Cross-cultural assessment of the Self-Care of Chronic Illness Inventory: A psychometric evaluation

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ABSTRACT

Background. Self-care refers to behaviors that individuals adopt to prevent or maintain the stability of an illness (self-care maintenance), to monitor signs and symptoms (self-care monitoring), and to respond to signs and symptoms of an illness exacerbation (self-care management). A generic measure of self-care, the Self-Care of Chronic Illness Inventory, based on the Theory of Self-Care of Chronic Illness, was developed for use in individuals with any number and type of chronic conditions.

Objective. The current study investigated the measurement equivalence of the Self-Care of Chronic Illness Inventory in individuals from three different cultural groups. We were interested in determining if Italians, Swedes, and Americans interpret the measure in a conceptually similar way.

Methods. This cross-sectional study enrolled 1,629 patients, 784 recruited in Italy, 438 in Sweden and 407 in the United States. Self-care (self-care maintenance, self-care monitoring and self-care management) was measured with the Self-Care of Chronic Illness Inventory. A multi-group confirmatory factor analytic approach was used to assess the equivalence of the measures across the three countries. Configural, metric, scalar and strict invariance were tested through a series of nested models where increasingly stringent equality constraints were posited.

Results. Participants were mostly males (54.3%), older adults (68.9%) and had at least two chronic conditions. Results indicated that three out of four measurement equivalence levels were partially or totally supported in all three of the Self-Care of Chronic Illness Inventory scales. The partial scalar invariance level was reached for self-care maintenance [$\chi^2(50) = 63.495$, $p<0.0952$; RMSEA = 0.022, $p<0.999$, 90% C.I=0.000 0.038; CFI = 0.981; TLI = 0.977; SRMR = 0.036], self-care monitoring [$\chi^2(22) = 28.770$, $p<0.0952$; RMSEA = 0.024, $p<0.978$, 90% C.I=0.000 0.046; CFI =

0.996; TLI = 0.995; SRMR = 0.054], and self-care management [$\chi^2(51) = 91.334$, $p<0.0004$; RMSEA = 0.048, $p<0.576$, 90% C.I=0.031 0.063; CFI = 0.949; TLI = 0.937; SRMR = 0.047] scales.

Conclusions. These findings suggest that patients in the three countries used an identical cognitive framework or mental model when responding and used the 1–5 Likert response scale in an almost identical way, almost without bias. In spite of sociocultural differences, patients in these countries seem to share the same fundamental view of self-care. The results of the Self-Care of Chronic Illness Inventory will be comparable in these countries.

What is already known about the topic?

1. The burden of chronic illness is growing globally and self-care is an important part of illness management and therefore important to assess.
2. The Self-Care of Chronic Illness Inventory is a generic instrument developed to measure self-care behaviors. However, cultural beliefs can influence self-care behaviors and measurement interpretation.
3. In psychometric literature, measurement invariance indicates that the same construct is being measured across groups.

What this paper adds

1. The Self-Care of Chronic Illness Inventory was comparable in populations in Italy, Sweden, and the United States.
2. There was a shared construct of self-care, measured by the Self-Care of Chronic Illness Inventory, across study populations demonstrated by measurement equivalence.
3. Minor differences were identified in specific behaviors, but overall study results illustrated a shared mental model.

1. INTRODUCTION

Chronic, non-communicable illnesses such as cardiovascular disease, cancer, and diabetes, are highly prevalent across both developed and developing countries, accounting for about 60% of all deaths (Mendis et al., 2015; World Health Organization, 2011). Managing such illnesses requires mastering self-care. The Middle Range Theory of Self-Care of Chronic Illness provided the framework for the original instrument (Riegel et al., 2012). According to that theory, self-care

involves a process of self-care maintenance, monitoring, and management. The SC-CII instrument was designed to measures each of these self-care processes.

Assessment of this mastery is typically judged using self-report instruments. We have developed several self-report measures of self-care, which have been translated into many languages (Jaarsma et al., 2013, Riegel et al., 2016, Riegel et al., 2009, Sedlar et al., 2017, Vellone et al., 2013, Matarese et al., 2019). The benefit of translations is that self-care behaviors of patients can be compared across different countries and cultural groups. However, cultural beliefs may influence the manner in which instrument items are interpreted, so cross-cultural validation of health measures is needed to ensure the validity of rating scales (Cano and Hobart, 2011).

1.1. Background

Cross-cultural differences exist in values, expectations, nuances of meanings, attitudes, language, settings, and perceptions of individuals (Saint Arnault, 2018). People in some cultural groups may be unfamiliar with terms and the conceptual meaning being measured in a self-report instrument (Chen, 2008). Together these issues call into question our assumption that an instrument that is valid in one cultural group can be translated and used in another. Although self-care measures have been extensively studied in recent years, we know of only one prior study of self-care measurement invariance (Ausili et al., 2019).

The growing trend of translating and validating existing instruments is based on a critical assumption that standardized and validated measures are sufficient to allow comparison of results across countries and cultural groups. If that assumption holds true, then the results of such studies are considered valid and their interpretations across cultural groups are meaningful. However, just because an instrument is valid in one cultural group does not mean that the results can be compared to those from another cultural group (Beaton et al., 2000, Reichenheim and Moraes, 2007). When outcomes from different cultural groups are compared, investigators and clinicians are left wondering if differences reflect true group differences or measurement issues. If measures are

found to be comparable across groups, then meaningful comparisons can be made. Assessing measurement invariance allows users to determine if the content, semantic, and technical equivalence of research instruments used to assess patients' health in their own cultural context are valid (Epstein et al., 2015, Gjersing et al., 2010, Squires et al., 2013).

1.2. Aim

The study aim was to investigate the measurement equivalence of the Self-Care of Chronic Illness Inventory (SC-CII) in individuals from three different cultural groups from Italy, Sweden and the United States (US).

2. METHOD

2.1. Data sources

Data on self-care were gathered in three cultural groups - Italy, Sweden, and the United States - using a generic measure of self-care was developed based on the Theory of Self-Care of Chronic Illness (Riegel et al., 2018). This generic measure, the SC-CII (pronounced "sky"), was designed for use in individuals with any number and type of chronic conditions. The SC-CII measures self-care defined as a naturalistic decision-making process involving health promoting practices and illness management that involve self-care maintenance, self-care monitoring, and self-care management (Riegel et al., 2012). Self-care maintenance reflects primarily health promoting and maintenance behaviors such as exercise and taking medication as prescribed. Self-care monitoring involves checking oneself for changes in signs and symptoms. Self-care management reflects the response to changes in signs or symptoms when and if they occur (e.g. adjusting diet or medication based on detection and interpretation of symptoms). The three concepts – self-care maintenance, monitoring, and management – are closely related and thought to be mastered in sequence in many chronically ill individuals.

The 20-items of the SC-CII are divided among three separate scales measuring the three behavioral processes: self-care maintenance, monitoring and management. The 8-item Self-Care Maintenance scale had two dimensions: illness related and health promoting behavior. The 5-item Self-Care Monitoring scale had a single dimension. The 7-item Self-Care Management scale had two factors: autonomous and consulting behavior. Initial psychometric testing revealed content validity and adequate reliability of the three scales (Riegel et al., 2018). Based on this testing, we suggested further testing in diverse populations. The testing reported in this article was done in five multicenter studies conducted in the three countries. All of the studies used cross-sectional methods because our goal was to test psychometric properties, not to assess change over time.

2.2. Study population

Italian data. Three Italian datasets were used for this study. The first dataset was obtained from a multicenter cross-sectional study aimed at measuring the psychometrics properties of the SC-CII in Italian outpatients and inpatients recruited in Southern and Central Italy. Patient inclusion criteria were aged 18 years and over, and suffering from heart failure (HF), chronic obstructive pulmonary disease (COPD), type I or type II Diabetes mellitus (DM), or Parkinson's disease for at least a year. Patients with a confirmed diagnosis of dementia were excluded. The second dataset was from a cross-sectional study conducted to assess outcomes associated with self-care in outpatients with type 2 DM enrolled in Northern Italy (Ausili et al., 2017). In this study, patients 18 years of age and older and with a confirmed diagnosis of type 2 DM were recruited. Those with documented cognitive impairment and severe illiteracy (i.e. completely not able to answer the study questionnaires) were excluded (Ausili et al., 2017). The third dataset was baseline data of a longitudinal study conducted to assess self-care in inpatients and outpatients with chronic conditions and their family caregivers enrolled in Southern and Central Italy (De Maria et al., 2018). The patient inclusion criteria were age 65 years and older, a diagnosis of DM, COPD, or HF and at least one other chronic illness, and ability to provide informed consent. Exclusion criteria

were a diagnosis of cancer or dementia (De Maria et al., 2018). The total Italian sample included 784 patients with chronic diseases.

Swedish data. The data come from a cross-sectional study with a consecutive sampling of more than 1000 participants, conducted to describe continuity of care and self-care in cardiac patients following an unplanned hospitalization. Inclusion criteria for this analysis specified inclusion of all patients with a cardiac diagnosis (e.g., HF, arrhythmia, angina) plus at least one additional comorbid illness. Exclusion criteria were dementia or inability to read and write in Swedish. Six to eight weeks after discharge from the hospital, study participants were mailed a survey packet, which included the SC-CII to measure self-care behaviors. In total, 438 Swedes contributed data to this analysis.

US data. The participant from the original psychometric testing of the SC-CII were used in the current analysis (Riegel et al., 2018). These cross-sectional data were collected at inpatient and outpatient settings at five sites in the United States. An additional 19 patients were recruited through ResearchMatch.org, an electronic, web-based registry supported by the US National Institutes of Health where people volunteer to participate in research studies. Inclusion criteria were adults over age 18 years with a chronic condition. Exclusion criteria were dementia or inability to read and write in English. Overall, the US sample included 407 adults with predominately hypertension, HF, DM and/or arthritis (Riegel et al., 2018).

2.3. Data Collection

The primary data on self-care were collected using the self-report survey. Additional clinical and descriptive data were collected from the medical records, by interview or by self-report. When data were collected in person, patients presenting vision or functional impairments that precluded independent questionnaire completion were assisted by trained research assistants if they otherwise met inclusion and exclusion criteria.

2.4. Measurements

Patients' sociodemographic characteristics, including age, gender, education level, occupation, and marital status were collected. Clinical data collected included years from the first diagnosed chronic condition and the number of chronic diseases.

The SC-CII was originally drafted in English, so the Italian and Swedish versions were translated and back-translated following the Principles of Good Practice for the Translation and Cultural Adaptation Process for Patient-Reported Outcomes (PRO) Measures (Wild et al., 2005). The Italian version was pilot tested for clarity and comprehensibility in a sample of 30 chronically ill patients. For the Swedish version, interpretation, comprehension and cultural relevance was checked using cognitive interviewing techniques in five out-patients recruited from a heart failure clinic. Based on the patients' suggestions, minor editing changes were made in both translated versions. All of these minor edits were reviewed and approved by the authors of the original instrument.

2.5. Ethical considerations

This research was conducted according to the principles of the Declaration of Helsinki and in accordance with the Medical Research Involving Human Subjects Act of the country where the data were collected. Authorization was obtained from the Institutional Review Boards or the regional ethical committee of participating centers in Italy, Sweden and the US. The SC-CII was completed by study participants after providing informed consent.

2.6. Statistical analyses

Descriptive statistics (i.e. means, standard deviations, percentages) were used to describe the sociodemographic characteristics of the samples and the study variables. Measurement equivalence (ME) was used to determine whether the interpretation of the measured constructs was conceptually similar in the different cultures. We used the framework developed by Meredith (1993) to test ME,

implemented via Multiple Group Confirmatory Factor Analysis (MG-CFA) (Bollen, 1989). Meredith's framework specifies four different levels of ME (Table 1). In examining metric, scalar and strict ME, if all constraints are tenable, one can claim *complete* metric, scalar, or strict ME. However, when specific constraints are untenable, they can be relaxed to achieve a less stringent but more fitting form of ME called *partial (metric, scalar or strict) invariance* (Byrne et al., 1989).

In this study we tested these increasingly stringent levels of ME of the three SC-CII scales. In a series of nested models, we tested increasingly stringent equality constraints posited on the item parameters. We compared goodness of fit indices to examine the extent to which additional constraints reduced model fit. Tests showing that the model fit did not decrease significantly supported a claim that the constraints were appropriate and justified (Cigularov et al., 2013).

The results obtained in the US validation of SC-CII (Riegel et al., 2018) were considered the benchmark for the factor pattern in the MG-CFA models, on which other results were compared. Item #7 of the Self Care Maintenance scale ("Avoid cigarettes and tobacco smoke") was excluded in this analysis as in the original psychometric testing. Since the SC-CII items were not normally distributed, we used a robust maximum likelihood estimator (ML-R estimator). To assess model fit (Tanaka, 1993), we consider the following goodness of fit indices: Comparative Fit Index (CFI) 0.90–0.95 indicates acceptable fit, >0.95 indicates good fit. Root Mean Square Error of Approximation (RMSEA) ≤ .05 indicates a well-fitting model, 0.05–0.08 indicates moderate fit, and ≥0.10 indicates poor fit. RMSEA with 90% confidence intervals (lower bound ≤ 0.05 to upper bound ≤ 0.08) indicates good fit (MacCallum, 1996). The test of close-fit examines the probability that the approximation error is low (p-values >0.05 indicates good fit). Standardized Root Mean Square Residual (SRMR) ≤0.08 indicates good fit (Hu and Bentler, 1999). Traditional chi-square statistics (χ^2) are also reported, but due to the sensitivity of the chi-square likelihood ratio test to sample size, chi-square test results were not used in interpreting model fit.

To compare the fit of nested models, chi-square difference tests (χ^2_{diff}) have been used by others; however, because of the large sample size, we used the difference in CFI (ΔCFI). Here, a

ΔCFI >0.01 indicates a meaningful change in model fit (Cheung and Rensvold, 2002).To further investigate where a lack of equivalence may exist, modification indices were examined (Cigularov et al., 2013, Ployhart and Oswald, 2004). Descriptive statistics were computed using SPSS version 21 while confirmatory factor analyses were conducted using Mplus 8.2 (Muthén and Muthén, 1998-2017).

3. RESULTS

3.1. Sample

The sociodemographic and clinical characteristics of the Italian, Swedish and US samples are summarized in Table 1. In total, we enrolled a sample of 1,629 patients, 784 recruited in Italy, 438 in Sweden, and 407 in the US. Most (68.9%) participants were older adults age 65 years or older with a mean age that ranged from 63 (US sample) to 75 (Swedish sample) years. The primary condition was diagnosed on average 10 years before and all participants had at least two chronic conditions. Overall, more men than women were enrolled.

Table 2. Sociodemographic and clinical characteristics of Italian, Swedish and the US samples.

Variables/Countries	**Italy (n=784)**	**Sweden (n=438)**	**US (n=407)**
	M ±SD (n)	M ±SD (n)	M ±SD (n)
Age (years)	71.31 ±11.43 (784)	75.00 ±9.3 (438)	62.94 ±14.99 (406)
Years since diagnosis of primary chronic condition	10.75 ±8.36 (626)	NA	10.33±9.74 (169)
Number of comorbid conditions	3.85 ±1.33 (522)	2.36 ±0.72 (438)	2.71±1.33 (406)
Gender:	% (n)	% (n)	% (n)
I. Female	49.11 (385)	36.50 (160)	45.54 (184)
II. Male	50.89 (399)	63.50 (278)	54.46 (220)
Education:			
I. Less than high school	74.94 (586)	53.70 (235)	10.84 (44)
II. High School or secondary education	19.95 (156)	32.2 (141)	27.59 (112)
III. Some College/University degree	5.12 (40)	14.2 (62)	61.58 (250)
Marital Status:			
I. Single/never married	6.69 (35)	34.25 (150)*	15.06 (53)
II. Married	60.23 (315)	65.75 (288)*	67.90 (239)
III. Divorced/Widowed	33.08 (173)	-	17.05 (60)
Occupation:			
I. Employed	23.28 (122)	16.00 (70)	37.11 (131)
II. Retired/unemployed	76.72 (402)	84.00 (368)	62.89 (222)

SD= standard deviation; **NA**= no data available

*For the Swedish population the two options were single or married/living with a partner.

3.2. Self-Care Maintenance scale

A first test of configural invariance *for the Self-Care Maintenance scale* was not completely adequate, with fit indices as follow: $\chi^2(39) = 98.95$, $p < 0.001$; RMSEA = 0.054, p = 0.312, 90% CI = 0.041 0.067; CFI = 0.92; TLI = 0.87; SRMR = 0.037. An inspection of modification indices (MI) revealed that one residual covariance in the US data (items #3 and #4) and two residual covariances in the Italian data (items #3 and #4, and items #5 and #4) had to be specified to improve the fit. The re-specified model had excellent fit (Table 3). Configural invariance was demonstrated since the same number of factors as well as the same pattern of fixed and free loadings held across the three countries.

When constraints on loadings were introduced to test metric invariance, the model fit was adequate: $\chi^2(46) = 71.70$, $p<0.001$; RMSEA = 0.032, p = 0.984, 90% CI = 0.016, 0.046; CFI = 0.97; TLI = 0.95; SRMR = 0.048. However, an inspection of the MI revealed that the constraint on the factor loading of item #2 (Try to avoid getting sick) in the US sample was not tenable ($p < 0.01$) (Scott-Lennox & Scott-Lennox, 1995). This constraint was relaxed and *partial* metric invariance model was achieved. The fit indices of this model are presented in Table 3. The difference between configural and partial metric models was not significant, $\chi^2_{diff}(9) = 14.965$, p=0.09, ΔCFI = 0.008.

When constraints on item intercepts were introduced, scalar invariance was not tenable, $\chi^2(54) = 469.7$, $p < 0.001$; RMSEA = 0.12, $p < 0.001$, 90% CI = 0.11, 0.13; CFI = 0.43; TLI = 0.33; SRMR = .011. In the US sample, constraints on item intercepts for #2, #3 and #5 resulted in a significant MI ($p<.01$), in Italy a constraint on the intercept of item #5 was significant, and in the Swedish sample, constraints on item intercepts #4 and #5 were significant. Once the constraints on these items intercepts were relaxed, the model fit improved dramatically (Table 3) and the difference between the chi-square of the partial scalar and the partial metric invariance models was

not significant, $\chi^2_{diff}(5) = 2.259$, p = 0.81, ΔCFI = -0.003. Thus, partial scalar invariance was reached.

When constraints on item residual variance were introduced, strict invariance was not tenable, $\chi^2(64) = 306$, p < 0.001; RMSEA = 0.084, p < 0.001, 90% C.I = 0.075 0.093; CFI = 0.67; TLI = 0.67; SRMR = 0.22. Five out of seven sets of constraints on residual variances were untenable, so strict invariance was not reached, even in partial form. The factor loadings of the final scalar partial invariant solution are presented in Table 3, second panel. Factor correlations were 0.72 in Italy, 0.61 in Sweden, and 0.49 in the US. The correlation between residuals of items #3 and #4 was 0.24 in Italy and 0.16 in the US. The correlation between residual of items #4 and #5 was 0.21 in Italy.

Table 3. Model fit indices the MG-CFA for testing Measurement Invariance and factor loadings estimates from the final solutions of Self-Care Maintenance scale

Self-Care Maintenance scale

	χ2	**DF**	**p(χ2)**	**CFI**	**SRMR**	**RMSEA and 90% Confidence Interval, *p*(RMSEA<0.05)**
CONFIGURAL	45.965	36	0.1235	0.986	0.026	0.023 0,000 0.040 (p= 0.997)
METRIC PARTIAL	60.993	45	0.0567	0.978	0.036	0.026 0.000 0.041 (p= 0.997)
SCALAR PARTIAL	63.495	50	0.0952	0.981	0.036	0.022 0.000 0.038 (p= 0.999)

Item	**Italy**		**Sweden**		**USA**	
	F1	F2	F1	F2	F1	F2
1. Make sure to get enough sleep?	0.455	0	0.598		0.641	0
3. Do physical activity (e.g., take a brisk walk, use the stairs)?	0.274	0	0.340		0.391	0
8. Manage stress?	0.461	0	0.545		0.586	0
2. Try to avoid getting sick (e.g., flu shot, wash your hands)?	0	0.319		0.234	0	0.396*
4. Eat a special diet?	0	0.521		0.433	0	0.339
5. See your healthcare provider for routine health care?	0	0.519		0.274	0	0.679
6. Take prescribed medicines without missing a dose?	0	0.511		0.467	0	0.630

F1 is Health Promoting Behavior; F2 is Illness Related Behavior

χ2= chi-square; **DF**=Degree of Freedom; **CFI**=Comparative Fit Index; **SRMR**=Standardized Root Mean Square Residual; **RMSEA**=Root Mean Square Error of Approximation.
The loadings estimates come from the completely standardized solution. Since constraints are imposed on the unstandardized estimates, factor loadings differ only apparently across the 3 countries. All loadings are invariant except where noted by *.

3.3. Self-Care Monitoring scale

In a first test of configural invariance *for the Self-Care Monitoring scale*, the MG-CFA model included the covariance between the residuals of items #9 and #10, consistent with the original psychometric analysis (Riegel et al 2018). This test was not adequate, with the following fit indices: $\chi^2(12) = 133.36$, $p < 0.001$; RMSEA = 0.138, $p < 0.001$, 90% CI = 0.12, 0.159; CFI =0.93; TLI = 0.82; SRMR = 0.043. An inspection of MI revealed that one residual covariance in the Swedish data (items #11 and #9) had to be specified to improve model fit. The re-specified model had excellent fit (Table 4). Thus, configural invariance was demonstrated.

When constraints on loadings were introduced, the model had an adequate fit: $\chi^2(19) = 53.83$, $p < 0.001$; RMSEA = 0.059, $p = 0.20$, 90% CI = 0.04, 0.077; CFI = 0.98; TLI = 0.97; SRMR = 0.10. However, inspection of the MI revealed that the constraint on factor loading of item #11 (monitor for medication side-effects) in the Swedish sample was not tenable ($p < 0.01$). This constraint was relaxed and *partial* metric invariance was achieved (Table 4). The difference between configural and partial metric invariance models was not significant, $\chi^2_{diff}(7) = 9.891$, $p = 0.19$, ΔCFI = 0.001. Moreover, all of the constraints imposed on the factor loadings (except the one relaxed, as noted above) were tenable since they were not associated with a significant MI.

When constraints on item intercepts were introduced, complete scalar invariance was not tenable, $\chi^2(26) = 146.5$, $p < 0.001$; RMSEA = 0.093, $p < 0.001$, 90% CI = 0.079, 0.11; CFI = 0.93; TLI = 0.92; SRMR = 0.10. The constraints on item intercepts for #3 in the Italian and #10, #11 and #14 in the Swedish data were not tenable. The respecified model without these constraints supported partial scalar invariance (Table 4). Further, the difference between the chi-square analyses of the metric and the partial scalar invariance models was not significant, $\chi^2_{diff}(4) = 5.526$, $p = 0.24$, ΔCFI = 0.001.

When constraints on item residual variance were introduced, strict invariance was not tenable, $\chi^2(32) = 195$, $p < 0.001$; RMSEA = 0.10, $p < 0.001$, 90% CI = 0.085, 0.11; CFI = 0.90; TLI = 0.91; SRMR = 0.24. Moreover, four out of five constraints were untenable. Thus, strict invariance was not reached in either the complete or the partial form.

Factor loadings of the final partial scalar invariant solution are presented in Table 4, second panel. The correlation between residuals of items #9 and #10 was 0.39 in Italy, 0.07 in Sweden, and 0.38 in the US. The correlation between residual of items #9 and #11 was 0.68 in Sweden.

Table 4. Model fit indices the MG-CFA for testing Measurement Invariance and factor loadings estimates from the final solutions of Self-Care Monitoring scale

Self-Care Monitoring scale

	χ2	**DF**	**p(χ2)**	**CFI**	**SRMR**	**RMSEA and 90% Confidence Interval, *p*(RMSEA<0.05)**
CONFIGURAL	13.615	11	0.2550	0.998	0.012	0.021 0.000 0.053 (p= 0.931)
METRIC	23.322	18	0.1785	0.997	0.050	0.024 0.000 0.048 (p= 0.966)
SCALAR PARTIAL	28.770	22	0.1516	0.996	0.054	0.024 0.000 0.046 (p= 0.978)

Item	**Italy**	**Sweden**	**USA**
9. Monitor your condition?	0.574	0.629	0.580
10. Pay attention to changes in how you feel?	0.651	0.559	0.715
11. Monitor for medication side-effects?	0.669	0.670*	0.731
12. Monitor whether you tire more than usual doing normal activities?	0.694	0.772	0.751
13. Monitor for symptoms?	0.773	0.856	0.862

χ2= chi square; **DF**=Degree of Freedom; **CFI**=Comparative Fit Index; **SRMR**=Standardized Root Mean Square Residual; **RMSEA**=Root Mean Square Error of Approximation.
The loadings estimates come from the completely standardized solution. Since constraints are imposed on the unstandardized estimates, factor loadings differ only apparently across the 3 countries. All loadings are invariant except where noted by *.

3.4. Self-Care Management scale

A first test for configural invariance *for the Self-Care Management scale* was not adequate, with the following fit indices: $\chi^2(39) = 146.73$, $p < 0.001$; RMSEA = 0.089, $p < 0.001$, 90% CI=0.074, 0.105; CFI = 0.86; TLI = 0.78; SRMR = 0.057. An inspection of the MI revealed that the

main cause of misfit was attributing item #17 (take a medicine to make the symptom decrease or go away) to factor 2 (Consulting Behavior) in the Swedish data. The meaning of this item is also congruent with Autonomous Behavior, another factor that refers to the capability of the patient to recognize symptoms, to change eating and drinking habits and activity level. The re-specification of the model with item #17 attributed to factor 1 (Autonomous Behavior) in all three countries was supported by excellent fit indices. In addition, factor loadings of this items in the Italian and the US data were higher than those obtained when these items were attributed to factor 2. The final configural invariance model (Table 5) incorporates the covariance between residuals of items #14 and #20, as suggested by the MI.

When constraints on loadings were introduced, the model fit adequately: $\chi^2(46) = 94.05$, $p < 0.001$; RMSEA = 0.055, p = 0.292, 90% CI = 0.039, 0.071; CFI = 0.94; TLI = 0.92; SRMR = 0.053. However, an inspection of the MI revealed that the constraint on the factor loading of item #17 (take a medicine to make the symptom decrease or go away) in the Swedish sample was not tenable ($p < 0.01$). This constraint was relaxed and a *partial* metric invariance model was achieved. The fit indices of this model are presented in Table 5. The goodness of fit of this model was confirmed by the non-significant difference between the chi-square of configural and partial metric invariance models, $\chi^2_{diff}(9) = 13.205$, p = 0.15, ΔCFI = 0.005.

When constraints on item intercepts were introduced, scalar invariance was untenable: $\chi^2(54) = 166$, $p<0.001$; RMSEA = 0.077, $p < 0.001$, 90% CI = 0.064, 0.091; CFI = 0.86; TLI = 0.83; SRMR = 0.067. An inspection of the MI revealed that the constraints on intercepts of items #14 and #18 in the Italian data and item #16 in the Swedish data were untenable. (Note that the item intercept of #17 was already specified as not being invariant in the Swedish data since it was associated with a non-invariant factor loading). The re-specified model, without these constraints, supported partial scalar invariance (Table 5). This level was also supported by a non-significant

difference among the chi-squares of the partial metric and partial scalar models: $\chi^2_{diff}(6) = 10.116$, p = 0.12, ΔCFI = 0.006.

When constraints on item residual variance were introduced, strict invariance was not completely adequate: $\chi^2(65) = 152$, p < 0.001; RMSEA = 0.062, p = 0.058, 90% CI = 0.049, 0.075; CFI = 0.89; TLI = 0.89; SRMR = 0.09. Four out of seven constraints were untenable. Thus, strict invariance was not achieved in either the complete or partial form.

The factor loadings of the final scalar partial invariant solution are presented in Table 5, second panel. Factor correlations were 0.55 in Italy, 0.57 in Sweden, and 0.51 in the US. The correlation between residuals of items #14 and #20 were 0.31 in Italy and 0.16 in Sweden.

Table 5. Model fit indices the MG-CFA for testing Measurement Invariance and factor loadings estimates from the final solutions of Self-Care Management scale

Self-Care Management scale

	χ2	DF	p(χ2)	CFI	SRMR	RMSEA and 90%Confidence Interval, *p*(RMSEA<0.05)
CONFIGURAL	68.101	36	0.0010	0.959	0.037	0.051 0.032 0.069 (p= 0.453)
METRIC PARTIAL	81.188	45	0.0008	0.954	0.046	0.048 0.031 0.065 (p= 0.553)
SCALAR PARTIAL	91.334	51	0.0004	0.949	0.047	0.048 0.031 0.063 (p= 0.576)

Self-Care Management scale	Italy		Sweden		USA	
	F1	F2	F1	F2	F1	F2
14. If you had symptoms in the past month, how quickly did you recognize it as a symptom of your illness?	0.287	0	0.312	0	0.361	0
15. When you have symptoms, how likely are you to …change what you eat or drink to make the symptom decrease or go away?	0.577	0	0.605	0	0.663	0
16. Change your activity level (e.g., slow down, rest)?	0.463	0	0.585	0	0.562	0
20. Think of a treatment you used the last time you had symptoms. Did the treatment you used make you feel better?	0.498	0	0.464	0	0.505	0
17. Take a medicine to make the symptom decrease or go away?	0.291	0	0.616*	0	0.332	0
18. Tell your healthcare provider about the symptom at the next office visit?	0	0.741		0.731	0	0.777
19. Call your healthcare provider for guidance?	0	0.653		0.663	0	0.658

F1 is Autonomous Behavior; F2 is Consulting Behavior

$\chi 2$= chi square; **DF**=Degree of Freedom; **CFI**=Comparative Fit Index; **SRMR**=Standardized Root Mean Square Residual; **RMSEA**=Root Mean Square Error of Approximation.
The loadings estimates come from the completely standardized solution. Since constraints are imposed on the unstandardized estimates, factor loadings differ only apparently across the 3 countries. All loadings are invariant except where noted by *.

4. DISCUSSION

The aim of this study was to investigate the measurement equivalence of the SC-CII in individuals from three different cultural groups. We set out to determine if chronically ill Italians, Swedes, and Americans interpreted the self-care measure in a conceptually similar way. Using the conceptual framework by Meredith (1993), the results indicate that three of four ME levels were fully or partially supported. Specifically, partial scalar invariance was reached in all three of the SC-CII scales. This result indicates that comparisons of self-care among these three populations and cultures are valid (Byrne et al., 1989). Thus, when differences in self-care are identified among samples in Italy, Sweden, and/or the US, we can be confident that true differences exist, which boosts the generalizability of research findings on self-care of chronic illness using the SC-CII.

Strong support for invariance for the SC-CII scales was provided by the results of this study. In particular, these findings suggest that patients in Italy, Sweden and the US (1) use the same mental model or cognitive framework when responding to questionnaire items (as indicated by configural equivalence), (2) use the 1–5 Likert response scale in a very similar or almost identical way (as shown by metric or partial metric equivalence), and (3) respond to the items with limited bias (as demonstrated by partial scalar equivalence). These results suggest that despite sociocultural differences among Italy, Sweden, and the US, patients in these three countries share the same fundamental view of self-care as assessed by the SC-CII.

4.1. Self-Care Maintenance scale

In the self-care maintenance scale, we demonstrated cultural invariance up to the partial scalar level, meaning that people in these three countries conceptualize self-care as including both

"health promoting behaviors" and "illness related behaviors" (configural invariance) and that these two latent variables influence the same observed behaviors aimed at maintaining the physiological and mental stability of the chronic condition (metric invariance). Minor differences among the three populations were observed in specific items when we tested metric and scalar invariance. Specifically, at the level of metric invariance, item #2 (try to avoid getting sick) loaded higher in the US. This means that in the US, the latent variable "illness related behaviors" was reflected more by item 2 than in Italy or Sweden. When testing scalar invariance, we observed that people in the US used higher scores when evaluating their physical activity (item #3), their diet (item #4), and in seeing a healthcare provider for routine care (item #5). These results may indicate a differential functioning of these items in the three countries, meaning that there is an unknown element that systematically distorts the scores of these items. Further research is needed to clarify this issue.

Our findings are consistent with a prior study of heart failure patients from 15 countries that found that Italians exercised less and took medication less regularly than Swedish and American people (Jaarsma et al., 2013). Together these findings suggest that people in the US may emphasize illness avoidance more than the other two populations. That is, Americans may be more health conscious than the other two groups or cultural differences in perceptions of vulnerability and control may explain these differences among the groups.

4.2. Self-Care Monitoring scale

In testing the self-care monitoring scale, we demonstrated configural, partial metric, and partial scalar invariance. These results demonstrate that Italian, Swedish, and US people have the same conceptual definition of self-care monitoring (configural invariance) and use the same behaviors, such as monitoring for medication side-effects, but attribute different weight (i.e., importance) to each of them. Specifically, at the metric invariance level, item #11 (monitoring for medication side-effects) loaded higher in the Swedes, item #13 (symptom monitoring) loaded higher in the Italians, while item #10 (paying attention to health changes) loaded lower in the

Swedes. Having demonstrated partial metric invariance suggests that these differences may reflect actual group differences.

4.3. Self-Care Management scale

In testing the self-care management scale, we found an issue with configural invariance. When we relaxed constraints on item #17 (Take a medicine to make the symptom decrease or go away) and attributed it to factor 1 (Autonomous Behavior), excellent fit indices were obtained in all three countries. Then, when we tested metric invariance, we needed to relax constraints on items #14 (symptom recognition) and #18 (consulting the provider), both of which were underestimated in the Italian population. We relaxed constraints on item #16 (change activity with symptoms) and item #17, both of which loaded significantly higher in Sweden than in the other two countries. These differences appear to reflect the different approaches that diverse populations use to deal with signs and symptoms. Further research is needed to test this hypothesis.

4.4. Implication for practice

It is important to measure self-care in individuals with a chronic illness because it is often necessary to regulate and adapt self-care throughout the course of an illness, for example with an exacerbation, if another illness is diagnosed, or if an advanced treatment is needed (Riegel et al., 2018). Self-care is the predominant form of care for chronically ill individuals and investigators around the world are studying self-care. Here we empirically highlight the importance of establishing that the research instrument we use are comparable among respondents from different nations and cultural background. The results of this study suggest that it is valid to compare scores on the SC-CII between these different groups. That is, we can now confidently assume that the meaning of self-care in chronic illnesses as measured by the SC-CII is substantially the same in Italy, Sweden, and the US. This is important because it represents a first evidence that the concept of self-care, at least in this configuration, could be universal with behaviors focused on maintaining

stability of the chronic illness, monitoring signs and symptoms of the illness, and doing something when the illness worsens.

The results of this study emphasize the importance of nurses and other health care professionals to acknowledge that different cultural groups share values, norms, feelings, and ways of thinking that shape how they think and behave. Cultural variations can influence how people behave in response to stimuli such as symptoms. Such information will help guide clinicians seeking better approaches to improving self-care across multiple contexts, languages, and cultures.

4.5. Strengths and Limitations

The major strength of the current study is our empirical evidence of the cross-country measurement equivalence of the SC-CII scales. There are also several limitations that must be acknowledged. Although we present a rigorous test of the ME, we compared only three countries. Clearly, further research is needed in other cultural and national contexts. Moreover, because we compared three countries with numerous sociocultural differences (in addition to language), we could not disentangle any observed non-invariance attributable to culture versus language. Another limitation was that strict invariance was not reached in any of SC-CII scales. This result suggests that certain items may be interpreted uniquely in the three countries. It could also be attributable to varying measurement error among the different countries, cultural or language idiosyncrasies, or a combination of the two. Further study is needed to explain this phenomenon. However, since invariance was largely supported, this is less of an issue in the current study. Another limitation is the use of convenience samples in Italy and the US; only the Swedish sample was consecutive. While acknowledging these limitations, it is important to note that the literature on measurement bias (Mellenbergh, 1989) suggests that while sample differences (or heterogeneity) might be a source of bias, this diversity is not typically considered a reason for ME, as found in the current study.

5. CONCLUSION

In conclusion, our study demonstrates an excellent level of invariance in the SC-CII among the Italian, Swedish and US populations. Further studies, especially those using mixed methodologies, could illuminate the reasons why some self-care behaviors are not invariant in the three population. Further research is also needed to see if the self-care construct that is common in Italian, Sweden and the US is valid for other populations. Future studies sampling patients from different sites in these countries may increase the generalizability of our findings.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethics approval

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REFERENCES

Ausili, D., Bulgheroni, M., Ballatore, P., Specchia, C., Ajdini, A., Bezze, S., Di Mauro, S., Genovese, S., 2017. Self-care, quality of life and clinical outcomes of type 2 diabetes patients: an observational cross-sectional study. Acta Diabetologica 54 (11), 1001-1008.

Ausili, D., Riegel, B., Barbaranelli, C., 2019. Generalizability of the Self-Care of Diabetes Inventory Across Cultures and Languages: Italy and the United States. Evaluations & the health professions 1, 163278719840689.

Beaton, D.E., Bombardier, C., Guillemin, F., Ferraz, M.B., 2000. Guidelines for the process of cross-cultural adaptation of self-report measures. Spine 25 (24), 3186-3191.

Bollen, K.A., 1989. A new incremental fit index for general structural equation models. Sociological Methods & Research 17 (3), 303-316.

Byrne, B.M., Shavelson, R.J., Muthén, B., 1989. Testing for the equivalence of factor covariance and mean structures: the issue of partial measurement invariance. Psychological bulletin 105 (3), 456.

Cano, S.J., Hobart, J.C., 2011. The problem with health measurement. Patient preference and adherence 5, 279.

Chen, F.F., 2008. What happens if we compare chopsticks with forks? The impact of making inappropriate comparisons in cross-cultural research. Journal of personality and social psychology 95 (5), 1005.

Cheung, G.W., Rensvold, R.B., 2002. Evaluating goodness-of-fit indexes for testing measurement invariance. Structural equation modeling 9 (2), 233-255.

Cigularov, K.P., Adams, S., Gittleman, J.L., Haile, E., Chen, P.Y., 2013. Measurement equivalence and mean comparisons of a safety climate measure across construction trades. Accidident Analysis & Prevention 51, 68-77.

De Maria, M., Vellone, E., Ausili, D., Alvaro, R., Di Mauro, S., Piredda, M., De Marinis, M., Matarese, M., 2018. Self-care of patient and caregiver DyAds in multiple chronic conditions: A LongITudinal studY (SODALITY) protocol. Journal of advanced nursing, 75 (2), 461-471.

Epstein, J., Santo, R.M., Guillemin, F., 2015. A review of guidelines for cross-cultural adaptation of questionnaires could not bring out a consensus. Journal of clinical epidemiology 68 (4), 435-441.

Gjersing, L., Caplehorn, J.R., Clausen, T., 2010. Cross-cultural adaptation of research instruments: language, setting, time and statistical considerations. BMC medical research methodology 10 (1), 13.

Hu, L.T., Bentler, P.M., 1999. Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria Versus New Alternatives. Structural Equation Modeling-a Multidisciplinary Journal 6 (1), 1-55.

Jaarsma, T., Stromberg, A., Ben Gal, T., Cameron, J., Driscoll, A., Duengen, H.D., Inkrot, S., Huang, T.Y., Huyen, N.N., Kato, N., Koberich, S., Lupon, J., Moser, D.K., Pulignano, G., Rabelo,

E.R., Suwanno, J., Thompson, D.R., Vellone, E., Alvaro, R., Yu, D., Riegel, B., 2013. Comparison of self-care behaviors of heart failure patients in 15 countries worldwide. Patient Education & Counseling 92 (1), 114-120.

MacCallum, R.C., Browne, M. W., & Sugawara, H. M, 1996. Power analysis and determination of sample size for covariance structure modeling. Psychological methods 1, 130.

Matarese, M., Clari, M., De Marinis, M. G., Barbaranelli, C., Ivziku, D., Piredda, M., & Riegel, B., 2019. The Self-Care in Chronic Obstructive Pulmonary Disease Inventory: Development and Psychometric Evaluation. Evaluation & the health professions, 0163278719856660.

Mellenbergh, G.J., 1989. Item bias and item response theory. International Journal of Educational Research 13, 127–143.

Mendis, S., Davis, S., Norrving, B., 2015. Organizational update: the world health organization global status report on noncommunicable diseases 2014; one more landmark step in the combat against stroke and vascular disease. Stroke 46 (5), e121-122.

Meredith, W., 1993. Measurement invariance, factor analysis and factorial invariance. Psychometrika, *58*(4), 525-543.

Muthén, L.K., Muthén, B.O., 1998-2017. Mplus User's Guide. Muthén & Muthén, Los Angeles, CA.

World Health Organization, 2011. NCD mortality and morbidity. Global Health Observatory. Geneva: WHO.

Ployhart, R.E., Oswald, F.L., 2004. Applications of mean and covariance structure analysis: Integrating correlational and experimental approaches. Organizational Research Methods 7 (1), 27-65.

Reichenheim, M.E., Moraes, C.L., 2007. Operationalizing the cross-cultural adaptation of epidemological measurement instruments. Revista de saúde pública 41 (4), 665-673.

Riegel, B., Barbaranelli, C., Sethares, K.A., Daus, M., Moser, D.K., Miller, J.L., Haedtke, C.A., Feinberg, J.L., Lee, S., Stromberg, A., Jaarsma, T., 2018. Development and initial testing of the self-care of chronic illness inventory. Journal of Advanced Nursing 74 (10), 2465-2476.

Riegel, B., Dickson, V.V., Faulkner, K.M., 2016. The Situation-Specific Theory of Heart Failure Self-Care: Revised and Updated. Journal of Cardiovascular Nursing 31 (3), 226-235.

Riegel, B., Jaarsma, T., Stromberg, A., 2012. A middle-range theory of self-care of chronic illness. ANS: Advances in Nursing Science 35 (3), 194-204.

Riegel, B., Jaarsma, T., Stromberg, A., 2018. A Middle-Range Theory of Self-Care of Chronic Illness. In: Smith, M.J., Liehr, P. (Eds.), Middle Range Theory for Nursing. Springer Publishing Company, New York, NY.

Riegel, B., Lee, C.S., Dickson, V.V., Carlson, B., 2009. An update on the self-care of heart failure index. Journal of cardiovascular nursing 24 (6), 485-497.

Saint Arnault, D., 2018. Defining and Theorizing About Culture: The Evolution of the Cultural Determinants of Help-Seeking, Revised. Nursing research 67 (2), 161-168.

Sedlar, N., Lainscak, M., Martensson, J., Stromberg, A., Jaarsma, T., Farkas, J., 2017. Factors related to self-care behaviours in heart failure: A systematic review of European Heart Failure Self-Care Behaviour Scale studies. European journal of cardiovascular nursing 16 (4), 272-282.

Squires, A., Aiken, L.H., van den Heede, K., Sermeus, W., Bruyneel, L., Lindqvist, R., Schoonhoven, L., Stromseng, I., Busse, R., Brzostek, T., 2013. A systematic survey instrument translation process for multi-country, comparative health workforce studies. International journal of nursing studies 50 (2), 264-273.

Tanaka, J.S., 1993. Multifaceted conceptions of fit in structural equation models. Sage focus editions, 154, 10-10.

Vellone, E., Riegel, B., Cocchieri, A., Barbaranelli, C., D'Agostino, F., Antonetti, G., Glaser, D., Alvaro, R., 2013. Psychometric testing of the Self-Care of Heart Failure Index Version 6.2. Research in nursing & health 36 (5), 500-511.

Wild, D., Grove, A., Martin, M., Eremenco, S., McElroy, S., Verjee-Lorenz, A., Erikson, P., Translation, I.T.F.f., Cultural, A., 2005. Principles of Good Practice for the Translation and Cultural Adaptation Process for Patient-Reported Outcomes (PRO) Measures: report of the ISPOR Task Force for Translation and Cultural Adaptation. Value Health 8 (2), 94-104.