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Longitudinal changes in psychosocial constructs and physical activity among adults with physical disabilities

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Abstract

Background: Given the importance of physical activity (PA) and the low activity levels among adults with physical disabilities, it is important to understand how temporal changes in psychosocial constructs affect PA changes over time.

Objective/Hypothesis: Examine if changes in the transtheoretical model (TTM) constructs affected changes in PA levels over time.

Methods: One hundred thirty-two adults with physical disabilities, such as multiple sclerosis and spinal cord injuries, completed a web-based survey once every 4 months, for a total of 3 time points, to assess the TTM constructs and PA. Six latent growth curve analyses were conducted using $Mplus_5$ to examine if longitudinal changes in the TTM constructs affected temporal changes in PA levels.

Results: All six hypothesized models fit the sample data well (e.g., χ^2 = NS; $RMSEA = < .001$-.06). In a descending order of significance, the best predictors of the initial levels of PA were the stages of change, the behavioral processes of change, the cognitive processes of change, self-efficacy, and perceived pros. The meaningful predictors of PA changes over time were the initial levels and the slopes of the cognitive processes of change, perceived pros, and the behavioral processes of change. Although the slopes of the stages of change and perceived cons did not have a statistically significant effect on PA changes, their effects approached a medium size (.33 and .38, respectively).

Conclusions: In order to reassure the maintenance of an exercise program, interventionists need to first emphasize cognitive, motivational strategies (cognitive processes of change), such as the importance of PA and positive thoughts about exercise participation as well as exercise benefits (pros) before they implement behavioral strategies (behavioral processes of change), such as social support, goal setting, and self-rewarding.

Keywords: Longitudinal study; Transtheoretical model; Physical activity; Latent growth curve analysis; Physical disabilities

Physical activity participation has numerous physiological and psychological benefits for all individuals and especially for people with physical disabilities, who tend to be less active than people without disabilities [1]. Only 18% of adults with disabilities participate in physical activity of moderate or higher intensity compared with 33% of adults without disabilities [1]. One of the goals of *Healthy People 2020* is to increase physical activity participation among adults [1]. One way to achieve this goal is to rely on motivational theories of physical activity behavior change, such as the transtheoretical model (TTM) [2,3].

The TTM encompasses 4 constructs: the stages of change, the processes of change, self-efficacy, and decisional balance [4]. The stages of change reflect physical activity intention and behavior within each stage [2]. Although 5 popular stages of change have been broadly used (i.e., precontemplation, contemplation, preparation, action, and maintenance), a recent study among adults with physical disabilities validated a modified, stages-of-change scale that includes 4 well-distinguished stages of change with improved conceptual and operational definitions [2]. Specifically, people designated as ‘‘precontemplators’’ are inactive or they do not meet the recommended activity levels and they do not intend to be regularly active in the next 6 months. Although they may engage in some types of activities, they do not exercise sufficiently to reap the health benefits of exercise. Similarly, people designated as ‘‘contemplators’’ may be inactive or insufficiently active and they intend to be regularly active in the next 6 months. Although people in preparation may engage in the same activity levels as

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those in the previous 2 stages, they intend to be regularly active in the immediate future (i.e., within 1 month). Instead of using 2 poorly distinguished active stages of change (action and maintenance), the improved and validated stages-of-change algorithm uses one active stage (action) that reflects the combination of action and maintenance. Specifically, people in the action stage are regularly active and they intend to continue being regularly active in the future [2]. The reason the 2 active stages of change (action and maintenance) are not well-distinguished among both people with and without disabilities may be because the only conceptual difference between the 2 stages of change is the 6-month time frame. In other words, people in action are expected to be active for 6 months or less, whereas people in maintenance are expected to be active for more than 6 months. Therefore, regularly active people tend to place themselves in maintenance and not in the action stage [2]. In this paper, the aforementioned, improved stages-of-change scale will be used.

The processes of change represent cognitive, emotional, and behavioral strategies people use to initiate and maintain active lifestyles. Such processes of change include being aware of ways to safely engage in different types of activities, thinking of oneself as an active and healthy role model for significant others, seeking social support to better enjoy physical activity participation, and rewarding oneself for meeting activity goals. Self-efficacy reflects one's perceived confidence to overcome activity barriers and be active. Finally, decisional balance is the perceived pros (advantages) and cons (disadvantages) of physical activity participation. Based on the TTM, people will be motivated to be active if they (1) use positive strategies toward physical activity participation; (2) are confident in initiating and maintaining active lifestyles; and (3) perceive more physical activity pros than cons [4].

Few recent studies have used the TTM in relation to physical activity among adults with physical disabilities. Based on their findings, in a descending order of significance the most important predictors of physical activity tend to be the behavioral processes of change, the cognitive processes of change, and self-efficacy. Decisional balance does not tend to be an important contributor to physical activity behavior change [3]. Additionally, physical activity tends to increase across the stages of change [2]. Although the aforementioned studies contribute to our understanding of important motivational factors associated with physical activity participation for adults with physical disabilities, they are cross-sectional in nature. Longitudinal studies are required to most appropriately examine if changes in the TTM constructs affect changes in physical activity levels [2].

Based on our knowledge, the only longitudinal study that used certain TTM constructs and was applied to people with disabilities (i.e., women with fibromyalgia) was the study by Oliver and Cronan (2005) [5]. Specifically, in their study a regression analysis was used to determine if the impact of fibromyalgia and changes in self-efficacy affected physical activity changes within a 2 time assessment period among females with fibromyalgia [5]. Based on their findings, self-efficacy was the most important predictor of physical activity. However, in their study there were only 2 assessment periods and physical activity was treated as an ordinal variable (sedentary, adopters, maintainers, and quitters) with unclear procedures for group creation. Additionally, beyond fibromyalgia, only self-efficacy was used from the TTM as a longitudinal predictor.

Purpose and Research Question

To our knowledge, there are no longitudinal studies that have examined temporal changes in the TTM constructs in relation to changes in physical activity levels over time among adults with physical disabilities. Additionally, there are no studies that have used advanced statistical and methodological procedures, such as latent growth curve analyses, to examine such relations. Therefore, the purpose of this longitudinal study was to use latent growth curve analyses to determine whether changes in the TTM constructs (self-efficacy, the cognitive and behavioral processes of change, perceived pros and cons, and the stages of change) affected changes in physical activity levels across 3 assessment periods.

Methods

Design

TTM constructs and physical activity levels were measured longitudinally, every 4 months, among adults with physical disabilities, such as spinal cord injuries and multiple sclerosis, using a web-based survey. Each study participant completed the survey 3 times. The cross-sectional data of the first time period were used to validate a modified, stages-of-change scale among 271 adults with physical disabilities [2].

Before the initiation of data collection, participants were screened for the study. Qualified participants were adults (over 18 years old) with physical disabilities (mobility impairment) who had Internet access and were willing to complete survey questionnaires online. Study participants received the study's consent form via e-mail and, after checking the "I agree to participate" box, they were automatically directed to the online survey. To maximize response rates during each wave of data collection, participants received 3 prompts via e-mail to remind them to complete the survey.

Participants

The study was approved by the first 2 authors' Institutional Review Boards and informed consent was obtained from the participants. The study participants were adults with physical disabilities, and mainly people with multiple sclerosis (53.8%) and spinal cord injuries (30.3%). The National Multiple Sclerosis Society (NMSS) and the Louisiana and Georgia Chapters of the NMSS assisted with participant recruitment by distributing a study flyer to their lists of individuals with multiple sclerosis. Participants from previous studies [e.g., 6] were also recruited to participate in this study. From the 271 individuals who completed the first survey [2], 132 people participated in all 3 assessments (~48.71% retention rate).

Measures

The 13-item self-report Physical Activity Scale for Individuals with Physical Disabilities ([PASIPD] [8]) was used to assess physical activity. The scale includes 6 leisure time activities, 6 household activities, and 1 work-related activity. Number of days and average hours/day of physical activity participation at varied intensities over the past seven days are assessed within each scale item. The PASIPD has exhibited adequate construct validity in relation to the health status of adults with physical disabilities [8] and in relation to the stages of change [3,6]. A composite PASIPD score is used based on the product of average hours/day and a metabolic equivalent (MET) value relevant to activity intensity. In this study, the range of Cronbach's alpha levels over the 3 time periods was .61-.76. The scale developers reported internal consistency values ranging between .37 and .65 [8].

A 5-item, five-point Likert scale (1 = *not at all confident*; 5 = *very confident*) was used to assess self-efficacy [9]. An example item is: "I am confident I can participate in regular physical activity when it is raining or snowing." The developers of the scale [9] supported its construct validity by illustrating an increase in self-efficacy across the stages of change. In their study, the scale's internal consistency among a US sample (α = .85) and an Australian sample (α = .80) was also acceptable. This scale has also been used among adults with physical disabilities, illustrating appropriate construct validity (i.e., expected relations between the stages of change and self-efficacy) [2] and internal consistency (α = .82) [10]. The scale's internal consistency across the 3 time points in this study varied from α = .85 to α = .86.

The 10 processes of change were assessed using a 30-item 5-point Likert scale (1 = *never*; 5 = *repeatedly*) [11]. The scale's content and construct validity was supported by the scale's developers [11]. 2 composite scores of the cognitive and behavioral processes of change are used to score the scale and the developers of the scale identified an acceptable fit of the 2 higher-order model (i.e., behavioral and cognitive processes) ($\chi^2/df = 2.69$, $CFI = .88$, $AASR = .04$). This scale has also been used in different studies for adults with physical disabilities illustrating appropriate construct validity (i.e., expected relations between the stages of change and processes of change) [2]. In this study, the Cronbach's alpha coefficients of the cognitive and behavioral processes of change were acceptable with levels over the 3 assessment times ranging between .86 and .92. In Table 1, a sample item of each cognitive and behavioral process of change is reported.

Table 1
Sample scale item of the Behavioral and Cognitive Processes of Change

Process	Sample Item
Cognitive	
Consciousness raising	I read articles to learn more about physical activity.
Dramatic relief	I am afraid of the results to my health if I do not do physical activity.
Environmental reevaluation	I think that regular physical activity plays a role in reducing health care costs.
Self-reevaluation	I feel more confident when I do physical activity regularly.
Social liberation	I have noticed that many people know that physical activity is good for them.
Behavioral	
Counter conditioning	Instead of taking a nap after work I do physical activity.
Helping relationships	I have someone who encourages me to do physical activity.
Reinforcement management	One of the rewards of regular physical activity is that it improves my mood.
Self liberation	I make commitments to do physical activity.
Stimulus control	I use my calendar to schedule my physical activity time.

A 10-item (5 pros and 5 cons), 6-point Likert scale (0 = *not at all*; 5 = *very much*) was used to test decisional balance [12]. A sample perceived pro item is "physical activity would help me have a more positive outlook" and an example of a perceived con item is "getting physical activity would cost too much money." The scale developers provided support of its content validity and its 2-week test-retest reliability (r_s = .84 and .74 for the pros and cons, respectively) among adults aged 18-65 years. In their study, the scale also exhibited factorial invariance across time and concurrent validity (expected relations between self-efficacy/intention and pros/cons). This scale has also been used among adults with physical disabilities [2]. In the present study, the internal consistency of the pros sub-scale over the 3 time periods was acceptable (.83-.85), whereas the internal consistency of the cons sub-scale was low (.63-.69).

Stages of physical activity change were assessed using a recently validated algorithm for adults with physical disabilities [2]. The scale includes 4 stages of change: precontemplation, contemplation, preparation, and action. The action stage reflects a combination of action and maintenance. Physical activity intention and behavior are assessed within each stage, and, based on the recent American College of Sports Medicine (ACSM) physical activity and public health guidelines [7], a long and specific definition of physical activity with regards to its intensity, duration, and frequency is incorporated in the scale. The algorithm's activity examples are pertinent to adults with physical disabilities, including walking, wheeling, arm cranking, swimming, and dancing.

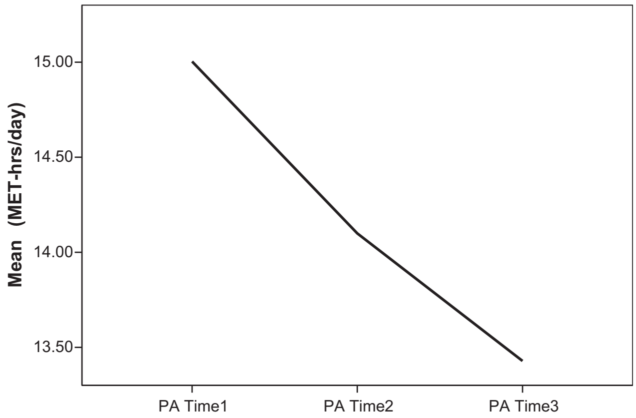

Figure 1. Physical activity changes over time.

Analyses

Descriptive statistics and pairwise correlations were used to describe participants' characteristics and identify variable relations, respectively. An independent-samples *t*-test was used to determine if there were any differences in the mean scores of physical activity over the 3 time periods stratified by the 2 major disability types in the study (i.e., multiple sclerosis and spinal cord injury). The Statistical Package for the Social Sciences (SPSS, Version 18) [13] was used to conduct the aforementioned analyses.

Six latent growth curve analyses were conducted using $Mplus_5$ [14] to examine if longitudinal changes in the TTM constructs (i.e., the stages of change, the cognitive and behavioral processes of change, self-efficacy, and perceived pros and cons) affected temporal changes in physical activity levels. Latent growth curve analysis is a powerful statistical technique that uses structural equation modeling to identify change in time. At least 3 time points are needed to be able to use this analytical technique with structural equation modeling. This technique has multiple functions and it can be used to examine how variables change across time and how changes in one variable can affect changes in another variable [15]. In Figure 1, for example, "initial self-efficacy/physical activity" reflects the intercept of those 2 variables. In other words, the intercept is the mean value of the 2 variables at the first assessment time (the mean value with which people start). The slope (e.g., slope self-efficacy) reflects how the curve changes over time (the growth trajectory). A negative slope in exercise levels reflects a decrease in physical activity across time, whereas a positive slope reflects an increase in the exercise levels.

Latent growth curve analyses have several advantages over traditional analytical techniques like repeated measures ANOVA. For example, with latent growth curve analyses a growth model is available by simultaneously examining how changes in one variable predict changes in another variable after excluding their effects at the initial levels (intercepts). Latent growth models allow for treating the same variables simultaneously as dependent and independent variables in order to examine their trajectories and effects. Additionally, individual differences in the growth curves are not treated as error; rather, they are accounted for in the growth model. Latent growth models can also provide accurate parameters for linear and nonlinear growth trajectories. As with other structural equation modeling techniques, latent growth models control for measurement error of the observed indicators, which is not assumed to be zero [16]. Extensive information about the comparisons between latent growth models and traditional analytical approaches can be found in the early papers of latent growth modeling [17].

Results

Participant profile

Participants self-reported their demographic characteristics. Most of them were women (76.5%) and well-educated (99.2% of them had at least a high-school degree and 40.2% and 24.2% of them had a college and a graduate degree, respectively). Participants self-reported a *median* income of \$60,500 ($SD = 71{,}548$; $n = 129$) and their disability levels as moderate (46.2%), mild (25.8%), and severe (23.5%). The majority of the participants had multiple sclerosis (53.8%) and spinal cord injury (30.3%). Other disability types were cerebral palsy (3.0%), post-polio (1.5%), and multiple or other neurological/physical disorders (11.3%). Most of the participants were white, European American (88.6%) followed by black, African American (6.1%), Hispanic or Latino American (3.0%), and of multiple ethnicities (2.3%).

There were no differences in demographic characteristics between the individuals who completed the survey on the first occasion (i.e., noncompleters) and those who completed the survey all 3 times. In Table 2, comparisons of the primary demographic categories of the participants and noncompleters are reported. 4 outliers were identified for only the cross-sectional data (time 1), and thus there were 128 people for all 3 times and 143 people for noncompleters.

Variable correlations and activity differences by disability type

Overall, the variable correlations over the 3 time periods were in the expected direction and of medium level (Table 3). Perceived cons did not correlate meaningfully with any other studied variable.

There were no significant differences in the mean scores of physical activity levels over the 3 time periods among people with spinal cord injuries ($M = 14.38 \pm 12.35$ MET-hr/day; $n = 40$) and multiple sclerosis ($M = 15.11 \pm 10.54$ MET-hr/day; $n = 71$) ($t(109) = -.33$, $p = .74$).

Table 2
Demographic characteristics of study participants and noncompleters

Variable	Non-completers[a] (n = 143)	All three times[a] (n = 128)	p
Gender			.17
Female	100 (50.3%)	99 (49.7%)	
Male	43 (59.7%)	29 (40.3%)	
Age	M = 48.31 years old	M = 50.30 years old	.10
Disability type			.43
Multiple Sclerosis	69 (50%)	69 (50%)	
Spinal Cord Injury	51 (56.7%)	39 (43.3%)	
Cerebral Palsy	5 (55.6%)	4 (44.4%)	
Disability Level			.79
Mild	29 (46.8%)	33 (53.2%)	
Moderate	74 (55.6%)	59 (44.4%)	
Severe	34 (53.1%)	30 (46.9%)	
Education			.67
Graduate degree	34 (52.3%)	31 (47.7%)	
College graduate	56 (51.4%)	53 (48.6%)	
Some college/no degree	34 (50%)	34 (50%)	
High school graduate	16 (64%)	9 (36%)	
Ethnicity			.88
Whites	128 (53.1%)	113 (46.9%)	
Blacks	7 (46.7%)	8 (53.3%)	
Hispanic	3 (50%)	3 (50%)	

[a] 4 outliers were identified for only the cross-sectional data (time 1), and thus they were excluded from this comparison analysis.

Changes in TTM constructs and physical activity

Figure 1 shows in a graph the linear declines of physical activity over the 3 time periods. Based on Figure 2, both self-efficacy and physical activity levels declined over time (see *means* of slopes). The initial levels of self-efficacy and changes in self-efficacy did not affect changes in the activity levels (−.06 and .00, respectively). However, the initial levels of physical activity were associated with higher beginning levels of self-efficacy (.46). As can be observed in Figure 2, this model fit the data well.

As with the 2 previous slopes, the levels of cognitive and behavioral processes of change decreased across time (see Figures 3 and 4). Positive relations were observed between the initial levels of both processes of change and physical activity (.48; .59; Figures 3 and 4), indicating that increased beginning processes of change were associated with increased activity levels in the beginning of a physical activity program. However, high levels of processes of change in the beginning of an exercise routine were related

Table 3
Correlation matrix of the mean scores of the transtheoretical model constructs and physical activity

	1	2	3	4	5	6
1. Physical activity	—	.42*	.39*	.35*	.27*	.04
2. Behavioral processes		—	.76*	.52*	.55*	−.15
3. Cognitive processes			—	.31*	.70*	−.05
4. Self-efficacy				—	.37*	−.12
5. Pros					—	.09
6. Cons						—

* $p \leq .01$.

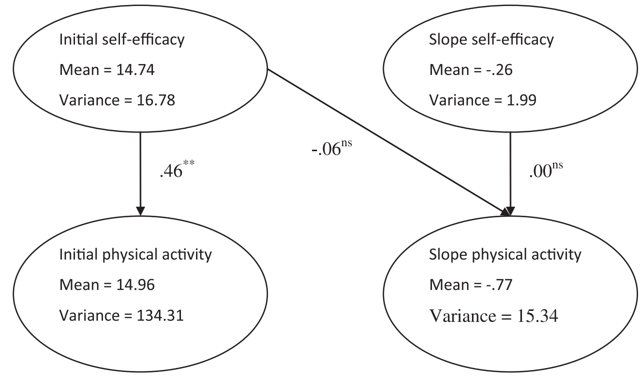

Figure 2. Self-efficacy and physical activity changes.
** p < .001, ns = not significant.
X^2 (8, N = 121) = 1.69, p = .99.
Confirmatory Fit Index (CFI) = 1.00; Root Mean Square Error of Approximation ($RMSEA$) < .01; Standardized Root Mean Square Residual ($SRMR$) = .01.

to decreased activity levels over time (−.80; −.70; see Figures 3 and 4). Positive changes in physical activity levels were linked to positive changes in the processes of change (.84; .54; see Figures 3 and 4). Changes in the cognitive processes of change had a stronger link to physical activity changes than changes in the behavioral processes of change. Although the intercept-to-slope and slope-to-slope relations in the cognitive and behavioral processes-of-change models were respectively not statistically significant, the coefficients were medium-to-large, indicating meaningful relations. Lack of statistical significance may be linked to the small sample size and the large standard errors. As with the previous model, these models exhibited a good fit to the data (see Figures 3 and 4).

Based on Figures 5 and 6, perceived pros were a significant predictor of physical activity, whereas perceived cons were not. Specifically, positive initial levels of perceived pros were associated with positive initial levels of physical activity (.43), and as perceived pros decreased physical activity levels also dropped (.88). As with the previous models, the intercept-to-slope relation was negative (−.77). Contrary to the other slopes, perceived cons (barriers) increased over

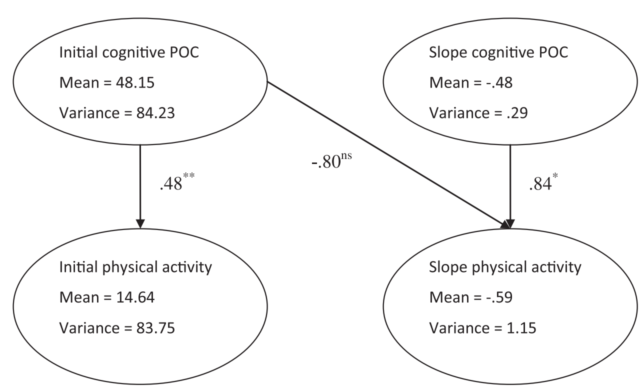

Figure 3. Cognitive processes of change and physical activity changes.
** p < .001, * p = .002, ns = not significant (p = .06).
X^2 (8, N = 120) = 9.0, p = .34; CFI = .99; $RMSEA$ = .03; $SRMR$ = .04.

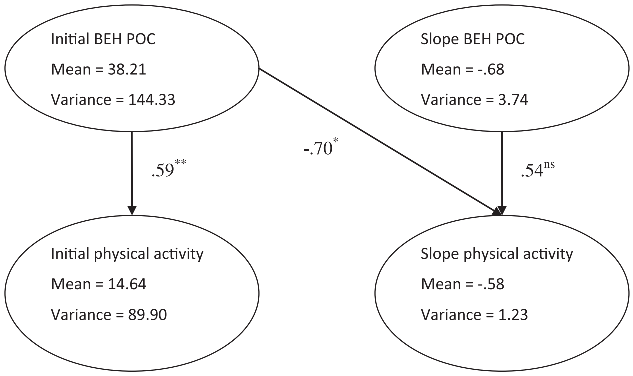

Figure 4. Behavioral processes of change and physical activity changes.
** $p < .001$, * $p = .03$, ns = not significant.
$X^2 (10, N = 120) = 5.16, p = .88; CFI = 1.00; RMSEA < .001; SRMR = .025$.

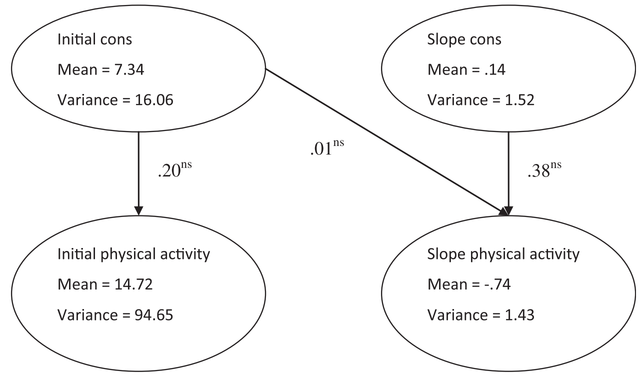

Figure 6. Perceived cons and physical activity changes.
ns = not significant.
$X^2 (8, N = 120) = 6.83, p = .55; CFI = 1.00; RMSEA < .001; SRMR = .04$.

time. Although there were no significant relations between perceived cons and physical activity, the slope-to-slope relation approached a medium effect (.38) (Figure 6). The positive relations between perceived cons and physical activity may be because individuals perceived very few cons (*mean* = 7.34 out of the maximum score of 25 per person) and there was a high variance in the cons scale. On the contrary, participants perceived more exercise pros (*mean* = 18.30) than cons. These models exhibited a good fit to the sample data (see Figures 5 and 6).

Stages of change also decreased over time (*mean* slope = −.06; Figure 7). Only the initial levels of the stages of change had a positive effect on the initial levels of physical activity (.66). However, the intercept of the stages of change did not affect the slope of physical activity (−.16) nor did changes in the stages of change affect changes in physical activity levels (.33). Similar to the previous models, this model fit the sample data well (see Figure 7).

Discussion

The purpose of this study was to examine whether longitudinal changes in the TTM constructs (self-efficacy, the cognitive and behavioral processes of change, perceived pros and cons, and the stages of change) affected temporal changes in physical activity levels among adults with physical disabilities. Based on our findings, in a descending order of significance, the most important predictors of the initial levels of physical activity were the stages of change, the behavioral processes of change, the cognitive processes of change, self-efficacy, and perceive pros. The strong relation between the stages of change and physical activity and the fact that the behavioral and cognitive processes of change have stronger links to physical activity than perceived pros were reported in previous, cross-sectional findings among adults with physical disabilities [2,3]. In this study, the stages of change along with the other variables were able to be treated simultaneously as dependent and independent variables within a cross-sectional and longitudinal setting. Therefore, these findings are unique, and comparisons between the current findings and those of previous studies, which have not used this study's advanced statistical and methodological design, are to be interpreted with caution.

The intercepts and slopes of the cognitive processes of change and perceived pros were more important to physical activity changes over time than the intercept and slope of the behavioral processes of change. This is another new and

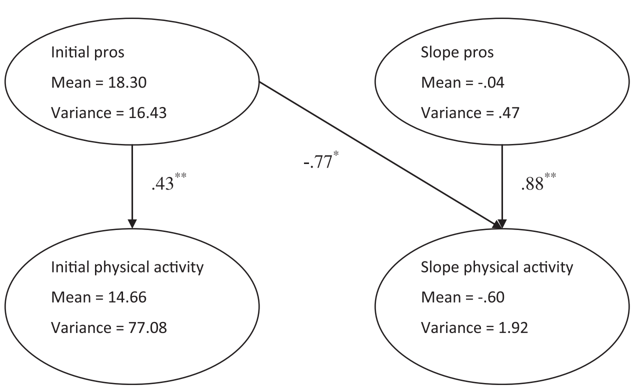

Figure 5. Perceived pros and physical activity changes.
** $p < .001$, * $p = .01$.
$X^2 (8, N = 121) = 11.35, p = .18; CFI = .99; RMSEA = .06; SRMR = .04$.

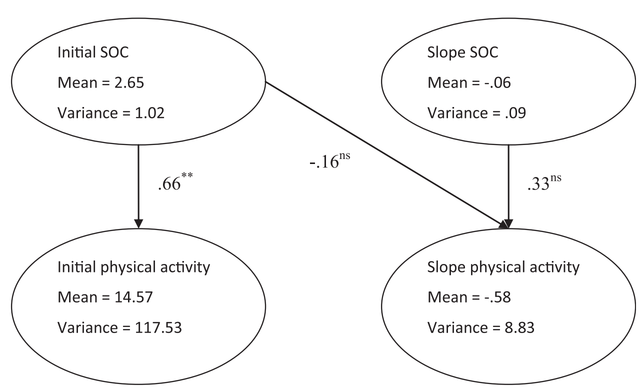

Figure 7. Stages of change and physical activity changes.
** $p < .001$, ns = not significant.
$X^2 (8, N = 121) = 4.08, p = .85; CFI = 1.00; RMSEA < .001; SRMR = .03$.

important finding, indicating that although in cross-sectional designs the behavioral processes of change tend to be crucial exercise predictors over the cognitive processes of change and perceived pros [2], temporal increases in physical activity levels are more linked to positive changes in the cognitive processes of change and perceived pros than changes in the behavioral processes of change.

None of the other 3 TTM constructs (the stages of change, self-efficacy, and perceived cons) predicted physical activity changes across time. Although the slope of the stages of change did not significantly predict the slope of physical activity, it approached a medium effect (.33). Once again, lack of statistical significance may be related to the small sample size and the high standard error between the 2 slopes. As already indicated, the intercept of the stages of change had a significant contribution to the intercept of physical activity levels. Taken together, these findings suggest that the initial levels of physical activity behavior and intention (stages of change) have stronger links to the initiation of an exercise program than to the maintenance of the program. Thus, increases in the stages of change over time may not necessarily relate to increases in a physical activity regimen. Similar to these findings, the stages of change, and especially the action and maintenance stages, did not accurately classify adults who met the physical activity guidelines across 3 time periods within a 12-month time range [18].

Although the initial levels of self-efficacy were able to predict the intercept of physical activity, changes in self-efficacy had no effect on changes in physical activity levels. Thus, while being confident toward exercise may be important to initiating an exercise program, self-efficacy may not be as important to physical activity participation over time. As identified in this study, such factors as the cognitive processes of change, perceived pros, and the behavioral processes of change tend to be more important to the maintenance of physical activity than confidence toward exercise. This finding contradicts the finding by Oliver and Cronan (2005) [5], who reported significant longitudinal effects of self-efficacy on physical activity among female adults with fibromyalgia. However, their study had several methodological limitations, such as only 2 time assessments, problematic operationalization of physical activity changes, and questionable statistical analysis (i.e., use of regression analysis to capture longitudinal changes). The importance of self-efficacy to the prediction of cross-sectional physical activity levels among adults with physical disabilities was reported elsewhere [3].

Similar to findings in cross-sectional research [3], perceived cons did not have a significant contribution to the initial and temporal levels of physical activity. As indicated above, though, the slope of perceived cons approached a medium effect on the slope of physical activity (.38). Contrary to perceived pros, participants perceived few cons, which, combined with the scale's high variance, may explain its positive relation to physical activity levels. Although the slope of physical activity dropped, perceived cons increased over time. On the contrary, all other slopes of the psychosocial predictors of physical activity decreased across time and the intercepts of those predictors had a negative effect on physical activity changes. Taken together, these findings suggest that although individuals may have positive attitudes toward the beginning of an exercise program, these positive attitudes along with exercise levels tend to decrease over time as they realize the challenges (cons) of exercise maintenance, such as increased pain, risk of injury, and fatigue, lack of transportation, accessibility, and time [2].

With regards to perceived cons, it is also important to state that the cons subscale had low internal consistency, indicating that the assessed cons may not be relevant to the studied population. The limited predictive power of the cons subscale has been reported in previous studies among adults with physical disabilities, indicating that population-based (e.g., disability-specific) decisional balance scales may be better predictors of physical activity behavior change than generalized scales [2]. Similar studies need to be conducted among adults without disabilities and other populations (e.g., older adults and youth) in order to examine if these results are generalizable.

It is important to acknowledge the current study's limitations. First, although this was a longitudinal study, cause-and-effect relations cannot be secured. True experimental designs, whereby participants are randomly assigned into a treatment and a control group, are needed to establish causal relations between psychosocial factors and physical activity behavior change. Second, physical activity was measured using a self-report scale that might not have captured the actual activity levels of the population. Although perceptions of activity levels are important to interventionists, using rater-based exercise measures may complement the information obtained by self-report measures. Third, although people with physical disabilities reflect an understudied population, the participants in this study represented the ''typical'' population observed in health promotion studies, such as Caucasian, well-educated females. Therefore, future studies need to replicate the current study among other populations, such as people with lower income levels and of diverse ethnicities.

This was the first study to examine how changes in *all* constructs of the TTM affected temporal changes in physical activity levels using an advanced statistical technique (latent growth curve analysis) among adults with physical disabilities. Based on the study findings, in a descending order of significance, the best predictors of the initial levels of physical activity were the stages of change, the behavioral processes of change, the cognitive processes of change, self-efficacy, and perceive pros. The meaningful predictors of physical activity changes over time were the initial levels and the slopes of the cognitive processes of change, perceived pros, and the behavioral processes of change. Perceived cons did not predict physical activity.

According to these findings, important implications can be identified for health promoters. Specifically, in order to reassure the maintenance of an exercise program, interventionists need to first emphasize cognitive, motivational strategies (cognitive processes of change), such as the importance of physical activity and positive thoughts about exercise participation as well as exercise benefits (pros) before they implement behavioral strategies (behavioral processes of change), such as social support, goal setting, and self-rewarding. In this way, health promoters can positively influence not only the initial levels of physical activity, but also long-term physical activity participation. Interventionists can also emphasize individuals' positive, beginning exercise experiences (self-efficacy) in order to motivate people with physical disabilities to initiate an exercise regimen. Furthermore, in the beginning of an exercise program, health promoters need to be realistic with regards to exercise challenges so that there is compatibility between a participant's initial exercise attitudes and exercise changes over time. In other words, a participant's exercise attitude should be realistic and compatible to their exercise goals; otherwise, they may be disappointed over time with regards to their exercise progress leading to both decreased activity levels and decreased positive attitudes. Finally, it is important to understand that changes in one's stages of change may not link to changes in their actual exercise levels. Therefore, interventionists should not rely only on changes in the stages of change as an indication of actual behavior change.

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