Community-Based Exercise Intervention: Zuni Diabetes Project

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Non-insulin-dependent diabetes mellitus (NIDDM) is a serious health problem among the Zuni Indians of New Mexico. In July 1983, Indian Health Service personnel initiated a community-based exercise program designed to help control NIDDM in the community. To retrospectively evaluate the effects of the exercise program, the medical records of 30 participants with NIDDM were compared with the medical records of 56 nonparticipants with NIDDM matched by age, sex, health-care provider, and duration of NIDDM. From 1 July 1983 through 1 October 1985, participants had a mean weight loss of 4 kg, whereas nonparticipants had a mean weight loss of 0.9 kg ($P < .05$). Participants' fasting blood glucose values dropped by a mean of 43 mg/dl, compared to a mean drop of 2 mg/dl among the nonparticipants ($P < .05$). Participants were significantly more likely than nonparticipants to have stopped their hypoglycemic medication (relative risk 4.2) and to have decreased their medication dosage (relative risk 2.2). These results suggest that participation in a community-based exercise program can produce significant weight loss and improvement in glycemic control among a group of Native Americans with NIDDM. *Diabetes Care* 10:579–83, 1987

Non-insulin-dependent diabetes (NIDDM) is characterized by glucose intolerance, resistance to developing ketosis, and onset predominantly after age 40 yr (1). The disease is often accompanied by hyperlipidemia, hypertension, and the development of microvascular and macrovascular complications (2–4). Obesity is a major factor increasing the likelihood of developing NIDDM (5,6). High prevalences of obesity and NIDDM have recently been described in several groups of Native American Indians (7,8). The Zuni Indians of western New Mexico are one of several tribes whose prevalence rates for NIDDM are high; among Zunis ≥45 yr of age, the rate is reported to be 25% (9).

Regular endurance exercise produces weight loss and positive changes in glucose metabolism (10–13). However, no information exists regarding the impact of a community-wide exercise promotion program on the control of NIDDM.

In July 1983, Indian Health Service (IHS) personnel initiated a community-based exercise program designed to instruct and motivate Zunis with NIDDM to increase their levels of physical activity, lose body fat, and achieve or maintain normal body weight. In September 1985, the IHS decided to carry out a retrospective evaluation of this program with the technical assistance of the Centers for Disease Control. Our study documents the effectiveness of this community-based exercise program in facilitating weight loss and improved glycemic control among patients with NIDDM.

METHODS

Program. The Zuni Indians (population 7900) live in western New Mexico. Their reservation occupies 407,247 acres anchored by the Pueblo of Zuni, the primary commercial and residential community, where the IHS maintains an outpatient clinic and 40-bed acute-care hospital staffed by eight IHS physicians. Residents of the Zuni Reservation depend almost exclusively on the IHS facilities for their health care.

The Zuni Diabetes Project is a community-based exercise program initiated in July 1983. The project has recently been described in detail (14). Briefly, the program began with two 1-h aerobic exercise sessions per week; it has grown to 48 sessions, offered 5 days/wk, several times daily, in various sites in the Zuni community. Sessions are offered specifically for individuals with NIDDM as well as for the general public. The sessions are offered continuously and maintain open enrollment. Attendance at exercise sessions varies from 15

to 50 participants. Participants in the community exercise program are recruited through personal invitations and recommendations from the medical staff as well as a general community advertisement campaign. Several exercise-oriented events, such as foot races, are also offered throughout the year and are supported and sponsored by community agencies and local businesses.

The community-based exercise program is coordinated by the IHS staff health educator with the aid of two health-education assistants and 48 Zuni Indians, who have been trained in exercise and group leadership.

Evaluation. The IHS maintains an active registry of all known diabetic patients in Zuni listed by patient name, patient number, age, sex, and birth date. For this study, an individual met the criteria for NIDDM if he/she had *1*) fasting blood glucose ≥140 mg/dl on at least two occasions or *2*) blood glucose ≥200 mg/dl 2 h after a 75-g glucose challenge on two occasions. Participants were defined as individuals who had NIDDM and had attended at least one exercise session. Thirty patients met the definition of participant, representing 14% of the 220 people participating in the exercise sessions and 7% of the 406 patients in the NIDDM registry as of September 1985.

We used a random-start method to select a comparison group from the registry of patients with NIDDM. The nonparticipants were matched to participants for residence, age (±2 yr), sex, health-care provider, and duration of NIDDM (±2 yr). Fifty-six nonparticipants were selected, 2 nonparticipants for each participant except 4, for whom only 1 match could be found. All patients were seen in the diabetic clinic; had received similar verbal counseling and written instructions regarding medications, diet, and home exercise; and were invited to participate in the exercise program.

We reviewed the medical records of the participants and nonparticipants for weight, height, hypoglycemic medications, fasting blood glucose values, resting blood pressure, complications of diabetes (e.g., neuropathy, retinopathy, and amputation), and history or presence of other diseases (e.g., coronary heart disease, hypertension, renal disease, and stroke). Laboratory and anthropometric values for the participants were abstracted from the closest date before beginning the exercise program and designated *initial values*. All values were recorded within 3 mo of the beginning of the program. The most current values, within 1 mo of 1 October 1985, were designated *follow-up values*. Nonparticipant values were recorded within 1 mo of their matched participant values at the onset and follow-up. Initial fasting blood glucose values were not available in the medical records of two nonparticipants, and follow-up fasting blood glucose values were not available for two other nonparticipants; these people were excluded from analyses of fasting blood glucose changes.

Statistical methods. Values are reported as group means ± SD. Between-group differences were measured by comparing the differences between the net change from initial values to follow-up values. Analysis of covariance and the Wilcoxon ranked-sums test were employed as measures of association (15). Statistical significance was set at $P < .05$. The differences in medication dosage changes are reported as relative-risk (RR) estimates with 95% test-based confidence intervals (CI)(16).

RESULTS

Description of sample. Participants and nonparticipants were of similar age, sex, duration of NIDDM, height, weight, blood pressure, and length of follow-up (Table 1). The prevalences of major diabetic complications among participants and nonparticipants are not shown but were also similar. No one in either group suffered from proliferative retinopathy, a condition for which exercise is contraindicated (17). The participants and nonparticipants represented 21% of the total patient population from the NIDDM registry (n = 406) on the Zuni reservation as of September 1985. They were younger than the registry population as a whole (mean age 54 ± 15 yr). Twenty percent of the participants were male, compared to 42% in the registry population. The mean duration of program attendance was 37 wk, with a mean of 1.7 sessions/wk and a range of 1–102 wk. Thirty-three percent of the participants engaged in exercise sessions for <3 mo. The average length of follow-up was 50 wk, with a range of 4–102 wk. Of the nonparticipants, 18% were identified as having begun a home exercise program during the follow-up period. Forty-three percent of the participants had begun similar programs.

Weight changes. The participants experienced a mean weight loss of 4 kg (range −15 to +14 kg) compared to a mean weight loss of 0.9 kg (range −9 to +17 kg) among the nonparticipants (Table 2). The between-group differences were statistically significant. Of the 30 participants, 25 (83%) lost weight during the follow-up period; 13 (43%) lost >5 kg. Of the 5 participants who failed to lose weight, only 2 gained >5 kg during the follow-up period, whereas the rest gained a mean of 1.8 kg. One woman lost 5 kg during 4 mo of participation in the program. However, she stopped

TABLE 1
Initial characteristics of patients with NIDDM in Zuni, New Mexico

	Participants	Nonparticipants
n	30	56
Age (yr)	42 ± 10	44 ± 10
Male	6 (20%)	12 (21%)
Female	24 (80%)	44 (79%)
Duration of NIDDM (yr)	8 ± 4	9 ± 5
Follow-up (wk)	50 ± 41	51 ± 42
Initial weight (kg)	80.0 ± 13	76.4 ± 15
Height (cm)	160 ± 8	163 ± 5
Initial body mass index (kg/m^2)		
<28	11 (37%)	24 (43%)
28–32	10 (33%)	21 (37%)
>32	9 (30%)	11 (20%)
Initial resting blood pressure (mmHg)	131/79	129/79
Initial fasting blood glucose (mg/dl)	238 ± 93	228 ± 73

TABLE 2
Mean changes in weight, body mass index, and fasting blood glucose for participants and nonparticipants in Zuni Diabetes Project

	Participants (n = 30)	Nonparticipants (n = 56)
Weight (kg)	−4.09 ± 4.9	−.91 ± 3.9
Body mass index (kg/m^2)	−1.50 ± 2.2	−0.40 ± 1.3
Fasting blood glucose (mg/dl)	−43 ± 78	−2 ± 67

Between-group differences are statistically significant ($P < .05$).

participating after 4 mo and over the next 12 mo gained 19 kg. The nonparticipants were less likely to lose weight; 31 (55%) lost weight, and only 5 (9%) lost >5 kg. The participants showed a significant decrease in body mass index from 31 to 29.5 kg/m^2, compared to no significant change among the nonparticipants. Although the male participants demonstrated a weight-loss pattern similar to that of the female participants, the male participants' weight loss compared with that of the male nonparticipants was not statistically significant (−3.2 vs. −2.3 kg, P = .18).

When the data were examined on the basis of duration of participation in the exercise sessions, there was evidence of a dose-response relationship. That is, participants attending sessions for the longest period (>52 wk) showed the greatest amount of weight loss (mean 9 kg), whereas those participating <8 wk had the least amount of weight loss (mean 2 kg). There was a similar pattern seen for fasting blood glucose levels.

Changes in fasting blood glucose. Participant mean fasting blood glucose values dropped significantly from 238 to 195 mg/dl. The nonparticipants experienced an insignificant drop from 228 to 226 mg/dl. The between-group differences were statistically significant. Nine (30%) participants developed normal fasting blood glucose levels (≤140 mg/dl). In contrast, only five (9%) nonparticipants developed normal blood glucose levels.

The fasting blood glucose changes were different among the male and female participants. Female participants (n = 24) had a mean drop in fasting blood glucose of 55 mg/dl, compared to an 8-mg/dl increase among the male participants (n = 6). However, the mean initial fasting blood glucose level for females was significantly higher than for males (248 vs. 197 mg/dl), and at the time of follow-up the females had experienced a drop to a mean level similar to that of the males (205 mg/dl). A similar discrepancy was seen between the initial fasting blood glucose levels of the nonparticipant males and females, which persisted throughout the follow-up period without any net change.

Changes in medication regimen. Figure 1 shows changes in hypoglycemic agent use during the study among both participants and nonparticipants. Before enrollment, 43% of participants and 48% of nonparticipants were taking only exogenous insulin. Two (7%) of the participants and none of the nonparticipants were initially taking both insulin and oral agents. Thirty percent of participants and 29% of nonparticipants were taking oral agents only. During exposure to the program, 7 (29%) of 24 participants who were initially on hypoglycemic agents were completely withdrawn from them, compared to only 3 (7%) of 43 nonparticipants (RR = 4.2; 95% CI = 1.3–13.3). Hypoglycemic medication dosage was examined over the study period for alterations in prescribed dose. Three (10%) of the participants increased their hypoglycemic agent dose, whereas 8 (27%) kept the same dose, and 19 (63%) decreased their dose. These changes were significantly different from those seen among the nonparticipants, 8 (14%) of whom increased their dosage, 32 (57%) of whom kept the same dose, and 16 (29%) of whom decreased their hypoglycemic agent dosage. The participants were >2 times as likely to have decreased their medication as the nonparticipants (RR = 2.2; 95% CI = 1.3–3.7).

A decrease in insulin dose may lead to a slight decrease in weight (18).Therefore, we examined changes in body weight among the 13 participants and 11 nonparticipants who had decreased their insulin doses. The participants lost a mean of 4 ± 5 kg, and the nonparticipants lost a mean of 0.9 ± 3 kg ($P < .05$).

To examine the potential influence of sex, age, body mass index, and duration of diabetes on weight loss and fasting blood glucose, we stratified the data by gender, age group (<30, 30–50, >50 yr), body mass index (<28, 28–32, >32 kg/m^2), and duration of diabetes (<7, ≥7 yr). The stratified results were essentially the same as the unstratified results. The only exception was that the six male participants had no decline in mean fasting blood glucose.

DISCUSSION

Participation in a community-based exercise program can successfully facilitate weight loss in a group of Native Americans with NIDDM. Furthermore, participation can improve metabolic control of diabetes, as shown by improvements in fasting blood glucose values and decreased need for insulin and/or oral hypoglycemic agents. The Zuni Diabetes Project enabled us to evaluate the effects of a community-wide intervention. To our knowledge, this is the largest group of patients with NIDDM enrolled in an evaluated community-based program.

Some limitations of our study make evaluation of this program more difficult. Specific dietary information was not available in this study. However, the probability that diet alone could explain the differences is highly unlikely, particularly in light of dietary failure reported in other studies (19,20). Unfortunately, we were unable to follow our patients prospectively to evaluate the impact of the exercise programming. In addition, information from medical records may be inaccurate or incomplete.

Future studies should emphasize a prospective study design with standard pre- and postprogram measures such as body weight and composition, multiple fasting blood glucose values, glycosylated hemoglobin measures, measures of fitness, and a more complete psychological and behavioral profile of participants and nonparticipants.

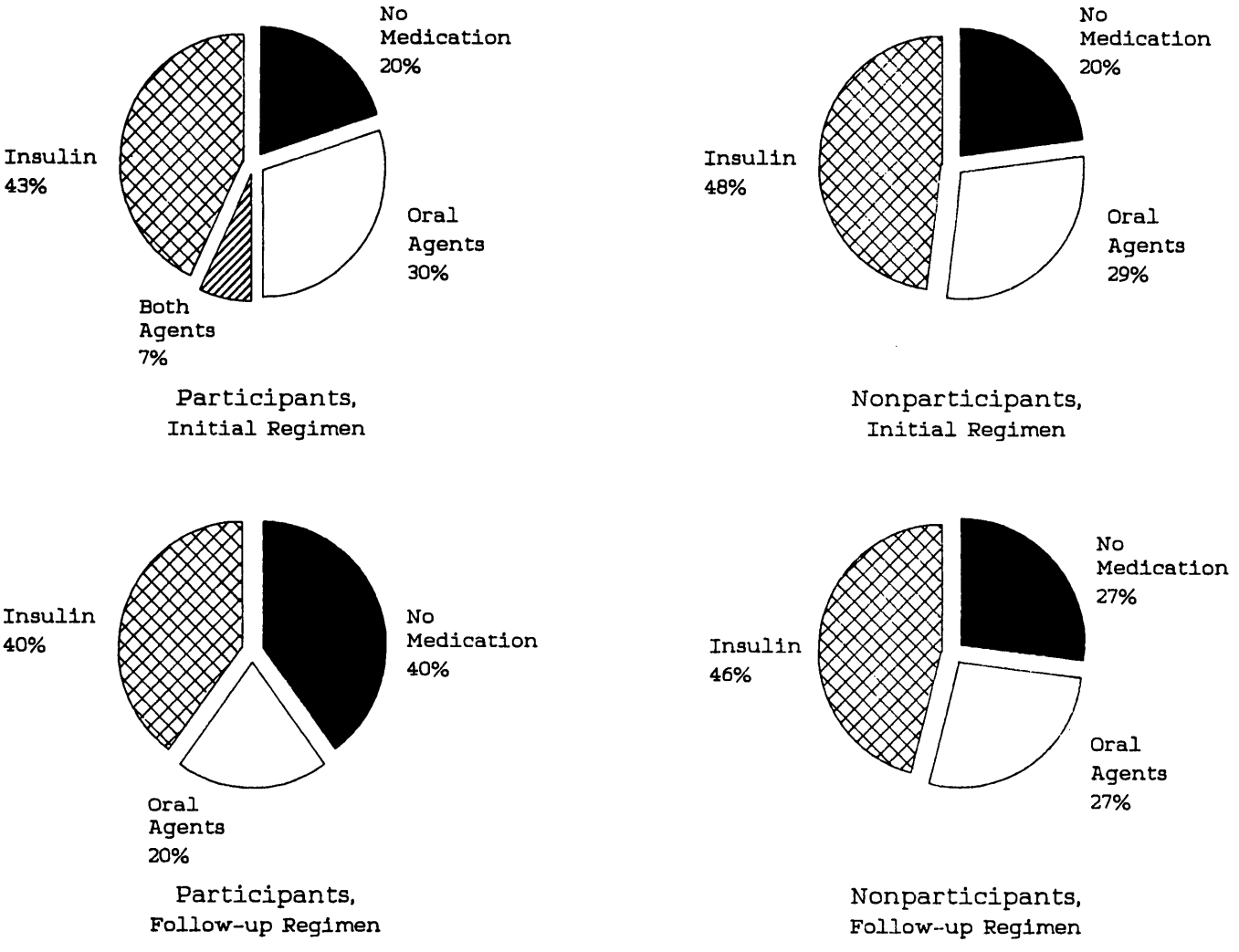

FIG. 1. Hypoglycemic agent status. Zuni Diabetes Project initial and follow-up regimens.

Compared with all diabetic individuals in the registry, participants were more likely to be younger and to be women. In addition, participants' initial body mass index was slightly greater than that of the nonparticipants, although not significantly. However, when stratified by age, duration of diabetes, and body mass index, the changes in weight, fasting blood glucose, and hypoglycemic agent use were no different from the unstratified results. These findings suggest that age, duration of diabetes, and body mass index did not influence the effect of participation on the metabolic outcomes. Therefore, it is participation in the program, and not these characteristics, that leads to success.

Our study also suggests the possibility of different responses by men and women to the intervention. The numbers are too small, however, to draw any definitive conclusions about these differences. By combining the male and female results, the measured effectiveness of the program is actually reduced. We believe that modifying the program to make it more appealing or accessible to men or to older people should produce equivalent changes in weight loss, fasting blood glucose, and hypoglycemic agent usage.

Further evidence for the success of the program was the apparent dose-response effect. When the data are stratified by duration of participation, the numbers become too small for testing significance. However, the greater changes in weight and fasting blood glucose levels among participants who had attended more exercise sessions lend support to our findings.

Eighteen percent of the nonparticipants had initiated home exercise during the study period. Thus, the program's physical activity message appears to have diffused into the Zuni community. If our nonparticipants could have been selected from another community where the exercise message had not been promoted, then we might have measured even greater differences between our participants and nonparticipants.

Because obesity increases the likelihood of developing NIDDM (5,6), intervention programs have recently focused on weight reduction as a method of improving metabolic control in patients with NIDDM. Studies have employed various clinic-based intervention strategies for weight reduction, including increased exercise (20–22). Results from

these studies have yielded modest average reductions in weight ranging from 1 kg after 10 wk of intervention up to 5 kg after 6 mo. One study showed weight loss of 6.4 kg after 4 mo of intervention; however, at a 16-mo follow-up, patients had gained back more than half of this weight (20). The Zuni Diabetes Project is not really comparable with other clinic-based intervention studies with defined termination points. Rather, the project emphasizes reinforcement of exercise behavior by offering numerous exercise sessions at multiple community sites and providing multiple exposures to the exercise message throughout the community. Another major difference from clinic-based studies is the continuous nature of program delivery rather than a time-limited exposure.

The Zuni community is unique because of its geographical location and the tradition of the Zuni as a socially close-knit people. However, we believe that community-based intervention for the prevention and control of NIDDM merits further investigation and may have application in other community settings.

In summary, this preliminary study has demonstrated the effectiveness of a community-based exercise program in facilitating weight loss and improved metabolic control in a group of Native American Indians with NIDDM. Further studies must be completed with more patients to document any long-lasting effects on NIDDM and its associated complications in this population.

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