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Psychometric properties of the Multiple Eating Antecedents Scale (MEAL): A behavioral assessment instrument for measuring diet nonadherence in diabetes mellitus.

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Psychometric Properties of the Multiple Eating Antecedents Scale (MEAL): A Behavioral Assessment Instrument for Measuring Diet NonAdherence in Diabetes Mellitus

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Introduction

Diabetes mellitus affects an estimated 6.5 million Americans (American Diabetes Association, 1993). The effects on individuals with diabetes are both public and personal. The public costs of diabetes mellitus are economic (increased absenteeism and decreased/lost productivity) and social (decreased quality of life for family members and significant others, and burden on national health care resources) (Galloway, Sinnock, & Davidson, 1985). The personal costs of diabetes mellitus are a decrease in quality of life, shortening of an individual's life span, potential development of life threatening complications, and permanent disability from the long term complications of diabetes.

The contemporary treatment for diabetes mellitus involves a myriad of lifestyle changes in diet and exercise patterns as well as administration of appropriate oral medication or insulin injections and self-monitoring of blood glucose. At present, there is no cure for diabetes mellitus; the diabetes treatment regimen attempts to maintain non-diabetic blood glucose levels. The chronic and progressive nature of diabetes mellitus requires the person with diabetes to adhere to the treatment regimen from the time of diagnosis until death. Nonadherence to the treatment regimen may create poor metabolic control that produces wide fluctuations in blood glucose levels. These, in turn, may predispose the person with diabetes to develop disabling complications (Foster, 1994).

The ability of the person with diabetes to maintain adherence to the diabetes treatment regimen over the course of his/her disease may reduce the individual's susceptibility to the long term complications associated with diabetes (Cahill, Etzwiler, & Freinkel, 1976; Foster, 1994). The field of psychology and, most recently, health psychology/behavioral medicine can assist in improving the quality of life for individuals with diabetes by investigating reasons for nonadherence and suggesting solutions to nonadherence. Thus, the following literature review and study focuses on one aspect of the diabetes regimen, adherence to diet and factors influencing diet adherence.

Description of Diabetes Mellitus

Diabetes mellitus is clinically diagnosed as an elevation of fasting blood glucose (hyperglycemia) above 140 mg/Dl and a random blood glucose greater than 200 mg/DL (National Diabetes Data Group/NIH, 1979). Other related symptoms associated with blood glucose greater than 200 mg/DL include glucose in the urine (glucosuria), excessive urination (polyuria), excessive thirst (polydipsia), increased food intake (polyphagia), and rapid weight loss (Foster, 1994). There are several classes of diabetes mellitus (e.g., impaired glucose tolerance, insulin-dependent diabetes, noninsulin-dependent diabetes mellitus, and gestational diabetes) that reflect the etiological differences and subclasses that reflect different treatment modalities (e.g., noninsulin-dependent diabetes mellitus requiring insulin) found among those who are diagnosed with this disease (National Diabetes Group/NIH, 1979).

Type I or insulin-dependent diabetes mellitus (IDDM) usually occurs before the age of fifteen. It is characterized by a complete absence of endogenous insulin. The beta cells within the pancreas which secrete insulin are completely dysfunctional. Therefore, people with Type I diabetes mellitus must rely on exogenous sources of insulin given by subcutaneous injection to remain alive.

Type II or noninsulin-dependent diabetes mellitus (NIDDM) usually has its onset in adulthood. It is characterized by the presence of adequate amounts of endogenous insulin, but difficulty with cellular receptiveness to the presence of insulin (insulin resistance). The diagnosis of Type II diabetes mellitus has been correlated with a genetic predisposition and obesity. Type II diabetes mellitus is treated with a variety of measures including: (1) diet and exercise alone or in combination with (2) oral hypoglycemic medications, presumed to increase either insulin receptor sensitivity of individual cells or promote production of higher quality endogenous insulin secretions, and sometimes (3) exogenous insulin injections.

The acute complications of diabetes include hypoglycemia, ketoacidosis, coma, and death (Foster, 1994). The long-term complications of diabetes are associated with the microangiopathic and macroangiopathic changes that occur during the disease process. These include nephropathy (renal disease), neuropathy (nerve degeneration), retinopathy (vascular changes leading to blindness), amputation, chronic infections, atherosclerosis, arteriosclerosis, and stroke (Foster, 1994). The goal of diabetes treatment is to keep a person's blood glucose as near to nondiabetic levels as possible. The complex diabetes treatment regimen maximizes opportunities for the individual with diabetes to achieve normal glucose values. The ability to maintain near nondiabetic glucose values helps prevent short term complications of diabetes (hyperglycemia, polyuria, hypoglycemia and polydipsia), as well as long term complications of diabetes (Foster, 1994).

Diabetes Regimen

The diabetes regimen is a complex regimen that requires the individual with diabetes to acquire a large amount of new knowledge, new skills specifically related to diabetes, and lifestyle changes to incorporate the regimen into her/his daily life. The diabetes regimen has several components: diet, exercise, blood and urine testing, record keeping, and self-administration of medication.

Diet

The individual with diabetes typically is instructed to follow a specific diet low in saturated fat and high in fiber with at least 50-60% of calories supplied by complex carbohydrates (American Diabetes Association, 1987). He/she also is told to avoid foods with refined sugars, molasses, or honey (American Diabetes Association, 1987).

Exercise

A second component of the diabetes regimen is exercise. Exercise allows glucose to be absorbed across the cellular membrane of muscle fibers without the presence of insulin. Therefore, exercise reduces the amount of insulin the person with diabetes needs or reduces the amount of oral hypoglycemic agents an individual requires to maintain the desired blood glucose levels. The cardiovascular benefits of exercise may slow the onset of microangiopathic and macroangiopathic changes that occur in the disease process of diabetes (American Diabetes Association, 1990).

Testing

The third component of the diabetes regimen is testing of blood for glucose levels and urine for ketone bodies. The recent technologic development of reflectance devices and reagent strips for determining blood glucose levels makes it possible for people with diabetes to monitor their blood glucose at home. Self-monitoring of blood glucose (SMBG) has become the method of choice for patient monitoring of level of diabetes control.

The frequency of self-monitoring of blood glucose (SMBG) varies depending upon the type of diabetes. Individuals with Type II diabetes may be told to test their blood glucose once a day or a few times a week. On the other hand, individuals with Type I diabetes may test their blood glucose multiple times (three or more) each day. This distinction in testing frequency reflects the difference in severity between the two types of diabetes. The reliance of individuals with Type I diabetes on exogenous insulin supplies as their only source of insulin places them in the precarious situation of having the potential for extreme fluctuations of their glucose levels in a very short period of time (i.e., hours). This lability of blood glucose is rarely seen in Type II diabetes. Thus, SMBG provides immediate information to the person with diabetes or his/her health professional that is useful for making regimen adjustments.

Ketone bodies are produced when insulin levels are insufficient to maintain glucose metabolism. Therefore, the body metabolizes fat and muscle to provide a source of energy. The ketone bodies are a by-product of this metabolic process and evidence of a toxic acidity occurring within the body known as diabetic ketoacidosis. These ketone bodies are excreted in the urine. Individuals with diabetes measure the amount of ketone bodies excreted in their urine to identify periods of insulin insufficiency that may require immediate medical attention.

Record keeping

The fourth component of the diabetes treatment regimen involves record keeping. Most people with diabetes are instructed to keep written records of their blood glucose testing results including blood glucose level, time sample was taken, date, day of the week, any hypoglycemic symptoms and, if blood glucose exceeds 250 mg/dl, urine ketone levels.

Record keeping also applies to the medication component of the regimen. Insulin doses, types of insulin taken, time insulin was taken, and the type of oral hypoglycemic agents taken also are recorded. The person with diabetes and her/his physician review these records periodically to observe any patterns in blood glucose fluctuations and make appropriate adjustments in medication (insulin or oral hypoglycemic agents).

Self-administration of medication

The final component of the diabetes regimen is the administration of medication. Individuals with Type II diabetes taking oral hypoglycemic agents have the most flexibility in the timing of their medications. The administration of insulin, whether in Type II or Type I diabetes, represents a more difficult set of parameters for the person with diabetes to master. Insulin doses should be drawn-up consistently and accurately into the syringe to avoid the acute complications of hypoglycemia or hyperglycemia resulting from errors in insulin dosage. Injection technique (choice of anatomical location and needle placement) can affect the absorption rate and subsequently the overall effectiveness of the insulin being administered. Finally, many people with diabetes, especially Type I, are expected to adjust their doses of insulin to compensate for variations in diet, exercise, SMBG values, or stress on a day-to-day basis so adequate blood glucose levels may be maintained. Thus, individuals with diabetes are required to perform a series of behaviors related to medication administration that are both relatively complex and interrelated.

Diet Adherence

The diet component of the diabetes regimen has consistently been found to be one of the most difficult areas of the regimen with which to adhere (Ary, Toobert, Wilson, & Glasgow, 1986; Glasgow, Toobert, Riddle, Donnelly, Mitchell & Calder, 1989). When comparing adherence across all regimen areas, individuals with Type I (Glasgow, McCaul, & Schafer, 1987) and Type II (Glasgow, Toobert et al., 1989) diabetes demonstrate the least amount of adherence to their diet regimen, as well as less consistency in their diet adherence over time. Although there has been a trend to investigate adherence by measuring an individual's adherence to the entire diabetes regimen, it may be more useful to measure adherence to each regimen area separately.

Ary et al. (1986) compared rates and reasons for nonadherence between adults with Type I (n = 24) and Type II (n = 184) diabetes. Subjects completed the Diabetes Daily Care Instrument and the behavioral component of the Diabetes-Specific Assessment Battery, both unpublished batteries developed by the authors to measure self-care behaviors and factors interfering with adherence. In addition, subjects reported their diabetes regimen and the percent of time over the preceding three months they adhered to each component of their regimen. To assess factors affecting adherence, subjects responded to a series of open-ended questions asking them to list reasons for nonadherence, things which made it difficult for subjects to adhere, and places or locations that made adherence difficult. Thus, this study asked subjects to provide a global assessment of reasons for nonadherence using a retrospective design. Results indicated that reasons for nonadherence were similar for individuals with both Type I and Type II diabetes. Individuals experienced the least amount of nonadherence to medication and SMBG regimen areas and the largest amount of nonadherence to exercise and diet regimen areas. The most frequently reported reason for dietary nonadherence was "eating in a restaurant" (p. 171).

Glasgow, McCaul, and Schafer (1987) examined the degree of adherence to each area of the diabetes regimen, consistency of adherence across different regimen areas, and the relationship between adherence and glycemic control in 93 adults with Type I diabetes. Diet adherence was measured using self-report, 24-hour recall interview, and prospective self-monitoring. Total calories consumed and percent calories from fat were compared to subjects' diet prescriptions. Adherence to timing of insulin injections (e.g., 30 minutes prior to meals and number per day) was measured by self-report, as was adherence to blood glucose testing (e.g., number and timing). Daily physical activity was measured using a pedometer, while number of days exercised per week was measured via self-report. Glasgow et al. (1987) found that subjects demonstrated the greatest amount of adherence to insulin injections and blood glucose monitoring, and the least amount of adherence to diet. Measures of exercise and physical activity were unreliable and conflicted with calorie expenditures. Therefore, calculation of adherence scores for these regimen areas were not reported. Results indicated that men were less adherent to their diet than women and men consumed more foods not included on a typical diabetes diet each day than women. Increased duration of diabetes was associated with higher consumption of foods with larger percentage of saturated fats, self-reported poorer diet adherence, and increased daily consumption of foods not included on a typical diabetes diet. Glasgow, McCaul, and Schafer (1987) also found that adherence to one aspect of the diabetes regimen did not predict adherence to other areas of the diabetes regimen.

Orme and Binik (1989) examined the consistency of adherence to weight/control, urine/blood testing, medication taking, symptom reporting, and carrying fast acting sucrose aspects of the diabetes regimen in 227 adult outpatients with diabetes (55 with Type I and 129 with Type II). They compared self-report of adherence to reports by others (i.e., physician, nurse, and significant other). Self-care behaviors were assessed using an adapted questionnaire designed to collect information regarding diabetes self-care behaviors. Health care professional ratings were determined using "an unbroken 10 cm line anchored by 'never' and 'always', and percentage scores were calculated from placement of marks on the lines" (p. 33). Subjects' self-report of carrying a fast acting source of sucrose was confirmed by having the subject show the substance to the interviewer. In addition, measures of physiological status were collected (e.g., glycosylated hemoglobin, fasting blood glucose, and physician ratings of diabetes related complications). Results indicated that adherence to one aspect of the regimen areas assessed was not associated with adherence to other regimen areas. Thus, focusing on diet nonadherence and the factors that precipitate and maintain it appears useful.

Factors Influencing Diet Adherence

Behavioral factors

Several studies have attempted to develop assessment devices aimed at identifying particular behavioral/skill deficits that are hypothesized to lead to regimen non-adherence. Toobert and Glasgow (1991) developed a Diabetes Problem Solving Interview designed to measure Type II diabetic adults' ability to problem solve scenarios involving potential interference in diet, exercise, and/or glucose testing adherence. This interview represents the first diabetes-specific applied problem solving measure applicable to adults. The Diabetes Problem Solving Interview consists of 13 scenarios representing a problematic event which has the potential to lead to nonadherence to either the glucose testing, diet, or exercise components of the diabetes regimen. However, only one of these scenarios deals directly with potential diet nonadherence. Results indicated that adults with Type II diabetes (n = 126) who use behavioral and cognitive strategies to problem-solve scenarios involving diet nonadherence were more likely to be adherent to their diet at the six month follow-up than were similar adults who did not use such strategies (Toobert & Glasgow, 1991). Thus, problem-solving skills appear to have a potential role in facilitating diet adherence.

Glasgow, McCaul, and Schafer (1986) developed the Barriers to Adherence Questionnaire (BAQ) to measure the frequency of environmental and cognitive events that may be obstacles to adherence among individuals with Type I diabetes. BAQ items were generated by two nurse educators and six individuals with Type I diabetes. The original 36 items were rated for frequency and severity with infrequent and less severe items eliminated. The final version of the BAQ consisted of 15 items, four assessing diet barriers, three insulin injection barriers, three exercise barriers, and five SMBG barriers.

The BAQ was administered to 65 subjects with insulin dependent diabetes who ranged in age from 12 to 64 years and had diabetes from 1 to 52 years. Subjects also retrospectively reported their adherence to dietary prescriptions, SMBG, insulin injection, and exercise regimens. During a week-long prospective monitoring period, subjects recorded time, number, and type of insulin injections and blood glucose tests. Twenty-four hour dietary recall interviews collected diet information. Exercise levels were prospectively measured with activity monitors and exercise logs.

Results indicated that BAQ regimen subscores were significantly related to self-reported adherence. Self-monitoring data were less strongly associated with BAQ scores. Monitoring data for SMBG and exercise were more strongly associated with adherence than BAQ scores. None of the diet monitoring data (e.g., calorie and exchange deviations) were significantly related to BAQ scores. Overall, subjects reported the most barriers to diet and exercise regimens.

The BAQ (Glasgow, McCaul, & Schafer, 1986) is notable for being one of the first measures to examine environmental and cognitive events that may affect adherence to the diabetes regimen. However, only four of the items assess the frequency of barriers to diet adherence. Four items may not adequately represent probable antecedent conditions for diet nonadherence.

Gross, Johnson, Wildman, and Mullett (1982) conceptualized regimen nonadherence as the result of a deficit in assertive skills in pre-adolescents with Type I diabetes. They examined the effectiveness of social skills training in five children with Type I diabetes ranging in age from 9 to 12 years old. These children were given the Diabetes Assertion Test (DAT) (Gross & Johnson, 1981) and three separate times to determine baseline measures of verbal and nonverbal behaviors (e.g., eye contact, duration of speech, appropriateness of speech). Following baseline assessment all subjects received five weeks of social skills training (e.g., modeling & role-playing exercises) conducted in a group format. Following training subjects were re-administered the DAT. During the five week follow-up period, subjects and their parents practiced role-playing DAT items. As a measure of in-vivo generalization of social skills all subjects were taken to dinner at a fast-food restaurant (Wendy's). Each child ordered their dinner without being observed by the experimenter or other subjects. While ordering their meal, each subject was prompted twice to buy a milkshake. None of the youth purchased a milkshake.

Results indicated that all subjects improved their eye contact, duration of speech, and appropriateness of speech following social skills training. In addition, generalization to the natural environment indicated that improvement in social skills may improve diet adherence in preadolescents with diabetes.

Stress

Some studies examining the relationship between stress, regimen adherence, and blood glucose control in Type I diabetes have not supported the view that increased stress affects blood glucose by interfering with adherence (Hanson, Henggeler, & Burghen, 1987a, 1987b; Hanson & Pichert, 1986). However, these studies have examined overall regimen adherence. It may be possible that increased stress may affect each regimen area differentially.

Balfour, White, Schiffrin, Dougherty, and Dufresne (1993) examined the relationship between perceived stress, dietary disinhibition, and blood glucose control in 65 girls and young women age 12-27 years old who had Type I diabetes between 1-22 years. Blood glucose control was assessed via HA1C assay. Perceived stress was measured using the Perceived Stress Scale (Cohen, Kamarck, & Mermelstein as cited in Balfour et al., 1993) with the directions modified to coincide with the preceding two months of glycemic control assayed by HA1C. Dietary disinhibition was defined as "the extent to which conscious control over eating was disrupted by emotional and social influences and food cues such as the sight, smell, and tastes of food" (p. 34). Dietary disinhibition was assessed by the Disinhibition subscale of the Three Factor Eating Questionnaire (Stunkard & Messick, 1985 as cited in Balfour et al., 1993).

Results indicated that women who reported moderate to high levels of dietary disinhibition were more likely to have poorer glycemic control when perceived stress was high. Women with low dietary disinhibition did not demonstrate an association between stress and glycemic control. Thus, it appears that some young women who perceive their life to be stressful may respond to the stress by eating which in turn may affect glycemic control. Therefore, it seems reasonable to further examine the relationship between stress, diet adherence, and blood glucose in individuals with diabetes.

Patient Surveys

The following studies interviewed persons with diabetes about their diet behavior in attempts to develop conceptual models that explain diet nonadherence. Maclean (1991) interviewed 34 adults with diabetes who took insulin about their diet self-care behaviors to determine what factors influenced choice to adhere or not adhere to their diet. She argued that people's diet adherence decisions were based upon a choice between either a "pursuit of health" (p. 694) or "compromising their well-being (p.694)". These decisions were influenced by three factors: (1.) individual factors, (2.) diabetes-related factors, and (3.) contextual factors. Development of Maclean's (1991) factors influencing diet self-care behavior decisions were rationally rather than statistically derived and cover a broad range of influences within each factor.

Using a structured interview format inquiring about diabetes regimen behaviors and diet adherence in particular, Schlundt, Rea, Kline, and Pichert (1994) interviewed 26 adults with diabetes (both Type I and Type II) at their regularly scheduled diabetes clinic appointment, recording examples of specific situations that made diet adherence difficult. Subjects generated a total of 86 problem situations. An evaluation of these situations via cluster analysis identified 12 situational description clusters of diet adherence obstacles; negative emotions, resisting temptation, eating out, feeling deprived, time pressure, tempted to relapse, planning, competing priorities, social events, family support, food refusal, and friend's support (Schlundt, Rea, Kline, & Pichert, 1994). In a similar procedure, Schlundt, Pichert, Rea, Puryear, Penha, and Kline (1994) utilized the same structured interview and assessed problem situations that create obstacles to diet adherence in 20 adolescents, age 13 to 19 years, with diabetes attending a two week summer camp for children with diabetes. A cluster analysis of the 57 problem situations identified ten situational description clusters; being tempted to stop trying, negative emotional eating, facing forbidden foods, peer interpersonal conflict, eating at school, social events/holidays, food cravings, snacking when home, alone, or bored, and social pressures to eat (Schlundt, Pichert, Rea, Puryear, Penha, & Kline, 1994). Differences in clusters of problematic situations between the two samples probably reflect developmental differences between adolescents and adults (i.e., eating at school), as well as the difference in lifestyles (i.e., time pressure). Both of these studies have identified cluster descriptions similar to the categories of diet nonadherence in the following descriptions of the MEAL.

Some of the research cited has assumed that an individual with diabetes is nonadherent to her/his diet because of skill deficits (e.g., problem-solving ability, assertive skills, etc.), others focus on stressful events, and others on broader patient reported reasons. As noted above, these skill deficits may contribute to nonadherence in some aspects of the diabetes regimen, but not others. In addition, it may be premature and overly simplistic to assume that people with diabetes are nonadherent to some or all areas of their regimen because of skill deficits. Therefore, it seems prudent to consider a broader range of factors that may contribute to diet nonadherence (e.g., skill deficits, environmental influences, affective states, etc.). The following study (Triplett, 1993a) was conducted to develop a questionnaire addressing these considerations.

The Multiple Eating Antecedent Scale (MEAL; Triplett, 1993a) was developed to assess potential diet nonadherence in persons with diabetes mellitus. Diet nonadherence was hypothesized to result from six antecedent conditions: (1.) mood/stress, (2.) environment, (3.) hunger/craving, (4.) knowledge deficits, (5.) food characteristics, and (6.) social skill deficits. MEAL items were generated by asking individuals with Type I (n = 10) and Type II (n = 10) diabetes to describe recent episodes of diet nonadherence. An episode of diet nonadherence was defined as a discrete, time limited sample of nonadherent behavior. The resulting 63 episodes of diet nonadherence were sorted into a primary antecedent condition by two judges knowledgeable about diabetes. These judges had 100 percent agreement. A second sorting of items was conducted by two additional judges who were relatively naive in diabetes knowledge, but knowledgeable about principles of behavior.

Items were examined to determine the amount of agreement between all judges' categorizations. Items sorted into different antecedent conditions were eliminated. Representative items for each category were selected based upon the frequency they were reported by subjects. Thus, an item was considered appropriate for a given category only if the majority of subjects reporting episodes in that category reported similar incidents of diet nonadherence. Items with similar antecedent themes were combined to form one item. For example, episodes describing eating while reading, studying, and doing paperwork were combined to form one item rather than three separate items.

The final version of the MEAL consisted of 20 items. The number of items for each category of diet nonadherence was determined by comparing the overall frequency of items generated for that category with the total number of items generated during the interview phase. Categories with more episodes of diet nonadherence were considered to represent areas with more diet adherence difficulty. Therefore, to maintain a similar representation of this difficulty in the MEAL, the number of items in each category was determined by the ratio of total episodes of diet nonadherence generated. Thus, the category of environment had the largest number of incidents of diet nonadherence (n = 31) and also had the largest number of items on the MEAL, 10 out of 20. The category of mood/stress had the second largest number of incidents of diet nonadherence (n = 10) and had the second largest number of items on the MEAL, three. The category of hunger/craving had the third largest incidents of diet nonadherence (n = 9) and had three items on the MEAL. The category of social skills had the fourth largest number of incidents of diet nonadherence (n = 6) and had two items on the MEAL. The category of knowledge had the fifth largest number of incidents of diet nonadherence (n = 5) and had two items on the MEAL. The category of food characteristics had the least number of incidents of diet nonadherence (n = 2) and had one item on the MEAL. The order of items was randomly determined. MEAL category scores were calculated by summing all probability ratings for items in each category. Total MEAL score is calculated by summing the category scores.

The MEAL was administered to 24 adults with Type I diabetes and 22 adults with Type II diabetes. Analyses revealed that MEAL scores did not differ by type of diabetes, gender, or method of diabetes treatment (e.g., diet only, hypoglycemic oral agent, or insulin) suggesting that the MEAL is appropriate for use with both Type I and Type II diabetes. Several indices of metabolic control and adherence were significantly correlated with total MEAL score. These included self-reported level of glycemic control ($r = -.42$, $p < .01$), days exercised per week ($r = -.37$, $p < .05$), and body mass index ($r = .32$, $p < .05$). In addition, significant others who were familiar with the subjects' meal plan and eating habits completed the MEAL as a measure of subjects' probable diet nonadherence. Significant others' MEAL score was significantly correlated to subjects' MEAL score ($r = .63$, $p < .001$).

While these preliminary results are promising, additional work is needed to delineate further psychometric properties of the MEAL. The reliability of the MEAL needs to be assessed. Likewise, the MEAL's validity when compared to other measures of adherence to the diabetes regimen has yet to be assessed. In addition, the association between objective measures of glycemic control (e.g., blood glucose or HA1C), diet, and MEAL score requires further investigation.

The purpose of the present study was to further assess the reliability and validity of the MEAL. Specifically, the MEAL's one week test-retest reliability was determined with a group of individuals with Type I and Type II diabetes. The MEAL's convergent validity was determined by comparing MEAL scores to other established measures of diabetes regimen adherence (e.g., Barriers to Adherence Questionnaire; Glasgow, McCaul, & Schafer, 1986). The convergent validity of MEAL category scores were assessed by comparing them to other diabetes-specific measures of daily stress (e.g., Diabetes Daily Hassles Scale; Meisler & Carey, 1991). The MEAL's convergent validity was further explored by comparing MEAL scores to prospective self-monitoring measures of blood glucose, stress, adherence and diet.

The present study used a prospective design to measure food intake, mood/stress, adherence, and blood glucose that minimized reliance on subject recall. Thus, the present study focused on validating total MEAL scores, as well as MEAL category scores (e.g., mood/stress, food characteristics, environment, knowledge, social skills, and hunger/craving). Specifically, it was hypothesized that; (1.) the MEAL should have good one week test-retest reliability, (2.) subjects who report more adherence barriers, especially diet barriers, should have higher MEAL scores, (3.) subjects who report higher levels of daily diabetes hassles should have higher MEAL mood/stress category scores, (4.) subjects who have not received formal diet instruction should be less adherent to their diet regimen, (5.) subjects who report they were more nonadherent on daily monitoring forms should have higher MEAL scores, (6.) subjects with higher MEAL scores should report being less adherent to their diet and consume a diet that does not meet the ADA recommendations, (7.) subjects who have more variance in their blood glucose should be less adherent to their diet and have higher MEAL scores, (8.) subjects who report stress/mood disturbance prior to eating should be less adherent to their diet, and (9.) subjects with higher MEAL mood/stress category scores should also report higher levels of nonadherence on days when they report more stress.

Method

Subjects

Forty individuals with diabetes (20 with Type I diabetes and 20 with Type II diabetes) treated with diet only, oral hypoglycemic agents, or insulin were recruited from University affiliated medical centers, a pool of previous diabetes-related research participants, and through public service radio and television announcements. Individuals responsible for their own diabetes care and who were able to complete the questionnaires participated. Individuals with sensory impairments, histories of dementia, psychosis, and mental retardation were excluded from participation. Subjects ranged in age from 18 to 70 years (M=41.2, SD=13.1). Subjects were paid five dollars for their participation. Two subjects became ill during the study were instructed to stop monitoring and paid for their participation. Their monitoring data were not included in the analysis.

Measures

Measures included the Multiple Eating Antecedent

Scale (MEAL; Triplett, 1993), Barriers to Adherence Questionnaire (BAQ; Glasgow, McCaul, & Schafer, 1986), Diabetes Daily Hassles Scale (DDHS; Meisler & Carey, 1991), Test of Diabetes Knowledge (DKN; Dunn, Bryson, Hoskins, Alford, Handelsman, & Turtle, 1984), and a demographic/health questionnaire. Copies of the measures are presented in Appendix A.

The MEAL (Triplett, 1993a) measures the likelihood of diet nonadherence under specific conditions (i.e., antecedents) by presenting 20 episodes of diet nonadherence and having subjects rate the likelihood of their being nonadherent in that situation, using a 6-point scale where 0 = not likely to 5 = very likely. A frequency rating scale was added to each item such that subjects rated how frequently in the past month they had encountered the same or similar situation. The frequency rating scale and its 6-point scale anchors are presented in Appendix A. Item scores are determined by multiplying the probability rating by the frequency rating. Total MEAL score is determined by summing subject's item scores across all 20 items; scores range from 0 to 500. In addition to total MEAL score, separate scores can be calculated for six categories of diet nonadherence influence: mood/stress, environment, hunger/craving, knowledge, food characteristics, and social skills. The six category scores ranges are as follows: mood/stress (0 - 75), environment (0 - 225), hunger/ craving (0 - 75), knowledge (0 - 50), food characteristics (0 - 25), and social skills (0 - 50).

Preliminary psychometric properties have been established in 46 Type I and Type II subjects with diabetes (Triplett, 1993a). The MEAL was significantly negatively correlated with self-reported glycemic control, indicating that subjects who report better glycemic control report fewer circumstances of potential diet nonadherence (low scores on the MEAL) (Triplett, 1993a). The MEAL also was significantly negatively correlated with self-reported exercise, suggesting that individuals with diabetes who report fewer circumstances of potential diet nonadherence (low scores on the MEAL) are more adherent to their exercise regimen (Triplett, 1993a). In addition, the MEAL was significantly positively correlated with weight and body mass index suggesting that individuals with diabetes who were overweight relative to their height reported more circumstances of potential diet nonadherence (higher MEAL scores) (Triplett, 1993b). Thus, the significant correlations of MEAL score with the aforementioned indices of adherence provide evidence of the MEAL's convergent validity (Triplett, 1993a).

Subjects' significant others, who were familiar with the subjects' meal plan and eating habits, completed the MEAL indicating the likelihood of subjects' potential diet nonadherence. Subjects' MEAL scores were significantly positively correlated with significant-others' MEAL scores, indicating that the MEAL is a preliminary reliable and valid measure of potential diet nonadherence (Triplett, 1993b). Multiple regression analysis revealed that 48% of the variance in subjects' MEAL score was accounted for by significant other MEAL score, self-reported level of glycemic control, number of days exercised per week, and body mass index (Triplett, 1993b). Finally, subjects' MEAL scores did not differ based upon their type of diabetes indicating that the MEAL is appropriate for use in both Type I and Type II diabetes (Triplett, 1993b). Thus, preliminary experience with the MEAL indicated that it possesses enough reliability and validity to warrant additional investigation. In addition to likelihood of engaging in diet nonadherence, subjects were asked to rate the frequency each MEAL item has occurred in the preceding month using the following scale; 0 = never, 1 = once a month, 2 = twice a month, 3 = once a week, 4 = twice a week, 5 = daily. The frequency data was used to further refine scoring and clinical relevance of MEAL items.

The BAQ (Glasgow et al., 1986) is a 15-item measure of the frequency of cognitive and environmental events that may be obstacles to regimen adherence among individuals with Type I and Type II. The BAQ measured potential barriers to insulin injections, SMBG, diet, and exercise aspects of the diabetes regimen. Items were rated on a scale of 1 (very rarely) to 7 (daily). Total BAQ scores were calculated by summing the frequency ratings across all items and range from 15 to 105. Barrier scores for each regimen area were calculated by summing frequency ratings across all items on that regimen area subscale and range from 4 - 28 (diet), 3 - 21 (insulin & exercise), and 5 - 35 (SMBG). The BAQ has a six month test-retest reliability of .71 in a mixed sample of 56 subjects with diabetes (both Type I and Type II) ranging in age from 12 to 64 years of age that had diabetes a minimum of one year (Glasgow et al., 1986). Validity studies have not been published.

The DDHS (Meisler & Carey, 1991) is a 37-item scale designed to assess the severity of daily stressors associated with diabetes. Subjects rated the severity of stress experienced over a variety of activities related to the daily management of diabetes on a 5-point scale from 0 (did not happen) to 5 (extremely severe). Items were summed to produce a score ranging from 0 to 210. The DDHS has high internal consistency (alpha = .92) and strong convergent validity with other measures of stress, adherence, and metabolic control in a mixed sample of 48 diabetic subjects ranging in age from 18 to 65 recruited from an outpatient diabetes clinic (Meisler et al., 1991).

The DKN (Dunn et al., 1984) is a 15-item multiple choice test assessing diabetes knowledge. Of the 15 items composing the DKN, five items addressed the diet regimen. Total scores on the DKN can range from zero to eighteen. The DKN has a reliability coefficient (Cronbach's alpha) of .80. The three parallel forms of the DKN correlate .90 with each other. No validity data have been published. Reliability studies were conducted with 56 adults with diabetes (no age range reported) who attended an outpatient diabetes clinic.

The BAQ, DKN, and the DDHS were selected because they have available reliability data. Much of the questionnaires used to measure diabetes knowledge, rates of adherence, and stress are created for a particular and lack reliability or validity data. This can significantly restrict generalizability of results. Therefore, the aforementioned questionnaires were selected for use in the present study.

The demographics/health questionnaire collected information on general subject characteristics (e.g., age, address, phone number, height, weight), as well as diabetes specific information (e.g., date of diagnosis, method of treatment, length of time from diagnosis to initiation of insulin treatment, etc.) In addition, subjects were asked to indicate the last time they received formal diet instruction and guidelines from a Registered Dietician.

Subjects measured their blood glucose using the One Touch blood glucose reflectance photometer. The One Touch produced a blood glucose reading from a capillary blood specimen. The One Touch meter was capable of detecting errors in subject performance (i.e., not enough or too much blood on the test strip) that can alter the enzymatic reaction on the test strip and will abort the test. This increased the accuracy of blood glucose measurements and decreased the variance in blood glucose readings due to subject error. In addition, to reduce the amount of error in blood glucose measurement introduced by the manufacture of test strips, the One Touch calibrated each vial of test strips electronically by the adjustment of a code number specific to each lot of strips. In tests of reliability across 50 trials, the One Touch meter correlated .99 with laboratory reference measures of blood glucose (ECRI, 1988). When compared to a laboratory reference value, the One Touch produced an average error rate of less than 15% across two ranges of blood glucose, 83 - 300 mg/Dl and 300 - 620 mg/Dl (ECRI, 1988). Thus, the One Touch meter appeared to be accurate across a wide range of blood glucose. The One Touch meter also has an automatic memory which stores up to 250 blood glucose measurements. This allows the accuracy of subject blood glucose monitoring records to be compared to memory entries.

Procedure

After giving informed consent, subjects completed the aforementioned questionnaires. A venous blood sample was obtained for assay of glycosylated hemoglobin (HA1C). Subjects who signed a written release and provided their physician's address had their HA1C results forwarded to their physician.

Subjects were then instructed in blood glucose self-monitoring procedures using a reflectance meter with memory (One Touch: Lifescan, Inc., Milpitas, CA) .

Following SMBG instruction, subjects performed blood tests until they had demonstrated reliable technique by producing three consecutive tests within 5%. Subjects were told the blood glucose meters had an automatic memory and that their SMBG records would be compared to memory entries at the conclusion of data collection. Subjects were provided with lancets, testing strips, alcohol swabs, and a One Touch reflectance meter with memory for the four day monitoring period. Subjects tested and recorded their blood glucose four times per day prior to breakfast, lunch, dinner, and bedtime. Upon completion of the four day monitoring period, subjects' blood glucose monitoring records were checked for accuracy by comparing them to blood glucose values in the meter's memory. If discrepancies were noted, blood glucose values in memory were used for data analysis. Meters were cleaned, checked for accuracy of electronic calibration, and checked for accuracy of each vial of test strips using control solution prior to use by each subject. These cleaning and calibration procedures were performed to the specifications described in the One Touch Owner's Manual.

Subjects were instructed to complete a diet log for four days, recording everything they ate or drank.

Two of these days were weekend days and two were weekdays. In addition, subjects were asked to respond to the following questions at the end of each day: (1.) Was your diet today an example of how you usually eat? (yes or no), (2.) On a scale of one to ten rate your level of adherence today (where 1 = 100% adherence and 10 = 0% adherence). Prior to consuming any food, subjects rated their stress level on a ten point scale where 1 = "no stress" and 10 = "most stress ever felt." Following each consumption of food, subjects indicated whether any food consumption resulted from craving or excessive hunger by circling that food item on their food log.

To determine subjects' accuracy in estimating portion sizes, subjects estimated portion sizes of two sample meals prior to initiation of data collection. These sample meals consisted of real food models in predetermined portion sizes, as well as pictures of food presented on a plate ready for consumption. Subjects were asked to estimate the portion size of various food items via a multiple choice format. No individuals failed to accurately estimate portion sizes on two sample meals. Therefore, no one was eliminated from further participation in the study based upon portion size estimation ability.

Upon completion of the home monitoring data collection phase, subjects were again required to demonstrate accuracy and reliability in portion size estimation and SMBG to the aforementioned reliability criteria. Subjects completed the MEAL a second time following the monitoring period, 7 to 10 days after their first session. Subjects returned their monitoring forms and meters and were paid for their participation at the end of monitoring. Forms are located in Appendix B.

Results

Means and standard deviations for demographic variables and questionnaire scores were calculated for the entire sample (n=40). These are reported in Tables 1 and 2. A series of two-tailed t-tests were computed to determine if subjects differed by type of diabetes. Results of these calculations revealed that groups differed on the following variables: age ($t(38) = -3.61$, $p < .001$), duration of diabetes ($t(38) = 2.92$, $p < .01$), DKN score ($t(38) = 3.97$, $p < .001$), and method of treatment ($t(38) = 5.60$, $p < .001$). Subjects with Type I diabetes were younger, had diabetes longer, knew more about diabetes, and were more likely treated with insulin than subjects with Type II diabetes. The sample did not differ significantly on any demographic or diabetes related variables by gender.

Total MEAL score and MEAL category score reliability coefficients are reported in Table 3. The MEAL seven day test-retest reliability was calculated and determined to be significant ($r=.70$, $p<.001$) as hypothesized. (#1) All MEAL category scores' seven day test-retest reliability calculations were significant as well (environment $r=.74$, $p<.001$; food characteristics $r=.56$, $p<.001$; hunger/craving $r=.71$, $p<.001$; diabetes knowledge $r=.62$, $p<.001$; social skills $r=.60$, $p<.001$ and mood/stress $r=.44$, $p<.01$). A series of two-tailed t-tests were calculated to determine if MEAL total and category scores differed by either gender or type of diabetes. None of these t-tests were significant. Thus, MEAL scores did not differ by gender or type of diabetes.

MEAL convergent validity was examined via a series of Pearson Product-Moment correlation coefficients calculated to determine the strength of association between total and category MEAL scores and various established diabetes-specific questionnaires (hypotheses #2,#3). These are reported in Table 4. Total MEAL score was positively, although not significantly, correlated with total score ($r=.20$) and diet subscore ($r=.23$) of the BAQ. Mood/stress MEAL category score was significantly positively correlated to DDHS score ($r=.41$, $p<.05$) indicating that subjects who reported high levels of diabetes specific stressors on the DDHS also had high Mood/Stress category scores on the MEAL.

Data were divided into those subjects who had received formal instruction from a Registered Dietician (n=30) and those who had not (n=8). A series of two-tailed t-tests were computed to determine if subjects differed on MEAL score, daily adherence rating, blood glucose, and total calories consumed by formal diet instruction (hypothesis #4). Results indicated that those who had received formal instruction by a Registered Dietician differed significantly on mean blood glucose ($t(36)= -2.95$, $p<.05$), total MEAL score prior to monitoring ($t(36)=2.13$, $p<.05$), and deviation from ADA recommendations for daily percent calories from carbohydrate ($t(36) = -2.16$, $p<.05$). A trend toward statistical significance was noted on deviation from ADA recommendations for daily percent calories from fat ($t(36)=1.96$, $p=.058$). Subjects who had received formal diet instruction had a mean blood glucose of 171.0 mg/Dl (SD=58.9), pre-monitoring total MEAL score of 45.9 (SD=35.6), and 14.5 % (SD=12.3) deviation in daily calories from carbohydrates.

Subjects who had not received formal diet instruction had a mean blood glucose of 135.7 mg/Dl (SD=15.1), pre-monitoring total MEAL score of 72.9 (SD=24.1), and 3.9% (SD=12.2) deviation in daily calories from carbohydrate. Thus, subjects who had received formal instruction from a Registered Dietician had lower mean blood glucose, ate fewer calories from carbohydrates and tended to eat more calories from fat during monitoring. They had higher MEAL scores prior to monitoring as well.

Convergent validity of the MEAL was further examined by computing a series of Pearson Product-Moment correlation coefficients between MEAL scores and subjects' prospective self-monitoring data. Subjects recorded self-monitoring data for four consecutive days, two weekdays and two weekend days. For the purposes of the present study, the data were collapsed and compared across all four days of monitoring. Future analyses will examine differences between weekdays and weekend days. Mean daily adherence ratings were significantly positively correlated with post-monitoring total MEAL score ($r=.49$, $p<.01$) indicating that subjects who reported more diet nonadherence during monitoring had higher MEAL scores following the monitoring period (hypotheses #5). Mean daily adherence ratings correlation with pre-monitoring total MEAL score approached significance ($r=.32$, $p=.057$) indicating a trend toward subjects with more diet nonadherence during monitoring having higher pre-monitoring MEAL scores.

Total calories consumed during monitoring was not significantly correlated with total MEAL score. Subjects' diet data were analyzed for percent calories consumed from protein, fat, and carbohydrate (hypothesis #6). These percentages were compared to those recommended by the American Diabetes Association (ADA) (1986) for people with diabetes (i.e., protein 10%, fat 30%, and carbohydrate 60%). Deviation scores were calculated to determine daily differences between percentages on diet logs and those recommended by the ADA. None of these deviation scores were significantly correlated to total MEAL score.

A series of Pearson Product-Moment correlations were calculated to determine the strength of association between MEAL category scores and subjects' deviation from ADA diet recommends for fat, protein, and carbohydrate. Pre-monitoring MEAL Social Skills category score was significantly negatively correlated to carbohydrate percent deviation ($r=-.48$, $p<.01$) indicating that subjects who had higher MEAL Social

Skills category scores prior to monitoring had less percent deviation in calories consumed from carbohydrate. Pre-monitoring MEAL Social Skills category score was significantly positively correlated to fat percent deviation ($r=.47$, $p<.01$) indicating subjects who had higher MEAL Social Skills category scores prior to monitoring had higher percent deviation in calories consumed from fat. Pre-monitoring MEAL Food Characteristics category score was significantly positively correlated with fat percent deviation ($r=.38$, $p<.05$) indicating that subjects who had higher MEAL Food Characteristics category scores prior to monitoring had more percent deviation in calories consumed from fat.

A series of two-tailed t-tests were calculated to determine if men and women differed on total calories consumed, deviation from ADA daily recommendations of percent protein, fat and carbohydrate. None of these t-tests were significant. However, a trend toward statistical significance was noted on mean calories consumed. Men tended to eat more calories on average than women ($t(36)=1.92$, $p=.058$).

Mean blood glucose across the four days of monitoring was significantly positively correlated with total MEAL post-monitoring score ($r=.40$, $p<.05$), indicating subjects with higher mean blood glucose during monitoring had higher MEAL scores (less diet adherence) at the conclusion of monitoring (hypothesis #7). In order to maximize the variability in blood glucose monitoring data, correlations between mean and maximum blood glucose range and MEAL scores were calculated (hypothesis #7). These did not reach statistical significance.

Subjects' who did not report mood/stress related diet nonadherence (n=29) were identified based on their MEAL mood/stress category score ($\leq$14). These subjects' MEAL mood/stress category score was not significantly correlated with daily adherence ratings, blood glucose and stress ratings as predicted. (hypothesis #9).

A multivariate mixed design ANOVA of Day (high stress versus low stress) X Stress (responders versus nonresponders based on MEAL mood/stress category score) with one within subjects measure (Day) was calculated with adherence, blood glucose, and total calories as dependent variables. There were no main effects of Day and Stress based on MEAL mood/stress category score. In addition, there were no interaction effects. However, a trend toward statistical significance was noted for total calories consumed on low stress versus high stress days. Subjects tended to eat more calories on low stress days ($F(1,30)=3.85$, $p=.059$) (hypothesis #9).

A subsample of participants (n=24) had venous blood assayed for glycosylated hemoglobin (HA1C). A series of Pearson Product-Moment correlation coefficients were calculated to determine the relation between an objective measure of relatively long-term glycemic control and questionnaire scores. Total MEAL score was the only questionnaire of those utilized that was significantly positively correlated with HA1C ($r=.42$, $p<.05$), indicating subjects with higher MEAL scores were in poorer glycemic control.

Discussion

Results of the MEAL's total score test-retest reliability indicated that MEAL scores are stable across a seven to ten day time period. Thus, the MEAL appears to be a consistent measure of potential diet nonadherence in persons with diabetes. These reliability results are even more impressive given that subjects monitored their diet and blood glucose during the interval between completion of the MEAL a second time. Subjects had five days of data reflecting their food consumption and its relation to blood glucose, stress and hunger/craving. Awareness of these relations (i.e., how certain foods or stress levels affected blood glucose; food consumption patterns while dining in a restaurant) could have easily impacted diet nonadherence following monitoring. Of equal note is the stability of the MEAL category scores across the same seven to ten day period. This category and total score stability indicates that MEAL items describe episodes of diet nonadherence that are representative of diet nonadherence occurring in-vivo and are not influenced by concurrent self-monitoring data that might influence subjects' ratings. Thus, the MEAL appears to be a reliable measure of potential diet nonadherence in people with diabetes.

Examination of individual MEAL reliability coefficients indicates that three of them were in the .70 to .80 range (i.e., total, environment, and hunger/craving). These MEAL scores (total and category) appear to have good reliability. These results are not surprising given the composition of the items comprising these categories. Situations in which environmental contingencies such as eating in a restaurant appear to consistently produce diet nonadherence in the majority of individuals with diabetes in the current study as well as earlier studies (Ary et al., 1986). Hunger serves as a physiological cue to eat in people without diabetes and hunger's ability to cue eating behavior is no different for individuals with diabetes.

The remaining MEAL categories' reliability coefficients range from .44 to .62. Diabetes Knowledge (r=.62) and Social Skills (r=.60) are relatively stable traits in that they are not changed without an intervention aimed specifically to address them. Therefore, MEAL Knowledge and Social Skill category scores would be expected to remain stable across administrations of the MEAL unless an intervention aimed at correcting these deficits were initiated. The single MEAL item comprising the Food Characteristics (r=.56) category specifically addresses a food item that is selected based on it being less expensive than a comparison item. Given the specificity of this comparison it would be expected that the Food Characteristics item would have adequate reliability. The Mood/Stress reliability coefficient (r=.44) may be lower due to the dynamic characteristics of the construct of stress and mood. Wording of MEAL items do not specify the type or reasons for feeling "stressed" and refer to mood changes as "upset." These types of nonspecific descriptions allow for the person completing the MEAL to provide an individualized definition for "stressed" and "upset" that may fluctuate based on the individuals recent experiences. Therefore, it is not surprising that the Mood/Stress reliability coefficient is .44.

While the above MEAL test-retest reliability data are encouraging, test-retest reliability covering a longer period of time needs to be examined if the MEAL will be used to assess the effectiveness of treatment interventions aimed at diet nonadherence. Based on the significant positive correlation between total MEAL score and HA1C, MEAL scores would be expected to remain stable across a minimum of four months, the time frame of glycemic control measured by HA1C. However, MEAL scores may vary when measures of test-retest reliability approach one year due to the likelihood of the person with diabetes experiencing a diabetes-related complication or change in treatment regimen (i.e., severe hypoglycemia, hyperglycemia, initiating insulin treatment, retinopathy, neuropathy, and nephropathy). These types of experiences are typically associated with a renewed attempt to improve glycemic control by increasing adherence across all areas of the diabetes regimen including diet (Foster, 1994). During early development of the MEAL, subjects reported significant improvements in their diet adherence following initiation of insulin treatment and the initial diagnosis of diabetes-related complications (Triplett, 1993a). In addition, the impact of environmental antecedents to diet nonadherence may fluctuate based on the coping behavior repertoire of the individual with diabetes. If individuals increase their coping behavior repertoire (i.e., increase assertiveness, receive diet instruction, increase in social support), their ability to adhere to the diabetes diet may increase while their MEAL score decreases. The strength of environmental antecedents to impact diet adherence may vary based on the frequency of their occurrence as well. If antecedents to diet nonadherence are occurring less frequently, then their ability to disrupt diet adherence may be diminished. Therefore, MEAL scores may vary based on the coping behavior of the individual with diabetes as well as the frequency and impact of environmental antecedents to diet nonadherence.

The tendency of post-monitoring MEAL scores to more often be correlated with monitoring data is an interesting pattern. Prior to monitoring, subjects' perceptions of their diet adherence were based on retrospective self-analysis of their behavior over the course of their diabetes. Following monitoring, subjects' perceptions of their diet adherence were more likely based upon their actual adherence during the monitoring period. Therefore, subjects' scores on the MEAL following monitoring may have been influenced by recent self-monitoring data.

The MEAL's convergent validity was demonstrated by its significant positive correlation with HA1C. Subjects with higher HA1C by definition had a recent history (i.e., 120 days) of elevated blood glucose which may be attributed to diet nonadherence. The significant correlation with the MEAL suggests that it is able to measure factors (diet nonadherence) contributing to elevations in HA1C. This ability of the MEAL to measure factors contributing to poor glycemic control has direct clinical significance such as identifying the need for referral to dieticians, diabetes educators, and psychologists to address behavioral deficits that may lead to diet nonadherence. The MEAL was the only questionnaire significantly correlated with HA1C. This implies that the MEAL measures factors contributing to glycemic control more directly than the established diabetes questionnaires used in this study (e.g., DKN, DDHS, and BAQ).

The lack of a significant correlation between MEAL score and BAQ score may have been due to a number of reasons. First, the BAQ measures adherence to all areas of the diabetes regimen. As Glasgow, McCaul et al. (1987) noted, adherence to one area of the diabetes regimen does not predict adherence to other areas of the diabetes regimen. Therefore, individuals with poor diet adherence would not necessarily have poor adherence to medication, exercise and SMBG. Second, the BAQ diet subscore is composed of only four items. The limited number of items and the specificity of content (e.g., family member nagging about diet) may have limited ability to capture reasons for diet nonadherence. Finally, in the original development of the BAQ, none of the diet monitoring data were significantly related to BAQ score (Glasgow, McCaul, & Shafer, 1986). Thus, it should not be considered deleterious to the validity of the MEAL that MEAL scores, although positively correlated to both BAQ and BAQ diet subscore, did not reach statistically significant associations.

Individuals who had received diet instruction from a Registered Dietician had lower blood glucose, ate less than the ADA recommended 60% of total calories from carbohydrate, tended to eat more than the 30% of total calories from fat, and had higher MEAL scores prior to monitoring than individuals who had not received formal diet instruction. These individuals' perceptions regarding their diet nonadherence were reflected in their MEAL scores and verified by their prospective diet monitoring data. Thus, the MEAL appeared to accurately measure these participants' potential and frequency of diet nonadherence. The pattern of their diet nonadherence (i.e., fewer calories from carbohydrate and a tendency to eat more calories from fat) may partially account for their lower blood glucose. The amount of available glucose from fat is minimal and has a limited ability to raise blood glucose once it has been digested (Rizza, 1985). The amount of available glucose from carbohydrate is much higher than fat and can create significant elevations in blood glucose rather quickly depending on the type of glucose contained in the carbohydrate (e.g., sucrose, fructose, maltose, lactose, etc.) (Rizza, 1985). Therefore, these subjects had lower blood glucose in part because their diet consisted of fewer carbohydrates and more fat. In addition, these subjects could have been increasing the amount of exercise or medication to achieve a reduction in blood glucose.

The indication that subjects who receive formal diet instruction from a Registered Dietician are less adherent to their diet can be explained by several possibilities. First, many of these subjects reported only one instructional evaluation from a dietician. The majority of these dietary evaluations occurred at the time subjects were diagnosed and for some of these subjects that was several years ago. Of the thirty subjects who had received formal diet instruction, only six had received instruction within the last two years. Therefore, the majority of subjects' formal knowledge of their diet regimen was dated. The six subjects who had recently received formal diet instruction within the last two years may have been referred for instruction for a number of reasons; pregnancy, recent diagnosis of nephropathy necessitating diet changes (e.g., low protein), and recent episodes of nonadherence related to their treating physician. Their experience with how particular foods affect their blood glucose may have lead some subjects to modify their eating patterns to match the individualized variation in blood glucose created by either specific foods or classes of foods (e.g., protein, fat, carbohydrate). Finally, the number of individuals in the group that had not received diet instruction from a Registered Dietician may have not been large enough to detect any differences. Regardless of the reasons for their diet nonadherence, subjects who had received formal instruction by a Registered Dietician were less adherent to the carbohydrate and fat recommendations and reported more potential diet nonadherence and encountered more situations of diet nonadherence as reflected in their MEAL score.

The convergent validity of the MEAL Mood/Stress category was demonstrated by its significant positive correlation with DDHS. Subjects who reported more daily hassles/stressors specific to diabetes also reported higher potential diet nonadherence in response to changes in mood/stress. Individuals experiencing increased global stress specifically related to their diabetes, as measured by the DDHS, may be at risk for diet nonadherence. The MEAL appears to accurately measure Mood/Stress related diet nonadherence in individuals with diabetes reporting increased stress specific to diabetes.

The lack of significant correlation between MEAL Mood/Stress category score and stress ratings during monitoring and the inability to detect differences in adherence, blood glucose, and total calories based on high versus low stress days and MEAL Mood/Stress category score may have been due to several reasons. First, stress ratings relied on subjective self-report.

Subjects may have altered their ratings to make them more socially desirable (i.e., report less stress). Second, the 10 point Likert-type scale may not have been sensitive enough to accurately capture subjects' stress levels. It had only two points with descriptive anchors. These points were both extreme ratings (i.e., one and ten). Thus, subjects may have been influenced to rate their answers closer to the lowest number (i.e., one) with the most socially desirable anchor (e.g., "no stress" versus "the most stress you've ever felt"). Third, stress levels during the monitoring period may not have been very high, creating low overall stress ratings (M=3.1, SD ±1.2; range=1.6 to 5.7). The association between MEAL Mood/Stress category score and subjective stress could have been weakened because stress levels during monitoring were low and not representative of the levels of stress which may lead to diet nonadherence. Finally, the lack of significant correlation between MEAL Mood/Stress category score and stress monitoring data may have been due to the frequency with which stress was measured. Subjects were required to rate their stress level prior to consuming any food or drink, requiring several ratings each day of monitoring. The number of stress ratings varied between subjects ranging from two to nine per day, as well as within subjects depending on the amount of food and drink consumed on a particular day of monitoring. This repeated rating of stress level may have diluted its level of intensity and been influenced by subjects' remembering previous ratings. Other research that utilizes prospective monitoring of subjective stress levels requires subjects to rate their stress at the same time each day without any variance in the number of required ratings (maximum of four times per day) (Goetsch, Wiebe, Veltum, & Van Dorsten, 1990; Goetsch, Abel, & Pope, 1994). In order to capture stress related diet nonadherence, it may be more useful to measure subjective levels of stress associated with episodes of diet nonadherence rather than prior to any consumption of food.

The MEAL's convergent validity was demonstrated by its significant positive correlation with mean blood glucose and daily adherence ratings across the four days of monitoring. The prospective design of this study allows statements to be made regarding actual behavior rather than retrospective recall of behavior. Thus, individuals who reported greater diet nonadherence during monitoring had higher MEAL scores. In addition, blood glucose was significantly positively correlated with MEAL score. One reason for elevated blood glucose is poor diet adherence. Thus, individuals with increased blood glucose may have had increased diet nonadherence that was reflected in increased MEAL scores. These results reflect the MEAL's ability to accurately measure potential diet nonadherence.

Two of the MEAL category scores, Social Skills and Food Characteristics, correlated significantly with percent deviation from calories consumed by fat and carbohydrate. Subjects who had higher MEAL Social Skills category scores consumed more calories from fat and fewer calories from carbohydrate when compared to ADA diet recommendations. Similarly, subjects who had higher MEAL Food Characteristics category scores ate more calories from fat than recommended by the ADA. Thus, subjects who have social skill deficits, such as lack of assertiveness, may have difficulty refusing foods high in fat when offered by others (i.e., dining in a restaurant or with friends/family). Thus, the MEAL appears to measure diet nonadherence that is influenced by the characteristics of the food (i.e., fat content) and social skill deficits (i.e., lack of assertiveness).

Despite the fact that MEAL score correlated significantly with HA1C, daily adherence ratings, and mean blood glucose, it did not correlate with diet monitoring data. The lack of significant correlation between total MEAL score and total calories consumed during monitoring, as well as diet deviation scores may be due to a number of reasons. First, the accuracy of subjects' diet logs may not have been adequate to capture the level of diet nonadherence. Subjects may not have recorded all food consumed, thereby excluding episodes of diet nonadherence. To increase the accuracy of diet logs, it may be useful to have a significant other who has observed the person with diabetes eating to complete a diet log and compare the entries, or utilize direct observation of eating by videotaping subjects eating or have an objective researcher complete the diet log. Second, subjects estimated the portion sizes of their food rather than using standard measuring cups/spoons or scales. This may increase the accuracy of diet logs and increase the likelihood of detecting diet nonadherence. Third, the portion size estimation reliability tests utilized may not have been sensitive enough to detect subjects who were not accurate in their portion size estimations. If subjects under-estimated the portion sizes of their food, diet logs would not accurately reflect their level of diet nonadherence. Finally, a lack of significant correlation between deviation scores and total MEAL score may be due to the lack of specificity in the percent deviation measurement. Perhaps percent deviation is not a sensitive enough measure to accurately detect diet nonadherence. Comparing subject diet logs to a diet prescription specifically designed for each subject may more accurately detect diet nonadherence rather than using broad based national guidelines.

Results of the current study, while promising, are limited due to the composition of the sample. The current study employed research subjects who were selected based on their response to advertisements or recruitment posters in a diabetes specialty clinic. Subjects who were more adherent to their diabetes diet may have been more likely to respond, thereby creating a sample with a bias toward increased diet adherence.

Future work needs to elucidate the MEAL's utility with more representative clinical samples presenting to physicians' offices for treatment of their diabetes. Examination of the MEAL's utility within the constraints of the time-limited office visit will help elucidate the practical uses of the MEAL with clinical samples. It would be expected that rates of diet nonadherence may be higher in individuals with diabetes who present for treatment to their physician's office compared to individuals volunteering to participate in a research study. It would also be important to determine if MEAL scores varied as a function of examiner (research clinical psychologist versus physician, diabetes educator, and nurse). It is anticipated that MEAL scores would be stable across examiners. However, individuals with diabetes, like other research participants divulging sensitive information, may minimize their diet nonadherence resulting in lower MEAL scores. This minimization of diet nonadherence by individuals with diabetes should occur equally between examiners who are familiar with the diabetes regimen.

In the current era of managed care, identification of diet nonadherence and its antecedent conditions early in the course of diabetes may help reduce costs associated with poorly controlled diabetes mellitus. The MEAL's ability to measure the impact and frequency of antecedents to diet nonadherence represents a step forward beyond the identification of general, non-specific adherence problems indicated by an elevation in HA1C. The ability to make appropriate referrals based on MEAL category scores to diabetes educators, dieticians, and psychologists represents a substantial cost saving intervention when compared to the cost of a single hospitalization for diabetic ketoacidosis or other diabetes-related complications. For example, higher scores on the MEAL category of Knowledge may necessitate a referral to a diabetes educator for diabetes education. High MEAL category scores on Food Characteristics and Hunger/Craving may require a referral to a Registered Dietician for education, evaluation and development of a prescribed meal plan. Higher MEAL Social Skills, Mood/Stress, and Environment category scores may indicate the need for a referral to a psychologist for assertion training, stress management, and problem-solving skills interventions. Interventions aimed at reducing the impact of antecedents to diet nonadherence may also improve quality of life for individuals with diabetes. In addition, the MEAL could be used to assess the effectiveness of these interventions utilizing a pre-post assessment design.

The current findings, coupled with preliminary psychometric properties of the MEAL (Triplett, 1993b) described earlier, indicate that the MEAL appears to be a reliable and valid measure of antecedents to diet nonadherence and their frequency in people with both Type I and Type II diabetes mellitus. Additional work needs to address the relationship between stress-related diet nonadherence and MEAL total and Mood/Stress category scores, as well as use of the MEAL with clinical populations. Future studies need to address the limits of the current study's diet monitoring methodology mentioned earlier and assess the association between MEAL scores and direct measures of diet adherence (diet monitoring) since these measures were not significantly correlated in the current study. Further refinement of MEAL items should be addressed via item analysis to shorten the MEAL if necessary and factor analysis to refine the number of diet nonadherence antecedent categories. The ability of the MEAL to detect clinically significant changes in diet adherence following diet directed interventions should also be addressed.

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Table 1. Means and standard deviations of demographic variables.

Variable	M	SD
Total Sample		
Education	2 years of college	--
Income	$25,001 to 30,000	--
Type I Subjects:		
Age	34.7 years***	12.4
Duration diabetes	12.4 years**	9.8
Mean BG	181.1 mg/Dl '	66.8
Hemoglobin A1C	10.0	1.9
Type II subjects:		
Age	47.8 years	10.6
Duration diabetes	4.8 years	6.4
Mean BG	147.8 mg/Dl '	35.3
Hemoglobin A1C	9.0	1.9

**$p<.01$

***$p<.001$

Table 2. Means and standard deviations of diabetes specific questionnaire scores.

Variable	M	SD
Type I Subjects:		
BAQ total	38.6	10.8
BAQ diet subscore	3.0	1.1
DDHS	64.8	33.0
DKN	15.5***	1.4
Type II subjects:		
BAQ total	27.1	9.3
BAQ diet subscore	2.6	1.2
DDHS	64.1	26.6
DKN	12.7***	2.8

***$p < .001$

Table 3. Seven day test-retest reliability correlations for total MEAL and category MEAL scores.

	r	p<
total MEAL score	.70	.001
MEAL category scores		
environment	.74	.001
food characteristics	.56	.001
hunger/craving	.71	.001
diabetes knowledge	.62	.001
social skills	.60	.001
mood/stress	.44	.01

Table 4. Correlation coefficients between MEAL scores, established diabetes-specific questionnaires and hemoglobin A1C.

	BAQ total	BAQ diet	DDHS
Total MEAL score			
pre-monitoring	.20	.23	--
post-monitoring	.23	-.03	--
MEAL Mood/Stress			
pre-monitoring			.41*
post-monitoring			.26

*p<.05

Table 5. Mean total and category MEAL scores for entire sample.

	M	SD
Pre-Monitoring MEAL scores		
total	51.97	34.99
Social Skills	3.90	5.53
Environment	18.82	13.68
Food Characteristics	2.45	4.73
Hunger/Craving	9.23	8.71
Mood/Stress	9.28	7.48
Knowledge	8.10	8.66
Post-Monitoring MEAL scores		
total	46.50	38.43
Social Skills	2.56	4.69
Environment	17.17	15.77
Food Characteristics	2.50	4.34
Hunger/Craving	7.56	7.69
Mood/Stress	8.25	9.40
Knowledge	8.47	10.56

Appendix A

Subject Questionnaires

MEAL scoring directions and category item listings

Category Item Listings

Environment: (9 items) 3, 6, 11, 13, 15, 18, 19, 20

Mood/Stress: (3 items) 2, 16, 17

Hunger/Craving: (3 items) 8, 10, 12

Social Skills: (2 items) 5, 7

Knowledge: (2 items) 1, 14

Food Characteristics: (1 item) 4

Scoring Directions

Item Score = Frequency rating X Probability rating

Category Score = Sum of item scores in category

Total Score = Sum of Category Scores

Multiple Eating Antecedent Scale (MEAL)

Read each of the scenarios below. On the scale provided below, rate how likely it is you would eat or do what is described in each of the MEAL items (probability). For each MEAL item, circle the number that best describes how often you have encountered the situation described on the MEAL in the last month (frequency).

1.) Although you did not test your blood glucose, you can tell it is in an acceptable range by the way you feel. You decide your blood glucose can handle some sweets, and you eat a slice of chocolate cake or other dessert.

Probability

0 1 2 3 4 5

0 = not at all likely
5 = definitely would

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

2.) You are feeling either bored or upset (e.g. angry, stressed, sad, overwhelmed, etc.) and eat snack foods or sweets.

Probability

0 1 2 3 4 5

0 = not at all likely
5 = definitely would

2.) (continued)

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

3.) You are dining out with a group of your friends at a restaurant that serves only dessert. You do not want to be the only person not eating, so you order and eat dessert.

Probability

0 1 2 3 4 5

0 = not at all likely
5 = definitely would

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

4.) While shopping at the grocery store, you purchase breaded chicken patties instead of boneless, skinless chicken breasts because the patties are less expensive and you get more of them for your dollar.

Probability

0 1 2 3 4 5

0 = not at all likely
5 = definitely would

4.) (continued)

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

5.) You are dining out at a restaurant and have asked your server for a specific change in the entree or salad (e.g. chicken without sweet n'sour sauce, salad dressing on the side, baked potato without butter or sour cream, etc.). When your food arrives it is not prepared as you requested, but you eat it anyway.

Probability

0 1 2 3 4 5

0 = not at all likely
5 = definitely would

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

6.) While studying, reading, or doing paperwork you eat.

Probability

0 1 2 3 4 5

0 = not at all likely
5 = definitely would

6.) (continued)

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

7.) You are dining out with a group of friends, some know you have diabetes, some do not. The restaurant everyone has agreed to eat at does not have anything available on the menu that fits into your meal plan. Instead of suggesting a different restaurant and calling attention to your diabetes, you go ahead and eat there.

Probability

0 1 2 3 4 5

0 = not at all likely
5 = definitely would

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

8.) While dining out, you eat more food than your meal plan allows because you were still hungry and there was still food on your plate.

Probability

0 1 2 3 4 5

0 = not at all likely
5 = definitely would

8.) (continued)
Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

9.) Some food is sitting on the counter or table in plain sight (e.g. crackers, cookies, candy, etc.). You eat some.

Probability

0 1 2 3 4 5

0 = not at all likely
5 = definitely would

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

10.) Your blood glucose is not low, but you are craving something sweet. You eat something sweet.

Probability

0 1 2 3 4 5

0 = not at all likely
5 = definitely would

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

11.) It's time for dinner, but you do not have anything in the house to eat. You decide to eat at a fast-food restaurant because it is quick and inexpensive. Since you are eating fast-food, you decide to go ahead and eat whatever you want.

Probability

0	1	2	3	4	5

0 = not at all likely
5 = definitely would

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

12.) Whenever there are sweets in the house or you are baking some goodies for other family members, you crave the sweets/goodies and eat some.

Probability

0	1	2	3	4	5

0 = not at all likely
5 = definitely would

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

Page 7, MEAL

13.) While preparing meals for other family members, you snack on the various food items. At mealtime you are full and do not eat.

Probability

0	1	2	3	4	5

0 = not at all likely
5 = definitely would

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

14.) Although you have received instruction regarding your mealplan, you find it confusing and difficult to follow. As a result you do not follow any prescribed diet and eat whatever you like in any quantity you like.

Probability

0	1	2	3	4	5

0 = not at all likely
5 = definitely would

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

Page 8, MEAL

15.) While watching TV or a movie in a theater you eat.

Probability

0	1	2	3	4	5

0 = not at all likely
5 = definitely would

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

16.) You are spending time with family members. You aren't getting along with them and become frustrated and angry. You eat foods that are not on your diet.

Probability

0	1	2	3	4	5

0 = not at all likely
5 = definitely would

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

17.) You are away from home running errand or on your way to an appointment and realize it is time for you to eat. You do not have time to eat at a restaurant with a healthy selection of food. You either go through the drive-through at a fast-food restaurant (eating a burger and french fries) or stop into the nearest convenience store (eating snack foods).

Probability

0	1	2	3	4	5

0 = not at all likely
5 = definitely would

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

18.) Whenever you dine out at a restaurant, you order and eat whatever you want, whether or not it is on your meal plan.

Probability

0	1	2	3	4	5

0 = not at all likely
5 = definitely would

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

19.) You are dining at an all-you-can-eat food bar. You want to get your money's worth so you eat more food than you usually would.

Probability

0	1	2	3	4	5

0 = not at all likely
5 = definitely would

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

20.) You are travelling with a group of friends/ colleagues. When it is time for your meal or snack you eat the food you've brought along. When the group stops for a meal, even though you have already eaten, you eat with your friends/colleagues because you do not want to be the only person not eating.

Probability

0	1	2	3	4	5

0 = not at all likely
5 = definitely would

Frequency

0	1	2	3	4	5
1x/month or less	2-3x/ month	1-2x/ week	3-4x/ week	5-6x/ week	1x or >/day

Health Questionnaire

Subject #________

Name: ________________________________ Gender: M F

Mailing address: ______________________________________

____

Home phone#: ________________ Work#: __________________

Birthdate: __________________ Age: ___________

1.) Circle the highest grade you completed.

Did not complete High School

High School Diploma or GED

Associate Degree (AA or AS)

Bachelor's Degree

Master's Degree

Doctorate Degree

Other: _______________________________________

2.) Circle the annual income range for your household.

Less than $5,000	$30,001 to $35,000
$5,001 to $10,000	$35,001 to $40,000
$10,001 to $15,000	$40,001 to $45,000
$15,001 to $20,000	$45,001 to $50,000
$20,001 to $25,000	$50,001 to $75,000
$25,001 to $30,000	Over $75,001

3.) How long have you had diabetes? ______________

4.) At what age were you diagnosed? ______________

5.) What type of diabetes do you have? (circle one)

Type I   Type II

6.) How is your diabetes treated? (circle one)

diet only   oral hypoglycemic agents   insulin

7.) If currently taking insulin, how long after diagnosis did you start? ______________________

8.) Do you have any diabetes related complications?

YES   NO

If YES, please list. ________________________________

____

____

Please describe how these complications limit your lifestyle.

____

____

____

9.) Please list ALL MEDICATIONS you currently take.

____

____

16.) (a.) Please indicate when you received instructions regarding your diet or mealplan from a Registered Dietician. ________________________

(b.) How often have you received diet instruction from a Registered Dietician? ________________________

(c.) Please indicate the last time you received instructions regarding your diet or mealplan from a Registered Dietician. ________________________

17.) Below, please list the aspects of your diabetes regimen that you have the most difficulty adhering to in order from the most difficult to the least difficult.

blood monitoring   diet   medication   exercise

(most difficult) 1.) ______________________________

2.) ______________________________

3.) ______________________________

(least difficult) 4.) ______________________________

10.) Height: ______________ Weight: __________________

11.) Please circle any additional medical problems you have:

hypertension stroke head injury

visual problems arthritis

other: ______________________________________

12.) How would you rate your level of diabetes control?

(circle one)

1	2	3	4	5	6
very poor	poor	fair	good	moderately good	very good

13.) How many diabetes related hospitalizations have you had in the previous year? ________________________

14.) How many times per day do you take medication to manage your diabetes? _______________________

15.) How many times per week do you exercise? _________

- -

Diabetes Knowledge Scale (DKN)

Please circle the correct answer to each question.

1. In poorly controlled diabetes the blood sugar is:
   a. normal
   b. increased
   c. decreased
   d. I don't know

2. Which one of the following is true?
   a. It doesn't matter if your diabetes is not fully controlled.
   b. It is best to show some sugar in the urine in order to avoid a hypoglycemic (low blood sugar) reaction.
   c. Poor control of diabetes could result in a greater chance of complications later.
   d. I don't know.

3. The normal range for blood glucose is:
   a. 40-60 mg/dl
   b. 70-120 mg/dl
   c. 180-230 mg/dl
   d. I don't know.

4. Butter is mainly:
   a. protein
   b. carbohydrate
   c. fat
   d. mineral and vitamin
   e. I don't know.

5. Rice is mainly:
   a. protein
   b. carbohydrate
   c. fat
   d. mineral and vitamin
   e. I don't know.

6. The presence of ketones in the urine is:
   a. a good sign
   b. a bad sign
   c. a usual finding in diabetes
   d. I don't know

7. Which of the following complications is usually

not associated with diabetes?

a. changes in vision
b. changes in the kidneys
c. changes in the lungs
d. I don't know

8. A diabetic on insulin, who finds his urines are constantly testing brown with Diastix should probably:
   a. stop taking insulin
   b. decrease his/her insulin
   c. increase his/her insulin
   d. I don't know

9. When a diabetic on insulin becomes ill and unable to eat their prescribed diet:
   a. he/she should immediately stop taking his/her insulin
   b. he/she must continue to take the insulin
   c. he/she should use oral medication (pills) instead of insulin
   d. I don't know

10 If you feel the beginnings of a hypoglycemic (low blood sugar) reaction, you should:
   a. immediately take some insulin
   b. immediately lie down and rest
   c. immediately eat or drink something
   d. I don't know

11. You can eat as much as you like of which of the following foods:
   a. apples
   b. chicken bouillon
   c. meat
   d. honey
   e. I don't know

12. A hypoglycemic (low blood sugar) reaction is caused by:
   a. too much insulin
   b. too little insulin
   c. too little exercise
   d. I don't know

In the last three (3) questions, there will be more than one correct answer. Please circle all the answers you think are correct. In each question, only circle ("I don't know") if you have no idea at all.

13. A kilogram is (circle at least two):
    a. a metric unit of weight
    b. equal to 10 pounds
    c. a metric unit of energy
    d. a little more than two pounds
    e. I don't know

14. Two of the following substitutions are wrong. Which are they?
    a. one slice bread = 4 saltines
    b. one egg = 1 oz T-bone steak
    c. 5 oz milk = 5 oz orange juice
    d. three quarters cup cornflakes = one half cup of cooked cereal
    e. I don't know

15. If I don't feel like the egg allowed on my diet for breakfast. I can: (circle at least two)
    a. have extra toast
    b. substitute one quarter cup cottage cheese
    c. have one ounce of cheese instead
    d. forget about it
    e. I don't know

Barriers to Adherence Questionnaire

Read through the following situations and, using the scale below, indicate how often each problem situation occurs for you. It is important that you rate every situation.

How frequently is this situation a problem for you? (Choose one number)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Very rarely	Once per month	Twice per month	Once per week	Twice per week	More than twice per week	Daily

____ 1. It is embarrassing to eat when the people around me are not eating.

____ 2. It is inconvenient to inject my insulin when I am not at home.

____ 3. Bad weather interferes with my regular exercise routine.

____ 4. When my (urine or blood) glucose tests are high my mother (or other family member) wants to know why.

____ 5. I am in the middle of an activity with friends when I realize it is time to have my afternoon snack.

____ 6. On a weekend, it is difficult to get up at the regular time to take my shot.

____ 7. It is too much trouble to write down the results of my urine (or blood) tests.

____ 8. I don't have my urine (or blood) testing materials when it is time to do the testing.

____ 9. I just don't like to exercise.

____ 10. It is easy to make a mistake on the number of food exchanges in a meal.

____ 11. Sometimes I don't draw the proper amount of insulin into the syringe.

____ 12. I feel out of place testing my urine (or blood) at school or work during the day.

____ 13. After eating what I am allowed at a meal, I still feel hungry.

____ 14. It is hard for me to regulate my exercise, because I work or go to school all week long; then I exercise a lot on the weekend.

____ 15. A watch or a clock with a second hand is not available to time my urine (blood) test.

Diabetic Daily Hassles Scale

<u>Directions</u>

Below are a number of hassles related to having diabetes that may have happened to you in the last **TWO MONTHS**. If a hassle did <u>not</u> happen to you in the last two months, circle 0 = Did not happen. If the hassle <u>did</u> happen to you in the last two months, please indicate how severe it was by circling a 1 = Not at all severe to 5 = Extremely severe.

SEVERITY

0	1	2	3	4	5
Did not happen	Not severe at all	Somewhat severe	Moderately severe	Very severe	Extremely severe

1.	Taking injections	0	1	2	3	4	5
2.	Remembering to take insulin or pills	0	1	2	3	4	5
3.	Being offered food you shouldn't eat	0	1	2	3	4	5
4.	Blood sugar testing	0	1	2	3	4	5
5.	Troubling thoughts about your health	0	1	2	3	4	5
6.	Thoughts about death	0	1	2	3	4	5
7.	Low blood sugar	0	1	2	3	4	5
8.	High blood sugar or diabetic coma	0	1	2	3	4	5
9.	Medical bills	0	1	2	3	4	5
10.	Getting adequate medical insurance	0	1	2	3	4	5
11.	Getting adequate life insurance	0	1	2	3	4	5
12.	Scheduling doctors' appointments	0	1	2	3	4	5
13.	Eating when your supposed to	0	1	2	3	4	5
14.	Concerns about getting food in case of low blood sugar	0	1	2	3	4	5
15.	Difficulty finding food you can eat when out	0	1	2	3	4	5
16.	Difficulty adhering to diet	0	1	2	3	4	5
17.	Fear of going to the doctor	0	1	2	3	4	5
18.	Getting enough exercise	0	1	2	3	4	5
19.	Coordinating food and exercise	0	1	2	3	4	5
20.	Coordinating insulin and exercise	0	1	2	3	4	5
21.	Pain or numbness	0	1	2	3	4	5
22.	Trouble with vision	0	1	2	3	4	5
23.	Trouble with sexual functioning	0	1	2	3	4	5
24.	Time spent in hospital	0	1	2	3	4	5
25.	Planning meals and/or snacks	0	1	2	3	4	5
26.	Trouble losing weight	0	1	2	3	4	5
27.	Concerns about family members dealing with your diabetes	0	1	2	3	4	5
28.	Concerns about your children getting diabetes	0	1	2	3	4	5
29.	Feeling tired or run down	0	1	2	3	4	5
30.	Embarrassment due to diabetes	0	1	2	3	4	5
31.	Limitations on your recreational activities	0	1	2	3	4	5
32.	Limitations on your work activities	0	1	2	3	4	5
33.	Feeling thirsty all the time	0	1	2	3	4	5
34.	Having to urinate frequently	0	1	2	3	4	5
35.	Skin irritation or deformity due to injections	0	1	2	3	4	5
36.	Self-doubt or low self-esteem	0	1	2	3	4	5
37.	Concerns about the future	0	1	2	3	4	5

HAVE WE MISSED ANY OF YOUR DIABETIC HASSLES? IF SO WRITE THEM IN BELOW

38.	______________________	0	1	2	3	4	5
39.	______________________	0	1	2	3	4	5
40.	______________________	0	1	2	3	4	5
41.	______________________	0	1	2	3	4	5
42.	______________________	0	1	2	3	4	5

Appendix B

Self-Monitoring Forms

PRE-BREAKFAST BLOOD GLUCOSE LOG

Date ____________________ WEEKEND WEEKDAY

(circle one)

Time ____________________

Blood Glucose ____________________

PRE-LUNCH BLOOD GLUCOSE LOG

Date ____________________ WEEKEND WEEKDAY

(circle one)

Time ____________________

Blood Glucose ____________________

PRE-DINNER BLOOD GLUCOSE LOG

Date ____________________ WEEKEND WEEKDAY

(circle one)

Time ____________________

Blood Glucose ____________________

PORTION SIZE ESTIMATE SCALE
PRE-TEST No. 1 - (MM2/cover)

Select the letter that most closely matches your estimate of the portion sizes of the foods described in each item.

1.) How many ounces (oz.) of orange juice are in the glass in front of you?

A.) 4 oz. B.) 8 oz. C.) 12 oz. D.) 16 oz.

2.) How many cup(s) of rice are on the plate in front of you?

A.) 1/2 - 1 cup B.) 2 - 3 cups

C.) 3 1/2 - 4 cups D.) 5 - 6 cups

3.) How many ounces (oz.) of grilled tuna steak are on the plate?

A.) 1 - 1 1/2 oz. B.) 2 - 2 1/2 oz.

C.) 3 - 4 oz. D.) 7 - 8 oz.

4.) How many cup(s) of steamed potatos are on the plate?

A.) 1/2 - 1 cup B.) 2 - 3 cups

C.) 4 - 5 cups D.) 6 - 6 1/2 cups

PORTION SIZE ESTIMATE SCALE
PRE-TEST No. 2 - (MM3/the menus)

Select the letter that most closely matches your estimate of the portion sizes of the foods described in each item.

1.) How many slices of bread are on the plate?

A.) 2   B.) 1   C.) 3   D.) 2 1/2

2.) How many ounces (oz.) of cheese are on top of both slices of bread?

A.) 2 oz.   B.) 4 oz.   C.) 5 oz.   D.) 6 oz.

3.) What size is the apple in front of you?

A.) 1 whole large   B.) 1 whole small

C.) 1/2 small   D.) 1/2 large

4.) How many ounces (oz.) of orange juice are in the glass?

A.) 4 oz.   B.) 8 oz.   C.) 12 oz.   D.) 16 oz.

PORTION SIZE ESTIMATE SCALE
POST-TEST - (MM4/intro.)

Select the letter that most closely matches your estimate of the portion sizes of the foods described in each item.

1.) How many pieces of bread are on the plate?

A.) 2 B.) 3 C.) 1 D.) 1/2

2.) What is the size of the baked potato in front of you?

A.) small B.) medium C.) large

3.) How many eggs are on top of the potato?

A.) 1 - 2 B.) 3 - 4

C.) 5 - 6 D.) 7 - 8

4.) How many ounces (oz.) of ham are on top of the potato?

A.) 5 - 6 oz. B.) 3 - 4 oz.

C.) 1 - 2 oz. D.) 7 - 8 oz.

5.) How many ounces (oz.) of orange juice are in the glass?

A.) 4 oz. B.) 8 oz. C.) 12 oz. D.) 16 oz.

Date ______________________ **Subject #**__________________

Day of Monitoring _______________ WEEKEND WEEK DAY
(circle one)

DIET LOG

Please write down everything that you eat or drink today from the time you get up until you go to bed. Include drinks of all kinds and everything else you put into your mouth and swallow. Also, specify the amount, how it is prepared, and anything that is added such as butter, margarine, fat, oil, salad dressing, sugar, syrup, etc. Circle any foods or drinks that you consumed due to hunger or craving.

Time & Meal **Food Eaten**

STRESS RATINGS PRIOR TO EATING

Prior to eating anything, rate your level of stress on the scale provided. Each time you eat a meal or snack use a new scale.

Date ____________________ WEEKEND WEEKDAY

(circle one)

Time ______________

Meal ____________________________

1 = no stress 10 = most stress you've ever felt

1 2 3 4 5 6 7 8 9 10

Abstract

The Multiple Eating Antecedent Scale (MEAL) is a behavioral instrument used to measure diet nonadherence in people with diabetes mellitus. The current study was conducted to gather additional reliability and validity indicators of the MEAL. A prospective design was used to measure diet, blood glucose, stress and adherence in 38 adults with both Type I and Type II diabetes mellitus for four consecutive days. Comparisons were made between self-monitoring data and MEAL scores. In addition MEAL category scores were compared to established diabetes-specific questionnaires as a measure of MEAL validity. Results indicated that the MEAL has good one week test-retest reliability and appears to be have good convergent validity with other diabetes-specific questionnaires and some of the self-monitoring data. Diet self-monitoring data and self-reported stress were less strongly associated with MEAL scores. Implications of these findings and directions for future refinement and use of the MEAL are discussed.

APPROVAL OF EXAMINING COMMITTEE

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