ENHANCING SELF-REPORTED PHYSICAL ACTIVITY AND RELATED
SELF-EFFICACY AMONG ADOLESCENTS

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by
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ABSTRACT

Physical activity (PA) declines significantly during adolescence. PA refers to individual's level of bodily movement and performance of activities requiring physical actions. Self-efficacy (SE) is considered a determinant of PA behavior. PA-SE is defined as one's belief in his/her capabilities to perform PA to achieve certain outcomes and capabilities in managing positive and negative experiences to participate in PA. Promoting PA levels in adolescents requires accurate assessment tools of PA and related SE. The existing self-regulatory PA-SE measures focus on measuring confidence against barriers to PA, and instruments have been validated for use in either younger or older adolescents. Adequate validity of instruments that demonstrates the relationship with PA has been established for older adolescents using a SE instrument, called the SE to Overcome Barriers to PA Scale. The International Classification of Functioning Disability and Health (ICF) emphasizes addressing both facilitators and barriers of contextual factors influencing health and health-related behaviors. Therefore, expanding measurement of PA-SE construct by including beliefs in doing PA with existence of perceived facilitators in addition to overcoming barriers based on perspective of both younger and older adolescents is needed to capture more possible variation in PA and changes in the relationship by age. PA should also be measured using a psychometrically robust PA instrument when examining validity of a PA-SE instrument.

The objective of this dissertation work was to enhance validity of self-reported PA and PA-SE in younger and older adolescents and better understand the perceived regulatory SE related to PA in this population. The specific aims for our studies were: 1) To ensure content validity of some existing PA-SE measures' items (items for SR to

overcome barriers) in addition to a new SE-related facilitators items for younger and older adolescents; 2) To examine convergent validity of the 7-day recall Patient Reported Outcome Measurement Information System pediatric measure of PA (PROMIS-PA), and to explore whether the ecological momentary assessment (EMA)- and/or end of day (EoD) recall- versions of PROMIS-PA are more representative of daily PA activity than the 7-day recall version due to reduced recall bias expected with using these methods; and 3) To assess the construct validity, including convergent validity, of the new PA regulatory SE (PARSE) instrument (the resultant item pools from aim 1).

In the first study, we conducted individual sessions of semi-structured and cognitive debriefing interviews with adolescents (n = 18, aged 11-17) to further explore the PA-SE related facilitators and barriers concepts and revise item pools. Participants completed 3 questionnaires for the cognitive interviewing: SE to Overcome Barriers to PA Scale, Perceived PA-SE Scale, and new SE-related facilitators items. Thematic analysis showed that personal and environmental facilitators and barriers all influence confidence of being physically active. The major categories of our PA-SE questionnaire were physical; psychological; interaction with surroundings; support and relationships; attitudes; and services, systems, and natural environments. The cognitive interviews resulted in 52 final items: 24 for SE with perceived facilitators and 28 for SE to overcome barriers. This study supports content validity including clarity, relevance, completeness of the resultant PA-SE instrument for younger and older adolescents.

For our second study, participants were asked to complete daily PROMIS-PA-based EMA surveys (5 scheduled EMAs/day) and EoD surveys through an application for 7 consecutive days and wear accelerometry devices on these days. On the seventh

day, they completed the 7-day recall PROMIS-PA and Youth Activity Profile (YAP). In our total sample (n = 84, aged 10-20), the 7-day recall PROMIS-PA showed significant positive moderate to high correlations with the YAP scores and the average of daily steps. Our further analyses in a subsample of participants (n = 25, aged 11-18) indicated that the 7-day recall version has positive high correlations with the averaged EMA or EoD ratings for the week. The associations of the average of daily steps with the averaged EMA and EoD ratings for the week were comparable to its association with the 7-day recall PROMIS-PA scores. These findings support the validity of the 7-day recall PROMIS-PA by showing that the PROMIS-PA, YAP, and daily steps measure related PA constructs, and it has a good representation of PA as EMA and EoD reporting. Our findings suggest that adolescents demonstrate higher compliance to the EoD and 7-day recall PROMIS-PA which summarize the EMA reporting or the daily steps comparably.

For our third study, the total sample of adolescents (younger adolescents n = 51, aged 10-14; older adolescents n = 33, aged 15-20), who participated in the second study, completed also both PARSE sections (PA-SE to overcome barriers (PARSE-OB) and PA-SE with facilitators (PARSE-F)) before the week of activity tracking. PARSE-OB showed significant moderate and low positive linear relationships with the RPOMIS-PA and step average, respectively. PARSE-OB and PARSE-F scores were highly correlated. The PARSE-OB validity was supported also by demonstrating a significant moderation effect of gender on the relationship between the PA-SE and PA in younger adolescence and a significant positive linear relationship between these variables, with no gender moderation effect, in older adolescents. Our results did not support the PARSE-F and PA relationship. These findings indicate that both sections of the PARSE instrument measure

similar constructs, and the PARSE-OB section measure a construct that is directly related to PA in younger and older adolescents.

The PARSE-OB and PROMIS-PA are valid for use in younger and older adolescents. The use of PARSE-OB to assess PA-SE provides an improved understanding of the effect of SE on PA and can inform the design of more effective PA behavioral intervention strategies for younger and older adolescents. The use of the PARSE-F warrants further investigation to its potential indirect effect on PA since it is related to PARSE-OB. Using the PARSE-F items with PARSE-OB can help in planning behavioral intervention strategies since adolescents' experiences, based on our qualitative interviews, indicate the importance of perceived SE around the facilitators for this population. The 7-day recall and EoD recall PROMIS-PA can provide sufficient representation of daily PA, and they are preferred self-reporting methods for adolescents when compared to EMA.

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CHAPTER 1

INTRODUCTION

Literature Review and Study Rationale

Physical activity (PA) is defined as "any bodily movement produced by skeletal muscles that results in energy expenditure."[1] This term refers to all types of PA and is not restricted to specific quality of movement. The term "exercise" refers to a planned, repetitive, and usually structured PA.[2] Children and adolescents are recommended to do at least 60 minutes of moderate-to-vigorous PA every day including aerobic, muscle-strengthening, and bone-strengthening activities.[3] Increased level of PA in childhood and adolescence has shown positive outcomes in terms of health promotion and disease prevention.[4] The evidence supports the importance of PA in public health given the beneficial effects of PA on cardiovascular and cardio-metabolic health, musculoskeletal health, mental health including self-concept, anxiety, and depression, and adiposity in children and youth.[4,5] Research suggests that PA benefits and habits during childhood and adolescence would likely be transferred into adulthood.[2,6,7]

Despite the reported benefits of PA, only about 20% of adolescents in the US meet the recommended level of aerobic and muscle-strengthening activities.[3] A longitudinal accelerometry-based study showed a significant decrease in the level of PA performance with increasing age in children between ages 9 and 15 years.[8] Based on the results of the National Health and Nutritional Examination Survey (NHANES)[9] using accelerometer data and based on the Youth Risk Behavior Survey (YRBS),[10] PA declines

significantly with age and between childhood and adolescence, and boys are more physically active than girls in the US adolescents. Evidence indicates the importance of promoting PA levels during adolescence transitional period which in turn requires accurate assessment tools of PA and related behaviors. [4,5]

Physical Activity Self-Efficacy and Outcome Measures

Bandura described self-efficacy (SE) as one's belief in his/her capabilities to attain certain goals and exercise control over health habits.[11,12] He proposed that SE is acquired from four major sources which are performance accomplishments, vicarious experiences, verbal persuasion, and physiological states.[12] The ability to differentiate, weight, and combine these different sources reflect changes in cognitive abilities and social environment during the transitional period from childhood to adolescence and from adolescence to adulthood.[13]

Different individual (e.g. demographics, psychological, genetics), social, and environmental correlates and determinants of PA behavior in adolescents have been reported in the literature.[14-19] According to social cognitive theory (SCT), perceived SE is one of the core determinants of health behaviors.[11] PA-SE refers to one's belief in his/her capabilities to perform PA to achieve certain outcomes and perceived capabilities in managing positive and negative experiences to participate in PA.[13] PA-SE was found to be a positive correlate and predictor of participation in PA in healthy adolescents.[14-21] A meta-analysis, conducted in 2013, showed that the SCT variables; which are SE, goals, outcome expectations, and socio-structural factors; accounted for 31% of variation in self-reported PA behavior and 30% of variation in objective PA, and SE consistently

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predicted the amount of PA.[14] When SE was incorporated into a model including subjective norm, attitude, perceived behavioral control, goal intention, task efficacy, and barriers efficacy to examine the potential determinants of PA in young adolescents, it was found that the barriers SE is the strongest predictor of PA ($\beta = 0.35$ whereas it ranged from 0.03 to 0.16 with the other variables).[21] However, different SE measures were used in these studies.

As recommended by Bandura and followed by most SE test developers, SE is measured by people's perceived ability against challenges (barriers) to perform activities.[22] Several Person Reported Outcome Measures (PROMs) were developed to assess different aspects of PA-SE in adolescents (e.g. task/domain-specific and overcoming barriers).[23-30] Among these PROMs, the recently developed Perceived Physical Activity Self-Efficacy Scale (P-PASES) and Self-Efficacy to Overcome Barriers to Physical Activity Scale (SOBPAS), which measure PA-SE to overcome barriers, have shown sufficient psychometric properties (explained in the next chapters).[26,30] SOBPAS, which is a comprehensive instrument containing 24 items in 5 subscales, accounted for 44% of the variation in PA level in adolescents aged 14-18 years. P-PASES, which is a short unidimensional PA-SE instrument containing 11 items, failed to show a significant relationship between PA and SE to overcome barriers among young adolescents aged 11-14.[30] In the development process of P-PASES, the original 19 items were reduced to 11 in the final version based on a pilot study with girls.[30] It is unclear whether this insignificance in the relationship is due to insufficiency in the content coverage of the SE instrument itself, inaccuracy of the PA measure used (i.e. Child and Adolescents Activity

Log),[31] or weakness of this relationship in young adolescents resulting from developmental changes in this transitional period. Therefore, to examine this theoretical relationship, the PA and SE need to be assessed accurately, and this relationship needs to be re-examined in both age groups (younger and older adolescents) using an age-appropriate PROM measuring the same SE concepts in both groups.

Expanding content coverage of the self-regulatory PA-SE instruments to include the concept of SE around perceived facilitators could further explain the relationship between PA-SE and PA. The ICF model,[32] which was developed by the World Health Organization (WHO) to be used as a common language in health, emphasizes the importance of examining the positive and negative aspects of health and health-related behaviors. That is, personal and environmental facilitators and barriers influencing the ICF model components (i.e. body function/structure and activity and participation) need to be addressed.[32, 33] Voskuil and Robbins[34] reported a concept analysis and defined youth PA-SE as a bi-dimensional construct involving youths' belief in their capability to participate in PA and to perform PA despite existence of barriers. This definition was stated to reflect the task-specific SE and self-regulatory SE in terms of overcoming barriers. Although few researchers have conceptualized SE as a multidimensional behavior and/or included some situations that could facilitate participation in PA under the construct of SE, to our knowledge the concept of PA-SE facilitators was not clearly highlighted either under the task SE or under the self-regulatory SE.

Saunders et al.[28] in 1997 involved some positive aspects in their developed SE instrument, but these items were sampled to explain a domain called "support seeking"

with the concept of beliefs in being able to ask someone (family, any adults, or friends) for different types of support to perform physical activity (e.g., "I think I can ask my parents or other adult to do physically active things with me"). Among the 7-items under the support seeking factor, only one positive item "I think I have the skills I need to be physically active" has different underlying concept which we can consider as a personal facilitator. The rest of items in this instrument can be considered as barriers or challenges to do PA (e.g., "I think I can be physically active no matter how tired I may feel"). Motl et al.'s[25] SE measure is based on Saunders et al.'s [28] instrument, but it is unidimensional. This measure was also used and validated by Steele et al.[23] as a part of Self-Efficacy for Healthy Eating and Physical Activity (SE-HEPA) and by Dishman et al.[35] In this modified instrument, only two items carrying the concept of support seeking were involved, and an item with positive aspect "I have the coordination I need to be physically active during my free time on most days" which we can consider as facilitator was added. All the other items in this instrument can be explained under the concept of barriers as well. As mentioned above, in the recently developed PA-SE instruments considering the general PA ones, the focus of researchers was to measure only adolescent's confidence in his/her ability to overcome specific barriers to participate in PA,[26,30] which accounted for considerable amount of PA prediction.[26] Even though reasons for doing physical activity and suggestions to improve the PA level in adolescents were discussed briefly in a qualitative study with this population,[36] Dwyer et al.[26] involved only the barriers to participate in PA in their SE instrument and prediction model. Based on the literature review and ICF framework, we hypothesize that adding

items of SE with existence of some PA facilitators to a SE-PROM to overcome barriers would improve the content coverage of the concepts influencing SE which would explain more of variation in PA.

We reviewed the existing PROMs measuring PA-SE in adolescents and identified the underlying concept of each item as a personal or environmental facilitator or barrier as defined by the ICF model (Appendix A).[23,25-28,30,37,38] Very few items in these PROMs were recognized as facilitators. The PA facilitators were identified recently in non-US healthy adolescents and previously in adolescents with physical disability through qualitative interviews with this population, their parents, or their teachers, and they were discussed briefly as reasons for participating in PA in healthy US adolescents.[36,39-41] The factors affecting PA in individuals with disability, such as adolescents with cerebral palsy, were categorized based on thematic analyses as personal and environmental facilitators and barriers.[39,42] Furthermore, recent advances in technology with increased use of smartphones, tablets, videogames, and computers, that can be viewed as PA barriers, have been shown to be associated with increased obesity and inactivity.[43] Therefore, the concept of PA-SE needs to be updated based on qualitative interviews with healthy US adolescents to discuss possible perceived PA personal and environmental facilitators and barriers, which could serve as items for a PA-SE instrument.

Contrary to the insignificant relationship between PA and PA-SE reported using P-PASES,[30] Dishman et al.[35] found a significant relationship between PA and SE in young adolescent girls during their 6th and 8th grade school years. These researchers used Actigraph accelerometers and a short PA-SE instrument which included few items that

could be conceptualized as positive aspects or facilitators.[35] Thus, gender could influence

this relationship in young adolescents. Although P-PASES was qualitatively developed

and quantitatively field tested with both boys and girls, the original 19 items were

reduced into 11 in the final version based on a pilot study with girls.[30] Therefore, we need

to re-examine the relationship after conducting qualitative interviews with adolescents

using P-PASES that has been validated in young adolescents and a comprehensive

instrument like SOBPAS because of possible lack of some significant items for young

boys in P-PASES. Spence et al.[44] found that gender was a moderator of the relationship

between SE and PA among adolescents in grades 7 to 10, and the association was

significantly stronger in girls. As a part of testing SOBPAS, researchers found that

SOBPAS factors model was the same for boys and girls aged 14-18 years old.[26] Gender

may affect the relationship between SE and PA especially in younger adolescence age

because this period is parallel to the timing of growth spurt and biological maturity.[45]

Gender differences also exist during this period in some psychosocial and cognitive

factors influencing PA (females are influenced by social support and perceived barriers to

PA).[35,46] Thus, there is a need to examine the moderation effect of gender on this

relationship in younger and older adolescents using accurate assessment tools for both SE

and PA.

Self-Reported Physical Activity

Free-living PA (typically performed activity in a natural setting) can be assessed

objectively and/or using PROMs. Each assessment method provides unique and

complementary information.[47] Since PA is defined as bodily movement, objective

monitoring techniques such as motion sensors are commonly used to detect that body movement by recording acceleration signals to estimate PA.[48] Limitations of using such objective monitoring techniques include: lack of consensus in the methodology used to collect and analyze processed data, subjects non-adherence, costs, and inadequacy in capturing some types of PA performed with restricted motion (force production or stationary activities such as weight lifting or cycling, respectively).[49-52] Nowadays, the self-reported method to measure PA is considered the most practical and economical method and viewed as a valid and optimal option in some circumstances such as assessing the habitual PA and/or in large samples.[44,53-55] Using both objective monitoring and a PROM developed with sound methodological standards such as the Patient Reported Outcome Measurement Information System pediatric measures of PA (PROMIS-PA®) will provide better information about PA to overcome some limitations in the previous studies examining the SE and PA relationship.[26,30]

PROMIS is the product of a cooperative work of research initiative launched by the National Institutes of Health (NIH) to develop a large set of PROMs based on a rigorous measure development process.[56-58] PROMIS-PA is one of the pediatric instruments developed using a mixed-methods approach.[59-61] The development process comprised domain conceptualization, harmonization of existing PA measures, content validation, and item bank calibration in a nationally representative sample of pediatric population using item response theory (IRT) to enable interpretation relative to national norms.[59-61] IRT models allow using the probability of correct response to an item as a function of person ability (the PA level) and specific properties of the item itself (e.g.

item's discrimination and item difficulty).[61] PROMIS-PA's items were selected based on IRT to reliably assess all levels of PA without bias against socio-demographic subgroups.[61,62]

Reporting PA based on 7-day retrospective recall could include some bias due to dependence on retrieving some PA information from memory to generate a response consistent with the format of the required responses.[63,64] In this situation, people usually tend to report the more recent performance and more readily recalled events because of novelty or special impact.[64] Using ecological momentary assessment (EMA) approach could reduce such bias.[64-66] The common key features to the EMA techniques are: 1) the "ecological" aspect, which allows subjects to report feelings or behaviors occurring in their natural environment, 2) the "momentary" aspect to report current feelings or behaviors or very recent ones rather than relying on long period-recall or summary, 3) the moments selected for assessment are event-based or time-based (following time schedule intervals), 4) the "Assessment" technique of EMA requires multiple assessments over time to enable capturing more information about variation in the behavior of interest throughout time.[66,67] Although EMA could reduce the 7-day recall bias, End of Day (EoD) reporting could be sufficient to substitute EMA.[68] Therefore, we will simultaneously administer parallel versions of PROMIS-PA: EMA, EoD-recall, and the established 7-day recall to test whether one or both of the recall-based PROMIS-PA measures accurately summarize the EMA-based reports or objective monitoring and provide some recommendations for using these versions accordingly.

In previous research conducted by Dunton et al.,[69-72] the feasibility of EMA using mobile phones provided by researchers in reporting PA performance for children aged 9-13 was demonstrated. Children responded to 80% of all EMA prompts, rates that are comparable to other EMA studies.[73,74] However, we need to further discuss the acceptance of EMA versus daily or weekly reporting with young and old adolescents in Philadelphia and accessibility to electronic devices. The construct validity of EMA assessing the type of current performed activities was tested by matching concurrent Actigraph accelerometer data which revealed that total step counts were greater when children reported PA than sedentary behavior.[69] To our knowledge, EMA surveys in the previous PA studies for adolescents were designed with minimal attention to PROM development and validation standards, which is a critical limitation.[69] Therefore, data quality will be enhanced by utilizing PROMIS-PA questions in EMA and EoD reporting and testing construct validity of PROMIS-PA, which uses a 7-day recall period.

Significance

Enhancing the level of PA in adolescents is of particular important to public health as it has long-life effects. Based on longitudinal accelerometry data from the US, the percentages of children not meeting the recommended PA increased from 0.4% at age 9 to about 69% at age15.[8] Such increase was associated to the transition from childhood to adolescence. Another longitudinal study showed that PA declined significantly for students in the 11th and 12th grade and such decline was maintained through their transition to adulthood.[75] A greater decrease in PA participation was found to be associated with a greater increase in weight gain, indicating that transition is a risky

period of reduced PA and increased weight gain.[76] Obesity in the US increased sharply with age with approximately 42% of adolescents aged 16-19 having obesity.[77] Inactivity was linked to about $117 billion in annual health care costs.[3]

The long-term goal of this research is to develop effective strategies to enhance the PA level in young and old healthy adolescents because of the critical changes happening in this transitional period that could influence health. This dissertation study provides the initial steps for this goal by using and validating the appropriate self-reported assessment tools of PA and an important related behavior, that is SE. This study will provide us with validated versions of pediatric PROMIS-PA and PA-SE measures and recommendations about using these PROMs in clinical practice and in the future research. The study findings will also enhance our understanding about the facilitators as well as the barriers that these individuals perceive to influence their confidence regarding PA performance and the appropriate ways to use EMA especially with young adolescents. Researchers will be able to examine different biopsychosocial models including SE as a predictor to PA in order to better understand the PA framework.

Innovation

This research is innovative in defining the PA-SE construct we intend to measure to involve facilitators that could influence one's belief in his/her capability to be physically active. In the early studies of developing PA-SE instruments,[25,28] researchers involved very few items with positive aspects that were sampled to represent "support seeking" domain or were a part of unidimensional SE construct. Instruments are designed based on how researchers define the construct they intend to measure. In the most

recently developed instruments, researchers clearly defined the SE construct to reflect

confidence to overcome barriers.[26,30] Based on the best-practice of PROMs development

methods,[78-81] and previous work by Tucker et al.,[59,60] content validity of the pediatric self-

reported outcome measures can be improved by obtaining input from children and

adolescents. The inputs from healthy adolescents and adolescents with physical disability

indicate that both positive and negative aspects of contextual factors could potentially

influence participation in PA.[36,39] In this dissertation work, we will address the confidence

to do PA with existence of the factors that this population perceives as facilitators in

addition to barriers to measure SE for PA. The WHO defined "facilitators" in the ICF

framework as factors improving functioning and reducing disability or restriction through

absence or presence of these factors.[32] The concept of perceived benefits, addressed in

the literature, [30,46,82] can also be viewed as a part of possible facilitators that could

influence someone's confidence to be physically active. Based on our literature review,

we identified some important PA facilitators to SE to serve as items in the PA-SE

questionnaire.[23,25,28,36,39]

Utilizing EMA to report performance of PA have some advantages such as

reducing recall bias, improving ecological validity, and maximizing the temporal

resolution of scores.[65,83] EMA will likely enhance measurement precision compared to

the recall versions. Some researchers, who examined the validity of an EMA approach in

which adult participants had to complete behavioral diary assessments (involving PA)

once a day, suggested that daily recall assessment could be considered as a valid

alternative to accelerometers to measure free-living PA.[84] Thus, as a part of examining

the construct validity of the 7-day recall PROMIS, we will use both EoD recall- and

EMA-based approaches. In comparison to the previous studies utilizing general questions

in EMA to assess PA in adolescents (e.g., type of current performed activity),[69,85] the

EMA data quality will be improved in our study by using a PA questionnaire that was

developed based on PROMIS standards. Furthermore, EMA data will be enhanced by

including expressions of an extended period of time (e.g., from about 8 am to 12 pm) in

question stems rather than using specific moment expressions (right now, right before the

beep…etc.) as in some previous studies.[64,69]

Specific Aims

The overall goal of this study is **to enhance validity of self-reported PA and
PA-SE in adolescents aged 10-20 years-old and better understand the association
between PA-SE and PA in this population.** Both PA and SE to be physically active
need to be assessed appropriately to design more effective intervention strategies to
improve the PA level in adolescents. The specific aim of this proposed study:

Aim 1: To explore the concept of PA-SE by addressing the behavior-related facilitators
and barriers to ensure the content validity of existing PA-SE measures (i.e., P-PASES[30]
and SOBPAS[26]). This aim will be accomplished with semi-structured and cognitive
debriefing interviews with adolescents aged 10-18 years to address conceptual framing
and comprehensibility of proposed items. In addition, acceptability of and preferences for
EMA techniques will be explored to inform the results interpretation for aim 2.

Hypothesis 1: Thematic analysis will reveal that personal and environmental

facilitators and barriers influence adolescents' confidence in being physically active.

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Hypothesis 2: Cognitive interviews will ensure comprehensiveness, relevance, and

comprehensibility of the tested items (i.e., derived from the P-PASES[30] and

SOBPAS[26] in addition to a new "Physical Activity Self-Efficacy with Facilitators"

survey) to younger and older adolescents.

Hypothesis 3: Semi-structured interviews will help us understand feasibility and

acceptability of using EMA on participant's electronic devices versus other recall-

PA assessment methods among this age group.

Aim 2: To examine convergent validity of the pediatric 7-day recall PROMIS-PA short

form by investigating the associations of PROMIS-PA's scores with the Youth Activity

Profile (YAP) scores and the average of daily steps using accelerometry (for activity

objective monitoring over 7 consecutive days) and testing the association between the 7-

day recall-, EoD recall-, and EMA-based versions (Table 1.1)

Hypothesis 1: There will be a high positive association between the 7-day recall

PROMIS-PA and YAP scores and a positive association with the average of daily steps

for that week.

Hypothesis 2: Average EMA ratings for the week $(\bar{x}_{m1-m35})$ will be moderately

correlated with the 7-day recall PROMIS-PA scores (w).

Hypothesis 3: Average of the EoD ratings for the week $(\bar{x}_{d1-d7})$ will be moderately

correlated with the 7-day recall ratings (w).

Hypothesis 4: Single EoD ratings (d_k) will be moderately to highly correlated with

average EMA ratings for that day $\left(\bar{x}_{m\sum i\ for\ each\ day}\right)$.

Hypothesis 5: There will be a positive moderate association between each EoD recall-/ the average daily EMA-based PROMIS-PA ratings and the daily steps for each day.

Hypothesis 6: The average EoD recall- $(\bar{x}_{d1-d7})$ and the average EMA-based $(\bar{x}_{m1-m35})$ PROMIS-PA ratings for the week will show higher association than the 7-day recall PROMIS-PA ratings with the average steps for that week.

Support for Aim 2 hypotheses:

Support for the main hypotheses 1, 2, and 3 will provide validity evidence for the 7-day recall PROMIS-PA by positive association with the YAP scores; average of daily steps; average of EoDs reporting; and average of EMAs. Support for hypothesis 2 will indicate that the 7-day recall version is an accurate representation of weekly PA because of its correlation with the EMA reporting that is an assessment method not impacted by recall bias. Support for hypothesis 3 will indicate that the 7-day recall version is an accurate representation of weekly PA because of its correlation with the EoD reporting that is less impacted by recall bias.

Support for the explored hypotheses 4, 5, and 6 may indicate that self-reporting, using either EoD reporting or EMA, is more representative of PA (expressed as daily steps) than the 7-day recall, and perhaps that EoD reporting is sufficient in representing PA as EMA. This would be evident by the EoD association with EMA and association with daily steps that is similar to the association between daily EMAs and daily steps.

Table 1.1							
PROMIS-PA Scores Collected from Each Participant							

PROMIS	DAY							
	1	2	3	4	5	6	7	Average/week
EMA	m_1	m_6	m_{11}	m_{16}	m_{21}	m_{26}	m_{31}	$\bar{x}_{m1-m35}$
	m_2	m_7	m_{12}	m_{17}	m_{22}	m_{27}	m_{32}	
	m_3	m_8	m_{13}	m_{18}	m_{23}	m_{28}	m_{33}	
	m_4	m_9	m_{14}	m_{19}	m_{24}	m_{29}	m_{34}	
	m_5	m_{10}	m_{15}	m_{20}	m_{25}	m_{30}	m_{35}	
Average EMA/day	$\bar{x}_{m1-m5}$	$\bar{x}_{m6-m10}$	$\bar{x}_{11-m15}$	$\bar{x}_{m16-m20}$	$\bar{x}_{m21-m25}$	$\bar{x}_{m26-m30}$	$\bar{x}_{m31-m35}$	
EoD	d_1	d_2	d_3	d_4	d_5	d_6	d_7	$\bar{x}_{d1-d7}$
7-days recall							w	

Abbreviations: PROMIS-PA, Patient-Reported Outcome Measurement Information System for Pediatric Physical Activity; EMA, Ecological Momentary Assessment; EoD, End of Day; m_i, EMA version scores where i is the number of a prompt; d_k, End of day version scores for each k day; w, the 7-day recall version score at the end of the week (on the 7th day); $\bar{x}$, the mean of weekly or daily scores; Average EMA/day= $\bar{x}_{m\sum i\ for\ each\ day}$.

Aim 3 (Exploratory): To assess the construct validity of the new PA regulatory SE (PARSE) instrument (the resultant item pools from aim 1) using both sections, PA-SE to overcome barriers (PARSE-OB) and PA-SE with facilitators (PARSE-F), across adolescence. As a major part of this construct validity, we will examine convergent validity of the PARSE instrument with PA measures (the 7-day recall PROMIS-PA and accelerometry tracking activity over 7 days).

Hypothesis 1: As evidence on convergent validity:

1.1: The PARSE scores will be positively and moderately correlated with the PROMIS-PA scores and step average (related but unique constructs).

1.2: Correlation between the PARSE-OB and PARSE-F will be positive and large (similar constructs).

Hypothesis 2: The moderation effect of gender on the relationship between the PARSE scores and PA measurements will differ by age group:

2.1: In old adolescents, 2.1.1: the moderator effect will not be significant (the relationship will not differ by function of gender), 2.1.2: with dropping the moderator, the new model will show a statistically significant positive linear relationship.

2.2: In young adolescents, 2.2.1. there will be a significant effect of gender on the relationship, 2.2.2. follow-up analyses will show a statistically significant positive linear relationship in male adolescents that is stronger than in female adolescents (PARSE would account for more variation in PA in male adolescents than in female adolescents).

Hypothesis 3: Adding scores of PARSE-F to PARSE-OB will explain more variation in PA.

Overview of Methods

This research used a mixed method that links the initial qualitative studies outcomes with the quantitative methods to validate some existing and refined self-reported PA and related SE measures for young and old adolescents. As a significant part

of this study, different PA-recall versions of the pediatric PROMIS-PA (i.e., EoD and EMA) and a new PA-SE survey measuring SE with PA facilitators were developed and tested. The qualitative part was conducted with the aim of improving the content validity of PA-SE outcome measures (P-PASES and SOBPAS in addition to PA-SE with facilitators item pool) and providing useful directions on how to improve PROMs of PA and PA-SE. The qualitative study was conducted using semi-structured and cognitive debriefing interviews to ensure the content validity of a refined PA regulatory SE instrument is explained in chapter 2.

The quantitative part of this dissertation is a cross-sectional self-reported outcome measure validation study which: 1) evaluated the pediatric PROMIS-PA convergent validity based on evidence of associations between recall- and EMA-based versions and associations of PROMIS-PA scores with scores on other validated PA instruments, and 2) evaluated the updated PA regulatory SE instrument's construct validity based on association with PA and a theoretical relationship between SE and PA in younger and older adolescents. In the last stated model, the moderation effect of gender was examined and whether the addition of the SE with PA facilitator items pool to the model improved the PA prediction was explored. Construct validation is usually used to provide evidence of validity when a gold standard that should serve as a criterion is lacking.[81] The Delphi panel highlighted in the COnsensus-based Standards for the selection of health status Measurement INstruments (COSMIN) guidelines that gold standards do not exist for PROMs unless the purpose is to validate a short version of a specific PROM.[86] Hypotheses testing, which focuses on the relationships to other instruments' scores, is an

aspect of construct validity that is appropriate for examining the PROMs in this study.[86] In hypotheses testing, based on conceptual model or theories, researchers examine relationships of scores on the measure they wish to validate with scores on other assessment tool that measures similar or different construct (convergent validity).[81]

The studies including hypotheses testing to examine the convergent validity of the pediatric PROMIS-PA, usefulness of its EoD and EMA versions, and adolescents' preferences for reporting their PA on different time periods will be explained in chapter 3. Chapter 4 involves the study exploring construct validity (including convergent validity) of the PARSE instrument (the refined self-regulatory PA-SE instrument from chapter 2) based on its relationship with PA. This dissertation provides detailed description for 3 studies conducted for establishing validity of specific self-reported PA and PA-SE PROMs, which have the potential to inform clinical practice and future research aiming to promote the PA level in adolescents.

CHAPTER 2

ENHANCING THE CONTENT VALIDITY OF SELF-REPORTED

PHYSICAL ACTIVITY SELF-EFFICACY IN ADOLESCENTS:

A QUALITATIVE STUDY

Introduction

Adherence to the recommended level of physical activity (PA) in adolescence has beneficial effects on cardiovascular and cardio-metabolic, musculoskeletal, and mental health, as well as on adiposity during this transitional life course period.[4,5] Despite the reported benefits of PA, only about 20% of adolescents in the US meet the recommended level of aerobic and muscle-strengthening activities.[3] Longitudinal studies showed a significant decrease in the level of PA performance as age increases in children aged 9 to 15 years,[8] and significant declines of PA during high school age was maintained throughout the transition to adulthood.[75] A higher inactivity level was found to be associated with a greater increase in weight gain indicating that the transition from childhood to adolescence and from adolescence to adulthood is a risk period of reduced PA and increased weight gain.[76] Obesity in the US increased sharply with age with approximately 42% of adolescents aged 16-19 having obesity.[77] As pediatric physical therapists play an important role in health promotion and disease/injury prevention, determinants and related behaviors of PA should be assessed accurately and incorporated into effective intervention strategies to improve PA and health in adolescents.

Different individual (e.g., demographics, psychological, genetics), social, and environmental correlates of PA behavior have been investigated in the literature.[14-19] Among psychosocial factors, SE was consistently found to be a positive correlate and a determinant of PA in adolescents. [14-21] Bandura described SE as one's belief in his/her capabilities to attain certain goals and exercise control over health habits.[11,12] According to Bandura's social cognitive theory (SCT), perceived SE is one of the core determinants of health behaviors.[11] A meta-analysis, conducted by Young et al. in 2013, showed that the SCT variables (i.e. SE, goals, outcome expectations, and socio-structural factors) accounted for 31% of variation in PA behavior, and SE was a consistently direct and/or indirect associated variable with this behavior among the reviewed studies.[14] Several Person Reported Outcome Measures (PROMs) were used in these studies to assess different aspects of PA-SE in adolescents such as task or domain-specific and self-regulatory (mainly overcoming barriers) SE.[23-30,34] As recommended by Bandura and followed by most SE instrument developers, the general PA-SE construct is measured by people's perceived ability against challenges (overcoming barriers) to perform activities.[22]

Among the existing self-regulatory PA-SE PROMs, the recently developed Self-Efficacy to Overcome Barriers to Physical Activity Scale (SOBPAS) by Dwyer et al. and Perceived Physical Activity Self-Efficacy Scale (P-PASES) by Wu et al. have adequate psychometric properties.[26,30] Both instruments were developed to measure adolescent's confidence or certainty in his/her ability to overcome different barriers to participate in PA (e.g., overcoming bad weather, not having enough skills, not having social

support…etc.) . SOBPAS is a long PROM containing 24 items in 5 subscales which accounted for 44% of the variation in PA level in old adolescents aged 14-18 years. P-PASES is a short unidimensional instrument, which was qualitatively developed and quantitatively field tested with both genders, containing 11 items reduced from 19 original items based on a pilot study with girls.[30] The P-PASES failed to show a significant relationship between PA and SE in young adolescents aged 11-14 years. It is unclear whether this insignificance is due to insufficiency in the content coverage of the P-PASES or weakness of this relationship in young adolescents resulting from biological, cognitive, and social developmental changes[12] in this transitional period. Therefore, it is important to ensure the adequacy of items reflecting the construct of SE to overcome barriers to PA to be able to measure SE and its prediction to PA accurately in young adolescents for both genders.

The content of these self-regulatory PA-SE PROMs focused on the concept of overcoming barriers and did not include any perceived positive aspects that could influence self-beliefs. The International Classification of Functioning, Disability and Health (ICF) model,[32] which was developed by the World Health Organization (WHO) to be used as a common language in health, emphasizes the importance of examining both positive and negative aspects of health and health-related behaviors. Personal and environmental facilitators and barriers that influence ICF model components (i.e. body function/structure and activity and participation) should also be addressed.[32, 33] The factors affecting PA in adolescents were identified across different qualitative studies as personal and environmental facilitators and barriers.[39-41,87-90] While several reasons for

engaging in PA and mechanisms to improve the PA level in adolescents were discussed briefly in a qualitative study by Dwyer et al.,[36] the related measures of SE in PA, SOBPAS and P-PASES, focus primarily on the concept of overcoming barriers, versus utilizing facilitators.[26,30] In earlier studies, researchers included very few items with positive aspects that were sampled to represent "support seeking" domain or were a part of unidimensional SE construct (e.g., having the coordination needed to be physically active, having the skills needed to be physically active, ability to ask best friends to join in PA…etc.).[25,28] For example, Dishman et al.[35] used a short PA-SE instrument including only a few facilitator items and found a significant relationship between PA and SE in young adolescent girls during their 6th and 8th grade years. Few researchers have conceptualized SE as a multidimensional behavior or included facilitators of SE in PA. The inclusion of concepts of PA-SE facilitators, not clearly highlighted under existing self-regulatory conceptualized SE models, would provide a broader representation of PA-SE.

Based on the review of literature and ICF framework, adding items representing SE with existence of some PA facilitators to a SE-PROM to overcome barriers would improve the content coverage of the concepts regulating SE which could explain more of variation in PA. The COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) consider content validity as the most important measurement property since the items of any PROM should obviously reflect the construct of interest in terms of relevance, comprehensiveness, and comprehensibility for the target population.[91] Based on the best-practice of PROMs development methods,[59,60,78-81]

content validity of the pediatric self-reported measures can be improved by obtaining input from children and adolescents. The purpose of this study was to explore the concept of PA-SE by addressing the behavior-related facilitators and barriers in order to enhance the content validity of some existing PA-SE measures' items for younger and older adolescents. This aim would be accomplished through semi-structured and cognitive debriefing interviews with adolescents to address the conceptual framing and ensure appropriateness of some potential PA-SE item pools to this population. We hypothesized that our thematic analysis would reveal the categories of personal and environmental facilitators in addition to personal and environmental barriers; our general examined conceptual framework that is supported by the ICF and literature review;[32,39-42,87-90] are all influencing the confidence of being physically active. The environmental factors were categorized in the ICF model as: products and technology, natural environment and human-made changes to environment, support and relationship, attitudes, and services, systems, and policies.[32] The personal factors were addressed in the ICF but not categorized. The physical and psychological factors were some categories identified in the literature as personal factors.[39,41] The concepts derived from our interview analysis for the PA-SE concepts were compared with respect to these subcategories. We also hypothesized in our study that cognitive interview would ensure comprehensiveness, relevance, and comprehensibility of the tested item pools to younger and older adolescents.

Methods

A generic qualitative approach with abductive logic of reasoning was used in this study.[92,93] Such approach was appropriate to ensure content validity of a refined PA-SE measure as it allowed us to start with a general conceptual framework before data collection based on the literature review of the PA-SE concepts and existing measures. Then, this framework was updated and refined with emerging themes based on participants insights. This qualitative study was conducted as a part of a mixed methodology study before examining the quantitative psychometric properties. In accordance with the protocol approved by the Institutional Review Board of Temple University, parental permission and informed child assent were obtained before the children's participation in this study.

Participants

A convenience sample of children was recruited through personal contacts and flyers posted in Philadelphia and surrounding regions in Pennsylvania. Participants were n= 18 children aged 11 to 17 years with 33% female, 61% white, 22% African American, 11% Asian, 6% of another race, and 77% younger adolescents aged 14 years and under. Adolescents were included in this study if they are aged 11 to 18 years; typically developing, defined as no self/parent-reported childhood conditions that could impair performing age-appropriate movement skills or participating in PA; and able to speak, read, and hold conversations in English. Exclusion criterion was having a current medical condition or chronic disease that precludes participation in PA (e.g., cancer or cardiovascular disorders). For participants recruitment, we considered interviewing until

reaching data saturation and no further refinements for the item pools were needed.

Cognitive interviewing is an iterative process conducted with the aim of reaching a

consensus regarding instruments' content, format, and structure.[78] Thus, we followed the

standards previously used by C.A.T and K.B.B in developing PROMs[60] that each item

had to be reviewed by at least 5 participants confirming no additional refinements are

required.

Procedures

One-on-one semi-structured and cognitive debriefing interviews were conducted

with each participant. An interview guide with open-ended questions was used in this

study following the guidelines cited by Brod and colleagues.[78] This guide was prepared

prior to the interviews and developed based on our prior knowledge and literature review.

The semi-structured interview part of the session included broad open-ended topical

questions about youths' understanding of what it means to have confidence in their

ability to exercise or be physically active (Appendix B). Youth were also asked about

factors influencing their PA-SE as well as PA facilitators and barriers that could

potentially influence their SE. Specific probes were used for further clarification as

needed. Age-appropriate language was used, and the guide was adapted between the

sessions to use the appropriate words in the subsequent interviews to further examine and

validate concepts identified by prior interviews.

The second part of the session was the cognitive debriefing interviewing.

Participants completed the standard SOBPAS[26] and P-PASES[30] measures in addition to

SE-related facilitator items (16 items) developed based on a review of the literature. They

were completed online through the Qualtrics survey platform that was accessed through a website link sent by email. The ''think-aloud'' technique was used during the cognitive interviewing part of the sessions. Each item was read aloud, and participants were asked how they interpreted the item and how/why they chose the selected answer.[60,78] The questionnaires with a total of 51 items were completed and reviewed in a randomized order by all participants, and items were skipped from either SOBPAS or P-PASES during the interview if identified by participants as repeated or having the same meaning. More questions about the overall instrument structure and exact terminology were asked and refined as interviewers progressed through the interviews.

The interviews were audio-recorded to allow for interview transcription for analyses. The interviewer took notes throughout the interviews about the participant's responses, important points, and concerns to be able to get more details or clarifications in the following discussion and to be reviewed with participants by the end of the session. The first 6 participants were interviewed in their home or in a public place. The rest of interviews were conducted via Zoom video calling due to limited personal contact issued with the COVID-19 pandemic. The interviewing sessions lasted for about 90 minutes including breaks, and they were conducted by the primary investigator (R.A.G.).

Data Analysis

Interviews were transcribed without any subject identifying information. The theoretical thematic analysis with constant comparison across the interviews' data was used for coding to validate the item pools contents.[78,92] This coding process was done using the Dedoose software and Microsoft Word and Excel. The meaningful statements

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in each transcript were highlighted, and those recognized as important or relevant to the research question were sorted into conceptually similar subdomains that were compared to the SE items completed by participants in this study. The subdomains were grouped into categories/themes. Our hypothesized conceptual framework was further explored and updated. The underlying item concepts were compared with respect to the subcategories stated at the beginning of this study based on the ICF and literature review.[32,39,41]

Responses to cognitive interview probes for each item, formatting and instructions, and response options were reviewed and discussed by 2 investigators after each interview. Consistent issues related to item clarity, understanding meaning, terminology used by adolescents, preferences, content coverage, and meaning overlapping were determined. Items identified by at least 2 participants to have wording or clarity issues were revised to be retested in the next interviews. Response options, instrument structure, and formatting were refined as needed after each interviewing round.

To ensure data trustworthiness and credibility, the interview notes and summary of the issues and suggestions were reviewed orally with participants by the end of each interview for correction and confirmation. Furthermore, decisions about coding, interpretation, and items revision were discussed and reviewed by a third investigator who did not conduct interviews. Researchers' preconceived assumptions were examined individually and discussed with the investigator who is not involved in interviewing or coding to suggest other questions for the subsequent interviews challenging the interviewer preliminary interpretations.

Results

Our hypothesized conceptual framework of PA-SE was consistent with the adolescents' input about the factors influencing their PA-SE. This framework was refined to reflect the adolescents' perceptions. For example, some subdomains that were not consistent in meaning with the initial categories were grouped to reflect an emerging category called 'interaction with surroundings' based on adolescents' input as expressed by saying, for example, "I usually think about me with other people or things that happen…like if I have a bad day at school." However, some initial coded categories were maintained, and they were explicitly highlighted by participants. For instance, a participant explained the potential influencing barriers and facilitators by saying "it needs to cover the emotional and psychological things in someone's life and not just the physical." The final framework was used to assure that items were sampled to represent all categories which are indicators of the regulatory PA-SE construct (Figure 2.1). These item concepts are shown in Table 2.1.

Item Pools Refinement Process

It was acceptable for all adolescents to answer and discuss all the items although they were offered to stop the discussion between the three sets of items. Items were revised due to issues in comprehension, relevance, or meaning overlapping (Table 2.2). The comprehension issues identified by adolescents included word meaning, vagueness, or complexity in phrases or sentence structures.
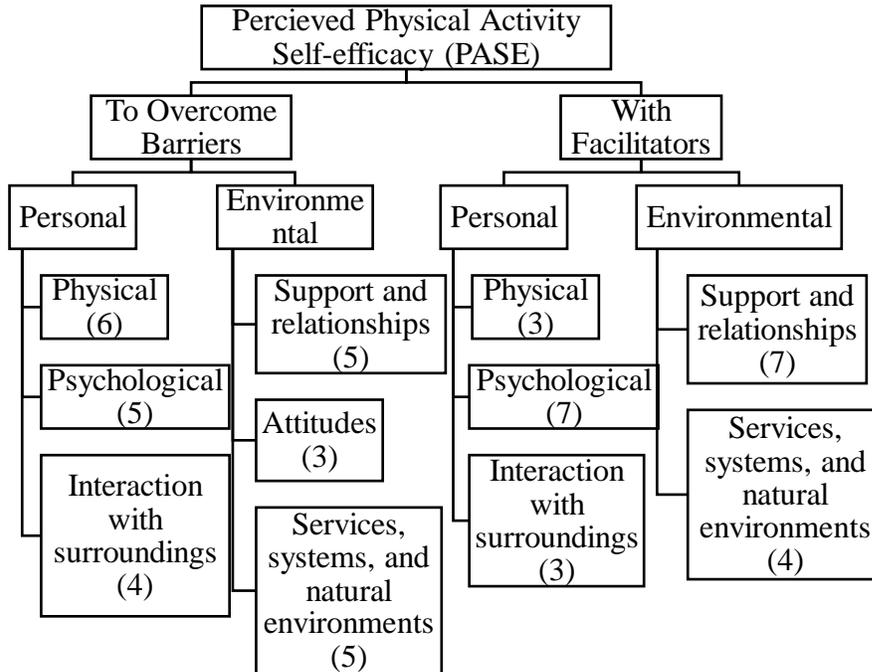
Figure 2.1 Thematic Analysis Results with (the Number of Items) in Each Final Category

Table 2.1	
The Specific Final Item Concepts Representing Each Category	
Thematic Categories	Final Item Concepts for the Item Pools
Physical personal barriers	Not having enough skills * Being sick or injured * Having minor aches/pain from activity ° Getting tired or feeling low in energy * ° Exercising is competitive * Perceiving exercising as a hard work °
Psychological personal barriers	Feeling self-conscious/concerned about appearance when exercising * ° Feeling not motivated or too lazy * ° Having concerns about weight * Feeling of not having fun * Being afraid of not performing exercise as it should be °
Interaction with surroundings personal barriers ●	Having other interests that are sedentary activities such as watching television or playing computer games *

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Table 2.1	
Continued	
Thematic Categories	Final Item Concepts for the Item Pools
Interaction with surroundings personal barriers •	Having a bad day at school ° Being busy with nondiscretionary tasks (e.g., job or work around house or for family) * ° Being so busy with schoolwork * °
Support and relationships environmental barriers	Having family responsibilities * Having a busy social life * ° Not supportive friends * Exercising alone * ° Not supportive parent *

Attitudes environmental barriers	Negative social influence:
	   – Teasing by friends *
	   – Bullied or intimidated by others *
	   – Unsafe places to exercise *

Services, systems, and natural environments-environmental barriers	Unavailability of exercising community programs or facilities * Unavailability of school programs * Costly exercising or physical activity * Transportation issues to exercising places * Bad weather * °
Physical personal facilitators	Having the needed skills for exercising Wanting to stay fit Having enough energy
Psychological personal facilitators	Enjoying exercise Thinking about health benefits of exercise Needing to relieve stress and decrease tension Needing to decrease anger Being interested in competing against others Being interested in challenges and improvement of skills Seeing or watching other people exercising or playing sports successfully
Interaction with surroundings personal facilitators •	Using technology that encourages/requires body movement (watching some workout videos or playing interactive video games) Seeking social benefits of exercising: Exercising to spend time with friends or meet new people Having a good day
Support and relationships environmental facilitators	Having family's help in signing up for sports or physical activity programs

Table 2.1	
Continued	
Thematic Categories	Final Item Concepts for the Item Pools
Support and relationships environmental facilitators	Having someone to company with for exercising (family or friends) Having family's support to get exercising equipment Ability of family to take the responsibility of transportation or arranging for it Having supportive friends Having supportive coaches or teachers (encouraging or training as expected)
Services, systems, and natural environments-environmental facilitators	Availability of exercising and sport opportunities at school Availability of exercising places close to home Availability of exercising programs with reasonable pricing Nice weather

• Interaction with surroundings: this category was not explicitly stated before based on our review to the literature and ICF, and it indicated how an individual him/herself can react to the things available or happening around him/her and such reaction could differ between individuals

* Item concepts addressed in the Self-Efficacy to Overcome Barriers to Physical Activity Scale (SOBPAS)[26]

° Item concepts addressed in the Perceived Physical Activity Self-Efficacy Scale (P-PASES);[30] some of them marked in the table but were only addressed as a general concept in P-PASES

Table 2.2

Examples on Items from the SOBPAS and P-PASES that were Modified or Eliminated for the Final Item Pool Based on Cognitive Debriefing Interviews

Items as Stated in SOBPAS or P-PASES	Corresponding Items in the Final Item Pool	Reasons for Modification or Elimination
"Having a job" *	"I believe I can still exercise even if I am busy with work that I have to do at job, around house, or for family"	Irrelevant to some participants or misunderstood
"Having a busy social life" *	"I believe I can still exercise even if I have a busy social life doing things with friends"	Ambiguous phrase needs to be explained

Table 2.2

Continued

Items as Stated in SOBPAS or P-PASES	Corresponding Items in the Final Item Pool	Reasons for Modification or Elimination
"I'm sure that I can still do my exercise even if I am too busy" °	Eliminated as it is Inferred by items such as the two stated above	Too general and is inferred by other items
"Community programs and facilities not being available" *	"I believe I can still exercise even if community programs and facilities (for example: parks, recreation centers, or gyms) are not available"	Unclear word meaning that needs to be explained by providing examples
"I'm sure that I can still do my exercise even if I am afraid to fail" °	"I believe I can still exercise even if I am afraid of not doing my exercise well"	The "afraid to fail" was a difficult phrase to understand or the "fail" was not the appropriate word describing adolescents' perspectives
"The cost of doing physical activity" *	"I believe I can still exercise even if doing exercise or physical activity is costly (high-priced)"	The "cost" was a problematic word that can be misunderstood to refer a non-financial issue
"Feeling embarrassed about others watching" * "I'm sure that I can still do my exercise even if I feel self-conscious or concerned about my looks when I exercise" °	"I believe I can still exercise even if I feel self-conscious or concerned about my looks when I exercise"	Both items have similar meaning, and the item from the P-PASES was retained because it is more inclusive for adolescents' perspectives and preferred over the word "embarrassed"
"I am sure that I can still exercise, be active, or do sports even if I face certain barriers or problems" °	Eliminated	Ambiguous in that an exact answer cannot be determined, summarizing all other items

Abbreviations: SOBPAS, the Self-Efficacy to Overcome Barriers to Physical Activity Scale; P-PASES, the Perceived Physical Activity Self-Efficacy Scale

* An item from SOBPAS.[26] Original items in this instrument were proceeded by the question "How confident are you that you can overcome each thing and still do moderate or vigorous physical activity?"

° An item from P-PASES[30]

Younger adolescents reported wording problems during the first and second cognitive interviewing rounds. They did not adequately understand concepts of reasonable program fees, cost, facilities, busy social life, transportation to facilities, and interactive games; and these were revised by using alternative words, descriptors, or examples as suggested by participants. Items with ambiguous phrases were clarified or integrated into other items having the same underlying concepts as explained by adolescents. For example, "afraid to fail" was replaced with "afraid of not doing my exercise well," and the item stating, "too busy" was deleted because it was inferred by other items such as "busy with work," "doing things with friends," …etc. Only the item with "having a job" barrier was found to be irrelevant to some participants or misunderstood by referring to "mom's job" during the first round. The item was accepted and considered as important when revised with "work that I have to do at job, around house, or for family."

When barriers and facilitators were stated in the items with the phrases "I'm confident…," "I'm sure…," or "I believe…," participants were able to explain it more consistently with the SE definition using the word 'believe.' Younger adolescents had a difficult time explaining the word 'confidence,' and some participants explained it as a PA accomplishment. For example, some participants explained it as "something you have done it before…and I'm proud of my accomplishments in that sport" and "you're able to do it, it's on your skill range." The adolescents found that using the phrase "I believe I can exercise because/ when/as…" with a facilitator has a different meaning than stating the facilitator with "…helps me believe I can exercise." The first phrase changed the

intended meaning by considering the facilitators as causes for doing PA while the second one maintained the meaning of SE.

Item concepts included in both the SOBPAS and P-PASES instruments were captured in and combined before the last cognitive interviewing round when the item statements' structure in both instruments were the same (Table 2.3). Repeated items with different wordings but same concepts were combined into one item using the easier words or phrases. Only the item stating the condition "even if I face certain barriers or problems" was deleted. It was identified by all participants as not important, summarizing all the previous items, or ambiguous for which an exact answer cannot be determined. The semi-structured interviews resulted in adding 8 items to the facilitators-SE item pool (Table 2.4).

Instrument Structure and Response Options

The instrument directions provided by SOBPAS including the examples on moderate and vigorous PAs were well understood and recommended to be maintained by all participants. Only minor changes have been made in wording to be consistent with the item pools. The younger adolescents found it easier to comprehend and explained faster when the items were stated as sentences rather than questions. The part of the sentence emphasizing the SE concept had to be repeated with each item to understand the meaning and emphasize the internal sense of SE. The items order was changed to keep items with similar concepts together as participants suggested "it's easier to answer related things at once than totally different things." Such change was helpful for participants to differentiate between similar situations and consequently provide more accurate answers.

Table 2.3

The Final version of the Physical Activity Self-Efficacy to Overcome Barriers Item Pool

The Instrument Component	Contents
Instructions	We have listed a number of things that may make it difficult for people to do moderate or vigorous physical activity. Please show how true each statement is regarding how you believe that you can do moderate or vigorous physical activities, exercises, or do sports when you face these listed things (please choose one number for each statement) *
Response Options	Not at all true [1], Not very true [2], Sort of true [3], True [4], Very true [5]
The phrase preceding each item to emphasize the SE concept in overcoming barriers	I believe I can still exercise even if …
Items	…Exercising is competitive. …I do not have enough skills. …I am sick or injured. …I have minor aches and pains from activity or exercise. …I am feeling tired or low in energy. …Exercising is very hard work. …I feel self-conscious or concerned about my looks when I exercise. …I am not motivated or feeling too lazy to exercise. …I am concerned about my weight. …I am not having fun. …I am afraid of not doing my exercise well. …I have other interests (for example: using the internet, watching television or videos, or playing computer games). …I have a bad day at school. …I am busy with work that I have to do at job, around house, or for family. …I have too much schoolwork. …I have family responsibilities. …I have a busy social life doing things with friends. …My friends are not supportive. …I have to exercise alone. …My parent is not supportive. …I am being teased by friends during exercising or sports. …I am being bullied or intimidated by others.

Table 2.3	
Continued	
The Instrument Component	Contents
Items	…I am not having a safe place to exercise. …Community programs and facilities (for example: parks, recreation centers, or gyms) are not available. …School programs are not available. …Doing exercise or physical activity is costly (high-priced). …I do not have transportation (for example not getting a ride) to places where I can exercise. …Weather is bad.
* The moderate and vigorous physical activity examples are shown within the instructions exactly as in SOBPAS	

Table 2.4	
The Final Version of the Physical Activity Self-Efficacy with Facilitators Item Pool	
The Instrument Component	Contents
Instructions	We have listed a number of things that may make it easy for people to do moderate or vigorous physical activity. Please show how true each statement is regarding how you believe that you are able to do moderate or vigorous physical activities, exercises, or sports considering these listed things (please choose one number for each statement) *
Response Options	Not at all true [1], Not very true [2], Sort of true [3], True [4], Very true [5]
The phrase coming after each item to emphasize the SE concept with facilitators	…helps me believe I can exercise.
Items	Having the skills I need to exercise… Wanting to stay fit… Having enough energy… Enjoying exercise… The health benefits of exercise… Needing to relieve stress and decrease my tension… Needing to decrease my anger... Being interested in competing against others…

Table 2.4	
Continued	
The Instrument Component	Contents
Items	Being interested in challenges and improvement of my skills in exercising…
	Seeing or watching other people exercising or playing sports successfully…
	Exercising when watching some workout videos or playing video games that make me move my body…
	Exercising to spend time with friends or meet new people…
	Having a good day…
	Having my family's help to sign up for a sport, dance, or other physical activity…
	Exercising with my family or my friends…
	Having my family's help to get the equipment I need to do my exercise…
	Ability of my family to take me to some places for physical activity, exercise, or sport practice…
	My parents' encouragement to exercise…
	Having supportive friends…
	Having supportive coaches or teachers who encourage me or train very well…
	Availability of the exercising (or physical activity) opportunities in my school…
	Having exercising places close to where I live (for example: a basketball court, park, or recreation center) …
	Availability of exercising programs with good pricing…
	Having nice weather…
* The moderate and vigorous physical activity examples are shown within the instructions exactly as in SOBPAS	

The majority of participants indicated their preference of having 5 response options rather than 4. Only 3 participants didn't have any preferences. With having only 4 options, some participants reported difficulty in choosing such as "It'd be easier just to have another one in between just to say true. That's true, but I chose 'sort of true' because it wasn't 'very true' to me."

Discussion

The purpose of this study was to ensure the content validity and comprehensibility of a PA self-regulatory efficacy PROM for adolescents. We derived item concepts from a review of the literature and 2 existing measures (SOBPAS and P-PASES). Our new PROMS included personal and environmental facilitators and barriers in accordance with the contextual factors influencing activity and participation in the ICF.[32] Our resultant PROM extends existing measures to include facilitators based on analyses of the semi-structured interviews with adolescents that supported the importance of both 'the existence of perceived facilitators' and 'overcoming barriers' as key self-beliefs of adolescent's self-efficacy for being physically active. The final cognitive interviewing round confirmed the comprehensiveness, relevance, and comprehensibility of the final version's items (24 items for perceived SE with facilitators and 28 items for SE to overcome barriers), instructions, response options, and phrases emphasizing the SE concept.

The inclusion of positive aspects or facilitators in a PA-SE instrument is not a completely new concept. Saunders et al.[28] in 1997 involved some positive aspects in their developed SE instrument with the concept of beliefs in being able to ask someone (family, any adults, or friends) for different types of support to perform PA. Our conceptualization differs than Saunders's concept by measuring beliefs in presence with perceived facilitators rather than beliefs in the act of support seeking. The facilitator influence on one's beliefs in doing PA is aligned with the WHO's definition to the "facilitators" in the ICF framework.[32] It was defined as factors improving functioning and

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reducing disability or restriction through absence or presence of these factors, which means presence of factors such as accessibility to programs, availability of necessary devices and technology, and positive attitudes could be facilitating. Very few SE facilitator items have been addressed in the previously developed instruments among other items of overcoming barriers. These items are "I think I have the skills I need to be physically active"[28] and "I have the coordination I need to be physically active during my free time on most days"[35] which represent self-beliefs concepts that can be influenced by presence of some positive factors, and this is consistent with the facilitator part of the SE construct addressed in this study.

The resultant item pool for the PA-SE to overcome barriers included item concepts combined from P-PASES and SOBPAS and refined based on the cognitive interviewing to be comprehensible and relevant to both younger and older adolescents. This item pool involved a range of item concepts with 18 additional items explaining other concepts than those involved in the original P-PASES. In comparison to the original SOBPAS instrument, this item pool was updated and refined according to the adolescents' inputs, included 4 additional items, and was thoroughly cognitively tested with adolescents as young as 11 years. Thus, this item pool can be used to measure the same SE construct in different age groups in adolescents. However, in future research, the psychometric properties will be further tested quantitatively in a large population sample.

Our study has some limitations. Although the interview's summary notes have been reviewed with participants and the last version of items was confirmed with a final cognitive interviewing round, the member checks (for the full transcripts and analytical

categories) by all participants have not been done due to limited time and the participants' age. Our sample of convenience involved more boys and only adolescents living in Philadelphia and surrounding areas which might limit generalizability of results. Since some interviews were conducted at beginning of the COVID-19 pandemic, participants' perspectives regarding the PA-SE facilitators and barriers could be influenced to some extent by changes in the amount, type, or location of PA.

Conclusion

The semi-structured and cognitive interviewing supported the content validity of two PA self-regulatory efficacy item pools for adolescences as young as 11 years. The semi-structured interview results supported our initial conceptual framework that indicated the importance of assessing adolescents' beliefs in capabilities using both perceived facilitators and overcoming barriers to PA. The updated conceptual framework based on participants' feedback helped to expand the item pool content coverage and measures' relevance to the younger and older adolescent sub-groups. The cognitive debriefing rounds improved the comprehensiveness, relevance, and comprehensibility of the items. Adolescents were able to complete the revised electronic version without any self-reported issues. Our current work includes validation in a larger cohort as well as convergent validation with other sources of PA information. The improved measurement of PA-SE will enable pediatric physical therapists to accurately assess this important determinant of PA which supports the design of better intervention programs that can include some behavioral strategies to enhance PA.

CHAPTER 3

CONVERGENT VALIDITY OF THE 7-DAY RECALL PROMIS

PEDIATRIC PHYSICAL ACTIVITY MEASURE WITH ECOLOGICAL

MOMENTARY ASSESSMENT, END OF DAY REPORTING,

AND ACCELEROMETRY

Introduction

The positive effects of physical activity (PA) on physical and mental health, and the importance of maintaining regular and enough PA are well known.[4,5] Decreased PA is noted during adolescence, and the decline is likely to continue through the transition to adulthood.[8-10,75] Precise and valid instruments assessing PA in adolescents are important to assess effectiveness of intervention strategies to improve PA levels in this age group.

Free-living PA (typically performed activity in a natural setting) can be assessed using wearable sensors to record motion acceleration of the body, or with person-reported outcome measures (PROMs).[47,48] Each assessment method provides unique and complementary information.[47] Challenges encountered with using wearable sensors include a lack of consensus in the methodology used to collect and analyze processed data, subjects non-adherence, cost, and inadequacy in capturing some types of PA performed with restricted motion (force production or stationary activities such as weight lifting or cycling, respectively).[49-52] Measuring PA with PROMs is considered more practical and economical than wearable sensors in epidemiological studies, and can provide relevant contextual information as well.[47,53-55] Rigorous studies establishing

measurement psychometric properties of self-reported PA in adolescents are essential to ensure the valid assessment of PA using PROMs.[94]

The Patient Reported Outcome Measurement Information System (PROMIS), a research network supported by the National Institutes of Health (NIH), developed psychometrically robust PROMs across multiple health domains for use as clinical trial endpoints.[56-58] The Pediatric PROMIS PA (PROMIS-PA) measure was developed using a mixed-methods approach,[59-61,95] and convergent validity with another self-reported PA instrument,[96] the Youth Activity Profile (YAP) reported for youth attending a community event.[97] However, the convergent validity of PROMIS-PA with an objective PA monitor or wearable sensor has not been determined.

The PROMIS-PA instrument uses a 7-day recall period. Reporting PA based on 7-day recall could introduce a recall bias,[63,64] as people usually tend to "over" report more recent PA performance and more readily recalled events because of novelty or special impact.[64] Ecological momentary assessment (EMA) approach has emerged as an option for self-report to reduce recall bias.[64-69,98-100] The common key features of EMA are: 1) allowing respondents to report behaviors occurring in their natural environment; 2) reporting of current or very recent feelings or behaviors by respondents rather than relying on a long period-recall or summary; 3) the timing selected for assessment are event-based or time-based (following time schedule intervals); and 4) capturing more information about the variation in behavior due to the multiple assessment responses collected over time.[66,67] Although frequent within-day EMA could reduce the 7-day recall bias, a less burdensome, daily or End of Day (EoD) reporting could be sufficient.[68]

Therefore, we simultaneously administered parallel versions of PROMIS-PA: EMA, EoD-recall, and the originally developed 7-day recall to explore whether PROMIS-PA scores based on EMA, EoD or 7-day reporting vary substantially across these reporting intervals, and how each compares with EoD and weekly step counts from wearable sensors.

The objectives of this study were to examine the PROMIS-PA's convergent validity in adolescents by investigating the association of PROMIS-PA's scores with YAP scores and the average of daily steps captured over the past 7 days using an accelerometry-based device-and testing the association between the 7-day recall-, EoD recall-, and EMA-based versions (Table 3.1). We hypothesized that:

1) there would be a high positive association between the 7-day recall PROMIS-PA and YAP scores and a positive association with the average of daily steps for that week;

2) average EMA ratings for the week $(\bar{x}_{m1-m35})$ would be moderately correlated with the 7-day recall PROMIS-PA scores (w);

3) average of the EoD ratings for the week $(\bar{x}_{d1-d7})$ would be moderately correlated with the 7-day recall ratings (w);

4) single EoD ratings (d_k) would be moderately to highly correlated with average EMA ratings for that day $\left(\bar{x}_{m \sum i \, for \, each \, day}\right)$;

Table 3.1

PROMIS-PA Reporting Versions and Scores Intended to Be Collected from Each Participant for Associations Testing

PROMIS	DAY							Average/week
	1	2	3	4	5	6	7	
EMA	m_1	m_6	m_{11}	m_{16}	m_{21}	m_{26}	m_{31}	$\bar{x}_{m1-m35}$
	m_2	m_7	m_{12}	m_{17}	m_{22}	m_{27}	m_{32}	
	m_3	m_8	m_{13}	m_{18}	m_{23}	m_{28}	m_{33}	
	m_4	m_9	m_{14}	m_{19}	m_{24}	m_{29}	m_{34}	
	m_5	m_{10}	m_{15}	m_{20}	m_{25}	m_{30}	m_{35}	
Average EMA/day	$\bar{x}_{m1-m5}$	$\bar{x}_{m6-m10}$	$\bar{x}_{11-m15}$	$\bar{x}_{m16-m20}$	$\bar{x}_{m21-m25}$	$\bar{x}_{m26-m30}$	$\bar{x}_{m31-m35}$	
EoD	d_1	d_2	d_3	d_4	d_5	d_6	d_7	$\bar{x}_{d1-d7}$
7-days recall							w	

Abbreviations: PROMIS-PA, Patient-Reported Outcome Measurement Information System for Pediatric Physical Activity; EMA, Ecological Momentary Assessment; EoD, End of Day; m_i, EMA version scores where i is the number of a prompt; d_k, End of day version scores for each k day; w, the 7-day recall version score at the end of the week (on the 7th day); $\bar{x}$, the mean of weekly or daily scores; Average EMA/day= $\bar{x}_{m\sum i\ for\ each\ day}$.

5) there would be a positive moderate association between each EoD recall-/ the

   average daily EMA-based PROMIS-PA ratings and the daily steps for each day;

   and

6) the average EoD recall- $(\bar{x}_{d1-d7})$ and the average EMA-based $(\bar{x}_{m1-m35})$ PROMIS-PA ratings for the week would show higher association than the 7-day recall PROMIS-PA ratings with the average steps for that week.

In sum, proving the main hypotheses 1, 2, and 3 would support the validity of the 7-day recall PROMIS-PA by positive association with the YAP scores; average of daily steps; average of EoDs reporting; and average of EMAs. Support for the explored hypotheses 4, 5, and 6 might indicate that self-reporting, using either EoD reporting or EMA, is more representative of PA (expressed as daily steps) than the 7-day recall, and perhaps that EoD reporting is sufficient in representing PA as EMA. This would be evident by the EoD association with EMA and association with daily steps that is similar to the association between daily EMAs and daily steps.

Methods

This is a prospective, observational study to evaluate the validity of a self-reported outcome measure of PA, the PROMIS-PA instrument, in adolescents.

Participants

We recruited a convenience sample of 84 adolescents aged 10-20 years from Philadelphia and surrounding regions in Pennsylvania through personal contacts and using snowball sampling technique. Participant were included in the study if they were aged 10 to 20 years; spoke and read English; were typically developing, defined as no self/parent reported childhood conditions that could impair their ability to perform age-appropriate movement skills or participate in PA; and had an accessible smart phone or tablet which they could use to answer surveys multiple times throughout the day for 7

consecutive days. Exclusion criteria were having an intellectual disability that could hinder completion of the questionnaires, an injury or surgical procedure in the past six months with a persistent effect on their level of PA, or a chronic health condition restricting PA. In compliance with the study protocol approved by the Institutional Review Board of Temple University, electronic parental consent and informed child assent were obtained before participation if participants were under 18 years, and participant consent was obtained if adolescents were 18 years of age or older. The EMA and EoD reporting data were collected and analyzed for a subsample (the first 25 enrolled participants) (Table 3.2).

Procedures and Measurements

All survey data were collected electronically using RKStudio^{TM} platform (CareEvolution, LLC). Participants and their parents were provided with a quick start guide and assisted by a study investigator as needed to download the Fitbit and MyDataHelps^{TM} applications on their own smart phone or tablet device. MyDataHelps^{TM} is the application through which participants completed all the required forms and surveys and shared their Fitbit data which were synced to the Fitbit application to be uploaded to the RKStudio^{TM} platform.

After providing the appropriate consent and/or assent, parents or 18- to 20-year-old participants completed "the general health information and sociodemographic questionnaire" which included basic information on age, gender, race, weight, height, and presence of any physical disabilities, chronic diseases, surgeries or injuries in the past 6 months, or reading/thinking issues. As this study was conducted during the COVID-19

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Table 3.2

Participants Descriptive Characteristics in the Total Sample (n=84) and the Subsample (n=25)

Variable	Total sample summary statistic (n=84)	Subsample summary statistic (n=25)
Gender, n (%)	Female 44 (52.4%) Male 40 (47.6%)	Female 12 (48%) Male 13 (52%)
Participant race, n (%)	White 66 (78.6%) African American 2 (2.4%) Asian 11 (13.1%) Other 5 (6%)	White 18 (72%) Asian 7 (28%)
Mother's race, n (%)	White 67 (79.8%) African American 2 (2.4%) Asian 11 (13.1%) Native Hawaiian and other Pacific Islander 1 (1.2%) Other 3 (3.6%)	White 18 (72%) Asian 6 (24%) Native Hawaiian and other Pacific Islander 1 (4%)
Father's race, n (%)	White 67 (79.8%) African American 3 (3.6%) Asian 10 (11.9%) Other 4 (4.8%)	White 19 (76%) Asian 6 (24%)
Age, mean± SD (range)	13.99± 2.44 (10-20)	14.16± 2.09 (11-18)
Weight, mean± SD (range)	57.98± 2.44 (23.59-120.20)	65.22± 23.12 (28.58-120.20)
Hight, mean± SD (range)	162.71± 2.44 (137.16-193.04)	166.71±13.57 (142.24-193.04)
The 7-day recall PROMIS-PA scores, mean± SD (range)	27.70± 7.68 (9-40)	29.12± 7.94 (12-40)
YAP scores, mean± SD (range)	14.46± 6.83 (0-32)	15.52± 6.39 (4-32)
Average of daily steps, mean± SD (range)	7936.76± 2972.39 (1795.71-17257)	8468.68± 3365.68 (3953.14-14893.43)

Abbreviations: PROMIS-PA, Patient-Reported Outcome Measurement Information System for Pediatric Physical Activity; YAP, Youth Activity Profile; n, number of participants; SD, standard deviation.

pandemic, upon enrollment participants also completed a 3-question survey to report

changes in the amount, type, and location of PA compared to last year. Participants were

instructed to wear a Fitbit all day for 7 consecutive scheduled days as possible (e.g.,

athletes were often required to remove devices for sport participation). They received 5

EMA surveys and an EoD survey every day during these scheduled days as explained

below and completed the 7-day recall PROMIS-PA and YAP on the 7th day. Each

evening subjects reported whether the Fitbit was taken off during the day, and if so the

time, duration, and reason for non-wear.

The 7-Day Recall PROMIS-PA

The 8-item form was used to measure PA lived experiences with items focusing

on 7-day recall of physiological responses and symptoms to PA as well as short bouts of

higher-intensity PA.[95,96] Each item was scored with a value ranging from 1 to 5, and the

summed scores were used for the purpose of the analysis in this study (the instrument can

be found on https://www.healthmeasures.net). The instrument development process has

been reported,[59,60,95] and the psychometric properties have been examined with stated

test-retest reliability of 0.65 and marginal reliability of 0.91.[95-96]

EMA and EoD of PROMIS-PA

The 4-item PROMIS-PA form was used with some modifications on the question

structures and response options to be appropriate for EMA purpose (Appendix C). The

EMAs asked about PA performed during 5 specific time segments parallel to the periods

stated in the modified YAP, and the time periods were selected based on participants

preferences indicated in our prior qualitative interviews. EMA survey timeframes were

early morning, 6 to 8 am; mid to late morning, 8 am to 12 pm; early afternoon, 12 to 3 pm; late afternoon, 3 to 6 pm; and evening, 6 pm until your bedtime. EMA surveys were scheduled to be delivered to participants on the MyDataHelps™ application by end of each period, and the last one was available for completion at 8 pm. Participants were provided with a timetable for survey completion times prior to participation and instructed to complete the surveys as soon as they could, given that school attendance mode was variable between participants and over the study period due to COVID-19. Surveys were deactivated after 24 hours as restricted by the platform available features. All responses were time stamped and considered valid for subsequent analysis if completed within allocated time segments before the start of next EMA (e.g. the early morning EMA asking about PA from 6 to 8 am had to be completed before getting next EMA that started at 12 pm), and for the 5th daily EMA if completed before 2 am. EMA data were accepted for each day analysis if participants responded to at least 3 EMA reports out of 5 within their allocated time segment during the day.[68] Participants received a daily push notification through the application every morning as a reminder to complete the surveys and to wear and sync their Fitbit. Other push notifications have been sent during the allocated time segments to specific participants if we noticed a survey was not completed.

The 8-item PROMIS-PA form was used to assess EoD recall of PA with similar modifications made as in the EMA (Appendix C). The recall period was stated in the EoD items as "today," and the survey was available on the application for completion every evening at 8 pm. Responses to EoD were valid for inclusion in the analysis if

completed before 2 am. Response options for the EoD and EMA items were yes and no

scored as 1 and 0 values respectively, and the summed scores were used for the analysis.

If valid daily data for EoD or EMA (at least 3 EMA reports/day) reporting were available

from at least 3 days, scores from only the non-missing days and non-missing EMAs were

averaged for the 7-day analysis.[68]

Youth Activity Profile (YAP)

The YAP is a 15-item self-report instrument that was developed to assess PA and

sedentary behaviors of youth over the past 7 days.[97] The instrument is divided into

activity at school, activity outside of school, and sedentary behaviors sections. The YAP

validity was tested in different samples,[97,101,102] and the correlations between the

electronic YAP and ActiGraph objective monitor data were 0.38 and 0.52 for school

activity and out-of-school activity, respectively.[101] The test-retest reliability examined

within 2 to 3 weeks was 0.74.[103] Since our study aimed to examine the validity of a PA

instrument and school activity was impacted by COVID-19 restrictions, we used the

modified YAP (removed school day activities) to assess activity throughout the day as in

the previous validation study of the PROMIS-PA.[96] The modified YAP included 7 items

scored on a 0-5 scale that were summed for the analysis (Appendix D).

Accelerometry-Based Devices

Participants were provided with a Fitbit Charge 3 or 4 for the duration of the

study and instructed to wear it on their non-dominant writs. Participants were allowed to

use their own Fitbit if it had comparable features to the Fitbit Charge. Evidence supports

using the consumer-based activity trackers for estimating free-living PA among

adolescents.[52,104,105] The daily step count data, included in our analysis, were downloaded

from RKStudio[TM] platform by linking participant's Fitbit account to his/her

MyDataHelps[TM] account. Weekly step count was calculated by averaging daily steps

across the total number of days that a subject wore a Fitbit. Consistent with prior

reports,[104,106,107] a minimum of 3 days of at least 8 hours of wear time per day and with a

daily step count over 1500 steps was required for data to be included in the analysis.

Data Analysis

Descriptive statistics were computed to summarize participants'

sociodemographic data, compliance rate, and PA measurements using means ± standard

deviations and ranges for continuous variables and frequencies and percentages for

categorical variables. Parametric statistical analyses were used since the PA data showed

normal distribution. All statistical procedures were performed using SPSS software,

version 27.0 (IBM Corporation), and the significance level was set at 0.05. The Pearson

product-moment correlation coefficient was used to examine all the correlations stated in

the hypotheses for the total sample and subsample. Independent *t* tests were used to

examine whether weight, height, 7-Day Recall PROMIS-PA scores, YAP scores, and

average of daily steps differed between the subsample and the rest of sample.

Results

All 84 participants completed the 7-day recall surveys. Valid step count data as

defined above was available for n=81 subjects from the total sample (and for n=22 from

the subsample, data for n=3 were lost due to device issues). The daily step count was

excluded from analysis if less than 1500 steps. This occurred for a single day for 6

participants and for 3 days for only one participant of the total sample. In the subsample of n=25, 616 (70.4% of a possible 875 EMA surveys delivered across all days and participants) were completed within the allocated time segments, and 152 (86.9% of the 175 EoD surveys delivered) were valid that they were completed before 2 am. Participants provided an average of 24.64 (SD= 8.35) valid EMA responses out of the 35 delivered EMA surveys. There was no discernible pattern of missing responses across the time segments. Compliance rates for providing valid EMA and EoD responses by days are detailed in Table 3.3. For the 7-day analyses in the subsample of n=25, valid EMA data were available from 21 (84%) participants and EoD data from 24 (96%) participants.

Table 3.3

Number of Participants with Valid EMA and EoD Data for Single-Day Analyses in the Subsample (n=25)

Day of activity tracking	Number of participants completed 3-5 EMA reports within the allocated time segments	Number of participants completed EoD reports before 2 am
1	22 (88%)	22 (88%)
2	22 (88%)	20 (80%)
3	19 (76%)	24 (96%)
4	16 (64%)	24 (96%)
5	16 (64%)	21 (84%)
6	15 (60%)	19 (76%)
7	17 (68%)	22 (88%)
Abbreviations: EMA, Ecological Momentary Assessment; EoD, End of Day; n, number of participants.		

In the total sample, the 7-day recall PROMIS-PA scores had significant positive moderate to high correlations with the YAP scores and the average of daily steps ($r = 0.53$, $P < 0.001$ and $r = 0.34$, $P = 0.01$; respectively). The YAP correlated moderately with the average of daily steps ($r = 0.33$, $P = 0.003$). In the subsample, the 7-day recall PROMIS-PA scores demonstrated positive high correlations with the averaged EMA and EoD ratings for the week ($r = 0.75$, $P < 0.001$ and $r = 0.91$, $P < 0.001$; respectively) (Table 3.4). The associations of the average of daily steps with the averaged EMA and EoD ratings for the week were comparable to its association with the 7-day recall PROMIS-PA scores.

Single-day analyses for all days revealed high positive correlations between EoD scores and average daily EMA scores (r range = 0.64-0.95, $P < 0.01$) (Table 3.5). The average daily EMA scores and daily steps had significant, high positive correlations on all days except for day 5 that showed moderate correlation (non-significant). The EoD scores were significantly and moderately to highly associated with daily steps except for day 2. The t tests showed that weight, height, 7-Day Recall PROMIS-PA scores, YAP scores, and average of daily steps did differ significantly between the subsample and the rest of participants in total sample.

Discussion

This study assessed the convergent validity of the 7-day recall PROMIS-PA instrument with other PA assessment tools in adolescents. The validity of this instrument was supported by our study findings that revealed significant positive associations between PROMIS-PA (7-day recall) and YAP scores and the average of daily steps for 7

Table 3.4

Pearson's Correlations ® from the 7-Day Analyses Run in the Subsample (n=25)

Average EMA ($\bar{x}_{m1-m35}$) and the 7-day recall PROMIS-PA	r = **0.75** n=21	*P* value < 0.001
Average EoD ($\bar{x}_{d1-d7}$) and the 7-day recall PROMIS-PA	r = **0.91** n=24	*P* value < 0.001
Average EMA ($\bar{x}_{m1-m35}$) and the average of daily steps	r = **0.51** n=18	*P* value = 0.03
Average EoD ($\bar{x}_{d1-d7}$) and the average of daily steps	r = **0.49** n=21	*P* value = 0.02
The 7-day recall PROMIS-PA and the average of daily steps	r = **0.57** n=22	*P* value = 0.01
Average EMA ($\bar{x}_{m1-m35}$) and Average EoD ($\bar{x}_{d1-d7}$)	r = **0.79** n=20	*P* value < 0.001

Abbreviations: PROMIS-PA, Patient-Reported Outcome Measurement Information System for Pediatric Physical Activity; EMA, Ecological Momentary Assessment; EoD, End of Day; ($\bar{x}_{m1-m35}$), the mean of all valid EMA scores across the week; ($\bar{x}_{d1-d7}$), the mean of all valid EoD scores across the week; *r,* Pearson's correlation coefficient; n, number of participants.

Table 3.5

Pearson's Correlations (r) from the Single-Day Analyses Run in the Subsample (n=25)

The day of activity tracking	Average daily EMA ratings & EoD score		Average daily EMA ratings & daily steps		EoD score & daily steps	
1	*r* = **0.84** n=19	*P* value < 0.001	*r* = **0.54** n=20	*P* value = 0.01	*r* = **0.47** n=19	*P* value = 0.02
2	*r* = **0.64** n=18	*P* value = 0.01	*r* = **0.56** n=20	*P* value = 0.02	*r* = 0.28 n=17	*P* value = 0.32
3	*r* = **0.86** n=19	*P* value < 0.001	*r* = **0.58** n=16	*P* value = 0.02	*r* = **0.54** n=21	*P* value = 0.01
4	*r* = **0.81** n=16	*P* value < 0.001	*r* = **0.56** n=14	*P* value = 0.03	*r* = **0.49** n=21	*P* value = 0.02
5	*r* = **0.78** n=14	*P* value = 0.00	*r* = 0.44 n=13	*P* value = 0.13	*r* = **0.61** n=18	*P* value = 0.01
6	*r* = **0.77** n=14	*P* value = 0.00	*r* = **0.67** n=13	*P* value = 0.01	*r* = **0.51** n=19	*P* value = 0.03
7	*r* = **0.95** n=16	*P* value < 0.001	*r* = **0.68** n=15	*P* value = 0.00	*r* = **0.66** n=19	*P* value = 0.02
Abbreviations: EMA, Ecological Momentary Assessment; EoD, End of Day; *r*, Pearson's correlation coefficient; n, number of participants.						

days measured by Fitbit. Previous studies used EMA techniques to reduce possible recall bias in self-reporting associated with long recall periods and demonstrated EMA is an accurate self-reporting technique for PA when compared with accelerometry-based measures.[69,98] Broderick et al.[68] indicated that EoD reporting is a highly accurate strategy that can replace EMA when the target is the average of a performed behavior over a period. A study by Knell et al.[84] supported the validity of daily reporting which demonstrated a better estimate of PA than the 7-day recall self-reporting. Both EMA and EoD reporting using PROMIS-PA-based items were employed in this study and provided an evidence supporting the 7-day recall PROMIS-PA validity.

This study used various outcome measures assessing PA to examine correlations with the 7-day recall PROMIS-PA as stated in our first 3 hypotheses. The correlation with the YAP scores in our sample was comparable to the same correlation tested in a previous study with a larger sample ($r = 0.60$, n = 348).[96] This correlation highlights that both instruments are measuring related constructs but different components. The PROMIS-PA items focus on the lived experiences of physiological responses to PA and short bouts of higher intensity of activity[95,96] whereas the YAP relies on quantifying the activity level through reporting the time spent being physically active during different periods of time.[108] The association of the 7-day recall PROMIS-PA scores with the YAP scores in our study was higher than the association with the average of daily steps. This was expected because wearable sensor derived step counts over a period is considered the most objective means to quantify the volume or intensity of PA[2] which is a related but dissimilar construct from the PROMIS-PA construct. The PROMIS-PA and YAP were

expected to show a higher correlation since both are 7-day recall self-reporting instruments of PA. However, the association with the average of daily steps was higher in the subsample than in the total sample possibly due to more reported occasions in the rest of the sample for taking off Fitbits for a few hours to follow sport rules when participating in soccer playing, field hockey, softball, boxing, cheerleading…etc. The average scores of EMA and EoD surveys, which are assumed to provide more accurate estimates than other self-reporting forms,[84] showed high correlations with the 7-day recall PROMIS-PA confirming the validity of this instrument.

Our exploratory analyses for the last 3 hypotheses stated in this study also supported validity of both EMA and EoD versions of PROMIS-PA. The EMA and EoD ratings generally correlated moderately to highly with daily steps based on the single-day analyses. This aligns with other study findings validating EMA or daily reporting with objective monitoring of PA.[69,84,98] The daily steps associations with the EMA were just slightly higher than those with the EoD on most days, and the EoD ratings correlated highly with the EMA ratings indicating that both versions have comparable accuracy in measuring PA. Our prior qualitative data indicated that most interviewed participants (17 out of 18 adolescents) reported preference to completing EoD surveys over multiple short EMAs throughout the day and over the 7-day recall reporting. The reasons provided were that the EoD reporting would be a more convenient option and easier for adherence than the EMA, and that there was little variation in their activity across days so one day (EoD reporting) would be an enough recall period to summarize their performed PA over the day and could be more accurate than the 7-day recall. The 7-day analyses showed that

both the EoD and the 7-day recall versions summarized the EMA reporting or the average of daily steps comparably. The compliance rates to the EoD were higher than those to EMA, and the delayed responses to EMA past the allocated time segments were observed more frequently across participants. Thus, using either EoD alone or in combination with EMA in future research or clinical practice could provide more complete information about the daily performed PA than using only EMA. All participants in this study completed their 7-day recall PROMIS-PA. These findings showed that the EoD and 7-day recall reporting are preferred over more frequent EMA in our adolescence sample.

This study has some limitations. The sample of convenience had different proportions in race categories than in the general US population which may limit generalizability. Another limitation to generalizability is that this study was conducted during COVID-19 pandemic, and 44% of participants reported doing less amount of PA now while 38% are doing more PA during the pandemic. Furthermore, due to COVID-19, compliance to EMA could have been enhanced as children could respond more be influenced to some extent by changes in the school attendance mode during the participation period for some subjects, who could not complete some EMA surveys when they switched to in-person attendance. EMA and EoD surveys were available for completion for 24 hours (not deactivated after the allocated time segment) as restricted by the platform we used, and that could induce some participants to complete them later which reduced the compliance rate. Some reported reasons for delaying responses included restrictions by parents for electronics time or limited access to when using parent's device for younger participants and being busy with schoolwork/exams.

Conclusion

The 7-day recall PROMIS-PA demonstrated convergent validity with other PA outcome measures (the YAP and accelerometry) and other reporting forms using the PROMIS-PA items (EoD recall and EMA). The validity of the three forms, the 7-day recall, EoD recall, and EMA of PROMIS-PA, is comparable. The EoD and EMA versions can be used in pediatric clinical practice or research when aiming to track lived experiences of PA on daily basis or throughout the day, respectively. More complete self-reported data about the daily performed PA can be obtained with using EoD alone or in combination with EMA than just using EMA. The 7-day recall and EoD recall PROMIS-PA may be more practical in some circumstances and enough representation of PA when compared to EMA as adolescents demonstrated higher compliance to these versions.

CHAPTER 4

VALIDITY OF PHYSICAL ACTIVITY SELF-EFFICACY

INSTRUMENTS IN YOUNGER AND OLDER

ADOLESCENTS: AN EXPLORATORY STUDY

Introduction

Physical activity (PA) declines significantly with age and particularly during adolescence[8,75] with approximately 78% of children and adolescents in the US not meeting the recommended level of PA.[9,10,109] During the transition to adolescence, an increased risk of lower levels of physical activity and greater obesity is noted with approximately 42% of adolescents in the US being classified as obese.[76,77] Evidence supports the importance of improving PA in this population given its beneficial effects on physical and mental health.[4,5] Developing effective strategies and interventions to improve PA participation requires full understanding of the relationships between PA and related behaviors or determinants which necessitates using accurate assessment and monitoring tools to measure these behaviors in youth.

Perceived self-efficacy (SE) is considered as a core determinant of health behaviors based on Bandura's social cognitive theory (SCT).[11] PA-SE refers to one's belief in his/her capabilities to perform PA to achieve certain outcomes and perceived capabilities in managing positive and negative experiences to participate in PA.[13] The PA-SE was frequently reported as a positive correlate and predictor of PA in healthy adolescents.[14-21] However, the strength and significance of this relationship varied across

different outcome measures and research studies in different age groups of adolescents. The relationship also differed by gender in middle school-age adolescents as studies supported the moderation effect of gender on the relationship in this group.[44,110] Person-reported outcome measures (PROMs) have been developed to measure different conceptual components of PA-SE based on researchers' definitions. Some of these PROMs are general and unidimensional[23,25,27] involving items indicating multiple aspects of the PA-SE construct, and some of them are specific and multi-dimensional[26,28,29] or unidimensional[30] measuring a determined type of the construct.[34] The primary SE constructs in the literature are self-regulatory and task-specific (related to skills/ability).[34] Self-regulatory PA-SE traditionally refers to an individual's beliefs about his/her ability in overcoming perceived barriers to PA. This type of SE was found to be a strong predictor of PA in adolescents.[1,21,26]

Two PA-SE PROMs were developed recently focused on the self-regulatory construct and field-tested in different age groups of adolescents. The first instrument is the Self-Efficacy to Overcome Barriers to Physical Activity Scale (SOBPAS) which consists of 24 items grouped into 5 subscales (self-efficacy to overcome internal, harassment, physical environment, social environment, and responsibilities barriers) measuring SE in adolescents aged 14-18.[26] SOBPAS accounted for 44% of variation in self-reported PA. The second PA-SE instrument, the Perceived Physical Activity Self-Efficacy Scale (P-PASES), was developed for middle school adolescents aged 11-14 and includes 11 items.[30] Psychometric properties have been established, but P-PASES did not support the SE and PA relationship which could occur due to insufficiency in the content

coverage, inaccuracy of the PA PROM used (Child and Adolescents Activity Log),[31] or changes in the relationship itself between gender groups during younger age of adolescence. Therefore, there is need for a PA-SE instrument with improved content coverage and that can be used with both younger and older adolescents to examine the change in this theoretical relationship accurately. In a prior qualitative study, we conducted semi-structured and cognitive debriefing interviews with younger and older adolescents to combine and update both SOPBAS and P-PASES items to develop a modified PROM called PA regulatory SE (PARSE).[111] The resultant instrument involved an additional part to the 'SE to overcome barriers' item pool (PARSE-OB) which is perceived 'SE with facilitators' survey (PARSE-F). The concept of including some regulatory SE items that are facilitators has been addressed, but not fully developed, in some previously developed PROMs.[25,28] The inclusion of both barriers and facilitators is also aligned with prior qualitative studies that categorize the factors influencing PA as barriers and facilitators, and by the International Classification of Functioning, Disability and Health (ICF) framework, which emphasizes addressing facilitators and barriers when examining factors affecting health behaviors.[32,39,41]

The purpose of this study was to assess the construct validity of the PARSE item pools among adolescents aged 10-20 years. As a major part of this construct validity, we examined convergent validity of the PARSE instrument (PARSE-OB and PARSE-F) with PA measures (the Patient Reported Outcome Measurement Information System pediatric measure of PA (PROMIS-PA)[95] and accelerometry tracking activity over 7 days). Since the development of the PA-SE in youth is influenced by age-related changes

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in biological, cognitive, and social aspects during adolescence,[12] we considered

examining the relationship between PARSE and PA in younger and older adolescents.

Gender differences also exist in the cognitive and psychosocial correlates of PA including

PA-SE among younger adolescents.[21] Dishman et al.[35] found a low association between

PA-SE and PA in younger female adolescents, and PA-SE had indirect relation to PA

mediated by perceived barriers (this is aligned with Bandura's theory that PA-SE can

affect PA directly or indirectly by social-cognitive factors). In our study, we also explored

the moderation effect of gender on this relationship using the PARSE instrument. We

hypothesized that:

1) as evidence on convergent validity: 1.1. the PARSE scores would be positively and

moderately correlated with the PROMIS-PA scores and *step average* (Related but unique

constructs), 1.2. correlation between the PARSE-OB and PARSE-F would be positive

and large (Similar constructs);

2) the moderation effect of gender on the relationship between the PARSE scores and PA

measurements would differ by age group: 2.1. in old adolescents, 2.1.1. the moderator

effect would not be significant (the relationship between would not differ by function of

gender), 2.1.2. with dropping the moderator, the new model would show a statistically

significant positive linear relationship, 2.2. in young adolescents, 2.2.1. there would be a

significant effect of gender on the relationship, 2.2.2. follow-up analyses would show a

statistically significant positive linear relationship in male adolescents that is stronger

than in female adolescents (PARSE would account for more variation in PA in male

adolescents than in female adolescents);

and 3) adding scores of PARSE-F to PARSE-OB would explain more variation in PA.

Methods

This is a study to evaluate the validity of a self-reported outcome measure of PA-SE, the PARSE instrument for younger and older adolescents.

Participants

We recruited a convenience sample of 84 adolescents aged 10-20 from Philadelphia and surrounding regions in Pennsylvania through personal contacts and using snowball sampling technique (Table 4.1).

Participants were included if they were aged 10 to 20 years, spoke and read English, and were typically developing, defined as no self/parent reported childhood conditions (e.g. cerebral palsy, spina bifida) that could impair their ability to perform age-appropriate movement skills or participate in PA. Exclusion criteria were having an intellectual disability that could hinder completion of the questionnaires, an injury or surgical procedure (e.g., musculoskeletal or cardiovascular) in the past six months with a persistent effect on their level of PA, or a chronic health condition restricting PA. In compliance with the study protocol approved by the Institutional Review Board of Temple University, electronic parental consents and informed child assents were obtained before participation if participants were under 18 years, and participant consents were obtained if adolescents were 18 years or older.

Table 4.1

Participant Descriptive Characteristics

Variable	Summary Statistic	
Gender, n (%)	Female 44 (52.4%) Male 40 (47.6%)	
Age groups, n (%)	Younger_10-14 y 51 (60.7%) • Female 28 (54.9%) • Male 23 (45.1%)	Older_15-20 y 33 (39.3%) • Female 16 (48.5%) • Male 17 (51.5%)
Participant Race, n (%)	White 66 (78.6%) African American 2 (2.4%) Asian 11 (13.1%) Other 5 (6%)	
Mother's race, n (%)	White 67 (79.8%) African American 2 (2.4%) Asian 11 (13.1%) Native Hawaiian and other Pacific Islander 1 (1.2%) Other 3 (3.6%)	
Father's race, n (%)	White 67 (79.8%) African American 3 (3.6%) Asian 10 (11.9%) Other 4 (4.8%)	
Age, mean± SD (range)	13.99± 2.44 (10-20)	
	Female 14.09± 2.21 (10-19) • Younger 12.75± 1.32 (10-14) • Older 16.44± 1.26 (15-19)	Male 13± 88 (10-20) • Younger 11.91± 1.24 (10-14) • Older 16.52±1.59 (15-20)
Weight, mean± SD (range)	57.98± 19.15 (23.59-120.20)	
Hight, mean± SD (range)	162.71± 13.70 (137.16-193.04)	
Abbreviations: n, number of participants; SD, standard deviation.		

Procedures and Measurements

All the survey data were collected electronically using RKStudio[TM] platform

(CareEvolution, LLC). Participants were provided with a quick start guide and assisted as

needed to download the Fitbit and MyDataHelps[TM] applications on their own or an

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available and permitted smart phone or tablet. MyDataHelps™ is the application through which participants completed all the required forms and surveys and allowed sharing their Fitbit data which were synced to the Fitbit application to be collected all through the RKStudio™.

After providing the appropriate consent, parents or 18- to 20-year-old participants completed "the general health information and sociodemographic questionnaire" that included basic information on age, gender, race, weight, height, and presence of any physical disability, chronic disease, surgery or injury in the past 6 months, or reading/thinking issues. Since this study was conducted during the COVID-19 pandemic, participants completed three short surveys upon enrollment related to changes in PA and PA-SE due to COVID-19. Participants were asked to complete PARSE within 3 days before starting activity tracking and PROMIS-PA on the 7th day of activity tracking. Participants were instructed to wear a Fitbit all day for 7 consecutive scheduled days as possible (e.g., athletes were often required to remove devices for sport participation). Each evening subjects reported whether the Fitbit was taken off during the day, and if so the time, duration, and reason for non-wear.

Pediatric PROMIS-PA

The 8-item form was used to measure PA lived experiences with items focusing on 7-day recall of physiologic responses and physical sensations to PA as well as PA performance. Each item was scored with a value ranging from 1 to 5, and the summed scores were used for the purpose of the analysis in this study. The instrument items were developed through conceptual and cognitive debriefing interviews and calibrated using

item response theory.[59,60,95] Psychometric properties have been examined with reported

test-retest reliability of 0.65 and marginal reliability of 0.91.[95,96]

Accelerometry-Based Devices

Participants were provided with a Fitbit Charge 3 or 4 for the duration of the

study and instructed to wear it on their non-dominant writs. Participants were allowed to

use their own Fitbit if it had comparable features to the Fitbit Charge. Evidence supports

using the consumer-based activity trackers for estimating free-living PA among

adolescents.[52,104,105] The daily step count data, included in our analysis, were downloaded

from RKStudio[TM] platform by linking participant's Fitbit account to his/her

MyDataHelps[TM] account. Weekly step count *(step average)* was calculated by averaging

daily steps across the total number of days that a subject wore a Fitbit. Consistent with

prior reports,[104,106,107] a minimum of 3 days of at least 8 hours of wear time per day and

with a daily step count over 1500 steps was required for data to be included in the

analysis.

Physical Activity Regulatory Self-Efficacy (PARSE)

The PARSE-OB consists of 28 items as a modified and merged version of

SOBPAS and P-PASES,[26,30] and PARSE-F consists of 24 items.[111] Both parts of this

instrument were used to measure believes in capability to be physically active with

presence of barriers or facilitators. Each item is scored on a 1-5 scale corresponding to

the response options: not at all true, not very true, sort of true, true, very true. The

summed score for each part was calculated for analysis. The content validity was

established in our prior qualitative research. Internal consistency reliability was examined

in this study, and Cronbach's alpha coefficients for PARSE-OB was 0.93 and PARSE-F was 0.90.

COVID-19 Surveys

This study took place during the COVID-19 pandemic, and given reported impact of COVID-19 on PA in the literature,[112] we included 9 questions related to PA during COVID-19. Three questions asked about changes in the amount, type, and location of PA compared to last year, before COVID-19, and six questions about the impact of COVID-19 on PA-SE. The COVID questionnaire was used primarily for information purposes and to assist with the interpretation of the results rather than as a study outcome variable.

Data Analysis

Descriptive statistics were computed to summarize participants' sociodemographic data and measurements of interest using means, range, and standard deviations for continuous variables and frequencies and percentages for categorical variables. Parametric statistical analyses were used since the data showed normal distribution. All statistical procedures were performed using SPSS software, version 27.0 (IBM Corporation), and the significance level was set at 0.05.

Convergent validity was examined, and a 2x2 analysis of variance (ANOVA) was used first to examine the differences in scores on PROMIS-PA and PARSE parts and step count by gender and age group (younger: 10-14 years versus older: 15-20 years). Convergent validity of both PARSE sections with PROMIS-PA scores and *step averages* was assessed using the Pearson product-moment correlation coefficient.

As a part of construct validity, linear regression analyses were conducted to test whether using the PARSE instrument support the theoretical SE and PA relationship with exploring the moderating effect of gender tested for each age group. The independent variable was SE scores measured by PARSE-OB or PARSE-F (in separate models first), and the dependent variable was PROMIS-PA scores or *step average*. A hierarchical multiple linear regression was used to assess the increase in variation explained by adding the interaction term between SE and gender to the main effects model. If the results of any age group showed a statistically significant increase in R^2 with the moderation effect of gender, follow-up analyses with simple regressions were used to examine the relationship between SE and PA for each gender group. If the results did not show a statistically significant interaction, a simple linear regression was used without the interaction term of gender to determine if the PARSE instrument can predict PROMIS-PA scores or daily *step average*. PARSE-F scores then was added to the PARSE-OB scores in a model to determine if there is an increase in R^2.

Results

There was a total of 84 participants. Valid daily step count data as defined above were available for n=81 subjects (n=3 were lost due to device issues). The daily step count was excluded from *step average* calculations if less than 1500 steps. This occurred for a single day for 6 participants and for 3 days for only one participant. The 2-way ANOVA revealed no significant interaction between gender and age group in PARSE, PROMIS PA Scores, or *step average* (Table 4.2). Older adolescents had significantly higher PARSE-OB and PARSE-F scores than younger ($P = 0.04$ and 0.02, respectively).

Table 4.2

Means and Standard Deviations of Self-report and Objective Measures and Mean Differences by Gender and Age Group

Outcome Measure	Group (Number of Participants)	Mean (Standard Deviation)	Mean Difference *P* Value
PROMIS-PA Score	All (n = 84)	27.70 (7.68) Range: 9-40	
	Male (n = 40) Female (n = 44)	27.03 (8.34) 28.32 (7.07)	0.36
	Older (n = 33) Younger (n = 51)	29.30 (8.21) 26.67 (7.21)	0.12
Step Average	All (n = 81)	7936.76 (2972.39) Range: 1795.71-17257	
	Male (n = 39) Female (n = 42)	8435.84 (3484.81) 7473.32 (2350.96)	0.20
	Older (n = 31) Younger (n = 50)	8763.10 (3334.13) 7424.42 (2630.37)	0.06
PARSE-OB Score*	All (n = 84)	95.24 (17.82) Range: 41-135	
	Male (n = 40) Female (n = 44)	92.48 (19.26) 97.75 (16.20)	0.23
	Older (n = 33) Younger (n = 51)	99.79 (17.35) 92.29 (17.70)	0.04
PARSE-F Score**	All (n = 84)	88.94 (13.22) Range: 61-120	
	Male (n = 40) Female (n = 44)	85.93 (11.88) 91.68 (13.91)	0.04
	Older (n = 33) Younger (n = 51)	92.94 (13.42) 86.35 (12.56)	0.02
Abbreviations: PROMIS-PA, Patient-Reported Outcome Measurement Information System for Physical Activity; PARSE-OB, Physical Activity Regulatory Self-Efficacy			

Table 4.2

Continued

to Overcome Barriers; PARSE-F, Physical Activity Regulatory Self-Efficacy with Facilitators.

* Higher scores on PARSE-OB indicate higher self-efficacy to overcome barriers to physical activity

** Higher scores on PARSE-F indicate higher self-efficacy with perceived facilitators to physical activity

Males had significantly lower PARSE-F scores than females ($P = 0.04$). PROMIS-PA scores and *step average* were not significantly different between males and females or age groups.

There was a statistically significant, moderate positive correlation between PARSE-OB scores and PROMIS-PA scores ($r = 0.35$, $P = 0.001$) and a significant low positive correlation between PARSE-OB scores and *step average* ($r = 0.23$, $P = 0.04$) (Table 4.3). Both parts of the PARSE instrument, the PARSE-OB and PARSE-F scores, demonstrated a statistically significant and strong positive correlation ($r = 0.52$, $P < 0.001$).

The results of the hierarchical multiple regression analyses assessing the relationship between SE, using PARSE-OB, gender; and PROMIS PA scores or *step average* as well as the increase in variation explained by adding the interaction term (PARSE-OB x gender) are illustrated in Table 4.4. In older adolescents, the first hierarchical regression revealed that gender was not a significant predictor of self-reported PA ($\beta = -0.13$, $P = 0.41$) and did not moderate the relationship between PARSE-

Table 4.3

Pearson's Correlations (r) Between Self-Efficacy Scores and Physical Activity as Measured by a Self-Report Instrument and Accelerometry

Self-Efficacy Measure	PROMIS-PA Scores (n = 84)	Step Count Average (n = 81)
PARSE-OB Scores	*r* = **0.35** *P* value = 0.001	*r* = **0.23** *P* value = 0.04
PARSE-F Scores	*r* = 0.18 *P* value = 0.10	*r* = 0.12 *P* value = 0.31
Abbreviations: PROMIS-PA, Patient-Reported Outcome Measurement Information System for Physical Activity; PARSE-OB, Physical Activity Regulatory Self-Efficacy to Overcome Barriers; PARSE-F, Physical Activity Regulatory Self-Efficacy with Facilitators.		

OB and PROMIS-PA scores as evidenced by an increase of 0.4% in total variation, which was not significant (F change $_{(1,29)}$ = 0.16, P = 0.69). A follow-up simple linear regression showed that PARSE-OB significantly predicted PROMIS-PA scores ($F_{(1, 31)}$ = 9.76, P=0.01) and explained 23.9% of variation. The subsequent hierarchical regression showed that PARSE-OB and gender were not significant predictors of *step average* in older adolescents. As multicollinearity was observed with gender and the interaction term in the second model of the hierarchical analysis, both variables were dropped from the regression model which also revealed non-significant prediction of PARSE-OB to *step average* in this group.

In younger adolescents, gender significantly moderated the effect of PARSE-OB scores on PROMIS-PA scores with 8.1% increase in total variation (F change $_{(1,47)}$ = 4.34, P = 0.04) (Table 4.4). Follow-up simple regression analyses in this age group

Table 4.4

Regression Analyses Testing the Relationship Between Physical Activity Regulatory Self-Efficacy in Overcoming Barriers and the Self-Reported or Objectively Measured Physical Activity

A) A hierarchical linear regression using PARSE-OB, gender, and their interaction to predict PROMIS-PA scores in older adolescents

Model and Variables	Standardized β	P Value	Model P Value	R^2	R^2 Change
Model 1			0.01	0.257	0.257**
PARSE-OB	0.49	0.00			
Gender (male)	-0.13	0.41			
Model 2			0.03	0.261	0.004
PARSE-OB	0.56	0.02			
Gender (male)	0.25	0.80			
PARSE-OB x Gender	-0.39	0.69			

B) A hierarchical linear regression using PARSE-OB, gender, and their interaction to predict *step average* in older adolescents

Model and Variables	Standardized β	P Value	Model P Value	R^2	R^2 Change
Model 1			0.77	0.019	0.019
PARSE-OB	0.01	0.98			
Gender (male)	0.14	0.47			
Model 2			0.63	0.062	0.043
PARSE-OB	0.22	0.42			
Gender (male)	1.34	0.23			
PARSE-OB x Gender	-1.25	0.28			

C) A hierarchical linear regression using PARSE-OB, gender, and their interaction to predict PROMIS-PA scores in younger adolescents

Model and Variables	Standardized β	P Value	Model P Value	R^2	R^2 Change
Model 1			0.33	0.045	0.045

Table 4.4

Continued

Model and Variables	Standardized β	*P* Value	Model *P* Value	R^2	R^2 Change
Model 1					
PARSE-OB	0.21	0.16			
Gender (male)	-0.02	0.91			
Model 2			0.09	0.126	0.081*
PARSE-OB	-0.11	0.60			
Gender (male)	-0.57	0.04			
PARSE-OB x Gender	0.52	0.04			

D) A hierarchical linear regression using PARSE-OB, gender, and their interaction to predict *step average* in younger adolescents

Model and Variables	Standardized β	*P* Value	Model *P* Value	R^2	R^2 Change
Model 1			0.01	0.191	0.191**
PARSE-OB	0.41	0.01			
Gender (male)	0.30	0.03			
Model 2			0.01	0.231	0.040
PARSE-OB	0.18	0.36			
Gender (male)	-0.78	0.28			
PARSE-OB x Gender	1.07	0.13			

Abbreviations: PROMIS-PA, Patient-Reported Outcome Measurement Information System for Physical Activity; PARSE-OB, Physical Activity Regulatory Self-Efficacy to Overcome Barriers; β, standardized beta co-efficient from regression; R^2, the coefficient of determination.
* $P < 0.05$, ** $P < 0.01$

indicated that PARSE-OB was a significant predictor of PROMIS-PA score in males (F

$_{(1, 21)}$ = 6.71, *P*=0.02) accounting for 24.3% of variation, but the relationship was not

significant in female adolescents ($F_{(1, 26)} = 0.26$, $P=0.62$) accounting for 1% of variation. When *step average* was entered as a dependent variable, PARSE-OB and gender were both significant predictors in the model ($\beta = 0.41$, $P = 0.01$ and $\beta = 0.30$, $P = 0.03$; respectively) and accounted for 19.1% of variation in *step average* in younger participants. Gender did not moderate the relationship between PARSE-OB and *step average* significantly, but multicollinearity was evident with the interaction term. Therefore, the interaction term was dropped and the prediction of PARSE-OB to *step average* was assessed in each gender group. PARSE-OB accounted for 30.6% of *step average* variation in males ($F_{(1, 26)} = 9.25$, $P=0.01$), but it was not a significant predictor in females accounting for 3.8% of variation ($F_{(1, 25)} = 0.99$, $P=0.33$).

The regression analyses results of the relationship between PARSE-F, gender, and PA measures and the addition of this part of PA-SE construct to the PARSE-OB showed non-significant results and PARSE-F explained only a small amount of increase in PA variation (Appendix E).

Discussion

This study assessed the construct validity of the PARSE-OB and PARSE-F instruments. Convergent validity of the PARSE-OB with the RPOMIS-PA and *step average* was demonstrated through correlation analyses revealing significant positive linear relationships. PARSE-OB and PARSE-F scores were highly correlated which indicates that both sections of the PARSE are measuring similar constructs. The construct validity of the PARSE-OB was further supported by proving our hypotheses regarding the significant moderation effect of gender on the relationship between the PA-SE and

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PA (measured by PROMIS-PA) in younger adolescence, as well as the significant positive linear relationship between these variables in older adolescents with no significant moderation effect of gender. Using *step average* as a measure of PA supported the validity of the PARSE-OB instrument when the relationship was tested in younger adolescents by gender. Examining the relationship between the PA-SE and PA did not support the validity of the PARSE-F instrument. Testing our last hypothesis stated in this study indicated that adding scores of the PARSE-F instrument to the PARSE-OB resulted in a very small increase in PA variation that was not significant in either younger or older adolescents.

The association of PARSE-OB scores with RPOMIS-PA scores was moderate and higher than that with the *step average*. The variation in the results between self-reported and objectively measured PA was expected. Fitbits assess body movement to measure volume of physical activity accumulated over a period which is expressed as *step average* in our study while the PROMIS-PA rely more on perceived physiological responses to body movement and reported short bouts of higher intensity activity.[2,95] Furthermore, the completed Fitbit wearing time reports showed that devices were taken off by some participants for a few hours to follow sport rules when playing soccer, field hockey, softball, boxing, cheerleading…etc., and that indicates losing some critical information about PA in our collected Fitbit data. PROMIS-PA could include some bias due to recall of PA, but both PARSE-OB and PROMIS-PA rely on the same assessment method, which is self-reporting of lived experiences, and thus although the constructs are

different, the correlation is higher than with *step average* indicating that they are

positively related.

The validity of PARSE instrument was assessed for two age groups (younger and

older adolescents). PARSE-OB was validated in our study for use with a broader age

range than in the previous studies[26,30] that established the validity of barriers PA-SE

instruments in either younger or older adolescents. In our study, PARSE-OB and

PARSE-F scores were significantly higher in older adolescents than in younger which

indicates that older adolescents have higher self-beliefs in their ability to overcome

barriers to PA and higher self-beliefs around perceived facilitators to be physically active

than younger adolescents in our sample. This may reflect the developmental changes in

occurring during this transitional period.[113] The transition from late childhood to

adolescence involves changes in the ability to use, weight, and combine the major

underlying sources of SE (as defined by Bandura: performance accomplishments,

vicarious experiences, verbal persuasion, and physiological states)[12] while experiencing

physical, cognitive, and social developmental changes.[13] For example, younger

adolescents focus on peer comparison or peer feedback as a source of confidence, and as

they mature, they become more able to use multiple sources of information (task

achievement, personal standards, parents and coaches' feedback…etc.),[114] and therefore

their self-belief may become higher by perceiving more ability to overcome barriers or

using facilitators. Younger adolescents tend to describe their capabilities in more abstract,

hierarchical, and multidimensional expressions, and with maturation, the perception of

capabilities and values becomes more stable and integrated.[115] This construct maturation

effect could account for the age group differences noted in our study.

The difference in the moderation effect of gender on PA-SE, using the PARSE-

OB instrument, and self-reported PA between the younger and older adolescents is

consistent with other studies.[26,44,110] Dwyer and colleagues[26] found that the SOBPAS

instrument's factors model measuring SE to overcome barriers in older adolescents (aged

14-18) was the same for male and female adolescents.[26] Consistent with our findings,

Chen et al.,[110] who validated an 8-item instrument that included SE with overcoming

barriers and some facilitators items, found that gender was a moderator of the relationship

in middle school adolescents but not for high school group, and the relationship was

stronger in male adolescents than in female adolescents. In these studies,[44,110] the gender

effect on the relationship is evident during younger adolescence age that is parallel to the

timing of growth spurt and biological maturity.[45] As in Chen's et al.[110] study, we found

that PARSE-OB significantly predicted self-reported PA and *step average* in younger

male adolescents but not in female adolescents. PA-SE was found to have an indirect

relation with PA mediated by perceived barriers that is inversely related to PA in middle

school female adolescents.[35] Future studies testing the SE and PA relationship using

PARSE-OB in younger adolescent females need to examine the indirect path through

other cognitive variables such as perceived barriers and perceived benefits.[46]

The study has several limitations. The sample of convenience had different

proportions in race categories than in the general US population which may limit

generalizability. Another limitation to generalizability is that this study was conducted

during COVID-19 pandemic, and 44% of participants reported doing less amount of PA now while 38% are doing more PA during the pandemic. Changes in type and location of PA due to COVID-19 that they are "not so similar" were reported by 23.8% and 28.6% participants, respectively. Our further analyses for the PA-SE to overcome barriers based on changes in PA due to COVID-19 (physical and social distancing, limited social gathering, and limited exercising locations) were significantly lower in older adolescents than in younger. The PA-SE with facilitators due to the pandemic (other alternatives such as online/recorded exercising classes or trying different types of exercise, more free time, and more time with family) did not change significantly among the gender or age groups. In our study, we relied on subjective reporting of Fitbit wearing time since the detailed minute-by-minute data could not be exported through the platform used. Future studies can benefit from additional detailed objective data in determining the exact wearing time to avoid delayed self-reporting that could happen on some days.

Conclusion

The PARSE is a detailed (52 items: 28 for SE to overcome barriers- PARSE-OB and 24 for SE with perceived facilitators- PARSE-F) self-reported measure of PA-SE designed for 10–20-year-old adolescents to assess the regulatory SE for PA. The content validity and internal consistency for both PARSE instruments were established for both younger and older adolescents. The use of PARSE-OB to assess PA-SE provides an improved understanding of the effect of SE on PA and can inform the design of more effective PA behavioral intervention strategies for younger and older adolescents. Further research is needed to examine the PARSE and PA relationships for further

validation in a larger US representative sample size, and to investigate the indirect

relationship between PARSE-F and PA in adolescents and between the PARSE-OB and

PA in middle school females by including other important socio-cognitive variables cited

in the literature (e.g., perceived barriers, perceived facilitators, social support…etc.).[35,46]

CHAPTER 5

CONCLUSION

Review of Specific Aims and Findings

The overall goal of this dissertation was to enhance validity of self-reported physical activity (PA) and physical activity self-efficacy (PA-SE) in adolescents aged 10-20 years-old, and to better understand PA-SE in this population. Both PA and PA-SE need to be assessed accurately to improve our understanding of PA and related behaviors to design more effective intervention strategies to promote PA in adolescents.

Aim 1 Summary

Aim 1 was motivated by a lack of PA-SE instrument with sufficient content coverage reflecting perspectives of both younger and older adolescents. Assessing PA-SE in adolescents is important because this behavior was frequently reported as a positive correlate and predictor of PA.[14-21] However, the strength and significance of this relationship varied across different outcome measures and research studies in different age groups of adolescents.[23,25-30] The PA-SE assessed by the Self-Efficacy to Overcome Barriers to Physical Activity Scale (SOBPAS), which measures an individual's confidence in overcoming barriers to PA through 24 items, was found to be a strong predictor of PA in older adolescents (aged 14-18 years).[26] Another existing instrument in the literature measuring self-beliefs in ability to overcome PA barriers is the Perceived Physical Activity Self-Efficacy Scale (P-PASES), but this instrument included only 11 items and did not show a significant relationship with PA when it was field tested in

younger adolescents (aged 11-14 years).[30] Both SOBPAS and P-PASES instruments that

were developed to measure the 'self-regulatory' PA-SE focus on efficacy to overcome

barriers to PA. Based on the International Classification of Functioning, Disability and

Health (ICF) framework[32] and literature review,[39-42,87-90] assessing personal and

environmental facilitators in addition to personal and environmental barriers influencing

the confidence of being physically active to inform the content coverage of a PA-SE

instrument was explored in our first study. The gap we addressed was the limited content

coverage of a PA-SE instrument that should reflect younger and older adolescents'

experiences and the focus on the 'overcoming barriers' aspect of the PA-SE construct.

In aim 1, we explored the PA-SE -related facilitators and barriers to ensure the

content validity of 2 existing PA-SE measures' items (P-PASES[26] and SOBPAS[30]

instruments) in addition to a new SE-related facilitators items for younger and older

adolescents. This was accomplished by considering literature review and semi-structured

and cognitive debriefing interviews with adolescents aged 11-17 years to address

conceptual framing and comprehensibility of items. Our results showed that the personal

facilitators and barriers influencing confidence of being physically active could be

categorized as physical, psychological, and interaction with surroundings. Similarly,

environmental facilitators and barriers were categorized as support and relationships,

attitudes, services, systems, and natural environments. Our results supported the

importance of both 'the existence of perceived facilitators' and 'overcoming barriers' as

key self-beliefs of adolescent's SE for being physically active. These findings are

consistent with previously reported instruments measuring the general PA-SE construct

that included only few SE facilitator items among other items of overcoming barriers.[28,35,110] The concept of including facilitators and barriers is aligned with the World Health Organization's guidelines in following the ICF framework which highlights the importance of assessing both facilitators and barriers of factors influencing health and health-related behaviors.[32] The facilitators influencing PA-SE in our study are consistent with a qualitative study conducted of the SOBPAS.[26] This study reported that adolescents acknowledged the importance of positive factors that help to participate in PA such as enjoyment, building relationships with friends and others, caring about physical appearance, dealing with stress…etc.[36] However, the final SOBPAS instrumented included only barriers to PA. Thus, our proposed instrument, the Physical Activity Regulatory Self-Efficacy (PARSE), extends existing measures[26,30] by including items reflecting self-efficacy around barriers and facilitators of PA.

Our cognitive debriefing process for the item pools resulted in 52 final PARSE items including items for PA-SE with facilitators (PARSE-F) and for PA-SE to overcome barriers (PARSE-OB) that were comprehensible and meaningful for younger and older adolescents. The resultant item pool for PARSE-OB (28 items) included item concepts combined from P-PASES[30] and SOBPAS[26] and was refined and cognitively tested with adolescents as young as 11 years. Our initial item pool addressing the concept of facilitators around the PA-SE, which involved 16 items relying on literature review,[23,25,28,36,39] was updated based on our interviews and resulted in 24 final items for PARSE-F. Thus, these findings supported the content validity of the PARSE instrument

for younger and older adolescents, which should be ensured before field testing and examining other aspects of validity.

Aim 2 Summary

After developing an adolescent informed measure of PA-SE, we proceeded to aim 2 which focused on convergent validity of the Patient Reported Outcome Measurement Information System pediatric measure of PA (PROMIS-PA)[95] and the response timeframe. The PROMIS-PA relied on 7-day recall of PA lived experiences, focusing on physiological responses and symptoms to PA as well as short bouts of higher-intensity PA,[95,96] and has not been examined with motion sensor data.

Reporting PA based on 7-day retrospective recall could include some bias due to dependence on retrieving some PA information from memory, and therefore people may tend to report the more recent performance and more readily recalled events because of novelty or special impact.[63,64] Using ecological momentary assessment (EMA) approach could reduce such bias because it requires respondents to report repeatedly on their experiences in real time and in real-world settings. [64,66,83]EMA has been used extensively in the literature to assess different human behaviors such as nutrition, PA, pain, affective constructs, fatigue…etc.[64-69,99] Some studies showed that using self-reporting once daily was a sufficient representation of behaviors.[68,84] Therefore, in our study we assessed PROMIS-PA completed by EMA and End of Day (EoD) reporting in addition to the standard 7-day recall used in PROMIS-PA.

For aim 2, we also examined convergent validity of the 7-day recall PROMIS-PA in adolescents by investigating the association of PROMIS-PA's scores with scores of

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another validated self-reported PA measure, the Youth Activity Profile (YAP), and the average of daily steps captured over the past 7 days using an accelerometry-based device (i.e., Fitbit device). The hypotheses for aim 2 were: 1) There would be a high positive association between the 7-day recall PROMIS-PA and YAP scores and a positive association with the average of daily steps for that week; 2) Average EMA ratings for the week (average of possible 35 EMA scores completed by each participant) would be moderately correlated with the 7-day recall PROMIS-PA scores; 3) Average of the EoD ratings for the week (average of possible 7 EoD scores completed by each participant) would be moderately correlated with the 7-day recall ratings; 4) Single EoD ratings (EoD score for each day) would be moderately to highly correlated with average EMA ratings for that day (average of possible 5 EMA scores completed by each participant for each day); 5) There would be a positive moderate association between each EoD recall-/ the average daily EMA-based PROMIS-PA ratings and the daily steps for each day; and 6) The average EoD recall- and the average EMA-based PROMIS-PA ratings for the week would show higher association than the 7-day recall PROMIS-PA ratings with the average of daily steps for that week.

Testing the Aim 2 main hypotheses 1, 2, and 3 addressed the validity of the 7-day recall PROMIS-PA; and Aim 2 hypotheses 4, 5, and 6 explored self-reporting, using EMA, EoD, and 7-day recall methods and their association with daily and weekly step counts. Our study findings supported convergent validity of the 7-day recall PROMIS-PA as demonstrated by significant positive associations of PROMIS PA scores with YAP scores and the average daily step counts over the 7 days. This association is consistent

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with previous study findings that examined the correlation between the 7-day recall PROMIS-PA and YAP in adolescents attending a community event.[96] Our analyses showed higher correlation between the 7-day recall PROMIS-PA and the YAP than between the 7-day recall PROMIS-PA and the average of daily steps. This was expected because the PROMIS-PA and YAP are both 7-day recall self-reporting instruments of PA measuring related constructs but different components. The PROMIS-PA items focus on the lived experiences of PA (reporting physiological responses to PA and performed short bouts of higher intensity of activity)[95,96] whereas the YAP relies on quantifying the activity level (reporting the time spent being physically active during different periods of time).[108] The wearable sensor derived step counts over a period is considered a more objective means to quantify the volume/intensity of free-living PA.[2] Step derived PA reflects a related but dissimilar construct from the PROMIS-PA construct. Step count is the quantity converted from recorded accelerations which are based on body motion (typically walking but limited in ability to assess activities with limited body motion such as cycling or weightlifting, and it depends on the time the sensor is worn).[45] The YAP relies on quantifying activity also, but it depends on self-reporting which could provide complementary information about activities that cannot be captured by measuring body motion. The PROMIS-PA depends more on reporting physiological symptoms which indicates perceived efforts to PA. [95,96] A previous study that examined validity of the YAP showed that correlations between YAP and wrist-worn ActiGraph data were 0.38 and 0.52 for school activity and out-of-school activity respectively.[101] These correlations are comparable to the correlations reported in our study between the PROMIS-PA and

the average of daily steps in the total sample and the subsample. The average scores of EMA and EoD surveys, through which possible recall bias is assumed to be reduced,[84] showed high correlations with the 7-day recall PROMIS-PA confirming the validity of the 7-day recall version.

Further exploratory analyses for hypotheses 4,5, and 6 supported validity of both EMA and EoD versions of PROMIS-PA. For hypotheses 4 and 5, the EoD ratings correlated highly with the EMA ratings, and the EMA and EoD ratings generally correlated moderately to highly with daily steps based on single-day analyses. The daily steps associations with the EMA were just slightly higher than those with the EoD reporting on most days. These findings indicate that both versions (the EMA and EoD) have comparable accuracy in measuring PA. This is consistent with the findings of a previous study that indicated the EoD reporting can provide a sufficient representation of behaviors as compared to the EMA.[68] The last hypothesis for aim 2 was not supported by our findings as the average EoD recall- and the average EMA-based PROMIS-PA ratings for the week did not demonstrate higher association than the 7-day recall PROMIS-PA ratings with the average of daily steps for that week. A previous study that compared the daily reporting with 7-day recall reporting in adults indicated that daily reporting had better associations with accelerometry data than the 7-day recall. However, that study used different PA self-reporting questionnaires for these reporting methods.[84] In our study we used the PROMIS-PA items for all the forms of reporting which showed comparable associations with steps, and both the EoD and the 7-day recall showed high comparable associations with the EMA version. An important factor that should be

considered is the compliance rates were higher for EoD and 7-day recall versions than for the EMA reporting. This is consistent with the findings from our semi-structured interviews conducted for aim 1 which showed adolescents expressing preference to completing EoD surveys over multiple short EMAs throughout the day. The findings from both the qualitative and quantitative studies about reporting PA support the use of EoD and 7-day recall reporting in adolescents rather than more frequent EMA reporting in studies using self-reported PA.

Aim 3 Summary

Based on the study findings for aim 1, content validity of the PARSE instrument was demonstrated for use in both younger and older adolescents. We proceeded to aim 3 which focused on further validation for the resultant PA-SE item pool from aim 1, the PARSE instrument. We proceeded to aim 3 which focused on further validation for the resultant item pool from aim 1, the PARSE instrument. According to Bandura's Social Cognitive Theory,[11] self-efficacy is a core determinant of health behaviors, and thus beliefs in oneself play a central role in changes in health behaviors. This theory has been tested in the PA literature; and a meta-analysis showed that among the variables; PA-SE, goals, outcome expectations, and socio-structural factors; PA-SE consistently predicted the amount of PA (measured by self-reporting instruments or objective motion sensors).[14] Since the PARSE instrument is intended to measure PA-SE, in this aim, we assessed convergent validity of the PARSE instrument with PA measures (the 7-day recall PROMIS-PA and accelerometry tracking activity over 7 days); and we used both PARSE sections, PARSE-OB and PARSE-F, to explore the relationship between PA-SE and PA

in younger and older adolescence. Since the development of the PA-SE in youth is influenced by age-related changes in biological, cognitive, and social aspects during adolescence,[12] we examined the relationship between PARSE and PA in younger and older adolescents. Dishman et al.[35] found that the relationship between PA-SE and PA is weak in younger female adolescents but are indirectly related. This relationship was mediated by perceived barriers which is inversely related to PA (younger female adolescents who had low PA-SE perceived more barriers resulting in lower amount of PA), and this is aligned with Bandura's theory that PA-SE can affect PA directly or indirectly by social-cognitive factors.[35] In our study, we also explored the moderation effect of gender on this relationship using our instrument.

It is important to consider the influence of developmental changes and gender differences that adolescents experience when examining PA-SE constructs. Cognitive development during late childhood to adolescence comprises a transition from concrete to abstract and mature thinking.[113] Younger adolescents experience some progress in concrete more logical reasoning, but their ability in abstract thinking or reasoning is still restricted to their past experiences.[113] This indicates that when a PA-SE instrument, addressing the concepts of overcoming barriers and perceiving facilitators, is used with younger adolescents; it is expected that these adolescents would rely more on what they have experienced in terms of facing barriers or using facilitators to evaluate their self-beliefs. Thus, younger adolescents might be limited in their ability to use and weight the underlying sources and concepts (types of perceived barriers and facilitators) of SE. During late adolescence, the abstract reasoning and hypothetical thinking mature, and

such cognitive development is important for evaluating self-beliefs, self-regulation of thoughts, and creating goals and strategies for PA.[113] That is, older adolescents are now able to use more hypothetical reasoning to capture multiple concepts and weight different sources when self-evaluating their beliefs in ability to overcome barriers or use facilitators. The ability to integrate sources of information for developing SE varies also with age during this transitional period.[13,113,114,116] Younger adolescents focus on peer comparison/feedback/acceptance as a source of self-beliefs, and as they mature, they become more able to use and integrate multiple sources of information (e.g., task achievement, personal standards, task improvement, parents' and coaches' feedback…etc.).[114] It is expected that gender differences in self-evaluation exist during younger adolescence age that is parallel to the timing of growth spurt and biological maturity.[45] After puppetry, there is a decrease in PA and self-perceptions related to sport in female adolescents.[113] Younger female adolescents experience a higher increase in the perception of importance of physical appearance (how they will be evaluated by others about how they look- social influence) than male adolescents, and they have lower satisfaction with their physical appearance (e.g., looking unathletic/ too feminine)[113] at the beginning of adolescence period associated with the pubertal changes.[116] The variation in self-perception due to changes in physical appearance depends on pubertal timing, and thus such variation disappears by late adolescence.[113] When examining validity of a PA-SE instrument, it is expected that such gender differences are reflected on the relationship between PA-SE and PA during early adolescents as female adolescents are more concerned about other factors (e.g., perception of physical

appearance and importance of social acceptance) that could influence their performance in PA.

Our study findings supported the validity of PARSE-OB. It demonstrated significant positive linear associations with the PROMIS-PA and step average over 7 days indicating that these instruments are measuring related but unique constructs. There was a significant relationship between PA-SE and PA (measured by PROMIS-PA) in older adolescents with no significant moderation effect of gender. This significant relationship is consistent with the previous study,[26] assessing validity of the SOBPAS that showed a significant relationship explaining variation in PA in high school adolescents aged 14-18 years with no difference in the factor model between male and female adolescents. Consistent with our findings, Chen et al.,[110] who validated an 8-item instrument that included SE with overcoming barriers and some facilitators items, found that among high school adolescents, the relationship between PA-SE and PA was significant and did not differ by gender. They also found that among middle school adolescents, the relationship was significantly strong in male adolescents but not in female adolescents. In the younger adolescents in our study, the PARSE-OB demonstrated significant relationship to PA only in male adolescents accounting for more variation in PA. The use of PARSE-OB to assess PA-SE provides an improved understanding of the effect of SE on PA, and it can be used to inform the design of PA behavioral interventions such as problem-solving strategies to overcome barriers influencing self-beliefs to PA for younger, especially male, and older adolescents.

Our results indicate that both the barriers and facilitators sections of the PARSE instrument measure similar constructs as evidenced by significant positive high correlation between the PARSE-OB and PARSE-F scores. However, using the PARSE-F alone did not support the relationship to PA, and when it was combined to the PARSE-OB, it resulted in a small amount of increase in the PA variation (not significant). The study by Chen et al.[110] showed significant relationship between PA-SE and PA when they examined the validity of an 8-item instrument that included concepts assessing the PA-SE in general, with overcoming barriers, and with facilitators. Thus, our findings suggest that the PARSE-OB and PARSE-F can be helpful in designing behavioral intervention programs (e.g., community programs) by using facilitators influencing PA-SE (as this importance has been highlighted through adolescents' perspectives in our qualitative study for aim 1) but with a more focus on strategies for overcoming barriers.

Limitations

This dissertation research has some limitations. The sample of convenience may limit results generalizability. Our samples showed different proportions in race categories than in the general US population. For example, in the quantitative studies, the sample involved more White and Asian race participants. The samples also involved participants from limited geographical locations and population density (Philadelphia and surrounding regions, mostly from urban regions). The interpretation of our results for aim 3 explorations was limited by having a small sample size to investigate the relationship between the PA-SE and PA in some regression models (e.g., PARSE-OB and step average in older adolescents). Thus, the PARSE instrument validity could be further

tested in a larger and more diverse sample size, involving adolescents with representative racial proportions and from several geographical locations including rural regions.

Another limitation that could influence the generalizability of this dissertation work is that the study was conducted during the COVID-19 pandemic. A recent study reported that COVID-19 restrictions impacted PA in adolescents, and the amount of PA was reduced in many adolescents (50% of 1214).[117] Participants in our study self-reported changes in the amount, type, and location of PA compared to the prior year (before the pandemic). Of the 84 adolescents in our study, 44% reported doing less amount of PA though 38% reported doing more PA than pre-COVID. In addition, the type and location of PA differed with 23.8% reported doing "not so similar" types of PA, and 28.6% reported doing PA in "not so similar" locations during the pandemic than pre-pandemic. During the 7-day participation period, some participants also experienced alterations in their school attendance mode (e.g., from virtual to in-person attendance) that could influence their PA level and PA-SE.

Although compliance rate to the EMA in our study is comparable to the rates reported in the literature for adolescents,[118] the ability to respond to surveys could have affected the completeness rates of the EMA in this study. The EMA platform relied on access to the web or application on cell phone/tablet to respond and made surveys available for 24 hours. Participants, especially younger adolescents, who switched to attend school in-person often delayed survey completion until they were dismissed from school. Younger participants may also have some restrictions to access their own/portent's electronic devices at any time to complete these surveys, and thus they

delayed their responses past allocated time segments. To assess EMA in our study, we did not include "late" surveys in our analyses. Future studies using EMA with adolescents should consider the timing, each of response on additional devices (e.g., sending surveys through wearable devices rather than cell phone or web) in addition to the timing of the surveys.

Future Directions

Our work supports the validity of the PARSE and PROMIS-PA instruments in research applications. Both instruments can be used to examine the effect of constructs in biopsychosocial models that include SE as a predictor of PA. In our validation study of the PARSE instrument, we examined only the direct effect of the 'self-regulatory' PA-SE on PA. Including a valid 'task-SE' instrument such as the Domain-Specific PA Efficacy Scale[29] in future studies may explain more variation in PA since previous research showed that both types of SE affect PA.[21] While our instrument measures SE to overcome barriers and SE with perceived facilitators, the Domain-Specific PA Efficacy Scale measures SE to engage in specific PA tasks across five domains (school, leisure time, ambulatory, household, and transportation).[29] PA-SE was found to have also an indirect relationship with PA mediated by perceived barriers in middle school females.[35] Future studies testing the SE and PA relationship using PARSE-OB in younger adolescent females need to examine the indirect path through other cognitive variables such as perceived barriers and perceived benefits.[35,46] The use of PARSE-OB alone provided an improved understanding of the direct effect of PA-SE on PA by gender in younger and older adolescents, but the use of the PARSE-F warrants further investigation

to its potential indirect effect on PA since it is highly correlated to PARSE-OB. The PARSE-F contents reflect adolescents experiences based on our qualitative interviews, and thus using PARSE-F items with the PARSE-OB can still inform the design of more effective PA behavioral intervention strategies for this population.

Our study demonstrated that the PARSE-OB is valid in younger and older adolescents. In the study examining the SOBPAS validity, which measures PA-SE to overcome barriers, the factor analysis supported the 5-factor model(internal barriers, harassment barriers, physical environment barriers, social environment barriers, and responsibilities barriers), and the structural regressions showed significant strong relationship between all the factors and PA with varied range of contribution between these factors in older adolescents.[26] In future studies, structural validity of the PARSE (with expanded content) can be examined to confirm whether potential underlying dimensions (factors) in this instrument account for variable relationships between multiple factors and PA in younger and older adolescents to inform the development of more effective behavioral interventions. In our study, the validity of each section of PARSE (the ability to 'overcome barriers' and 'use facilitators') was examined separately and then combined in a model (using two separate scores) to assess the relationship with PA. However, the dimensionality was not examined to ensure whether potential underlying domains/subdomains would factor differently providing multiple dimensions of SE or only one dimension indicating the construct of SE. Two previous studies that included some items with the concept of 'using facilitators' among other items having the concept of 'overcoming barriers' in an 8-item instrument of PA-SE supported the

unidimensionality of the construct.[110,119] A study that examined validity of a 17-item instrument that includes 7 items carrying the concept of 'using facilitators' demonstrated multidimensionality of the instrument.[28] As mentioned above, the prior SOBPAS that only included the construct of barriers also supported multidimensionality of the construct[26] indicating that 'SE to overcome barriers' or 'SE with facilitators' could demonstrate multiple subdomains. In our qualitative study, we have discussed the multidimensionality nature of PARSE-OB and PARSE-F with the potential underlying subdomains: physical; psychological; interaction with surroundings; support and relationships; attitudes; and services, systems, and natural environments. Since the importance of these subdomains to self-perception and the ability to integrate multiple concepts varies by age and gender,[113,116] testing dimensionality of the construct in future research could further our understanding about how adolescents from different age and gender groups may score differently on multiple dimensions.

Our dissertation work supports the use of PARSE in healthy adolescents, and the findings of this study can be used to inform future research adapting PARSE for further validation in adolescents with neuromotor disorders. A previous qualitative study reported that personal and environmental facilitators and barriers are key factors in determining participation in PA in adolescents with cerebral palsy.[39] The themes identified under the personal facilitators/barriers were physical ability of the child and child-related psychological factors; and the themes reported for the environmental facilitators/barriers were parental factors, opportunities for sport and physical activity, practical feasibility, social environment, and facility/program factors. These themes are

generally consistent with our conceptual framework about the factors influencing self-beliefs in PA. This indicates that PARSE was developed based on a conceptual framework that is useful for adolescents with neuromotor disorders. The concept of 'using facilitators' to support PA-SE might be as important as the concept of 'overcoming barriers' in this population because of the changes in physical abilities that these individuals experience over time which could increase their perception for the existence of facilitators. However, the items sampled to represent each subcategory in our conceptual framework might be modified to include more details that pertain to this population due to the additional support and care they receive (e.g., long-term rehabilitation, more parental attention) and limitations/restrictions that this population may perceive. Detailed items may entail the desire to move, importance of PA for symmetrical movement/ health promotion/ prevention or delay of chronic diseases or further complications related to their motor impairments, acceptance by peers, ability to participate in PA with assistive devices, accessibility to community programs/ transportations…etc.[39,42] A recent study examined the relationship between PA and PA-SE using a 10-item instrument measuring general self-confidence in performing regular PA among children and adolescents with a physical disability showed a positive strong association.[120] Another study that explored the relationship between the 'task-SE' and the time spent in moderate to vigorous PA in a small sample (n=26) of adolescents with cerebral palsy indicated positive moderate association between these variables.[121] These findings warrant further investigations about using a 'self-regulatory' PA-SE instrument

such as PARSE to inform the development of effective intervention strategies for this population.

Conclusion

The PARSE-OB and PROMIS-PA are valid for use in adolescents aged 10-20 years. The 7-day recall and EoD recall versions of PROMIS-PA provide enough representation of PA and may be more practical in some circumstances when compared to EMA as adolescents showed more preferences to these versions. The PARSE is a detailed self-reported instrument of PA-SE that can be used to examine different biopsychosocial models in the future research and to inform the design of more effective PA behavioral intervention strategies, especially for community programs interested in promoting PA in youth.

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APPENDIX A

PROMS MEASURING THE GENERAL PA-SE CONSTRUCT IN ADOLESCENTS

We reviewed the existing PROMs measuring PA-SE in adolescents and identified the underlying concept of each item as a personal or environmental facilitator or barrier as defined by the ICF model. The majority of these outcome measures focuses on the self-regulatory SE with overcoming barriers. Very few items were recognized as facilitators.

Table A.1					
Review of PROMs Measuring the General PA-SE Construct in Adolescents					
Study	Test Name	Population	Items (n)	SE Dimensions	Identified Conceptual Domains
Reynolds et al.[27]	SE (Psychosocial Predictors of PA in Adolescent)	Longitudinal data from 743, 10th grade students (14-16 years)	8	1	3 Personal/Barriers 3 Environmental/Barriers 2 PA specific
Saunders et al.[28]	Self-Efficacy scale	Children: 422, 5th grade students (10-11 years)	14	3: support seeking, barriers, positive alternatives	1 Personal/facilitator 1 Personal/Barrier 5 Environmental/facilitators 6 Environmental/Barriers 1 General
Motl et al.[25]	Self-efficacy questionnaire about physical activity	955 adolescent girls in 8th grade (13-14 years)	8	1	3 Environmental/facilitators 4 Environmental/Barriers 1 General

Study	Test Name	Population	Items (n)	SE Dimensions	Identified Conceptual Domains
				Table A.1	
				Continued	
Wu et al.[30]	Perceived Physical Activity Self-Efficacy Scale	206 adolescents (11–14 years)	11	1	6 Personal/Barriers 4 Environmental/Barriers 1 General/Barrier
Dwyer et al.[26]	Self-Efficacy to Overcome Barriers to Physical Activity Scale (SOBPAS)	484 adolescents (14-18 years)	24	5: internal barriers, harassment barriers, physical environment barriers, social environment barriers, and responsibilities barriers.	10 Personal/Barriers 14 Environmental/Barriers 3 Potential Personal/facilitator 1 Potential Environmental/facilitator
Steele et al.[23]	As a part of Self-Efficacy for Healthy Eating and Physical Activity (SE-HEPA) Items	319 students 6th, 7th, 8th graders, boys and girls (11–14 years)	(The same items as in Motl et al.[13])		
Lassetter et al.[37,38]	As a part of the Healthy Eating and Physical Activity Self-Efficacy Questionnaire for Children (HEPASEQ-C)	492 children (9-13 years)	2	A part of 1 dimension	1 Environmental/Barrier 1 PA specific

EXAMPLES FROM THE INTERVIEW GUIDE ON THE QUESTIONS ASKED

DURING THE SEMI-STRUCTURED AND COGNITIVE INTERVIEWS

Examples on the Questions Asked During the Semi-Structured

Interview Part of the Session

- Sometimes people feel that they have confidence in being able to exercise or be physically active. Can you explain what this 'confidence in exercising' means to you?

  o What other words can you use to explain it?

- what are the things that could affect/change this confidence on some days?

- Think about days when you found it easy to be active and to get enough exercise. What are some things that made it easy for you to exercise those days?

- Think about days when you found it hard to be active and to get enough exercise. What are some things that made it hard for you to exercise those days?

Examples on the Questions Asked During the Cognitive

Interview Part of the Session

- Please read the question and tell me what it means to you. (For all reviewed items)

- Explain your thoughts about how you are answering the question and why did you choose your answer? (For all reviewed items).

- How would you ask it in your own words? How would you change the word to make it easier/clearer? (For problematic words/phrases/sentences)

- Can you explain how the following sentences are similar or different in meaning…?

- Do you prefer having 4 or 5 answer options or something else? and why?

- What are the other conditions, if anything, you would like to add to these questions?

APPENDIX C

ECOLOGICAL MOMENTARY ASSESSMENT

AND END OF DAY VERSIONS OF PROMIS-PA

The PROMIS-PA Ecological Momentary Assessment Version

(4 Questions- The Early Morning Survey as an Example)

Please respond to each question by choosing one answer *

1. From about 6 to 8 am, did you exercise or play so hard that your body got tired?

• Yes • No

2. From about 6 to 8 am, did you exercise really hard for 10 minutes or more?

• Yes • No

3. From about 6 to 8 am, did you exercise so much that you breathed hard?

• Yes • No

4. From about 6 to 8 am, were you being so physically active that you sweated?

• Yes • No

The PROMIS-PA End of Day Recall Version (8 Questions)

Please respond to each question by choosing one answer *

1. Today, did you exercise or play so hard that your body got tired?

• Yes • No

2. Today, did you exercise really hard for 10 minutes or more?

• Yes • No

3. Today, did you exercise so much that you breathed hard?

• Yes • No

4. Today, were you so physically active that you sweated?

• Yes • No

5. Today, did you exercise or play so hard that your muscles burned?

• Yes • No

6. Today, did you exercise or play so hard that you felt tired?

• Yes • No

7. Today, were you physically active for 10 minutes or more?

• Yes • No

8. Today, did you run for 10 minutes or more?

• Yes • No

* The "Yes" and "No" responses were scored as 1 and 0 values, respectively, to calculate the summed score for each EAM or EoD survey

APPENDIX D

MODIFIED YOUTH ACTIVITY PROFILE (YAP)

These questions ask about your overall levels of physical activity during different periods of time. This would include structured exercise or sport activities as well as activity playing with friends, dancing or doing work/chores. Answer the questions based on your physical activity in the last 7 days

1. Activity Early Morning: How many days in the early morning (6:00-8:00 am) did you do some form of physical activity for at least 10 minutes?

a. 0 days b. 1 day c. 2 days d. 3 days e. 4 - 5 days f. 6 - 7 days

2. Activity Mid-Late Morning: How many days in the mid-late morning (8:00 am-12:00 pm) did you do some form of physical activity for at least 10 minutes?

a. 0 days b. 1 day c. 2 days d. 3 days e. 4 - 5 days f. 6 - 7 days

3. Activity Early Afternoon: How many days in the early afternoon (12:00-3:00 pm) did you do some form of physical activity for at least 10 minutes?

a. 0 days b. 1 day c. 2 days d. 3 days e. 4 - 5 days f. 6 - 7 days

4. Activity Late Afternoon: How many days in the late afternoon (between 3:00 -6:00 pm) did you do some form of physical activity for at least 10 minutes? (This can include playing with your friends/family, team practices or classes involving physical activity).

a. 0 days b. 1 day c. 2 days d. 3 days e. 4 - 5 days f. 6 - 7 days

5. Activity on Evenings: How many evenings (6:00-10:00 pm) did you do some form of physical activity for at least 10 minutes? (This can include playing with your friends/family, team practices or classes involving physical activity).

a. 0 days b. 1 day c. 2 days d. 3 days e. 4 - 5 days f. 6 - 7 days

6. Activity on Saturday: How much physical activity did you do last Saturday? (This could be for exercise, work/chores, family outings, sports, dance, or play. If you don't remember, try to estimate)

 a. No activity (0 minutes) b. Small amount of activity (1 to 30 minutes) c. Small to Moderate amount activity (31 to 60 minutes) d. Moderate to Large amount of activity (1 to 2 hours) e. Large amount of activity (more than 2 hours)

7. Activity on Sunday: How much physical activity did you do last Sunday? (This could be for exercise, work/chores, family outings, sports, dance, or play. If you don't remember, try to estimate)

 a. No activity (0 minutes) b. Small amount of activity (1 to 30 minutes) c. Small to Moderate amount activity (31 to 60 minutes) d. Moderate to Large amount of activity (1 to 2 hours) e. Large amount of activity (more than 2 hours)

APPENDIX E

THE RELATIONSHIP BETWEEN SELF-EFFICACY AND
PHYSICAL ACTIVITY USING THE PARSE-F INSTRUMENT

Results

PARSE-F and gender were not significant predictors of PA measured by PROMIS-PA or *step average* in either older or younger adolescents, and gender did not moderate any of these relationships. In older adolescents, simple regression showed that PARSE-F accounted for 0.9% of variation in PROMIS-PA scores and 0.2% of variation in *step average* ($F_{(1, 31)} = 0.27$, $P=0.61$, $F_{(1, 29)} = 0.06$, $P=0.81$; respectively). In younger adolescents, PARSE-F explained 3.6% of variation in PROMIS-PA scores and 2% of variation in *step average* ($F_{(1, 49)} = 1.81$, $P=0.19$, $F_{(1, 48)} = 0.99$, $P=0.32$; respectively).

Adding the PARSE-F variable to PARSE-OB in the hierarchical models accounted for non-significant small amount of increase in variation ranging from 0.1% to 1% in PROMIS-PA or *step average* in either younger or older participants. Since gender was evident to be a moderator of the relationship between PARSE-OB and PROMIS-PA in younger adolescents, the addition of PARSE-F to PARSE-OB was tested in males and females which indicated a non-significant increase of 1.1% and 2.4% in variation respectively.

Table E.1

Regression Analyses Testing the Relationship Between Physical Activity Regulatory Self-Efficacy with Facilitators and the Self-Reported or Objectively Measured Physical Activity and the Variation Change when PARSE-F is Added to PARSE-OB

A) A hierarchical linear regression using PARSE-F, gender, and their interaction to predict PROMIS-PA scores in older adolescents

Model and Variables	Standardized β	P Value	Model P Value	R^2	R^2 Change
Model 1			0.72	0.022	0.022
PARSE-F	0.72	0.70			
Gender (male)	-0.12	0.54			
Model 2			0.87	0.023	0.001
PARSE-F	0.12	0.68			
Gender (male)	0.15	0.91			
PARSE-F x Gender	-0.27	0.84			

B) A hierarchical linear regression using PARSE-F, gender, and their interaction to predict *step average* in older adolescents

Model and Variables	Standardized β	P Value	Model P Value	R^2	R^2 Change
Model 1			0.76	0.019	0.019
PARSE-F	0.02	0.91			
Gender (male)	0.13	0.49			
Model 2			0.86	0.027	0.007
PARSE-F	0.06	0.82			
Gender (male)	-0.74	0.59			
PARSE-F x Gender	-0.60	0.66			

C) A hierarchical linear regression using PARSE-F, gender, and their interaction to predict PROMIS-PA scores in younger adolescents

Model and Variables	Standardized β	P Value	Model P Value	R^2	R^2 Change
Model 1			0.42	0.036	0.036
PARSE-F	0.18	0.23			

Table E.1					
Continued					
Model and Variables	Standardized β	*P* Value	Model *P* Value	R^2	R^2 Change
Model 1 Gender (male)	-0.02	0.88			
Model 2			0.27	0.079	0.043
PARSE-F	0.04	0.82			
Gender (male)	-0.62	0.14			
PARSE-F x Gender	0.58	0.15			
D) A hierarchical linear regression using PARSE-F, gender, and their interaction to predict *step average* in younger adolescents					
Model and Variables	Standardized β	*P* Value	Model *P* Value	R^2	R^2 Change
Model 1			0.15	0.079	0.079
PARSE-F	0.21	0.16			
Gender (male)	0.25	0.09			
Model 2			0.24	0.087	0.008
PARSE-F	0.15	0.40			
Gender (male)	-0.41	0.71			
PARSE-F x Gender	0.66	0.54			
E) Adding PARSE-F to PARSE-OB scores in a hierarchical linear regression to predict PROMIS-PA scores in older adolescents					
Model and Variables	Standardized β	*P* Value	Model *P* Value	R^2	R^2 Change
Model 1			.01	0.239	0.239**
PARSE-OB	0.49	0.01			
Model 2			0.02	0.240	0.001
PARSE-OB	0.49	0.01			
PARSE-F	-0.02	0.89			
F) Adding PARSE-F to PARSE-OB scores in a hierarchical linear regression to predict *step average* in older adolescents					

Table E.1					
Continued					
Model and Variables	Standardized β	*P* Value	Model *P* Value	R^2	R^2 Change
Model 1			0.97	0.000	0.000
PARSE-OB	0.01	0.97			
Model 2			0.97	0.002	0.002
PARSE-OB	0.02	0.93			
PARSE-F	-0.05	0.80			
G) Adding PARSE-F to PARSE-OB scores in a hierarchical linear regression to predict PROMIS-PA scores in younger adolescents					
Model and Variables	Standardized β	*P* Value	Model *P* Value	R^2	R^2 Change
Model 1			0.13	0.045	0.045
PARSE-OB	0.21	0.13			
Model 2			0.30	0.049	0.004
PARSE-OB	0.17	0.41			
PARSE-F	0.08	0.66			
H) Adding PARSE-F to PARSE-OB scores in a hierarchical linear regression to predict *step average* in younger adolescents					
Model and Variables	Standardized β	*P* Value	Model *P* Value	R^2	R^2 Change
Model 1			0.02	0.106	0.106*
PARSE-OB	0.33	0.02			
Model 2			0.06	0.116	0.010
PARSE-OB	0.42	0.03			
PARSE-F	-0.13	0.47			
Abbreviations: PROMIS-PA, Patient-Reported Outcome Measurement Information System for Physical Activity; PARSE-OB, Physical Activity Regulatory Self-Efficacy to Overcome Barriers; PARSE-F, Physical Activity Regulatory Self-Efficacy with Facilitators; β, standardized beta co-efficient from regression; R^2, the coefficient of determination. * $P < 0.05$, ** $P < 0.01$					

Discussion

Facilitators of PA-SE (PARSE-F items) alone did not predict PA, but when used in combination with PA-SE barriers (PARSE-OB items), a slight increase in accounting for PA variation was noted over using PARSE-OB alone. This is the first study to our knowledge that investigates the effect of facilitators in SE as a separate part of the PA-SE construct. In previous studies, when a shortened version of an 8-item PA-SE instrument, consisting of 2 support seeking concepts and a facilitator concept in addition to the PA-SE barriers, PA was shown to be significantly related to PA-SE in middle and high school adolescents.[35,110] Adding PARSE-F to PARSE-OB in the regression models to predict PA in younger or older adolescents only slightly increased the variation explained. However, PARSE-F and PARSE-OB scores were highly correlated indicating the constructs of facilitators and barriers are related and serve as predictors of PA. Wu et al.[46] found that the "perceived benefits" itself did not show a significant direct path to PA, but the PA-SE to overcome barriers had a direct path to PA. Further research is needed to examine the potential effect of 'PA-SE with facilitators' through investigating the indirect path between PARSE-F scores and PA.