

Measuring the Processes of Change From the Transtheoretical Model for Physical Activity and Exercise in Overweight and Obese Adults

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Abstract

Purpose: This study aimed to test three factorial structures conceptualizing the processes of change (POC) from the transtheoretical model and to examine the relationships between the POC and stages of change (SOC) among overweight and obese adults.

Design: Cross-sectional study.

Setting: This study was conducted at the University Hospital of Montpellier, France.

Subjects: A sample of 289 overweight or obese participants (199 women) was enrolled in the study.

Measures: Participants completed the POC and SOC questionnaires during a 5-day hospitalization for weight management.

Analysis: Structural equation modeling was used to compare the different factorial structures.

Results: The unweighted least-squares method was used to identify the best-fit indices for the five fully correlated model (goodness-of-fit statistic = .96; adjusted goodness-of-fit statistic = .95; standardized root mean residual = .062; normed-fit index = .95; parsimonious normed-fit index = .83; parsimonious goodness-of-fit statistic = .78). The multivariate analysis of variance was significant ($p < .001$). A post hoc test showed that individuals in advanced SOC used more of both experiential and behavioral POC than those in preaction stages, with effect sizes ranging from .06 to .29.

Conclusion: This study supports the validity of the factorial structure of POC concerning physical activity and confirms the assumption that, in this context, people with excess weight use both experiential and behavioral processes. These preliminary results should be confirmed in a longitudinal study.

Keywords

physical activity, behavior change, transtheoretical model, processes of change, factorial structure, prevention research

Purpose

The last decades have witnessed a sharp increase in obesity rates worldwide; these numbers are expected to worsen in the years to come.^{1,2} Although physical activity (PA) is recognized to be an undeniable cornerstone of obesity management, a large portion of individuals with weight concerns are unwilling to put it into practice in daily life.³ In fact, in the last 30 years, the dramatic increase in sedentary time has been observed to parallel a significant decrease in PA.⁴ Hence, understanding the underlying mechanisms associated with the adoption and maintenance of an active lifestyle remains crucial and necessary for weight management and control.

The transtheoretical model (TTM) of behavior change⁵ is an attractive framework for understanding behavior modification

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over time. In fact, regarding PA, the TTM interestingly encompasses a vast array of behavioral patterns ranging from a low to a high willingness to engage in PA.⁶ The TTM comprises several components, including decisional balance (weighting pros and cons of engaging in a behavior), self-efficacy (confidence to engage in a specific task), temptation (intensity of the desire to return to habits), stages of change (SOC; series of stages relating the progress/motivation to change), and processes of change (POC; strategies used to change one's behavior and progress through SOC).

Concerning the SOC, the TTM assumes that people move nonlinearly through five distinct stages^{7,8}: precontemplation (no intention to change), contemplation (intention to change within the next 6 months), preparation (intention to change within the next month), action (engaged in the behavior for less than 6 months), and maintenance (behavior changed for more than 6 months). Progression through stages is partially due to the activation of POC, which are strategies adopted by individuals in order to change their behavior according to their inner cognitive, affective state and outer environmental surroundings.

The POC, originally developed in the context of smoking cessation, were organized according to a hierarchical structure with 2 first- and 10 second-order factors. The first of the first-order factors, called experiential processes, consists of five processes: consciousness raising, dramatic relief, selfreevaluation, environmental reevaluation, and self-liberation. Behavioral processes, the second first-order factor, also consists of five processes: helping relationships, counterconditioning, reinforcement management, stimulus control, and social liberation.⁹ However, compared to the initial structure, the evaluation of the POC in domains other than smoking cessation revealed some differences.¹⁰ For example, the POC related to weight management is a first-order structure with four and not five processes.¹¹

Within PA adoption/management, studies have noted that the adoption of a hierarchical factorial structure form of POC identical to the one used for tobacco cessation is not the best solution.¹² In fact, studies in adolescents showed that some processes are absent from procedures of PA change,^{13,14} and Blaney et al.¹⁵ also identified a nonhierarchical structure among African-American adults.

Nonetheless, this has never been tested among individuals with chronic conditions. Then, given that PA is a complex health behavior with its specific mechanisms,¹⁶ two revised models have been hypothesized¹⁷: the first is a five-fully-correlated-factor model, whereas the second is a hierarchical model with two second-order factors and eight firstorder factors. These two models do not vary according to age, sex, or ethnicity,¹⁷ but no data are available to ensure that the factorial structure is invariable with weight status. This question is of interest because research on POC suggests that their factorial structure can be either behavior dependent (according to PA adoption, weight management, or tobacco cessation) or population dependent (different structures in adolescents^{13,14} and in African-Americans¹⁵).

Then, in the TTM, POC are closely related to SOC, with people in advanced SOC using significantly more both experiential and behavioral POC.¹² Previous studies suggest that a parallel increase of behavioral-experiential POC is associated with SOC progression in the PA domain,^{18,19} especially in individuals with type 2 diabetes, most of whom are overweight/obese.

The objective of this research was, on the one hand, to test the validity of the factorial structure of POC in overweight and obese adults, and, on the other hand, to verify whether individuals in advanced SOC have higher scores regarding experiential and behavioral POC.

Methods

Design

Enrolled participants were admitted to the hospital during a 5-day period for weight management. They completed the POC²⁰ and SOC²¹ questionnaires in either paper-and-pencil or electronic format at their convenience. Data were then merged because no differences existed in the population between these two formats.²² The questionnaires were completed during the first 2 days of hospitalization. The protocol was administered under routine care at the Montpellier University Hospital after the patients had signed a consent form.

Sample

Overweight or obese (body mass index [BMI] >25 kg/m²) inpatients of the Nutrition-Diabetes Department of the Montpellier University Hospital were considered for study inclusion. Participants were included if they had no contraindications to the practice of PA and/or exercise and had no major psychiatric disorders that may have influenced their judgment.

Measures

Stages of Change. SOC for PA and exercise were evaluated using a staging questionnaire previously used for obese subjects.²¹ In previous research, the SOC have been shown to be reliable regarding PA among people with obesity or diabetes.²³⁻²⁵ Regular PA and exercise was defined as "at least 30 minutes per session, at least 4 days per week." Given that individuals with obesity have difficulties engaging in PA, with up to 70% of individuals with overweight not practicing or not considering practicing regular PA, defined as 20 minutes at least 3 times per week,²⁶ the SOC algorithm was not intended to be based on American College of Sports Medicine's recommendation²⁷ but on the practice of PA as it was previously done.^{21,25}

Participants were also asked to answer the following four questions: Do you regularly engage in PA? Do you intend to engage in regular PA within 6 months? Do you intend to engage in PA within 30 days? Have you been regularly

physically active over the last 6 months? Based on their replies, participants were divided into five groups according to their SOC (precontemplation, contemplation, preparation, action, and maintenance).

Processes of Change. To evaluate POC, participants were asked how often they used the different processes by means of a 30-item questionnaire with a fivepoint Likert-type scale rating from 1 = never to 5 = repeatedly.²⁰ Based on the results of previous research,^{20,28} three factorial structures were evaluated. The first (model A) was hierarchical, with 2 second-order factors (experiential and behavioral) and 10 first-order factors representing the 10 POC. The second structure (model B) was also hierarchical, with two second-order factors (experiential and behavioral) and eight first-order factors representing eight POC (four experiential: consciousness raising, dramatic relief, reevaluation, self-liberation; and three behavioral: counterconditioning, helping relationships, and reinforcement management/self-liberation). The third structure (model C) was a five-correlated factor, the five factors being self-reevaluation/reinforcement management/self-liberation, counterconditioning, helping relationships, dramatic relief/environmental reevaluation, and consciousness raising.

Analysis

Confirmatory factor analysis using AMOS 20 (IBM Corporation, Armonk, New York) was used to test the three precited factorial structures. Before estimating the fit indexes, we examined the multivariate normality of our data using the Mardia's coefficient²⁹ and its critical ratio. The assumption of a multivariate normality should be rejected when the coefficient exceeds 3 and its critical ratio 1.96.^{30,31}

In the present study, the Mardia's coefficient was 93.37 and its critical ratio was 18.89, indicating a severe multivariate nonnormality distribution of the data. Consequently, the unweighted least-squares (ULS) method of estimation was used. This method is useful because it does not require the multivariate normality of data and it reduces the sum of squared values in the residual matrix between an observation and the model prediction of the dependent variable.³⁰⁻³² The ULS method was thus retained for the present study.

Selection of Fit Indices Regarding the Factorial Structure. As we used the ULS method, the majority of fit indices based on the χ^2 statistic were not applicable. To assess the validity of the tested models, the goodness-of-fit statistic (GFI), the adjusted goodness-of-fit statistic (AGFI), and the standardized root mean residual (SRMR) were selected as absolute fit indices. The normed-fit index (NFI) was considered as a relative fit index. The parsimonious goodness-of-fit index (PGFI) and the parsimonious normed-fit index (PNFI) were selected as indices of parsimony.

GFI and AGFI values range from 0 to 1, with values close to 1 revealing a good fit to the data. Based on previous studies and taking into account sample size, the GFI should be superior to

.93 and the AGFI superior to .91.³³ SRMR values range from 0 to 1, with values close to 0 indicating a good fit to the data. In the present study, the SRMR value should be below .10 to be acceptable. Values of the NFI range from 0 to 1 and should be higher than .92. For the parsimonious indexes, values range from 0 to 1, with higher values indicating good fit to data, and these values should be higher than .75 for both PNFI and PGFI. Reaching the aforementioned values guarantees no rejection of a correct model because of its sample size.³³

Use of POC. To examine the extent to which people in advanced SOC used both experiential and behavioral processes, a multivariate analysis of variance (MANOVA) was computed with POC as dependent variables and SOC as an independent variable. In case of significance, the least significant difference (LSD) test was directly used as a post hoc test to examine any potential differences in POC according to SOC.

Partial eta squared (η_p^2) was reported as a measure of effect size, and by convention values of .01, .06, and .14 were considered small, medium, and large, respectively. These tests were performed using Statistica 7.1 (Statsoft, Inc., Tulsa, Oklahoma) software.

Results

Subjects

A total of 289 (199 women; 90 men), overweight/obese (mean BMI of 36.6 ± 7.6 kg/m²) participants with a mean age of 49.7 ± 14.9 years were enrolled in this study. Regarding tobacco use, 16.1% subjects were smokers, 51.5% nonsmokers, and 32.3% former smokers. The majority of the included individuals were married (48.6%) or cohabiting (17.3%). Also, most recruited subjects were employees (40.7%), executives (15.6%), unemployed (13.9%), or retired (12.9%).

The analyses of the distribution of the population across the different SOC for PA/exercise showed that 5.9% of the population was in precontemplation ($n = 17$; BMI: 38.40 ± 7.87 kg/m²), 9.7% in contemplation ($n = 28$; BMI: 37.92 ± 6.63 kg/m²), 46.7% in preparation ($n = 135$; BMI: 37.44 ± 8.55 kg/m²), 10.4% in action ($n = 30$; BMI: 37.24 ± 8.48 kg/m²), and 27.3% in maintenance ($n = 79$; BMI: 36.40 ± 7.87 kg/m²).

Factorial Validity of POC

Concerning model A, the solution was considered not admissible because of a negative residual variance of the self-liberation process. To correct this problem, the residual variance was therefore fixed at 0 to enable model conversion. After this modification, psychometric properties of model A were considered adequate: GFI = .94, AGFI = .92, SRMR = .078, NFI = .91, PNFI = .82, and PGFI = .79. The correlation coefficient between the two second-order factors was .79. Model B, a model specific to PA adoption, had the following indexes: GFI = .94, AGFI = .93, SRMR = .076, NFI = .90,

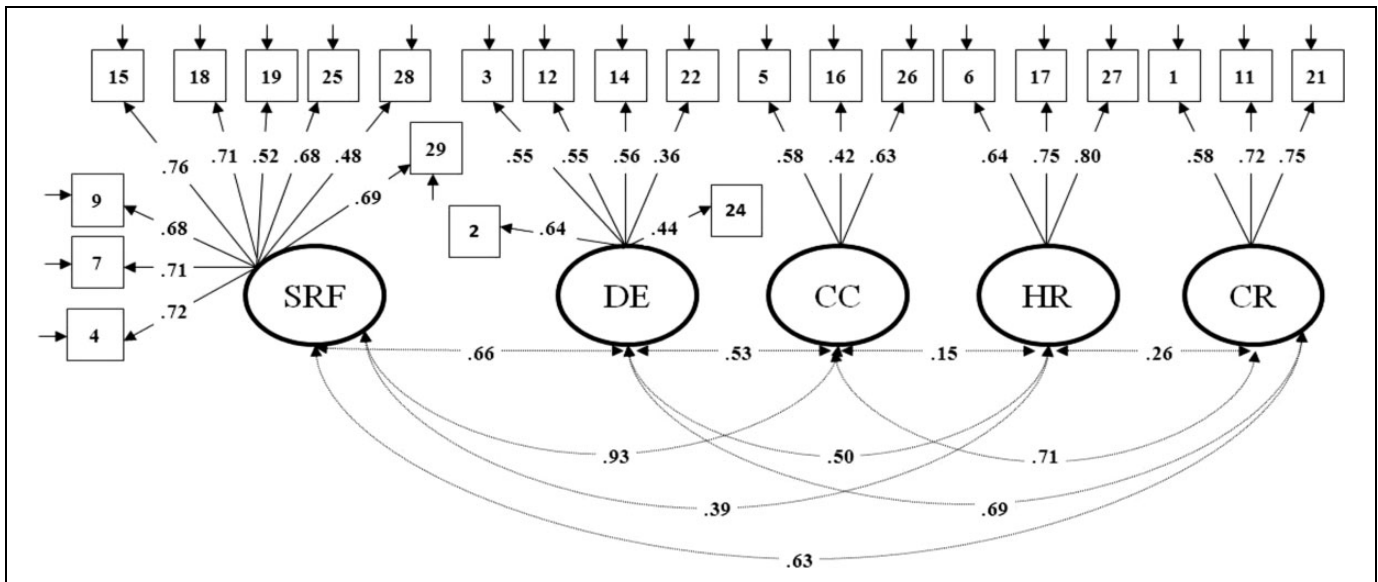


Figure 1. The Five-Factor Model of Processes of Change (Model C)*

*SRF indicates self-reevaluation/reinforcement management/self-liberation; DE, dramatic relief/environmental reevaluation; CC, counterconditioning; HR, helping relationships; and CR, consciousness raising.

Table 1. Score per Processes of Change According to Stages of Change*

	PC	C	PREP	A	M	Floor/Ceiling Effects, %	LSD
SRF	2.33 (0.54)	2.87 (0.80)	3.55 (0.56)	3.64 (0.68)	3.88 (0.69)	0/1.4	PC < C < PREP, A < M
DE	2.40 (0.62)	2.67 (0.82)	3.12 (0.78)	2.97 (0.69)	3.02 (0.79)	0/1	PC, C < PREP, M PC < A
CC	1.82 (0.62)	2.08 (0.67)	2.49 (0.78)	2.81 (0.69)	3.26 (0.79)	4.8/0.7	PC, C < PREP < A < M
HR	2.56 (1.23)	2.38 (1.02)	3.15 (1.04)	3.10 (1.10)	2.99 (1.08)	7.6/3.4	PC, C < PREP C < A, M
CR	1.56 (0.77)	1.78 (0.72)	2.30 (0.86)	2.40 (0.98)	2.47 (0.93)	13.8/0.3	PC, C < PREP, A, M

* Data are means with standard deviations in parentheses. PC indicates precontemplation; C, contemplation; PREP, preparation; A, action; M, maintenance; LSD, least significant difference; SRF, self-reevaluation/reinforcement management/self-liberation; DE, dramatic relief/environmental reevaluation; CC, counterconditioning; HR, helping relationships; and CR, consciousness raising.

PNFI = .81, and PGFI = .78. The correlation coefficient linking the two secondorder factors was .69. Model C was the most consistent, with the following psychometric properties: GFI = .96, AGFI = .95, SRMR = .062, NFI = .95, PNFI = .83, and PGFI = .78 (Figure 1).

Use of POC According to SOC

Regarding fit indexes, model C, evaluating the five previously described dimensions, was used to test the theoretical validity of the following analyses. As for internal validity, Cronbach α was .87 for self-reevaluation/reinforcement management/self-liberation, .72 for dramatic relief/environmental reevaluation, .55 for counterconditioning, .73 for consciousness raising, and .76 for helping relationships. No ceiling or floor effect was detected (percentage of participants scoring at the lowest or highest scale levels, and is considered adequate when below 20%; Table 1) for any of the five dimensions evaluated.

The MANOVA revealed a significant multivariate effect of SOC on the five POC (Wilks' $\lambda = .59$; $F_{20,929.60} = 7.87$; $p < .001$; $\eta_p^2 = .15$).

Concerning the dimension of selfreevaluation/reinforcement management/self-liberation, the effect size was $\eta_p^2 = .29$ and the LSD showed that participants in higher SOC had higher values than those in preaction stages (Table 1). For the dimension of dramatic relief/environmental reevaluation, the effect size was considered as medium ($\eta_p^2 = .06$) and participants in precontemplation and contemplation stages had the lowest values (Table 1). Regarding the dimension counterconditioning, the effect size was large ($\eta_p^2 = .25$) and the post hoc test showed that individuals in postaction stages had the highest values, as theoretically expected (Table 1). Regarding helping relationships, the effect size was medium ($\eta_p^2 = .05$), with individuals in postaction stages having the highest value (Table 1). Finally, regarding consciousness raising, the effect size was medium ($\eta_p^2 = .07$) and, similarly to the other dimensions, participants in postaction stages had higher values (Table 1).

Discussion

The purpose of the present study was twofold. It first aimed to test the factorial structure of the POC questionnaire in overweight/obese individuals and its second objective was to test how participants use POC according to their SOC in the context of PA. This study is of importance because although the popularity of TTM is increasing, relatively few studies have examined the POC. To answer our first aim, we compared 3 different factorial structures: (1) a hierarchical structure with 2 second-order factors and 10 processes (model A), (2) a second hierarchical structure with 2 second-order factors and 8 processes (model B), and (3) a first-order structure measuring 5 processes (model C). The analyses of fit indexes showed that, although models A and B exhibited good fit indexes, model C obtained the best five fit indexes among six and could thus be considered as the best one. These results are in agreement with those of previous studies,^{17,20,34} although in a previous work,²⁰ the hierarchical structure with eight processes (model B) had poor fit to the studied data by contrast with the present data investigated. Our results suggest that all three models are of equal interest in measuring POC; no argument was obtained to prefer one model use/validity over another. Furthermore, as we used the ULS method of estimation, we were not able to use the Akaike information criterion to compare the three factorial structures. Actually, to help us select a model, it would have been interesting to test each model regarding its capacity to predict PA behavior similarly to what was previously done by Cardinal et al.,³⁵ who included all the components of the TTM. Our second research objective was to examine the use of each POC according to SOC. In line with previous cross-sectional studies,^{34,36,37} people in advanced SOC had higher scores than those in preaction stages, but this result was not verified with the dramatic relief/environmental reevaluation process. In fact, regarding the latter dimension, the highest score was found in the preparation stage, suggesting that it would be more related to the decision of PA practice initiation than the other POC. Nonetheless, in the context of PA, both experiential and behavioral processes are known to be involved in behavior change in different types of populations.^{38,39} However, this needs to be further confirmed by longitudinal studies conducted on obese populations.

Furthermore, in the analysis of the effect size, large effects were found for two behavioral processes (i.e., self-reevaluation/reinforcement management/self-liberation and counterconditioning) that seem to be more involved in behavior change regarding PA than experiential POC in obese individuals. Previous studies^{40,41} have also shown similar results, with behavioral processes being more predictive of behavior change regarding PA. The other size effects ranging from small to medium probably show that experiential processes are less involved in behavior change than behavioral POC. However, these results should also be confirmed in a longitudinal study.

The present study has several limitations that need to be acknowledged. First of all, our small sample size probably

impacted the fit indices. However, the use of cutoff values indicated by Sivo et al.³³ decreased the probability of a type II error. The second study limitation is the lack of multivariate normality, preventing us from statistically comparing the different models and testing their invariance. The third limitation concerns the cross-sectional design of the study, which limits the interpretations regarding the joint use of POC. A fourth limitation is the fact that the results of this study may not be generalized to a community setting.

To conclude, our study showed that to evaluate POC, the five-factor model was effective among obese individuals and the hierarchical solutions were also compatible. This result partially confirmed our hypothesis because it showed that several solutions may be envisaged to measure POC. Then, regarding SOC, this investigation confirms that, in PA, both experiential and behavioral types of POC are used with people in advanced SOC having higher scores, which gives support to our hypothesis.

We could thus conclude that counseling based on POC aiming at increasing the level of PA should target both types of processes, with a preference for behavioral processes, notably in obesity.⁴²

SO WHAT? Implications for Health Promotion Practitioners and Researchers

What is already known on this topic?

There are three factorial structures conceptualizing the POC regarding PA. These structures have been tested in different populations and behaviors with various results.

What does this article add?

The factorial structures of POC are similar for obese and normal-weight people. Thus, it could be supposed that these factorial structures do not seem to depend on the type of population but rather on the targeted behavior.

What are the implications for health promotion practice and research?

Our results suggest that there are five POC that should be used to guide interventions promoting PA practice. The size effects obtained also suggest that behavioral processes are prominent in PA promotion. Techniques such as helping relationships (list persons who may help in the practice of PA), the establishment of goals with rewards, the management of time to increase PA, and discussion about PA and the consequences of inactivity could be promising strategies without neglecting the increase of knowledge regarding the interest of PA.

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