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Original Research

Application of the Transtheoretical Model to Identify Physical Activity-Related Psychological Variables in Disabled Adults

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ABSTRACT

OBJECTIVES The current study aimed at identifying the theoretical relation of the transtheoretical model (TTM) to explain physical activity in Korean adults with physical disabilities.

METHODS A total of 194 participants (Age Mean = 48.65 years) were voluntarily recruited for this study. Dissemination sources for participant recruitment included: (a) a press release issued through the authors' university; (b) recruitment flyers posted on various websites (e.g., Independent Living Centers, Rehabilitation Research and Training Centers, Veteran's Administration Hospitals); and (c) announcements made through and in conjunction with the Rehabilitation Research and Training Center on Health and Wellness consortium members. Through these procedures, 194 adults (80.83%) completed the survey form; there were 113 males (58.3%) and 81 females (41.7%). The remaining 46 (19.17%) were excluded because they did not complete the survey form or return.

RESULTS Results indicated that the TTM constructs assessed were significantly ($P < 0.001$) associated with the stages of change for physical activity. The largest portion of variance was derived from the behavioral processes of change ($\eta^2 = .40$), followed by self-efficacy ($\eta^2 = .30$), the pros for exercise ($\eta^2 = .19$), the cognitive processes of change and the cons for exercise ($\eta^2 = .16$, respectively). Moreover, four discriminant functions (i.e., composite scores of the predictors) were produced in the first DDF analysis. These accounted for 71.0% (Wilks' $\Lambda = .31$, χ^2 [56] = 368.04, $P < .001$), 20.9% (Wilks' $\Lambda = .66$, χ^2 [39] = 129.91, $P < 0.001$), 6.3% (Wilks' $\Lambda = .88$, χ^2 [24] = 39.39, $P < 0.05$), and 1.8% (Wilks' $\Lambda = .97$, χ^2 [11] = 9.04, $P = .62$), respectively, of the between-group (stage of change) variability.

CONCLUSIONS The results provide further cross-sectional support for the internal validity of the transtheoretical model, as the processes of change, self-efficacy, and decisional balance were important variables of a stage of change for physical activity, Additionally, the study is in general agreement with existing evidence among nondisabled populations and, therefore, it supports the external validation of TTM to a unique and understudied population segment.

Introduction

Many adults with physical disabilities needlessly experience hypokinetic diseases (i.e., diseases associated with disuse and inactivity), thus placing themselves at increased risk for sedentary death syndrome (SeDS). SeDS represents, "... sedentary lifestyle-mediated disorders that ultimately result in increased mortality" [1]. These disorders include angina, chronic pain, depression, heart disease, obesity, sleep apnea, stroke, and difficulty with the control of and recovery from

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various types of cancer, to name only a few. It is estimated that 70% of the U.S. population is affected by SeDS, and people with physical disabilities are among the most vulnerable [2,3].

Regular physical activity allows most people to decrease, delay, or avoid all together with their risk of experiencing hypokinetic diseases and SeDS [4]. Depending on the exercise definition used, 77– 88% of adults with physical disabilities do not exercise at a level sufficient to avoid hypokinetic diseases and SeDS [5].

Most research aimed at understanding why the majority of adults with physical disabilities do not exercise has been atheoretical, with a number of studies identifying or prioritizing study participants' self-perceived barriers to exercise involvement [6,7]. Others have written about the benefits of exercise for those with disabilities and provided "how to exercise" information [8]. However, very little is known about theoretically based and practically important behavioral strategies that might be useful for encouraging and supporting exercise initiation and/or maintenance among adults with disabilities [9,10]. This priority area is featured in *Healthy People 2010*, which for the first time in the *Healthy People* series included an entire chapter on "Disability and Secondary Conditions" [11]. Moreover, within a separate chapter on "Physical Activity and Fitness," the need for research targeting the elimination of disparities observed in physical activity is highlighted for various target groups, including people with disabilities.

Given there is little known about the factors influencing adults with physical disabilities' physical activity [12,13], and in an effort to improve this situation, exercise scientists have been encouraged to examine the exercise behavior of adults with physical disabilities using contemporary psychosocial theories [9]. One such theory is the transtheoretical model (TTM) of behavior change [14]. TTM is comprised of four main dimensions: (a) stages of change, of which, depending on the behavior, five or six are hypothesized; (b) processes of change, of which five behavioral and five cognitive processes are hypothesized; (c) self-efficacy; and (d) decisional balance [15]. Conceptually, the stages of change seek to capture the temporal, motivational, and constancy dimensions of behavior change. The processes of change are the activities, events, and strategies that help people successfully change their behavior. A person's situation-specific self-confidence in the face of barriers constitutes self-efficacy. And decisional balance suggests that a person will not adopt or maintain a regular exercise program unless her/his pros exceed her/his cons [16].

In a meta-analysis of 91 TTM studies in the exercise domain, no study was found that examined TTM's constructs among adults with physical disabilities [17]. However, subsequent to the collection and review of studies used in the meta-analysis, one study has been published that examined the stage of change dimension (only) of TTM among adults with type-2 diabetes [18]. This study found that those in the more advanced stages of exercise behavior change, relative to those in the earlier stages, reported feeling less hopelessness and emotion-based coping responses on standardized questionnaires. Given these initially promising results, and due to its success among other population segments, TTM has been identified as a potentially useful model for understanding the physical activity of adults with physical disabilities [9]. However, due to the psychosocial dynamics experienced by adults with physical disabilities, before TTM is widely adopted or applied in intervention studies aimed at this population segment, its relevance and utility must first be examined within this population segment.

In addition to TTM and its associated constructs, a need for examining other variables and constructs relative to those proposed by TTM has been identified [19]. As noted, exercise decisional balance and self-efficacy are the most often studied construct in relation to people with disabilities [20,21]. In psychology, such psychological constructs are thought to be insurmountable obstacles that reside either within the individual or the environment and which interfere with the satisfaction of a need [22].

The purpose of this study was to examine the theorized associations of TTM of behavior change constructs (behavioral and cognitive processes of change, decisional balance, and self-efficacy) by stage of change for exercise behavior among individuals with physical disabilities. The specific research question of interest was: How are behavioral, cognitive, and environmental factors (i.e., processes of change, self-efficacy, and decisional balance) differentially associated with the stage

of change for physical activity among adults with physical disabilities?

Methods

Participants

A total of 194 participants were voluntarily recruited for this study. Dissemination sources for participant recruitment included: (a) a press release issued through the authors' university; (b) recruitment flyers posted on various websites (e.g., Independent Living Centers, Rehabilitation Research and Training Centers; and (c) announcements made through and in conjunction with the Rehabilitation Research and Training Center on Health and Wellness consortium members. Such recruitment occurred over 4 months. Participants who expressed an interest in the study during this time period were added to a wait-list database. Through these procedures, 240 adults with physical disabilities consented to participate in the study. Of those, 194 adults (80.83%) completed the survey form; there were 113 males (58.3%) and 81 females (41.7%). The remaining 46 (19.17%) were excluded because they did not complete the survey form or return. All participants provided their informed consent in compliance with the approval of the Institutional Review Board and the study was carried out in accordance with the International Declaration of Helsinki guidelines.

Measures

The stage of physical activity change scale, developed by Marcus, Selby, Niaura, and Rossi [23] was translated into Korean. In this questionnaire, the stage of physical activity was assessed using the 5-item dichotomous (yes/no) scale related to regular physical activity and intentions. Individuals have been categorized into one of the five stages of physical activity change described above. In a pilot phase of the test, test-retest reliability was carried out as a measure of instrument stability and achieved.85 on the Korean scale [24].

The decisional balance scale is a 10-items questionnaire that has been developed by Plotnikoff, Blanchard, Hotz, and Rhodes [25]. The scale was revised for the Korean version in the study, and the English version was used in the Malaysia-based sample. The scale consists of two sub-scales (pros and cons with five items each). The 5-point Likert scale was used, and participants were required to respond on the basis of their preference from "not at all important" to "extremely important". Two main components of the decisional balance scale are the pros and cons, which represent the positive and negative aspects of the behavioral changes of the individual. The internal reliability of the Korean scale was reported as 0.89 for pros and 0.88 for cons [24].

Bandura [26] developed the self-efficacy scale for physical activity and was revised for the Korean and English versions of this study. The participants were asked to indicate on a 5-point Likert scale from 1 (cannot do) to 3 (moderately certain can do) through intermediate levels of assurance, then to 5 (certain can do). Individuals rated in one space under a column labeled "confidence" how confident they were that they could perform exercise routines regularly (three or more times a week) under the different circumstances. Internal reliability was 0.91 on the Korean scale [24].

The processes of change scale developed by Nigg, Norman, Rossi, and Benisovich [27], is a 30-items question, that was revised into the Korean version. Similarly, the English version was used for the Malaysian sample. By using the 5-point Likert scale, students were asked to answer from "never (1)" to "repeatedly (5)". In this study, cognitive processes and behavioral processes were influenced by second-order factors. The five components in cognitive processes are dramatic relief, consciousness-raising, environmental re-evaluation, self-re-evaluation, and social liberation, whereas the five components in behavioral are counter conditioning, helping the relationship, self-liberation, reinforcement management, and stimulus control. The internal reliabilities of the Korean version were 0.84 for cognitive processes of change and 0.87 for behavioral processes of change [24].

Statistical analysis

Descriptive statistics along with univariate *F*-tests and accompanying post *hoc* analyses were initially calculated for each TTM construct. Bivariate correlation coefficients for each major TTM construct were generated and examined for multicollinearity. Two direct discriminant function (DDF) analyses were conducted from which a classification matrix

was generated (33). The Statistical Package for the Social Sciences (SPSS version 26.0) was used for all data analysis.

Results

Descriptive statistics and univariate analyses

The majority of participants reported being in the maintenance stage of change (n = 78, 40.2%), followed by action (n = 50, 25.8%), preparation (n = 46, 23.7%), contemplation (n = 12, 6.21%), and precontemplation (n = 8, 4.10%). The means, standard deviations, F-tests, and Tukey *post hoc* contrasts for the behavioral and cognitive processes of change, self-efficacy, and decisional balance across the five stages of change are shown in <Table 1>.

All of the major constructs assessed were significantly

Table 1. Comparison of means and SDs of the TTM constructs across the stages of change.

Variable		Stage of change					F	η^2	Post hoc
		PC	CO	PR	AC	MA			
1	M	9.0	11.7	12.5	13.2	14.6	34.2**	.30	PC<CO,PR<MA; PC<AC
	SD	4.2	4.2	1.8	2.0	2.4			
2	M	7.6	9.7	10.6	9.9	10.1	19.1**	.19	PC<CO,PR,AC,MA
	SD	2.7	2.4	1.8	1.9	1.8			
3	M	6.0	5.4	4.7	5.3	4.4	11.2**	.12	PC>PR,MA; MA<CO,AC
	SD	2.2	1.6	1.7	1.8	1.4			
4	M	41.4	53.9	56.9	53.4	52.2	15.0**	.16	PC<CO,PR,AC,MA
	SD	11.2	10.7	10.1	12.3	10.5			
5	M	8.4	9.6	10.9	9.8	9.0	12.1**	.13	PC<CO,PR,AC,MA
	SD	3.0	2.8	2.2	3.0	3.1			
6	M	8.4	9.6	10.9	9.8	9.9	2.9*	.04	PC<PR
	SD	3.8	3.4	3.1	3.5	3.2			
7	M	7.4	10.3	10.3	9.4	9.0	6.6**	.08	PC<CO,PR,AC,MA
	SD	3.1	3.2	3.6	3.4	3.0			
8	M	9.0	12.9	13.6	12.6	13.2	30.4**	.28	PC<CO,PR,AC,MA
	SD	3.3	2.2	2.1	3.2	2.4			
9	M	8.4	9.7	10.0	10.1	10.2	6.5*	.08	PC<AC,MA
	SD	2.3	2.4	2.9	2.4	2.7			
10	M	36.1	44.7	49.6	55.5	57.7	52.9**	.40	PC<CO<AC,MA; PC<PR,MA
	SD	10.3	10.3	10.9	9.9	9.7			
11	M	7.5	9.4	10.7	11.3	11.3	23.9**	.23	PC<CO,PR,AC,MA; CO<AC,MA
	SD	2.7	2.6	2.6	2.5	2.9			
12	M	7.3	8.5	9.8	11.7	12.8	61.8**	.45	PC<PR<AC,MA; CO<AC,MA
	SD	2.7	2.3	2.5	2.6	2.5			
13	M	6.5	7.4	8.8	9.1	9.4	11.6**	.13	PC<PR,AC,MA; CO<MA
	SD	2.4	3.0	2.8	3.3	3.3			
14	M	8.9	11.5	12.1	13.8	13.3	35.0**	.31	PC<CO,PR,AC,MA; CO<AC,MA
	SD	3.0	2.4	2.6	2.3	2.6			
15	M	6.0	8.0	8.4	9.8	10.0	29.2**	.27	PC<CO,PR,CO,MA; CO<AC,MA
	SD	2.2	2.7	2.7	2.4	2.8			

1=self-efficacy, 2=pros, 3=cons, 4=cognitive processes, 5=conscious raising, 6=dramatic relief, 7=environmental reevaluation, 8=self-reevaluation, 9=social liberation, 10=behavioral processes, 11=contingency management, 12=counter conditioning, 13=helping relationships, 14=self liberation, 15=stimulus control
PC=precontemplation, CO=contemplation, PR=preparation, AC=action, MA=maintenance
*P < .05, **P <.001

($P < 0.001$) associated with the stages of change for physical activity. The largest portion of variance was derived from the behavioral processes of change ($\eta^2 = .40$), followed by self-efficacy ($\eta^2 = .30$), the pros for exercise ($\eta^2 = .19$), the cognitive processes of change, and the cons for exercise ($\eta^2 = .16$, respectively). The correlation matrix for this set of variables is shown in <Table 2>. Notably, all correlation coefficients were < .70, which suggests multicollinearity was not a major issue.

After adjusting alpha using the Bonferroni correction ($P < .05/10 = p < .05$), all of the individual processes of change were significantly associated with the stages of change ($p < .001$) except dramatic relief ($P > .05$). In descending order of importance, the individual processes of change accounting for the most variance were counter conditioning ($\eta^2 = .45$), self-liberation ($\eta^2 = .31$), self- reevaluation ($\eta^2 = .28$), stimulus control ($\eta^2 = .27$), contingency management ($\eta^2 = .23$), consciousness raising ($\eta^2 = .13$), helping relationships ($\eta^2 = 0.13$), environmental reevaluation and social liberation ($\eta^2 = .08$, respectively), and dramatic relief ($\eta^2 = .04$). *F*-tests and Tukey *post hoc* contrasts for each of these variables are shown in <Table 2>.

The correlation coefficients among this set of variables (not shown) ranged from .22 to .72, with all but two of the 56 possible bivariate correlations being < .70. The two bivariate correlation coefficients > .70 were between contingency management and stimulus control (r = .71), and self-liberation

Table 2. Correlation among the TTM constructs.

Variables	Self-efficacy	Pros	Cons	Cognitive processes	Behavioral processes
Self-efficacy					
Pros	.42				
Cons	-.35	-.24			
Cognitive processes	.34	.52	-.17		
Behavioral processes	.61	.48	-.29	.67	

* All correlations ≥ 0.17 are significant ($P < 0.01$).

Table 3. Discriminant function analysis for the TTM constructs

Predictor variables	Structure coefficients			
	Function 1	Function 2	Function 3	Function 4
Counter conditioning	.82*	-.09	.01	-.01
Self-efficacy	.61*	.14	-.22	-.19
Self-liberation	.59*	.30	.32	-.07
Stimulus control	.56*	.14	.07	-.18
Contingency management	.49*	.24	.10	.23
Helping relationships	.35*	.09	.00	.27
Social liberation	.25*	.19	-.04	-.03
Self-reevaluation	.48	.56*	-.29	-.01
Consciousness raising	.25	.49*	.03	.20
Environmental reevaluation	.12	.45*	-.04	-.03
Pros	.39	.42*	-.17	.26
Cons	-.32	-.07	.43*	-.18
Dramatic relief	.03	.29	.09	.47*
Canonical R	.73	.50	.31	.17
Eigenvalue	1.15	.34	.10	.03

* Signifies largest absolute correlation between each variable and any discriminant function

and self-reevaluation (r = .72).

Direct discriminant function analysis

Four discriminant functions (i.e., composite scores of the predictors) were produced in the first DDF analysis. These accounted for 71.0% (Wilks' $\Lambda = .31$, χ^2 [56] = 368.04, $P < .001$), 20.9% (Wilks' $\Lambda = .66$, χ^2 [39] = 129.91, $P < 0.001$), 6.3% (Wilks' $\Lambda = .88$, χ^2 [24] = 39.39, $P < 0.05$), and 1.8% (Wilks' $\Lambda = .97$, χ^2 [11] = 9.04, $P = .62$), respectively, of the between-group (stage of change) variability. The structure matrix for each discriminant function, along with canonical correlations and eigenvalues are shown in <Table 3>.

After adjusting for group size differences, the stage of change classification probabilities revealed maintenance (90.2%), precontemplation (73.8%), and contemplation (55.2%) were the most reliably predicted stages. The least reliably predicted stages were preparation (23.8%) and action (15.8%). The overall classification accuracy across the stages of change was 70.8% <Table 4>.

The DDF analysis was repeated. The results were generally supportive of the first DDF. Specifically, in this analysis the four discriminant functions generated accounted for 75.4% (Wilks' $\Lambda = .33$, χ^2 [52] = 341.84, $P < .001$), 18.2% (Wilks' $\Lambda = .71$, χ^2 [36] = 105.03, $P < .001$), 4.5% (Wilks' $\Lambda = .91$, χ^2 [22] = 29.25, $P = .14$), and 1.9% (Wilks' $\Lambda = .97$, χ^2 [10] = 8.83, $P = .55$), respectively, of the between-group (stage of change) variability. The eigenvalues and canonical correlations were 1.14 and .73 (first function), .28 and .46 (second function), .07 and .25 (third function), and .03 and .17 (fourth function), respectively. The order and magnitude of each structure coefficient remained the same (though, with the barriers excluded, the values varied slightly for the second through fourth functions). After adjusting for group size differences, the stage of change classification probabilities in this analysis revealed maintenance (91.3%), precontemplation (73.8%), and contemplation (48.3%) were the most reliably predicted stages. As before, the least reliably predicted stages were preparation (23.8%) and action (5.3%). The overall classification accuracy across the stages of change was 69.6%.

Discussion

The study results support the following initial observations. First, the behavioral processes of change (as both a higher order construct and as five individual constructs) along with self-efficacy improved in linear sequence from precontemplation (low) to maintenance (high) and, as hypothesized, these were the most important concomitants of the stages of change for physical activity. Counter conditioning, an individual behavioral change process strategy, was the single most important predictor of stage of change in both univariate and multivariate analyses. Second, the cognitive processes (as both a higher order construct and as five individual constructs) improved sequentially from precontemplation (low) to preparation (high), where they peaked, before descending in the action and maintenance stages (curvilinear pattern). The only exception to this was the pattern observed for social liberation, which followed a

Table 4. Classification accuracy within and cross the stage of change

Observed stage of change	Predicted stage of change					
	PC	CO	PR	AC	MA	Total
PC	73.8(45)	6.6(4)	1.6(1)	1.6(1)	16.4(10)	18.9(61)
CO	6.9(2)	55.2(16)	10.3(3)	10.3(3)	17.2(5)	9.0(29)
PR	4.8(1)	28.6(6)	23.8(5)	4.8(1)	38.1(8)	6.5(21)
AC	7.9(3)	5.3(2)	0.0(0)	15.8(6)	71.1(27)	11.8(38)
MA	5.2(9)	2.3(4)	0.0(0)	2.3(4)	98.2(156)	53,7(173)
Total	18.6(60)	9.8(32)	3.0(9)	4.7(15)	64.0(206)	70.8(322)

Cell values are reported as percentages with frequencies reported in parentheses.
Percentages may not total 100 due to rounding.
PC=precontemplation; CO=contemplation; PR=preparation; AC=action; MA=maintenance.

linear trend. Third, the cross-over point in decisional balance scores was observed in the preparation stage, which replicates a consistent finding observed in previous research (27). Fourth, those in contemplation perceived the most barriers to exercise, followed, in order, by those in action, preparation, pre- contemplation, and maintenance.

Using the 10 individual processes of change, self-efficacy, pros, cons, and exercise barriers to classify participants into their respective stage of change for exercise behavior, the most reliably predicted stages were maintenance (90.2%), precontemplation (73.8%), and contemplation (55.2%), with an overall classification accuracy of 70.8%. When this analysis was repeated without including the exercise barriers, the overall classification accuracy dropped by only 1.2%.

The bivariate correlation coefficients among predictor variables support the conceptual independence of the TTM constructs and exercise barriers. Of particular note is the 0.67 correlation observed between the behavioral and cognitive processes of change. Dating back to the initial TTM research in the area of smoking cessation where a 0.77 correlation was observed between these two constructs [28], and in the original TTM research in the exercise domain where a 0.91 correlation was observed, there has been some concern for the lack of empirical support for the conceptual distinction between these two constructs [29]. Within our sample, there was an empirically supported distinction between the higher-order behavioral and cognitive processes of change.

Relative to previous studies employing the full TTM among different population segments, and using similar multivariate statistical techniques, the stage of change for exercise behavior classification accuracy was higher in the present study (69.6% with exercise barriers excluded). In previous studies, the classification accuracy has been between 50% and 64.4% [29, 30]. The enhanced classification accuracy observed in the present study supports the relevance of TTM for this population segment. When the exercise barriers were included, there was a small increase (+1.2%) in the overall stage of change for physical activity classification accuracy (70.8%). Exercise barriers had the highest canonical correlation in the second discriminant function and therefore do appear to play an important and independent role across the hypothesized stages of change; particularly in univariate analysis and for those in the contemplation, preparation, and action stages of change. Because those in precontemplation were non-exercisers with no intention of starting an exercise program, it seems plausible that the exercise barriers queried lacked relevance for those in this stage of change.

This was a cross-sectional study, and therefore developmental trends in stage of change for exercise behavior cannot be observed. Longitudinal designs are recommended in order to examine the stability of different physical activity predictors across time. Second, actual physical activity behavior was not measured in this study. Future studies should attempt to measure both physical activity and stages of change to better establish the concurrent validity of the results. Third, the behavioral and psychological questionnaires used in the study rely on the self-report format. The results, therefore, may be subject to self-report bias, resulting in some unspecified amount of misclassification as to the participants' actual levels of physical activity.

This is the first attempt to examine stage of change for physical activity among adults with physical disabilities on the basis of the full TTM. As the behavioral and cognitive processes of change, self-efficacy, and decisional balance were important variables of stage of change for physical activity, the results offer further cross-sectional support for the internal validity of TTM. Overall, the results are in general agreement with existing evidence among nondisabled populations and, therefore, they support the external validation of TTM to a unique and understudied population segment. This suggests behavioral strategies derived from TTM (e.g., gathering information, getting social support, making a commitment, making substitutions, taking advantage of social mores, using cues) may all positively influence adults with physical disabilities' stage of change for physical activity. Moreover, and consistent with theory, these behavioral strategies appear to be differentially important across the hypothesized stages of change. It is hoped that this initial research will spawn the development of theory-based and empirically supported physical activity intervention strategies and programs directed toward adults with physical disabilities.

Conflict of Interest

The authors declare no conflict of interests

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