Stages of Change for Healthy Eating in Diabetes

Relation to demographic, eating-related, health care utilization, and psychosocial factors

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OBJECTIVES — To identify diabetes-related characteristics of individuals at different stages of readiness to change to healthy, low-fat eating.

RESEARCH DESIGN AND METHODS — Stage-based differences in demographic, eating-related, health care utilization, and psychosocial factors were examined in a sample of 768 overweight (BMI >27 kg/m^2) individuals with diabetes enrolled in a randomized behavioral intervention trial.

RESULTS — Stage-based differences occurred for type 1 diabetic participants on percent of calories from fat and number of daily vegetable servings. For type 2 diabetic participants, sex, disease-specific quality of life, percent calories from fat, and number of daily vegetables servings differed across stages. Those in action stages were more likely to be female and have a better quality of life and healthier eating habits. Type 2 diabetic insulin-requiring participants in action stages were more likely to be married. Social support was highest for those in the contemplation stage and lowest for those in the action stage. Type 2 diabetic participants on pills in the action stages were older, had a lower BMI, ate more fruit, were nonsmokers, recently attended diabetes education, had a better quality of life and social support, and had less stress. One anomalous finding for type 2 diabetic participants was that precontemplators scored similarly to those in action stages.

CONCLUSIONS — These data validate the Transtheoretical Model, where those in the action stages displayed healthier eating. They also indicate that demographic and psychosocial factors may mediate readiness to change diet. Precontemplators were a heterogeneous group and may need individually tailored interventions.

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Within the fields of diabetes and health promotion, a change is occurring in how we help those individuals who are unable to consistently follow through on behavioral recommendations (1). Behavioral self-care has always been important in diabetes management, given the complex behavioral demands involved (2). Achieving optimal blood glucose control requires a complex regimen of behaviors that must be followed consistently over a lifetime. Insulin/medication administration and adjustment, self-testing blood glucose levels, and managing food intake and activity patterns represent significant behavioral demands. Traditionally, health care providers have focused on action-oriented interventions (education, skills acquisition, problem solving [3]). These interventions work well with individuals in a motivational state of readiness to change. However, those not motivated to follow through have benefited less from these interventions.

The Transtheoretical Model (TTM) of behavior change has been beneficial to those interested in enhancing motivation for self-care. In this model, five distinct motivational stages are identified (1,4):

- Precontemplation.
  The individual is not intending to change in the foreseeable future, usually measured as the next 6 months.
- Contemplation.
  The individual is not prepared to take action at present, but is intending to within the next 6 months.
- Preparation.
  The individual is actively considering changing his or her behavior in the immediate future (e.g., within the next month).
- Action.
  The individual has actually made an overt behavior change in the recent past, but the changes are not well established (i.e., for 6 months or less)
- Maintenance.
  The individual has changed his or her behavior for >6 months and is working to sustain the overt change.

Individuals in the first three stages (precontemplation, contemplation, and preparation) were considered to be in the

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Abbreviations: DISC, Diabetes Stages of Change; PTC, Pathways to Change Diabetes; TAU, treatment as usual; TTM, Transtheoretical Model.

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

See accompanying editorial, p. 1624.

preaction stages, whereas those in the last two stages (action and maintenance) were considered to be in the action stages. Stages are specific to different behaviors and change is often cyclical; that is, behaviors slip from one stage back to a previous stage.

The TTM has become popular with diabetes educators. However, to date, little research has been published validating the model for healthy eating in diabetes. In this study, the relation of stages of change for healthy, low-fat eating in overweight diabetic individuals to demographic variables, eating-related factors, health care utilization, and psychosocial factors was examined. The findings are useful for developing a better understanding of the factors related to readiness for healthy eating and may help guide the development of interventions to enhance readiness for change.

Based on data in other populations, it is predicted that those who are in the action stages for a healthy, low-fat diet would, compared to those in a preaction stage,

- Eat fewer calories from fat, consume more daily servings of fruit and vegetables, and have a lower BMI;
- Be more likely to have attended a diabetes education program in the past year and to have more frequent appointments with their physician, as well as be less likely to smoke;
- Have fewer psychosocial problems as assessed by quality of life, social support, and life events stress; and
- Be older and more likely to be female and be on insulin.

RESEARCH DESIGN AND METHODS

Overall intervention trial

The data for this study were obtained from a large randomized clinical trial called Diabetes Stages of Change (DISC). The intervention, called Pathways to Change Diabetes (PTC), was based on the TTM and was compared to treatment as usual (TAU). The design was a multifactorial split-plot, with two randomized among-subjects factors: treatment (PTC and TAU) and strips (free strips and no strips) and one within-subject factor (pre- and posttreatment). Because treatment recommendations differed, participants were stratified into insulin (n = 350) or oral agents only groups (n = 679) and then randomized into PTC/TAU and free test strips/no strips groups. Blood glucose meters and modems were supplied for use during the study. All participants received a full assessment at intake and 1-year follow-up. Assessments included biomedical evaluation (HbA_{1c}, serum blood glucose, lipids [total, HDL, and LDL cholesterol and triglycerides], and BMI), psychosocial functioning (quality of life, social support, and stress), health care utilization, and TTM constructs for self-testing, smoking, and healthy eating. (A brief synopsis of the overall trial methodology is presented here; a more detailed account has been previously published [5]).

The PTC intervention focused on three behaviors: healthy eating, glucose self-testing, and smoking cessation. At intake, participants were provided with a stage-based handbook containing information on behavior change strategies for the three behaviors. The TTM constructs for each target behavior were assessed at intake and quarterly. An expert/system-generated, individualized report that provided stage-matched feedback on the processes of change, pros and cons, situational temptations, and additional strategies to help facilitate movement through the stages was produced (6). In addition, stage-matched phone counseling was provided quarterly (6). Finally, PTC participants received regular stage-based newsletters focused on dietary issues including fruit and vegetable consumption and eating out and helpful tips for using relevant strategies to move through the stages to action and maintenance.

Participants

The study participants were 1,029 individuals with type 1 or type 2 diabetes who were recruited into the trial between January 1998 and April 1999. To be included in the trial, participants needed to demonstrate at least one of the following behaviors at baseline: self-testing less than four times per day if insulin treated and less than two times per day if on antihyperglycemic agents; currently smoking cigarettes; or having a BMI $\geq$27 kg/m^2. A more detailed account of inclusion/exclusion criteria has been provided elsewhere (5). A total of 860 participants were enrolled for self-testing, 768 for obesity, and 168 for smoking. The 768 obese participants were staged on readiness to adopt a healthy, low-fat diet and formed the sample for this report. Of these participants, 65.2% were from Toronto and 34.8% from Nova Scotia. Sex was evenly split, with 48.9% being men and 51.1% being women. Participants with type 1 diabetes represented 15.8% of the sample. Of those with type 2 diabetes, 69.8% were on antihyperglycemic medication alone and 30.2% were on insulin with or without antihyperglycemic medication. Participants were distributed across the stages for healthy eating (precontemplation 10.2%, contemplation 25.0%, preparation 27.2%, action 5.8%, and maintenance 31.8%). Regarding glycemic control, 21.5% of the sample was in optimal control (HbA_{1c} <110% max value, mean actual value 7.31%), 47.7% were in acceptable control (110–140% of max HbA_{1c} value, actual mean value 9.02%), and 30.8% demonstrated compromised control (>140% of max HbA_{1c}, actual mean value 10.84%) (7). The average BMI of the sample was 34.1 ± 5.94 (SD).

Type 1 diabetic patients in this sample were, on average, 47.5 years old and had a mean BMI of 32.8 and an average duration of diabetes of 15.5 years. Those with type 2 diabetes were older (mean = 56.4; $P < 0.001$) and heavier (mean = 34.3; $P < 0.015$) and had diabetes for a shorter duration (mean = 8.75; $P < 0.001$).

Measures

Stage of change for healthy, low-fat eating. The independent variable in this study was the stage of readiness to adopt healthy, low-fat eating habits. Categorization focused on reducing dietary fat within the context of weight control (all subjects were overweight with BMI $\geq$27 kg/m^2). It involved three steps (8), determined by intentional and behavioral criteria. Step 1 posed the question, "Do you consistently avoid eating high-fat foods?" Participants responding "No" were assigned to the *1*) precontemplation stage ("No, and I do not intend to in the next 6 months."), *2*) contemplation stage ("No, but I intend to in the next 6 months."), or *3*) preparation stage ("No, but I intend to in the next 30 days."). Participants responding "Yes" were assigned to either the *1*) action stage ("Yes, and I have been for less than 6 months.") or *2*) maintenance stage ("Yes, and I have been for more than 6 months."). Before being classified as in the action or maintenance stage, a behav-

ioral criterion of <30% dietary fat intake was applied (step 2) (9). Participants were required to meet this behavioral criterion to be classified into these stages of change. Step 3 was for participants who perceived that they consistently avoided high-fat foods, but failed to meet the behavioral criterion. These individuals were presented with five specific fat-reducing behaviors that have been found to discriminate between those with fat intake >30% of calories and those with fat intake ≤30% of calories (10). Stage was assigned based on readiness to use the five behaviors as follows: *1*) precontemplation stage ("No, and I do not intend to in the next 6 months."), *2*) contemplation stage ("Yes, and I intend to in the next 6 months."), or *3*) preparation stage ("Yes, and I intend to in the next 30 days.").

The dependant variables were grouped into four categories: demographic, eating-related, health care utilization, and psychosocial factors.

Demographic factors. Data were collected on age, sex, geographic region (Toronto versus Nova Scotia), diabetes duration, type 1 or type 2 diabetes, and the method of treatment (antihyperglycemic medication alone versus insulin with or without medication).

Eating-related factors. We assessed BMI, percent of daily calories from fat, and daily serving of vegetables and fruit. Dietary intake was assessed using the National Cancer Institute Block Food Frequency questionnaire (11,12), modified to increase sensitivity to low-fat food substitutes (13,14).

Health care utilization factors. The authors developed a self-report tool to assess the number of physician visits (primary care and specialist visits) within the previous year, diabetes-related emergency room visits or hospitalizations in the previous year, participation in recent diabetes education (≥1 h of formal education), current smoking status, and financial burden of diabetes management (assessed as fully reimbursed, partially reimbursed, or not reimbursed for the cost of diabetes supplies).

Psychosocial factors. Several possible mediating factors were examined, including quality of life, social support, and life events stress.

Quality of life was assessed using a diabetes-specific and a non–disease-specific measure:

- Diabetes Quality of Life Scale (15). This is a diabetes-specific measure of quality of life with three subscales: satisfaction (15 items), impact (20 items), and worry (11 items). Reliability (internal consistency, 0.66–0.92; test-retest reliability, 0.78–0.92) and validity (concurrent) data are acceptable.
- Mental Health Inventory-Short Form (16). This is a five-item short form of the Mental Health Inventory (16), which has been well validated and has strong reliability and validity indexes. The five items for the short form were selected as the "best" items predicting the total score ($r = 0.95$).

Social support was assessed using a disease-specific and non–disease-specific measure:

- Diabetes Family Behaviors Checklist (17). This measure assesses the frequency of supportive or nonsupportive behavior by the patient's closest significant other. There are two subscales: supportive (nine items) and nonsupportive behaviors (eight items). Acceptable reliability (internal consistency, 0.43–0.73; test-retest, 0.58–0.72) and validity (convergent and predictive) data are reported.
- Interpersonal Support Evaluation List (18). This non–diabetes-specific measure of social support assesses appraisal (10 items assessing perceived availability of others to talk to about one's problems) and belonging (10 items assessing the perceived availability of people with whom to do things). Internal consistency (α 0.70–0.82 for appraisal, 0.75–0.78 for belonging) and test-retest reliability (0.63 for appraisal, 0.65 for belonging) are acceptable.

Stressful life events were assessed using the Holmes and Rahe (19) instrument, modified to take into consideration appraisal of stress (20). This method was further modified by grouping events into the following categories: finances, relationships, health, and social problems. Finally, a summary evaluation of daily stress over the past month, using a seven-point Likert scale, was obtained.

RESULTS

To minimize the problem of compounding error rates, the data were analyzed by category: demographic (age, sex, diabetes type and duration, treatment method, region), eating-related (BMI, percent calories from fat, daily servings of vegetables and fruit), health care utilization (past diabetes education, financial burden of diabetes, medical doctor or emergency room visits in past year, smoking status), and psychosocial factors (disease quality of life, social support, stress). A MANOVA was run on all factors for each category. Significant MANOVA results were followed up with univariate analyses and post hoc testing with either Tukey's least significant differences procedure (interval level data) or χ^2 (nominal level data). Data for those with type 1 diabetes (requiring insulin within the first year of diagnosis, $n = 112$), insulin-requiring type 2 diabetes ($n = 126$), and type 2 diabetes on oral antihyperglycemic agents ($n = 474$) were analyzed separately.

MANOVAs

Results. Multivariate analyses revealed few stage-based differences for type 1 diabetic participants. The only factor that showed a difference was for the eating-related factors ($\lambda = 1.91$, $P = 0.019$). In contrast, many stage-based differences occurred for type 2 diabetic participants. Type 2 diabetic participants on insulin demonstrated stage-based differences on demographic ($\lambda = 1.99$, $P = 0.007$), eating-related ($\lambda = 2.61$, $P = 0.001$), and psychosocial ($\lambda = 1.59$, $P = 0.03$), but not health care utilization (NS), factors. Type 2 diabetic participants on medication demonstrated stage-based differences on all factors: demographic ($\lambda = 3.18$, $P < 0.001$), eating-related ($\lambda = 7.51$, $P < 0.001$), health care utilization ($\lambda = 1.60$, $P = 0.046$), and psychosocial factors ($\lambda = 2.11$, $P < 0.001$).

Follow-up ANOVAs. For type 1 diabetic participants, stage-based differences occurred for percent of calories from fat ($F = 3.06$, $P = 0.02$) and daily serving of vegetables ($F = 3.72$, $P = 0.007$). For type 2 diabetic insulin-requiring participants, stage-based differences occurred on the following variables: sex ($\chi^2 = 9.35$, $P = 0.053$), marital status ($\chi^2 = 114.00$, $P = 0.007$), percent calories from fat ($F = 6.41$, $P < 0.001$), daily servings of vegetables ($F = 2.45$, $P = 0.05$), diabetes-specific quality of life ($F = 6.19$, $P < 0.001$), and general social support ($F = 3.14$, $P = 0.017$). Finally, for type 2 diabetic participants on medication, stage-based differences occurred for age

Table 1—*Post hoc testing of ANOVA results*

	Precontemplation	Contemplation	Preparation	Action	Maintenance
Type 1 diabetes (n = 112)					
Eating-related factors					
Calories from fat (%)	37.7*†	40.3†	40.2†	34.6*†	33.5*
Daily vegetable servings	2.1*†	1.67†	1.4†	2.3*†	2.5*
Type 2 diabetes (n = 126)					
Demographics (%)					
Sex					
Men	16.7	31.5	18.5	7.4	25.9
Women	6.9	18.1	33.3	4.2	37.5
Marital status					
Married	14.5	21.7	18.1	7.2	38.6
Lives alone	4.7	27.9	44.2	2.3	20.9
Eating-related factors					
Calories fat (%)	39.0*†	42.8†	39.9†	33.4*	34.5*
Daily vegetable servings	1.4*	1.5*	2.0*†	2.0*†	2.3†
Psychosocial factors					
Diabetes quality of life	61.6*	61.9*	60.5*	47.7†	68.8‡
General social support	3.8*†‡	4.3‡	3.5*	3.3*§	4.2‡§
Type 2 diabetes oral antihyperglycemics (n = 475)					
Demographics					
Age	54.5*†	53.8†	55.3*†	57.8*‡	59.8‡
Sex (%)					
Men	14.7	24.1	26.9	4.9	29.4
Women	4.3	22.6	26.5	7.4	39.1
Eating-related factors					
BMI	33.3*	35.6†	34.5*†	34.0*†	33.4*
Calories fat (%)	39.9*	39.9*	39.6*	34.7†	33.2†
Daily vegetable servings	2.09*†	1.6*	1.9*†	2.3†‡	2.4‡
Daily fruit servings	1.3*	1.7*†	1.5*	1.8*†	1.9†
Health care utilization (%)					
Past diabetes education					
Yes	8.5	18.5	25.9	5.8	41.3
No	10.5	26.6	27.3	6.3	29.4
Smokes cigarettes					
Yes	18.9	32.1	17.0	5.7	26.4
No	8.5	22.3	28.0	6.2	35.1
Psychosocial factors					
Diabetes quality of life	69.5*	65.3†‡	64.5†	69.6*‡	70.4*
General quality of life	20.4*‡	18.2†	18.7*†	18.3*†‡	20.6‡
Nonsupportive family behaviors	0.8*†	0.9*	0.9*	0.9*†	0.7†
Daily stress level	2.5*†	3.0*	2.8*	2.4*†	2.3†

For each measure, numbers with different symbols are significantly different.

($F = 8.94$, $P < 0.001$), sex ($\chi^2 = 17.71$, $P < 0.001$), BMI ($F = 2.49$, $P = 0.043$), percent calories from fat ($F = 4.08$, $P = 0.003$), daily servings of fruit ($F = 6.60$, $P < 0.001$) and vegetables ($F = 23.42$, $P < 0.001$), past diabetes education ($\chi^2 = 2.41$, $P = 0.049$), smoking status ($\chi^2 = 2.63$, $P = 0.034$), diabetes-specific ($F = 5.69$, $P < 0.001$) as well as general quality of life ($F = 3.61$, $P = 0.007$), diabetes nonsupportive behaviors ($F = 2.58$, $P = 0.037$), and daily stress level ($F = 3.53$, $P = 0.007$).

Stage-based differences

For type 1 diabetic participants, post hoc testing indicated that those in the action and maintenance stages had the lowest percent calories from fat and the highest number of daily servings of vegetables. Those in maintenance were significantly different than those in contemplation and preparation (Table 1).

For type 2 diabetic insulin-requiring participants, the following stage-based differences were found. Women were further along the stages of change than men (75% of women in preparation or beyond compared to 51.8% of men). Married participants were further along the stages of change than those living alone (45.8% of married participants were in the action or

maintenance stage compared to 23.2% of those living alone). On eating factors, those in the action or maintenance stage consumed fewer calories from fat and had more servings of vegetables daily. The psychosocial differences revealed that quality of life was highest for those in the maintenance stage, but lowest for those in the action stage. General support was highest for those in the contemplation stage and lowest for those in the action stage (Table 1).

For type 2 diabetic participants on oral antihyperglycemic medication, numerous staged-based differences were seen. Older participants were more likely to be in the action stages, with those in the maintenance stage being older than those in the precontemplation, contemplation, and preparation stages. Women were more likely to be in the maintenance stage and less likely to be in the precontemplation stage than men. BMI was highest for those in the contemplation stage and significantly lower for those in the precontemplation and maintenance stages. Percent of calories from fat decreased across the stages, with those in the action and maintenance stages significantly lower than those in all the preaction stages. Daily vegetable servings increased through the progression of stages, with scores in the maintenance stage being significantly higher than in all the preaction stages. Daily fruit servings also increased across stages, with those in the maintenance stage scoring significantly higher than those in the precontemplation or preparation stage. Health care utilization differences on past diabetes education indicated that those in the maintenance stage were more likely to have had diabetes education within the past year. Smokers were more likely to be in the precontemplation stage and less likely to be in the maintenance stage than nonsmokers. For psychosocial factors, diabetes-specific quality of life was lowest for those in the contemplation and preparation stages and highest for those in the maintenance, action, and precontemplation stages. General quality of life was highest for those in the maintenance and precontemplation stages. Nonsupportive family-based diabetes behaviors were lowest for those in the maintenance and precontemplation stages and highest for those in the contemplation and preparation stages. Daily stress levels were lowest for those in the maintenance stage and highest for those in the contemplation and preparation stages (Table 1).

CONCLUSIONS — The results of this study indicated that the stage of readiness to adopt a healthy, low-fat diet is influenced by a number of factors. Because of the natural distribution within diabetes subtypes, sample sizes for the type 1 and type 2 diabetic insulin-requiring participants were lower (n = 112 and 126, respectively) than for type 2 diabetic medication participants (n = 474). Given that there were five stages, the interpretation of results for type 1 and type 2 diabetic insulin-requiring groups must be tentative. We will therefore focus on the type 2 diabetic medication group results.

The data on eating-related factors provide support for the staging algorithm. There was an increase in healthy eating as participants moved from the preaction to the action stages: percent of calories from fat was lower and the number of daily servings of vegetables/fruit was higher. This pattern was also found on some measures for type 1 and type 2 diabetic insulin-requiring participants. We can conclude that in this study the staging model was supported, and that the stage matched the actual eating behavior.

The results for BMI were interesting. Those lowest in BMI were either in the maintenance (model consistent) or precontemplation stage (model inconsistent). A previous qualitative study found similar results for individuals in the precontemplation stage, who indicated they felt they did not have to reduce fat intake because only overweight individuals needed to cut down on fat (21). Although the precontemplators may have indeed perceived themselves as not being overweight, and were in fact less overweight than most other subjects, all subjects in this study exceeded the range for normal weight (BMI <25 kg/m^2). These results emphasize the complexity of assessing intention. Precontemplators for healthy eating may be a heterogeneous group.

Regarding demographics, women were more likely to be in the maintenance and less likely to be in the precontemplation stage than men (this was also true for type 2 diabetic insulin participants), suggesting that women are more interested in healthy eating, or at least fat reduction, than men. Older type 2 diabetic participants were more likely to be in the action stage, suggesting that age is an important mediator of readiness to follow a healthy meal plan in this group. Age was independent of diabetes duration, which did not differ among stages. When duration of diabetes was used as a covariate, the effect of age was still significant (F = 8.94, $P <$ 0.001). Marital status differed for the type 2 diabetic insulin group (married participants more likely to be in the action stage), but not for type 2 diabetic subjects on medication. It may be that being alone and being on insulin interferes with healthy eating (e.g., those living alone may be less willing to invest time in meal preparation), but the small sample size necessitates caution in interpreting this finding.

Regarding health care utilization, type 2 diabetic participants on medication in the action stages were more likely to have received diabetes education over the last year (reflecting the demonstrated efficacy of diabetes education) and to not smoke. The finding on smoking may reflect the fact that smokers are less interested in healthy behavior in general. If replicated, this finding may shed light on the nature of the task required to help smokers change. Smoking may be associated with more general negative attitudes toward healthy behavior. It may be that if these general attitudes can be altered, smoking cessation efforts may be more effective.

Regarding psychosocial functioning, type 2 diabetic participants on medication in different stages of healthy eating demonstrated a general pattern in which those being in the action stage, and especially the maintenance stage, had a better quality of life. An exception occurred in that those in the precontemplation stage performed similar to those in the maintenance stage on several factors, including quality of life (disease specific and general) and diabetes-specific family nonsupportive behaviors. The anomalous performance of the participants in precontemplation on a number of factors warrants exploration.

The type 2 diabetic insulin group demonstrated stage-based differences on several psychosocial factors that are difficult to interpret. Quality of life was highest for those in the maintenance stage and lowest for those in the action stage. This may reflect the fact that the action stage can be a time of transition that interferes with quality of life. Social support was

highest for those in the contemplation stage and lowest for those in the action stage; perhaps when an individual is actively thinking about change, but has not yet begun to change, support is easier to give. Alternatively, significant others may perceive the individual in action as having fixed the problem and therefore being in less need of support. Those in the contemplation stage may be more willing to seek out and accept support as they decide whether or not to change, whereas those in the action stage may need less support as their confidence (self-efficacy) increases or may be less willing to seek support for fear of appearing less competent. The limited sample size for this group necessitates these conclusions being tentative without replication.

The results of this study can be beneficial to the management of diabetes in a number of ways. First, some of the variables examined in this study can be altered directly with counseling and clinical intervention. This includes psychosocial intervention to improve quality of life and social support as well as diabetes education and regular medical follow-up. Second, although some of the factors examined in this study cannot be directly manipulated, such as sex and age, these factors can be considered in a risk assessment. For example, these data suggest that men and younger individuals with type 2 diabetes on medication are likely to be in the preaction stage for healthy eating. Third, risk assessment (which can apply to those factors that can be manipulated as well as those that cannot) can be used to direct motivational enhancement intervention. The main purpose of the DISC study was to evaluate the effectiveness of PTC (a specific motivational enhancement intervention). The findings supported the efficacy of PTC compared to TAU. As additional motivational enhancement interventions are developed and shown to be effective, improving readiness to change directly will be more achievable.

The data from this study confirm the stages of change construct and the hypotheses of this study, with one exception. Those in the precontemplation stage functioned more like those in the action stages than those in the preaction stages on a number of variables. It is important to realize that individuals may be classified in precontemplation through step 1 of the algorithm (no intention of avoiding fat) or step 3 (perceived as avoiding fat, but failing to meet behavioral criteria for use of fat-reducing behaviors and no intention of using five specific fat-reducing behaviors). Ounpuu et al. (22) found that nondiabetic female precontemplators who perceived they were avoiding fat demonstrated process of change use, decisional balance, and self-efficacy that were more similar to those of subjects in the maintenance stage than those in the precontemplation stage who did not perceive they were avoiding fat. Clearly, within the diabetes model, those in the precontemplation stage are a complex and diverse group. In this study, these were individuals who reported no intention to change their goal behavior in the foreseeable future. However, they often had profiles more similar to those of action than preaction participants on a number of variables. It is likely that this group was heterogeneous. Some may have been precontemplators who were poorly motivated for self-care. Others could have been in this stage because they perceived they were doing well, were balancing high-fat foods with other healthy food choices, and may have been following recommendations that carbohydrate and monounsaturated fat provide 60–70% of energy intake. Many were, in fact, doing well, with their blood glucose levels in the target range (indeed, precontemplators did not differ from those in the action stage on HbA_{1c}, in contrast to those in the contemplation and preparation stages), and therefore these individuals might have no perceived need or intent to change. Still others may have been demoralized from past failures at dietary change, and others may have had insufficient, or even inaccurate, information on healthy eating. Clearly, diabetes self-care is very complex and involves the interplay of many factors. Examining the precontemplator group demonstrates this diversity: ~50% of these participants judged themselves to be following a low-fat diet (53.4%) and to be testing their blood glucose levels as recommended (47.9%). However, those that did judge themselves as not adhering to the recommended regimen, did not differ from the adherent group on HbA_{1c}, cholesterol (HDL/LDL), or triglyceride levels (all NS). Although this heterogeneity may appear to invalidate the use of the staging algorithm for diabetic individuals, the algorithm does accurately assesses intention; all subjects in the precontemplation stage were at the lowest level of motivational readiness to change. Furthermore, as predicted by the model (1), a higher percentage of precontemplators (17.8%) were in denial and did not consider themselves overweight compared to participants in all other stages (range 4.5–11.5%; $\chi^2 = 13.21$, $P = 0.01$); however, all participants were overweight (BMI $\geq$27 kg/m^2). Nevertheless, the heterogeneity found in this study suggests that diabetes educators should assess each individual precontemplator's reasons for not changing and help them understand how changing specific dietary behaviors could improve health.

It should be noted that the design for this study was a cross-sectional comparison of patients at entry into the intervention trial. No counseling to improve healthy eating had yet taken place. When the data were examined from the end of study, improved eating was associated with improved control. Specifically, when an intention-to-treat analysis was conducted on all participants who were in preaction at the beginning of the study ($n = 445$) and an ANCOVA analysis of end-of-study HbA_{1c} was performed for those reaching the action or maintenance stage (7.97%) compared to those who stayed in the preaction stage (8.51%), this difference was highly significant ($P = 0.007$).

In summary, the results of this study shed light on the general factors, including demographic, eating-related, diabetes-related, and psychosocial factors, that are associated with different stages of readiness to adopt a healthy, low-fat diet. Some of these factors are unchangeable (sex, age) whereas others are modifiable (diabetes education, quality of life). By becoming aware of the diabetes-related characteristics of readiness to change, we can promote the likelihood of change by intervening based on these factors. These stage-related differences suggest that traditional action-oriented interventions will need to be tailored to motivational readiness to change.

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References

1. Ruggiero L, Prochaska JO: Readiness for change: application of the transtheoretical

model to diabetes. *Diabetes Spectrum* 6:22–60, 1993
2. Glasgow RE, Fisher EB, Anderson B, La-Greca A: Behavioral science in diabetes: contributions and opportunities. *Diabetes Care* 22:832–843, 1999
3. Glasgow RE: A practical model of diabetes management and education. *Diabetes Care* 18:117–126, 1995
4. Glanz K, Patterson RE, Kristal AR, DiClemente CC, Heimendinger J, Linnan L, McLerran DF: Stages of change in adopting healthy diets: fat, fiber, and correlates of nutrient intake [Erratum in *Health Educ Q* 22:261, 1995]. *Health Educ Q* 21:499, 1994
5. Jones H, Ruggiero L, Edwards L, Vallis TM, Rossi S, Rossi JS, Greene G, Kelly K, Prochaska JO, Zinman B: Diabetes Stages of Change (DISC): evaluation methodology for a new approach to diabetes management. *Canadian Journal of Diabetes Care* 25:97–10, 2001
6. Velicer WF, Rossi JS, Ruggiero L, Prochaska JO: Minimal interventions appropriate for an entire population of smokers. In *Interventions for Smokers: An International Perspective*. Richmond R, Ed. Baltimore, MD, Williams & Wilkins, 1994, p. 69–92
7. Daneman D, Ellis G: Interpreting glycated hemoglobin levels. *Canadian Diabetes* 9:1–8, 1996
8. Greene GW, Rossi SR: Stages of change for dietary fat reduction over 18 months. *J Am Diet Assoc* 98:529–534, 1998
9. Greene GW, Rossi S, Fava J, Velicer W, Laforge R, Willey C, Rossi J: The relationship between a dietary behavior change questionnaire and dietary intake. Paper presented at the Society for Behavioral Medicine meeting, Washington, DC, March, 1996
10. Greene GW, Rossi SR, Reed GR, Willey C, Prochaska JO: Stages of change for reducing dietary fat to 30% of energy or less. *J Am Diet Assoc* 94:1105–1110, 1994
11. Block G, Hartman AM, Dresser C, Carroll MD, Gannon J, Gardner L: A data-based approach to diet questionnaire design and testing. *Am J Epidemiol* 124:453–469, 1986
12. Block G, Woods M, Potosky A, Clifford C: Validation of a self-administered diet history questionnaire using multiple diet records. *J Clin Epidemiol* 43:1327–1335, 1990
13. Kristal AK, Shattuck AL, Williams AE: Food frequency questionnaires for diet intervention research. In *Proceedings of the 17th National Nutrient Database Conference*. Washington, DC, International Life Sciences Institute, 1994, p. 110–125
14. Shakel SE, Sievert YA, Buzzard IM: Sources on data for developing and maintaining a nutrient database. *J A Diet Assoc* 88:1268–71, 1988
15. The Diabetes Care and Complications Trial Research Group: Reliability and validity of a diabetes quality of life measure for the Diabetes Control and Complications Trial. *Diabetes Care* 11:725–732, 1989
16. Veit CT, Ware JE: The structure of psychological distress and well-being in general populations. *J Consult Clin Psychol* 51: 730–742, 1983
17. Schafer LC, McCaul KD, Glasgow RE: Supportive and nonsupportive family behaviors: relationships to adherence and metabolic control in persons with type I diabetes. *Diabetes Care* 9:179–185, 1986
18. Cohen S, Mermelstein R, Kamarck T, Hoberman HM: Measuring the functional components of social support. In *Social Support: Theory, Research and Applications*. Sarason IG, Sarason SB, Eds. Boston, MA, Dordrecht, 1985, p. 73–94
19. Holmes TJ, Rahe RH: The Social Readjustment Rating Scale: *J Psychosom Res* 11:213–218, 1967
20. Monroe S, Bromet E, Connell M, Steiner S: Social support, life events, and depressive symptoms: a 1-year prospective study. *J Consult Clin Psychol* 54:424–431, 1986
21. Brown J, Greene GW, Rossi S, Armitage J, Knoll L, Lovejoy J: Focus groups matched to stage of change for dietary fat reduction. Paper presented at the American Dietetic Association meeting, Orlando, FL, October, 1995
22. Ounpuu S, Woolcott DM, Greene GW: Defining stage of change for lower-fat eating. *J Am Diet Assoc* 100:674–679, 2000