Problem Solving and Diabetes Self-Management

Investigation in a large, multiracial sample

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OBJECTIVE — Problem solving is a core aspect of effective diabetes and chronic illness self-management, yet there are relatively few objective evaluations of problem-solving skills, especially in large, multiracial samples.

RESEARCH DESIGN AND METHODS — A multiracial sample of 506 adults who have type 2 diabetes were assessed on a variety of patient characteristics, self-management behaviors, and biological and psychosocial measures. They also completed the Diabetes Problem-Solving Interview (DPSI).

RESULTS — DPSI scores revealed significant variability across patients in problem-solving skill and were related to a number of comorbid conditions and complications but not to several other demographic factors, including race/ethnicity. Problem solving was also related to self-management behaviors (eating and exercise patterns), biological variables (A1C and lipids), and psychosocial measures (Diabetes Distress Scale) in multivariable analyses controlling for a variety of potential confounding factors.

CONCLUSIONS — Diabetes problem solving, as measured by the DPSI, is an important patient skill related to several key diabetes management variables that appears applicable across racial and ethnic groups. Future research is needed to identify the generality versus specificity of diabetes problem solving and practical interventions to enhance problem-solving skills.

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Self-management support is established as an evidence-based intervention for diabetes (1). A variety of reviews and syntheses have concluded that, at least in the short to medium term, diabetes self-management support is effective (1–3). Further, almost all models or conceptualizations of the core aspects of self-management support include problem-solving ability as a central feature. This is true of the widely adopted chronic disease self-management program of Lorig et al. (4), Chronic Care Model applications of self-management support (5,6), the evidence-based five A's approach to health behavior change (7), and other well-controlled studies that have been especially successful at longer-term maintenance of behavior change (8).

A substantial amount of research supports the importance of effective problem solving for successful adjustment and coping. Much of this work has been based upon the social problem-solving model of D'Zurilla and colleagues (9,10). This model has broad applicability to health-related conditions (11) and to regimen adherence (12). In diabetes, Hill-Briggs (13) has applied problem-solving theory to diabetes self-management and identified problem-solving skill, along with problem-solving orientation, disease-specific knowledge, and transfer of past experience as key components of effective self-management. Little is known, however, about how patient characteristics including demographics, race, and psychological distress are related to problem solving.

Finally, from a patient perspective, the challenges associated with having diabetes and other chronic illnesses are not static. Rather, they are dynamic and change over time, underscoring the need to have skills to cope with emerging issues, as opposed to simply "education" about standard responses or regimen behaviors. Figure 1 depicts our conceptual model of how problem solving relates to diabetes. As can be seen, we conceptualize problem-solving skills as determining how individuals will respond to challenges and as strongly influencing the resulting levels of diabetes regimen self-management. Self-management regimen behaviors, in turn, impact clinical outcomes. In addition, all of the above factors are potentially influenced by the personal, social, and medical characteristics in the patients' lives.

This study used a previously validated assessment procedure, the Diabetes Problem-Solving Interview (DPSI), which has been found in prior research to be one of the strongest predictors of diabetes self-management behaviors, to be sensitive to a self-management training intervention and to mediate behavior change in prior research (14,15). Use of both cognitive and behavioral problem-solving strategies appeared to enable subjects to be more successful in coping with the variety of challenges posed by diabetes self-management behaviors. However, to our knowledge, the DPSI has not been studied with large, multiracial samples or related to comprehensive measures of diabetes control and self-management. Given the impact of health disparities, we felt it important to determine whether problem-solving skills appear applicable

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Abbreviations: DPSI, Diabetes Problem-Solving Interview.

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

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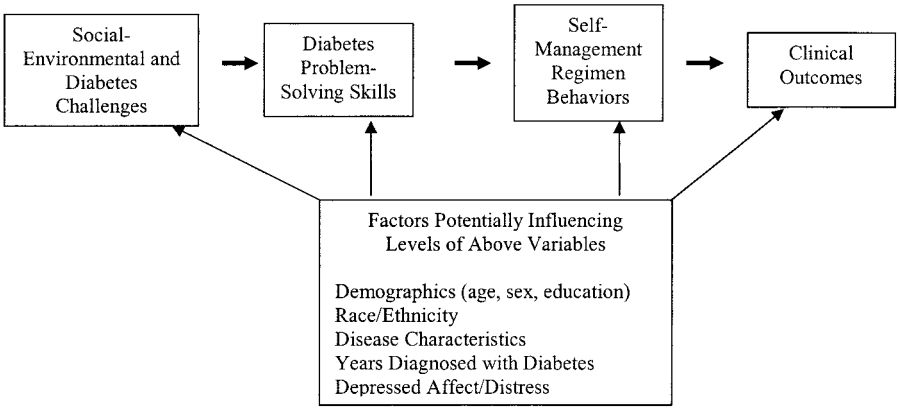

Figure 1—*Hypothesized role of problem solving in diabetes.*

cross-culturally and whether there were differences among racial/ethnic groups in problem solving.

The primary purposes of this study were *1*) to assess the range of problem-solving skills in a diverse sample and to investigate patient characteristics potentially associated with problem solving; *2*) to investigate the relationship between depression, depressed affect, and problem solving; and *3*) to evaluate the relationship of DPSI scores to a variety of self-management, psychosocial, and biologic measures. We hypothesized that diabetes problem solving would be significantly related to self-management, diabetes control, and depression/distress, both before and after controlling for other factors for all ethnic groups.

RESEARCH DESIGN AND METHODS

— This report is based on the first of a three-wave, longitudinal study of diabetes and depression. To assure a diverse, multiethnic community sample, patients were recruited from several San Francisco Bay area medical groups and diabetes education centers. Inclusion criteria included the following: patients with type 2 diabetes between age 21 and 75 years, the ability to read and speak English or Spanish fluently, and no severe diabetes complications. Letters were sent to each patient from their health care facility, cosigned by a facility and a project representative, informing them of the project and that they would receive a phone call from the project office if one of two opt-out procedures was not initiated (return decliner postcard or 800-number phone call). A screening phone call followed and, for eligible patients, an appointment was made in the patient's choice of their home, our office, or a community setting to explain the project in detail, collect informed consent, and begin assessment. Patients received a 1.5-h home visit that included questionnaires, physical measurements and interviews, a 150-item mail-back questionnaire, and a visit to one of several community laboratories for collection of blood and urine specimens. All materials were prepared in English and Spanish, and research assistants were fluent in both languages. The project was approved by the institutional review board at the University of California San Francisco and at each participating facility.

Screening identified 640 eligible patients, and 506 (79%) completed data collection. There were no significant differences between those who participated versus those who declined on the variables available to us (age, sex, ethnicity, and education). As can be seen in Table 1, we were successful in recruiting a diverse, multicultural sample, with substantial variability in race/ethnicity, education, and history of diabetes and comorbid conditions. The average age was almost 60 years, BMI levels were elevated (M = almost 33), most patients had had diabetes for a number of years, and the average number of other comorbid chronic conditions was almost four.

Table 1—*Sample characteristics*

	n (%)	Means ± SD
Demographic characteristics (overall *n* = 506)		
Sex (female)	288 (57)	
Mean age		57.8 ± 9.8
Years of education		14.5 ± 3.3
Ethnicity		
Asian American	85 (16.8)	
African American	104 (20.5)	
Hispanic	98 (19.3)	
Non-Hispanic white	186 (36.7)	
Other	34 (6.7)	
Medical characteristics		
BMI (kg/m^2)		32.7 ± 7.7
Taking psychotropic meds	105 (20.8)	
Number of comorbidities		3.8 ± 2.5
Years with diabetes		8.1 ± 7.5
Medication regimen		
Diet/exercise	84 (16.6)	
Oral	346 (68.2)	
Insulin	76 (15.0)	

Measures

Problem solving related to diabetes self-management was assessed using our previously validated interview procedure (14,15). The current DPSI was divided into two scales for this study: one for healthful eating and one for physical activity. Each scale contained three items and began with a description of a hypothetical barrier or problem situation. One such scenario is, "You're going to spend a holiday with your relatives. In the past, this has always been a problem for you because the group never eats until extremely late in the day, hardly any of the foods are healthful, and you always end up eating too much. You're worried about the same thing happening again. In your own words, describe how you have dealt (or would deal) with such a situation. Be specific." Respondents were asked to describe how they would react to each scenario and prompted for up to three coping strategies for each situation.

Table 2—*Diabetes problem-solving scores by patient characteristics*

Patient characteristics	Dietary problem solving	Exercise problem solving
Overall means	3.70 ± 0.95	2.87 ± 1.17
Demographic factor		
Sex		
Male	3.66 ± 0.98	2.93 ± 1.17
Female	3.74 ± 0.92	2.83 ± 1.16
Education		
≤12th grade	3.68 ± 0.90	2.82 ± 1.19
>12th grade	3.71 ± 0.97	2.89 ± 1.16
Race/ethnicity		
Asian American	3.63 ± 0.95	2.65 ± 1.24
African American	3.86 ± 0.84	2.72 ± 1.12
Hispanic	3.67 ± 0.95	3.02 ± 1.15
Non-Hispanic white	3.69 ± 0.97	2.95 ± 1.13
Other	3.55 ± 1.10	3.05 ± 1.24
Medical characteristics		
BMI level (kg/m^2)		
<30	3.78 ± 0.87	2.87 ± 1.23
≥30	3.64 ± 0.99	2.88 ± 1.12
Number of comorbid conditions		
Less than three	3.70 ± 1.00	2.95 ± 1.12*
Four or more	3.70 ± 0.85	2.73 ± 1.23*
Number of diabetes complications		
Less than two	3.71 ± 0.97	2.97 ± 1.14†
Two or more	3.68 ± 0.87	2.54 ± 1.20†

Data are means ± SD. *$P < 0.05$; †$P < 0.001$.

Following the initial hypothetical situation within each regimen area, participants were asked to provide a personally relevant situation that made it difficult for them to engage in that lifestyle practice (eating a healthful diet, engaging in physical activity). Then they were asked to describe strategies they would use for overcoming each obstacle to diabetes self-care. Prompts were provided to encourage participants to list multiple strategies. Finally, respondents were asked to describe the strategies they generally use to help them adhere to that aspect of their regimen.

Coders provided an overall problem-solving rating for each situation on a 5-point scale (from 1 = very poor strategy to 5 = excellent strategy). A rating of 1 or 2 points was assigned if nothing was done to improve the problem situation or if a strategy would produce a detrimental effect (for instance, "If I have a stressful day, I skip exercise and watch television."). A score of 4 or 5 points was assigned if strategies included planning ahead and flexibility in carrying out the regimen activity (for instance, "In case my first strategy did not work, I would then . . ."; "I would either walk before work if the weather was good or meet my neighbor at the mall if the weather was bad."). Coders were research assistants who read and discussed the detailed coding manual and coded practice responses before the actual study. The surveys were coded by independent raters who received 10 h of training and held regular discussions of coding disparities. Ratings were summed across items in that scale to produce an average overall rating of problem-solving skill for diet and physical activity, respectively. Interrater reliability for a randomly selected subset of surveys (25%) coded by two different coders was $r = 0.96$ ($P < 0.001$).

Demographic and diabetes treatment variables. These included age, sex, ethnicity (Hispanic, non-Hispanic white, African American, or Asian American), education in years, and type of diabetes medication (diet/exercise, oral medication, or insulin determined by self-report).

Biological variables. These included standardized A1C and non-HDL cholesterol assays conducted in a central laboratory.

Behavioral variables. The behavioral management measures included average calories from saturated fat as a percentage of total calories consumed per day, derived from the Block 2000 Brief Food Frequency Questionnaire (Block Dietary Data Systems, Berkeley, CA). The other behavioral measure was physical activity, assessed by the International Physical Activity Questionnaire (16). This score reflects minutes of activity per week across three categories (walking, moderate, and vigorous) weighted by multiples of the resting metabolic rate for each activity for a 60-kg person.

Psychosocial variables. The Center for Epidemiologic Studies Depression Scale is a 20-item questionnaire that assesses depressive symptoms over the previous 7 days (17). The Diabetes Distress Scale was used to assess discomfort and negative emotions specifically related to diabetes (18). It has strong psychometric properties and produces an overall score as well as subscales measuring distress related to emotional burden, physician-related distress, regimen-related distress, and interpersonal distress (18).

Analyses

Analyses included descriptive statistics to characterize the sample, psychometric characteristics of the DPSI (interrater reliabilities), adjusted and unadjusted bivariate correlations and multiple regression analyses to evaluate the association between problem solving, and *1*) patient characteristics, *2*) self-management behaviors, *3*) biological variables, and *4*) psychosocial variables, including depressive affect and diabetes distress.

RESULTS — Overall scores on the DPSI indicated sufficient variability to explore relationships to patient characteristics and self-management behaviors. The mean DPSI scores were comparable on the dietary scale and slightly lower on the exercise scale than found in previous studies of more homogenous diabetes samples (14,15). Table 2 presents DPSI scores by different patient subgroups. As can be seen, there were no differences by race/ethnicity, which is of interest since this is the first study to our knowledge to have adequate numbers of nonwhite participants to investigate this issue. Similarly, there were no significant differences on either problem-solving score by sex, education, or BMI levels. Those with more comorbid conditions and those with more diabetes-related complications scored significantly lower than those with fewer complications/conditions on the exercise problem-solving score, although there were no differences on dietary problem-solving scores.

Table 3—*Significant regression coefficients (standardized β and significance level) by dependent variable*

Predictor variables	Dependent variables: Diet (% calories fat)	Exercise (International Physical Activity Questionnaire)	A1C	Non-HDL cholesterol
Control variables				
Age (years)	−0.20 ($P < 0.000$)	NS	−0.17 ($P < 0.000$)	−0.09 ($P < 0.045$)
Sex (0 = male; 1 = female)	NS	−0.18 ($P < 0.000$)	NS	NS
Education (years)	NS	−0.14 ($P < 0.004$)	NS	NS
Race (0 = other; 1 = non-Hispanic white)	0.32 ($P < 0.000$)	NS	−0.13 ($P < 0.006$)	NS
Medication (0 = no insulin; 1 = insulin)	NS	NS	0.31 ($P < 0.000$)	−0.16 ($P < 0.001$)
Problem-solving variables				
Problem-solving diet score	−0.15 ($P < 0.000$)	NS	−0.11 ($P < 0.012$)	NS
Problem-solving exercise score	NS	0.10 ($P < 0.03$).	NS	−0.10 ($P < 0.036$)
Overall model	$F = 13.5$; $P < 0.000$	$F = 5.07$; $P < 0.000$	$F = 12.1$; $P < 0.000$	$F = 4.77$; $P < 0.000$

As in prior research, DPSI scores were significantly related to self-management behaviors. As predicted by behavioral specificity theory, the DPSI dietary behavior score was significantly related to the dietary self-management measure, and the DPSI exercise score was not (Table 3). Conversely, again congruent with expectations, the DPSI exercise score was significantly correlated with the exercise self-management score, whereas the DPSI dietary score was not. As shown in Table 3, these relationships remained significant after controlling for a variety of other possible factors in multiple regression analyses.

The DPSI scores were also related to both biologic outcomes studied, albeit different DPSI scores predicted different biologic variables. Specifically, the DPSI dietary behavior score predicted A1C level, and the DPSI exercise score predicted non-HDL lipid levels. As shown in Table 3, once again both of these relationships remained significant after controlling for a variety of other factors in multiple regression analyses.

Finally, the DPSI scores were related to measures of depressive affect/Center for Epidemiologic Studies Depression Scale ($r = -0.11$ and -0.13, $P < 0.05$, for dietary and exercise problem-solving scores, respectively) and to diabetes-specific distress ($r = -0.17$, $P < 0.001$, for both dietary and exercise problem-solving scores). Analyses of Diabetes Distress Scale subscales revealed that problem solving was most strongly related to distress related to one's regimen (r for dietary and exercise problem solving = −0.22 and −0.16, respectively, $P < 0.001$). Including depressive affect in the list of control variables did not, however, alter the significance or outcome of any of the regression analyses reported in Table 3 concerning the relationship of the DPSI scores to self-management and biologic control measures.

CONCLUSIONS — This report replicates and extends previous work on problem solving and diabetes and the DPSI in particular. As in prior studies (14,15), the DPSI appears to produce meaningful scores, to be reliably rated and internally consistent, and to be significantly associated with a variety of important diabetes outcomes. The DPSI was generally not associated with patient characteristics, despite considerable variability in the DPSI scores and inclusion of a diverse sample. The main exception to this was on comorbidities and complications; patients with more of these conditions had lower physical activity problem-solving scores.

These data also replicate and extend prior research with more homogenous and largely non-Hispanic white samples (14,15), as well as an entirely African-American sample (19), and indicate that the linkage between problem-solving skill and diabetes outcomes occurs across diverse ethnic groups. One caveat is that the mean education level was fairly high, and results may not generalize to less educated populations. To our knowledge, this is the first study to examine the relationship of problem solving to depressive affect and disease-related distress among diabetic patients. It is of interest that diabetes problem solving is significantly related to both disease-related distress (the Diabetes Distress Scale) and to traditional measures of depressive affect (Center for Epidemiologic Studies Depression Scale).

The DPSI was moderately related to several different self-management behaviors, and most notably dietary problem-solving scores were associated with dietary self-management and not exercise and vice versa. This convergent-divergent validity set of findings enhances confidence that participants were not just uniformly responding in a socially desirable direction. It was also important to find that problem solving remained significantly related to self-management behaviors after controlling for several other factors, including depressive affect.

In contrast to earlier research on the DPSI, problem-solving scores also appeared to be related to the biological variables of A1C and non-HDL lipids, respectively. This may have been due to the larger, more diverse sample used. The significant relationships between these objective measures of diabetes control and the DPSI also suggest that the associations between DPSI and the self-report variables were not due solely to shared method variance or demand characteristics. Other strengths of the study are the high and representative participation rate and the high interrater reliability of the DPSI coding system.

It is important not to overgeneralize results from this study, especially because cross-sectional data cannot determine directionality or causality. However, other longitudinal research has shown that the DPSI scores are modifiable and sensitive to intervention (15), that they prospectively predict diabetes self-management,

even after controlling for potential confounding variables (14), and that DPSI mediated treatment outcomes (15). Considered along with related conceptual work on understanding how problem solving impacts health behaviors and disease management (10,13), the present study helps to explicate paths between skills such as problem solving, self-management, and diabetes control (13,20). Our findings also suggest that problem-solving therapy may be beneficial for those with low levels of regimen self-management (9,10), including those with depression and diabetes distress.

A practical limitation to the broader use of the current DPSI interview procedure is that it does not provide immediate feedback and is moderately expensive, requiring trained raters (15). We estimate that the assessment procedure used in this study took 10 min of participant time, and the coding responses cost ~$10 per patient. From an ease of use and immediacy of feedback perspective, it would be desirable if the DPSI could be immediately scored by clinic staff or even self-administered. This may someday be possible, but to date we have not found versions of the assessment such as paper-and-pencil or multiple-choice formats to be sufficiently sensitive, perhaps pointing out the difference between the ability to recognize versus generate high-quality solutions to potential problems (9).

Future research is needed to determine whether shorter or self-report measures of problem solving can perform as well, to determine whether problem solving is a general or specific skill (or both), and to investigate culturally sensitive, cost-efficient interventions to see if they can significantly increase problem-solving skills and produce long-term improvements in diabetes self-management, control, and quality of life.

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