Measuring Diabetes Self-Care

A psychometric analysis of the Self-Care Inventory-revised with adults

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OBJECTIVE — To examine psychometric properties of the Self-Care Inventory-revised (SCI-R), a self-report measure of perceived adherence to diabetes self-care recommendations, among adults with diabetes.

RESEARCH DESIGN AND METHODS — We used three data sets of adult type 1 and type 2 diabetic patients to examine psychometric properties of the SCI-R. Principal component and factor analyses examined whether a general factor or common factors were present. Associations with measures of theoretically related concepts were examined to assess SCI-R concurrent and convergent validity. Internal reliability coefficients were calculated. Responsiveness was assessed using paired *t* tests, effect size, and Guyatt's statistic for type 1 patients who completed psychoeducation.

RESULTS — Principal component and factor analyses identified a general factor but no consistent common factors. Internal consistency of the SCI-R was $\alpha = 0.87$. Correlation with a measure of frequency of diabetes self-care behaviors was $r = 0.63$, providing evidence for SCI-R concurrent validity. The SCI-R correlated with diabetes-related distress ($r = -0.36$), self-esteem ($r = 0.25$), self-efficacy ($r = 0.47$), depression ($r = -0.22$), anxiety ($r = -0.24$), and HbA_{1c} ($r = -0.37$), supporting construct validity. Responsiveness analyses showed SCI-R scores improved with diabetes psychoeducation with a medium effect size of 0.62 and a Guyatt's statistic of 0.85.

CONCLUSIONS — The SCI-R is a brief, psychometrically sound measure of perceptions of adherence to recommended diabetes self-care behaviors of adults with type 1 or type 2 diabetes.

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To prevent serious morbidity and mortality, diabetes treatment requires dedication to demanding self-care behaviors in multiple domains, including food choices, physical activity, medications, glucose monitoring, and symptom management (1,2). Because no universally accepted regimens incorporating all of these domains exist for the treatment of diabetes, assessment of self-care behaviors is extremely challenging (3,4) and remains a critical problem for clinical care and research. Although clinicians and researchers require a simple, practical method of assessing self-care behaviors, there are few easy-to-use instruments with established psychometric properties (3). Most methods to assess self-care behaviors rely on patient memory, using time-intensive interviews of behavior recall over a specific time period, typically 24 h (5) or 1 week (6), or using surveys covering the previous week (7). Another approach uses patients' reports of frequency of specific self-care behaviors (7), but such measures may not take into account differences in patients' prescriptions for diabetes care. The Self-Care Inventory (SCI) developed by La Greca and colleagues (8,9) is a self-report questionnaire assessing patients' perceptions of self-care behaviors. Self-care is defined as the daily regimen tasks that the individual performs to manage diabetes. The SCI, unlike measures that assess the frequency of self-care behaviors, doesn't presume that all individuals have the same treatment prescription, nor is it based on an "ideal" regimen, as are 24-h recall interviews (5). Rather, the SCI allows for various treatment regimens across individuals, while evaluating individuals' perceptions of how well they adhere to their treatment prescriptions. The global score of self-care behavior makes the SCI a concise and practical tool for outcome research.

The original SCI has been used to assess perceptions of self-care tasks in children and adolescents (10–14), adults (15–22), and people with type 1 (10–13,17) and type 2 diabetes (18,23). Although research with children and adolescents has shown that the SCI has good psychometric properties, and that youth with better self-care levels have significantly better glycemic control (10–14), no psychometric information on the SCI with adults has been published (8,9,14). We modified SCI items to reflect current diabetes practice. Here we report the results of psychometric analyses, including reliability, factor structure, validity analyses, and sensitivity to change (responsiveness) for the SCI-revised (SCI-R) among adults with type 1 or type 2 diabetes.

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Abbreviations: CIDS, Confidence in Diabetes Scale; PAID, Problem Areas In Diabetes scale; RSE, Rosenberg Self-Esteem; SCI, Self-Care Inventory; SCI-R, SCI-revised; SCL-90, Symptoms Checklist-90; SDSCA, Summary of Diabetes Self-Care Activities.

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A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

RESEARCH DESIGN AND METHODS

— The analyses of the SCI-R involved three studies. Study 1 evaluated the internal reliability, convergent validity, and concurrent validity of the SCI-R. Study 2 pooled three patient data sets ($n = 410$) to examine further convergent validity and determine the factor structure of the SCI-R. Study 3 examined the responsiveness of the SCI-R to changes in HbA_{1c} levels of 56 type 1 patients who completed a diabetes education intervention. The committee on human subjects reviewed all protocols; subjects provided informed written consent before participation.

Sample

Inclusion criteria included: *1*) age ≥18 years, *2*) diabetes diagnosis ≥1 year, and *3*) the ability to read, write, and understand English. Subjects provided a blood sample for measurement of HbA_{1c}.

Study 1. The participants were patients who attended regularly scheduled medical or educational appointments at a diabetes outpatient clinic ($n = 90$, mean age 51 ± 15 years, 56% women, duration of diabetes = 12 ± 12 years, $HbA_{1c} = 8.6 \pm 1.7\%$, 92% Caucasian) with either type 1 ($n = 46$, 56% women) or type 2 ($n = 48$, 50% women) diabetes. Participants completed two measures of diabetes-specific functioning (Benefits/Barriers scale and Problem Areas In Diabetes [PAID] scale). We expected that patients who reported better self-care levels on the SCI-R would also report having fewer barriers to treatment and fewer problems in diabetes care (i.e., convergent validity analyses). In addition, we expected that the SCI-R would correlate with another existing measure of self-care behaviors, thus supporting the concurrent validity of the SCI-R. Internal consistency reliability analyses were also conducted.

Study 2. This study used pooled data from three studies of similar design (including study 1 data, but not study 3 data) to reach sufficient sample size to perform SCI-R factor analyses and tests of reliability (24). The sample consisted of 407 participants with diabetes (mean age 47 ± 15 years, 57% women, duration of diabetes 13 ± 12 years, HbA_{1c} 8.1 ± 1.6%, 61% type 1 diabetes, 88% Caucasian). In addition, participants completed four measures of psychological functioning: PAID, Rosenberg Self-Esteem (RSE) scale, Confidence in Diabetes Scale (CIDS), and Symptoms Checklist-90 (SCL-90) for concurrent validity analyses. Specifically, we expected that patients who reported better self-care on the SCI-R would report having fewer problem areas in diabetes (PAID) and greater self-efficacy (CIDS). Moreover, because prior studies found that poor psychosocial functioning was associated with problems with treatment adherence (13,17,25), we expected that low SCI-R scores would be moderately associated with poor psychosocial functioning (i.e., depression, anxiety, and low self-esteem).

Study 3. A total of 57 type 1 patients in poor glycemic control (mean age 31 ± 8 years, 61% women, duration of diabetes 12 ± 5 years, HbA_{1c} 9.9 ± 1.8%, 92% Caucasian) who received either a psychological intervention to improve attitudes to diabetes self-management or lipid/cholesterol nutrition education completed the SCI-R for responsiveness analyses. HbA_{1c} levels were assessed at baseline and 3 months after the interventions. We examined mean SCI-R score differences and effect sizes, using HbA_{1c} as an external standard to evaluate SCI-R's responsiveness to a change in clinical status (improved versus stable HbA_{1c}) (26).

Instruments

SCI-R. The original SCI (8) was a 14-item self-report measure, assessing patients' perceptions of their adherence to diabetes self-care recommendations over the previous 1–2 months. In conjunction with focus groups conducted with diabetes educators, items were developed to reflect type 1 treatment regimens, including monitoring blood glucose, insulin and food regulation, exercise, and emergency precautions. Many items apply to self-care of type 2 diabetes.

We modified the original SCI (8,9) to reflect current diabetes practice. Individuals rated SCI-R items on a 5-point Likert scale that reflects how well they followed recommendations for self-care during the past month (i.e., 1 = "never do it" to 5 = "always do this as recommended, without fail"). The Flesch-Kincaid Reading level for the SCI-R is 6th grade. A multidisciplinary expert panel (nursing, psychology, and nutrition) assessed the SCI for content validity and consistency with current practice. The panel recommended combining two items, i.e., "eat meals on time" and "eat snacks on time" to form "eat meals/snacks on time;" omitting "exercise strenuously;" changing "testing blood glucose" to "check blood glucose with monitor;" and changing "recording ketones" to "check ketones when blood glucose level is high." Three items were added: "keeping food records," "reading food labels," and "treating low blood glucose." Finally, the response option "not applicable or N/A" was deleted on all items with the exception of questions that asked about ketones, insulin, or pills because not all individuals are treated with diabetes pills or insulin or recommended to check ketones. Thus, 4 of the SCI-R's 15 items address diet, 2 address glucose monitoring, 3 address medication administration, 1 addresses exercise, 2 address low glucose levels, and the remaining 3 items address preventative/routine aspects of self-care. For patients with type 2 diabetes, three items (checking ketones, adjusting insulin, and wearing Medic Alert) are not scored. For scoring, items are averaged and converted to a 0- to 100-point scale (see Data analysis). A high score indicates high levels of self-care.

The Summary of Diabetes Self-Care Activities. The Summary of Diabetes Self-Care Activities (SDSCA) (7) is a 25-item self-report measure of the frequency of performing diabetes self-care tasks over the preceding 7 days. This measure served as another index of patient self-care, to examine concurrent validity. Areas assessed include diet, exercise, glucose monitoring, medication taking, foot care, and smoking. Inter-item correlations ranged from $r = 0.20$ to $r = 0.76$ for four SDSCA subscales; 6-month test-retest reliability ranged from $r = 0.00$ to $r = 0.58$ across three studies (27). Concurrent validity was examined by comparing the SDSCA to other measures of level of self-care; the correlations were high for exercise and modest and variable for diet and blood glucose monitoring. Factor analyses did not include medication items, but they showed a three-factor structure accounting for 70–80% of variance, with food, exercise, and blood glucose testing items defining the factors.

Benefits/Barriers scale. The Benefits/Barriers scale (28) provides three subscales assessing attitudes toward diabetes: benefits, barriers, and cost-effectiveness (i.e., benefits minus barriers). The barriers scale was associated with poor treatment adherence (25); consequently, we expected that high SCI-R scores would be related to lower barriers scores. The mea-

sure has acceptable internal reliability (α = 0.67–0.79) (28,29). The scale is weakly correlated with glycemic control ($r = 0.16$, $P < 0.05$) and moderately correlated with depression ($r = 0.27$, $P < 0.001$), anxiety ($r = 0.34$, $P < 0.001$), and treatment satisfaction ($r = -0.27$, $P < 0.001$) (29).

PAID. The PAID is a 20-item measure of diabetes-related emotional distress that assesses a broad range of feelings related to living with diabetes, including guilt, anger, frustration, depressed mood, worry, and fear. This measure was expected to correlate negatively with the SCI-R. The PAID has high internal reliability (α = 0.95) (18,20). High PAID scores are associated with low self-reported adherence (20). Test-retest correlations supported the temporal stability of the instrument (r = 0.83) (30). The PAID is also sensitive to changes in therapy (31).

CIDS. The CIDS is a 21-item measure assessing patient self-efficacy, confidence in their ability to perform diabetes self-care tasks. Thus, this measure was expected to correlate positively with the SCI-R. Patients rate each item on a 5-point scale, ranging from "No, I am sure I cannot" to "Yes, I am sure I can." The CIDS has high internal consistency (α = 0.86–0.90) (15).

SCL-90. The SCL-90 (32,33), a widely used 90-item questionnaire, provides a global assessment of psychiatric symptomatology, the Global Severity Index, and nine subscales, including depression and anxiety. The SCL-90 has demonstrated stability in repeated assessments of reliability and validity (33). High scores are indicative of greater symptomatology. Because problems with adherence have been associated with psychosocial difficulties (13,18), we expected the SCI-R to be negatively correlated with scores from the SCL-90.

RSE. The RSE scale (34) is a 10-item measure of an individual's feelings of self worth. The RSE scale has been extensively used and psychometrically evaluated in diverse populations (35,36). Test-retest correlations ranged from $r = 0.63$ to $r = -0.88$ for a 2-week period. RSE global self-esteem scores have correlated with psychological well-being (37). We expected the SCI-R to correlate positively with patients' reports of self-esteem.

HbA_{1c}. The HbA_{1c} estimates glycemic control for the previous 2–3 months. The Joslin Diabetes Center uses the high-performance liquid chromatography ion capture method (reference range = 4.0–6.0%; Tosoh Medics, San Francisco, CA). We expected high SCI-R to be related to lower HbA_{1c} levels.

Data analysis

Spearman's correlation coefficients examined associations between SCI-R and other measures because SCI-R scores were not normally distributed. To examine the internal structure of the SCI-R, we performed exploratory principal component factor analysis, examining the pattern of loadings for evidence of a large general factor that would support use of a total score. A general factor would be evident if the first mean loading was high (i.e., ≥0.30) and the standard deviation low for the first principal component and the mean loadings low and standard deviations high for the remaining principal components (38). We then conducted a forced factor analysis for three–and two–orthogonal factor solutions using Varimax (orthogonal) rotation to identify meaningful common factors. An item-loading of ≥0.40 was the criterion of item salience of the rotated factor loadings used to guide interpretation. We assessed the internal consistency of the SCI-R and SDSCA using Cronbach's α-coefficient. To examine responsiveness to important clinical change, we used paired t tests, effect size, and Guyatt's statistic (26). Effect size is the difference in baseline and postintervention means divided by the baseline standard deviation. Guyatt's statistic is the difference in baseline and postintervention means divided by the standard deviation of change scores from clinically stable patients (defined as patients whose HbA_{1c} levels remained within 0.4 percentage points of the baseline level). Data were analyzed using SAS version 8.02 (SAS Institute, Cary, NC). Survey scores are converted to a 0- to 100-point scale for ease of interpretation by subtracting the minimum possible item score from the individual's averaged raw score, multiplied by 100. This value is then divided by the difference of the minimum possible item score subtracted from the maximum possible item score ([mean raw score − minimum] × 100)/(maximum − minimum) (39). Data are expressed as the means ± SD unless otherwise indicated.

RESULTS

Study 1: reliability: internal consistency

Mean SCI-R total scores were 65 ± 15 (range 23–100) for type 1 subjects and 63 ± 21 (0–100) for type 2 subjects. Internal consistency of the SCI-R was high (α = 0.87), whereas the SDSCA demonstrated moderate internal consistency (α = 0.62). Item-to-total correlations ranged from 0.36 to 0.67 for the SCI-R and 0.11 to 0.63 for the SDSCA.

Concurrent validity. The SCI-R score correlated with three of the four SDSCA subscales: checking blood glucose ($r = 0.49$, $P < 0.001$), diet ($r = 0.50$, $P < 0.001$), and exercise ($r = 0.38$, $P < 0.001$). For purposes of comparison, we standardized individual items on the SCI-R according to procedures suggested by SDSCA authors (7) by first converting scores to T-scores and then grouping items to create SCI-R subscales based on four SDSCA subscales: diet, exercise, blood glucose monitoring, and medication administration. Standardized SCI-R and SDSCA total scores were correlated ($r = 0.63$, $P < 0.0001$). Correlations between the standardized subscales of the two instruments were moderate to high (diet: $r = 0.25$, $P < 0.02$; medication administration: $r = 0.38$, $P < 0.0003$; exercise: $r = 0.60$, $P < 0.0001$; and blood glucose monitoring: $r = 0.68$, $P < 0.0001$) .

Convergent validity. As expected, the SCI-R negatively correlated with the PAID ($r = -0.37$), glycemic control ($r = -0.38$), and the perceived barriers to diabetes subscale ($r = -0.30$); it was not correlated with the benefits subscale (Table 1).

Study 2: reliability, validity, and structural analysis

Reliability. The mean SCI-R score was 65.4 ± 16 (total sample: range 0–100; type 1: 65.8 ± 15.4, range 15–100; type 2: 64.4 ± 17.9, range 0–100). Cronbach's coefficient was high (total sample: α = 0.85; type 1: α = 0.84; type 2: α = 0.85). Item-to-total correlations for the SCI-R ranged from $r = 0.34$ to $r = 0.59$.

Validity. Convergent validity analyses showed that, as expected, the SCI-R correlated positively with self-esteem ($r = 0.25$, $P < 0.0001$) and self-efficacy ($r = 0.47$, $P < 0.0001$) and negatively with measures of diabetes-related emotional

Table 1—*Results from convergent validity analyses showing correlations between SCI-R and psychosocial measures (study 2)*

	Estimated correlation coefficients		
	All subjects	Type 1	Type 2
Age	0.16*	0.15†	0.35*
Duration of diabetes	0.14†	0.13‡	0.12
Years of education	0.08	0.8	0.07
HbA_{1c}	−0.37*	−0.38*	−0.33*
PAID	−0.36*	−0.34*	−0.43*
CIDS	0.47*	0.49*	0.44*
Global psychiatric symptomatology (SCL-90)	−0.23*	−0.23*	−0.26
Depression	−0.22*	−0.21*	−0.29‡
Anxiety	−0.24*	−0.26*	−0.18
RSE	0.25*	0.24*	0.36†

*$P < 0.001$; †$P < 0.01$; ‡$P < 0.05$.

distress ($r = -0.36$, $P < 0.0001$), anxiety ($r = -0.24$, $P < 0.0001$), depression ($r = -0.22$, $P < 0.0001$), and global psychiatric symptoms ($r = -0.23$, $P < 0.001$) (Table 1). When we adjusted for age and diabetes duration, the relationship of the SCI-R with psychosocial measures held ($P = 0.001$–0.0001) for those with type 1 diabetes. However, for those with type 2 diabetes, the relationship between the SCI-R and the PAID ($P < 0.0001$) and CIDS ($P = 0.001$) held, whereas the relationship with self-esteem and depression did not. Also as expected, SCI-R scores correlated negatively with HbA_{1c} ($r = -0.37$, $P < 0.0001$).

To evaluate the SCI-R's ability to discriminate between patients in good versus poor glycemic control, we dichotomized participants into poor control ($HbA_{1c} \geq 9.0$, mean SCI 57.3 ± 17.8) and good control ($HbA_{1c} \leq 7.0$, mean SCI 67.5 ± 14.8) groups (24). The SCI-R was sensitive to these extremes ($t = 4.45$, $P < 0.0001$). We also used multiple regression to examine the HbA_{1c}/SCI-R relationship, controlling for demographic factors. Age, sex, diabetes duration, and education taken together explained 7.6% of the variation in HbA_{1c} (only education individually predicted HbA_{1c}), whereas the SCI-R, controlling for demographic characteristics, explained 20.9% ($P < 0.001$) of the variation in HbA_{1c}.

Internal structure analysis. Principal components analyses of the SCI-R showed a large general factor for both type 1 and type 2 diabetic patient analyses. For type 1 diabetes, all items loaded ≥0.34 (range 0.34–0.77, mean 54.4 ± 12.1) on the first principal component, and the remaining principal components had low mean loadings with high standard deviations (e.g., 4.0 ± 31.8). The two items with loadings <0.40 were "wearing a medic alert ID" (0.34) and "administer the correct insulin dose" (0.34). For type 2 diabetes, all items loaded ≥0.40 (range 0.44–0.79, mean 60.8 ± 11.6) on the first principal component, and the remaining principal components had low mean loadings with high standard deviations (e.g., 2.1 ± 38.9). Inspection of the Scree plot of the principal component eigenvalues suggested a one-factor solution. Using the Kaiser rule, three factors had eigenvalues >1: 4.6, 1.4, and 1.2 for those with type 1 diabetes explaining 31, 10, and 8% of the variance and 4.5, 1.6, and 1.3 for those with type 2 diabetes explaining 38, 13.8, and 11% of the variance. However, closer examination of rotated two- and three-factor solutions did not reveal a clear interpretation (Table 2). Specifically, for those with type 1 diabetes, a two-factor solution showed that 2 of the 15 items loaded on both factors, and 2 additional items were very close to loading on both factors. For those with type 2 diabetes, only one item double-loaded on both factors. For both types of diabetes, the factor loadings did not clearly divide by domain nor did they clearly indicate concepts such as "preventative maintenance" and "active management." For a three-factor solution, four items double-loaded for type 1 patients, and no items double-loaded for type 2 patients. Moreover, where groups of items loaded uniquely and clearly defined a given factor, no clinically coherent grouping of items (e.g., medication, food, or glucose monitoring) could be determined (Table 2). In summary, the SCI-R results showed a large general factor to be present for both type 1 and type 2 patients, supporting the use of a total test score, but there were no common factors supporting SCI-R subscales.

Study 3: responsiveness

As expected, mean SCI-R scores for patients completing a psychological or cholesterol-intensive intervention were higher ($t = 5.91$, $P = 0.001$) 2 months postintervention (64.4 ± 10.8) compared with baseline (57.9 ± 10.6). Subsequent analyses examining differences based on clinically significant HbA_{1c} changes (>0.5 percentage points) showed that a mean difference in SCI-R score was 9.7 ± 6.9 ($n = 17$) for "improvers" and 4.7 ± 7.7 ($n = 33$) for "stable" patients. Effect size calculated for the total group was 0.62, whereas Guyatt's responsiveness statistic for improvers was 0.85. These results provided support for the responsiveness of the SCI-R to change.

CONCLUSIONS — This study examining the psychometric characteristics of an updated version of the SCI (SCI-R), a measure of perceptions of self-care behaviors, provided support for its reliability, concurrent and convergent validity, and responsiveness to treatment for type 1 and type 2 diabetic patients. The reliability findings are consistent with earlier studies using the original SCI, suggesting that, despite modifications of individual scale items, the scale remained internally consistent.

Moderate to high correlations with a previously published measure of diabetes self-care behaviors (SDSCA) provided support for SCI-R concurrent validity. To establish convergent validity, we compared the SCI-R with several measures that assess related constructs. Moderate correlations in the expected directions generally supported its construct validity while indicating that the SCI-R scale provides unique information. We examined responsiveness and found that the SCI-R scores changed over the course of a 2-month intensive intervention and were sensitive to differences between groups based on extremes in glycemic control.

The SCI-R was moderately correlated with HbA_{1c}, diabetes-related emotional distress, and barriers to self-care. The SCI-R scores are associated with other

Table 2—*SCI-R rotated factor loadings for 2- and 3-factor solutions for type 1 and type 2 diabetic patient groups*

	2 Factor		3 Factor		
SCI-R items*	Factor 1	Factor 2	Factor 1	Factor 2	Factor 3
Type 1 diabetic patients					
Exercise regularly	**47**	08	21	**53**	−12
Attend clinic appointments	**50**	21	**42**	34	05
Eat recommended food portions	**53**	**45**	**58**	28	**31**
Adjust insulin	**57**	26	**42**	**47**	06
Keep food records	**58**	00	38	**44**	−19
Treat low blood glucose	**63**	25	**69**	19	12
Carry quick acting sugar for lows	**66**	**42**	**73**	25	26
Read food labels	**74**	−01	**71**	21	−18
Wear medic alert	23	25	**42**	−09	24
Check blood glucose with monitor	38	**44**	03	**81**	19
Eat meals/snacks on time	38	**44**	23	**52**	27
Take diabetes pills/insulin at the right time	31	**58**	**50**	08	**52**
Record blood glucose results	22	**60**	01	**64**	**43**
Check ketones	08	**70**	28	06	**68**
Take correct dose of diabetes pills/insulin	−18	**75**	−05	13	**75**
Type 2 diabetic patients					
Exercise regularly	**67**	26	32	**72**	18
Attend clinic appointments	**56**	28	**58**	18	27
Eat recommended food portions	17	**76**	16	16	**74**
Keep food records	**71**	−33	**60**	34	−37
Treat low blood glucose	**60**	32	**65**	16	31
Carry quick-acting sugar for lows	**69**	**40**	**75**	18	38
Read food labels	**76**	−17	**84**	13	−18
Check blood glucose with monitor	**69**	23	22	**89**	12
Eat meals/snacks on time	10	**71**	00	25	**69**
Take diabetes pills/insulin at the right time	**56**	36	**59**	18	34
Record blood glucose results	**60**	26	13	**86**	16
Take correct dose of diabetes pills/insulin	13	**71**	22	01	**71**

Factor loadings are in decimals. Significant loadings (i.e., ≥0.40) are in bold. Three items are not used in SCI-R for type 2 patients and were not included in analyses for that patient group. *Some items are shortened for ease of presentation.

variables known to impact self-care: diabetes self-efficacy, self-esteem, depression, and anxiety. These negative correlations with psychological barriers to diabetes self-care are consistent with the substantial literature on the relationship between emotional functioning and adherence and control. One interpretation is that the SCI-R measures a general construct more closely related to emotional measures than actual self-care behaviors. However, one study (13) that found adherence (measured by the original SCI) and emotional functioning (anxiety, depression) make independent contributions to HbA_{1c}. Another study found the original SCI to be highly correlated with glucose monitoring ($r = 0.80$) and moderately with exercise frequency ($r = 0.39$) measured by the 24-h Recall Interview (9). Also, because emotions often interfere with adherence to self-care recommendations, it is likely that the SCI-R would be related to emotional functioning as well. Furthermore, in the current study, the highest magnitude of correlations for the SCI are with the self-care adherence measure rather than the psychosocial measures, further suggesting the SCI-R is more related to adherence to treatment recommendations than to psychosocial functioning. Thus, these relationships between the SCI-R and emotions give credence to the SCI-R as a measure of self-care perceptions.

Interestingly, factor analytic findings supported the presence of a large general factor. This finding is consistent with the Cronbach α-coefficients, indicating high internal consistency. Although current wisdom posits that self-care areas are weakly correlated and thus should be measured separately (3), our data suggest a level of consistency across these self-care domains under a general construct of diabetes self-care. Furthermore, as expected, the SCI-R score discriminated between extreme glycemic control groups (>9 vs. <7%).

We did not find evidence for common factors defining specific diabetes self-care domains (food choices, exercise, medications, glucose monitoring). However, specific subscales related to as yet undefined constructs might exist, particularly for those with type 2 diabetes. Examples of such constructs include "active management" and "preventative activities." Further investigation using confirmatory factor analysis may be necessary to better evaluate underlying structures.

The SCI-R differs from recall surveys and interviews in that it allows respondents to estimate the degree to which they follow treatment recommendations, rather than recall the frequency of self-care behaviors over time. This estimate relies on patients' ability to summarize their own behavior, an easier task and, as our data suggest, possibly a more accurate task than remembering behavior frequencies. Thus, the SCI-R reflects the patients' perceptions of self-care performance rather than an exact recall of behaviors. It is possible that the SCI-R provides a better estimate of patients' self-care behaviors because it summarizes over a 1-month period, rather than a 1-week period. Thus, the SCI-R may be a useful assessment of self-care behavior when used alone or in conjunction with recall surveys or interviews.

A limitation of this study and of others examining the measurement of self-care behavior is the lack of a "gold standard" comparison. In this case, we used another validated self-report survey that relies on memory, HbA_{1c}, and validated measures examining issues thought to interfere with diabetes self-care. It is important for future studies to compare SCI-R results with more objective measures of self-care behaviors. Another limitation pertains to the sample, which is relatively homogenous. Future exploration of the SCI-R's utility in more diverse populations to address factors such as race/ethnicity, socioeconomic status, age, and other variables is important, although studies using the SCI with children and

adolescents included diverse populations (12–14).

One weakness of the SCI-R is the inclusion of only one item for exercise. From both a clinical and psychometric perspective, having an additional item representing exercise might better balance the scale, as suggested by La Greca et al. (8,40). We also recommend the following items that address important areas not currently assessed by the SCI-R: "Check feet regularly" and "Look for blood glucose patterns." Thus, the SCI-R may need further refinement to improve its content validity and clarify its factor structure. However, as it stands, the measure provides a coherent set of diabetes self-care items for use as a screening tool or to explore patient problem areas.

The SCI-R gives health care providers an indication of how well their patients follow self-care recommendations, but this information needs to be viewed in the context of the treatment program that was recommended for a particular patient. One advantage of the SCI-R is that it doesn't assume that each patient has the same regimen, and it allows for some flexibility of regimens. Another advantage is that the SCI-R is short, taking only a few minutes for patients to complete, and is easily scored. Furthermore, the individual items are useful for busy clinicians to begin a conversation about self-care behavior with their patients.

In conclusion, we found support for the reliability and validity of the SCI-R measure for use with individuals with type 1 and type 2 diabetes. Because the SCI-R renders a global scale summarizing self-care behaviors, it is a valuable tool for use in outcomes research as well as busy clinical settings.

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