Culturally Competent Diabetes Self-Management Education for Mexican Americans

The Starr County Border Health Initiative

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OBJECTIVE — To determine the effects of a culturally competent diabetes self-management intervention in Mexican Americans with type 2 diabetes.

RESEARCH DESIGN AND METHODS — A prospective, randomized, repeated measures study was conducted on the Texas-Mexico border in Starr County. A total of 256 randomly selected individuals with type 2 diabetes between 35 and 70 years of age, diagnosed with type 2 diabetes after 35 years of age, and accompanied by a family member or friend were included. The intervention consisted of 52 contact hours over 12 months and was provided by bilingual Mexican American nurses, dietitians, and community workers. The intervention involved 3 months of weekly instructional sessions on nutrition, self-monitoring of blood glucose, exercise, and other self-care topics and 6 months of biweekly support group sessions to promote behavior changes. The approach was culturally competent in terms of language, diet, social emphasis, family participation, and incorporation of cultural health beliefs. Outcomes included indicators of metabolic control (HbA_{1c} and fasting blood glucose), diabetes knowledge, and diabetes-related health beliefs.

RESULTS — Experimental groups showed significantly lower levels of HbA_{1c} and fasting blood glucose at 6 and 12 months and higher diabetes knowledge scores. At 6 months, the mean HbA_{1c} of the experimental subjects was 1.4% below the mean of the control group; however, the mean level of the experimental subjects was still high (>10%).

CONCLUSIONS — This study confirms the effectiveness of culturally competent diabetes self-management education on improving health outcomes of Mexican Americans, particularly for those individuals with HbA_{1c} levels >10%.

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The four Texas-Mexico border counties located in the Lower Rio Grande Valley are predominantly populated by Mexican Americans and have the highest diabetes-related death rates in Texas (1). In some areas of the Lower Rio Grande Valley, type 2 diabetes affects 50% of the Hispanic population >35 years of age (2). Mexican Americans tend to be diagnosed with diabetes at younger ages and exhibit higher fasting glucose levels, decreased insulin sensitivity, increased insulin response, and more severe forms of diabetes complications (3–5). Native American genetic admixture has been linked to type 2 diabetes in Mexican Americans, perhaps contributing to ethnic differences in rates of energy expenditure and obesity and in patterns of body fat distribution (6,7).

In addition to genetic influences, evidence of the importance of environmental factors in the development and treatment of type 2 diabetes has been mounting for years. Although it is estimated that ~40% of the "variability in BMI is related to genetic factors involved in the regulation of food intake and/or volitional activity. . . ," the "most likely successful therapy for obesity may target pathways of the regulation of food intake and an environment favoring engagement in physical activity. . . " (8). Physical activity is believed to play a significant role in the prevention of obesity, and perhaps diabetes, in genetically susceptible populations, such as Native Americans, Mexican Americans, and African Americans (9). Other environmental factors, some of which are modifiable and amenable to intervention, have also been implicated: low socioeconomic status, access barriers to health care, diet, and lack of education about health and using healthcare systems (9).

Lifestyle self-management and medical treatment resulting in tight glucose control have been shown to delay the onset of or reduce diabetes complications by 50–75% (10,11). Lifestyle self-management is most effective when augmented with careful medical supervision and a patient who is well educated in lifestyle behaviors (12). For Mexican Americans, the largest Hispanic subgroup, achieving glucose control reportedly has been even more difficult, because these individuals are more likely to rely on family and curanderos (folk healers) for health advice, to lack transportation to health care facilities, to be isolated from mainstream culture, to consider family needs as more important than their own personal needs, and to experience language differences with health care workers (13). Culturally competent approaches, however, have rarely been inves-

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Abbreviations: DCCT, Diabetes Control and Complications Trial; FBG, fasting blood glucose.
A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

tigated or used in clinical or community settings, and traditional interventions have been ineffective. As a result, Hispanics in some locales have been labeled "noncompliant" and have been treated with insulin more often than individuals of other cultures (4).

For 10 years, we have tested culturally competent diabetes self-management education interventions that meet national standards for diabetes care and that address specific cultural characteristics of Mexican Americans. This study describes the Starr County Border Health Initiative (1994–1998) and the effects of the intervention on metabolic control and other health outcomes. The following is the primary null hypothesis that was tested in this study: there will be no significant differences in metabolic control, diabetes knowledge, or diabetes-related health beliefs at 3, 6, and 12 months between subjects in experimental groups compared with subjects in 1-year wait-listed control groups.

RESEARCH DESIGN AND METHODS

Design

Effectiveness of the intervention was examined with a prospective, randomized, repeated-measures design. The design of the investigation was nested; that is, longitudinal observations were nested within subjects, and these subjects were nested within experimental or 1-year wait-listed control groups who received usual care provided by their private physicians or local clinics. Because investigators deemed it unethical to withhold diabetes self-management education from the control subjects, all participants ultimately received this intervention, regardless of whether they were randomly assigned to experimental or wait-listed control condition. An important advantage of this approach is that we were better able to retain control group subjects because of their expectations of eventually receiving the intervention. The disadvantages were the costs in terms of money and time that were involved in providing the intervention to every study participant and the delay in providing the intervention to the control subjects.

Setting: Starr County, Texas

Located on the Texas-Mexico border approximately halfway between Brownsville and Laredo, Starr County has a population of 52,618; 97.7% of the residents are Mexican American (14). The Texas border area is characterized by the presence of many colonias, which are unincorporated settlements on either side of the border distinguished by extreme poverty, pollution, and deprivation. Starr County is the poorest county in Texas and one of the poorest counties in the U.S. Starr County is characterized by the highest unemployment rate in Texas (24.4% compared with 4.6% for the state) and the lowest personal income. In 1998, estimated per capita income for Starr County residents was $8,225, compared with $25,369 for the rest of the state. In January 2000, all of Starr County was designated as a health professional shortage area and as a medically underserved area (14).

Subject selection and characteristics

A total of 256 individuals with type 2 diabetes were randomly selected for the intervention study from rosters of previous Starr County research studies; 128 individuals were allocated to the experimental group and 128 individuals were allocated to the 1-year wait-listed (control) group. Previous research involvement of these individuals had been limited to annual blood sampling; none had participated in any intervention studies, neither pharmacological nor behavioral, so we did not consider them to be a contaminated sample. A total of ~64 subjects were recruited quarterly during 1994–1995 to constitute four cohorts; in each cohort, 32 individuals entered treatment groups and 32 individuals entered wait-listed groups. Groups were then randomly assigned to experimental or control conditions.

Subjects were required to be *1*) between 35 and 70 years of age; *2*) diagnosed with type 2 diabetes after 35 years of age, *a*) two verifiable fasting blood glucose (FBG) test results ≥140 mg/dl or *b*) taking or have taken insulin or hypoglycemic agents for ≥1 year in the past; and *3*) willing to participate. To capitalize on the importance that the Mexican American culture places on family and social relationships, each subject identified a family member, preferably a spouse or first-degree relative, who agreed to participate as a support person. If a family member was not available, a close friend was substituted. Subjects were excluded if they were pregnant or if they had medical conditions for which changes in diet and exercise levels would be contraindicated.

Procedures

Experienced bilingual research office staff contacted each potential subject by telephone. Willing subjects were grouped by area of the county in which they lived, thereby controlling for within-group differences in socioeconomic status. Written informed consent was obtained before collecting baseline data, according to procedures approved by the two relevant University Institutional Review Boards. At all data collection sessions, ≥79% of the subjects returned for their examinations; the overall average data collection retention rate was 90% (Fig. 1). A mutually convenient time for the intervention sessions was negotiated with each group at completion of baseline data collection. For all data collection and intervention sessions, field office staff provided transportation when necessary.

Community physicians and other healthcare providers in Texas and Mexico were contacted to gain support and to enlist approval for dietary and exercise recommendations for their patients who were participating in the study. Data collection occurred as cohorts reached 3-, 6-, and 12-month examination dates. Questionnaires were read aloud in Spanish to each subject during one-on-one interviews, thus avoiding subject embarrassment about reading ability. Many participants spoke a blend of Spanish and English, easily changing between both languages; therefore, questions were stated in both languages (15). Data collectors were instructed to create a comfortable environment, read questions aloud without leading subjects to desired answers, and communicate nonjudgmentally about perceived negative health practices (e.g., use of unusual folk remedies). Practice and random observations ensured consistency in data collection.

Description of the culturally competent intervention

The intervention has been described in greater detail elsewhere (16). An overview of the intervention is provided in Table 1. The primary emphasis was on providing an intervention in accessible community-based sites and offering activities that reflected cultural characteristics and preferences of Mexican American participants. The intensive instructional and

Table 1—*Characteristics of the intervention*

Baseline	Intervention		
Measures	Weekly education sessions (12 weekly meetings)	Support group sessions (14 biweekly meetings)	Postintervention at 3, 6, and 12 months
• Demographics (age, gender, age of diabetes diagnosis, etc.) • Acculturation • Family, medical, and medication history • Diabetes knowledge • Diabetes-related health beliefs • Glycosylated hemoglobin • Fasting blood glucose • Systolic and diastolic blood pressure • Total cholesterol: HDL cholesterol LDL cholesterol • Triglycerides	• Introduction • What is hyperglycemia? • Glucose self-monitoring • Dietary principles for Mexican American foods • Food preparation • Food labels (trip to grocery store) • Medications • Exercise • Hygiene: illness days, foot care, etc. • Short-term complications: hyper- and hypoglycemia • Long-term complications • Family support and community resources	Format for each session is: • Review of previously learned content • Assessment of participants' knowledge and skills regarding area under discussion • Discussion of ongoing barriers to adopting healthy lifestyle changes—group problem solving • Demonstration of healthy, low-fat foods • Open discussion of any topic the group chooses	• Demographics • Diabetes knowledge • Diabetes-related health beliefs • Glycosylated hemoglobin • Fasting blood glucose • Systolic and diastolic blood pressure • Total cholesterol HDL cholesterol LDL cholesterol • Triglycerides • Home glucose monitoring

Characteristics of the intervention

- Culturally referenced:
  A) employed bilingual Mexican American nurses and dietitians from the community
  B) used videotapes filmed in Starr County showing community leaders describing their experiences with diabetes (e.g., the local priest talking about why people get diabetes)
  C) focused on realistic health recommendations consistent with Mexican American preferences (e.g., dietary choices)
  D) offered in Spanish, the preferred language
- Intensive (52 h over 1 year)
- Longitudinal (follow-up for up to 3 years)
- Community-based schools, churches, adult day care centers, agricultural extension centers, and community health clinics sites throughout the county
- Focused for success (improving blood glucose levels rather than on weight loss, since participants had perceived they had "failed" at weight loss many times in the past)
- Designed to provide rapid, frequent feedback
- Designed to promote group problem-solving to address individuals' health questions and issues
- Organized to obtain support from family, friends, group participants, and nurses/dietitians/community workers
- Conducted in a community where Mexican Americans are the majority group, a community that serves as an excellent clinical laboratory for testing interventions for Mexican Americans
- Based on results of four meta-analytic reviews of related diabetes literature and 6 years of developing/testing culturally appropriate Spanish-language educational materials, particularly videotapes, and the intervention.

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support group intervention of 52 contact hours over 12 months was provided in the preferred language, predominantly Spanish with a blend of English, by bilingual Mexican American nurses, dietitians, and community workers from Starr County. Key elements included 3 months of weekly 2-h instructional sessions on nutrition, self-monitoring of blood glucose, exercise, and other self-care topics and 6 months of biweekly plus 3 months of monthly 2-h support group sessions to promote behavior changes through problem-solving and food preparation demonstrations. The approach was culturally competent in terms of language, diet, social emphasis, family participation, and incorporation of cultural health beliefs. For example, typical Mexican American dietary preferences were incorporated into dietary recommendations, and food demonstrations were provided at each session based on healthy adaptations of favorite Mexican American recipes. Dietitians led visits to the local grocery store to help individuals apply the dietary information they had learned. Social support was fostered through family members and friends, group participants, the intervention team, and community workers.

The biweekly support group sessions provided opportunities for patients and family members/friends to meet in an informal atmosphere to discuss their problems in managing diabetes, express feelings about the impact of diabetes on the family, ask questions in a nonthreatening environment, review previously learned information and skills, and participate in cooking demonstrations. Also, group leaders emphasized support from family members and encouraged support persons to improve their health habits. Individual participants discussed their concerns and problems, and members of the group assisted each other in solving problems, with facilitation by the nurse or dietitian. For the final 3 months, group meetings decreased from biweekly to monthly to gradually "wean" individuals off this support mechanism.

Groups received the year-long intervention offered in schools, churches, county agricultural extension offices, adult day care centers, and health clinics located in Starr County. Eight trained community workers with type 2 diabetes from Starr County managed preparations for group sessions associated with intervention studies (arranged location, contacted patients and their families weekly, organized equipment/supplies, provided transportation when necessary, assisted dietitians with food preparation, etc.). Community workers assisted the nurses and dietitians and provided important links with the local Mexican American community.

Table 2—*A profile of subjects upon admission to the study*

Characteristic*	Treatment	Wait-listed
Total patients	126 (50)	126 (50)
Women	75 (60)	86 (68)
Age (years)		
Mean ± SD	54.7 ± 8.2	53.3 ± 8.3
n	126	126
Range	35–71	35–70
Duration of diabetes (years)		
Mean ± SD	7.6 ± 5.8	8.1 ± 6.9
n	126	126
Range	<1–25	<1–33
Acculturation†		
Mean ± SD	0.9 ± 1.0	1.0 ± 1.0
n	126	123
Range	0–4	0–4
Language of preference = Spanish	113 (90)	109 (87)
Language spoken at home = Spanish	98 (78)	94 (75)
First language as a child = Spanish	123 (98)	119 (94)
Read little or no English	55 (44)	45 (36)
Diabetes treatment modality		
Diet only	10 (8)	7 (6)
Oral agent only	83 (66)	86 (68)
Insulin only	25 (20)	26 (21)
Oral agent + insulin	8 (6)	7 (6)

Data are n (%), unless otherwise indicated. *No significant differences between experimental and control groups on any of these variables; †0–4, 4 = higher acculturation.

Measures

Low literacy rates in this community may be compounded by changes in vision caused by diabetes; therefore, investigators minimized written materials. Primary outcomes were diabetes-related knowledge ($r = 0.88$) and health beliefs, HbA_{1c}, FBG, lipids, and BMI (17–19). Language-based acculturation was determined at baseline, primarily to explore the language history and current language preferences of the subjects (20). Body weight was measured using a balance-beam scale with individuals wearing street clothes but no shoes. Height was measured using a secured stadiometer. BMI was calculated in kilograms per meters squared. Blood samples (10 ml) were collected at baseline and at postintervention intervals. FBG (10-h fasting) was assessed with a desktop glucose analyzer (YSI Model 2300, STAT PLUS Glucose Analyzer; YSI, Yellow Springs, OH). HbA_{1c} was analyzed at The University of Texas at Houston (Glyc-Affin; Isolab, Akron, OH). FBG and cholesterol testing was performed on site in the field office, and at each data collection session, results were reviewed with individuals before the end of their examinations. Prebreakfast and supper blood glucose levels were measured by subjects 3 days per week with home monitoring devices provided by the project.

Data analysis

Descriptive statistics were used to characterize the sample and to summarize outcome measures before, during, and after the intervention. Hierarchical Linear and Nonlinear Modeling software (HLM 5; Scientific Software International, Lincolnwood, IL) was used to perform individual growth curve analysis, using multilevel modeling. The multilevel modeling consists of two stages: a within-subject analysis to estimate the parameters of the individual growth curve and a between-subject analysis to predict differences in the growth parameters (21,22). One of the major advantages of multilevel modeling is that it uses all of the available data for a given subject to estimate a growth curve for that subject (23). Therefore, subjects with missing data were not eliminated from the investigation.

Because the primary purpose of the investigation was to examine the effects of the diabetes self-management education and support group intervention on a series of outcome measures, conditional models were tested. Specifically, the general two-level models were estimated by means of restricted maximum likelihood. The time variable, coded as 0 (baseline), 3, 6, and 12 months, was entered at level 1. The intervention variable, coded as 1 for the experimental group and 0 for the control group, was entered at level 2. The HLM 5 software tested the intervention effect at baseline and over time.

To better understand the nature of the outcome measures that were significantly affected by the intervention (i.e., HbA_{1c}, FBG, and diabetes knowledge), a series of univariate analyses of covariance was performed. Although random assignment of subjects had been implemented and there were no statistically significant baseline differences between experimental and control groups on the above variables, the baseline measures were treated as covariates to reduce systematic bias and error variance. Effect sizes were also computed, using η^2, and 0.01, 0.l6, and 0.14 were used to indicate small, medium, and large associations, respectively (24). All analyses were conducted at the 0.05 level of significance.

RESULTS — Most subjects were female, obese, and, on average, in their mid-fifties (see Table 2). Individuals had elevated FBG and HbA_{1c} levels, indicating poor metabolic control. Language-based acculturation scores were low, on average, indicating that the language of preference was Spanish; 90% of the subjects preferred Spanish and 78% spoke Spanish at home. A total of ~25% of subjects were taking insulin alone or in combination with oral hypoglycemic agents. One third reported using home remedies, such as herbal teas (e.g., teas from the chaya plant), garlic, aloe vera, etc., to lower blood glucose levels (25).

There were no statistically significant differences at baseline between the experimental and control groups on any of the outcome measures (Tables 3 and 4). Over time, there were statistically significant differences between the two groups on HbA_{1c}, FBG, and diabetes knowledge.

The series of univariate analyses of covariance indicated that the experimental group showed statistically significant lower measures of HbA_{1c} and FBG at 6 and 12 months and higher diabetes knowledge scores at 3 and 12 months than the control group. Diabetes knowledge was not measured at 6 months. (Table 5 and Figs. 2–4.)

For a clearer understanding of the clinical significance of the changes that occurred in HbA_{1c}, FBG, and diabetes knowledge, average improvements in each of these variables were explored. In the experimental group, the level of HbA_{1c} was decreased by 1.2 percentage points at 3 months compared with the baseline level, increased by 0.19 percentage point between 3 and 6 months, and increased by 0.09 percentage point between 6 and 12 months. In the control group, the level of HbA_{1c} decreased by 0.58 percentage point from the baseline to 3 months, increased by 0.98 percentage point from between 3 and 6 months, and decreased by 0.56 percentage point between 6 and 12 months.

In the experimental group, the FBG level was decreased, on average, by 23.4 mg/dl from baseline to 3-month follow-up and by 4.4 mg/dl from 3- to 6-month follow-up; the FBG level was increased by 9.7 mg/dl from 6- to 12-month follow-up. In the control group, the FBG

Table 3—*Mean and SD for outcome measures*

	Experimental group				Control group			
Outcome measure	Baseline	3 Months	6 Months	12 Months	Baseline	3 Months	6 Months	12 Months
Physiological indicators								
HbA_{1c}	11.81 ± 3.00 (*n* = 126)	10.6 ± 2.64 (*n* = 108)	10.80 ± 2.80 (*n* = 117)	10.89 ± 2.56 (*n* = 112)	11.80 ± 3.02 (*n* = 125)	11.22 ± 2.77 (*n* = 99)	12.20 ± 2.95 (*n* = 109)	11.64 ± 2.85 (*n* = 112)
FBG	213.01 ± 64.06 (*n* = 126)	189.62 ± 66.97 (*n* = 120)	185.24 ± 60.90 (*n* = 119)	194.95 ± 63.27 (*n* = 114)	207.12 ± 71.41 (*n* = 126)	201.01 ± 62.16 (*n* = 101)	215.04 ± 66.81 (*n* = 110)	210.51 ± 66.55 (*n* = 113)
Cholesterol	211.83 ± 45.34 (*n* = 126)	191.39 ± 41.12 (*n* = 108)	192.46 ± 40.34 (*n* = 118)	189.88 ± 36.35 (*n* = 112)	203.57 ± 48.82 (*n* = 125)	187.93 ± 40.84 (*n* = 102)	185.88 ± 40.53 (*n* = 112)	187.64 ± 42.66 (*n* = 113)
Triglycerides	215.35 ± 130.07 (*n* = 126)	186.41 ± 96.06 (*n* = 107)	189.12 ± 107.85 (*n* = 117)	214.43 ± 194.93 (*n* = 113)	195.58 ± 118.95 (*n* = 125)	192.20 ± 128.39 (*n* = 98)	237.66 ± 234.10 (*n* = 112)	198.65 ± 148.38 (*n* = 113)
BMI	32.33 ± 5.97 (*n* = 125)	31.90 ± 6.05 (*n* = 119)	31.70 ± 5.84 (*n* = 118)	32.17 ± 6.45 (*n* = 114)	32.12 ± 6.35 (*n* = 124)	32.73 ± 6.84 (*n* = 100)	32.47 ± 6.83 (*n* = 109)	32.28 ± 6.52 (*n* = 113)
Psychoeducational indicators— Health beliefs								
Control	3.12 ± 1.45 (*n* = 123)	3.63 ± 1.33 (*n* = 115)	—	3.65 ± 1.26 (*n* = 110)	3.08 ± 1.41 (*n* = 121)	3.41 ± 1.40 (*n* = 98)	—	3.43 ± 1.26 (*n* = 106)
Barriers	2.42 ± 0.85 (*n* = 126)	2.18 ± 0.80 (*n* = 116)	—	2.11 ± 0.72 (*n* = 110)	2.50 ± 0.76 (*n* = 122)	2.18 ± 0.82 (*n* = 99)	—	2.30 ± 0.81 (*n* = 107)
Social support	4.05 ± 0.96 (*n* = 119)	4.26 ± 1.04 (*n* = 115)	—	4.05 ± 1.10 (*n* = 110)	4.07 ± 0.93 (*n* = 119)	4.30 ± 0.78 (*n* = 97)	—	4.19 ± 0.95 (*n* = 107)
Impact of job	2.69 ± 1.13 (*n* = 103)	2.37 ± 1.09 (*n* = 91)	—	2.33 ± 0.98 (*n* = 89)	2.46 ± 1.16 (*n* = 101)	2.12 ± 0.91 (*n* = 70)	—	2.24 ± 0.99 (*n* = 89)
Benefits	4.64 ± 0.44 (*n* = 126)	4.70 ± 0.40 (*n* = 116)	—	4.57 ± 0.48 (*n* = 110)	4.61 ± 0.43 (*n* = 122)	4.59 ± 0.45 (*n* = 99)	—	4.63 ± 0.42 (*n* = 107)
Diabetes knowledge	36.23 ± 6.17 (*n* = 126)	41.44 ± 5.13 (*n* = 117)	—	42.94 ± 4.87 (*n* = 110)	37.30 ± 6.28 (*n* = 122)	39.10 ± 5.75 (*n* = 100)	—	40.92 ± 4.87 (*n* = 107)

Data are mean ± SD unless otherwise indicated.

Table 4—*Growth curve analysis of outcome measures*

	Intervention effect—baseline				Intervention effect—over time			
Outcome measure	Coefficient	Standard error	*t*	*P*	Coefficient	Standard error	*t*	*P*
HbA_{1c}	−0.32	0.35	−0.93	0.354	−0.07	0.03	−2.40	0.016*
FBG	−3.25	7.78	−0.42	0.675	−1.76	0.75	−2.33	0.020*
Cholesterol	7.25	5.38	1.35	0.178	−0.45	0.36	−1.25	0.211
Triglycerides	−0.20	14.72	−0.01	0.989	−5.43	6.36	−0.85	0.394
BMI	−0.25	0.82	−0.31	0.760	0.01	0.03	0.40	0.691
Health belief								
Control	−0.10	0.16	−0.70	0.489	−0.01	0.02	−0.71	0.477
Barriers	0.04	0.09	0.44	0.658	0.01	0.01	1.02	0.309
Social support	0.01	0.10	0.10	0.924	0.01	0.01	0.86	0.390
Impact of job	−0.24	0.14	−1.67	0.095	0.01	0.01	0.87	0.383
Benefits	−0.07	0.05	−1.48	0.139	0.01	0.01	1.50	0.132
Diabetes knowledge	−0.42	0.75	−0.56	0.575	0.53	0.14	3.87	<0.001*

*Significant at $P < 0.05$.

level was decreased by 6.1 mg/dl from baseline to 3-month follow-up, increased by 14.0 mg/dl from 3- to 6-month follow-up, and decreased by 4.5 mg/dl from 6- to 12-month follow-up. Compared with the baseline level, the experimental group showed a decrease of 27.8 mg/dl in FBG level at the 6-month follow-up, whereas the control group showed an increase in FBG of 7.9 mg/dl. The same comparison at 12-month follow-up showed a decrease of 18.1 mg/dl in the experimental group and an increase of 3.4 mg/dl in the control group.

In the experimental group, diabetes knowledge was increased by 5.2 items correct (14.4%) from baseline to 3-month follow-up and increased by 1.5 items correct (3.6%) from 3- to 12-month follow-up. In the control group, increases of 1.8 items correct (4.8%) were observed from baseline to 3-month follow-up and from 3- to 12-month follow-up. One year after initiation of the intervention, diabetes knowledge in the experimental and control groups increased by 6.7 items correct (18%) and 3.6 items correct (9.7%) on the diabetes knowledge scale, respectively.

No variables other than HbA_{1c}, FBG, and diabetes knowledge were shown to respond to the self-management educational intervention. Additionally, the influence of age and gender on the above outcome measures was investigated. Specifically, age and gender were treated as random and fixed variables, respectively, and were included in a number of multilevel models. Results were not statistically significant; therefore, it was concluded that the age and gender of study participants had not affected the outcome measures. In addition, we found no differences in rates of home glucose monitoring between subjects who were successful in reducing HbA_{1c} and those who were not.

CONCLUSIONS — The Starr County diabetes self-management education study demonstrated that, comparing experimental to wait-listed control groups, statistically significant changes were achieved in three health outcomes: diabetes knowledge, FBG, and HbA_{1c}. It has been known for some time that diabetes knowledge is a prerequisite to, but not sufficient for, achieving improved metabolic control. A 60-item instrument was developed specifically for Spanish-speaking border populations, such as the residents of Starr County. The data demonstrated that diabetes knowledge increased in both experimental and control group subjects during the 1-year intervention. We believe that the increased knowledge of control group subjects might have resulted from the four data collection points (baseline and 3, 6, and 12 months). During data collection sessions, subjects' questions were answered honestly, regardless of whether subjects were participants of the treatment group or the control group. Investigators believed that it was not ethical to withhold information from the control group subjects during data collection. In addition, as each subject completed a data collection session, he/she was required to participate in an exit interview. The interview provided immediate feedback by reviewing results of each person's laboratory tests and other outcome data (e.g., weight, blood pressure). Results were interpreted, trends in individual outcomes

Table 5—*Trend analysis of significant intervention effects: ANCOVA controlling for baseline measures*

Outcome measure	Measurement time (months)	Experimental group (M_{adj}*)	Control group (M_{adj}*)	*P*	Effect size†
HbA_{1c}	3	10.64	11.20	0.051	0.02
	6	10.79	12.21	<0.001	0.07
	12	10.87	11.66	0.011	0.03
FBG	3	187.88	202.74	0.038	0.02
	6	184.15	216.13	<0.001	0.08
	12	193.72	211.74	0.019	0.02
Diabetes knowledge	3	41.70	38.86	<0.001	0.08
	6	NM	NM	NM	NM
	12	43.15	40.78	<0.001	0.07

*M_{adj} = adjusted mean (based on baseline mean); †effect size measured by η^2: 0.01 = small effect, 0.06 = medium effect, 0.14 = large effect. NM, not measured.

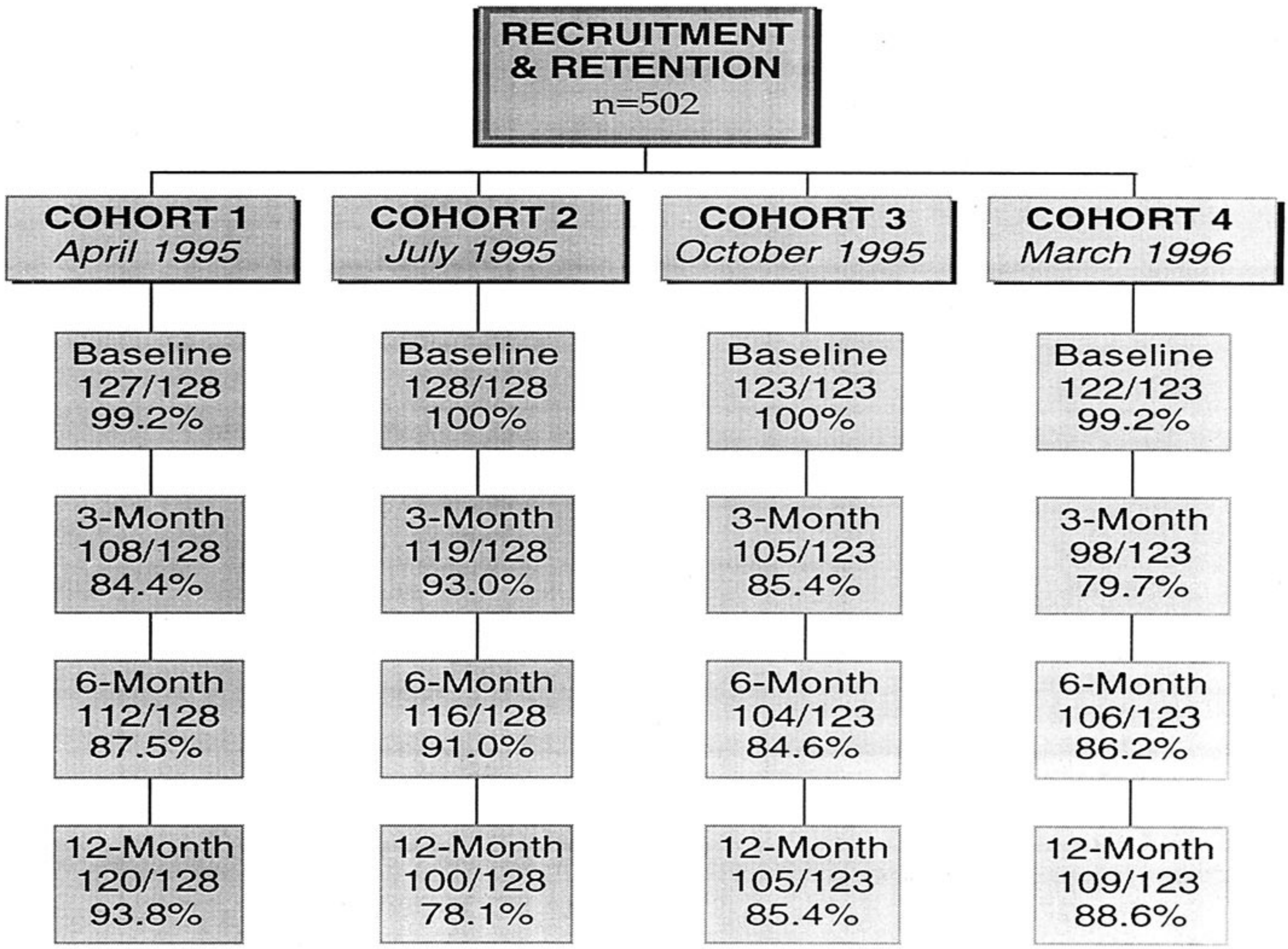

Figure 1—*Subject recruitment and retention data.*

were reviewed, questions were answered, and a written report of individual results was provided. These efforts to provide ethical treatment both of experimental and control group subjects likely resulted in increased knowledge of subjects in both groups. However, experimental subjects achieved statistically higher diabetes knowledge levels both at 3 and 12 months.

FBG and HbA_{1c} showed statistically significant changes as a result of the self-management education intervention, particularly at the 6-month measurement period. Benefits of the intervention on FBG peaked at 6 months, when the average differential between experimental and control group subjects was 29.8 mg/dl. For HbA_{1c}, the change from baseline to 6 months in the experimental group reflected a decrease by 1.0 percentage point, whereas HbA_{1c} in the control

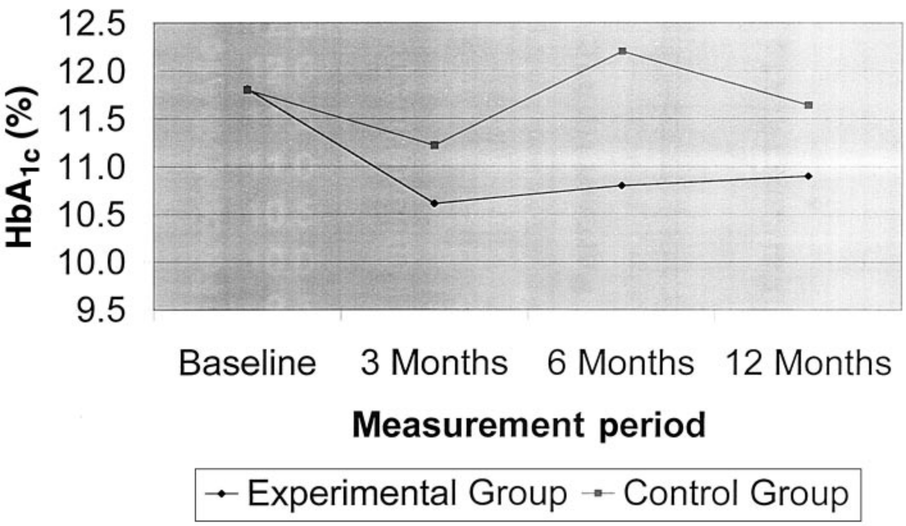

Figure 2—*HbA_{1c} growth curve.*

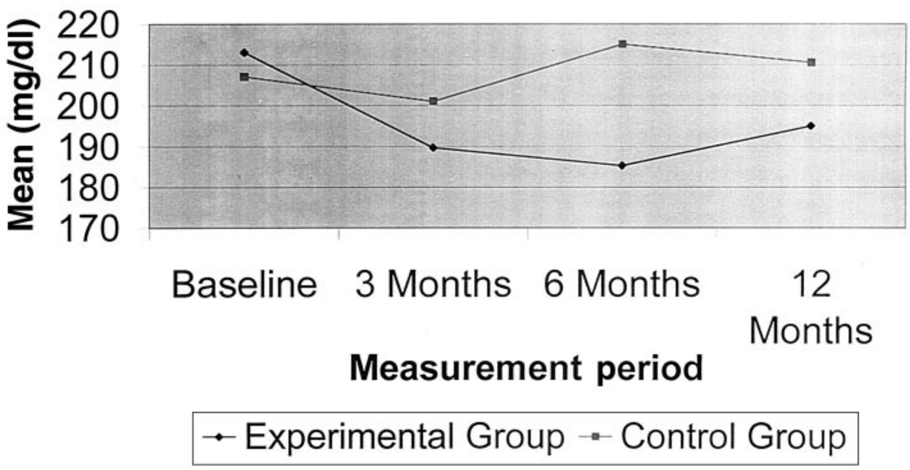

Figure 3—*FBG growth curve.*

group increased by 0.4 percentage point. In other words, there was a 1.4 percentage point differential between experimental and control groups at 6 months. It should be noted that the mean HbA_{1c} of both experimental and control group subjects began near 12% at baseline and remained >10% throughout the study period.

The Diabetes Control and Complications Trial (DCCT) demonstrated that a reduction of 0.5 percentage point in HbA_{1c} resulted in a significant reduction in diabetes complications (10). With intensive therapy, a reduction of ~2 percentage points in HbA_{1c} was achieved in persons with type 1 diabetes, whereas the Starr County study demonstrated a decrease of 1.4 percentage points in type 2 diabetes with self-management strategies alone. The DCCT baseline HbA_{1c} values were much lower (8.8–9.0% by cohort), compared with Starr County (11.8%). It is not clear how the advantages of reducing HbA_{1c} from 9 to 7, as reported in the DCCT, translate to reducing HbA_{1c} levels from 12 to 10, as reported in Starr County; however, these reductions may indeed be clinically significant from the perspective of reducing the risk of diabetes-related complications.

We are currently refining and testing our intervention to achieve more favorable outcomes. It should also be noted that the decrease in HbA_{1c} from baseline to 12 months was 0.92 percentage point in the experimental group and only 0.16 percentage point in the control group, reflecting a slight abatement in the effects of the intervention over time. This is not an unexpected finding and perhaps suggests the need for booster self-management sessions and motivation strengthening strategies, although an optimal strategy has yet to be developed.

Initial improvements in BMI were seen in experimental subjects, but by 12 months, levels returned to baseline. This failure to maintain weight loss is typically seen in weight loss clinical trials (26), but improved metabolic control can be attained with a modest weight loss of 5% (27). Baseline levels of cholesterol and triglycerides were not that much higher than recommended levels, despite the levels of obesity in this population. Initial focus groups conducted in Starr County indicated that individuals had numerous prior weight loss failures and advised us that they would not participate in a study focusing on weight. They were more interested in learning about diabetes and how to improve blood glucose levels. Therefore, we designed a program that focused on dietary principles, self-monitoring, and other activities that targeted reducing blood glucose levels, with the expectation that some weight loss would occur naturally.

We identified numerous barriers to participating in exercise, some of which were the existence of complications from diabetes, comorbid conditions, history of sedentary lifestyle, and decreased mobility associated with aging. Environmental barriers included no access to exercise facilities, cultural factors (such as the inappropriateness of women walking alone in the neighborhoods), and few areas in the community with sidewalks or paved streets. In addition, with the high temperatures that are common in the South Texas area, sometimes >110°, and no enclosed malls available for walking, individuals find it difficult to exercise on a regular basis. Furthermore, investigators have had concerns about the safety of unsupervised exercise in a community setting such as this, particularly in individuals with longstanding diabetes. However, stretching and walking for 20–30 min three times per week were recommended for individuals who were safely able to do it.

The intent of this project was to determine, from a population perspective, whether a culturally competent diabetes self-management intervention that focused primarily on diet and self-

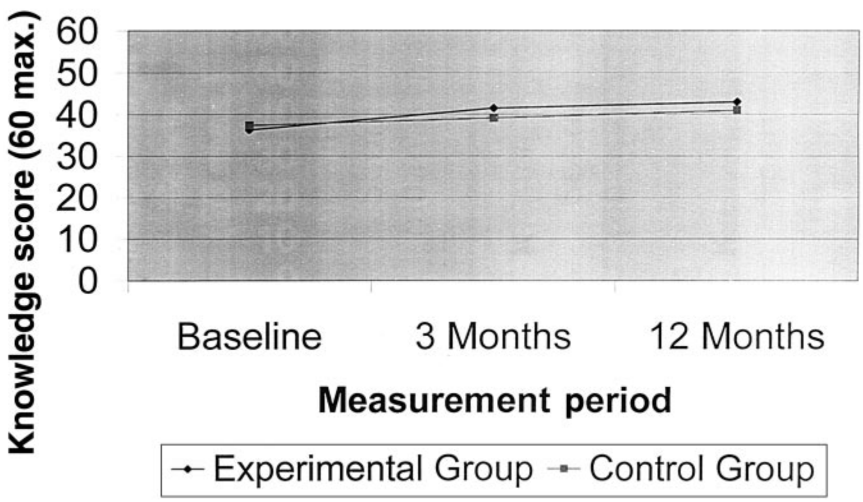

Figure 4—*Diabetes knowledge growth curve.*

monitoring education would improve metabolic status, independent of the medical care that these individuals were receiving. Consequently, pharmacological treatment was not adjusted by project staff but was managed by each participant's regular physician. We provided physicians with copies of their patients' laboratory reports, progress letters, and diet and exercise recommendations of the study dietitians and nurses for each participant. In addition, we periodically notified physicians by phone of particular health problems of their patients that required attention.

One of the major questions that we have been asked is whether the 1-year intervention tested in this study can be incorporated realistically into clinical practice settings. First, this question is less often asked of other treatment modalities, such as pharmaceuticals. If the effective "dosage" of the self-management educational intervention requires 1 year or more with booster sessions, then this is what must be provided and reimbursed by third-party payers. Second, although an extensive cost analysis was not proposed in the original project, basic costs of providing the 1-year intervention were estimated and are modest; Medicaid or other third-party insurance could cover monitors and strips, educational materials would be a one-time purchase at the outset of the project, and free community-based sites are available. During the current intervention, numerous sites in the community were provided at no cost to the project. Also, overhead charges that would be added to patient costs by organizations that might offer such an intervention are not included, but current local programs report charging an overhead of 50% or more. Remaining costs of the intervention are personnel and food necessary for meal preparation. A nurse, a dietitian, and a community worker all attended sessions 1–12; a nurse or a dietitian and a community worker attended sessions 13–26. Based on this scenario, a cost of $384 per person can be estimated as the cost of providing the intervention as described here, assuming costs for monitoring supplies are covered by third-party reimbursement (16). Therefore, we have concluded that the cost of the intervention is not a reasonable obstacle to providing the 1-year intervention described here.

There is, however, a more serious obstacle to providing this intervention: the availability of bilingual Hispanic nurses, dietitians, and community workers. For example, in Starr County, the ratio of residents per registered nurse is 822:1, compared with 169:1 for the rest of the state (14). Because of the low numbers of Hispanic health professionals, some communities use lay workers for purposes of diabetes self-management education (28). Our initial plan was to have the nurses and dietitians provide the educational component of the intervention, followed by support groups directed by trained community lay workers. However, early in the project, subjects expressed their preference to have health professionals available throughout the 1-year intervention. Therefore, we modified the role of the community workers to one of providing support through making telephone calls to subjects to remind them of the sessions, providing travel for subjects to intervention and data collection sessions, preparing food for demonstrations, and keeping attendance logs. Even though the role of the community workers changed, their logistical support was key to the success of the intervention. The efficacy of using community workers in other capacities could be tested in future studies.

The targeted population of this study had few personal resources: some had limited literacy, some had limited access to health care providers, and many had longstanding diabetes as well as longstanding lifestyle habits that negatively impact health. Barriers, such as the low socioeconomic status of the residents of the border area, were only partially addressed by the study. For example, free home glucose monitors and strips were provided for all study participants; however, individuals sometimes expressed difficulties with the cost of purchasing the foods that were recommended for achieving dietary goals. In addition, although monitoring supplies were provided, due to the budget limitations of the project, self-monitoring recommendations were limited to two times per day on 3 days each week. It seems logical to suggest that, considering the improvements that were attained in the study, removing other possible barriers (some yet to be identified), increasing the frequency of home glucose monitoring, and providing more intensive medical/pharmacological therapy would result in greater improvements in metabolic control.

Culturally competent behavioral interventions should be the focus of major national initiatives. Future research should be aimed at developing culturally appropriate outcome measures, addressing translation issues for non–English-speaking populations, and exploring motivating factors and strategies for diabetes self-management. If scientific advances in behavioral strategies are not supported and encouraged as a national imperative, other recent medical advances in diabetes treatment, such as pharmaceutical agents, will be diminished in importance or found to be irrelevant. No medication or other therapeutic discovery currently available is likely to completely overcome unhealthy lifestyles or a lack of knowledge of self-management in individuals with diabetes.

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References

1. The University of Texas System Texas-Mexico Border Health Coordination Office: *Texas-Mexico Border Counties: 1998*. Edinburg, TX, Author, 1998
2. Hanis CL, Ferrell RE, Barton SA, Aguilar L, Garza-Ibarra A, Tulloch BR, Garcia CA, Schull WJ: Diabetes among Mexican Americans in Starr County, Texas. *Am J Epidemiol* 118:659–668, 1983
3. Haffner SM, Diehl HK, Mitchell BD, Stern MP, Hazuda HP: Increased prevalence of clinical gallbladder disease in subjects with non-insulin-dependent diabetes mellitus. *Am J Epidemiol* 132:327–335, 1990
4. Haffner SM, Fong D, Stern MP, Pugh JA, Hazuda HP, Patterson JK, van Heuven

WAI, Klein R: Diabetic retinopathy in Mexican Americans and non-Hispanic whites. *Diabetes* 37:878–884, 1988
5. Hanis CL, Ferrell RE, Tulloch BR, Schull WJ: Gallbladder disease epidemiology in Mexican Americans in Starr County, Texas. *Am J Epidemiol* 122:820–829, 1985
6. Hanis CL, Boerwinkle E, Chakraborty R, Ellsworth DL, Concannon P, Stirling B, Morrison VA, Wapelhorst B, Spielman RS, Gogolin-Ewens KJ, Shepard JM, Williams SR, Risch N, Hinds D, Iwasaki N, Ogata M, Omori Y, Petzold C, Rietzch H, Schroder HE, Schulze J, Cox NJ, Menzel S, Boriraj VV, Chen X, et al: A genome-wide search for human non-insulin-dependent (type 2) diabetes genes reveals a major susceptibility locus on chromosome 2. *Nat Genet* 13:161–166, 1996
7. McDermott R: Ethics, epidemiology and the thrifty gene: biological determinism as a health hazard. *Soc Sci Med* 47:1189–1195, 1998
8. Ravussin E, Bogardus C: Energy balance and weight regulation: genetics versus environment. *Br J Nutr* 83:S17–S20, 2000
9. Esparza J, Fox C, Harper IT, Bennett PH, Schulz LO, Valencia ME, Ravussin E: Daily energy expenditure in Mexican and USA Pima Indians: low physical activity as a possible cause of obesity. *Int J Obes Relat Metab Disord* 24:55–59, 2000
10. DCCT Research Group: The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med* 329:977–986, 1993
11. UKPDS Group: Intensive blood glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet* 352: 837–853, 1998
12. Norris SL, Engelgau MM, Narayan KMV: Effectiveness of self-management training in type 2 diabetes. *Diabetes Care* 24:561–587, 2001
13. Lipton RB, Lee ML, Giachello A, Mendez J, Girotti MH: Attitudes and issues in treating Latino patients with type 2 diabetes: views of healthcare providers. *Diabetes Educ* 24:67–71, 1998
14. Texas Department of Health: *Selected Facts for Starr County –1999*. Austin, TX, Texas Department of Health, 2001
15. Garcia AA, Villagomez ET, Brown SA, Kouzekanani K, Hanis CL: The Starr County diabetes education study: development and testing of a Spanish-language diabetes knowledge questionnaire. *Diabetes Care* 24:16–21, 2001
16. Brown SA, Hanis CL: Culturally competent diabetes education for Mexican Americans: the Starr County Study. *Diabetes Educ* 25:226–236, 1999
17. Villagomez ET: *Health Beliefs, Knowledge, and Metabolic Control in Diabetic Mexican American Adults*. Master's thesis. Houston TX, University of Texas Health Science Center, 1989
18. Brown SA, Hanis CL: A community-based, culturally-sensitive education and group support intervention for Mexican-Americans with NIDDM: a pilot study of efficacy. *Diabetes Educ* 21:203–210, 1995
19. Brown SA, Becker HA, Garcia AA, Barton SA, Hanis CL: Measuring health beliefs in Spanish-speaking Mexican Americans with type 2 diabetes: adapting an existing instrument. *Res Nurs Health*. In press
20. Hazuda HP, Haffner SM, Stern MP, Eifler CW: Effects of acculturation and socioeconomic status on obesity and diabetes in Mexican Americans. *Am J Epidemiol* 128:1289–1301, 1988
21. Raudenbush S, Bryk A, Cheong YF, Congdon R: *Hierarchical Linear and Nonlinear Modeling*. Lincolnwood, IL, Scientific Software International, 2000
22. Francis D, Schatschneider C, Carlson C: Introduction to individual growth curve analysis. In *Handbook of Research in Pediatric and Clinical Child Psychology*. Drotar D, Ed. New York, Kluwer Academic/Plenum Publishers, 1999, p. 51–73
23. Bryk A, Raudenbush S: Application of hierarchical linear models to assessing change. *Psychol Bull* 101:147–158, 1987
24. Cohen J: *Statistical Power Analysis for the Behavioral Sciences*. Hillsdale, NJ, Lawrence Erlbaum Associates, 1988
25. Brown SA, Upchurch S, Garcia A, Barton SA, Hanis C: Symptom-related self-care of Mexican Americans with NIDDM: preliminary findings of the Starr County Diabetes Education Study. *Diabetes Educ* 24: 331–339, 1998
26. Foreyt JP, Goodrick GK: Attributes of successful approaches to weight loss and control. *Appl Prev Psychol* 3:209–215, 1994
27. Wing RR, Koeske R, Epstein LH, Nowalk MP, Gooding W, Becker D: Long-term effects of modest weight loss in type II diabetic patients. *Arch Intern Med* 147:1749–1753, 1987
28. Alcalay R, Alvarado M, Balcazar H, Newman E, Huerta E: Salud para su corazon: a community-based Latino cardiovascular disease prevention and outreach model. *J Community Health* 24:359–379, 1999