Psychometric Properties of the Healthful Eating Belief Scales for Persons at Risk of Diabetes

By: Carolyn L. Blue, PhD, RN, CHES; David G. Marrero, PhD

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Abstract:
Objective: To examine the validity and reliability of Theory of Planned Behavior (TPB) scales for healthful eating for persons at risk for diabetes.
Design: Cross-sectional, using a self-administered questionnaire.
Setting: Community in the Midwest.
Participants: 106 adults who self-identified based on one or more American Diabetes Association diabetes risks.
Variables Measured: Behavioral, normative, and control beliefs; and attitude, subjective norm, perceived behavioral control, and intention to eat a healthful diet.
Analysis: Construct validity was assessed with factor analyses and measurement and structural models using structural equation modeling. Reliability of the scales was assessed with Cronbach alpha and a 2-month test-retest.
Results: Factor analysis loadings were greater than .37. Cronbach alphas for the behavioral, normative, and control belief scales were .80, .91, and .84, respectively. The measurement model revealed that the measures were significant estimates for the TPB constructs, and they fit well as indirect measures of attitude, subjective norm, and perceived behavioral control in predicting intention to eat a healthful diet. Test-retest revealed 2-month stability of the scales.
Conclusions and Implications: Scales for measuring TPB behavioral, normative, and control beliefs were valid and reliable for use with adults at risk for diabetes. Further examination with minority persons is warranted.
Key Words: beliefs, health behavior, behavioral research, diabetes mellitus, theory of planned behavior

Article:

INTRODUCTION

Diabetes mellitus and its complications (heart disease, stroke, hypertension, blindness, kidney disease) are among the leading causes of morbidity and mortality in the United States.[1] In addition to the loss of quality of life, more than $132 billion is spent annually for direct medical care and indirect costs owing to disability, work loss, and premature mortality.[2] Over 11 million adults aged 20 years or older have been diagnosed with diabetes, and 1 million adults will be newly diagnosed with diabetes each year.[3] It is estimated that an additional 5.9 million persons may have undiagnosed diabetes.[3]

Age and genetic factors appear to be important in the etiology of diabetes, but they are not modifiable. However, moderate changes in diet, along with increases in physical activity, have been shown to prevent or delay type 2 diabetes.[4,5] The American Dietetic Association emphasizes that eating practices to achieve health benefits require a lifelong commitment .[6] Despite widespread efforts, in the United States many people continue to make unwise food choices that contribute to the problems of overweight and obesity, as well as to diabetes. Whitehead and Russell emphasize the difficulty of changing a person's behavior and the importance of "selling" the behavior as something palatable and appealing.[7] This idea suggests that understanding beliefs about healthful eating among persons at risk for diabetes may help to develop interventions to change these beliefs as a mechanism for changing dietary behaviors in this population.

Currently no theoretically grounded instruments measure cognitive beliefs surrounding healthful eating for persons at risk for diabetes. Therefore, the purpose of the study was to test the psychometric properties of an instrument to measure the cognitive beliefs of persons at risk for type 2 diabetes with respect to healthful eating.

METHODS

Conceptual framework

The Theory of Planned Behavior (TPB)[8] was the conceptual framework for this study. The TPB is an expectancy-value model with emphasis on attitudes, subjective norms, perceived behavioral control, and intentions directed toward a specific behavior. According to the theory, the best single predictor of a person's behavior is the intention to perform that behavior. Behavioral intentions, which are the immediate antecedents to a behavior, are a function of attitude toward performing the behavior; the subjective norm that expresses the person's perception of whether relevant others think the person should or should not perform the behavior; and perceived behavioral control, or a person's perception of ease or difficulty in carrying out a behavior. Perceived behavioral control is proposed to have both direct and indirect effects on behavior through intention. Attitude, subjective norm, and perceived behavioral control are functions of 3 belief structures: (1) behavioral beliefs (ie, beliefs about the likely outcomes of the behavior weighted by the evaluation of those outcomes), (2) normative beliefs (ie, beliefs about the expectations of important others weighted by the motivation to comply with these expectations), and (3) control beliefs (ie, beliefs about factors that make a behavior easy or difficult, weighted by the perceived power of these factors) .[9]

Setting and sample

Adults who were self-identified as at risk for developing type 2 diabetes based on the American Diabetes Association risk factors (ie, family history of diabetes, overweight, and diabetes during pregnancy),[10] or who had been told they were at risk for diabetes by their health care provider, were recruited from a Midwestern community via posters and newspaper advertisements. Participants had to be 21 years or older and English speaking.

Procedures

After approval from the Institutional Review Board, prospective participants (n = 134) were sent a letter describing the study, volunteer participation, and confidentiality. Subjects were screened for diabetes risk by phone to determine eligibility. The author explained the study to each participant, and questions about the study were answered. Prospective participants were told they would receive a $10 gift card for each completed questionnaire to compensate them for their time. Data were collected using mailed, self-administered questionnaires. Participants were instructed to return the questionnaire in the enclosed addressed, stamped envelope. A second questionnaire was mailed 2 months later to those who returned the first questionnaire (n = 106, 79.1%). Of those respondents, 66 (62.3%) mailed back the second questionnaire. No significant differences were found between those who returned and those who did not return a questionnaire at time 2 on any of the belief measures at time 1 ($F_{(70,35)} = 0.76$, $P > .70$).

Measures

Belief scale development. Items for the behavioral beliefs, normative beliefs, and control beliefs were generated from a qualitative study eliciting beliefs about healthful eating using the content analysis technique of Ajzen and Fishbein.[9,11] This technique involves sampling salient beliefs from a representative population, grouping together similar beliefs, counting the frequency of elicited beliefs, determining the number and kinds of beliefs to be included in modal belief sets, and constructing questionnaire items from the modal belief sets.[11] After approval by Indiana University's Human Subjects Institutional Review Board, salient beliefs about healthful eating were collected by free-response telephone interviews from a subsample of persons enrolled in the Diabetes Prevention Program Outcome Study, an ongoing research study of participants enrolled in the Diabetes Prevention Program .[4] All of the clients interviewed were at least 21 years old, English speaking, had access to a telephone, and had not converted to diabetes. Recruitment of subjects was continued to saturation of qualitative data where no new beliefs were elicited. Saturation of data was reached with 32 subjects who were white (71.9%), black (21.9%), Native American (3.1%), and Hispanic (3.1%).

Subjects were given a definition of healthful eating [12] and examples of recommended healthful foods to ensure the subjects understood the behavior in question. To elicit behavioral beliefs, participants were asked about the behavioral outcome expectancies of advantages (good outcomes) and disadvantages (bad outcomes) of modifying their diet to be healthier. Normative referents were elicited with the question, "Who are those people who would or would not support your eating a healthier diet?" Control factors were elicited with the question, "What would make it easy or difficult for you to eat a healthier diet?" Comparable responses and most frequent responses were grouped together into "modal belief sets." There were 10 modal belief sets of behavioral outcome expectancies, 4 modal belief sets of normative referents, and 10 modal belief sets of control factors.

Content validity of the modal belief sets was established by a review by 5 experts in nutrition, the TPB, and scale development. The experts were asked to (1) examine responses and determine whether or not they supported the belief statements in the modal sets; (2) note whether or not each of the items reflected the appropriate construct; and (3) evaluate the clarity and conciseness of the modal statements that would be used to construct the behavioral, normative, and control belief items. The experts agreed that 97.6% of the 170 belief statements supported the modal belief sets for healthful eating. The experts judged 100% of the items to be relevant or very relevant. Based on the judges' recommendations, the referent "my family members" was separated into "spouse/partner," "children," and "other family members," leaving 6 modal belief sets of normative referents. The 10 outcome expectancies and 10 control factors modal belief sets were retained unchanged.

Behavioral beliefs. The behavioral belief scale was developed from the outcome expectancy modal belief set and included 9 items on outcome expectancies (b) and 9 corresponding items to measure evaluation of the outcomes (e). The stem for the behavioral outcome belief items assessed how likely the stated outcome of healthful eating was to occur with responses from 1 (*very unlikely)* to 5 (*very likely)* (eg, "Eating a healthful diet will improve my overall physical health"). Corresponding outcome evaluation items assessed the value of each outcome, with univalent responses as suggested by Ajzen (personal communication, May 22, 2003) from 1 (*neither good nor bad)* to 5 (*very good* or *very bad*, depending on the valence direction of the outcome) (eg, "Improving my overall physical health is ..."). This deviation from the norm of using bipolar rating scales was done because of the potential confusion or irritation to the respondents and because a bipolar rating scale would most likely result in skewed distribution of scores. For example, why would "improving my health" ever be rated as very bad? Negative items were reverse-scored, so that higher scores indicated a more positive behavioral belief. Each outcome expectancy score was multiplied by its corresponding outcome evaluation item, and the products were summed for a weighted behavioral belief score (1b • e). An average of the product scores resulted in possible scores from 1 to 25, with higher scores indicating more positive behavioral beliefs.

Normative beliefs. The normative belief scale was developed from the normative referents modal belief set and included 6 items on normative belief referents (nb) and 6 for the corresponding motivation to comply with the referents (mc). The stem for the normative referents items assessed referents who have a social influence on the respondent (eg, "My spouse or partner thinks that I ... 1 *definitely should not* to 5 *definitely should* ... eat a healthful diet."). Corresponding items measured the motivation to comply with those referents, with responses from 1 (*not at all*) to 5 (*very much*) (eg, "How strongly do you want to do what your spouse or partner thinks you should do about eating a healthful diet?"). Each normative referent score was multiplied by its corresponding motivation to comply score, and the products were summed for a weighted normative belief score (nb • mc). An average of the product scores resulted in possible scores from 1 to 25, with higher scores indicating stronger social influence or normative beliefs for eating a healthful diet.

Control beliefs. The control belief scale was developed from the control factors modal belief set and included 10 items on control belief factors that may facilitate or impede carrying out the behavior (cf) and 10 corresponding items for control belief power (p). The stem for the control factor assessed agreement with conditions that would make carrying out healthful eating difficult or easy (eg, "I keep healthful foods available"), with responses from 1 (*strongly disagree*) to 5 (*strongly agree*). Corresponding items measured the power of the condition to make healthful eating difficult or easy (eg, "Keeping healthful foods available would

make it easier to eat healthful foods"), with responses from 1 (*strongly disagree*) to 5 (*strongly agree*). Negative items were reverse-scored. Each control factor score was multiplied by its corresponding power of the factor, and the products were summed for a weighted control belief score (cf • p). An average of the product scores resulted in possible scores from 1 to 25, with higher scores indicating stronger belief of control over factors that facilitated or impeded healthful eating.

Attitude. Attitude toward healthful eating, using items developed by Conner, Norman, and Bell,[13] was measured with 6 semantic differential scales ("My eating a healthful diet from now to 2 months from now would be..." *very unpleasant-very pleasant*, *very foolish-very wise*, *very unenjoyable-very enjoyable*, *very bad-very good*, *very unnecessary-very necessary*, *very harmful-very helpful*). All measures were scored from 1 to 5. Scores were averaged for a possible range from 1 to 5, with higher scores indicating a more positive attitude toward eating a healthful diet. Cronbach's alpha for the scale in this study was .80 at time 1 and .81 at time 2.

Subjective norm. Subjective norm was measured by 4 items suggested by Ajzen,[9] using Likert-type scales to rate agreement with the following statements: "It is expected of me that I eat a healthful diet from now to 2 months from now," "Most people who are important to me think I should eat a healthful diet," "When it comes to eating a healthful diet, I want to do what most people who are important to me want me to do," and "The people in my life whose opinions I value eat a healthful diet." All of the measures were scored from 1 (*strongly disagree*) to 5 (*strongly agree*). Scores were averaged for a possible range from 1 to 5, with higher scores indicating greater perceptions of social influence on eating a healthful diet. Cronbach's coefficient alpha for the scale in this study was .77 at time 1 and .80 at time 2.

Perceived behavioral control. Perceived behavioral control was assessed with the 6 items developed by Conner et al,[13] asking the respondent to rate agreement with the following statements: (1) "For me to eat a healthful diet in the future would be. . ." "(1 *very difficult* to 5 *very easy*); (2) I am confident that if I ate a healthful diet I could keep to it" (1 *strongly disagree* to 5 *strongly agree*); (3) "How much control do you feel you have over eating a healthful diet in the future?" (1 *no control* to 5 *complete control*); (4) "I would like to eat a healthful diet but don't really know if I can" (1 *strongly disagree* to 5 *strongly agree*); (5) "Whether I do or do not eat a healthful diet in the future is entirely up to me" (1 *strongly disagree* to 5 *strongly agree*); and (6) "I am confident that I could eat a healthful diet if I wanted to" (1 *strongly disagree* to 5 *strongly agree*). Cronbach's coefficient alpha for the scale in this study was .73 at time 1 and .76 at time 2.

Intention. Intention to eat a healthful diet was assessed with the 3 items adapted from Ajzen[9]: (1) "I intend to eat a healthful diet each day in the next 2 months," with responses from 1 *extremely unlikely* to 5 *extremely likely*; (2) "I will try to eat a healthful diet each day in the next 2 months," with responses from 1 *definitely false* to 5 *definitely true*; and (3) "I plan to eat a healthful diet each day in the next 2 months," with responses from 1 *strongly disagree* to 5 *strongly agree.* The three items will be used as separate measures in the linear structural relations (LISREL) analysis.

The questionnaire contained 69 TPB items, 6 demographic items, 1 item that asked for height in feet and inches, and 1 item that asked for weight in pounds. Height and weight were used to calculate a body mass index for descriptive purposes, because overweight and obesity are risk factors for diabetes. Items for the scales were validated with the Flesch-Kincaid grade level score of 7th grade. The questionnaire takes approximately 20 minutes to complete. Based on the *Dietary Guidelines for Americans*,[14] healthful eating was defined on the questionnaire cover sheet as follows:

A healthful diet refers to foods that we should eat more of and those we should eat in small amounts. Foods to eat more of are fruits and vegetables and whole grain breads and cereals. Foods to eat smaller amounts of are meat, cheese, and fried foods that have a lot of fat and foods that have a lot of sugar such as pies, cakes, and pastries. A healthful diet is balanced so you eat more fruits, vegetables, and grains and less fat and sugar.

Data Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS 12.0 Windows; SPSS Inc., Chicago, IL) program. Descriptive statistics (means, standard deviations, and frequencies) were obtained for all the variables. The amount of missing data was very small (1.4%). Most of the missing data was observed with the normative belief measure, where spouse, children, or people at work did not apply. For missing data, the median score for each subject for each scale was imputed so the scale would have a value and not be biased at a lower score.

Construct validity of the instrument was established by determining the intercorrelations and mutual exclusiveness of the items through factor analysis.[15] Construct validity was examined by principal component factor analysis of each scale. Scree plots were examined for any distinct breaks and trailing off of factors, indicating items that did not correlate with the larger factor. The magnitude of the item correlations was also examined. Items with eigenvalues greater than 1 and factor loadings equal to or greater than .30 were retained. Internal consistency reliability coefficients (Cronbach alpha) and correlations among items were examined to estimate true-score variance.[15] Scales with a Cronbachs alpha of .70 and above are considered acceptable for a new scale. [15]

Construct validity was further tested with examination of the measures as indicators of TPB constructs using the LISREL 8.5 program (Scientific Software International, Lincolnwood, IL, 2000). The measurement (confirmatory factor) model specified the relationships between the unobserved latent variables and the observed variables as indicators of the unobserved latent variable from which they were derived.[16] Based on the TPB, behavioral beliefs, normative beliefs, and control beliefs are expected to be highly correlated with attitude, subjective norm, and perceived behavioral control, respectively. Ajzen stated that the behavioral beliefs are indirect measures for the attitude construct, the normative beliefs are indirect measures for the subjective norm construct, and the control beliefs are indirect measures for perceived behavioral control .[9] Therefore, evidence that both the indirect measures and their corresponding direct measures originate from the same latent constructs provides support for construct validity.

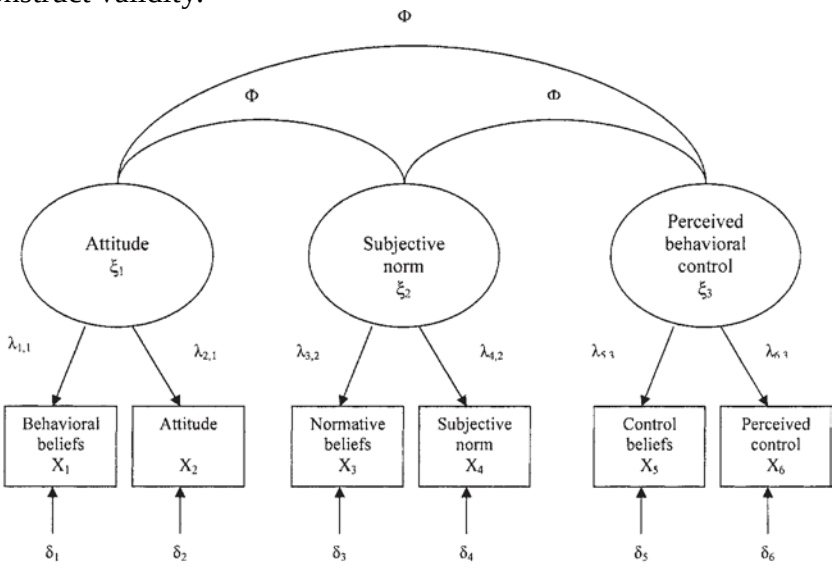

Figure 1. Measurement Model for Theory of Planned Behavior Constructs

The proposed measurement model is in Figure 1. The ovals ( ) denote the constructs, and the rectangles (X) denote the observed variables that are measured with error ( ). Of the 6 X variables, 2 were measures of attitude (behavioral beliefs and attitude), 2 were measures of subjective norm (normative beliefs and subjective norm), and 2 were measures of perceived behavioral control (control beliefs and perceived control). The lambda coefficients (λ) link the constructs to the measured variables. The arrows directed toward the measured variables represent residuals or measurement error. The curved lines represent the covariance between the latent (unobserved) constructs and are denoted by phi ( ).

Construct validity was also assessed by examining the fit between the concepts and measures of the concepts.[17] The TPB proposes that the unobserved latent constructs of attitude, subjective norm, and perceived behavioral control predict intention. A structural model using the belief measures as indirect indicators of each of the exogenous or independent constructs was used to examine this aspect of construct validity. A structural model specified by the TPB was examined with LISREL to determine the relationships among attitude, subjective norm, perceived behavioral control, and intention to eat a healthful diet. The 3 intention scale items were used as separate indicators to estimate measurement properties for intention.

Temporal stability was assessed to determine reliability over time.[15] A subsample of 65 participants who returned the second questionnaire was used to calculate test-retest reliabilities. Total scale scores from time 1 and time 2, 2 months later, were used in the analysis.

RESULTS

Sample Characteristics

The participants (n = 106) were mostly female (68.8%), white (71.9%), and married (71.9%). Their ages ranged from 31 to 71 years and older, with the largest age group from 41 to 50 years old (40.6%). They were well educated, with over half (59.4%) college graduates; 48.4% reported an income of $60,000 and over. Their mean body mass index [BMI = weight (kg)/[height $(m)^2$]][18] was 34.0 kg/m^2.

Validity and Reliability Analyses

Exploratory factor analysis with varimax rotation was done to examine the interrelationships among the items and to determine factors or dimensions of the constructs underlying the items. This analysis revealed 3 factors for the behavioral belief scale, accounting for 75.0% of the cumulative variance, with all items loading at .77 to .90. There was 1 factor for the normative belief scale, accounting for 60.0% of the cumulative variance, with loadings from .61 to .87. The control belief scale had 2 factors, accounting for 55.0% of the variance, with all items loading from .37 to .87. The 2-factor attitude scale had factor loadings from .72 to .96, explaining 74.3% of the variance, and the subjective norm scale had 1 factor, with loadings from .75 to .80, explaining 62.2% variance. The 1-factor perceived control scale had factor loadings from .51 to .81, explaining 49.0% of the variance. The intention scale loaded on 1 factor, explaining 87.2% of the variance. Factor loadings were from .92 to .96. All of the items for the scales were retained for further analysis.

Table 1 shows the item means, standard deviations, and item-total correlations, and Cronbach's alpha coefficients for the behavioral, normative, and control belief scales. The 3 most strongly held beliefs were the positive beliefs about health—that eating a healthful diet would result in improving overall physical health, controlling weight, and delaying or preventing diabetes. The negative behavioral beliefs were least important to the participants. The 2 normative beliefs, my doctor and my spouse or partner, were the most influential to the participants' eating a healthful diet. Keeping healthful foods available, having support from family and others, having time to prepare healthful foods, and planning healthful meals ahead of time were the most important control beliefs.

Item-to-total correlations for the behavioral belief scale were from .48 to .81. The coefficient alphas were all acceptable ($\geq$ .70) for the separate factors and total scales at time 1 and time 2 (see Table 1). Because the definition of behavioral beliefs includes both positive and negative outcome beliefs, the total scale's Cronbach's alpha of .81 was acceptable. The normative belief scale had item-to-total correlations from .49 to .78, and the coefficient alpha reliabilities were acceptable. All 10 control belief items were retained, with item-to-total correlations from .33 to .69 and acceptable alpha coefficients.

Table 2 shows the correlations, means, and standard deviations of the TPB variables used in the LISREL analysis. With the exception of the small correlation between the normative belief and perceived control measures, all of the measures were significantly correlated. In agreement with the TPB, the largest correlations were between the behavioral belief and attitude measures, the normative belief and subjective norm measures, and

the control belief and perceived control measures. All of the belief measures, attitude, subjective norm, and perceived control were significantly correlated with the 3 measures of intention.

T411ble 1, Item Means, Standard Deviations, Item-total Correlations, and Coefficient Alphas for the Scales

Construd	Modal Belief Items	Item Means	Standard Deviations	Item-total Correlations	a* Time 1	a* Time 2
Behavioral beliefs	Total Scale:				.81	.80
	Factor 1: Positive beliefs about health				.89	.80
	Improves my overall physical health	19.83	5.77	0.67		
	Controls my weight	19.59	5.80	0.67		
	Delays or prevents diabetes	19.03	5.55	0.75		
	Factor 2: Positive beliefs about self				.88	.88
	Improves the way I think about myself	18.26	6.19	0.78		
	Improves the way I look	17.96	6.27	0.77		
	Improves my outlook on life	17.29	5.83	0.81		
	Saves money	11.74	6.33	0.48		
	Factor 3: Negative Beliefs				.73	.70
	Is inconvenient	12.35	6.08	0.54		
	Results in being hungry	11.90	5.97	0.56		
	Would make me miss tasty foods I like	10.03	6.12	0.58		
Normative beliefs	My doctor	18.48	5.54	0.60	.86	.91
	My spouse or partner	16.50	5.67	0.49		
	My children	15.03	5.97	0.68		
	My friends	14.28	5.27	0.78		
	Other family members	14.24	5.58	0.77		
	People I work with	12.47	5.24	0.63		
Control beliefs	Total Scale:				.83	.84
	Factor 1				.75	.80
	I keep healthful foods available.	15.75	4.66	0.59		
	I have support for healthful eating from family and others.	13.75	5.77	0.33		
	I have the time to prepare foods that are healthful.	13.33	5.40	0.50		
	I am able to plan meals ahead of time.	13.24	5.77	0.59		
	I am able to keep track of my eating.	11.58	5.62	0.48		
	The cost of healthful foods is not a problem for me.	11.04	7.00	0.36		
	Factor 2				.84	.83
	I am not able to choose healthful foods when eating outside my home	9.90	6.08	0.52		
	I am not able to taste my favorite foods when I eat healthful foods.	9.35	5.77	0.54		
	I lack the will power to eat healthful foods.	7.92	6.48	0.69		
	I find it hard to break eating habits.			0.60		

*Coefficient alpha reliability.

Table 2. Intercorrelations, Means, and Standard Deviations of the Theory of Planned Behavior Variables

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	M (SD)
1. Behavioral beliefs	1.00									15.80(3.60)
2. Normative beliefs	0.38**	1.00								15.17(4.27)
3. Control beliefs	0.38**	0.05	1.00							11.11(3.63)
4. Attitude	0.51**	0.35**	0.36**	1.00						4.15(0.57)
5. Subjective norm	0.24*	0.56**	0.21*	0.44**	1.00					3.43(0.74)
6. Perceived control	0.41**	0.19	0.63**	0.38**	0.35**	1.00				3.76(0.61)
7. Intend to	0.37**	0.38**	0.43**	0.56**	0.50**	0.56**	1.00			3.29(1.05)
8. Will try	0.37**	0.38**	0.41**	0.63**	0.40**	0.47**	0.75**	1.00		3.70(0.85)
9. Plan to	0.34**	0.34**	0.46**	0.63**	0.51**	0.51**	0.79**	0.86**	1.00	3.46(0.92)

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

LISREL estimates of the parameters of the measurement model can be seen in Table 3. The standardized lambda coefficients for the observed variables (measures) ranged from .58 (behavioral belief measure) to .87 (attitude measure). Although both measures were acceptable, the direct measure of subjective norm was a better indicator than the normative belief measure. Both the control belief measure and perceived control measure were good estimates for the perceived behavioral control construct. The *t* values and explained variance (R^2) for the indicators suggest adequate relationships between the latent variables and their indicators. The fit of the measures to the model was good (χ^2 = 34. 1, *P* = 0.02; Standardized Root Mean Square Residual = 0.04; Adjusted Goodness of Fit Index = 0.84; Parsimony Goodness of Fit Index = 0.39).

Figure 2 shows the final structural equation model relating the TPB constructs. The modification indices in the LISREL output suggested correlations between the error terms for the behavioral belief and control belief measures and between the behavioral belief and perceived behavioral control measures. The estimates for the measurement model differed slightly from the initial measurement model to reflect these error term correlations. The direct effects of attitude and perceived behavioral control had the largest influence on intention, although all 3—attitude, subjective norm, and perceived behavioral control—had significant direct effects on intention to eat a healthful diet. Attitude, subjective norm, and perceived behavioral control explained 73% of the variance in intention to eat a healthful diet. The fit of this final model was excellent (χ^2 = 22.4, *P* = 0. 17; Standardized Root Mean Square Residual = 0.03; Adjusted Goodness of Fit Index = 0.88; Parsimony Goodness of Fit Index = 0.45).

Intercorrelations for variables at time 1 and time 2, based on listwise exclusion of missing cases in time 2, were computed. The correlations between behavioral belief (*r* = 0.99, *P* < .01) normative belief (*r* = 1.00, *P* < .01), and control belief (*r* = 1.00, *P* < .01) scale measures at time 1 and time 2 were large and significant, demonstrating excellent test-retest stability of the scales. Paired samples test tables for *t*-test analyses for the normative and control belief measures were not produced because there were no difference in means or standard deviations between time 1 and time 2. Although the behavioral belief measures were highly correlated, paired samples *t*-test analysis for the behavioral belief scales revealed a significant difference between time 1 (*M* = 16.29, *SD* = 3.44) and time 2 (M = 17.02, SD= 3.61), *t*(62) = —10.14,*P*<.01).

Table 3. LISREL Estimates of the Parameters of the Measurement Model for Eating a Healthful Diet

		Latent Variables								
		Attitude			Subjective Norm			Perceived Behavioral Control		
Observed Variables	R^2	Unstd*	Std†	t‡	Unstd*	Std†	t‡	Unstd*	Std†	t‡
Behavioral beliefs	.34	1.00§	.58							
Attitude	.76	.24	.87	5.09						
Normative beliefs	.46				1.00§	.68				
Subjective Norm	.71				.21	.84	5.13			
Control beliefs	.57							1.00§	.76	
Perceived Control	.69							.18	.83	6.40C

*Unstandardized LISREL lambda coefficients.
†Standardized LISREL lambda coefficients.
‡Critical value for t approximately ± 1.96.
§Fixed parameter value.

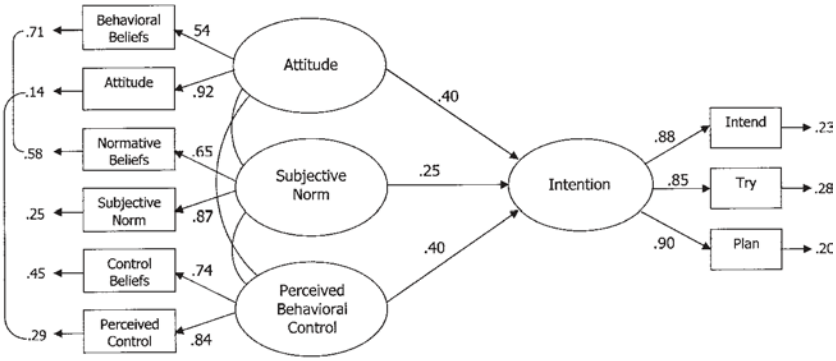

Figure 2. Final Measurement and Structural Model for Healthful Eating

DISCUSSION

The primary purpose of the study was to test the psychometric properties of an instrument to measure the cognitive beliefs of persons at risk for type 2 diabetes with respect to healthful eating. The scales to measure TPB behavioral belief, normative belief, and control belief variables were developed using an open-ended interview and content analysis technique outlined by Ajzen and Fishbein.[9,11] Thus, the scales were grounded in the cognitive beliefs expressed by the target population, which included white, black, Native American, and Hispanic adults who were at risk for developing diabetes.

Overall, there is preliminary evidence that the behavioral, normative, and control belief scales are valid and reliable measures. Factor analyses revealed that the behavioral beliefs, normative beliefs, and control beliefs were mutually exclusive, with acceptable item-to-total correlations and internal consistency reliability coefficients greater than .70.[15] This study thus provides evidence that the behavioral, normative, and control belief scales for eating a healthful diet are reliable and valid measures of their respective latent constructs and the measures are temporally stable.

The study also supports Ajzen's view that the belief-based measures are indirect measures of attitude, subjective norm, and perceived behavioral control latent constructs rather than constructs .[9] Support for this concept was provided by the large correlations of the indirect measures with their respective direct measures of the same construct. Additional support comes from the measurement model using LISREL, which provided evidence that the indirect measures and their corresponding direct measures originated from the same latent constructs.

The finding of correlated error terms between the behavioral belief measure and both the indirect and direct perceived behavioral control measures indicates a need to examine possible overlap among measures. However, the development of measures that uniquely measure each construct may not be possible, because people's beliefs and perceptions do not occur as unique entities; rather, beliefs, such as the positive outcomes of eating a healthful diet, may indeed influence other beliefs, such as having control over factors that promote the behavior.

Another contribution of this research was the directional scaling of the evaluation (value) items corresponding to behavioral beliefs. Generally, other researchers have scaled the evaluation of the outcome items as +1 (*strongly disagree*) to +5 (*strongly agree*).[19] This bidirectional response format would most likely be positively or negatively skewed, depending on the positive or negative direction of the question. In this study, the neutral value of 1 (*neither good nor bad*) and more choices from 2 to 5 for positive (or negative) values added to the variability of responses for each scale item. Future research is needed, however, to explore the impact of scale scoring for the TPB belief evaluation items.

Structural equation modeling in this study revealed that the behavioral belief, normative belief, and control belief scales were satisfactory indirect measures for the attitude, subjective norm, and perceived behavioral control theoretical constructs. The TPB was found to predict intentions to eat a healthful diet in adults at risk for diabetes. The large percentage of explained variance suggests that the TPB provides a good account of determinants of intention to eat a healthful diet. The findings of the present study in relation the TPB endorse previous studies of eating behavior, in that attitude and perceived behavioral control constitute the strongest in-

tentions of healthful eating.[20-24] The lesser importance of subjective norm in this and other studies in explaining intention to eat healthful foods suggests that adults may not be influenced by others' eating behaviors. However, an examination of the individual beliefs in this study reveals that adults at risk for diabetes are somewhat influenced by their doctor, spouse, or partner and that eating a healthful diet becomes easier when there is support from family and others.

IMPLICATIONS FOR PRACTICE AND RESEARCH

There are practical implications from the development of scales to measure the behavioral, normative, and control beliefs of adults at risk for diabetes. Valid and reliable instruments are needed for designing and evaluating nutrition programs that are based on behavioral theories from the social and behavioral sciences.[25] Interventions to promote healthful eating can target the behavioral, normative, and control beliefs that guide behavior to strengthen the positive beliefs and weaken the negative beliefs to help people achieve healthier behaviors. The scales can be used to measure changes in beliefs to better understand the mechanisms of dietary behavior change and metabolic outcomes both at the individual level and the population level.

Further examination of the scales in a sample with lower incomes, less education, and more ethnic diversity is needed. Beliefs may differ among different subgroups of adults who are at risk for diabetes. In addition, cognitive factors that predict intention to eat a healthful diet may differ among population subgroups. Future research should also assess the beliefs of persons at risk for diabetes that predict intention to eat a healthful diet and dietary behaviors.

In conclusion, the behavioral belief, normative belief, and control belief scales for eating a healthful diet appear to be valid and reliable instruments to assess these TPB constructs in persons at risk for diabetes. Health care providers who work with adults who are at risk for diabetes can use the measures to identify beliefs that promote healthful eating and can intervene to strengthen these beliefs to delay or prevent diabetes.

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