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Abstract

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Objectives: The purpose of this study is to test the psychometric properties of the Self-care of Hypertension Inventory (SC-HI).

Methods: Using the Self-care of Chronic Illness theory, we developed a 24-item measure of maintenance, monitoring, and management appropriate for persons with chronic HTN, tested it for content validity, and then tested it in a convenience sample of 193 adults. Exploratory factor analysis was used to identify measure structure. Cronbach's α and factor determinacy scores and were used to assess reliability. Validity was tested with the Medical Outcomes Study General Adherence Scale and the Decision Making Competency Inventory.

Results: Seventy percent of the sample was female; mean age was 56.4 ± 13 years; mean duration of HTN was 11 ± 9 years. Removal of 1 item on alcohol consumption resulted in a unidimensional self-care maintenance factor with acceptable structure and internal consistency ($\alpha = .83$). A multidimensional self-care management factor included "consultative" and "autonomous" factors (factor determinacy score = 0.75). A unidimensional confidence factor captured confidence in and persistence with each aspect of self-care ($\alpha = .83$). All the self-care dimensions in the final 23-item instrument were associated with treatment adherence and several with decision making.

Conclusion: These findings support the conceptual basis of self-care in patients with HTN as a process of maintenance, monitoring, and management. The SC-HI confidence scale is promising as a measure of self-efficacy in self-care.

Keywords

adherence, blood pressure, decision making, hypertension, instrument development, measurement, self-care, self-management

Disciplines

Analytical, Diagnostic and Therapeutic Techniques and Equipment | Behavioral Medicine | Cardiology | Cardiovascular Diseases | Circulatory and Respiratory Physiology | Hematology | Medical Humanities | Medicine and Health Sciences | Nursing | Preventive Medicine

Psychometric Testing of the Self-Care of Hypertension Inventory

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Introduction

Globally, the prevalence of hypertension (defined as systolic blood pressure (BP) of 140 mmHg or higher or diastolic blood pressure of 90 mmHg or higher¹ in adults aged 25 and over) is estimated to be 40%.² In the United States, 70 million American adults (1 in 3) have HTN; only 52% report that their blood pressure is controlled.³ Experts agree that self-care, a process of maintaining health through the practice of health-promoting practices within the context of managing a chronic condition,⁴ is critical to BP control and prevention of sequelae such as myocardial infarction, stroke and heart failure.¹ According to evidence-based guidelines, adherence to BP lowering medications and lifestyle modifications are essential to HTN management.^{1,5} The lifestyle modification needed to control HTN include a heart healthy diet, regular physical activity, avoiding tobacco, managing stress, and achieving/maintaining a healthy weight.⁶ In addition, self-monitoring of BP has been shown to improve control of BP presumably through recognition of elevated BP that leads to efforts to control the BP.^{7,8}

Although the role of self-care in the clinical management of HTN is well-established and incorporated into patient education and intervention strategies, few valid instruments are available to measure self-care in patients with HTN.⁹⁻¹¹ To date, measurement has targeted discrete behaviors (e.g., assessing medication adherence, weight loss or physical activity levels), or influencing factors (e.g., motivation, self-efficacy), which has limited the evaluation of self-care intervention effectiveness. Thus, the purpose of this study was to test the psychometric properties of the theoretically-based Self-Care of Hypertension Inventory (SC-HI).

Theoretical Framework

Self-care was conceptualized by the middle range theory of self-care in chronic illness and defined as a naturalistic decision-making process of maintaining health through health

promoting practices and managing illness.⁴ Self-care maintenance refers to those behaviors used by patients with a chronic illness to maintain physical and emotional stability. Self-care monitoring refers to the process of observing oneself for changes in signs and symptoms. Self-care management is the response to signs and symptoms when they occur. The SC-HI was designed to capture the theoretical process of the middle range theory of self-care in chronic illness with three scales: self-care maintenance, management, and confidence. Self-care confidence refers to the confidence one has in the ability to perform a specific action and to persist in performing that action despite barriers.

Methods

Instrument Development

Items in the SC-HI were designed to reflect the theoretical constructs of self-care maintenance, monitoring, and management. Items in the self-care maintenance scale reflect 12 common adherence behaviors recommended for persons with HTN: check BP, eat fruits and vegetables, be physically active, keep medical appointments, eat a low salt diet at home and when dining out, exercise, take medications, use a medication reminder system, eat a low fat diet, and control body weight. These items were written using published literature, clinical guidelines, and scientific statements from the American Heart Association.^{5,6} Two similar items addressing diet and exercise were included in the maintenance scale to increase internal consistency of the scale. Respondents rate how frequently they engage in each behavior on an ordinal rating scale (1, never or rarely to 4, always or daily). A rating scale with an even number was used to avoid an undecided midpoint.

The self-care management scale is completed and scored if patients report that their BP has been high in the prior interval, even briefly. To capture monitoring, respondents are first

asked how quickly they recognized that their BP was high (0 not recognized, 1 not quickly to 4 very quickly) and to indicate how likely they were to use each of 4 recommended actions (reduce the salt in your diet, reduce your stress, be careful to take your prescription medicines more regularly, and call your doctor/ nurse for guidance) for controlling their BP (1 not likely to 4 very likely) if they recognized that their BP was elevated. The last question on the self-care management scale assesses the ability to evaluate treatment effectiveness (0 nothing tried, 1 not sure to 4 very sure).

The self-care confidence scale is a 4-point scale (1 not confident to 4 very confident) used to assess confidence in one's ability to engage in each individual element of self-care. Self-care confidence is not an element of self-care but we have shown previously that it is a powerful predictor of self-care. Each of the three scales (maintenance, management and confidence) is scored separately and standardized 0 to 100 with higher scores indicating better self-care. That is, three separate scores are produced. The SC-HI is freely available on our website:

<http://www.self-careofheartfailureindex.com/>.

Content Validity

Content validity of an instrument is the degree to which it includes an appropriate sample of items for the construct being measured. Polit and Beck¹² describe two phases: careful conceptualization and domain analysis prior to item generation and then evaluation of the content with expert assessment. The SC-HI was designed to reflect the underlying middle range theory of self-care of chronic illness. Relevance of the proposed items was judged by a 6-member expert panel comprised of 2 cardiovascular nurse clinicians and 4 nurse scientists. These individuals were asked to rate the content relevance of each item on a scale of 1 (unnecessary) to 3 (essential).¹³ The content experts were asked for suggested revisions and whether any

important content was missing.¹⁴

Content validity was quantified using the Content Validity Index (CVI).¹⁵ The CVI was calculated for each individual item and then for the full instrument. The CVI for each item was calculated as the proportion of experts who rated its content as useful or essential (2 or 3). The CVI for the full instrument was calculated as the proportion of items the experts rated as relevant.¹³

A panel of 6 experts in HTN rated each item for content validity.¹³ Every individual item achieved 100% agreement as essential or useful except for one. That one item—take an extra BP pill—was rated as unnecessary by 2 of 6 reviewers. That item was changed to “Be careful to take your prescription medicines more regularly”. The overall content validity index was .96. Minor editing suggested by the expert panel was incorporated into the final instrument.

Psychometric Testing Methods

Sample

A convenience sample of 193 adults with HTN was used to assess the psychometric properties of the instrument. Individuals were recruited directly from small urban communities and outpatient clinical settings from 4 large medical centers in the Northeastern, Southeastern and Midwestern United States. In each of these settings, recruitment flyers were posted or distributed by research staff. Persons were eligible to participate if they were over age 18 and reported having chronic HTN. In order to enroll in this study, individuals self-identified as having HTN and reported how long they had had HTN. Review and approval for this study and all procedures was obtained from the appropriate Institutional Review Boards.

Participants completed: 1) a short demographic questionnaire, 2) the SC-HI, 3) the Medical Outcomes Study General Adherence Scale (MOS-GAS), and 4) the Decision Making Competency

Inventory (DMCI). The MOS-GAS (Coefficient α .78) is a widely used valid and reliable instrument used to assess treatment adherence (medication, diet, exercise).¹⁶ The Decision Making Competency Inventory (DMCI) (Coefficient α =.86) measures decision making skill in four domains: 1) informed awareness (i.e., being reflective in the decision-making process and gathering adequate information in order to make an informed decision); 2) self-appraisal (being mindful of personal qualities that can affect the consequences of choices; 3) autonomy in critically evaluating options and making a choice, and 4) confidence in making appropriate decision.¹⁷

Analysis

Standard descriptive statistics (proportions, means and standard deviations) were used to describe the sample and SC-HI item responses. The proportions of respondents that endorsed different response options provide information about item difficulty, and means and standard deviations provide information about item distribution. Item-rest correlations (i.e. linear correlation between an item and scale formed by all other items)¹⁸ were quantified to detect poor fitting items. Item-rest correlations were calculated because in the alternative item-test correlations poorly fitting items can distort the total test scale making poor fitting items more difficult to detect.¹⁸

Although the SC-HI was designed to capture the three theoretical self-care processes of maintenance, management and confidence, we were unsure of how many factors should inform each process; in some instances measures linked to this middle-range theory have been unidimensional and in others they have been multidimensional within each process.^{19,20} Accordingly, we performed exploratory factor analysis to gain insight into the number of factors that inform each self-care process in the context of HTN. Because the SC-HI item responses are

ordinal in nature, we chose to perform exploratory factor analysis with geomin (oblique) rotation and weighted least square parameter estimation with mean- and variance-adjusted statistics.²¹

When performing exploratory factor analysis of ordinal data, eigenvalues and explained variance are not used to identify the number of factors. Instead, factor solutions are compared using χ^2 tests (non-significant), comparative fit indices (CFI) (>0.95), Tucker-Lewis indices (TLI) (>0.95), root mean square errors of approximation (RMSEA) (<0.08), and the standardized root mean square residual (SRMSR) (<0.08 acceptable) and their common thresholds of acceptable fit;²²⁻²⁴ the number of factors is chosen based on the solution with the best fit. When using ordinal items in exploratory factor analysis, CFI and TLI provide the most accurate information on the number of factors followed by RMSEA and SRMSR.²⁵

Cronbach's alpha was computed when unidimensional scales were observed to fit these data best. When more than one factor was observed to fit these data best, multidimensional factor analysis was used to calculate a factor determinacy score (FDS), range 0-1, ≥ 0.70 is adequate).^{26,27} Finally, concordant validity was tested using linear correlations between observed SC-HI domains and both adherence (MOS-GAS) and decision-making (DMCI). All analyses were performed in Stata v14 (College Station, TX) or Mplus v.7.31 (Los Angeles, California).

Results

The sample of 193 adults was mostly (70%) female and ethnically diverse (60% Black, 32% White, 6% Latino, 2% Asian). The mean age was 56.4±13 years; mean duration of HTN was 11±9.4 years. Further details describing the sample are shown in Table 1.

Self-Care Maintenance

Item responses on the SC-HI are presented in Table 2. The easiest maintenance behavior for respondents was taking their medications as prescribed (item #7) and the most difficult

behavior was checking their BP daily (item #1). One item focused on alcohol consumption (item #10) had poor fit with other items and internal consistency was improved with its removal.

Removing this item resulted in a unidimensional scale with the best fit (Table 3). Cronbach's alpha on the SC-HI maintenance scale (without item 10) was 0.83, and it was strongly associated with adherence and with informed awareness (Table 4).

Self-Care Management

The easiest management behavior for respondents was being careful to take prescription medicines more regularly (item #16) and the most difficult management behavior was judging whether an action helped or not (item #18). Several items in this scale were problematic with regard to fitting with a single scale (Table 2); a single factor analysis of the SC-HI management items had poor fit ($\chi^2=21.9$, $p=0.015$; RMSEA=0.117; CFI=0.628, TLI=0.442, SRMR=0.199) and a 2 factor structure to management had better fit compared with the unidimensional structure (Table 5). The two factors in the self-care management scale were named "consultative" (e.g., recognizing high BP (item #13), calling a provider for guidance (item #17), and reducing salt in your diet (item #14) and "autonomous (i.e. reducing stress (item #15), refining medication adherence (item #16), and judging whether an action helped or not (item #18)). Reliability of the 2-factor self-care management structure was sufficient (FDS=0.75). The consultative factor was associated significantly with informed awareness but not general adherence, and the autonomous management factors was associated significantly with medication adherence and informed awareness (Table 4).

Self-Care Confidence

Participants were most confident in their ability to follow the treatment regimen (item #20), and least confident in their ability to control their BP (item #19); individual confidence

items formed a single scale (Table 2) with acceptable fit (Table 6). Reliability of the unidimensional self-care confidence structure was sufficient ($\alpha=0.83$). The single self-care confidence factor was associated significantly with adherence and both informed awareness and self-appraisal (Table 4).

Discussion

The purpose of this study was to test the psychometric properties of the SC-HI, a new measure of self-care designed for use with individuals with HTN. The results of this study illustrate that the SC-HI is reliable and valid and ready for further testing. Our findings support the conceptual basis as defined in the middle range theory of self-care in chronic illness⁴ of self-care in patients with HTN as a process of health maintenance within the context of management of HTN as a chronic condition. Self-care management of HTN requires monitoring of BP and associated symptoms as well as a timely response to elevated BP.

In this analysis self-care maintenance reflected 11 health promoting behaviors identified by experts as having a beneficial effect on BP lowering.^{1,6} These behaviors capture both treatment adherence and lifestyle activities—both of which are necessary for HTN control. Although the finding of a unidimensional maintenance scale differs from the other self-care instruments,^{19,28} it is consistent with the collective evidence that a health promoting lifestyle contributes to achieving BP control even in patients taking anti-HTN medications.⁶ For example, there is compelling evidence that weight loss, best achieved through a combination of decreased caloric intake and exercise, is associated with lower BP in pre-hypertension or stage 1 hypertension, but neither is likely to be fully effective without medication adherence in those with more elevated BP.^{29,30} According to The Lifestyle Work Group,⁶ the effects of both a heart healthy diet (i.e., vegetables, fruits, whole grains, low fat dairy products, poultry, fish, legumes and limited sweets and red meats) and reduced sodium intake are even greater when

combined.

Self-Care Management

Our analysis of the self-care management scale revealed two factors: consultative and autonomous. As a naturalistic decision making process, self-care management requires consideration of past experience in order to make a decision on what action to take in a specific situation.³¹ Accordingly, the consultative dimension of management included three behaviors: recognizing an elevated BP, reducing dietary salt, and calling a healthcare provider. We were surprised that dietary salt reduction was in the consultative dimension but perhaps this reflects the difficulty that people have in correctly labeling the sodium content of foods, **identifying hidden sodium sources in food** and that they require consultation with providers to reduce dietary sodium. These behaviors are standard components in patient education materials. For example patients are routinely instructed to measure and record BP at home and call a healthcare provider if a reading exceeds a specific level. Then in consultation with the provider, action is taken. Home BP monitoring has been used to evaluate the response to antihypertensive medicines and to optimize medication management.⁸

The second self-care management dimension, autonomous management (e.g., reduce stress, take medication regularly, evaluate if action helped) suggests a decision making process that is thoughtful or reflective. For example, using past experience, individuals may reflect on the potential reasons for their symptom or elevated BP. They may ponder if there is a stress-related reason, or perhaps consider if they had forgotten a medication. Then they may consider potential options or autonomous actions (i.e., manage stress, take medication) and the likely effectiveness of each behavior. This reflective process is consistent with the underlying theory and our prior work in heart failure self-care, also a naturalistic decision making process, in which

decisions are made based on experience, situation awareness and mental simulation of options.³¹

Self-Care Confidence

Similar to our other self-care instruments,^{19,32} the SC-HI confidence scale is a promising measure of self-efficacy defined by Bandura³³ as the confidence that one has in the ability to perform a specific task despite obstacles. Several large clinical trials of ethnic minority persons with HTN have demonstrated the importance of self-efficacy and engagement in health promoting behaviors associated with BP control.^{34,35} For example, in the Counseling of African Americans to Control Hypertension (CAATCH) trial (n=1039), self-efficacy for medication taking was higher in the intervention group than in the control group (p=.02).³⁶ Self-efficacy is often targeted in cardiovascular risk reduction interventions focused on increasing physical activity, diet modification, weight management and smoking cessation. Thus, the SC-HI self-confidence scale will be useful to researchers developing and testing HTN self-care interventions.

Limitations of this study include the small sample size that was recruited mostly from small urban communities and large medical centers. Additional testing in rural populations and those who are cared for in general primary care practices is warranted. Also, our sample was well-educated (mean of 15 years of education) and we did not assess health literacy. Further testing in populations with varied education and literacy levels is needed. In addition, test-retest reliability testing is still needed. Strengths of this study include the ethnically diverse sample and representation of ethnic minority women who are often underrepresented in HTN research. Although non-English speaking populations were excluded, efforts are currently underway to translate the SC-HI into Spanish, Portuguese, and Italian for additional psychometric testing. Part of this translation process is to ensure cultural appropriateness of the self-care items in other

populations.

Conclusions

Self-care is an essential component in controlling BP and preventing complications associated with HTN. The final 23-item SC-HI fills an important gap in the literature and is anticipated to be useful in research aimed at understanding and improving self-care among persons with HTN.

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Table 1: Sociodemographic Characteristics of the Sample of Adults with Hypertension

	Total N= 193
Age, y	56.4(13.5)
Gender	
Female	127 (70%)
Ethnicity	
Black	116 (60.1%)
Hispanic	12 (6.2%)
White	61 (31.6%)
Other	4 (2.1%)
Education, y	15 (3)
Marital Status	
Married/co-habiting	82 (42.5%)
Single, Widowed, Divorced	111 (57.5%)
Financial status	
Comfortable, more than enough	33 (29.2%)
Enough to make ends meet	64 (55.6%)
Not enough to make ends meet	16 (14.2%)
Length of HTN diagnosis, y	11 (9.4)
Median, y	10
percentiles 25 th	4
50 th	10
75 th	15

Data are presented as mean± SD or n (%); HTN – Hypertension; y-years

Table 2: Self-Care of Hypertension Item Analysis

Maintenance Items	Never or Rarely	Sometimes	Frequently	Always or Daily	mean±SD	Item-rest correlation	alpha if removed
1. Check your BP	19.2%	44.6%	29.5%	6.7%	2.24±0.84	0.36	0.79
2. Eat lots of fruits and vegetables	12.9%	37.6%	26.8%	22.7%	2.59±0.98	0.54	0.78
3. Do some physical activity	11.4%	35.2%	32.6%	20.7%	2.63±0.94	0.54	0.78
4. Keep doctor or nurse appointments	0.5%	9.4%	21.5%	68.6%	3.58±0.68	0.33	0.80
5. Eat a low salt diet	19.2%	31.6%	21.8%	27.5%	2.58±1.09	0.62	0.77
6. Exercise for 30 minutes	26.5%	30.7%	26.0%	16.7%	2.32±1.04	0.58	0.78
7. Take medicines as prescribed	3.2%	9.5%	7.9%	79.4%	3.63±0.78	0.41	0.79
8. Ask for low salt items when eating out or visiting others	51.6%	22.9%	13.5%	11.9%	1.86±1.05	0.49	0.79
9. Use a system to help you remember your medicines? For example, use a pill box or reminders.	41.9%	5.8%	6.3%	46.1%	2.57±1.42	0.32	0.80
10. Cut down on the alcohol you drink (If you never drink, circle 4 for always)	11.4%	12.4%	13.5%	62.7%	3.27±1.07	0.06	0.83
11. Eat a low fat diet	16.2%	44.8%	25.5%	13.5%	2.36±0.91	0.65	0.77
12. Try to lose weight or control your body weight	17.1%	36.8%	23.8%	22.3%	2.52±1.02	0.55	0.78
Management Items	I did not Recognize it/ Try Anything	Not Quickly/ Likely/ Sure	Somewhat Quickly/ Likely/ Sure	Quickly/ Likely/ Sure	Very Quickly/ Likely/ Sure	mean±SD	Item-rest correlation
13. How <i>quickly</i> did you recognize that your blood pressure was up	29.0%	11.0%	16.0%	22.0%	22.0%	1.97±1.55	0.27
14. Reduce the salt in your diet	-	12.8%	19.2%	29.1%	39.0%	2.94±1.05	0.44
15. Reduce your stress level	-	7.8%	23.4%	33.3%	35.5%	2.96±0.95	0.36
16. Be careful to take your prescription medicines more regularly	-	27.1%	4.3%	10.0%	58.6%	3.00±1.31	0.09
17. Call your doctor/ nurse for	-	25.0%	17.1%	20.0%	37.9%	2.71±1.21	0.13

Confidence Items	Not Confident	Somewhat Confident	Confident	Very Confident	mean±SD	Item-rest correlation	alpha if removed
guidance 18. How sure were you that the action helped or did not help	33.1%	18.3%	12.7%	20.4%	15.5%	1.67±1.50	0.29
19. Control your BP	4.2%	32.8%	45.5%	17.5%	2.76±0.79	0.45	0.80
20. Follow your treatment regimen	3.7%	19.2%	38.8%	38.3%	3.12±0.84	0.44	0.80
21. Recognize changes in your health	1.6%	22.9%	45.2%	30.3%	3.04±0.77	0.44	0.80
22. Evaluate changes in your BP	5.4%	27.8%	42.3%	24.6%	2.86±0.85	0.47	0.82
23. Take action that will control your BP	2.7%	21.3%	48.4%	27.7%	3.01±0.77	0.43	0.79
24. Evaluate how well an action works	7.9%	28.7%	42.6%	19.7%	2.75±0.86	0.45	0.81

Table 3: Self-Care of Hypertension Maintenance Exploratory Factor Analysis

Maintenance Items	Unidimensional
1. Check your blood pressure?	0.414*
2. Eat lots of fruits and vegetables?	0.700*
3. Do some physical activity?	0.718*
4. Keep doctor or nurse appointments?	0.438*
5. Eat a low salt diet?	0.758*
6. Exercise for 30 minutes?	0.779*
7. Take medicines as prescribed?	0.561*
8. Ask for low salt items when eating out or visiting others?	0.660*
9. Use a system to help you remember your medicines?	0.393*
11. Eat a low fat diet?	0.762*
12. Try to lose weight or control your body weight?	0.626*

$\chi^2=75.4$, $p=0.002$
RMSEA = 0.085
CFI = 0.973
TLI = 0.958
SRMSR = 0.060

* factor loadings significant at 5% level

Abbreviations: (CFI) comparative fit index, (RMSEA) root mean square errors of approximation, (SRMSR) standardized root mean square residual, (TLI) Tucker-Lewis index. Note that item 10, cut down on the alcohol you drink, has been deleted.

Table 4: Linear Correlations Between Self-Care of Hypertension Inventory Domains and Adherence and Decision-Making

Domain	Medical Outcomes Study		Decision-Making	
	General Adherence Survey	Informed Awareness	Self-Appraisal	Autonomy
<i>Maintenance</i>	0.729; p<0.001	0.500; p<0.001	-0.085; p=0.436	-0.083; p=0.450
<i>Management</i>				
Consultative	0.242; p=0.058	0.328; p=0.010	-0.081; p=0.535	-0.025; p=0.847
Autonomous	0.387; p<0.001	0.322; p=0.002	-0.014; p=0.895	-0.039; p=0.720
<i>Confidence</i>	0.342; p<0.001	0.365; p<0.001	-0.265; p=0.010	-0.178; p=0.089

Table 5: Self-Care of Hypertension Management Exploratory Factor Analysis

Management Items	Multidimensional	
	Consultative	Autonomous
13. How quickly did you recognize that your blood pressure was up?	0.824*	
14. Reduce the salt in your diet	0.317*	
15. Reduce your stress level		0.862*
16. Be careful to take your prescription medicines more regularly		0.616*
17. Call your doctor/ nurse for guidance	0.843*	
18. How sure were you that the action helped or did not help?		0.354*
	<hr/>	
	$\chi^2=10.7, p=0.154$	
	RMSEA = 0.07	
	CFI = 0.998	
	TLI = 0.997	
	SRMSR = 0.030	

* factor loadings significant at 5% level

Abbreviations: (CFI) comparative fit index, (RMSEA) root mean square errors of approximation, (SRMSR) standardized root mean square residual, (TLI) Tucker-Lewis index.

Table 6: Self-Care of Hypertension Confidence Exploratory Factor Analysis

Confidence Items	Unidimensional
19. Control your blood pressure?	0.728*
20. Follow your treatment regimen?	0.782*
21. Recognize changes in your health?	0.751*
22. Evaluate changes in your blood pressure?	0.653*
23. Take action that will control your blood pressure?	0.772*
24. Evaluate how well an action works?	0.686*
	$\chi^2=30.9, p=0.003$
	RMSEA = 0.071
	CFI = 0.979
	TLI = 0.965
	SRMSR = 0.051

* factor loadings significant at 5% level

Abbreviations: (CFI) comparative fit index, (RMSEA) root mean square errors of approximation, (SRMSR) standardized root mean square residual, (TLI) Tucker-Lewis index.