respondent
Health-enhancing physical activity	2017 Youth Risk Behavior Surveillance Survey	Ordinal	Q79	Youth
Health-enhancing physical activity	PROMIS Pediatric Physical Activity Short Form 8a	T-score	8	Youth

Table 28

Measures of Health

Construct	Questionnaire	Scale	Items	Respondent
Body structure & function	Gross Motor Function Classification System	Categorical	4	Parent
Body structure & function	Child and Adolescent Factors Inventory	Index	18	Parent
Body structure & function	PROMIS Fatigue Short Form	T-score	10	Youth
Body structure & function	PROMIS Pain Interference Short Form	T-score	8	Youth
Body structure & function	PROMIS Strength Impact Short Form	T-score	8	Youth
Activity capacity	Gross Motor Function Classification System	Ordinal	1	Youth
Activity capacity	PROMIS Physical Function Mobility Short Form	T-score	8	Youth
Activity capacity	PROMIS Physical Function Upper Extremity Short Form	T-score	8	Youth
Activity capacity	PROMIS Cognitive Function Short Form	T-score	7	Youth

Table 29

Measures of Personal Factors

Construct	Questionnaire	Scale	Items	Respondent
Age	2017 Youth Risk Behavior Surveillance Survey	Ordinal	Q1	Youth
Sex	2017 Youth Risk Behavior Surveillance Survey	Categorical	Q2	Youth
Grade	2017 Youth Risk Behavior Surveillance Survey	Ordinal	Q3	Youth
Ethnicity	2017 Youth Risk Behavior Surveillance Survey	Categorical	Q4	Youth
Race	2017 Youth Risk Behavior Surveillance Survey	Categorical	Q5	Youth
Height	2017 Youth Risk Behavior Surveillance Survey	Integer	Q6	Youth
Weight	2017 Youth Risk Behavior Surveillance Survey	Integer	Q7	Youth
Intention	Stages of Change Questionnaire	Categorical	1	Youth
General competence compared to peers	Dimensions of Mastery Questionnaire	Ordinal	5	Youth
Gross motor persistence	Dimensions of Mastery Questionnaire	Ordinal	8	Youth
Global self-worth	Self-Perception Profile for Adolescents	Ordinal	45	Youth
Social competence	Self-Perception Profile for Adolescents	Ordinal	5	Youth
Athletic competence	Self-Perception Profile for Adolescents	Ordinal	5	Youth
Behavioral conduct	Self-Perception Profile for Adolescents	Ordinal	5	Youth
Close friendship	Self-Perception Profile for Adolescents	Ordinal	5	Youth

Table 30

Measures of Family Factors

Construct	Instrument	Scale	Items	Respondent
Socioeconomic status	Income	Ordinal	1	Parent
Socioeconomic status	Parent's education	Ordinal	1	Parent
Parent PA level	International Physical Activity Questionnaire	Integer	7	Parent
Family relationships	PROMIS Family Relationship Short Form	T-score	4	Youth
Parent physical health	PROMIS Global Physical Health Short Form	T-score	2	Parent
Parent mental health	PROMIS Global Mental Health Short Form	T-score	2	Parent
Parent physical function	PROMIS-29 Profile	T-score	4	Parent
Parent anxiety	PROMIS-29 Profile	T-score	4	Parent
Parent depression	PROMIS-29 Profile	T-score	4	Parent
Parent fatigue	PROMIS-29 Profile	T-score	4	Parent
Parent ability to participate in social roles and activities	PROMIS-29 Profile	T-score	4	Parent
Parent pain interference	PROMIS-29 Profile	T-score	4	Parent
Parent social support	PROMIS Companionship Short Form	T-score	4	Parent
Parent emotional support	PROMIS Emotional Support Short Form	T-score	4	Parent
Parent instrumental support	PROMIS Instrumental Support Short Form	T-score	4	Parent
Parent informational support	PROMIS Informational Support Short Form	T-score	4	Parent
Parent social isolation	PROMIS Social Isolation Short Form	T-score	4	Parent
Family finances	Child and Adolescent Scale of Environment	Ordinal	Q14	Parent
Family stress	Child and Adolescent Scale of Environment	Ordinal	Q15	Parent

Table 31

Measures of Social Factors

Construct	Instrument	Scale	Items	Respondent
Bullying	2017 Youth Risk Behavior Surveillance Survey	Ordinal	Q23, Q24	Youth
Peer relationships	PROMIS Peer Relationships Short Form	T-score	8	Youth
Close friendships	Self-Perception Profile for Adolescents	Ordinal	5	Youth
Support	Child and Adolescent Scale of Environment	Ordinal	Q4, Q5	Parent
Social attitudes	Child and Adolescent Scale of Environment	Ordinal	Q6, Q7	Parent
Assistance	Child and Adolescent Scale of Environment	Ordinal	Q9, Q10	Parent

Table 32

Measures of Community Factors

Construct	Instrument	Scale	Items	Respondent
Safety	Child and Adolescent Scale of Environment	Ordinal	Q16	Parent
Violent crime rate	County Health Rankings	Ratio	1	Ecological
% children living in poverty	County Health Rankings	Ratio	1	Ecological
% high school graduation	County Health Rankings	Ratio	1	Ecological
% with severe housing problems	County Health Rankings	Ratio	1	Ecological
Social association participation rate	County Health Rankings	Ratio	1	Ecological
% physical inactivity	County Health Rankings	Ratio	1	Ecological
Urban/Rural	American Community Survey	Ratio	1	Ecological

Table 33

Measures of Organizational Factors

Construct	Instrument	Scale	Items	Respondent
Institutional policies, services, and resources	Child and Adolescent Scale of Environment	Ordinal	Q17	Parent
Programs and Services	Child and Adolescent Scale of Environment	Ordinal	Q12, Q13	Parent
Devices and Equipment	Child and Adolescent Scale of Environment	Ordinal	Q8	Parent

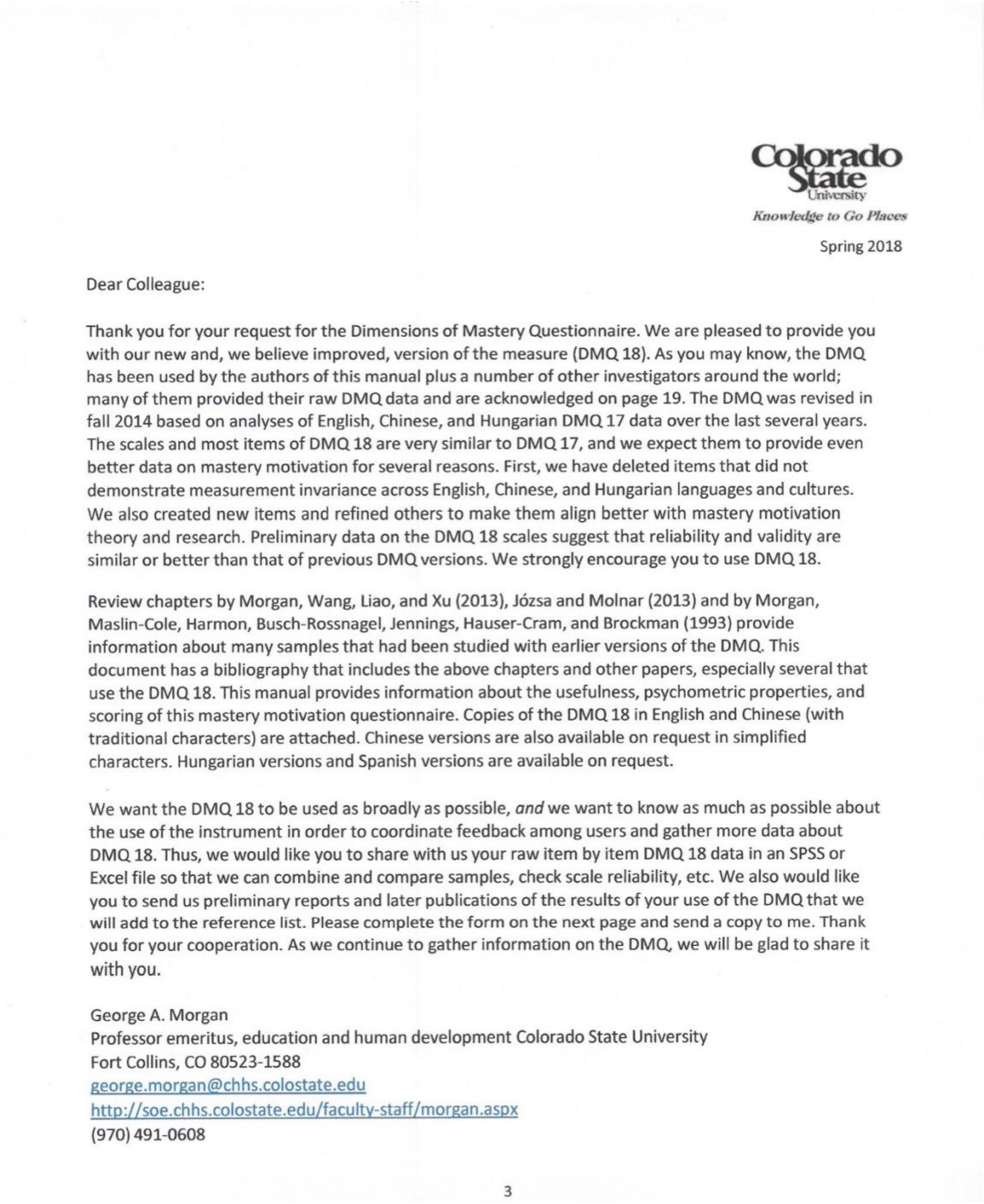
Table 34

Measures of Physical Environment Factors

Construct	Instrument	Scale	Items	Respondent
Physical design and access	Child and Adolescent Scale of Environment	Index	Q1, Q2, Q3	Parent
Transportation	Child and Adolescent Scale of Environment	Ordinal	Q11	Parent
% with access to exercise facilities	County Health Rankings	Ratio	1	Ecological
Air pollution	County Health Rankings	Ratio	1	Ecological
# days precipitation	National Oceanographic and Atmospheric Administration	Integer	1	Ecological
# days max temperature <32 degrees	National Oceanographic and Atmospheric Administration	Integer	1	Ecological
# days snow depth >1 inch	National Oceanographic and Atmospheric Administration	Integer	1	Ecological
Average daily maximum temperature	National Oceanographic and Atmospheric Administration	Integer	1	Ecological

Appendix B: Permission to Use Test Instruments

User Agreement to Use Dimensions of Mastery Questionnaire



Colorado State University
Knowledge to Go Places

Spring 2018

Dear Colleague:

Thank you for your request for the Dimensions of Mastery Questionnaire. We are pleased to provide you with our new and, we believe improved, version of the measure (DMQ 18). As you may know, the DMQ has been used by the authors of this manual plus a number of other investigators around the world; many of them provided their raw DMQ data and are acknowledged on page 19. The DMQ was revised in fall 2014 based on analyses of English, Chinese, and Hungarian DMQ 17 data over the last several years. The scales and most items of DMQ 18 are very similar to DMQ 17, and we expect them to provide even better data on mastery motivation for several reasons. First, we have deleted items that did not demonstrate measurement invariance across English, Chinese, and Hungarian languages and cultures. We also created new items and refined others to make them align better with mastery motivation theory and research. Preliminary data on the DMQ 18 scales suggest that reliability and validity are similar or better than that of previous DMQ versions. We strongly encourage you to use DMQ 18.

Review chapters by Morgan, Wang, Liao, and Xu (2013), Józsa and Molnar (2013) and by Morgan, Maslin-Cole, Harmon, Busch-Rossnagel, Jennings, Hauser-Cram, and Brockman (1993) provide information about many samples that had been studied with earlier versions of the DMQ. This document has a bibliography that includes the above chapters and other papers, especially several that use the DMQ 18. This manual provides information about the usefulness, psychometric properties, and scoring of this mastery motivation questionnaire. Copies of the DMQ 18 in English and Chinese (with traditional characters) are attached. Chinese versions are also available on request in simplified characters. Hungarian versions and Spanish versions are available on request.

We want the DMQ 18 to be used as broadly as possible, *and* we want to know as much as possible about the use of the instrument in order to coordinate feedback among users and gather more data about DMQ 18. Thus, we would like you to share with us your raw item by item DMQ 18 data in an SPSS or Excel file so that we can combine and compare samples, check scale reliability, etc. We also would like you to send us preliminary reports and later publications of the results of your use of the DMQ that we will add to the reference list. Please complete the form on the next page and send a copy to me. Thank you for your cooperation. As we continue to gather information on the DMQ, we will be glad to share it with you.

George A. Morgan
Professor emeritus, education and human development Colorado State University
Fort Collins, CO 80523-1588
george.morgan@chhs.colostate.edu
http://soe.chhs.colostate.edu/faculty-staff/morgan.aspx
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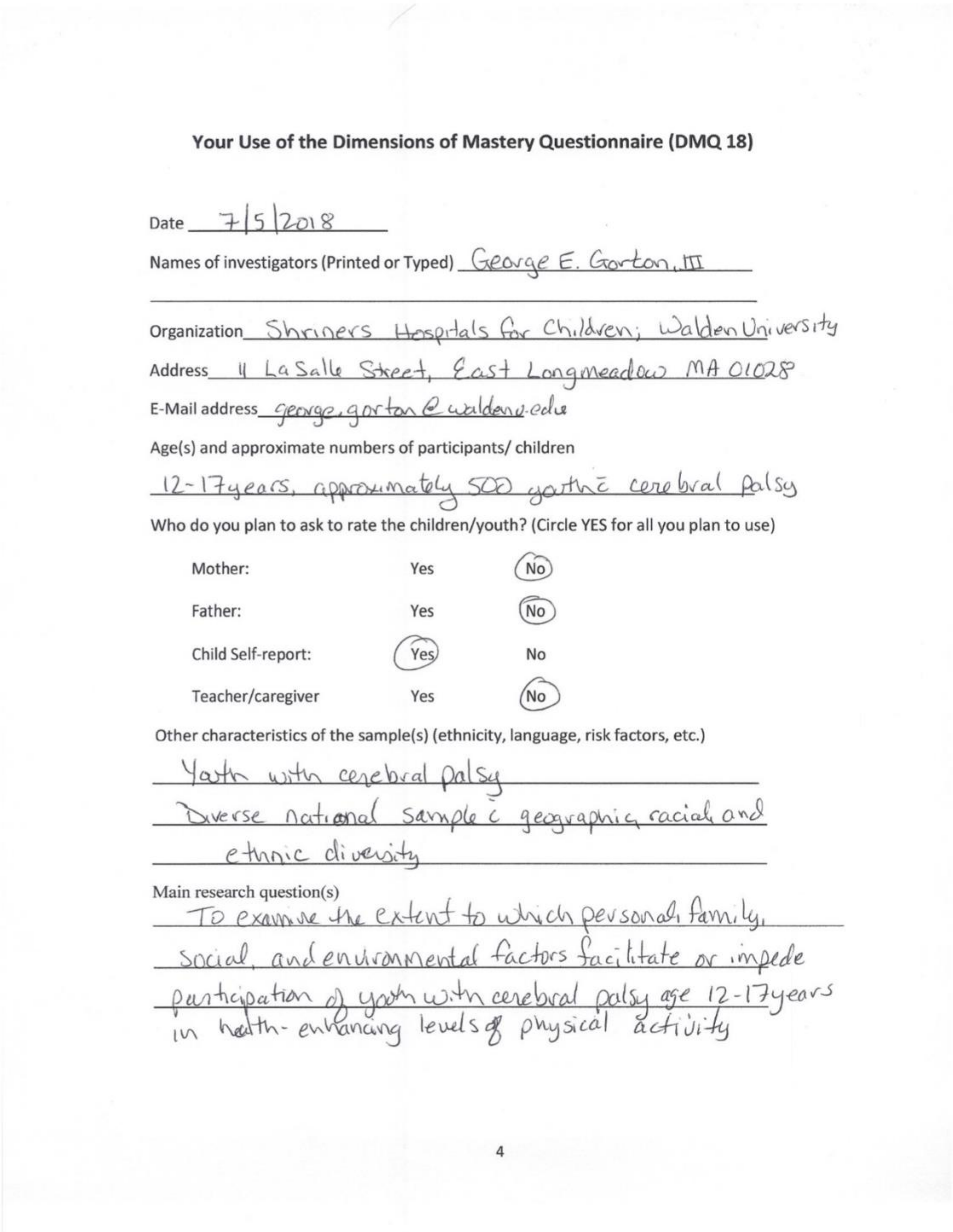


Your Use of the Dimensions of Mastery Questionnaire (DMQ 18)

Date 7/5/2018

Names of investigators (Printed or Typed) George E. Gorton, III

Organization Shriners Hospitals for Children; Walden University

Address 11 LaSalle Street, East Longmeadow MA 01028

E-Mail address george.gorton@waldenu.edu

Age(s) and approximate numbers of participants/ children

12-17 years, approximately 500 youth c̄ cerebral palsy

Who do you plan to ask to rate the children/youth? (Circle YES for all you plan to use)

Mother: Yes [✓ No]

Father: Yes [✓ No]

Child Self-report: [✓ Yes] No

Teacher/caregiver Yes [✓ No]

Other characteristics of the sample(s) (ethnicity, language, risk factors, etc.)

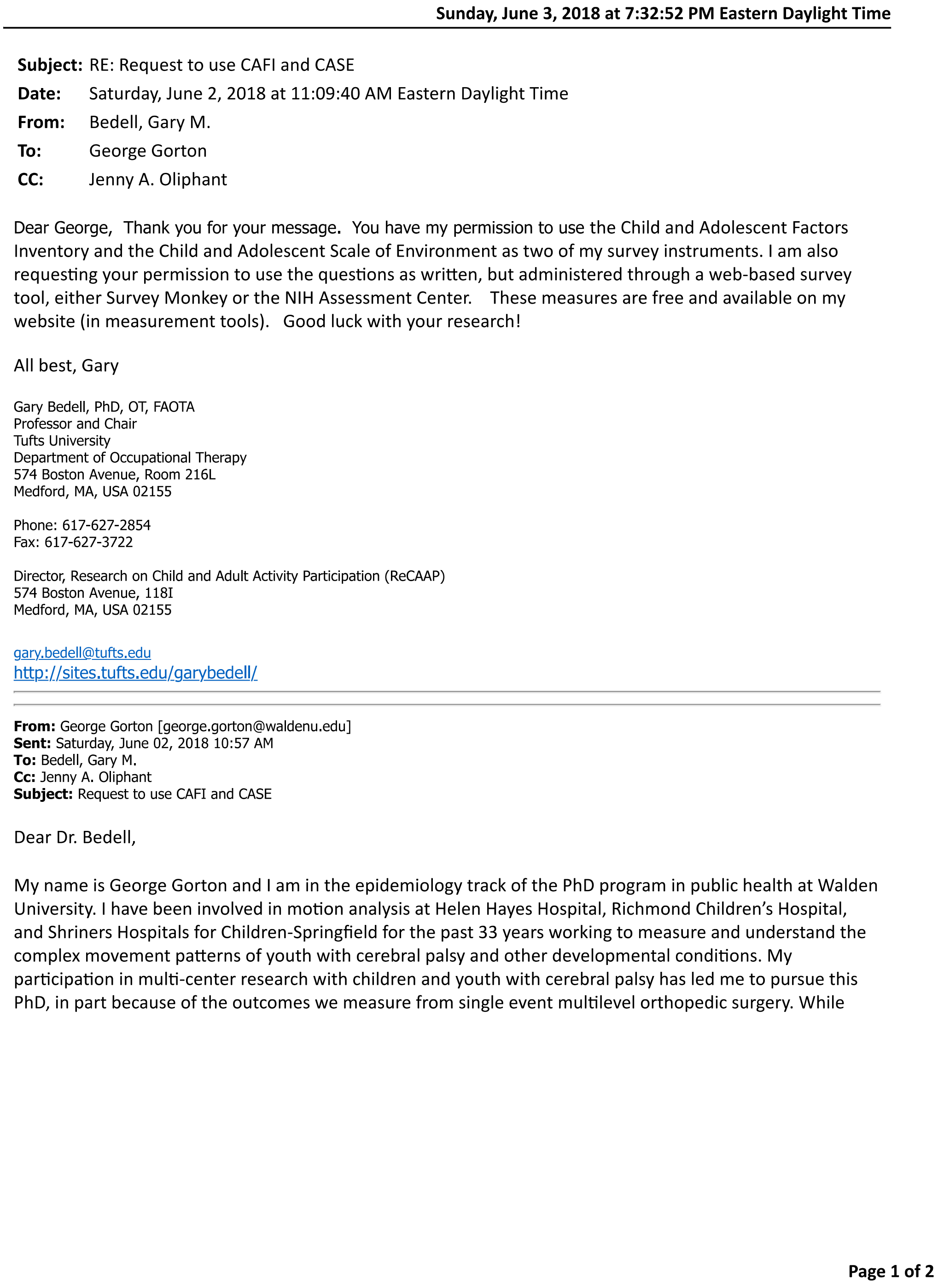
Youth with cerebral palsy

Diverse national sample c̄ geographic, racial and ethnic diversity

Main research question(s)

To examine the extent to which personal, family, social, and environmental factors facilitate or impede participation of youth with cerebral palsy age 12-17 years in health-enhancing levels of physical activity

Letter of Permission to Use the CASE and CAFI



Sunday, June 3, 2018 at 7:32:52 PM Eastern Daylight Time

Subject: RE: Request to use CAFI and CASE
Date: Saturday, June 2, 2018 at 11:09:40 AM Eastern Daylight Time
From: Bedell, Gary M.
To: George Gorton
CC: Jenny A. Oliphant

Dear George, Thank you for your message. You have my permission to use the Child and Adolescent Factors Inventory and the Child and Adolescent Scale of Environment as two of my survey instruments. I am also requesting your permission to use the questions as written, but administered through a web-based survey tool, either Survey Monkey or the NIH Assessment Center. These measures are free and available on my website (in measurement tools). Good luck with your research!

All best, Gary

Gary Bedell, PhD, OT, FAOTA
Professor and Chair
Tufts University
Department of Occupational Therapy
574 Boston Avenue, Room 216L
Medford, MA, USA 02155

Phone: 617-627-2854
Fax: 617-627-3722

Director, Research on Child and Adult Activity Participation (ReCAAP)
574 Boston Avenue, 118I
Medford, MA, USA 02155

gary.bedell@tufts.edu
http://sites.tufts.edu/garybedell/

From: George Gorton [george.gorton@waldenu.edu]
Sent: Saturday, June 02, 2018 10:57 AM
To: Bedell, Gary M.
Cc: Jenny A. Oliphant
Subject: Request to use CAFI and CASE

Dear Dr. Bedell,

My name is George Gorton and I am in the epidemiology track of the PhD program in public health at Walden University. I have been involved in motion analysis at Helen Hayes Hospital, Richmond Children's Hospital, and Shriners Hospitals for Children-Springfield for the past 33 years working to measure and understand the complex movement patterns of youth with cerebral palsy and other developmental conditions. My participation in multi-center research with children and youth with cerebral palsy has led me to pursue this PhD, in part because of the outcomes we measure from single event multilevel orthopedic surgery. While