Validity of the Stage of Exercise Scale in Children with Rheumatologic Conditions

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ABSTRACT. Objective. To determine the face, content, and construct validity of the Stages of Exercise Scale (SOES) in children with rheumatologic conditions [juvenile idiopathic arthritis (JIA) and juvenile dermatomyositis (JDM)], and if the validity of the SOES differs by disease type by comparing it with a disease control with a chronic respiratory illness [cystic fibrosis (CF)].

Methods. Sixty-seven children and adolescents (43 female) ages 11 to 18 years with a diagnosis of either JDM (n = 15), JIA (n = 39), or CF (n = 13) completed the SOES; scales of sensibility, process of change, decisional balance, and self-efficacy; the Child Health Assessment Questionnaire; and patient/physician ratings of disease severity. Physical activity was measured by an accelerometer. Relationships among SOES and measured constructs were determined by ANOVA and with logistical modeling.

Results. SOES, decisional balance, and self-efficacy as well as behavioral and cognitive processes from the process of change demonstrated significant differences across the staging subgroups. Disease groups did not significantly differ on the scoring across the SOES. Children and adolescents in higher stages participated in more minutes of vigorous physical activity compared with those in the lower stages.

Conclusion. The SOES demonstrated good face, content, and construct validity in children and adolescents with rheumatic disease. (First Release November 1 2016; J Rheumatol 2016; 43:2189–98; doi:10.3899/jrheum.151377)

Key Indexing Terms:
PEDIATRIC RHEUMATOLOGY
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Children with rheumatic disease are often less active and less fit than their peers, and may be at a greater risk of developing secondary disease conditions such as obesity, diabetes, or heart disease[1,2]. Intervention trials to promote increased physical activity or improve physical fitness through exercise in children with arthritis often report small to no effect largely because of poor program adherence[3,4,5,6]. Tailoring interventions to match an individual's stage of readiness for physical activity may result in improved program effectiveness, adherence, and outcomes; however, these models have not been well studied in children with chronic conditions[7,8].

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The transtheoretical model of behavior change is often used to describe the process of change that one undergoes when adopting a new behavior[9]. The model describes 4 specific dimensions that relate to behavior change: stages of change, process of change, self-efficacy, and decisional balance[10]. The stages of change dimension suggests that individuals move through a series of 5 stages while adopting a new behavior (e.g., physical activity), including precontemplation, contemplation, preparation, action, and maintenance[11,12]. The 3 other dimensions of the transtheoretical model — process of change, decisional balance, and self-efficacy — are constructs that relate to movement through the stages of change[10,12]. In short, self-efficacy, defined as an individual's level of confidence in taking part in physical activity, was hypothesized to increase across the stages. The advantages (or "pros") of exercise were expected to increase while the disadvantages (or "cons") were expected to decline. To progress through the early stages, people apply cognitive processes such as becoming aware of the benefits of changing their behavior. As people move toward action and maintenance, they rely more on behavioral processes such as rewarding behavior change.

Tools to measure stage of readiness for exercise have been shown to be valid for healthy children and adults, but have not been studied in children with rheumatologic disease.

Cardinal's study established the construct validity of the Stages of Exercise Scale (SOES) in 178 healthy adult women by correlating the stage of exercise selected by the participant with their current physical activity and fitness level[13]. The SOES was able to classify individuals into the appropriate stage based on the amount of physical activity reported on a self-report questionnaire ($r = 0.83$ to 0.97, $p = 0.001$)[13]. Initial reports on the test-retest reliability in a convenience sample of 12 subjects indicated good reliability ($r_s = 1.0$, $p = 0.0001$)[13]. Validity has also been demonstrated in a sample of 235 healthy adults as well as 490 healthy fifth and sixth graders, in whom self-reported physical activity significantly differed among stages[14]. Children were categorized according to whether they self-reported as taking part in fewer than or greater than 30 min of physical activity per day[14]. Seventy-six percent of the study sample that identified themselves as being less active and 67% who identified as more active were found to be correctly classified in the early stages and action stages of the scale, respectively[14]. Initial validation work on 322 adults with physical disabilities also indicated that the transtheoretical model could correctly classify 70% of the sample in the appropriate stage of readiness for exercise[10].

The ability of the SOES to correctly classify children with rheumatic disease has not been studied. Previous validation work involving the transtheoretical model's stages of change have failed to include all of the constructs of the transtheoretical model (e.g., process of change, decisional balance, self-efficacy), thereby limiting the use of the transtheoretical model to only the stages of change[15]. In addition, the validity of readiness to exercise has largely been substantiated by self-reported physical activity, which has been shown to be unreliable in children[16,17]. Validation studies using all of the constructs of the transtheoretical model as well as an objective method for measuring physical activity are needed to further validate the SOES[15,18]. Differences in barriers and limitations to physical activity participation in children with rheumatologic diseases may also result in a need for modifications to the SOES[10,16,19].

Thus, the objective of our study was to examine the face, content, and construct validity of the SOES in determining the readiness for exercise in children with rheumatic disease. Specifically, we focused on juvenile idiopathic arthritis (JIA) and juvenile dermatomyositis (JDM). A disease control group of patients with respiratory disease [cystic fibrosis (CF)] was also included in our study to determine whether our findings were unique to one type of childhood chronic illness.

It was hypothesized that self-efficacy and pros from the decisional balance questionnaire would demonstrate a positive linear trend from precontemplation to maintenance. Cons from the decisional balance questionnaire were hypothesized to demonstrate a negative trend from precontemplation to maintenance stages. In line with the initial conceptualization of the transtheoretical model[9], we hypothesized that cognitive processes would be more important during the early stages, where scores are expected to be at their highest, with behavioral processes more important at the later stages. Scores related to the cognitive processes are expected to peak in the contemplation or preparation stage; thus, we hypothesized that cognitive processes would demonstrate a negative trend from contemplation to maintenance. However, we acknowledge for exercise that there may not be the same shift across the stages in the use of behavioral or cognitive processes[20]. Moderate to vigorous physical activity was hypothesized to increase linearly across the stages with the maintenance stage demonstrating greater participation than the precontemplation group[21]. No specific hypotheses were proposed for the relationship between sedentary or light physical activity and the stages; thus, exploratory analyses were conducted.

MATERIALS AND METHODS

Children and adolescents aged 11 to 18 years and diagnosed with JDM (n = 15), JIA (n = 39), or CF (n = 13; they served as disease controls) were recruited from The Hospital for Sick Children in Toronto, Ontario, Canada. Participants were excluded if they were unable to cooperate with the protocol as determined by their attending physician or if the child or guardian was unable to communicate in the English language. Each participant or their guardian provided written informed consent in accordance with The Hospital for Sick Children institutional research ethics board (REB#1000013841). Potential participants were approached during their scheduled clinic visit and were asked to participate in a 60-min questionnaire session. Upon questionnaire completion, participants were given, at their study visit, an Actical (Koninklijke Philips Electronics) accelerometer to wear for 7 consecutive days, along with a prepaid envelope to return the accelerometer.

Psychosocial measures. Participants were requested to complete, in a random order (out of 4 possible orderings to control for an order effect), the SOES[22], a self-efficacy scale[23], a process of change scale[24], and a decisional balance scale[23]. A debriefing questionnaire was administered upon completion of all other scales.

The SOES is a 5-item staging scale that is presented as a ladder with each rung of the ladder representing a different stage of readiness[13]. Respondents were asked to circle the rung with the description of exercise behavior that was most representative of them. The scale defined regular exercise as exercise taking part on the equivalent of 3 or more days per week of 20 min or more each day (e.g., swimming or walking). A score of 0 to 4 was given and was used to place the respondent in the appropriate classification with 0 = precontemplation ("I presently do not exercise and do not plan to start exercising in the next six months"), 1 = contemplation ("I presently do not exercise, but have been thinking about starting exercising in the next six months"), 2 = preparation ("I presently get some exercise, but not regularly"), 3 = action ("I presently exercise on a regular basis, but I have only begun to do so in the last six months"), and 4 = maintenance ("I presently exercise and have been doing so for longer than six months")[13].

Self-efficacy was measured using a modified scale that asked respondents to rate how confident they felt about participating in different physical activities. The scale contains 5 items that are scored on a 5-point ordinal scale from 1 = "not confident at all" to 5 = "extremely confident". The scale has demonstrated good internal consistency (Cronbach's alpha = 0.82) and reliability ($r = 0.90$) in a population of 917 adults[11].

The processes of change scale was used to determine the relative contribution of behavioral or cognitive processes related to participating in physical activity[23]. Nigg and Courneya reported significant differences [$F_{(4,810)} = 7.72$, $p < 0.05$] in the processes used across the 5 stages of change in a sample of 814 students in grades 9 to 12[23]. Small to large effect sizes were also reported for each of the processes ($\omega 2 = 0.07–0.25$)[23]. The scale contains 40 items that are deemed either cognitive or behavioral in design and rated on a 5-point ordinal scale (with 1 = "never" and 5 = "frequently"). Scores were obtained for each of the 10 processes by averaging their respective items. Cognitive and behavioral scores were derived by summing their related processes and dividing by 20.

Perceived pros and cons of participating in exercise were determined by the decisional balance questionnaire[25]. The decisional balance questionnaire contains 16 items (10 pros, 6 cons) related to the perceived advantages and disadvantages of changing behavior and are rated on a 5-point ordinal scale. Validity of the decisional balance questionnaire has been previously demonstrated in a population of 814 adolescents with pros increasing and cons decreasing in the hypothesized direction across the stages of change: $F_{(4,814)} = 26.59$, $p < 0.0038$ and $F_{(4,814)} = 4.45$, $p = 0.0038$, respectively[23]. The mean scores for the pro and con items were calculated.

Physical function and disease activity. The Child Health Assessment Questionnaire (CHAQ) was administered to determine subjective physical function[26]. The CHAQ is a well-validated, self-report questionnaire that provides a summary score based on 8 functional activity domains and is rated on a scale in which 0 indicates no limitations and 3 indicates severe limitations[26]. In addition, the severity of illness, pain severity, and the overall well-being of the participant over the past week were also measured using self-reported, 10-cm, double-anchored visual analog scales (VAS)[27].

Disease severity and disease activity were determined by an attending physician as well as the participant using double-anchored, 10-cm VAS. Scores were calculated by measuring to the center point of the rating made by the participant or physician, and a continuous score between 0 and 10 was given.

Face validity. A debriefing questionnaire was developed to assess the acceptability, understandability, comprehensiveness, time burden, and ease of completing the SOES questionnaire. The scale contained 7 items; each item was rated using a 7-point Likert scale anchored by strongly disagree and strongly agree.

Physical activity level. Each participant received an Actical accelerometer to wear on their right hip over a 7-day period during waking hours except for when they were swimming or bathing. Accelerometry has been proven to be a valid and reliable measure of physical activity for adults and children[28,29,30].

Sample size. The sample size for our study was calculated based on the number of rheumatologic patients needed while conducting a 1-way ANOVA with planned comparisons of the means (contrast) of accelerometry counts (amount of physical activity) between respondents at each of the 5 levels of stages of change. A total sample of 35 subjects achieves 83% power to detect a non-zero contrast of the means versus the alternative that the contrast is zero using an F test with a 0.05 significance level. The common SD within a group was assumed to be 35 counts[31,32]. Based on a 10% dropout rate, an additional 4 subjects were needed; a total sample size of 39 subjects was calculated.

Statistical analysis. Descriptive statistics including mean, SD, and ranges were used to describe demographic variables. A 1-way ANOVA was used to test for differences in scores of the constructs of the transtheoretical model (self-efficacy, pros, cons, processes) and time spent in sedentary, light, moderate, moderate and vigorous physical activity (MVPA), and vigorous physical activity based on accelerometer counts across the identified stage groups. Differences in construct scores across the stages of exercise between the rheumatological and control groups were determined in the model by testing for an interaction between disease group and SOES. When the interaction effect was not significant (indicating no difference between disease groups) the interaction was taken out of the model and further models were tested using only data from the rheumatological groups. Differences in time spent in the varying physical activity intensities between the 3 disease groups (CF, JDM, JIA) were also analyzed with ANOVA. Tukey adjustments were used posthoc to analyze the differences in physical activity levels between disease groups when a significant F test was present. To account for the influence of age on physical activity level, a test of the relationship between SOES, age, and MVPA was conducted using an ordinal logistic regression model in which age, MVPA, and the interaction between age and MVPA were included as independent variables and SOES was the dependent variable. A significant log likelihood ratio test was used to indicate an association between age or age and MVPA with SOES.

Data handling. Questionnaire items along with their calculated scores were entered and stored in a Filemaker database for each participant. Data from the accelerometers were downloaded and analyzed using Kinesoft (Kinesoft Software Inc.). All data were imported into SAS 9.3 (SAS Inc.) for further analysis. The amount of time and intensity spent in different physical activities was determined from disease-specific cutpoints developed in children with chronic diseases and established for the Actical accelerometer[33,34]. Sixty min of consecutive zeros was used as the criterion for non-wear time[35]. A valid day was defined as a minimum of 8 h of wear time, and 3 valid days were required to be included in our analysis[35]. Three days of monitoring and a minimum of 6 to 10 h of wear time per day are necessary to derive accurate and valid physical activity profiles[35,36].

Content, feasibility, and face validity. Content validity has been defined as "the degree to which an instrument is an adequate reflection of the construct to be measured" and face validity as "the degree to which an instrument looks as though it is an adequate reflection of the construct to be measured"[37]. Content and face validity were determined using a 7-question debriefing scale developed by the investigators. The scale evaluated face validity with 4 items, content validity with 2 items, and feasibility with 1 item. An average score of 5 or above was set *a priori* to represent attainment of good face and content validity. Content and face validity were calculated separately for each disease group included in our study (e.g., JDM, JIA, and CF).

Construct validity has been defined by the COnsensus-based Standards for the selection of health Measurement INstruments panel "as the degree to which scores of a measurement instrument are consistent with hypotheses [...] based on the assumption that the instrument validity measures the construct to be measured"[37]. Construct validity of the SOES was determined by the differences in scores from the self-efficacy, processes of change, and decisional balance questionnaires, and physical activity levels between stage of change groups identified by the SOES using a 1-way ANOVA.

To determine whether the scores across the stage were dependent on disease type, the combined scores from the rheumatologic conditions were compared to scores from the disease control group, with the addition of an interaction term between SOES and disease type in the statistical model. An analysis for linear trend was also conducted for significant F tests, and posthoc analyses using Tukey adjustment were conducted to elucidate the differences among the SOES categories as well as between disease groups when a significant interaction term was present.

RESULTS

Descriptive statistics including subject characteristics and results for questionnaires by stage of readiness are presented in Tables 1A, 1B, and 1C. Sixty-seven participants (54 with a rheumatological condition and 13 disease controls) consented to take part in this study. Questionnaire data were complete for 65 participants; 2 did not complete the SOES scale and were excluded from the analysis, 2 participants (1 CF and 1 JDM) did not provide accelerometer data, 1 other participant did not return their accelerometer, 11 participants were missing physician's rated disease activity, and 5 participants did not rate their disease severity. An average of 5 valid days of physical activity data was available for the entire sample with 58 out of the 64 participants with accelerometer data (91%) achieving 3 or more valid days. For the purposes

Table 1A. Subject characteristics for the contemplation and preparation stages. Values are mean (SD) unless otherwise specified.

Items	Contemplation				Preparation			
	JIA, n = 1	JDM, n = 0	CF, n = 1	Total, n = 2	JIA, n = 14	JDM, n = 8	CF, n = 4	Total, n = 26
Age, yrs	14	—	14	14 (0)	15 (1.7)	15.8 (1.2)	12 (1.0)	14.8 (1.9)
Sex, n								
Male	0	—	1	1	3	3	4	10
Female	1	—	0	1	11	5	0	16
Medical status								
Disease severity, out of 100	0	—	16	8.5 (10.6)	19 (18)	24 (28)	22 (24)	20 (22)
CHAQ, out of 10	0	—	0	0 (0)	0.26 (0.43)	0.1 (0.1)	0.1 (0.1)	0.2 (0.35)
CHAQ illness VAS	0	—	0	0 (0)	1.4 (1.2)	1.2 (2.1)	1.9 (1.9)	1.4 (1.6)
CHAQ pain VAS	0.8	—	0	0.38 (0.53)	1.2 (1.1)	2.0 (2.9)	1.5 (2.9)	1.5 (2.0)
CHAQ QOL VAS	1.2	—	0	0.6 (0.85)	1.2 (1.5)	1.2 (1.6)	0.9 (1.8)	2.4 (2.3)
Psychosocial								
Self-efficacy	3.0	—	2.6	2.8 (0.3)	2.8 (0.6)	2.8 (0.5)	2.6 (0.7)	2.7 (0.6)
Decisional balance, pros	3.4	—	4.1	3.8 (0.5)	3.7 (0.9)	3.3 (0.3)	2.3 (0.8)	3.4 (0.9)
Decisional balance, cons	2.3	—	3.0	2.7 (0.5)	2.8 (1.0)	2.7 (0.8)	2.3 (0.8)	2.7 (0.9)
Process of change, behavioral	3.0	—	2.3	2.7 (0.5)	2.9 (0.7)	2.7 (0.5)	2.1 (0.3)	2.7 (0.6)
Process of change, cognitive	3.1	—	2.8	3.0 (0.2)	2.9 (0.6)	2.9 (0.6)	2.1 (0.6)	2.8 (0.7)
Physical activity, mins								
Sedentary	543	—	—	543	475 (73)	545 (79)	438 (104)	492 (85)
Light	158	—	—	158	158 (36)	157 (46)	257 (25)	174 (52)
Moderate	38	—	—	38	18 (17)	18 (14)	25 (3)	20 (15)
Vigorous	12	—	—	12	6 (6)	5 (5)	14 (5)	7 (6)
MVPA	56	—	—	56	26 (24)	25 (19)	42 (7)	29 (21)

JIA: juvenile idiopathic arthritis; JDM: juvenile dermatomyositis; CF: cystic fibrosis; CHAQ: Childhood Health Assessment Questionnaire; VAS: visual analog scale; QOL: quality of life; pros: advantages; cons: disadvantages; MVPA: moderate and vigorous physical activity.

Table 1B. Subject characteristics for the action and maintenance stages. Values are mean (SD) unless otherwise specified.

Items	Action				Maintenance			
	JIA, n = 4	JDM, n = 0	CF, n = 3	Total, n = 7	JIA, n = 20	JDM, n = 6	CF, n = 4	Total, n = 30
Age, yrs	14.7 (1.7)	—	16 (1.7)	15.3 (1.7)	13.8 (2.2)	14.7 (2.7)	15 (1.3)	14.2 (2.2)
Sex, n								
Male	2	—	2	4	4	2	2	8
Female	2	—	1	3	16	4	2	22
Medical status								
Disease severity, out of 100	21 (34)	—	29 (2.8)	45 (34)	26 (26)	16 (20)	5.8 (6.0)	14 (17)
CHAQ, out of 10	0.28 (0.56)	—	—	0.16 (0.43)	0.21 (0.27)	0.1 (0.1)	—	0.16 (0.24)
CHAQ illness VAS	1.0 (1.5)	—	3.4 (0.4)	2.0 (1.7)	2.1 (2.7)	0.2 (0.4)	0.2 (0.2)	1.5 (2.4)
CHAQ pain VAS	0.7 (0.8)	—	1.4 (1.3)	0.98 (1.0)	2.3 (2.9)	0.1 (0.2)	0.2 (0.2)	1.6 (2.5)
CHAQ QOL VAS	1.1 (2.0)	—	4.2 (1.3)	2.4 (2.3)	1.6 (2.5)	0.2 (0.4)	0.2 (0.2)	1.3 (2.1)
Psychosocial								
Self-efficacy	3.1 (0.9)	—	2.9 (0.3)	3.0 (0.7)	3.3 (0.5)	3.5 (0.9)	3.3 (1.1)	3.3 (0.7)
Decisional balance, pros	3.9 (0.7)	—	2.6 (1.0)	3.3 (1.0)	4.0 (1.0)	3.9 (1.1)	3.3 (0.7)	3.8 (1.0)
Decisional balance, cons	2.2 (0.5)	—	1.9 (0.5)	2.1 (0.5)	2.1 (0.7)	1.6 (0.6)	1.5 (0.6)	1.9 (0.7)
Process of change, behavioral	2.8 (1.2)	—	2.6 (0.4)	2.6 (0.8)	3.5 (0.7)	3.3 (0.5)	3.0 (0.7)	3.4 (0.7)
Process of change, cognitive	2.9 (1.0)	—	2.5 (0.2)	2.7 (0.7)	3.6 (0.7)	3.4 (0.6)	3.2 (0.7)	3.5 (0.7)
Physical activity, mins								
Sedentary	540 (62)	—	498 (38)	522 (54)	447 (66)	541 (78)	481 (40)	465 (71)
Light	234 (45)	—	188 (54)	214 (51)	192 (66)	212 (79)	199 (33)	196 (63)
Moderate	26 (7)	—	11 (4)	19 (10)	21 (12)	25 (7)	30 (4)	23 (11)
Vigorous	12 (5)	—	1 (0.4)	7 (7)	12 (14)	14 (7)	9 (5)	12 (13)
MVPA	39 (12)	—	13 (5)	28 (17)	35 (25)	40 (13)	42 (3)	36 (22)

JIA: juvenile idiopathic arthritis; JDM: juvenile dermatomyositis; CF: cystic fibrosis; CHAQ: Childhood Health Assessment Questionnaire; VAS: visual analog scale; QOL: quality of life; pros: advantages; cons: disadvantages; MVPA: moderate and vigorous physical activity.

Table 1C. Totals for subject characteristics. Values are mean (SD) unless otherwise specified.

Items	Total			
	JIA, n = 39	JDM, n = 14	CF, n = 12	Total, n = 67
Age, yrs	14.3 (2.0)	15.5 (2.0)	14 (2.1)	14.6 (2.1)
Sex, n				
Male	9	5	9	24
Female	30	9	3	43
Medical status				
Disease severity, out of 100	22 (24)	20 (24)	15 (16)	21 (23)
CHAQ, out of 10	0.23 (0.36)	0.1 (0.1)	0.1 (0.1)	0.23 (0.36)
CHAQ illness VAS	1.7 (2.2)	0.8 (1.6)	0.8 (1.7)	1.5 (2.0)
CHAQ pain VAS	1.7 (2.2)	1.2 (2.3)	1.2 (2.3)	1.4 (2.2)
CHAQ QOL VAS	1.4 (2.1)	0.7 (1.3)	0.7 (1.3)	1.3 (1.9)
Psychosocial				
Self-efficacy	3.1 (0.6)	3.1 (0.8)	2.9 (0.8)	3.0 (0.7)
Decisional balance, pros	3.8 (0.9)	3.6 (0.8)	2.8 (0.9)	3.6 (1.0)
Decisional balance, cons	2.3 (0.9)	2.2 (0.9)	2.0 (0.7)	2.3 (0.8)
Process of change, behavioral	3.2 (0.7)	3.1 (0.7)	2.5 (0.6)	3.0 (0.7)
Process of change, cognitive	3.2 (0.7)	3.0 (0.6)	2.6 (0.7)	3.1 (0.8)
Physical activity, mins				
Sedentary	469 (72)	544 (75)	470 (68)	483 (77)
Light	184 (59)	177 (62)	217 (46)	189 (58)
Moderate	21 (13)	20 (12)	23 (9)	21 (12)
Vigorous	10 (11)	9 (7)	9 (7)	10 (10)
MVPA	34 (24)	31 (18)	34 (14)	33 (21)

JIA: juvenile idiopathic arthritis; JDM: juvenile dermatomyositis; CF: cystic fibrosis; CHAQ: Childhood Health Assessment Questionnaire; VAS: visual analog scale; QOL: quality of life; pros: advantages; cons: disadvantages; MVPA: moderate and vigorous physical activity.

of the analysis of the physical activity data, the contemplation and preparation groups were collapsed into 1 group.

Good content and face validity of the stage of exercise scale were demonstrated by the debriefing questionnaire based on an average rating of 6.1 in all 3 disease groups. There were no significant interaction effects between disease type and stage of exercise for any of the overall psychosocial scores (self-efficacy, decisional balance, or processes of change); thus, further analyses were conducted excluding data from the control group because their presence did not change the results.

Psychosocial constructs. Results from the ANOVA for differences across the stages for psychosocial measures of readiness to exercise are presented for the rheumatic group in Table 2. The SOES demonstrated good construct validity with psychosocial measures of readiness to exercise. Significant differences between the staging groups were demonstrated in the self-efficacy, decisional balance cons, and process of change scores (Figure 1). When decisional balance was broken into its core components (pro and con scores), a significant difference between the stages was demonstrated for the con score, but not the pro score.

Tests for difference in the 10 individual core processes identified from the process of change questionnaire are presented for the rheumatic group in Table 3. There were no significant interaction effects between disease type and SOES for individual processes with the exception of the behavioral process "committing," which resulted in a significant interaction [$F_{(65,3)} = 3.16$, $p < 0.03$]. In comparison to the rheumatic group, the controls displayed lower "committing" scores in the contemplation and preparation stages and higher scores than the rheumatic group in the action and maintenance stages of the SOES.

Table 2. ANOVA test for difference in psychosocial constructs across subgroups identified by the stage of exercise scale in the rheumatic group.

Questionnaires	$F_{(3,53)}$	p	Test for Linear Contrast, $F_{(5,53)}$
Self-efficacy	3.6	< 0.02	P < M*
Decisional balance, pros	1.1	0.37	NS
Decisional balance, cons	4.6	< 0.006	P > M*
Process of change, behavioral	3.7	< 0.02	P < M*
Process of change, cognitive	3.3	< 0.03	P < M*

* p < 0.05. Questionnaires: total scores from questionnaires were entered as the outcome variable with Stage of Exercise subgroup as the variable; F: F test value with 53 degrees of freedom; test for linear contrast: describes difference between groups presented with significance level; pros: advantages; cons: disadvantages; NS: not significant; P: preparation; M: maintenance.

Clinical constructs. There were no significant interactions between disease type and SOES for disease activity, severity, or self-reported physical function; thus, further results are presented excluding the control group. Global ratings of

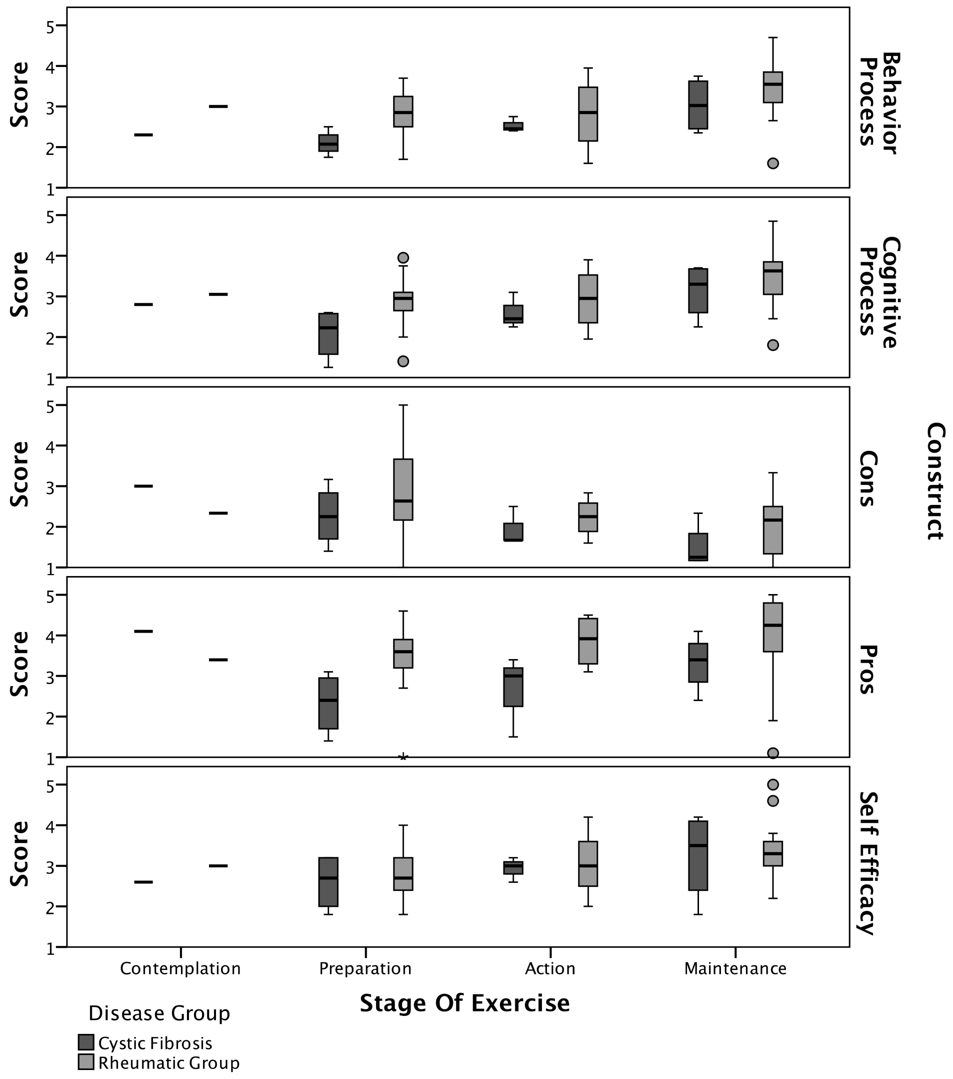

Figure 1. Mean construct score by stage of exercise in the rheumatic and CF groups. Pros and cons are pro and con scores from the decisional balance scale; behavior process and cognitive process are behavioral and cognitive processes from the process of change scale; and self-efficacy is the self-efficacy overall score. The lines represent the scores for the 1 participant with rheumatic disease and 1 participant with CF who identified themselves as contemplative. Dots represent outliers in the data. CF: cystic fibrosis; pros: advantages; cons: disadvantages.

disease activity and disease severity rated by the attending physician showed no significant differences among the 4 exercise stages [$F_{(53,3)} = 0.2$, $p = 0.9$ and $F_{(53,3)} = 1.6$, $p = 0.21$, respectively]. There were no significant differences among the stages in self-reported physical function as measured by the CHAQ [$F_{(38,3)} = 0.22$, $p = 0.88$] or with patient-rated disease severity [$F_{(52,3)} = 0.40$, $p = 0.75$].

Physical activity. Time spent in light, moderate, MVPA, or vigorous activity was not different among the 3 disease groups. The control group took part in an average of 470 ± 68 min per day of sedentary activity, while those with JDM or JIA took part in an average of 544 ± 75 min and 469 ± 72 min, respectively. There was a significant effect of disease type on time spent in a sedentary activity [$F_{(58,2)} = 4.8$, $p = 0.01$]. Posthoc analyses revealed that participants in the JDM group accumulated significantly more minutes (74 min per day) of sedentary time in comparison to those in the JIA group; no other differences in sedentary time among disease types were found. There was no significant effect for the interaction between disease type and SOES for minutes of sedentary time. Sedentary time decreased across the stages in the rheumatic group. Those in the higher stages (action or maintenance) participated in an average of 28 min less sedentary activity in comparison with those in the lower stages (contemplation); however, a significant difference between the staging groups was not found ($T = -1.25$, $p = 0.21$).

There was a significant interaction effect between stage

Table 3. ANOVA test for group differences in the 10 core processes of change across subgroups identified by stage of exercise scale in the rheumatic group.

Process Score, Dependent Variable	$F_{(5,53)}$	p	Test for Contrast, $F_{(3,53)}$
Cognitive processes			
Increasing knowledge	2.0	0.12	NS
Aware of risks	2.7	< 0.05	P < M*
Consequences to others	0.6	0.60	NS
Comprehending benefits	1.6	0.20	NS
Increasing healthy opportunities	0.44	0.73	NS
Behavioral processes			
Substituting alternatives	12.0	< 0.0001	P < M**
Social support	2.2	0.09	NS
Rewarding	4.8	< 0.005	P < M*
Committing	4.1	< 0.01	P < M*
Reminding	4.1	< 0.01	P < M*

* p < 0.01. ** p < 0.0001. F: F test value with 53 degrees of freedom; p value: level of significance of F test for overall group differences; test for contrast: describes relationship between subgroups; NS: not significant; P: preparation; M: maintenance.

of exercise and disease type for minutes of light physical activity [$F_{(65,3)} = 5.1$, $p = 0.009$] and total physical activity [light, moderate, or vigorous; $F_{(58,2)} = 5.1$, $p = 0.009$]. In both cases, the rheumatic group participated in less physical activity in the preparation stage, more activity in the action stage, and similar activity in the maintenance stage of the SOES when compared with the control group. In the rheumatic group, those in the higher stages took part in significantly more light physical activity in comparison to those in the lower stages ($T = 2.89$, $p = 0.006$). Total physical activity was also significantly different between the higher and lower stages in the rheumatic group ($T = 2.83$, $p = 0.007$).

Overall, participation in moderate to vigorous physical activity was similar among the disease groups with participants diagnosed with JIA averaging 33.5 ± 23.6 min, JDM 30.5 ± 18 min, and CF 34 ± 14.4 min per day. Minutes of MVPA across the SOES are presented in Figure 2 for the rheumatic and CF group. There were no significant interaction effects for disease type and SOES for MVPA or vigorous physical activity. There was no significant relationship between age, or the interaction between age and MVPA and SOES. Physical activity levels of MVPA did not differ significantly between those in the higher and lower stages in the rheumatic group. However, a significant difference was determined between the stages for participation in vigorous physical activity ($T = 2.4$, $p = 0.02$). Those in the higher rungs of the SOES participated in an average of 6.4 min more vigorous physical activity in comparison with those in the lower rungs.

DISCUSSION

The results of our study suggest that the SOES is valid in children with rheumatic disease and perhaps other chronic illnesses as demonstrated by good face and content validity in children with JIA, JDM, and CF. Overall, the SOES did not differ between the disease groups. However, there were a few significant differences between the disease groups across the SOES; the process of change "committing" construct as well as light and total physical activity participation suggest that further validity testing may be warranted in other disease groups.

Scores from the psychosocial measures significantly differed across the staging groups in the hypothesized manner in the rheumatic group supporting good construct validity of the SOES. Self-rated measures of physical function and illness did not differ across the staging groups, suggesting that these constructs may not be involved in decisions to take part in exercise among children with rheumatic disease. Participants who identified themselves in the higher stages participated in more minutes of MVPA, although these differences were not statistically significant between the stages. However, when compared to the lower stages of the SOES, those in the action or maintenance stage did take part in significantly more vigorous physical activity minutes, lending support to the construct validity of the SOES. Differences in vigorous physical activity found between those identifying with the higher and lower stages align with what theory would predict. While the scope of our current analysis precludes comment on whether the differences in vigorous physical activity between the higher and lower stages are clinically meaningful, participating in even short periods of vigorous activity has been reported to be associated with reduced risk factor profiles in children[38].

Our findings demonstrating significant differences across stages on the measures of self-efficacy, process of change, and the decisional balance score agree with previous studies conducted in healthy adolescents supporting good construct validity of the SOES in children with rheumatologic diseases[23,39]. The cognitive process "Aware of Risks" increased across the stages in a manner opposite of what was

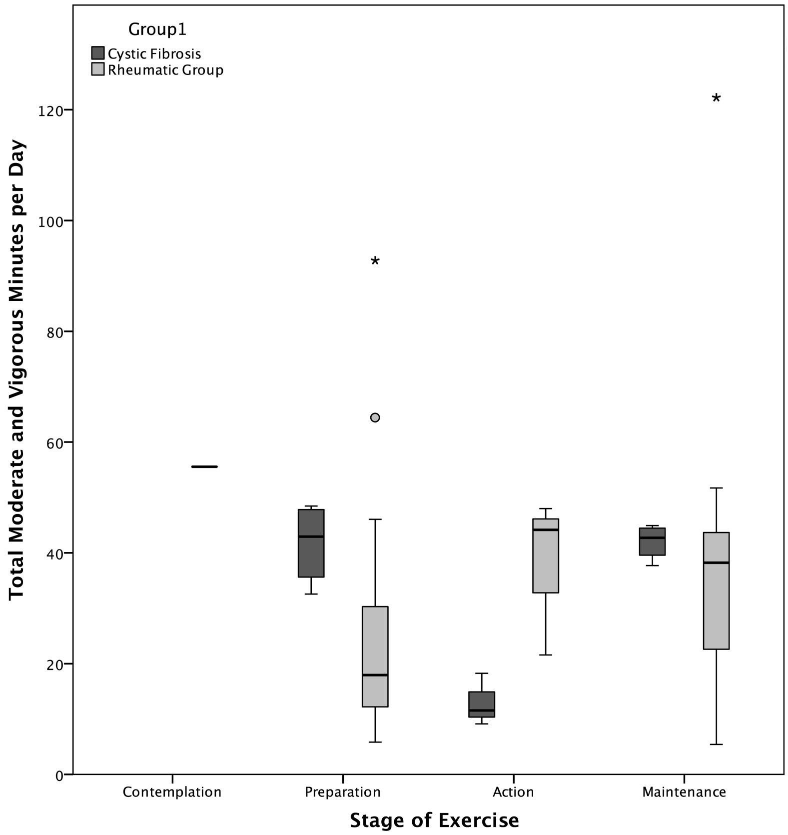

Figure 2. Participation in MVPA across the stages in the rheumatic and cystic fibrosis groups. The line represents the mean minutes for 1 participant who fell into that category. The dot and asterisks represent outliers. MVPA: moderate and vigorous physical activity.

hypothesized, but in line with what has been previously reported in a metaanalysis of the application of the transtheoretical model in other exercise studies[20]. A lack of differences among the staging subgroups related to the remaining cognitive process constructs may be explained by the lack of participant membership in the precontemplation and contemplation subgroups in our study where such cognitive processes are theorized to be more prominent[40]. Differences identified in the use of the behavioral processes (committing) among the disease groups may suggest that the use and importance of a particular process for enacting behavioral change may not be uniform across disease groups.

Clinical measures used to determine physical function, disease severity, and pain were not significantly different across the stage subgroups identified from the stage of exercise scale. Arthur, *et al* also reported no relationship when readiness to self-manage arthritis was compared with participants' scores of pain, disability, disease duration, disease severity, and physical function in 47 adults diagnosed with rheumatoid arthritis or osteoarthritis[41]. Our findings seem to indicate that physical function, pain, and disease severity status are not related to determining whether a child with a rheumatic disease plans to take part in exercise.

While those in the action and maintenance stages demonstrated the highest level of moderate physical activity and spent less time in sedentary activities, this finding did not result in a statistically significant difference between the stages. However, light, vigorous, and total physical activity significantly differed between the stages in the rheumatic group. Our findings agree in part with those of Hass and Nigg, who found significant differences among the stages for self-reported moderate and vigorous activity, but not light or sedentary activity in a sample of schoolchildren[21]. Differences in the findings of our study with regards to the light activity may be attributed to the use of an objective method to determine physical activity versus the use of questionnaires in the previous studies[21]. The use of a questionnaire to derive information about different physical activity intensities was cited by Hass and Nigg as a potential limitation in their study, because children may be unable to accurately differentiate between intensities[21].

Future validity studies using stage of exercise may need to restructure the construct to better identify physical activity behaviors among the different stages[16]. For example, when using physical activity level, one may wish to describe each of the stages more fully by providing criterion minute ranges, frequencies in terms of days or hours per week, as well as more graphical and descriptive representations of exercise[42]. Adding other aspects of physical activity behavior such as physical activity plans (e.g., when, how, and where) could be useful in better defining distinct stages for children[42].

There are limitations to our present study that should be recognized. Data related to the effect of the duration of the participants' disease course on physical activity levels was unavailable for all of the included cohorts. It is possible that the duration of disease might influence physical activity levels; however, other clinical outcomes that are related to disease burden including disease severity, activity, and physical function were not found to be different among the disease groups, suggesting that disease burden may not be related to physical activity level in the included groups. There were few participants who considered themselves to be in the precontemplation (0%) or contemplation (3%) stages; thus, in some cases the findings were limited to differences between the preparation group and maintenance group. This is not uncommon in cross-sectional studies using the transtheoretical model[20]. Despite the fact that there was a small distribution of children among the stages of exercise scale, we still found significant differences between the stages suggesting that Type 2 errors were not present. To draw a more diverse sample, it has been suggested that the use of passive recruitment methods (e.g., public study advertisements) in addition to active strategies (physician or medical personnel contact) may be needed[10,43].

The SOES demonstrated good face, content validity, and construct validity in children with rheumatologic conditions. Suggestions for future validation of the SOES scale are to enhance the descriptions of each of the stages. Future comparisons of constructs of the transtheoretical model such as pros and cons as well as physical activity levels should be made to provide further confirmation of the scales validity. Most importantly, future experimental research is required to examine whether changes in the psychosocial constructs (e.g., self-efficacy) mediate stage transition, and that such transition is accompanied by increases in physical activity.

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