Psychosocial Predictors of Self-Care Behaviors (Compliance) and Glycemic Control in Non-Insulin-Dependent Diabetes Mellitus

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This study assessed potential psychosocial correlates of self-care behaviors (compliance) and of glycemic control in a community sample of 184 people diagnosed as having non-insulin-dependent (type II) diabetes mellitus. Four different diabetes self-care behaviors were studied (medication taking, glucose testing, diet, and exercise), and glycemic control was assessed by glycosylated hemoglobin analyses. Multiple measures were collected within each of several categories of psychosocial variables including knowledge, stress, depression, anxiety, diabetes-specific health beliefs, and social support. Findings indicate that ~25% of the variance in self-care behaviors can be explained by psychosocial and demographic variables. In contrast, psychosocial variables were not significant predictors of level of glycemic control. The diabetes-specific psychosocial measures of health beliefs and social support were the most consistent and strongest predictors of self-care behavior across the different regimen areas studied. Possible reasons for these findings, limitations of the study, and directions for future research are discussed. DIABETES CARE 1986; 9:614–22.

The relationship of behavioral and psychosocial factors to self-care behaviors (regimen compliance) and glycemic control of diabetes mellitus is receiving increased attention from researchers.[1,2] Studies have been conducted primarily with adolescents[3,4] and, more recently, with samples of adults diagnosed as having insulin-dependent diabetes mellitus (IDDM).[5,6] There have been very few studies of people with non-insulin-dependent diabetes mellitus (NIDDM).[7] This is surprising because most people with diabetes are middle-aged or older and have NIDDM.[8] Cohort and disease differences are such that results obtained with adolescent or adult samples with IDDM may not apply generally to middle-aged or older people with NIDDM.

Studies have also tended to focus either on relationships between psychosocial variables and regimen compliance or on relationships between psychosocial variables and glycemic control but have not studied both sets of relationships with the same subjects. Furthermore, other investigations seem to have confused these two types of outcomes (regimen compliance and glycemic control) by failing to acknowledge that self-care behavior is only one of several important contributors to glycemic control (e.g., stress, illness, hormonal factors). [Throughout this article the term *self-care behaviors*, rather than *compliance*, is used to remind the reader that we are studying patients' reports of their regimen and regimen behavior. Glasgow et al.[9] and W.W. and D.V.A. (unpublished observations) discussed conceptual issues and common confusions in the use of the terms *adherence*, *compliance*, and *self-care behaviors* as they apply to diabetes-regimen behaviors.] Whereas these studies appear to be encouraging with regard to the importance of psychosocial variables, there are, to our knowledge, no studies that address the relative importance of various psychosocial variables for predicting different outcomes.

The purpose of our study was to mitigate the deficiencies delineated above by examining the relationships of demographic and psychosocial variables (general and regimen specific) to diabetes self-care behaviors and glycemic control in middle-aged and older people with NIDDM. Specifically we wanted to know *1*) the relative importance of psychosocial variables to self-care behaviors and glycemic control, *2*) whether psychosocial variables were differently related to self-care behaviors and glycemic control at different age levels, *3*) if different psychosocial variables were associated with self-care behaviors in different regimen areas, *4*) whether general or diabetes-regimen–specific variables were better predictors of self-care behaviors and glycemic control, and *5*) if psycho-

social variables accounted for variance beyond that explained by demographic variables.

These purposes are addressed by *1*) separately assessing and predicting self-care behaviors and glycemic control, *2*) studying a sizable sample of middle-aged and older adults with NIDDM, *3*) examining the relative importance of different psychosocial variables for predicting different self-care behaviors (taking medication, testing glucose, following diet, and exercise), and *4*) including both diabetes-specific psychosocial measures (health beliefs and social support for regimen self-care behavior) and more general psychosocial measures (e.g., depression, anxiety, stress).

METHODS

Subjects

Subjects were 208 outpatients with diabetes mellitus who were recruited from Lane County, Oregon, by newspaper advertisements, physician referrals, requests in the county medical society newsletter, and presentations to the local chapter of the American Diabetes Association. Physician verification of self-reported diagnosis of diabetes was obtained for all subjects. The clinical criteria recommended by Welborn et al.[10] were used to further classify our sample by type of diabetes. The method of Welborn et al. distinguishes IDDM from NIDDM on the basis of age at onset, relative weight, and length of time between diagnosis and treatment with insulin. Using these criteria, we were unable to classify 6 subjects. These unclassified subjects and the 18 subjects categorized as having IDDM are not included in these analyses.

Table 1 describes the characteristics of the resulting sample of 184 subjects. Two-thirds were women and over 86% were ≥120% of ideal body weight. The mean age of the subjects was 58 yr (range 36–82 yr), and most subjects had diabetes for a number of years. Average socioeconomic status,[11] a combination of occupation and education levels, was 36.8, indicating the middle strata of Hollingshead's schema. Most of the participants (97.8%) were Caucasian.

Data on subjects' regimen prescriptions are also presented in Table 1. Attempts were made to obtain regimen prescriptions from subjects' medical records and to use these prescriptions to verify the accuracy with which regimens were recalled. Unfortunately, up-to-date regimen prescriptions were not available for many patients or for several aspects of the regimen. Consequently, subjects' description of their regimen prescriptions were used as the standard against which to compare reports of self-care behaviors. In terms of subject-recalled regimen prescriptions, most subjects reported that they had been instructed to test their blood rather than urine glucose levels. Approximately one-third reported that they had been prescribed insulin, usually a single injection per day. As can be seen in Table 1, almost all subjects reported that they had been advised to lower their caloric intake and were provided with written meal plans. Most subjects were advised to increase their physical activity, but few had received specific instructions on how to become more active.

TABLE 1
Sample characteristics (N = 184)

Demographic variables	
Age (mean yr ± SD)	57.9 ± 10.2
Gender	66.8% Women
Duration of diabetes (mean yr ± SD)	8.0 ± 7.5
Percentage of subjects ≥120% ideal body weight	86.4
Regimen characteristics (% of subjects)	
Medication prescription	
Insulin	31
Oral	37
Both	1
Neither	30
Glucose testing prescription (% of subjects)	
Blood	56
Urine	15
Both	4
Neither	25
Diet	
Advised to limiting caloric intake	85.2
Received written instructions regarding caloric intake	73.8
Advised to follow specific meal plan	84.2
Received written meal plan instructions	76.0
Exercise	
Advised to exercise regularly	76.1
Received written instructions regarding physical activity	21.2

Procedures

Packets of questionnaires (to be completed as "homework") were mailed to the subjects. The packet contained two sets of measures that were to be completed on 2 separate days to reduce fatigue effects. On day 1 the "Diabetes Daily Care" instrument was to be completed, and on day 2 the "Diabetes Knowledge" instrument was to be completed.

Subjects brought completed questionnaires to their scheduled appointment at our offices. Questionnaires were reviewed for completeness and questions answered. Measures of height, weight, and several psychosocial variables were obtained. Subjects were reminded to go to the laboratory (during the same week as their appointment) and provide a blood sample for assessment of their level of glycosylated hemoglobin.

General Psychosocial Measures

Standardized psychosocial measures of psychological functioning, developed for use in the general population, facilitate comparison of our results with the larger literature of psychology and sociology. Depression, anxiety, and stress measures are presented separately, although they may overlap conceptually.

Depression. A multiple-measures approach to the assessment of depression was adopted to provide convergent validity on the occurrence of depression in our sample. The presence of depression was assessed with the Beck Depression Inventory (BDI)[12] and the Center for Epidemiologic Studies Depression Scale (CES-D).[13] In addition, a 48% subset of

the sample was selected to undergo extensive structured interviews with the Schedule for Affective Disorders and Schizophrenia to produce psychiatric diagnoses with the Research Diagnostic Criteria. These data are from a study focusing on the relationship between depression and diabetes (unpublished observations).

Although there are several self-report measures of depression, the BDI appears to be the most extensively validated.[14] The CES-D is a 20-item self-report scale designed to measure depressive symptomatology in the general population. The CES-D has been found to have high internal consistency, to have adequate test-retest reliability, and to be significantly correlated with both clinical ratings and other self-report measures of depression.[13]

Anxiety. The State-Trait Anxiety Inventory (STAI)[15] measured general anxiety, and the Social Avoidance and Distress Scale[16] assessed social anxiety. The STAI provides a measure of both state and trait anxiety. The measure of state anxiety has been shown to vary as a function of anxiety-arousing or -reducing experimental manipulations, and trait anxiety scores are higher for "known" groups of anxious college students and psychiatric patients[17] than for control subjects.

Watson and Friend[16] developed the Social Avoidance and Distress questionnaire to assess the degree of discomfort in social situations. It has been widely used in research to identify socially anxious subjects.[18,19] This measure has been found to discriminate between people who are anxious and unskillful in social situations and those who are not.[20]

Stress. Stress resulting from both positive and negative life events was assessed with the Events Checklist (developed by L. Friedman and A. B., unpublished observations). The Events Checklist is a second-generation adaptation of the Life Experiences Survey.[21] The earlier measure provided an inventory of positive and negative life events that were identified as occurring within the previous 6 mo to 1 yr. The response format is such that both the frequency of occurrence and impact of these events is recorded. The present adaptation of the Life Events Checklist expanded the events inventory and focused on events during the previous 3 mo.

Social support. The Interpersonal Support Evaluation List (ISEL)[22,23] assesses the perceived availability of general social support. This 40-item questionnaire assesses four separate functions of support: *1*) "appraisal," perceived availability of someone with whom to talk about problems; *2*) "belonging," perceived availability of persons with whom to do things; *3*) "tangible," perceived availability of material aid; and *4*) "self-esteem," perceived availability of praise from others or from social comparisons. Mermelstein[23] reported that the entire ISEL has a coefficient α-reliability of .90. The test-retest correlation of the scale over a 6-wk interval was .70.

Diabetes-Specific Psychosocial Measures

Diabetes-specific measures of knowledge, health beliefs, and social support were collected to assess whether variables targeting psychosocial factors and behaviors specific to self-care behaviors would be more predictive than the general psychological measures described above.

Knowledge. This measure (developed by W.W., D.V.A., D.J.T., and D. Calder, unpublished observations) assessed both general information and ability to apply knowledge about diabetes. The measure used was an adaptation of the Test of Diabetes Knowledge, revised.[24] Validity was ensured by basing items on research done with diabetic populations and by retaining only those items that were answered similarly by a panel of local health care professionals. Reliability estimates (split-half Spearman-Brown procedure) of .90 were reported for the original measure. The Test of Diabetes Knowledge includes both a section on general information (e.g., "What is insulin?") and a section on problem solving (e.g., "What should you do if . . . ?").

Health beliefs. Subjects' health beliefs were assessed in three areas. Discomfort was assessed by asking each subject to rate how unpleasant or discomforting it was to perform tasks in each of four regimen areas. A seven-point scale with end points labeled "very unpleasant" and "not at all unpleasant" was used for each item.

Effectiveness was measured by having the subject answer the following question about each regimen area: "Do you think that (specific self-care behavior) can be helpful in controlling your diabetes?" Subjects were presented with a seven-point rating scale with end points labeled "very helpful" and "very unhelpful." The specific diabetes self-care behaviors included taking medication (both oral medication and insulin), testing glucose (both urine glucose and blood sugar), physical activity, and diet. Diet was divided into the following five components: limiting calories, avoiding sweets, scheduling meals, eating according to a meal plan, and avoiding alcohol. These ratings were then averaged across the five diet subareas.

Life-style interference was assessed by asking the subject to indicate whether diabetes and its treatment interfered with seven life-style areas. The life-style items from the Diabetes Educational Profile (part A, revised)[25] were answered true or false and included the following: having enough money, doing work or other responsibilities, going out or traveling, being active, eating favored foods, having good relationships with people, and having a desirable schedule.

Social support. Perceived social support from significant others, specific to the performance of diabetes self-care behaviors, was assessed with 10 items. Degree of social support was assessed for the following individual regimen tasks: taking medication (2 items: oral agents or insulin), following dietary requirements (5 items: intake of sweets, alcohol consumption, scheduling of meals, following one's meal pattern, and restraint in problematic situations), testing glucose (2 items: blood glucose testing and urine glucose testing), and physical activity. Each item was answered by use of a seven-point scale ranging from "very unhelpful" (1) to "very helpful" (7). A composite was formed in each of the areas containing multiple measures.

Self-Care Behaviors

Self-reported self-care behaviors in response to several aspects of the diabetes regimen were assessed with the Diabetes-Specific Assessment Battery (W.W., D.V.A., D.J.T., and D. Calder, unpublished observations).

A general question about each area was presented in the form "In the past three months what percentage of the time did you (specific self-care behavior) as instructed?" Note that this task requires subjects to compare their level of self-care behaviors against what they recall to be their prescription for that aspect of the regimen. Although this may not provide a totally accurate picture of the prescribed regimen,[26] it assesses level of self-care based on the subject's representation of appropriate self-care behaviors, as recommended by Leventhal et al.[27] Aspects of the regimen assessed included taking medication (separate options for subjects injecting insulin and for those taking oral hypoglycemic agents), testing glucose (separate questions for those testing urine and for those testing blood glucose), physical activity, and diet (measured by limitation of caloric intake). For each of the questions, subjects selected one of five response options: 0, 25, 50, 75, or 100% of the time.

Glycemic Control

Glycosylated hemoglobin (GHb) was determined by a modification of the Fluckiger-Winterhalter method.[28] Blood samples of 10 ml were collected in two 5-ml tubes, each containing 7.5 mg EDTA. Red cell hemolysates were prepared by hemolyzing the packed, washed red cells with a 1:1 volume of distilled H_2O and freeze/thawing once to ensure good lysing. Membranes were spun down and discarded. Oxalic acid (1 ml of 0.3 N) was added to 2.0 ml lysate and incubated for 1 h at 100°C. After cooling, 1.0 ml 40% trichloroacetic acid (TCA) was added to the tubes and the resultant precipitate spun down and discarded. A portion of the supernatant (1 ml) was then incubated with 0.5 ml 0.05 M 2-thiobarbituric acid at 40°C for 40 min. Optical density was read at 443 nm. All samples were done in duplicate. The average glycosylated hemoglobin level was 10% (2.2 SD), indicating a moderate level of glycemic control. The Fluckiger-Winterhalter method was selected as the procedure of choice because it is more precise than the chromatographic technique, its results are reproducible, it is capable of estimating GHb levels in the presence of variant hemoglobins, and it may be used with hemolysates that have been frozen for up to 5 mo.

Data Analysis Strategy

Initially, descriptive analyses were conducted to evaluate potential predictor variables for distribution of scores and to eliminate measures with insufficient variability. Within each of the categories of psychosocial variables (depression, anxiety, stress, social support, knowledge, and health beliefs) composite variables were formed by standardizing and then averaging the component measures. The purpose of this procedure was to yield a composite measure with greater reliability than that of the individual component measures and to increase the subjects-to-predictor variable ratio for conducting multivariate analyses. Finally, separate multiple regression analyses were performed using composite psychosocial variables to predict four areas of self-care behaviors (taking medication, testing glucose, diet, and exercise) and level of glycemic control (glycosylated hemoglobin level). In these analyses, age and sex were entered in the regression

TABLE 2
Distribution of scores on psychosocial measures

Category/measure	Mean	SD	Range of possible values
Depession			
Beck Depression Inventory	8.66	6.48	0–63
CES-D	18.26	7.64	0–60
Anxiety			
STAI, trait anxiety	38.07	10.75	20–80
STAI, state anxiety	64.58	10.62	20–80
Social avoidance and distress	5.91	4.60	0–28
Stress			
Events checklist, positive	47.61	37.75	0–420
Events checklist, negative	17.53	18.71	0–420
Social support, general interpersonal support evaluation total	31.94	6.85	0–40
Social support, regimen specific			
Taking medication			
Oral medication (N = 69)	4.88	2.45	1–7
Insulin (N = 52)	4.36	2.67	1–7
Testing glucose			
Urine testing (N = 42)	3.54	2.28	1–7
Blood sugar testing (N = 97)	4.47	2.34	1–7
Diet (N = 172)	4.55	1.78	1–7
Exercise (N = 167)	3.92	2.21	1–7
Diabetes knowledge			
General knowledge	17.09	3.35	0–22
Problem solving	3.71	0.54	0–4
Health beliefs, discomfort/unpleasant			
Taking medication			
Oral medication (N = 76)	1.31	0.83	1–7
Insulin (N = 59)	3.31	1.60	1–7
Testing glucose			
Urine testing (N = 45)	2.92	1.44	1–7
Blood sugar testing (N = 109)	3.56	1.71	1–7
Diet (N = 183)	3.39	1.36	1–7
Exercise (N = 183)	3.64	1.95	1–7
Health beliefs, effectiveness			
Taking medication			
Oral medication (N = 76)	6.39	1.22	1–7
Insulin (N = 59)	6.67	0.79	1–7
Testing glucose			
Urine testing (N = 43)	4.53	2.31	1–7
Blood sugar testing (N = 109)	5.58	1.73	1–7
Diet (N = 183)	5.86	1.15	1–7
Exercise (N = 181)	3.76	2.55	1–7
Health beliefs, interference	1.44	1.51	0–7

N = 184 unless otherwise stated.
High scores on all measures indicate more of the characteristic being measured, i.e., more anxiety, greater knowledge.

equation, followed by the psychosocial variables entered as a set, and finally by stepwise entry of interaction terms between each of the psychosocial variables and age. If the set of interaction terms was significant, separate analyses were conducted for older and younger subjects.[29]

RESULTS

Table 2 presents information on the mean level and distribution of individual measures that were used in forming composites within each of the six psychosocial categories studied. Inspection of the mean scores on the regimen-specific social support and health belief items reveals a consistent pattern of results. For each of these instruments there were separate items for each regimen task. Subjects reported the greatest amount of social support, the least amount of discomfort, and the highest belief in effectiveness for the medication-taking aspect of the regimen. On the other hand, subjects reported the lowest amount of social support, comfort, and belief in effectiveness for exercise. Social support and health beliefs regarding glucose testing and diet were intermediate. This pattern of results is interesting because it parallels data presented by Ary et al.,[30] i.e., subjects report the highest levels of self-care behaviors for taking medication and the lowest levels for exercise.

Multiple regression analyses. Table 3 summarizes the results of multiple regression analyses to predict self-care behavior in each of the four areas of the regimen studied and to predict glycemic control. In each case, the demographic variables of age and sex were entered into the equation, followed by the six psychosocial composites. Next, interaction terms between age and each of the psychosocial composites were eligible for entry in a stepwise fashion. Essentially, this procedure answers questions concerning *1*) whether the psychosocial variables account for variance in self-care behavior and glycemic control beyond that explained by demographic variables, *2*) whether psychosocial variables are differentially related to self-care behaviors and glycemic control at different age levels, and *3*) the relative importance of different classes of psychosocial variables as predictors of self-care behaviors and glycemic control.

Psychosocial variables explained significant incremental variance over that explained by demographic variables for each of the areas of self-care behavior ($P < .01$). No significant interactions between age and psychosocial variables were obtained on any of the dependent variables. In general, by adding information on psychosocial variables to the demographic variables of age and sex, it was possible to explain ~25% of the variance in self-care behaviors.

Neither demographic nor psychosocial variables were significant predictors of level of glycemic control.

As seen in Table 3, the psychosocial variable most highly correlated with self-care behaviors (and weighted most heavily in the regression equations) was the regimen-specific measure of health beliefs. This pattern of results was fairly consistent across areas of the regimen, with the exception of taking medication. Social support was also moderately correlated ($r = .15–.27$) with the various regimen areas. The only other psychosocial variables to correlate >.2 with a self-care behavior were anxiety ($r = -.25$, with glucose testing), depression ($r = -.25$, also with glucose testing) and knowledge ($r = .38$, with medication taking).

Both diabetes-specific and general measures of social support were available. Therefore, follow-up analyses were conducted to determine if one of these measures was more highly related to self-care behaviors. For all of the four self-care behavior measures, the diabetes-specific social support measure was significantly more highly correlated with self-care behavior ($r = .20, .45, .24$, and $.41$) than was the more general measure of interpersonal support ($r = .06, .21, .14$, and $.14$) for taking medication, diet, testing glucose, and exercise, respectively ($P < .001$ for all comparisons).

DISCUSSION

The set of psychosocial variables investigated in our study significantly enhanced our ability to predict self-care behaviors. In each of the four regimen areas studied, psychosocial variables explained an additional 18–24% of the variance in self-care behaviors beyond that accounted for by demographic variables. Considered along with age and sex, the psychosocial predictors explained ~25% of the variance in self-care behavior (multiple $r = .43–.58$). The psychosocial variables were also generally more strongly related to self-care behavior than they were to age and sex.

In order of importance, the psychosocial variables most predictive of adherence to self-care behaviors were health beliefs, social support, knowledge, anxiety, and depression. The first three are discussed. Health beliefs and social support were relatively stable across different areas of the regimen. With the exception of taking medication, health beliefs correlated .40–.48 and social support correlated .16–.27 with self-care behaviors in each of the other three regimen areas, and both had high β-weights in the multiple regression equations. Although both health beliefs and social support are positively related to self-care behaviors, they are essentially independent of each other (mean $r = .08$ across regimen areas). The positive relationship of health beliefs and social support to self-care behaviors replicates findings observed for IDDM subjects.[3,4,31] Although health beliefs and social support have previously been found to be associated with regimen adherence for IDDM subjects, they were a unique feature of our study because they are diabetes-specific measures and because of the type of individuals (NIDDM) assessed.

In contrast to the other psychosocial variables, the health belief measures and one of the social support measures were specific to the different regimen tasks. In addition, the regimen-specific measures of social support were significantly more strongly associated with self-care behaviors than was the global measure of social support. Other investigators have recently speculated that diabetes- and regimen-specific measures should be more strongly associated with diabetes behaviors than more global psychological measures,[32] but our

TABLE 3
Results of multiple regression equations to predict self-care behaviors and glycemic control

Dependent variable	Predictor variables entered at each step	Simple correlation*	Multiple r at each step	Significance of change in r^2
Dietary self-care behaviors	Demographics		.17	NS
(N = 156)	Age	.14†		
	Sex	−.10		
	Psychosocial variables		.51	$P < .001$
	Health beliefs	.45§		
	Social support	.27§		
	Stress	.16†		
	Knowledge	.09		
	Anxiety	−.16†		
	Depression	−.09		
			Total = .51§	
Exercise self-care behaviors	Demographics		.22	NS
(N = 114)	Age	.12		
	Sex	−.19†		
	Psychosocial variables		.50	$P < .001$
	Health beliefs	.40§		
	Social support	.24‡		
	Stress	.17†		
	Knowledge	.20†		
	Anxiety	−.13		
	Depression	−.13		
			Total = .50§	
Glucose testing	Demographics		.33	$P < .01$
(N = 116)	Age	.33§		
	Sex	−.08		
	Psychosocial variables		.58	$P < .001$
	Health beliefs	.48§		
	Social support	.16†		
	Stress	.15		
	Knowledge	.15		
	Anxiety	−.25‡		
	Depression	−.25‡		
			Total = .58§	
Medication taking	Demographics		.07	NS
(N = 119)	Age	−.01		
	Sex	−.06		
	Psychosocial variables		.43	$P < .01$
	Health beliefs	−.07		
	Social support	.15		
	Stress	.16†		
	Knowledge	.38§		
	Anxiety	−.07		
	Depression	−.14		
			Total = .43‡	
Glycosylated hemoglobin	Demographics		.19	NS
(N = 142)	Age	−.16†		
	Sex	.12		
	Psychosocial variables		.22	NS
	Health beliefs	.05		
	Social support	.00		
	Stress	.02		
	Knowledge	.09		
	Anxiety	−.01		
	Depression	.04		
			Total = .22	

*Simple correlation refers to the Pearson Product Moment correlation between that individual predictor variable and the dependent variable.
†$P < .05$; ‡$P < .01$; §$P < .001$.

study is one of the few empirical demonstrations of this speculation and, to our knowledge, the only one conducted with NIDDM subjects. The health-belief and social-support variables were the strongest psychosocial predictors of adherence, despite the fact that they were composed of only a few items developed for this study, whereas other psychosocial measures were extensively validated inventories of psychological functioning (e.g., BDI, CES-D, and STAI). We tentatively conclude that the stronger relationships observed between regimen-specific measures and diabetes behavior are due to the greater conceptual validity of regimen-specific measures.

Our findings concerning health beliefs suggest that health-care professionals should pay greater attention to explaining the rationale behind regimen prescriptions and eliciting patients' perceptions of regimen effectiveness and to addressing patient concerns about discomfort in carrying out regimen activities and the degree to which self-care behaviors interfere with their life-styles.[30] Our data also suggest that improved outcomes may be obtained if diabetes treatment programs identify and attempt to intervene with individuals with low levels of social support for performing diabetes self-care behaviors. Two possible avenues for accomplishing this goal could be the inclusion of family members and significant others in education and treatment programs and the establishment of diabetes peer support/self-help groups. Pratt et al.[33] report better dietary adherence for older people with NIDDM who participated in peer support groups.

Note also that demographic variables (age and sex) and knowledge were generally not strongly related to degree of adherence. With one exception in each case (r = .3–.4), correlations between these variables and adherence to each of the four regimen areas studied were predominantly nonsignificant and did not exceed .20. These data suggest that diabetes education programs should be provided for patients of all ages and that such programs must do more than just provide factual information about diabetes. Knowledge of what a patient is supposed to do and possession of skills with which to do it may be necessary, but they are not sufficient conditions for regimen adherence. What seems to be needed is diabetes education that includes strategies to facilitate lifestyle change.

On a less optimistic note, the psychosocial variables did not meaningfully enhance our ability to predict levels of glycemic control. Even when combined with age and sex, it was possible to explain only 5% (nonsignificant) of the variance in level of glycemic control (glycosylated hemoglobin). These findings suggest that the variables affecting glycemic control are different from those affecting regimen self-care behaviors and/or that we were not successful in identifying variables strongly related to glycemic control in this study. If the former is true, this further exemplifies problems inherent in the use of the phrase "compliance and control" as if it referred to a single, homogeneous entity. With regard to identifying variables strongly related to glycemic control, it might be useful to expand the scope of predictor variables to include an assessment of efficacy of the prescribed treatment[34] and measures of biomedical status. Metabolic control of diabetes is an extremely complex issue, and accumulating evidence suggests that it is influenced by numerous factors including illness, physical activity,[35] age,[36,37] extent of and skill in carrying out self-care behaviors,[38] and responsiveness of fat cells to insulin.[39] These variables might be expressed in the equation $C = f(T_x + BF + PS + SCB)$, where C (control) is a function of T_x (efficacious treatment) and BF (biomedical factors) and PS (psychosocial status) and SCB (self-care behaviors). Thus, it seems logical that psychosocial and behavioral variables would be more strongly related to behavioral variables, such as self-care behaviors, than to a physiologic variable, such as glycemic control.[35] It is therefore not too surprising that psychosocial variables were not strongly predictive of glycemic control in our study.

Like any single study, this investigation has limitations. Two of the most important qualifications concerning the above results are that the design was cross-sectional rather than longitudinal and that the self-care behavior measures were all self-report instruments. Although additional work in this new field with more objective measures of self-care behaviors should be encouraged, there are currently no widely accepted or well-validated measures of regimen adherence.[40] Until such measures are developed, investigators should rely on multiple measures of adherence and include diverse methods of measurement (e.g., self-monitoring, informant reports, observational measures, mechanical devices, and "marker" strategies). The study is also limited by the use of subject-recalled rather than more objective indices of regimen prescriptions. Future adherence research could benefit from use of "contracts," or written records of explicit recommendations in each area of the regimen, with copies provided to patients and physicians. Finally, our results are obviously correlational. The tentative conclusions that we have drawn must be reproduced by other investigators and tested in experimental studies before being implemented on a wide-scale basis.

Despite the above limitations, our study has several strengths. Relatively many free-living people with NIDDM were studied in contrast to more typical and less generalizable studies of few IDDM patients evaluated while they were hospitalized or at a diabetes summer camp.[3,4] Our study also reflects some of the complexity of the diabetes regimen[36,41] by assessing several different aspects of self-care behavior and by using multiple measures of psychosocial constructs.[42] Additional investigations using similar approaches with prospective long-term longitudinal designs and explicitly contrasting general with diabetes- and regimen-specific psychosocial measures and IDDM with NIDDM samples are warranted.

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REFERENCES

[1] Fisher, E. B., Delamater, A. M., Bertelson, A. D., and Kirkley, B. G.: Psychological factors in diabetes and its treatment. J. Consult. Clin. Psychol. 1982; 50:993–1003.

[2] Hamburg, B. A., Lipsett, L. F., Inoff, G. E., and Drash, A. L., Eds.: Behavioral and psychosocial issues in diabetes. Proc. Natl. Conf. of the Natl. Inst. of Arthritis, Metabolism, and Digestive Disease, Madison, Wisconsin, May 20–23, 1979. NIH Publ. No. 80-1993.

[3] Hauser, S. T., and Pollets, D.: Psychological aspects of diabetes mellitus: a critical review. Diabetes Care 1979; 2:227–32.

[4] Johnson, S. B.: Psychosocial factors in juvenile diabetes: a review. J. Behav. Med. 1980; 3:95–116.

[5] Glasgow, R. E., McCaul, K. D., and Schafer, L.: Barriers to regimen adherence among persons with type I diabetes. J. Behav. Med. 1986; 9:65–77.

[6] Schlenk, E. A., and Hart, L. K.: Relationship between health locus of control, health value, and social support and compliance of persons with diabetes mellitus. Diabetes Care 1984; 7:566–74.

[7] Kaplan, R. M., Atkins, C. J., and Reinsch, S.: Specific efficacy expectations mediate exercise compliance in patients with COPD. Health Psychol. 1984; 3:223–42.

[8] National Diabetes Data Group: Classification and diagnosis of diabetes mellitus and other categories of glucose intolerance. Diabetes 1979; 28:1039–57.

[9] Glasgow, R. E., Wilson, W., and McCaul, K. D.: Regimen adherence: a problematic construct in diabetes research. Diabetes Care 1985; 8:300–301.

[10] Welborn, T. A., Garcia-Webb, P., Bonser, A., McCann, V., and Constable, I.: Clinical criteria that reflect C-peptide status in idiopathic diabetes. Diabetes Care 1983; 6:315–16.

[11] Hollingshead, A. B.: Four-Factor Index of Social Status. New Haven, CT, Yale Univ., 1975.

[12] Gallagher, D., Breckenridge, J., Steinmetz, J., and Thompson, L.: The Beck Depression Inventory and research diagnostic criteria: congruence in an older population. J. Consult. Clin. Psychol. 1983; 51:945–46.

[13] Radloff, L. S.: The CES-D Scale: a self-report depression scale for research in the general population. Appl. Psychol. Meas. 1977; 1:385–401.

[14] Rehm, L. P.: Assessment of depression. *In* Behavioral Assessment: A Practical Handbook. Hersen, M., and Bellack, A. S., Eds. Oxford, UK, Pergamon, 1976:233–59.

[15] Spielberger, C. D.: State-Trait Anxiety Inventory: Self-Evaluation Questionnaire. Palo Alto, CA, Consulting Psychologists, 1983.

[16] Watson, D., and Friend, R.: Measurement of social-evaluative anxiety. J. Consult. Clin. Psychol. 1969; 33:448–57.

[17] Spielberger, C. D., Gorsuch, R. L., and Lushene, R. E.: Test Manual for the State-Trait Anxiety Inventory. Palo Alto, CA, Consulting Psychologists, 1970.

[18] Arkowitz, H., Lichenstein, E., McGovern, K., and Hines, P.: The behavioral assessment of social competence in males. Behav. Ther. 1975; 6:3–13.

[19] Glasgow, R. E., and Arkowitz, H.: The behavioral assessment of male and female social competence in dyadic heterosexual interactions. Behav. Ther. 1975; 6:488–98.

[20] Biglan, A., Glaser, S. R., and Dow, M. G.: Conversational skills training for social anxiety: an evaluation of its validity. Natl. Meet. Speech Communication Association, San Antonio, TX, November 1979.

[21] Sarason, I. G., Johnson, J. H., and Siegel, J. M.: Assessing the impact of life changes: development of the life experiences survey. J. Consult. Clin. Psychol. 1978; 46:932–46.

[22] Cohen, S., and Hoberman, H. M.: Positive events and social supports as buffers of life change stress. J. Appl. Soc. Psychol. 1983; 13:99–125.

[23] Mermelstein, R. J.: Psychosocial Stress, Social Support, and Smoking Cessation and Maintenance. PhD thesis. Eugene, Univ. of Oregon, 1983.

[24] Johnson, S. B., Pollak, R. T., Silverstein, J. H., Rosenbloom, A. L., Spillar, R., McCallum, M., and Hardavy, J.: Cognitive and behavioral knowledge about insulin-dependent diabetes among children and parents. Pediatrics 1982; 69:708–13.

[25] Diabetes Educational Profile Project: Diabetes Educational Profile: User's Manual. Ann Arbor, Univ. of Michigan, 1980.

[26] Page, P., Verstraete, D. G., Robb, J. R., and Etzwiller, D. D.: Patient recall of self-care recommendations in diabetes. Diabetes Care 1981; 4:96–98.

[27] Leventhal, H., Zimmerman, R., and Gutmann, M.: Compliance: a self-regulation perspective. *In* Handbook of Behavioral Medicine. Gentry, W. D., Ed. New York, Guilford, 1984:369–436.

[28] Fluckiger, R., and Winterhalter, K. H.: In vitro synthesis of hemoglobin A_1. FEBS Lett. 1976; 71:356–60.

[29] Cohen, J., and Cohen, P.: Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences. Hillsdale, NJ, Erlbaum, 1975.

[30] Ary, D., Toobert, D., Wilson, W., and Glasgow, R. E.: A patient perspective on factors contributing to nonadherence to diabetes mellitus. Diabetes Care 1986; 9:168–72.

[31] Cerkoney, K. A. B., and Hart, L. K.: The relationship between the health belief model and compliance of persons with diabetes mellitus. Diabetes Care 1979; 3:594–98.

[32] Glasgow, R. E., and McCaul, K. D.: Psychological issues in diabetes: a different approach. Letter. Diabetes Care 1982; 5:645–46.

[33] Pratt, C., Wilson, W., Porter, C., Kingsley, L., and Leklem, J.: Nutrition/diabetes education and peer support groups' effect on dietary modification in older diabetics. Abstract. Gerontologist 1983; 23:201.

[34] Epstein, L. H., and Cluss, P. A.: A behavioral medicine perspective on adherence to long-term medical regimens. J. Consult. Clin. Psychol. 1982; 50:950–71.

[35] Lipman, R. L., Raskin, P., Love, T., Triebwasser, J., Lecocq, F. R., and Schnure, J. J.: Glucose intolerance during decreased physical activity in man. Diabetes 1972; 21:101–107.

[36] Agner, E., Thorsteinsson, B., and Ericksen, M.: Impaired glucose tolerance and diabetes mellitus in elderly subjects. Diabetes Care 1982; 5:600–604.

[37] Wilson, W., Ary, D., Biglan, A., DiRocco, A., and Farmer, R.: Type II diabetes: relationships between age, compliance, and control. Abstract. Diabetes 1984; 33:196A.

[38] Williams, T. F., Martin, D. A., Hogan, M. D., Watkins, J. D., and Ellis, E. V.: The clinical picture of diabetic control, studied in four settings. Am. J. Public Health 1967; 57:441–51.

[39] Lonnroth, P., Digirolamo, M., Krotkiewski, M., and Smith,

U.: Insulin binding and responsiveness in fat cells from patients with reduced glucose tolerance and type II diabetes. Diabetes 1983; 32:748–54.

[40] Wing, R. R., Epstein, L. H., and Nowalk, M. P.: Dietary adherence in patients with diabetes. Behav. Med. Update 1984; 6:17–21.

[41] Cox, D. J., Gonder-Frederick, L., Pohl, S., and Pennebaker, J. W.: Diabetes: incidence and nature of diabetes mellitus. *In* Self-Management in Health Psychology and Behavioral Medicine. Holroyd, K. A., and Creer, T. L., Eds. New York, Academic, 1984:305–46.

[42] Campbell, D. T., and Fiske, D. W.: Convergent and discriminant validation by the multitrait-multimethod matrix. Psychol. Bull. 1959; 56:81–105.