This version of the article has been accepted for publication, after peer review (when applicable) and is subject to Springer Nature's AM terms of use, but is not the Version of Record and does not reflect post-acceptance improvements, or any corrections.

Measurement Equivalence of the English and French Versions of the Self-Efficacy to Manage Chronic Disease Scale: A Scleroderma Patient-Centered Intervention Network (SPIN) Study

Alyssa K. Choi, MS[1] https://orcid.org/0000-0002-2389-8533; Chelsea S. Rapoport, BA[1] https://orcid.org/0000-0002-5140-289X; Linda Kwakkenbos, PhD[2] https://orcid.org/0000-0002-1573-4504; Marie-Eve Carrier, MSc[3] https://orcid.org/0000-0002-5189-3350; Karen Gottesman, BA[4]; Scott C. Roesch, PhD[1, 5]; Daphna Harel, PhD[6] https://orcid.org/0000-0001-7015-5989; Brett D. Thombs, PhD[3, 7] https://orcid.org/0000-0002-5644-8432; Vanessa L. Malcarne, PhD[1, 5] https://orcid.org/0000-0002-7526-9982; and the SPIN Investigators

[1]SDSU/UC San Diego Joint Doctoral Program in Clinical Psychology; [2]Department of Clinical Psychology, Radboud University Behavioural Science Institute; [3]Lady Davis Institute for Medical Research, Jewish General Hospital; [4]Scleroderma Foundation, Southern California Chapter; [5]Department of Psychology, San Diego State University; [6]Department of Applied Statistics, Social Science, and Humanities, New York University; [7]Department of Psychiatry, McGill University

Address for Correspondence: Dr. Vanessa L. Malcarne, San Diego State University/UC San Diego Joint Doctoral Program in Clinical Psychology; 6363 Alvarado Court, Suite 103; San Diego, CA 92120-4913, United States; Tel (619) 594-8642. vmalcarne@sdsu.edu

Word count: 3,101

Keywords: Self-efficacy; scleroderma; systemic sclerosis; measurement equivalence

ABSTRACT

Purpose: The Self-Efficacy to Manage Chronic Disease (SEMCD) scale is widely used, including in systemic sclerosis (SSc). The SEMCD has been validated in SSc, but the metric equivalence of the English and French versions has not been assessed (i.e., whether psychometric properties are equivalent across English and French).

Methods: Participants were adults from the Scleroderma Patient-Centered Intervention Network (SPIN) Cohort ($N = 2159$) who completed baseline measures in English- ($n = 1473$) or French ($n = 686$) between May 2014 to July 2020. Analyses assessed internal consistency reliability via Cronbach's alpha and McDonald's omega, convergent validity via Pearson's correlations, structural validity via confirmatory factor analysis (CFA), and differential item functioning via the Multiple-Indicator Multiple-Cause (MIMIC) model.

Results: Internal consistency reliability was high in English ($\alpha = .93$, $\omega = .93$) and French ($\alpha = .92$, $\omega = .93$). All correlations between the SEMCD and measures of health outcomes were moderate to large, statistically significant, and in the hypothesized direction in both languages. The CFA demonstrated that the one-factor model of self-efficacy, overall, fit reasonably well (CFI = .96, TLI = .93, SRMR = .03, RMSEA = .14). Standardized factor loadings were large (.76 to .88). Three items displayed statistically significant uniform DIF and all six nonuniform DIF; all DIF was of minimal magnitude. Comparison of unadjusted and DIF-adjusted models indicated that DIF did not meaningfully impact total score (ICC = 0.999, $r = 0.999$).

Conclusion: Scores from English- and French-speaking adults with SSc can be combined for analysis or compared.

Plain English Summary

Systemic sclerosis (SSc) is a rare autoimmune disease that affects the skin and various other organ systems. Individuals with SSc report lower quality of life compared to the general population. Self-efficacy, which is an individual's confidence in their ability to perform a specific task, has been shown to impact key health behaviors (e.g., sleep, taking medications) that affect quality of life. Therefore, it is important to study self-efficacy in chronic illness populations that reported impaired quality of life, such as SSc. One widely used measure of self-efficacy is the Self-Efficacy to Manage Chronic Disease Scale (SEMCD). The SEMCD has been validated in many chronic illness populations, including SSc. However, it is also crucial to examine whether the SEMCD is valid in different languages, such as English and French. The results of this study indicate that the SEMCD can be appropriately administered to English- and French-speaking adults with SSc, and their scores can be compared and combined. Evidence from this study can encourage further research on self-efficacy in diverse populations with SSc.

INTRODUCTION

Self-efficacy is a key predictor of health behaviors and self-management programs are designed to help people with chronic diseases increase their self-efficacy, defined as their perceived capability to perform necessary behaviors to manage their disease [1]. Self-efficacy also plays an important role in predicting quality of life in chronic illness populations (e.g., cancer [2], rheumatoid arthritis [3]). The Self-Efficacy to Manage Chronic Disease Scale (SEMCD) [4] is a 6-item, widely used, self-report measure of self-efficacy for individuals with chronic diseases. The SEMCD has demonstrated high internal consistency, convergent validity, and structural validity across a variety of chronic disease populations, adults with systemic sclerosis (SSc) [4, 5].

SSc is a rare autoimmune connective tissue disease that is characterized by hardening and tightening of the skin and effects on other organs systems (e.g., gastrointestinal tract, vascular system). There is no curative treatment, and clinical care focuses on managing disease manifestations and improving or maintaining quality of life. Individuals with SSc widely report impaired quality of life compared to the general population [6]. Furthermore, quality of life in individuals diagnosed with diffuse SSc (i.e., subtype of SSc with more extensive skin involvement, rapid disease progression, and earlier manifestations of organ complications) [7] is even lower compared to those diagnosed with limited SSc [6]. The Scleroderma Patient-centered Intervention Network (SPIN) was developed to design and test accessible online psychosocial, educational, and rehabilitation interventions to enhance quality of life for adults with SSc, including a self-management program [8]. Riehm et al. [5] used cross-sectional data from the SPIN cohort ($N = 553$) to evaluate the measurement properties of the SEMCD in English-speaking adults with SSc. Their results found support for high internal consistency reliability (α

= 0.93) and the hypothesized unidimensional structure of the SEMCD [5]. Convergent validity was also established via moderate to large (| r | = 0.48-0.67) correlations in the hypothesized directions with psychological and physical outcomes.

The SEMCD is used to evaluate self-efficacy in adults with SSc in English and French [9]. However, no study has investigated whether SEMCD scores are comparable across these languages. It is essential that translations be examined for equivalence across populations in order to support comparison or combination of scores. The current study assessed the measurement properties and cross-language measurement equivalence of the SEMCD in a large sample of adults with SSc who completed measures in English or French.

METHODS

Participants and Procedures

The sample included adults from the SPIN Cohort who completed baseline study questionnaires from May 2014 through July 2020 in English or French. Participants were enrolled at 46 centers from Canada, USA, UK, France, and Australia. To be eligible for the SPIN Cohort, adults must have been classified as having SSc according to the 2013 ACR/EULAR classification criteria [10], confirmed by a SPIN physician, and being able to respond to questionnaires via the internet. The SPIN sample is a convenience sample. Eligible adults are invited by the attending physician or a supervised nurse coordinator to participate, and written informed consent is obtained. The local SPIN physician or supervised nurse coordinator then completes a medical data form that is submitted online to initiate patient registration in the SPIN Cohort. After completion of online registration, an automated welcoming email is sent to participants with instructions to on how to activate their SPIN online account and how to complete the SPIN Cohort patient measures online. SPIN Cohort participants complete outcome

measures via the internet upon enrollment and subsequently every 3 months. The SPIN Cohort study was approved by the Research Ethics Committee of the Jewish General Hospital, Montreal, Canada and by the Institutional Reviews Boards of each participating center.

Measures

Participants' demographic information, including age, sex, race or ethnicity, country, years of education, employment status, and marital status, was collected. SPIN physicians provided medical information, including time since SSc diagnosis, SSc subtype (limited or diffuse), and modified Rodnan skin score.

SEMCD

Participants completed the 6-item SEMCD [4]. Participants rated their confidence in their ability to manage symptoms caused by their disease (fatigue, physical discomfort/pain, emotional distress, other symptoms/health problems), to complete tasks to manage their health and minimize the number of medical visits needed, and to manage their disease with approaches other than medication. The SEMCD has a 10-point response format: 1 (*not at all confident*) to 10 (*totally confident*). The total score is an average of the six items, with higher scores indicating greater self-efficacy. The English version of the SEMCD has been validated in SSc [5], and there was high internal consistency reliability ($\alpha = 0.93$), a unifactorial structure, and expected convergent validity with measures of psychological and physical health outcomes. The French version was translated by SPIN using the PROMIS translation and cultural adaptation guidelines [11]. This involved an iterative process that included forward-backward translation, expert review and pre-testing with native speakers, cognitive debriefing, harmonization of conceptual meaning across language, and using a universal approach to develop a translation that would be applicable across countries where French is spoken.

PROMIS-29

The 29-item Patient Reported Outcomes Measurement Information System (PROMIS-29) profile, version 2.0, is a measure of health status over the past 7 days. The PROMIS-29 assesses 8 domains of health status: physical function, anxiety, depression, fatigue, sleep disturbance, ability to participate in social roles and activities, pain interference, and pain intensity. The first 7 domains each contain 4 items that are rated on a scale from 1 to 5, with different response anchors across the domains. The last domain, pain intensity, is a single-item rated on a scale from 0 (*no pain*) to 10 (*worst imaginable pain*). Item responses are summed to create total scores for each domain, which are then converted into T-scores that have been standardized to the United States general population. Higher T-scores represent more of the construct that is being measured (e.g., more anxiety). The PROMIS-29 has been validated in SSc [12] and had good reliability across the total (α's > .86, ω's > .86), English-speaking (α's > .86, ω's > .86), and French-speaking (α's > .84, ω's > .84) samples.

PHQ-8

The 8-item Patient Health Questionnaire (PHQ-8) measures depressive symptoms over the past 2 weeks [13]. Each item is rated on a scale from 0 (*not at all*) to 3 (*nearly every day*). Items are summed to create a total score, with higher scores representing more depressive symptoms. The PHQ-8 has been shown to perform equivalently to the PHQ-9 [13], which is validated in SSc [14]. In this study, the PHQ-8 demonstrated good reliability across the total (α = .88, ω = .88), English-speaking (α = .89, ω = .89), and French-speaking (α = .87, ω = .88) samples.

HAQ DI

The Health Assessment Questionnaire disability index (HAQ DI) is a measure of functional disability over the past 7 days. The HAQ DI contains 20 items and assesses 8 domains of activity (dressing/grooming, arising, eating, walking, hygiene, reach, grip, and common daily activities), with at least 2 items comprising each domain. The response scale ranges from 0 (*without any difficulty*) to 3 (*unable to do*), with higher scores representing greater functional disability. The total score is calculated by averaging the highest score from each domain, ranging from 0 (*no disability*) to 3 (*severe disability*). The HAQ DI has been validated in SSc [15] and demonstrated good reliability across the total ($\alpha = .95$, $\omega = .96$), English-speaking ($\alpha = .96$, $\omega = .96$), and French-speaking ($\alpha = .94$, $\omega = .95$) samples.

Statistical Approach

Means and standard deviations were calculated for each item of the SEMCD and the total score. An independent samples *t*-test and one-way ANOVA were used to compare the SEMCD items and total score across language and country, respectively (SPSS software, version 27). Cronbach's coefficient alpha and McDonald's omega were used to assess and compare internal consistency reliability between language groups. Pearson's correlations between the SEMCD total score and other health measures were used to examine convergent validity. Based on prior research in this sample, we hypothesized that all correlations would be moderate to large and negative, except with two outcomes (physical function and ability to participate in social roles and activities) for which we expected to obtain positive correlations [5]. We expected all study hypotheses to be consistent across the total, English-speaking, and French-speaking samples. Correlations were interpreted as follows: small ($| r | \leq 0.3$), moderate ($0.3 < | r | < 0.5$), or large ($| r | \geq 0.5$).[16] To test for differences between the correlations by language, correlations for the English- and French-speaking samples were transformed to Fisher *Z* values. The difference

between the *Z* values was tested via univariate general linear modeling. Confirmatory factor analysis (CFA) was used to evaluate the previously identified single-factor structure of the SEMCD (Mplus software, version 8.5). Maximum likelihood estimation was used for analysis. Overall model fit was evaluated with descriptive fit indices and interpretation guidelines [17], including (a) the comparative fit index (CFI), with values greater than 0.95 indicating good model fit and values greater than .90 indicating acceptable model fit; (b) the Tucker-Lewis Index (TLI), with values greater than .95 indicating good model fit and values greater than .90 indicating acceptable model fit; (c) the root mean square error of approximation (RMSEA), with values less than .08 indicating acceptable model fit and values less than .06 indicating good model fit; and (c) the standardized root mean square residual (SRMR), with values less than .08 indicating acceptable model fit and values less than .05 indicating good model fit. Because the chi-square test is sensitive to sample size, it was not used as a primary indicator of model fit but is also reported for completeness [18]. In order to estimate the factor loading for item one of the SEMCD, item two was used to set the metric for the latent variable.

The Multiple-Indicator Multiple-Cause (MIMIC) model was used to examine uniform and nonuniform differential item functioning (DIF) for the English versus French versions of the SEMCD. The MIMIC model uses structural equation modeling and adds the language group variable to the CFA model as an observed variable. The base MIMIC model is comprised of the CFA model and the direct effect of language group on the latent self-efficacy factor, which controls for group differences on the level of the latent factor. It also adds a direct effect of the covariates on the latent factor, controlling for any differences on the sociodemographic and disease-related variables. To assess for uniform DIF, each item on the SEMCD was regressed on language group through a sequential procedure. Uniform DIF was considered significant if there

was a statistically significant association (alpha = 0.05) between the item and language group, after controlling for any differences in the overall level of the latent factor between groups. To evaluate nonuniform DIF, an interaction between language group and the latent variable was added to the MIMIC model [19]. The presence of nonuniform DIF was indicated by a statistically significant difference between factor loadings across language groups. Due to the large sample size, we expected the MIMIC model to show statistically significant DIF for multiple items. In order to assess whether any DIF had a meaningful and practically significant effect on SEMCD scores, the magnitude of DIF was assessed by comparing factor scores from the baseline CFA model that did not account for DIF to factor scores from the final MIMIC model that accounted for both uniform and nonuniform DIF via the intraclass correlation coefficient (ICC) and Pearson's correlation.

RESULTS

The initial sample had a combined total of 2,281 English- or French-speaking participants, but there were 122 participants (n = 85 English-speaking; n = 37 French-speaking) who did not complete any item of the SEMCD and were therefore removed. There were no partial completions of the SEMCD. All remaining participants (N = 2,159) who completed the questionnaires in English (n = 1,473) or French (n = 686) and completed every item of the SEMCD were included in analyses. Sociodemographic and disease characteristics are displayed in Table 1. Overall, participants endorsed moderate levels of self-efficacy related to their disease on all items of the SEMCD. The mean ± SD total score on the SEMCD was 6.45 ± 2.26 and was not significantly different by language (p = .438) or by country, except between the USA and UK (p = .025; USA: 6.6 ± 2.3; UK: 6.1 ± 2.2). The score for each of the six items on the SEMCD did not significantly differ by language (all p's > .05). The mean ± SD for item three was

significantly higher for participants in the USA (7.2 ± 2.6) compared to those in the UK (6.5 ± 2.6; $p = .002$) and France (6.6 ± 2.6; $p < .001$). The mean ± SD for item four was significantly higher for participants in the USA (6.2 ± 2.7) compared to those in the UK (5.6 ± 2.6; $p = .013$). The mean ± SD for item six was significantly higher for participants in the USA (7.1 ± 2.5) compared to those in the UK (6.5 ± 2.6; $p = .007$). The SEMCD demonstrated good internal consistency reliability for the total ($\alpha = .93$, $\omega = .93$), English-language ($\alpha = .93$, $\omega = .93$), and French-language samples ($\alpha = .92$, $\omega = .93$).

Correlations between the SEMCD and health outcome measures by language are displayed in Table 2. Study hypotheses were confirmed with all correlations being moderate to large, statistically significant, and in the expected direction across language. The SEMCD had a positive correlation with physical function and ability to participate in social roles and activities. All other outcome measures had significant negative correlations with the SEMCD. The magnitude of the correlations was large, except for four outcomes. Sleep disturbance had a moderate correlation for both language groups. Whereas the English-speaking sample had large correlations for anxiety, pain intensity, and disability, the French-speaking sample showed moderate correlations for those outcomes. The differences between the correlations of the English- and French-speaking samples were statistically significant for all outcomes except physical function, depression, and sleep disturbance. Magnitudes of differences were between 0.04 and 0.13.

Results from the CFA indicated that the one-factor model of self-efficacy fit well descriptively based on two indices of model fit (CFI = .96; TLI = .93, SRMR = .03; χ^2 [9] = 413.33, $p < .001$). The RMSEA indicated less than acceptable model fit (RMSEA = .14).

Standardized factor loadings for all items were large and statistically significant, ranging from .755 to .879 (see Table 3).

Statistically significant uniform DIF was found for three items (i.e., degree of confidence in ability to manage fatigue, manage emotional distress, and do things other than just taking medication to manage the disease) across language. Results indicated that English-speaking individuals were expected to have slightly higher item-level responses for items 3 and 5, but a slightly lower item-level response for item 1, compared to French-speaking participants with equal levels of self-efficacy. All six items displayed statistically significant nonuniform. However, the ICC and Pearson's correlation between factor scores derived from the unadjusted and DIF-adjusted models demonstrated near perfect agreement (ICC = 0.999 [95% CI 0.999, 0.999]) and correlation (r = 0.999 [95% CI 0.999, 0.999]).

DISCUSSION

The current study evaluated the cross-language measurement equivalence of the SEMCD in a large sample of adults with SSc. The SEMCD had good internal consistency reliability and convergent validity, which was consistent with prior research [4, 5]. An unexpected finding was that the total score on the SEMCD and the scores for certain items on the SEMCD (e.g., confidence to manage other symptoms or health problems) were consistently higher for participants from the USA compared to those in the UK. However, the differences between the means of the total score and the items were small (i.e., less than .08 on a 10-point response scale) and not practically significant. Overall, participants from all countries endorsed a moderate level of self-efficacy to manage their SSc. Although findings revealed that the differences in the correlations of three of the outcomes (i.e., physical function, depression, and sleep disturbance) with the SEMCD across language were not significant, the differences were small (i.e., less than

.08) and the cross-language correlations for each outcome were of the same magnitude (e.g., the correlation between the SEMCD and physical function in both the English- and French-speaking samples was large). Results confirmed the previously established single-factor model of the SEMCD. This provides further evidence of good structural validity and indicates that that SEMCD total score is valid. As expected, given the large sample size of our study, analyses identified statistically significant uniform DIF for three items and nonuniform DIF for all items. The correlation, however, between unadjusted and DIF-adjusted models demonstrated that DIF did not substantially influence total scores between English- and French-speaking participants. Accounting for DIF across English-and French speaking individuals with SSc did not provide substantial information regarding participants' levels of self-efficacy.

Overall, the findings provide evidence that the SEMCD can be used as a reliable and valid single-factor measure of self-efficacy in SSc. SEMCD scores from English- and French-speaking individuals with SSc can be compared or combined for analysis, which is essential to understanding the role of self-efficacy in quality of life in SSc across diverse populations of patients, as well as evaluating interventions designed to increase self-efficacy, and consequently quality of life, in international samples of patients.

This study had several strengths and limitations. First, the final analyses used a large sample of 2,159 adults with SSc, which is more than sufficient to conduct a CFA with reasonably precise parameter estimates [20]. The sample was comprised of adults from several different countries, which enhances support for the validity of the SEMCD for international use. However, the SPIN cohort is a convenience sample and data were included from five high-income countries, which limits the generalizability of the current findings to other countries. In addition, the vast majority of adults in the SPIN cohort identified as married, white women, which

minimizes the generalizability of this study to adults with SSc from other backgrounds (e.g., racial or ethnic minorities, men). Lastly, although various indices were used in this study to evaluate the psychometric properties of the SEMCD, discriminant validity with a theoretically distinct construct has yet to be established and warrants further study in adults with SSc.

Future research should assess the psychometric equivalence of the SEMCD across other chronic disease populations. In sum, the present results replicate the findings of past studies and provide evidence that the SEMCD is a brief, valid measure of chronic disease-related self-efficacy and can be compared or combined for analysis in English- and French-speaking adults with SSc.

REFERENCES

[1] K. Lorig, D. S. Sobel, P. L. Ritter, D. Laurent, and M. Hobbs, "Effect of a self-management program on patients with chronic disease," *Eff. Clin. Pract. ECP*, vol. 4, no. 6, pp. 256–262, 2001.

[2] B. K. Haas, "Focus on health promotion: self-efficacy in oncology nursing research and practice," *Oncol. Nurs. Forum*, vol. 27, no. 1, pp. 89–97, 2000.

[3] J. Martinez-Calderon, M. Meeus, F. Struyf, and A. Luque-Suarez, "The role of self-efficacy in pain intensity, function, psychological factors, health behaviors, and quality of life in people with rheumatoid arthritis: A systematic review," *Physiother. Theory Pract.*, vol. 36, no. 1, pp. 21–37, Jan. 2020, doi: 10.1080/09593985.2018.1482512.

[4] P. L. Ritter and K. Lorig, "The English and Spanish Self-Efficacy to Manage Chronic Disease Scale measures were validated using multiple studies," *J. Clin. Epidemiol.*, vol. 67, no. 11, pp. 1265–1273, 2014, doi: 10.1016/j.jclinepi.2014.06.009.

[5] K. E. Riehm *et al.*, "Validation of the Self-Efficacy for Managing Chronic Disease scale: a Scleroderma Patient-centered Intervention Network cohort study," *Arthritis Care Res.*, vol. 68, no. 8, pp. 1195–1200, 2016, doi: 10.1002/acr.22807.

[6] M. Hudson *et al.*, "Health-related quality of life in systemic sclerosis: A systematic review," *Arthritis Care Res.*, vol. 61, no. 8, pp. 1112–1120, Aug. 2009, doi: https://doi.org/10.1002/art.24676.

[7] Y. Allanore *et al.*, "Systemic sclerosis," *Nat. Rev. Dis. Primer*, vol. 1, no. 1, p. 15002, 2015, doi: 10.1038/nrdp.2015.2.

[8] J. Nordlund *et al.*, "The Scleroderma Patient-centered Intervention Network Self-Management (SPIN-SELF) Program: protocol for a two-arm parallel partially nested randomized controlled feasibility trial with progression to full-scale trial," *Trials*, vol. 22, no. 1, p. 856, Nov. 2021, doi: 10.1186/s13063-021-05827-z.

[9] D. H. Dougherty *et al.*, "The Scleroderma Patient-Centered Intervention Network Cohort: baseline clinical features and comparison with other large scleroderma cohorts," *Rheumatology*, vol. 57, no. 9, pp. 1623–1631, Jun. 2018, doi: 10.1093/rheumatology/key139.

[10] F. van den Hoogen *et al.*, "2013 classification criteria for systemic sclerosis: an American college of rheumatology/European league against rheumatism collaborative initiative," *Arthritis Rheum.*, vol. 65, pp. 2737–2747, Nov. 2013, doi: 10.1136/annrheumdis-2013-204424.

[11] PROMIS Health Organization and PROMIS Cooperative Group, "PROMIS® Instrument Development and Validation: Scientific Standards Version 2.0 (revised May 2013)," 2013. [Online]. Available: https://www.healthmeasures.net/images/PROMIS/PROMISStandards_Vers2.0_Final.pdf

[12] M. Hinchcliff *et al.*, "Validity of Two New Patient Reported Outcome Measures in Systemic Sclerosis: the PROMIS-29 Profile and the FACIT-Dyspnea," *Arthritis Care Res.*, vol. 63, no. 11, pp. 1620–1628, Nov. 2011, doi: 10.1002/acr.20591.

[13] K. Kroenke, T. W. Strine, R. L. Spitzer, J. B. W. Williams, J. T. Berry, and A. H. Mokdad, "The PHQ-8 as a measure of current depression in the general population," *J. Affect. Disord.*, vol. 114, no. 1, pp. 163–173, 2009, doi: https://doi.org/10.1016/j.jad.2008.06.026.

[14] K. Milette, M. Hudson, M. Baron, B. D. Thombs, and Canadian Scleroderma Research Group, "Comparison of the PHQ-9 and CES-D depression scales in systemic sclerosis:

internal consistency reliability, convergent validity and clinical correlates," *Rheumatology*, vol. 49, no. 4, pp. 789–796, Jan. 2010, doi: 10.1093/rheumatology/kep443.
[15] J. L. Poole and V. D. Steen, "The use of the Health Assessment Questionnaire (HAQ) to determine physical disability in systemic sclerosis," *Arthritis Rheum.*, vol. 4, no. 1, pp. 27–31, Mar. 1991, doi: 10.1002/art.1790040106.
[16] J. Cohen, *Statistical Power Analysis for the Behavioral Sciences*, 2nd ed. New York: Routledge, 1988. doi: 10.4324/9780203771587.
[17] L. Hu and P. M. Bentler, "Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives," *Struct. Equ. Model. Multidiscip. J.*, vol. 6, no. 1, pp. 1–55, Jan. 1999, doi: 10.1080/10705519909540118.
[18] G. W. Cheung and R. B. Rensvold, "Evaluating Goodness-of-Fit Indexes for Testing Measurement Invariance," *Struct. Equ. Model. Multidiscip. J.*, vol. 9, no. 2, pp. 233–255, Apr. 2002, doi: 10.1207/S15328007SEM0902_5.
[19] C. M. Woods and K. J. Grimm, "Testing for nonuniform differential item functioning with multiple indicator multiple cause models," *Appl. Psychol. Meas.*, vol. 35, no. 5, pp. 339–361, 2011, doi: 10.1177/0146621611405984.
[20] E. J. Wolf, K. M. Harrington, S. L. Clark, and M. W. Miller, "Sample size requirements for structural equation models: An evaluation of power, bias, and solution propriety," *Educ. Psychol. Meas.*, vol. 76, no. 6, pp. 913–934, Dec. 2013, doi: 10.1177/0013164413495237.

Statements and Declarations

Funding: The Scleroderma Patient-centered Intervention Network (SPIN) has received funding for the SPIN Cohort from the Canadian Institutes of Health Research, the Arthritis Society, the Lady Davis Institute for Medical Research of the Jewish General Hospital, Montreal, Quebec, Canada, the Jewish General Hospital Foundation, Montreal, Quebec, Canada, McGill University, Montreal, Quebec, Canada, the Scleroderma Society of Ontario, Scleroderma Canada, Sclérodermie Québec, Scleroderma Manitoba, Scleroderma Atlantic, the Scleroderma Association of BC, Scleroderma SASK, Scleroderma Australia, Scleroderma New South Wales, Scleroderma Victoria, and Scleroderma Queensland. Ms. Choi was supported by a National Science Foundation Graduate Research Fellowship under Grant 1842470 and the Rheumatology Research Foundation Medical and Graduate Student Preceptorship. Dr. Thombs was supported by a Tier 1 Canada Research Chair.

Competing Interests: The authors have no relevant financial or non-financial interests to disclose.

Table 1. Participant sociodemographic and disease characteristics (*N* = 2,159)

Variable	Total sample (*N* = 2,159)	English-language sample (*n* = 1,473)	French-language sample (*n* = 686)
Demographic variables			
Age, years	55.0 ± 12.7	55.5 ± 12.2	54.0 ± 13.7
Female, no. (%)	1,889 (88)	1,294 (88)	595 (87)
Country			
Canada, no. (%)	529 (25)	412 (28)	117 (17)
USA, no. (%)	785 (36)	784 (53)	1 (0)
UK, no. (%)	234 (11)	234 (16)	-
France, no. (%)	570 (26)	2 (0)	-
Australia, no. (%)	40 (2)	40 (3)	568 (83)
Race			
White, no. (%)	1,790 (83)	1,221 (83)	569 (83)
Black, no. (%)	149 (7)	79 (5)	70 (10)
Other, no. (%)[a]	218 (10)	171 (12)	47 (7)
Higher education > 12 years, no. (%)	1,576 (73)	1,158 (79)	418 (61)
Currently employed, no. (%)	886 (41)	606 (41)	280 (41)
Married, no. (%)	1,531 (71)	1,074 (73)	457 (67)
Medical variables			
Years since first non-Raynaud's symptom	11.1 ± 8.8	11.7 ± 9.1	10.0 ± 8.0
Disease subtype			
Limited SSc, no. (%)	1244 (58)	826 (56)	418 (61)
Diffuse SSc, no. (%)	830 (38)	605 (41)	225 (33)
Modified Rodnan Skin Score	7.8 ± 8.2	7.9 ± 8.6	7.6 ± 7.4
Self-report questionnaire scores			
Self-Efficacy to Manage Chronic Disease total score	6.5 ± 2.3	6.5 ± 2.3	6.4 ± 2.1
Country			
Canada	6.5 ± 2.3	6.4 ± 2.4	6.8 ± 2.0
USA	6.6 ± 2.3	6.6 ± 2.3	-
UK	6.1 ± 2.2	6.1 ± 2.2	-
France	6.3 ± 2.2	5.7 ± 3.8	6.3 ± 2.2
Australia	6.6 ± 2.1	6.6 ± 2.1	-
PROMIS-29			
Physical function score	43.5 ± 9.0	43.0 ± 9.0	44.5 ± 8.9
Ability to participate in social roles and activities	48.1 ± 10.0	47.9 ± 9.8	48.4 ± 10.0
Anxiety	52.1 ± 10.0	51.9 ± 10.1	52.7 ± 10.0
Depression	51.4 ± 9.4	50.8 ± 9.3	52.7 ± 9.4
Fatigue	54.9 ± 11.1	55.9 ± 11.0	52.7 ± 10.8
Sleep disturbance	52.5 ± 8.6	52.5 ± 8.8	52.6 ± 8.3
Pain interference	55.6 ± 9.7	55.8 ± 9.7	55.2 ± 9.7
Pain intensity	3.6 ± 2.6	3.7 ± 2.6	3.6 ± 2.6

Patient Health Questionnaire-8 score	6.4 ± 5.4	6.2 ± 5.4	6.7 ± 5.5
Health Assessment Questionnaire disability index score	0.7 ± 0.7	0.8 ± 0.7	0.6 ± 0.6

Values are mean ± SD, unless indicated otherwise. PROMIS-29 = 29-item Patient Reported Outcomes Measurement Information System.

[a] Race or ethnicity data were self-reported in each country using standard categories used in that country. Therefore, categories differed between countries.

Table 2. Convergent validity hypotheses and Pearson's correlation of variables with the Self-Efficacy to Manage Chronic Disease scale[a]

Convergent validity hypotheses[b]	Total sample (*N* = 2,159)	English-language sample (*n* = 1,473)	French-language sample (*n* = 686)	Difference and 95% CI between the English and French correlations	Hypotheses supported
Moderate to large positive correlation					
Physical function score	0.56	0.58	0.51	.07 (–.00, .15)	Yes
Ability to participate in social roles and activities	0.64	0.68	0.55	.13 (.06, .21)	Yes
Moderate to large negative correlation					
Anxiety	–0.50	–0.53	–0.44	–.09 (–.16, –.01)	Yes
Depression	–0.56	–0.57	–0.53	–.04 (–.11, .04)	Yes
Fatigue	–0.62	–0.65	–0.58	–.07 (–.15, –.01)	Yes
Sleep disturbance	–0.43	–0.45	–0.38	–.07 (–.15, .01)	Yes
Pain interference	–0.59	–0.63	–0.51	–.12 (–.19, –.05)	Yes
Pain intensity	–0.53	–0.57	–0.44	–.13 (–.21, –.05)	Yes
Symptoms of depression, PHQ-8	–0.59	–0.62	–0.53	–.09 (–.17, –.02)	Yes
Disability, HAQ DI score	–0.50	–0.53	–0.43	–.10 (–.18, –.02)	Yes

[a] All measures are drawn from the 29-item Patient Reported Outcomes Measurement Information System, unless indicated otherwise. PHQ-8 = 8-item Patient Health Questionnaire; HAQ DI = Health Assessment Questionnaire disability index.
[b] Magnitude of correlations: small = $|r| \leq 0.3$, moderate = $0.3 < |r| < 0.5$, and large = $|r| \geq 0.5$.
[c] All correlations were statistically significant at $p < .05$.

Table 3. Characteristics of the Self-Efficacy to Manage Chronic Disease scale in the total, English-language, and French-language samples

Item	Mean ± SD	Corrected item-total correlation[a]	Standardized factor loading
Total sample (*N* = 2,159)			
1. Fatigue	6.1 ± 2.7	0.80	0.85
2. Physical discomfort or pain	6.0 ± 2.7	0.84	0.88
3. Emotional distress	6.9 ± 2.6	0.76	0.79
4. Other symptoms or health problems	6.0 ± 2.6	0.83	0.87
5. Reduce need to see doctor	6.8 ± 2.5	0.81	0.83
6. Do things other than just taking medication	6.9 ± 2.6	0.73	0.76
Total score	6.5 ± 2.3	–	–
English-language sample (*n* = 1,473)			
1. Fatigue	6.0 ± 2.8	0.80	0.85
2. Physical discomfort or pain	6.1 ± 2.8	0.83	0.88
3. Emotional distress	6.9 ± 2.7	0.76	0.79
4. Other symptoms or health problems	6.1 ± 2.7	0.84	0.88
5. Reduce need to see doctor	6.8 ± 2.5	0.81	0.83
6. Do things other than just taking medication	6.9 ± 2.6	0.75	0.78

Total score	6.5 ± 2.3	–	–
French-language sample (n = 686)			
1. Fatigue	6.1 ± 2.6	0.80	0.85
2. Physical discomfort or pain	6.0 ± 2.6	0.84	0.89
3. Emotional distress	6.8 ± 2.6	0.75	0.78
4. Other symptoms or health problems	6.0 ± 2.5	0.82	0.86
5. Reduce need to see doctor	6.7 ± 2.3	0.81	0.83
6. Do things other than just taking medication	6.8 ± 2.6	0.68	0.71
Total score	6.4 ± 2.1	–	–

On a 10-point scale, where 1 = not at all confident and 10 = totally confident.
[a]Corrected item-total correlations are the correlation between each item and all the other items on the scale, therefore avoiding correlating each item with a total score that includes that item.