Validation of Scale Measuring Environmental Barriers to Diabetes-Regimen Adherence

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This study reports on the validation of a diabetes-specific measure of environmental barriers to regimen adherence. The reliability and validity of the environmental barriers to adherence scale (EBAS) were determined for a sample of 214 insulin-dependent and non-insulin-dependent diabetic patients. The scale was shown to be a valid measure of barriers to adherence as assessed by its relationship to the barriers to adherence questionnaire and the barriers to adherence portion of the diabetes-care profile. The medication, testing, exercise, and diet subscales of the EBAS were correlated with four corresponding and three noncorresponding measures of self-care behavior from the diabetes self-care behaviors scale. Each subscale correlated well with its corresponding self-care behavior and less well with noncorresponding self-care behavior. The internal consistency of the scale and the test-retest reliability were found to be good. The results suggest that the EBAS scale is a valid, reliable measure of barriers to diabetes-regimen adherence. *Diabetes Care* 13:705–11, 1990

Identification of factors influencing self-care behavior is a major theme in diabetes patient-education research. Efforts to understand interindividual differences in levels of self-care have historically focused on intrapsychic factors such as knowledge (1,2), health beliefs (3–5), attitudes, psychological traits, and psychological adjustment (6–9). Research is evolving in the direction of multifactorial models, which aim at elucidating the interrelationship between intrapsychic and environmental variables (10–17). This article is concerned with one aspect of such work—measurement of perceived environmental barriers to self-care.

The measurement of perceived environmental barriers to self-care is grounded in social learning theory (18,19). It proceeds from the assumption that a given barrier to self-care, such as a person's work schedule, has a differential psychological effect among individuals and thus affects their self-care behavior differentially. Moreover, it is assumed that individuals will vary not only in their perception of barrier severity but also in their sensitivity to different categories of barriers (e.g., diet vs. exercise barriers) and in the overall number of barriers they endorse. The measurement of each of these aspects of barrier perception has potentially important clinical and research implications.

Schafer et al. (20) measured perceived barriers to self-care with a 15-item scale created for type I (insulin-dependent) diabetic adolescents and adults. They found that barriers to self-care were associated with following a diet and care in measuring insulin dose. Ary et al. (21) explored barriers to self-care with a sample of 208 type I and type II (non-insulin-dependent) diabetic individuals. They used both structured and unstructured questionnaire formats and found that barriers were a significant problem for diet, glucose testing, and exercise self-care behavior.

These studies were significant in terms of demonstrating the influence of perceived barriers on self-care behavior. However, the measure used was limited in terms of the total number of barriers assessed and its ability to measure differential sensitivity to categories of barriers.

The purpose of this article is to report preliminary

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validation of a scale that addresses these shortcomings. The environmental barriers to adherence scale (EBAS) measures a total of 60 barriers. Thirteen environmental barriers are measured across four areas of self-care behavior (i.e., diet, exercise, blood glucose testing, and medication), making it possible to calculate subscale scores that reflect differential sensitivity to the four categories of barriers measured. In addition, the scale measures 3 barriers unique to exercise and 5 barriers unique to diet.

RESEARCH DESIGN AND METHODS

Structured telephone interviews were conducted with a total of 13 type I and type II diabetic individuals randomly selected from the files of the outpatient diabetes unit at a large hospital in Virginia. The standardized interview solicited responses to a set of 11 questions on the following topics: *1*) problems with diet, exercise, glucose testing, and medication regimen; *2*) problems with diabetes care at work or school; and *3*) ways that family or friends help or hinder diabetes self-care. Six diabetes health-care providers, including a physical therapist, a diabetologist, a nutritionist, and three nurse practitioners, were also interviewed with the same interview format.

Responses to the interviews were analyzed for content, and a pool of distinguishable responses identified by two or more respondents was generated. From this pool, only items that reflected environmental barriers (as opposed to emotional or social-support barriers) were selected for inclusion in the scale. The result is a 60-item scale, consisting of four self-care behavior subscales (SCBSs) that assess environmental barriers to diet (18 items), exercise (16 items), glucose testing (13 items), and medication (13 items) (Table 1). Responses to each item are rated on a five-point scale from 1 (never) to 5 (always).

Because of the degree of overlap in potential barriers across the adherence behaviors and in the interest of

TABLE 1
Environmental barriers to adherence questionnaire

Problems With Self-Care

For the following questions, circle the correct letter where N = never, R = rarely, S = sometimes, O = often, A = always, and NA = not applicable. Please do not skip any of the questions.

To what extent does each of the following keep you from taking *your medication* (or insulin) as you think you should?						
1. Finding the time at work	N	R	S	O	A	NA
2. Finding the time at home	N	R	S	O	A	NA
3. Finding a good place	N	R	S	O	A	NA
4. The inconvenience (of carrying my medication with me, etc.)	N	R	S	O	A	NA
5. Problems with my health (trouble seeing, etc.)	N	R	S	O	A	NA
6. Forgetting to take it	N	R	S	O	A	NA
7. Feeling sick	N	R	S	O	A	NA
8. It's too complicated	N	R	S	O	A	NA
9. It's too painful	N	R	S	O	A	NA
10. Being away from home (shopping, traveling, etc.)	N	R	S	O	A	NA
11. Changes in my routine (sleeping late, working late, etc.)	N	R	S	O	A	NA
12. The cost	N	R	S	O	A	NA
13. Special occasions (weddings, holidays, etc.)	N	R	S	O	A	NA
To what extent does each of the following keep you from *exercising* as you think you should?						
1. Finding the time at home	N	R	S	O	A	NA
2. Finding the time at work	N	R	S	O	A	NA
3. Finding a good place	N	R	S	O	A	NA
4. The inconvenience (of going to the gym, carrying the equipment, etc.)	N	R	S	O	A	NA
5. Problems with my health (trouble seeing, painful legs, etc.)	N	R	S	O	A	NA
6. Forgetting to exercise	N	R	S	O	A	NA
7. Feeling sick	N	R	S	O	A	NA
8. It's too complicated (keeping track of my heart rate, time, etc.)	N	R	S	O	A	NA

TABLE 1 (*continued*)

9. It's too painful	N	R	S	O	A	NA
10. Being away from home (shopping, traveling, etc.)	N	R	S	O	A	NA
11. Changes in my routine (sleeping late, working late, etc.)	N	R	S	O	A	NA
12. Getting back to it after a break in my routine	N	R	S	O	A	NA
13. Bad weather	N	R	S	O	A	NA
14. Changes in the season	N	R	S	O	A	NA
15. The cost	N	R	S	O	A	NA
16. Special occasions (weddings, holidays, etc.)	N	R	S	O	A	NA
To what extent does each of the following keep you from *testing* your blood sugar (urine or blood testing) as you think you should?						
1. Finding the time at home	N	R	S	O	A	NA
2. Finding the time at work	N	R	S	O	A	NA
3. Finding a good place	N	R	S	O	A	NA
4. The inconvenience (of carrying my materials)	N	R	S	O	A	NA
5. Problems with my health (trouble seeing, etc.)	N	R	S	O	A	NA
6. Forgetting to test	N	R	S	O	A	NA
7. Feeling sick	N	R	S	O	A	NA
8. It's too complicated	N	R	S	O	A	NA
9. It's too painful	N	R	S	O	A	NA
10. Being away from home (shopping, traveling, etc.)	N	R	S	O	A	NA
11. Changes in my schedule (sleeping late, working late, etc.)	N	R	S	O	A	NA
12. The cost of supplies	N	R	S	O	A	NA
13. Special occasions (holidays, etc.)	N	R	S	O	A	NA
To what extent does each of the following keep you from *eating* (staying on your diet) as you think you should?						
1. Finding the time at home (to prepare meals, eat on time, etc.)	N	R	S	O	A	NA
2. Finding the time at work (to prepare a meal, eat on time, etc.)	N	R	S	O	A	NA
3. Finding a good place (restaurant with food on my diet)	N	R	S	O	A	NA
4. The inconvenience (of preparing special foods, using food exchanges)	N	R	S	O	A	NA
5. Problems with my health (trouble seeing, no energy, etc.)	N	R	S	O	A	NA
6. Forgetting my diet	N	R	S	O	A	NA
7. Feeling sick	N	R	S	O	A	NA
8. It's too complicated	N	R	S	O	A	NA
9. It's too painful (hunger)	N	R	S	O	A	NA
10. Being away from home (shopping, traveling)	N	R	S	O	A	NA
11. Changes in my routine (sleeping late, working late, etc.)	N	R	S	O	A	NA
12. The cost	N	R	S	O	A	NA
13. Special occasions (weddings, holidays, social gatherings)	N	R	S	O	A	NA
14. Getting back on my diet after getting off it	N	R	S	O	A	NA
15. Not having the right food in the house	N	R	S	O	A	NA
16. Having junk food in the house	N	R	S	O	A	NA
17. No one else eats like I have to	N	R	S	O	A	NA
18. Too few foods I like that are on my diet	N	R	S	O	A	NA

scaling, parallel forms for most of the items were included in each subscale. For example, each SCBS included items about cost, difficulty finding time at work, finding time at home, finding a place, inconvenience, complexity, pain, forgetting, health problems, being away from home (i.e., traveling, shopping), special occasions, sickness, and changes in routine.

The EBAS can be scored and used in several ways. A global barriers score can be calculated by summing the responses to all of the items, or individual scores can be obtained for the four SCBSs. Finally, 13 four-item barriers subscales (FIBSs) can be scored by adding together the common parallel items (e.g., inconvenience) found in each of the SCBSs.

Subjects. Letters were sent to 1171 diabetic individuals inviting them to participate in a large diabetes study. Potential subjects were asked to complete a lengthy questionnaire, requiring ~2 h, and to provide a blood sample. A payment of $40.00 and laboratory test results were offered to those participating in the study. A total of 214 subjects actually took part in the study. Participants included 37 type I diabetic subjects, 96 type II diabetic subjects on insulin, and 81 type II diabetic subjects on a diet-controlled regimen. Type I diabetic subjects were defined as subjects diagnosed before 30 yr of age and at <120% of their ideal body weight. One hundred nine of the total sample were female, and 105 were male. Age for the sample ranged from 20 to 89 yr (mean ± SD 48.7 ± 14.1 yr). The median educational level was completion of high school, ranging from less than an eighth-grade education to a postgraduate degree. The mean ± SD duration of diabetes was 10.1 ± 9.8 yr. One hundred fifty-four reported their race as White, 57 as Black, and 3 as other.

Measures. The barriers to diabetes adherence scale (BAS) is a 15-item scale assessing frequency of both environmental and cognitive events that are obstacles to regimen adherence among people with type I diabetes (22). The scale yields a total barrier score and subscale scores for diet, exercise, insulin-injection, and glucose-testing barriers. Each subscale is 3 or 4 items long. Responses are scored by frequency of occurrence on a seven-point scale ranging from 1 (very rarely) to 7 (daily).

The diabetes-care profile (DCP) is a scale designed to measure psychosocial aspects of diabetes, including self-care and barriers to self-care behavior (23). The barriers include both environmental and cognitive barriers for diet, exercise, glucose testing, and medication adherence. The barrier scale contains three to six items per self-care behavior and yields a single score for total barriers. Responses are scored on a five-point scale ranging from 1 (never) to 5 (frequently).

The diabetes self-care behavior (DSCB) scale is a 24-item measure of self-reported level of adherence (24). Self-care behaviors included in the scale are diet, exercise, medication (oral and insulin), glucose testing (blood glucose and urine testing), alcohol consumption, foot care, and carrying identification. In each case, subjects are asked if the behavior was prescribed by a physician and the percentage of time the behavior is performed (0, 25, 50, 75, and 100%).

Two hundred fourteen patients responded to a letter sent to 1171 patients from an outpatient diabetes clinic inviting them to participate in a study of psychosocial factors in the management of diabetes. These patients were sent a questionnaire packet and were scheduled for a laboratory visit within the next month. The questionnaire packet contained the EBAS, the BAS portion in the DCP (DCP-BAS), and the DSCB questionnaire.

At the laboratory visit, subjects' questionnaires were examined for missing data. The following physiological measures were taken during the visits: blood pressure, height, weight, and glycosylated hemoglobin (HbA_1). Subjects were paid $40.00 for their participation. Six weeks later, a follow-up questionnaire packet was sent out, which included the EBAS, the BAS, and the DSCB, for estimates of test-retest reliability.

RESULTS

Test-retest reliability for the total scale was 0.80 ($P < 0.001$). Test-retest scores for the medication, exercise, testing, and diet barriers subscales were 0.59, 0.59, 0.74, and 0.74 ($P < 0.001$ for each), respectively. The internal consistency of the total scale and the subscales was assessed with Cronbach's α. Coefficients were as follows: total scale, 0.94; diet, 0.91; exercise, 0.86; glucose testing, 0.86; and medication, 0.84. These coefficients suggest a high level of internal consistency for the scales.

Tests of internal consistency for the FIBS ranged from $\alpha = 0.52$ to 0.81. Three subscales had $\alpha < 0.60$, including finding a place ($\alpha = 0.59$), inconvenience ($\alpha = 0.57$), and pain ($\alpha = 0.52$). The shortness of the FIBS tends to suppress reliability; therefore, the Spearman-Brown formula (25) was used to recalculate reliabilities assuming a scale size equal to that of the SCBS (i.e., 13). Reliabilities for all the FIBSs after this adjustment ranged from $\alpha = 0.93$ to 0.98.

In examining the validity of the EBAS, four measures of validity were assessed: content, concurrent, statistical conclusion, and discriminant (26). Estimates of content validity were made by five diabetes professionals who reviewed the questionnaire for representativeness and face validity.

Concurrent validity was assessed by correlating the EBAS with both the BAS and the DCP-BAS subscale. The correlations were $r = 0.63$ and 0.51, respectively. The SCBSs were also correlated with the BAS and DCP-BAS subscale (Table 2). Correlations ranged from $r = 0.34$ to 0.62 for the BAS and from $r = 0.30$ to 0.51 for the DCP-BAS, suggesting a moderate level of concurrent validity.

Statistical conclusion validity (26) tests whether the dependent variable (self-care behavior) is related to the independent variable (environmental barriers). This was determined by correlating the EBAS with the DSCB

TABLE 2
Correlations of environmental barriers to adherence scale, barriers to adherence (BAS) questionnaire, and BAS portion of diabetes-care profile (DCP-BAS)

		Barriers			
	Total scale	Medication	Exercise	Testing	Diet
BAS	0.63	0.34	0.41	0.51	0.62
DCP-BAS	0.51	0.44	0.30	0.51	0.37

$P < 0.001$ for all correlations.

questionnaire (Table 3). These correlations consistently reflect the negative relationship expected between barriers and adherence behaviors. The highest correlations were between each adherence behavior (e.g., adherence to a meal plan) and its respective EBAS subscale (e.g., diet barriers). These correlations ranged from $r = -0.33$ to -0.52 ($P < 0.05$). The presence of high barriers to adherence might also be expected to be reflected in higher levels of blood glucose. HbA_1 was correlated ($r = 0.28$, $P < 0.001$) with the total EBAS scale.

Discriminant validity was assessed in two ways. First, the SCBSs were correlated with those items on the DSCB that reflected regimen behavior not measured by the EBAS, including alcohol use, foot care, and carrying identification. Correlations between these adherence behaviors and the SCBS ranged from $r = 0.01$ to -0.18, with the exception of the correlation between foot care and diet barriers ($r = -0.32$). Discriminant validity was also assessed by intercorrelating the SCBSs. Correlations among these subscales ranged from $r = 0.28$ to 0.65 (Table 4). In contrast, correlations between the SCBSs and the total score for the EBAS ranged from $r = 0.73$ to 0.86.

DISCUSSION

The results of these analyses demonstrate that the EBAS is a valid, reliable measure of barriers to diabetes self-care regimens. Test-retest reliability and internal consistency of the items were high.

Estimates of concurrent validity showed the EBAS to be related to the BAS and to the DCP-BAS. Correlations between the EBAS and both the BAS and DCP-BAS were moderately strong, suggesting that these scales are measuring similar constructs. The level of these correlations may have been reduced due to certain important differences between the scales. The BAS was developed on a sample of type I diabetic subjects and is limited to 15 items. The EBAS was developed on a broader sample of type I and type II diabetic subjects and measures a larger sample of barriers. The restricted scope of the BAS reduces the common variance between the EBAS and the BAS.

The response categories for the two scales are also different. The BAS measures frequency of the behaviors in days, weeks, and months. Additionally, items on the BAS that occurred less than once a day and that caused less than a moderate degree of difficulty were deleted from this scale. The EBAS is scored in terms of relative frequency, from never to always. These differences in scoring may also have reduced the common variance.

The moderate association between the EBAS and the DCP-BAS may reflect the lack of overlap of items in these scales. A comparison of the two scales revealed only five items measuring the same barriers. These were *1*) forgetting to take medication, *2*) forgetting to test glucose, *3*) not having the time to test, *4*) not having a place to test, and *5*) the cost of testing.

Statistical conclusion validity was established by correlating self-reported adherence items from the DSCB

TABLE 3
Correlations of self-care barriers and diabetes self-care behaviors

		Barriers			
	Total scale	Medication	Exercise	Testing	Diet
Take pills	−0.22	−0.41*	−0.01	−0.23*	−0.24*
Take insulin	−0.39*	−0.33*	−0.31*	−0.21*	−0.24*
Limit calories	−0.35*	−0.18*	−0.23*	−0.17†	−0.39*
Avoid sweets	−0.38*	−0.30*	−0.30*	−0.21*	−0.43*
Eat on time	−0.41*	−0.32*	−0.27*	−0.31*	−0.44*
Follow meal plan	−0.42*	−0.21*	−0.25*	−0.30*	−0.52*
Test blood	−0.41*	−0.23*	−0.23*	−0.46*	−0.37*
Test urine	−0.33†	−0.33†	−0.25†	−0.25†	−0.22
Exercise	−0.32*	−0.08	−0.37*	−0.06	−0.40*
Drink alcohol	0.01	0.04	0.03	0.03	0.05
Foot care	−0.18†	0.07	−0.09	−0.17†	−0.32*
Carry identification	−0.06	−0.13	0.12	−0.12	−0.12

*$P < 0.001$.
†$P < 0.05$.

TABLE 4
Intercorrelations for self-care barriers scales

	Barriers			
	Medication	Exercise	Testing	Diet
Total	0.73	0.81	0.75	0.86
Medication barriers		0.28	0.54	0.39
Exercise barriers			0.42	0.65
Testing barrier				0.50

$P < 0.001$ for all correlations.

scale with the SCBSs and the total EBAS score. These analyses demonstrated that the total scale was related to the adherence behaviors. In addition, barriers to medication, exercise, blood glucose testing, and diet were more strongly associated with their respective levels of adherence to medication, exercise, blood glucose testing, and diet regimen than to noncorresponding self-care behaviors. The overall pattern of significant correlations between the SCBSs and the self-care behaviors may be attributed to the parallel items in each SCBS. We expect, for instance, that if cost is endorsed as a testing barrier, it might also be endorsed as a medication, diet, and exercise barrier. Common variance might also reflect a response bias.

Two measures of discriminant validity were used, and in both cases, the EBAS was found to be a valid measure of barriers to adherence. The correlations among the four subscales demonstrated that they were sufficiently independent to measure variance unique to each self-care behavior. It was also demonstrated that the EBAS did not correlate consistently with noncorresponding self-care behavior (i.e., foot care, alcohol use, carrying identification).

This study has several limitations that should be considered when evaluating the scale. These include the low volunteer rate of subjects solicited for the study (18%), the small number of type I diabetic subjects, and the self-report method of measuring self-care behavior. The selection bias and the relatively small sample of type I diabetic subjects may influence the external validity of the results. Self-report can be a biased representation of actual levels of self-care (27). Future validation of the instrument would benefit from inclusion of multiple convergent measures of self-care. These might include self-care diaries, 24-h recall of self-care activities, or assessment of self-care by independent observers.

Despite the limitations just discussed, we believe this instrument is an improvement over previous efforts to measure environmental barriers to diabetes-regimen adherence. The content validity of the scale is improved by the number of barriers examined, which allows researchers to capture a greater proportion of the variance attributable to environmental barriers. The scale is designed to measure barriers in both type I and type II diabetic populations, making it more versatile. It also uses a parallel-item structure that allows researchers and clinicians to examine the role of specific barriers (e.g., cost, convenience) through the use of the FIBS. This is an improvement over the single-item analysis previously used to examine the role of individual barriers.

Clinically, the EBAS offers clinicians an increased ability to identify environmental contingencies that limit self-care and the opportunity to modify interventions to address these obstacles. Theoretically, the scale supports the social learning model discussed previously by showing that environmental barriers are related to reduced levels of adherence. The EBAS therefore provides a theoretically important adjunct to the investigation of environmental contingencies for self-care.

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