The Starr County Diabetes Education Study

Development of the Spanish-language diabetes knowledge questionnaire

ALEXANDRA A. GARCIA, RN, MS
EVANGELINA T. VILLAGOMEZ, MSN, RN, CS, FCCM, CDE
SHARON A. BROWN, PHD, RN, FAAN
KAMIAR KOUZEKANANI, PHD
CRAIG L. HANIS, PHD

OBJECTIVE — This study reports the psychometric properties of the 24-item version of the Diabetes Knowledge Questionnaire (DKQ).

RESEARCH DESIGN AND METHODS — The original 60-item DKQ was administered to 502 adult Mexican-Americans with type 2 diabetes who are part of the Starr County Diabetes Education Study. The sample was composed of 252 participants and 250 support partners. The subjects were randomly assigned to the educational and social support intervention (n = 250) or to the wait-listed control group (n = 252). A shortened 24-item version of the DKQ was derived from the original instrument after data collection was completed. Reliability was assessed by means of Cronbach's coefficient α. To determine validity, differentiation between the experimental and control groups was conducted at baseline and after the educational portion of the intervention.

RESULTS — The 24-item version of the DKQ (DKQ-24) attained a reliability coefficient of 0.78, indicating internal consistency, and showed sensitivity to the intervention, suggesting construct validation.

CONCLUSIONS — The DKQ-24 is a reliable and valid measure of diabetes-related knowledge that is relatively easy to administer to either English or Spanish speakers.

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Although type 2 diabetes is a serious and growing problem in the general U.S. population, affecting nearly 16 million people, it has become a health care crisis among Hispanics and other minority groups (1). Mexican-Americans, the largest Hispanic subgroup, are two to three times as likely to have type 2 diabetes as non-Hispanic whites and are more likely to suffer more serious diabetes complications (2–5). Starr County, TX, a predominantly Mexican-American community situated on the border with Mexico, endures high rates of type 2 diabetes. Half of the adult population of Starr County either has diabetes or is closely related to someone with diabetes (4).

Research has demonstrated that knowledge about medications, diet, exercise, home glucose monitoring, foot care, and treatment modifications is necessary to effectively self-manage diabetes (6–9). Although knowledge alone does not guarantee requisite behavior modifications or effective self-management (10,11), the assessment of diabetes-related knowledge is an important first step from which to individualize diabetes education programs and make evaluations of their effectiveness (12). However, there are few reliable and valid instruments with which to measure outcomes, particularly for individuals who speak a language other than English.

This study reports on psychometric properties of a 24-item version of the Diabetes Knowledge Questionnaire (DKQ-24), derived from the original 60-item version used with Spanish-speaking subjects in the Starr County Diabetes Education Study (1994–1998). The DKQ-24 is a relatively easy-to-use measure of general diabetes knowledge (see APPENDIX). Specifically, reliability, item difficulty and discrimination indexes, and construct validation were assessed.

RESEARCH DESIGN AND METHODS

Setting and sample

The study site, Starr County, TX, one of 14 Texas counties bordering northern Mexico, has been described previously (13–15). Of the population residing in this area, 20% is foreign-born (16). Economically, Starr County is the most impoverished in Texas and one of the poorest in the U.S. In 1990, 55% of individuals >18 years of age lived below the poverty level (16).

The sample was recruited as part of The Starr County Diabetes Education Study (13,14). The 4-year project (1994–1998) focused on delivery and evaluation of a culturally competent community-based intervention consistent with national standards for diabetes care and designed to improve the health of Mexican-Americans with type 2 diabetes and their families. Participants were joined by support individuals—spouses, relatives, or close friends. The intervention consisted of weekly educational sessions for 3 months followed by biweekly support sessions for 6 months, tapering to monthly support sessions for the final 3 months of the intervention. Subjects completed the original 60-item Diabetes

From the University of Texas School of Nursing (A.A.G., S.A.B., K.K.), Austin; the University of Texas Health Science Center, School of Public Health (C.L.H.), Houston, Texas; and Bayer Pharmaceuticals (E.T.V.), San Antonio, Texas.

Address correspondence and reprint requests to Alexandra A. Garcia, RN, MS, 1700 Red River St., Austin, TX 78701. E-mail: alexgarcia@mail.utexas.edu.

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Abbreviations: DKQ, Diabetes Knowledge Questionnaire; DKQ-24, 24-item DKQ.

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

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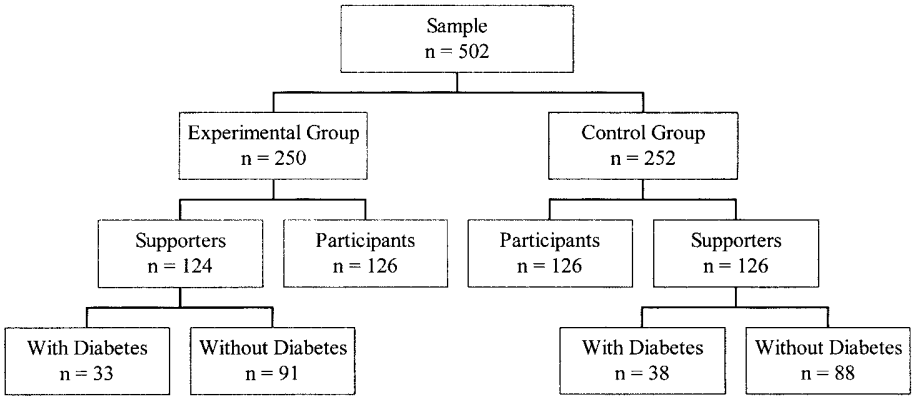

Figure 1—*Distribution of subgroups at baseline.*

Knowledge Questionnaire (DKQ) at baseline, 3 and 12 months, and annually thereafter for the length of the project.

A cohort of 502 Starr County residents, consisting of 252 participants and 250 support partners, formed the study sample. Of the supporters, 71 (28%) also had diabetes. Subjects were randomly assigned to the educational intervention (n = 250) or the 1-year wait-listed control group (n = 252) (Fig. 1).

Participants were *1)* 35–70 years of age, *2)* diagnosed with type 2 diabetes (determined by either two verifiable testing blood sugar test results of ≥140 mg/dl or taking, or have taken, insulin or hypoglycemic agents for at least 1 year in the past), and *3)* willing to participate in a 1-year intervention consisting of educational and support group sessions. The only requirements for support individuals were that they were >18 years of age and willing to attend intervention sessions. The experimental and control groups did not differ significantly on aspects of age or acculturation.

Original 60-item DKQ

The original DKQ is a 60-item instrument developed by Villagomez (17) in association with project investigators (S.A.B., C.L.H.). Items on the instrument, presented both in English and Spanish, were designed to assess overall diabetes knowledge according to content recommendations in the National Standards for Diabetes Patient Education Programs (18). When devising the items, the instruments' authors took into account that the average educational level for Starr County residents was sixth grade and that a large portion of the population was unable to read because of visual impairments or illiteracy. Items were written in simple language to aid translation into the style of Spanish used by this population. Questions were written in a manner that could easily be read aloud to all study participants (17).

The instrument was first translated using regional native and bilingual speakers and licensed translators and was then back-translated for accuracy and clarity. To avoid difficulties previously reported with using Likert-type scales with Mexican-Americans (19), potential response choices for the DKQ were *1)* Yes, *2)* No, and *3)* I don't know. Items were scored as correct or incorrect, and the correct items were summed to attain a total score.

Content validity of the items was established by a panel of experienced nurses and researchers familiar with diabetes-related issues of Mexican-Americans (17). Initial reliability of the 60-item DKQ was established in 1989 with 60 Mexican-Americans with type 2 diabetes who resided in Starr County (r = 0.88) (17).

Procedures

The 60-item DKQ was administered at baseline and after the subjects had completed 12 weekly diabetes education sessions. The DKQ was read to participants in one-to-one interviews in their language of preference, Spanish or English, or a blend common to bilingual speakers along the Texas-Mexico border. Test administrators recorded item responses. Individuals who administered the instrument were bilingual Mexican-American residents of Starr County who were trained specifically on obtaining these knowledge data. Test administration took ~30 min. SPSS 9.0 was used for data entry, manipulation, and analysis.

Besides the DKQ, information was collected on age, sex, time since diagnosis with type 2 diabetes, diabetes treatment, and the participants' levels of acculturation or degree of adaptation to the dominant U.S. culture. Acculturation was measured with a four-item language-based acculturation scale (20).

Development of the 24-item DKQ

After data collection, project investigators derived a shortened version of the DKQ to ease future participant burden. The 60-item DKQ is lengthy, particularly when used in combination with other instruments. The shortened version was created by evaluating each of the item's performance at baseline and 3 months later (i.e., after the intensive educational portion of the intervention and just before beginning the support group sessions). Item performance was measured by item discrimination (item-to-total correlation) and item difficulty (percent of respondents answering the item correctly) and was assessed for the total sample and three subgroups—participants with diabetes, support people with diabetes, and nondiabetic support people. Subjects were grouped into these categories, regardless of their membership in experimental or control groups, to assess the consistency of the psychometric properties of the DKQ-24 among subsamples.

As a general rule, items were included in the 24-item version if they maintained item-to-total correlations ≥0.25. However, some items that did not meet this criterion were retained if the items *1)* reflected content critical to the intervention, *2)* had little variability (i.e., >90% of the subjects had correct responses) causing a low item-to-total correlation, or *3)* demonstrated sensitivity to the intervention in at least one of the diabetic subgroups.

The scores on the 60- and 24-item versions were well correlated (r = 0.85, $P <$ 0.001). Although all 60 items were administered at all data collection sessions, only data pertaining to the 24 items were used for this article.

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Table 1—*Demographic characteristics at baseline*

	Participants	Supporters with diabetes	Supporters without diabetes	Total sample
n	252	71	179	502
Women (%)	63.90	71.80	78.80	70.00
Age (years)†	53.98 ± 8.24 (35–71)	50.24 ± 13.58 (23–79)	45.03 ± 13.90 (20–75)	50.27 ± 12.04 (20–79)
Acculturation* (on a scale of 0–4)	0.97* ± 1.00 (0–4)	1.27 ± 1.14 (0–4)	1.30 ± 1.12 (0–4)	1.13 ± 1.08 (0–4)
Years since diagnosis	7.86 ± 6.39 (0–33)	7.68 ± 7.55 (0–33)	NA	NA
Diabetes treatment (%)				
Diet only†	6.70	22.50	NA	NA
Oral agent*	67.10	47.90	NA	NA
Insulin	20.20	19.70	NA	NA
Oral agent and insulin	6.00	5.60	NA	NA

Data are *n*, %, or means ± SD (range). *$P < 0.01$; †$P < 0.001$. NA, not applicable.

Statistical analyses

The examination of the reliability of the instrument was limited to 492 subjects for whom complete knowledge data had been obtained at baseline, using Cronbach's coefficient α. Examination of the validity of the instrument was limited to the 410 subjects with complete data at baseline and 3 months. There were no significant differences between those who completed the 3-month follow-up examination ($n = 410$) and those who did not ($n = 82$), based on age, sex, or baseline DKQ scores. Absentees were more likely to be nondiabetic supporters.

Construct validation of the DKQ-24 was assessed using an approach known as differentiation between groups (21). Specifically, sensitivity of the DKQ-24 to the intervention was investigated. We had hypothesized that, if the DKQ-24 was a valid instrument, subjects receiving the intervention would score higher on the DKQ than the control group upon completion of the 3-month diabetes education program. To test the hypothesis, experimental and control groups with complete data were compared on the basis of their baseline and 3-month follow-up DKQ scores, using a one-between and one-within-factor repeated-measures design. The between-factor variable was a group with two levels (experimental and control). The within-factor variable was a time, also with two levels (baseline and 3 months). A two-by-two repeated-measures analysis of variance was performed.

RESULTS

Demographics

The subjects were predominantly female (70%) with a mean age of 50 years. The average level of language-based acculturation (1.13 on a 0–4 scale, 4 reflecting higher acculturation levels) was low and indicated a strong preference for Spanish language over English. The diabetic participants were older ($P < 0.001$) and less acculturated ($P = 0.005$) than the support people without diabetes. The two diabetic subgroups (participants and supporters) were comparable in length of time since diagnosis. Significantly more of the supporters with diabetes were treated with diet only ($P < 0.001$), whereas more participants than supporters were treated with oral agents ($P < 0.01$). Approximately 20% of all the diabetic subjects were treated with insulin (Table 1).

Even though the DKQ was administered in the subjects' preferred language (in English, Spanish, or a combination), those who scored higher on the language-based acculturation scale also scored higher on the DKQ-24. Those who scored above the median on acculturation scored significantly higher on both the baseline and 3-month follow-up DKQ-24 scores than did those at or below the median.

Internal consistency reliability and item analysis of the DKQ

The 60-item DKQ achieved a coefficient α of 0.83 in this sample, indicating reliability; the coefficients for the subgroups ranged from 0.79 to 0.88. The DKQ-24 achieved a coefficient α of 0.78 with coefficients for the subgroups ranging from 0.73 to 0.84 (Table 2). Because reliability is a function of the length of the test, it was expected that reducing the questionnaire from 60 to 24 items would result in a lower, albeit adequate, reliability coefficient (22).

Item difficulties ranged from 0.14 to 0.96 with an average difficulty level of 0.57, which is desirable (22) (Table 2). Item discriminations averaged 0.31 for the total sample; averages ranged from 0.27 to 0.37 among the three subgroups.

Construct validation of the DKQ

Experimental and control group scores on the DKQ-24 were compared at baseline and at 3 months using a two-by-two repeated-measures analysis of variance to determine construct validation of the instrument. The group-by-time interaction effect was statistically significant [F (degrees of freedom 1,408) = 23.32, $P < 0.001$]. To better understand the nature of the interaction, an analysis of simple effects was performed. There were no significant differences between the two groups at baseline [t (408) = 0.90, $P = 0.37$]. The group differences at the 3-month follow-up, on the other hand, were statistically significant [t (degrees of freedom 408) = 3.68, $P < 0.001$] and showed higher diabetes knowledge scores for the experimental group, compared with the control group. Additionally, subjects receiving the intervention significantly improved their knowledge scores from baseline to the 3-month follow-up [t (220) = 8.49, $P < 0.001$], whereas the change in the control group was not statistically significant [t (188) = 1.92, $P = 0.06$] (Table 3).

CONCLUSIONS — Knowledge of diabetes self-management is imperative for people with diabetes who need to make effective daily self-care decisions. Clinicians and researchers involved in diabetes self-management programs frequently develop their own knowledge instruments to determine if their efforts have been effective in imparting knowledge. Consequently, there are few reliable and valid instruments appearing in the literature. And in the case of Spanish-language instruments, there are even fewer.

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Table 2—*Means, SD, percent correct of total score, α coefficients, test item difficulty (percent correct), and discrimination (item-total correlation) of the 24-item DKQ at baseline*

	Participants* (*n* = 252)		Supporters with diabetes† (*n* = 71)		Supporters without diabetes‡ (*n* = 179)		Total§ (*n* = 502)	
	Percent correct	Item-total correlation	Percent correct	Item-total correlation	Percent correct	Item-total correlation	Percent correct	Item-total correlation
Item no.								
1	18	0.36	16	0.51	22	0.28	19	0.34
2	78	0.27	80	0.23	64	0.20	73	0.25
3	16	0.42	21	0.63	16	0.26	17	0.40
4	42	0.50	47	0.41	42	0.39	42	0.44
5	90	0.29	83	0.39	80	0.31	85	0.32
6	94	0.19	87	0.18	91	0.22	92	0.20
11	62	0.47	59	0.40	62	0.41	61	0.43
12	92	0.23	90	0.40	72	0.22	84	0.26
15	30	0.40	31	0.46	29	0.34	30	0.39
18	55	0.42	56	0.50	52	0.39	54	0.42
20	81	0.30	84	0.45	75	0.30	79	0.33
24	20	0.35	21	0.39	18	0.35	20	0.36
25	41	0.36	43	0.45	42	0.34	41	0.36
33	94	0.30	90	0.32	89	0.26	92	0.30
34	94	0.21	100	0.00	96	0.27	95	0.21
37	96	0.25	100	0.00	95	0.18	96	0.20
38	14	0.27	11	0.44	15	0.24	14	0.28
40	86	0.22	86	0.34	84	0.27	85	0.26
47	95	0.27	94	0.24	85	0.27	91	0.27
48	96	0.25	91	0.29	86	0.23	92	0.25
52	18	0.31	25	0.50	08	0.09	15	0.29
53	52	0.43	44	0.52	34	0.27	44	0.40
56	28	0.27	37	0.29	25	0.21	28	0.26
57	18	0.30	23	0.51	22	0.22	20	0.30
Average	59	0.32	59	0.37	54	0.27	57	0.31

*Means ± SD (% correct) 14.08 ± 3.71 (58.66), α = 0.78; †14.22 ± 4.32 (58.66), α = 0.84; ‡13.00 ± 3.61 (54), α = 0.73; §13.72 ± 3.80 (57), α = 0.78.

The knowledge instrument reported here has been used in Starr County studies since 1992. Past difficulties encountered in administering Likert-type or multiple-choice scales prompted us to develop a more simplified true-false–type scale. Individuals who administered the scale (data collectors) and the literate subjects who read the instrument along with the data collectors were bilingual. Careful scrutiny both of the subjects and data collectors during the data collection process yielded an interesting observation: both groups used a blend of English and Spanish words, moving easily between both languages. Of those who could read, many of them read both the English and Spanish versions to ensure complete understanding of a specific item on the instrument. For example, individuals would be speaking fluidly in Spanish, come to the words "support group," and change to English to verbalize this concept. Because these terms are not frequently used in Spanish, most people were more familiar with the English words. Therefore, we formatted the instrument in both languages, with the Spanish and English version of each item placed together. The question of which language individuals used to answer the questions is neither relevant nor possible to answer. This blend of English and Spanish is a common phenomenon along the border and not thought to be unique to individuals who participated in this project.

Table 3—*DKQ means ± SD for the experimental and control groups at baseline and the 3-month follow-up*

	Experimental group	Control group
n	221	189
Baseline	13.66 ± 3.82	14.00 ± 3.81
3-Month follow-up	15.71 ± 3.42	14.34 ± 3.58

Data are *n* or means ± SD.

The intervention had a small but statistically significant impact on experimental group subjects, compared with control subjects, indicating the instrument is sensitive to change. But, it is interesting to note that these study participants had considerable diabetes self-management knowledge before receiving the educational intervention. People without diabetes had remarkable levels

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APPENDIX—*Diabetes Knowledge Questionnaire*

Item #	Preguntas Questions	Sí Yes	No No	No sé I don't know
1.	**El comer mucha azúcar y otras comidas dulces es una cause de la diabetes.**		√	
1.	Eating too much sugar and other sweet foods is a cause of diabetes.		√	
2.	**La cause común de la diabetes es la falta de insulina efectiva en el cuerpo.**	√		
2.	The usual cause of diabetes is lack of effective insulin in the body.	√		
3.	**La diabetes es causada porque los riñones no pueden mantener el azúcar fuera de la orina.**		√	
3.	Diabetes is caused by failure of the kidneys to keep sugar out of the urine.		√	
4.	**Los riñones producer la insulina.**		√	
4.	Kidneys produce insulin.		√	
5.	**En la diabetes que no se está tratando, la cantidad de azúcar en la sangre usualmente sube.**	√		
5.	In untreated diabetes, the amount of sugar in the blood usually increases.	√		
6.	**Si yo soy diabético, mis hijos tendran más riesgo de ser diébeticos.**	√		
6.	If I am diabetic, my children have a higher chance of being diabetic.	√		
7.	**Se puede curar la diabetes.**		√	
7.	Diabetes can be cured.		√	
8.	**Un nivel de azucar de 210 en prueba de sangre hecha en ayunas es muy alto.**	√		
8.	A fasting blood sugar level of 210 is too high.	√		
9.	**La mejor manera de checar mi diabetes es haciendo pruebas de orina.**		√	
9.	The best way to check my diabetes is by testing my urine.		√	
10.	**El ejercicio regular aumentará la necesidad de insulina u otro medicamento para la diabetes.**		√	
10.	Regular exercise will increase the need for insulin or other diabetic medication.		√	
11.	**Hay dos tipos principales de diabetes: Tipo 1 (dependiente de insulina) y Tipo 2 (no-dependiente de insulina).**	√		
11.	There are two main types of diabetes: Type 1 (insulin-dependent) and Type 2 (non-insulin-dependent).	√		
12.	**Una reacción de insulina es causada por mucha comida.**		√	
12.	An insulin reaction is caused by too much food.		√	
13.	**La medicina es más importante que la dieta y el ejercicio pare controlar mi diabetes.**		√	
13.	Medication is more important than diet and exercise to control my diabetes.		√	
14.	**La diabetes frequentemente cause mala circulación.**	√		
14.	Diabetes often causes poor circulation.	√		
15.	**Cortaduras y rasguños cicatrizan mas despacio en diabéticos.**	√		
15.	Cuts and abrasions on diabetics heal more slowly.	√		
16.	**Los diabéticos deberían poner cuidado extra al cortarse las uñas de los dedos de los pies.**	√		
16.	Diabetics should take extra care when cutting their toenails.	√		
17.	**Una persona con diabetes debería limpiar una cortadura primero yodo y alcohol.**		√	
17.	A person with diabetes should cleanse a cut with iodine and alcohol.		√	
18.	**La manera en que preparo mi comida es igual de importante que las comidas que como.**	√		
18.	The way I prepare my food is as important as the foods I eat.	√		
19.	**La diabetes puede dañar mis riñones.**	√		
19.	Diabetes can damage my kidneys.	√		
20.	**La diabetes puede causer que no sienta en mis manos, dedos y pies.**	√		
20.	Diabetes can cause loss of feeling in my hands, fingers, and feet.	√		
21.	**El temblar y sudar son señales de azúcar alta en la sangre.**		√	
21.	Shaking and sweating are signs of high blood sugar.		√	

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APPENDIX—*Contined*

Item #	Preguntas Questions	Sí Yes	No No	No sé I don't know
22.	**El orinar seguido y la sed son señales de azúcar baja en la sangre.**		√	
22.	Frequent urination and thirst are signs of low blood sugar.		√	
23.	**Los calcetines y las medias elásticas apretadas no son malos para los diabéticos.**		√	
23.	Tight elastic hose or socks are not bad for diabetics.		√	
24.	**Una dicta diabética consiste principalmente de comidas especiales.**		√	
24.	A diabetic diet consists mostly of special foods.		√	

Includes the DKQ-24 and correct responses. √ = correct answer.

of knowledge also. Clearly, individuals living in a community that bears an enormous burden of type 2 diabetes have other sources of diabetes-related information—their physicians, relatives, neighbors, and friends. People with diabetes (both participants and supporters with diabetes) scored higher than nondiabetic support individuals.

It is also notable that both experimental and control group subjects demonstrated increased knowledge at the 3-month period, compared with baseline levels. Diabetes-related self-management information was transmitted during data collection sessions as a result of our belief that it was unethical to withhold information or to refuse to answer questions from control group subjects. Consequently, it was not surprising that control group subjects also demonstrated increased knowledge at the 3-month measurement period. In this context, then, the increased knowledge of the control group is further evidence of construct validity of the DKQ-24.

The DKQ, both the long and short versions, is a beginning attempt to develop Spanish-language instruments to measure outcomes of diabetes self-management education. Other important outcome variables that need to be considered for future instrument development and testing include health beliefs (work in progress), aspects of psychological adaptation (e.g., depression and anxiety), quality of life, and culturally specific constructs. Current and future work in Starr County will be aimed at contributing Spanish-language psychosocial measures. Further testing of the DKQ is ongoing.

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