

A Systematic Review of Interventions to Improve Diabetes Care in Socially Disadvantaged Populations

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OBJECTIVE — To identify and synthesize evidence about the effectiveness of patient, provider, and health system interventions to improve diabetes care among socially disadvantaged populations.

RESEARCH DESIGN AND METHODS — Studies that were included targeted interventions toward socially disadvantaged adults with type 1 or type 2 diabetes; were conducted in industrialized countries; were measured outcomes of self-management, provider management, or clinical outcomes; and were randomized controlled trials, controlled trials, or before-and-after studies with a contemporaneous control group. Seven databases were searched for articles published in any language between January 1986 and December 2004. Twenty-six intervention features were identified and analyzed in terms of their association with successful or unsuccessful interventions.

RESULTS — Eleven of 17 studies that met inclusion criteria had positive results. Features that appeared to have the most consistent positive effects included cultural tailoring of the intervention, community educators or lay people leading the intervention, one-on-one interventions with individualized assessment and reassessment, incorporating treatment algorithms, focusing on behavior-related tasks, providing feedback, and high-intensity interventions (>10 contact times) delivered over a long duration (≥6 months). Interventions that were consistently associated with the largest negative outcomes included those that used mainly didactic teaching or that focused only on diabetes knowledge.

CONCLUSIONS — This systematic review provides evidence for the effectiveness of interventions to improve diabetes care among socially disadvantaged populations and identifies key intervention features that may predict success. These types of interventions would require additional resources for needs assessment, leader training, community and family outreach, and follow-up.

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D iabetes affects at least 171 million people worldwide and is dramatically increasing in many countries as a consequence of increased obesity, sedentary lifestyle, and aging populations (1). Certain population subgroups are at higher risk of acquiring diabetes including nonwhite ethno-racial groups and those with low socioeconomic status (SES) (2). These same groups are often at

higher risk of late diagnosis, poor diabetes control and self-management, the development of diabetes-associated complications, and more frequent emergency room visits and hospitalizations (3–8).

Interventions to improve diabetes outcomes can be directed at individuals with diabetes, health providers, or the health system. Patient-level interventions include those directed at improved self-

management, including medication taking, diet, exercise, self-monitoring, and appropriate use of health care services (9). Continuing professional education and knowledge translation activities are examples of strategies intended to improve health provider care (10–13). Health system changes with the potential to improve access to care and quality of care include expanded hours of service, language translation, case management, reducing financial barriers to health providers and medications, and changes in health care provider roles (14,15).

When interventions are designed for general populations, however, disadvantaged groups may not be reached or may not be able to take full advantage of the opportunities provided to them. Socially disadvantaged groups may experience difficulties with language, cultural beliefs, transportation, getting time off work, child care, and low health literacy in addition to financial barriers to care. Given that these factors can influence uptake, interventions designed to reduce health inequalities may need to be targeted to specific audiences and place special emphasis on the way programs are designed and delivered to promote access to and use of resources and services (16).

In this systematic review, we define socially disadvantaged groups as those that have low SES or belong to an ethno-racial minority. We conceptualize social disadvantage as related to patient, provider, and health system factors that can affect self-management and provider management and ultimately manifest as clinical outcomes. The objective of this systematic review is to identify and synthesize evidence about the effectiveness of patient, provider, and health system interventions to improve diabetes care among socially disadvantaged populations.

RESEARCH DESIGN AND METHODS

Inclusion criteria

We included studies that targeted interventions toward socially disadvantaged adults with type 1 or type 2 diabetes and that were conducted in industrialized

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Abbreviations: SES, socioeconomic status.

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

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countries and measured self-management, provider management, or clinical outcomes. Self-management includes home glucose monitoring, regulation of diet and exercise, adherence to and self-adjustment of medications, and attendance at office appointments when needed or as scheduled by the provider. Provider management includes diagnostic testing, prescribing, educational and behavioral counseling, and referrals. Clinical outcomes include measures of fasting blood glucose, glycosylated hemoglobin (A1C), blood pressure, BMI and lipids, and patient-oriented outcomes of hospitalization, mortality, diabetes complications, and quality of life. To be included, studies had to be randomized controlled trials, controlled trials, or before-and-after studies with a contemporaneous control group. Articles written in all languages were included. Studies were excluded if they focused on specific age-groups such as youth, targeted only gestational diabetes, included only hospital process-of-care measures, or did not clearly specify the socially disadvantaged group being studied.

Search strategy

In consultation with an information specialist, electronic databases, including Medline, Embase, Cinahl, HealthStar, Cochrane Library, Sociological Abstracts, Social Science Citation Index, and International Pharmaceutical Abstracts, were searched for relevant studies from articles published in any language between January 1986 and December 2004. The references of review articles and of included original publications were also screened for potentially relevant studies.

Methods of the review

Two reviewers (N.R.K. and K.W.) independently screened citations and abstracts to identify articles potentially meeting the inclusion criteria. For those articles, full text versions were retrieved and independently screened by two reviewers to determine whether they met inclusion criteria. Disagreements about whether the inclusion criteria were met were resolved through discussion with a third reviewer (J.B. or R.H.G.).

Data extraction

Data extraction of relevant study information for articles meeting inclusion criteria was performed independently by two reviewers (N.R.K. and K.W.). Disagreements were resolved through discussion.

A data extraction form was used to collect information on type of social disadvantage (low SES population or specific ethno-racial group), study objectives, study design, setting of intervention, study population (including demographics, SES, and health insurance), measures and scales used, and main findings.

To systematically describe the scope and components of the interventions, specific features were extracted from each intervention article using main components that have been previously described for the taxonomy of diabetes interventions by Elasy et al. (17). We extracted the main target of the intervention (patient, provider, or health system); type of needs assessment conducted, tailoring to the population; components of the intervention; diabetes-related content; timing/intensity; and the provider of the intervention. For articles that referenced previous publications (e.g., describing needs assessments or interventions), the original publication was retrieved and relevant data summarized.

Validity assessment

To assess the methodological quality of the intervention studies, we adapted the criteria suggested by Jadad et al. (18) if the study was described as randomized, if the sequence of randomization was described and appropriate, and if there was a description of withdrawals and dropouts. We did not assess blinding, as the types of interventions under study could not be blinded. We also assessed whether there was an adequate description of the intervention.

Data analysis

Due to heterogeneity of populations, interventions, and outcomes, it was not possible to combine outcomes in a meta-analysis. As an alternative, we used a recently described method to identify specific features of interventions that are likely to be associated with successful or unsuccessful outcomes (19). A total of 26 features were identified based on five categories: 1) target of the intervention, 2) how the intervention was designed, 3) setting of the intervention, 4) how the intervention was delivered, and 5) intensity and duration of the intervention (listed in Table 3). For each intervention, two reviewers (J.B. and N.R.K.) independently determined the absence or presence of these specific features. Disagreements were resolved through discussion with a third reviewer (R.H.G.).

Next, two reviewers (R.H.G. and N.R.K.) independently assessed whether the intervention resulted in a positive outcome that was both statistically and clinically significant. Statistical significance was set at $P < 0.05$, but due to the large number of possible outcomes, no predefined criteria for clinical significance were established. Instead, each reviewer provided a global judgment about clinical importance. In circumstances where studies reported multiple types of outcomes, judgments were primarily based on clinical measures. For studies that did not report clinical measures, provider management and self-management outcomes were used to make judgments. For each of the 26 features, we calculated the percentage success rate with and without the feature (percent of articles with the feature having positive outcomes minus percent of articles without the feature having positive outcomes). Positive and negative rate differences indicated that interventions with and without the feature, respectively, were more often associated with positive study results. Due to the small number of articles included, CIs were not calculated and we limited judgments about features to those that appeared in at least five included studies. Our use of this analytic approach was therefore more descriptive than quantitative. To assess whether our findings were related to the methodological quality of the included studies, two sensitivity analyses were performed as follows. 1) Studies were limited to those with a randomized controlled design, and 2) studies with randomized controlled designs were further limited to those in which randomization was described and appropriate and which had a description of withdrawals.

RESULTS

Description of studies

The initial search identified a total of 16,750 citations. After scanning titles of the citations, 615 were accepted for further screening and complete abstracts of these studies were reviewed. Of these, 163 citations were identified as potentially meeting the inclusion criteria. In addition, five articles were identified when scanning bibliographies of relevant published articles in the field. After examination of full text articles, 17 intervention studies (20–36) were included in the review. Common reasons for exclusion were that the population under study did not meet the criteria for a socially disad-

vantaged population and/or there was no comparison group involved.

The characteristics of included studies appear in Table 1. Among the 17 studies, 7 (21,22,24,27,28,31,36) targeted low SES populations and 10 (20,23,25,26,29,30,32–35) focused on specific ethno-racial groups, including African Americans (23,25,26,30,32,33), Mexican Americans (29,34), and Native Americans (33). Ten studies (21,22,25,28,29,30,32–34,36) were randomized controlled trials, two (26,27) were prospective controlled trials, and five (20,23,24,31,35) were comparative studies. Four studies (29,32,34,35) were community based, 10 (20,22–28,30,31) took place in primary care settings, and 3 (21,33,36) were hospital based.

Eleven (20–23,27,29–33,35) of the 17 studies were judged by two reviewers to have both statistically and clinically significant positive outcomes. Due to the modest sample size of these studies, none were found to have statistically significant results that were not of clinical importance. Interventions were associated with significant improvement in A1C in 8 (20–23,27,29,31,33) of 13 studies, weight/BMI in 2 (33,35) of 9, lipids in 2 (20,23) of 7, blood pressure in 2 (21,25) of 4, dietary intake in 0 of 4, eye examination in 3 (20,23,32) of 3, American Diabetes Association care indicators in 2 (23,28) of 3, physical activity in 1 (30) of 3, diabetes knowledge in 2 (29,30) of 2, physician trust in 1 (28) of 1, and mental and social well-being in 0 of 1 study.

Methodological quality

Ten (21,22,25,28–30,32–34) of 17 studies were described as randomized trials. The randomization process was described and appropriate in 6 (22,25,28,30,32,33) of 10 studies, all of which also had a description of withdrawals and dropouts and all had a well-described intervention.

Description of features of the interventions

Table 2 describes the features of the interventions. Some of the studies targeted more than one level; specifically, 12 (21,22,25,27–30,32–36) of 17 studies targeted the intervention at the patient level, 1 intervention (24) targeted the provider level, and 7 interventions (20–23,25,26,31) targeted the system level. Three (27,29,30) of 17 studies described or referenced previous work (37,38) related to a needs assessment that had guided the development or adaptation of

the intervention to their specific socially disadvantaged population (27,29,30). This generally included conducting meetings with staff involved with the patient group, conducting a needs assessment using community focus groups with the target population, testing of educational materials to ensure cultural appropriateness, or adapting the educational materials to low health literacy standards.

Ten (21,22,24,27–30,33,34,36) of 17 studies described how specific aspects of the intervention were tailored to the socially disadvantaged population and described how the intervention was designed to meet the needs of the specific study population. Eight (21,22,24,29,30,33,34,36) of 17 studies considered literacy and language of the populations. Culturally specific references were used and described in five studies (22,29,30,33,34). Common materials that were used to adapt interventions included video and written materials; incorporated appropriate languages, cultural beliefs, and social values; targeted for low health literacy; and included records or logs that focused on recording behavioral modifications.

Six (28,29,30,33,34,36) of 17 studies provided diabetes education as the main focus of their intervention. Educational interventions used a variety of delivery methods including didactic lectures, skill building, problem solving, behavioral strategies (e.g., exercise), feedback (e.g., diaries), family member participation, and/or individualized assessment.

Six (20–23,25,31) of 17 studies delivered an intervention that focused on innovative health care provider roles. These included individualized assessment using treatment algorithms by nurse case managers and clinical pharmacists and coordination of care by community health workers.

Other studies described interventions that were more focused on specific aspects of diabetes-related care. These included physical activity sessions (35), a focused education and support intervention to improve ophthalmic examinations (32), implementation of a visual communication tool (27), reminder cards for diabetes care indicators (24), and rapid A1C testing (26).

Analysis of features

We identified 26 features of the diabetes interventions (Table 3). Eight of these features appeared in fewer than five studies each, limiting any judgment about their

effectiveness. Among the remaining 18 features, 13 were associated with positive rate differences and thus were more likely to be associated with successful interventions in socially disadvantaged populations. Features found in multiple studies with more consistent effects included cultural tailoring of the intervention, use of community educators or lay people leading the intervention, one-on-one interventions with individualized assessment and reassessment, use of treatment algorithms by various health care providers, focus on behavior-related tasks in the intervention, use of feedback about patient's control of disease or performance, and high-intensity interventions (>10 contact times) delivered over a long duration (≥6 months). Interventions in multiple studies that were associated with the largest negative rate differences included those that used mainly didactic teaching or that focused only on diabetes knowledge.

Sensitivity analyses limiting results to only higher methodological quality studies indicated that most of the features had similar rate differences (remained positive or negative in the analysis), except that use of feedback to patients and treatment algorithms had an inconsistent pattern.

CONCLUSIONS — The results of this systematic review provide reason for optimism that interventions for socially disadvantaged populations can be effective and have the potential to reduce health disparities in diabetes care and outcomes. They also have practice and policy implications. The results indicate that short-term group-based didactic teaching aimed at improving diabetes knowledge may be of limited value for disadvantaged populations. To be successful, interventions appear to require organizational inputs and resources that go well beyond traditional diabetes education programs. The time and effort required to adapt interventions to the local community is likely to yield important benefits but must be done in each setting to fit local circumstances. The key aspects of tailoring in the reviewed studies were for culture and health literacy, both of which require substantial expertise and knowledge of local communities. Achieving a high degree of responsiveness to individual needs and making extensive use of behavioral methods requires one-on-one attention by highly trained personnel, again, with significant resource implications. If those personnel are community members, additional time and effort is required for

Table 1—Intervention studies

Author(s)	Social disadvantage	Objective(s)	Study design	Setting of intervention	Study population	Measures	Main findings (intervention versus control groups)
Fanning et al. (2004) (20)	Hispanic	To compare treatment algorithms versus usual care for patients with type 2 diabetes.	Comparative study. Three groups were assessed: 1) community clinic following treatment, 2) university clinic following treatment algorithms, and 3) community clinic following usual care practices.	Three community-based outpatient health care facilities in San Antonio, Texas, serving mainly low-income Spanish-speaking populations.	A total of 106 participants were in group 1, 170 in group 2, and 82 in group 3; mean age 43–48 years, 41–60% Mexican American, 41–60% employed, and mean highest grade achieved 8–10.	Primary end point was A1C. Secondary end points were fasting blood glucose, lipids, blood pressure, weight, and foot and eye examinations performed. Length of follow-up was 12 months.	Treatment algorithm groups had greater reductions in A1C (group 1: 3.1% change; group 2: 3.3% change) versus control subjects (1.3% change) ($P < 0.0001$). Treatment algorithm groups had greater reduction in LDL cholesterol ($P < 0.0001$). No differences between the groups were noted for blood pressure or weight reduction. Treatment algorithm groups had more documented eye exams ($P < 0.0001$) and foot exams ($P < 0.0001$) versus control subjects.
Rothman et al. (2004) (21)	Low SES	To examine the role of literacy on the effectiveness of a comprehensive disease management program for patients with diabetes.	Randomized controlled trial. Participants were randomly assigned into an intervention or usual care.	University general internal medicine practice in North Carolina.	A total of 105 participants were in the control group and 112 patients in the intervention group broken down into high- and low-literacy groups; mean age 51–56 years, ~58% female, and more than one-third had low literacy (sixth grade level or lower)	Literacy was assessed using the Rapid Estimate of Adult Literacy in Medicine. Outcome measures were A1C and systolic blood pressure. Length of follow-up was 12 months.	Greater improvements in levels of A1C (-2.1%) versus control subjects (-1.2%) at 12 months (adjusted difference, -1.0% [95% CI -1.5 to -0.4]; $P = 0.001$). This difference was only significant among participants with low literacy (adjusted difference, -1.4% [-2.3 to -0.6]; $P < 0.01$). Greater improvement in systolic blood pressure (adjusted difference, -7.6 mmHg [-13.0 to -2.2]; $P = 0.006$). Differences were comparable for participants with low and higher literacy levels.
The California Medi-Cal Type 2 Diabetes Study Group (2004) (22)	Low SES	To determine whether intensive diabetes case management using specific, population-directed, case management strategies could improve glycemic control in type 2 diabetes	Randomized controlled trial. Participants were randomized to receive intensive case management or usual care.	One community-based and two university-based sites in Santa Barbara, California; Medicaid, Los Angeles and San Diego counties.	A total of 171 participants were in the intervention group and 146 in the control group; mean age 57 years, 71% female, ~20% African American, 39% Hispanic, and 80% did not have education > 12 th grade.	Primary end point: A1C. Secondary end points: weight, blood pressure, and lipids. The mean duration of follow-up was 25.3 months.	Greater reduction in A1C (-1.88%) versus control subjects (-1.13% at 36 months) ($P < 0.01$ in every time period). Greater reduction in achieving specified A1C levels (≤ 6.5 , ≤ 7.0 , and $\leq 7.5\%$, $P < 0.01$). There were no statistically significant changes in secondary end points including weight, blood pressure, and lipid levels between the groups.
Davidson (2003) (23)	African American and Hispanic	To determine whether diabetes care directed by nurses following detailed protocols and algorithms and supervised by a diabetologist results in meeting evidence-based guidelines more often than under usual care.	Comparative study. Participants were referred to the diabetes managed care program from two county clinics (Clinics A and B). Clinic C patients were used as control subjects.	Three county clinics in Los Angeles, California.	A total of 252 participants were referred to clinic A, 252 to clinic B, and 209 to clinic C; 66–76% female, mean age 52 years, 2–19% African American, and 79–85% Hispanic.	ADA process measures. The time period of the study was 2 years.	Of 10 ADA process measures, 8 were significantly better performed among patients receiving nurse-directed care including A1C goal, lipid profile, eye exam, renal profile, foot exam, diabetes education, and nutritional counseling (all P values < 0.01). Among patients followed for ≥ 6 months, A1C fell by 3.5% in the nurse-directed group and 1.5% in usual care ($P < 0.0001$).

Echevery et al. (2003) (24)	Low SES	To determine whether a low-literacy diabetes educational reminder card would enhance process measures of diabetes care.	Comparative study. Medical charts were reviewed for the intervention site and compared with diabetic patients seen on the same day at a nonintervention site.	County clinics in Los Angeles, California, serving an underserved minority population.	A total of 209 medical charts were reviewed in the intervention site and 218 in the nonintervention site; mean age 53 years, 67% female, and majority of the population was Hispanic and African American.	ADA process measures including completed foot exam, urine protein, and lipid panel. Length of follow-up was 1 month.	Intervention and nonintervention participants who met process measures were 48 and 95% for foot exam, 67 and 89% for urine protein, and 35 and 45% for lipid panel, respectively. No <i>P</i> values were reported.
Gary et al. (2003) (25)	African American	To determine whether a multifaceted, behavioral intervention implemented by an NCM and/or CHW could improve A1C and other indicators of diabetes control in type 2 diabetic subjects.	Randomized controlled trial. Four arms: usual medical care (control), usual medical care + NCM, usual medical care + CHW, and usual medical care + NCM + CHM (combined team) interventions.	East Baltimore, predominantly African-American inner-city community.	A total of 34 participants completed the study in the usual care group, 38 in the NCM group, 41 in the CHW group, and 36 in the combined intervention group; mean age 59 years, mean level of education attained was grade 10, and 50% of the participants had a yearly income of \leq \$7,500.	A1C, LDL cholesterol, triglycerides, blood pressure, dietary risk score, leisure-time physical activity index, and BMI. Length of follow-up was 2 years.	The combined team intervention group demonstrated a statistically significant improvement in triglycerides (-35.5 mg/dl, $P = 0.041$) and diastolic blood pressure (-5.6 mmHg, $P = 0.042$) from baseline compared with the control group. No other changes were significantly different between groups.
Miller et al. (2003) (26)	African American	To determine whether rapid-turnaround A1C availability would improve intensification of diabetes therapy and reduce A1C levels in patients with type 2 diabetes.	Prospective controlled study. Patients were allocated by day of the week to a "rapid" group with A1C results at the time of the visit or a "routine" group.	Neighborhood primary care clinic in Atlanta, Georgia.	A total of 280 participants were enrolled in the routine group and 317 in the rapid group; mean age 61 years, 78% female, and ~96% African American.	Frequency of intensification of diabetes therapy; A1C levels. Average length of follow-up was 7 months.	The average A1C level decreased from 8.4 to 8.1 in the rapid group ($P = 0.04$) and from 8.1 to 8.0 in the routine group ($P = 0.31$), but between-group results were not provided. Among participants with A1C $\geq 7\%$, providers intensified diabetes therapy in 51% of the rapid patients compared with 32% of the routine participants ($P = 0.0003$). There were no significant differences between the rapid and routine groups in the amount of change of medications.
Chapin, Williams, and Adair (2003) (27)	Low SES	To develop and test an inexpensive visual tool, the THDR, to help patients with diabetes improve glycemic control.	Prospective controlled study. Patients were assigned by the first letter of the last name of their primary care resident physician into either intervention or usual care groups.	Primary care clinic in an inner-city neighborhood in Minneapolis, Minnesota.	A total of 57 participants in the intervention group and 70 participants in the control group; mean age 52 years, 53% female, ~60% had Medicaid and 20% had no insurance, 30% African American, 20% recent immigrant, and 5% Native American.	A1C at least 3 months after the first use of the THDR. Length of follow-up was 15 months.	Greater decrease in mean A1C versus control subjects ($P = 0.047$). A total of 51% achieved a decrease in A1C ≥ 0.9 vs. 18% of control subjects. The mean change in A1C was greater in patients who used the THDR four or more times.
Clancy et al. (2003) (28)	Low SES	To evaluate group visits in the management of uninsured patients with uncontrolled type 2 diabetes.	Randomized controlled trial. The intervention group received group visits and the control group received usual care.	Adult Primary Care Centre at the Medical University of South Carolina in Charleston, South Carolina.	A total of 120 participants: 77.5% African American, 78% female; average age 54 years (range 22–83); mean reported educational level 10.6 years; average literacy level grade 7.5, 44.3% had Medicaid, 19.1% had Medicare, and 30% had no insurance; and 23% reported working either full- or part-time.	Trust in Physician Scale and Patient Care Assessment Tool and ADA standards of care indicators. A1C and lipids. Follow-up at 2 weeks, 3 months, and 6 months.	No statistically significant differences were seen in diabetes or lipid control at 3 and 6 months. Statistically significant improvement was seen in compliance with the ADA process-of-care indicators at the last group visit ($P < 0.001$). Significantly higher scores in the Trust Physician Scale ($P = 0.02$) versus control subjects.

Continued on following page

Table 1—Continued

Author(s)	Social disadvantage	Objective(s)	Study design	Setting of intervention	Study population	Measures	Main findings (intervention versus control groups)
Brown et al. (2002) (29)	Mexican American	To determine the effects of a culturally competent diabetes self-management intervention in Mexican Americans with type 2 diabetes.	Randomized controlled trial. The experimental group was compared with a 1-year wait-listed control group who received usual care.	Starr County, Texas, on the border of Mexico.	A total of 126 participants were in the experimental group and 126 in the control group. Eligibility was aged 35–70 years, mean age 54 years. Most spoke Spanish at home and ~50% read little or no English. Starr County is characterized by high unemployment (24.4%) and low per capita income (\$8,225).	Diabetes-related knowledge, health beliefs, A1C, fasting glucose, lipids and BMI. Length of follow-up was 12 months.	After controlling for baseline measures, A1C was significantly lower at the end of the study versus control subjects ($P = 0.011$). Lower fasting blood glucose and diabetes knowledge ($P = 0.019$ and <0.001 , respectively versus control subjects). There was an increase in diabetes knowledge of 6.7 items correct (18% on the diabetes knowledge scale ($P < 0.001$) versus control subjects. No statistically significant differences were observed between experimental and control groups in lipids, BMI, or health beliefs.
Keyserling et al. (2002) (30)	African American	To determine whether a culturally appropriate clinic- and community-based intervention for African-American women with type 2 diabetes increases moderate-intensity physical activity.	Randomized controlled trial. Three groups: 1) clinic and community, 2) clinic only, and 3) minimal interventions.	Five primary care practices in central North Carolina.	A total of 200 participants: African-American women, mean age 59 years; ~30% reported total household income of $< \$10,000$ /year; ~30% were employed.	The primary outcome was physical activity by Caltrac accelerometer for 7 days. Diabetes knowledge, dietary intake, diabetes health status instruments, A1C, total cholesterol, HDL, and weight. The length of follow-up was 12 months.	The average 6- and 12-month difference in physical activity measured by kcal/day was 44.1 in group 1 compared with group 3 ($P = 0.0055$) and 33.1 in group 2 compared with group 3 ($P = 0.029$). At 12 months, physical activity was higher in group 1 compared with group 2 ($P = 0.019$) but not in group 2 compared with group 3 ($P = 0.31$). There was an increase of 1.6 points in diabetes knowledge in group 1, 1.2 points in group 2, and 0.7 points in group 3. The P value for the test of overall group effect at 6 and 12 months was 0.037. No statistically significant differences were found between the groups for dietary intake, total cholesterol, HDL, A1C and weight, and health status at 6 months.
Davidson et al. (2000) (31)	Low SES	To evaluate care in a diabetes management program carried out by pharmacists in a general free medical clinic setting compared with usual care in the same clinic.	Comparative study. The experimental group was referred to the pharmacist-run diabetes management program; the control group was randomly selected from diabetic patients not seen in the pharmacy clinic.	Venice Family Clinic in Los Angeles County, California.	A total of 89 participants in the experimental group and 92 participants in the control group. Patient representing the cohort selected: 92% no medical insurance, 15.6% homeless, 60.1% female, 64.3% Hispanic, 20.3% Caucasian, 9.5% African American, 2.5% Asian, and 0.6% Native American.	A1C. The length of the study was 12 months.	Greater prevalence of insulin use, diabetes complications, hypertension, and initial values of A1C versus control subjects (8.8 vs. 7.9). A1C improved significantly (0.8 reduction versus 0.05 reduction in the control group; $P < 0.03$).
Basch et al. (1999) (32)	African American	To evaluate a multicomponent educational intervention to increase ophthalmic examination rates.	Randomized controlled trial. The intervention group received routine care plus the educational intervention; the control group received only routine care.	General medicine clinics at five different sites in the New York City metropolitan area.	A total of 280 African-American participants: 34% male, 70% unemployed, 50% high school graduates, 40% received Medicare and 20% received Medicaid, and 65% had a family income $< \$10,000$ /year.	Documented retinal examination within 6 months of randomization.	The examination rates across study sites were 54.7 vs. 27.3% in the control group. The odds ratio for examination status 6 months after randomization associated with the intervention was 4.3 (95% CI 2.4–7.8).

Agurs-Collins et al. (1997) (33)	African American	To evaluate a weight loss and exercise program designed to improve diabetes management in older African Americans.	Randomized controlled trial. The intervention group consisted of group and individual sessions; the control group received usual care.	Urban hospital in Washington, DC, other providers and local community.	A total of 32 participants in each of the intervention and usual care groups, 66–88% women, mean age 62 and 61 years (range 55–79), 56 and 59% high school graduates, and 59 and 56% not employed, respectively.	Nutrition knowledge questionnaire, PASE, food frequency questionnaire, A1C, weight, and self-efficacy for diabetes management. The length of follow-up was 6 months.	Mean weight at 6 months decreased versus an increase in control subjects, overall net difference from baseline of –2.8 kg for women ($P = 0.007$) and –2 kg for men ($P = 0.26$). Decreased A1C at 6 months, a net difference of –2.5% for women ($P < 0.001$) and –1.9% for men ($P < 0.01$) versus control subjects. Significant improvements in physical activity, nutrition knowledge, and dietary intake of cholesterol were observed at 3 months but decreased in magnitude at 6 months and were not statistically significant.
Elshaw et al. (1994) (34)	Mexican American	To assess the impact of a culturally specific, intensive diabetes education program on dietary patterns.	Randomized controlled trial. The intervention group received education sessions; the control group did not.	Clinics and community settings in rural border towns of Harlingen and Brownsville, Texas.	A total of 31 Mexican-American men and 73 women age >50 years with type 2 diabetes; mean age 62 years for men and 60 years for women; low income area.	Twenty-four-hour dietary recall; weight measured at 10 and 14 weeks.	All groups experienced significant weight loss except for experimental female subjects. Weight loss between groups was similar. There was a trend toward decreased caloric intake in all groups over time. Cholesterol did not change.
Heath et al. (1987) (35)	Zuni Indians	To evaluate the effects of a community-based exercise program.	Comparative study. Participants attended at least one exercise session; a matched comparison group was selected using a random-start method from the registry of patients with type 2 diabetes.	Zuni reservation in western New Mexico	A total of 30 participants and 56 nonparticipants: 79 and 80% female, mean age 42 and 44 years, and duration of diabetes 8 and 9 years, respectively.	Weight, fasting blood glucose, and medication use. Study duration was 27 months.	Mean weight loss of 4.1 vs. 0.9 kg among nonparticipants ($P < 0.05$). Decrease in BMI from 31 to 29.5 kg/m ² compared with no significant change among the nonparticipants. Between-group differences in weight were not significant for men. Participants attending sessions for the longest period (>52 weeks) showed the greatest amount of weight loss. Mean fasting blood glucose values dropped significantly from baseline (238 to 195 mg/dl) compared with an insignificant drop in the nonparticipant group (228 to 226 mg/dl). Participants were more than twice as likely to have decreased their medication as nonparticipants (RR 2.2 [95% CI 1.3–3.7]).
Mulrow et al. (1987) (36)	Low SES	To determine whether an education program specifically designed for patients with type 2 diabetes and limited literacy could improve and sustain glucose and weight control.	Randomized controlled trial. Three programs were tailored for intervention, monthly groups, and single didactic lecture.	St. Thomas' Hospital Diabetes Clinic in central London, U.K.	A total of 120 participants: mean age 53 years, 53% female, 50% West Indian, and mean education level 9 years.	Weight, A1C, and lipids. Length of follow-up was 11 months.	No statistically significant differences in changes in A1C, lipids, and weight were found among the three groups at the 11-month follow-up visit.

ADA, American Diabetes Association; CHW, community health worker; NCM, nurse case manager; PASE, Physical Activity Scale for the Elderly Questionnaire; RR, relative risk; THDR, Take Home Diabetes Record.

Table 2—Features of interventions

Author(s)	Target of the intervention	Needs assessment	Tailoring to the population described	Components of the intervention	Diabetes-related content	Timing/intensity	Provider of intervention
Fanning et al. (2004) (20)	Health system	None identified	Not described	Intervention groups received one-on-one individualized medical care from nurse case managers following specific treatment algorithms.	Participants in the intervention group were assessed at each visit using treatment hyperglycemia algorithms. This included review of their blood glucose logs, weight management, self-monitoring of blood glucose, exercise, and education class attendance.	During the 12-month follow-up visit, participants in groups 1, 2, and 3 had 11, 10, and 9 follow-up visits, respectively.	Nurse case managers.
Rothman et al. (2004) (21)	Patient and health system	None identified	Individualized communication including verbal education with concrete, simplified explanations of critical behaviors and goals; “teach-back” to assess comprehension; and picture-based materials.	The intervention consisted of three components: 1) one-on-one educational counseling and medication management sessions; 2) evidence-based treatment algorithms for initiation and titration of blood pressure- and glucose-lowering medications; and 3) strategies to address patient barriers, including transportation difficulties and lack of health insurance.	Main topics addressed in the sessions included treatment goals, identification of hypoglycemic and hyperglycemic symptoms, prevention of long-term complications, and self-care.	Participants were contacted by telephone or in person every 2–4 weeks and followed for 12 months.	Three clinical pharmacist practitioners and a diabetes care coordinator.
The California Medi-Cal Type 2 Diabetes Study Group (2004) (22)	Patient and health system	None identified	Individualized treatment and education strategies designed to address barriers to care. Education strategies considered education, literacy and functional understanding, treatment goals, general health status, cultural beliefs, and support network.	The intervention group received collaborative case management including evidence-based guidelines for glucose, hypertension, dyslipidemia, and medication management; glucose meter and education, general diabetes and self-management education by diabetes educators, and ongoing contact to support ongoing retention. Participants received one-on-one individualized assessment and education.	The case management interventions consisted of blood glucose management; nutrition education and management; exercise, foot care, retinopathy, neuropathy, hypertension, dyslipidemia, and cardiovascular disease assessment management; and regular monitoring of participant progress.	Intensity not specified. Mean duration of follow-up was 25.3 months.	Registered nurses and registered dietitians working in close collaboration with an endocrinologist.
Davidson (2003) (23)	Health system	None identified	Not described	Participants in the intervention group received one-on-one individualized diabetes care from nurses or pharmacists who followed detailed protocols and algorithms under the supervision of a diabetologist.	The protocols and algorithms addressed evaluation and management of glycemic control, lipids, neuropathy, and microalbuminuria.	Intensity not specified. The time period of the study was 2 years.	Clinic A had a full-time nurse, a part-time nurse, and a part-time pharmacist. Clinic B had one full-time nurse.

Echeverry et al. (2003) (24)	Provider	None identified	Reminder cards were developed at the fifth-grade level, and the message was written in English and also in Spanish.	Participants in the intervention sites were given reminder cards to show to their provider at their next regular medical visit to prompt performance of three process measures of diabetes care. The nonintervention group did not receive reminders (usual care). Intervention groups received usual care plus 1) NCM intervention with care coordinated according to clinical practice guidelines, 2) CHW intervention, and 3) NCM + CHW (combined team) intervention.	The reminder card included prompts of three process-of-care measures for diabetes: foot exams, urine protein, and lipid panel.	Intensity not specified. Length of follow-up was 1 month.	Physician
Gary et al. (2003) (25)	Patient and health system	None identified	Not described	Participants in the NCM group received coordinated care according to the ADA clinical practice guidelines. The CHW scheduled appointments, monitored behaviors, mobilized social support, reinforced treatment recommendations, provided education, and provided physician feedback.	Participants in the NCM group received coordinated care according to the ADA clinical practice guidelines. The CHW scheduled appointments, monitored behaviors, mobilized social support, reinforced treatment recommendations, provided education, and provided physician feedback.	NCM and CHW visits were 45–60 min long. A total of 25% of the NCM and 62% of the CHW group had at least three visits over 2 years. Half of participants received at least one telephone intervention.	Nurse case manager and community health workers.
Miller et al. (2003) (26)	Health system	None identified	Not described	During each visit, participants had an A1C measured using a rapid-testing instrument (DCA 2000). Patients were randomized into a "rapid" group, and A1C results were revealed to the provider at the time of the visit, or a "routine" group, and results were revealed to the provider after the patient visit.	A rapid A1C test provided results at the time of the participant visit to assist in treatment decisions.	Study visits included a baseline and two follow-up visits scheduled 2–4 months apart.	Clinic was staffed by three family practitioners, two general internists, and three nurse practitioners.
Chapin, Williams, and Adair (2003) (27)	Patient	Input for design of the intervention obtained through meetings with nurses, resident and staff physicians, social workers, diabetes educators, and a health psychologist.	The development of the intervention tool focused on using visual communication to emphasize achievable patient-specific actions and how these connect with clinical results. Colors (e.g. red, green) were used to indicate agree of acceptability of readings.	The THDR was designed as a patient-physician communication tool. The tool was used during the medical visit to discuss diabetes management and monitoring and was provided to participants after the visit to take home where family could help with the self-care activities.	The THDR included medication taking, home glucose tests, frequency of exercise, frequency of eye exam, and blood glucose and A1C readings.	The form was updated at each visit. Intensity was not specified. Length of follow-up was 15 months.	Physician

Continued on following page

Table 2—Continued

Author(s)	Target of the intervention	Needs assessment	Tailoring to the population described	Components of the intervention	Diabetes-related content	Timing/intensity	Provider of intervention
Clancy et al. (2003) (28)	Patient	None identified	This specific intervention was developed to deliver health information efficiently to patients by a multidisciplinary team, to provide socialization opportunities, and as an alternative to brief one-on-one physician visits.	During the group visit, participants received didactic group education, individualized assessment of needs, and one-on-one consultations with the health care providers if patients needed care in between scheduled visits or if specific medical needs could not be accommodated in the group visit.	The educational components discussed during the group visit included a health-related topic such as nutrition, exercise, sick day management, and stress management.	Two-hour group visits monthly for 6 months.	Group visits were co-led by an internal medicine physician and a diabetes nurse educator.
Brown et al. (2002) (29)	Patient	Formal needs assessment including focus groups with providers, community, and patients; materials designed and adapted for language and culture; effectiveness measures validated; and intervention and intervention pilot tested. (37)	The intervention employed bilingual health care providers from the community, used videotapes with community leaders, and focused on recommendations consistent with population preferences. The intervention was designed to be community based, promote problem solving, provide feedback, and obtain family support and involvement.	The intervention included weekly education group sessions and biweekly support group sessions in local schools, churches, county agricultural extension offices, adult day care centers, and health clinics. Education sessions, predominantly in Spanish, used videotapes and hands on experience (e.g. visits to local grocery store). Social support was fostered through family members and friends, group participants, the intervention team, and community workers.	The education session included nutrition, self-monitoring of blood glucose, exercise, and other self-care topics. The goals of the support group sessions were to promote behavior changes through informal discussion, problem solving, and preparation demonstrations and provided opportunities to discuss problems with managing diabetes.	Twelve 2-h education sessions weekly for 3 months. Support group sessions included 6 months of biweekly and 3 months of monthly 3-h support sessions.	Bilingual Mexican-American nurses, dietitians, and community workers.
Keyserling et al. (2002) (30)	Patient	Needs assessment using 11 focus groups with African-American women to explore diet, physical activity, psychosocial issues, and role of community diabetes advisor. Additional six focus groups for pretesting (38).	The intervention was based on behavior change theory and included individualized tailoring of lifestyle change advice. Educational materials were developed at the fifth- or sixth-grade level, used illustrations, and behavior change recommendations were broken into small achievable steps. A community component was designed to improve cultural relevance as well as to provide social support, feedback, and reinforcement.	Group A received clinic and community intervention including individual counseling visits and two group sessions and monthly phone calls from a peer educator. The community component included a physical activity assessment that facilitated individual tailoring of lifestyle change. Group B received individual counseling visits. Group C were mailed pamphlets published by the ADA.	The community component consisted of 1) a physical activity education component developed to increase moderate-intensity physical activity to a cumulative total of 30 min per day; 2) a dietary education component designed to decrease total and saturated fat intake and to improve control and distribution of carbohydrate intake; and 3) a diabetes care education component addressing various aspects of diabetes self-care.	During the first 6 months, groups A and B received individual counseling visits at months 1, 2, 3, and 4. Group A received two group sessions and monthly phone calls from a peer educator. During the second 6-month period, group A continued to receive monthly phone calls.	Clinic-based counseling by a nutritionist. Community facilitation by diabetes advisors and peer counselors who were African-American women with type 2 diabetes.
Davidson et al. (2000) (31)	Health system	None identified	Not described	Diabetes care in the experimental group was delivered by pharmacists who followed a detailed algorithm written by a diabetologist.	The algorithms addressed evaluation and management of glycemic and lipid control.	A total of 15.5 visits in the experimental group over a 12-month period and 8.8 visits among control subjects.	Pharmacists

Author(s)	Patient	None identified	Not described	The intervention included a low-literacy, nine-page color booklet; a motivational videotape; and one-on-one semistructured telephone education and counseling. The booklet and videotape were mailed to participants. If during follow-up telephone calls it was determined necessary, participants received individually tailored mailings of tip sheets provided practical strategies for overcoming barriers.	The booklet addressed diabetic retinopathy, what you can do about diabetic retinopathy, and encouraged yearly dilated eye examination. The videotape used emotional appeals to increase motivation for the yearly eye exam.	The median number of phone calls was four, and the median time spent per person was 53 min.	Health educator
Basch et al. (1999) (32)	Patient	None identified	Not described	The intervention included a low-literacy, nine-page color booklet; a motivational videotape; and one-on-one semistructured telephone education and counseling. The booklet and videotape were mailed to participants. If during follow-up telephone calls it was determined necessary, participants received individually tailored mailings of tip sheets provided practical strategies for overcoming barriers.	The booklet addressed diabetic retinopathy, what you can do about diabetic retinopathy, and encouraged yearly dilated eye examination. The videotape used emotional appeals to increase motivation for the yearly eye exam.	The median number of phone calls was four, and the median time spent per person was 53 min.	Health educator
Agurs-Collins et al. (1997) (33)	Patient	None identified	The intervention was designed for older African-American adults including the use of large-print, easy-to-read materials; a focus on a limited number of concepts at each session; and the use of materials depicting African-American individuals, families, and community settings. Guidance about food and recipes was based on the types of foods and flavorings characteristic in African-American communities.	Intervention participants received group education sessions (8–10 participants) providing nutrition education and exercise; an individualized weight reduction diet; individualized evaluation and exercise prescription; and food and exercise diaries for self-monitoring. Verbal and written feedback was provided for the food and exercise diaries.	Nutrition education included meal planning, food shopping, label reading, recipe modification, food selection in restaurants, and creative cooking. The exercise component consisted of a 5-min warm-up, 20 min of low impact aerobic activity, and a 5-min cool down. The behavioral component included strategies such as goal setting, controlling or avoiding triggers to eat, and portion control.	A total of 12 weekly sessions of 1 h of education followed by 0.5 h of exercise for the first 6 months followed by 6 biweekly group sessions in the second 6 months.	Registered dietitian and exercise physiologist, both African American.
Elshaw et al. (1994) (34)	Patient	None identified	Videos were developed in English and Spanish using the format of a television drama and were designed to be culturally sensitive and appropriate to populations with poorly developed abstraction skills and with low literacy rates.	The intervention group received education weekly sessions in groups of 8–10 participants in a local community setting. Sessions were delivered didactically with a videotape and incorporated group discussions.	Education session topics were hypertension, nutrition, foot care, eye care, oral health, and kidney as they related to self-care and diabetes complications.	Participants received weekly 2-h education sessions for 8 weeks. Follow-up sessions were conducted at 10 and 14 weeks.	Two Mexican-American bilingual nurses
Heath et al. (1987) (35)	Patient	None identified	Not described	Community-based program offering group aerobic exercise sessions (15–50 participants/session).	One-hour aerobic exercise session.	One-hour sessions were offered several times a day, five times per week. The mean duration of program attendance was 37 weeks, with a mean of 1.7 sessions per week (range 1–102).	A health educator, 2 health education assistants, and 48 Zuni Indians trained in exercise and group leadership.
Mulrow et al. (1987) (36)	Patient	None identified	Materials used in the intervention were written at a fourth- to sixth-grade educational level.	Group 1 received group sessions (three to five participants) using a standardized videotape lesson, printed materials, and personalized goal setting. Group 2 received monthly group sessions (three to five participants) with didactic education and open discussion. Group 3 received a single didactic lecture.	Group 1 included three sessions focusing on dietary habits, two covering basic concepts of diabetes, complications, and urine testing and one addressing a physical exercise program. Group 2 included a first session covering concepts of diabetes, diet, and urine testing and subsequent sessions that had open discussion for weight and blood glucose feedback monitoring.	Group 1 had a 0.5-h session monthly for 6 months. Group 2 had a 1-h initial session then monthly 0.5-h sessions.	Nurse clinician, trained in diabetes education

ADA, American Diabetes Association; CHW, community health worker; NCM, nurse case manager; THDR, Take-Home Diabetes Record.

Table 3—Analysis of intervention components

Feature	Feature prevalence (%)	Number of participants studied	Percent success rate		Rate difference (%)
			With feature (%)	Without feature (%)	
Target of the intervention					
Patient: intervention targets knowledge, skills, attitudes, and behaviors of patients	70.5 (12/17) (21,22,25,27–30,32–36)	2,036	67	60	7
System: intervention targets information systems, access to care, and/or health care provider roles	41 (7/17) (20–23,25,26,31)	2,532	71	60	9
Provider: intervention targets the knowledge, skills, attitudes, and behaviors of providers	6 (1/17) (24)	427	0	69	–69*
How the intervention is designed					
Language or literacy tailoring: intervention is tailored to the specific populations' language or literacy level	53 (9/17) (21,22,24,29,30,32–34,36)	1,981	67	63	4
Cultural tailoring: intervention is tailored to the specific populations' culture	29 (5/17) (22,29,30,33,34)	937	80	58	22
Needs assessment: intervention is designed based on an assessment of patient's needs	18 (3/17) (27,29,30)	579	100	57	43*
Who delivered the intervention					
Health care provider: delivered by a licensed health care provider	82 (14/17) (20–23,25–31,33,34,36)	3,519	64	67	–3
Community educator/layperson led: delivered by a layperson trained to deliver the intervention	29 (5/17) (25,29,30,32,35)	967	80	58	22
Setting of the intervention					
Primary care: delivered in the primary care system (e.g. family practice)	59 (10/17) (20,22–28,30,31)	3,189	60	71	–11
Community based: delivered outside of the health care setting (e.g. local church)	23.5 (4/17) (29,32,34,35)	722	75	62	13*
Hospital based: delivered in a clinic affiliated with a hospital	18 (3/17) (21,33,36)	401	67	64	3*
How the intervention was delivered					
Individual: intervention is delivered individually, one on one	76 (13/17) (20–28,30–33)	3,750	69	40	29
Individualized assessment: patient is assessed individually and intervention is tailored to the assessment	76 (13/17) (20–28,30–33)	3,570	69	50	19
Reassessment/reintervention: patient attends follow-up visit for reassessment and further education or management	59 (10/17) (20–22,25,27–30,32,33)	2,084	80	43	37
Group: intervention is delivered to a group of patients	41 (7/17) (28–30,32–36)	1,226	57	70	–13
Diabetes education: intervention is aimed at patient's diabetes knowledge for specific diabetes management topics	41 (7/17) (21,25,28,32–34,36)	1,054	43	80	–37
Use of treatment algorithms: use of a predefined treatment algorithm or clinical guidelines (e.g. cholesterol, diabetes)	35 (6/17) (20–23,25,31)	1,935	83	54	29
Behavioral: focuses on behavior-related tasks (e.g. exercise, diet) using behavior-based interventions	29 (5/17) (28,29,33,34,36)	660	40	75	–35
Feedback: intervention provides specific feedback to patients on their diabetes control or performance	29 (5/17) (27,29,30,33,35)	729	100	50	50
Interactive/discussion: education provided was delivered mainly by an interactive format	29 (5/17) (20,25,27,29,33)	950	80	58	22
Self-management education: comprehensive education that focuses on developing diabetes knowledge and patients' ability to self-manage their diabetes	23.5 (4/17) (29,33,34,36)	540	50	69	–19*
Problem solving: development of patient's problem-solving skills required to manage their diabetes	18 (3/17) (22,29,30)	769	100	57	43*
Family support: intervention encourages family members to get involved in attending the session	18 (3/17) (29,32,33)	596	100	57	43*
Intensity of the intervention	12 (2/17) (27,29)	379	100	60	40*
Long duration: intervention is delivered over ≥6 months	82 (14/17) (20–23,25,27–33,35,36)	3,184	79	0	79
High intensity: the patient is in direct contact with the intervention > 10 times	47 (8/17) (20,21,29–31,33–35)	1,462	87	44	43

*Rate difference should be interpreted carefully due to low number of studies examined.

their training, supervision, and support. Finally, successful interventions may require multiple contacts over a prolonged period of time.

Are such interventions affordable? Many of the resources needed for such community-oriented behaviorally mediated and intensive interventions are “up front,” including intervention design and recruiting and training community-based educators. Ongoing costs will mostly relate to multiple one-on-one sessions. The disadvantaged populations included in this study have significantly higher rates of diabetes complications, health services use, and poor control. A 1% drop in A1C has been associated with a 10% reduction in diabetes-related deaths and a 25% reduction in microvascular end points (39). Interventions targeting glucose, blood pressure, and lipid control simultaneously have the potential for up to 50% reductions in cardiovascular events and risk of microvascular complications (40). Reductions of 1% in A1C were achieved in several of the successful interventions included in this review, as were substantial improvements in blood pressure and lipids, so it is reasonable to expect major impacts on morbidity, mortality, and health services use from interventions such as these.

Our findings were less clear in several areas. Due to the small number of studies included and inconclusive results, it was not possible to clearly identify whether patient, provider, system-level interventions, or combinations of these are most effective. The results also did not point to hospital, primary care, or community as the best setting for intervention. Other features appeared to have positive effects, but definitive conclusions could not be made due to low numbers of studies identified. These features require further study and included needs assessment to design the intervention, delivery of comprehensive self-management education, problem solving tasks as part of the intervention, and the incorporation of family support.

The features of successful interventions identified in our review are consistent with those described for multiple health conditions as leading to positive outcomes for disadvantaged groups (16). Arblaster et al. (16) found that to reduce health inequalities among disadvantaged groups, intensive approaches, community involvement, face-to-face interventions, development of skills to promote behavior change, attention to the agent

delivering the intervention, provision of prompts and reminders, and the use of prior needs assessment to inform intervention design were needed. They also found that multifaceted interventions and multidisciplinary approaches were desirable.

A review that was limited to diabetes self-management interventions in disadvantaged populations included five of the studies in this systematic review (41). That study found that interventions in community settings and those that explicitly address social-contextual issues tended to be more effective. They also identified the need to intervene at multiple levels with multiple strategies. Changing behavior and diabetes control in the long term may be much more difficult than achieving increases in knowledge. Active, hands-on, participatory, and behavioral approaches in self-management education appear to be more effective than didactic interventions, but long-term glycemic control tends to decline once interventions are over (9,42).

This study has several limitations. Social disadvantage is defined differently across studies, which limits their comparability (16,41). The studies included in this review primarily focused on black, Hispanic, and low-income people living in the U.S., and it is not known how these results relate to other socially disadvantaged populations. Our findings are based on a small number of heterogeneous studies that could not be combined in meta-analysis due to varying populations, interventions, and outcomes. The small number of studies and large heterogeneity also means that our conclusions about the effectiveness of various intervention strategies should be interpreted with caution. Few studies included in this review reported outcomes beyond 1 year, so the long-term effectiveness of interventions for disadvantaged populations is not known. Many of the included interventions had multiple components, and it was rarely possible to isolate the key elements that were responsible for beneficial outcomes. Additionally, no studies measured relevant patient-oriented outcomes. These issues represent areas for future research.

In conclusion, this systematic review highlights important features of interventions to improve diabetes care among socially disadvantaged populations. Key strategies include cultural tailoring of the intervention, community educators or lay people leading the intervention,

one-on-one interventions with individualized assessment and reassessment, incorporating treatment algorithms, focusing on behavior-related tasks, providing feedback, and high-intensity interventions (>10 contact times) delivered over a long duration (≥ 6 months). These types of interventions would require additional resources for needs assessment, leader training, community outreach, and follow-up. Active and intensive strategies are justified, however, by the large burden of illness born by disadvantaged groups with diabetes, their greater need for health care services, and the demonstrated efficacy of diabetes control in reducing adverse outcomes. Further research is needed, in particular on which strategies are most effective for specific groups, on which interventions produce long-term improvement in clinical and patient-oriented diabetes outcomes, on interventions aimed at providers and the health system, and that incorporate a formal economic analysis.

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References

1. World Health Organization: Diabetes programme [homepage]. Available from <http://www.who.int/diabetes/en/>. Accessed 4 October 2005
2. Hux JE, Mei T: Patterns of prevalence and incidence of diabetes. In *Diabetes in Ontario: An ICES Practice Atlas*. Hux JE, Booth GL, Slaughter PM, Laupacis A, Eds. Toronto, Canada, Institute for Clinical Evaluative Sciences, 2003, p. 2–15
3. Booth GL, Hux JE: Relationship between avoidable hospitalizations for diabetes mellitus and income level. *Arch Intern Med* 163:101–106, 2003
4. Bazargan M, Johnson KH, Stein JA: Emergency department utilization among Hispanic and African-American underserved patients with type 2 diabetes. *Ethn Dis* 13:369–375, 2003
5. Jiang HJ, Stryer D, Friedman B, Andrews R: Multiple hospitalizations for patients with diabetes. *Diabetes Care* 26:1421–1426, 2003
6. Karter AJ, Ferrara A, Darbinian JA, Acker-

- son LM, Selby JV: Self-monitoring of blood glucose: language and financial barriers in a managed care population with diabetes. *Diabetes Care* 23:477–483, 2000
7. Karter AJ, Ferrara A, Liu JY, Moffet HH, Ackerson LM, Selby JV: Ethnic disparities in diabetic complications in an insured population. *JAMA* 287:2519–2527, 2002
 8. Simmons D, Gatland BA, Leakehe L, Fleming C: Ethnic differences in diabetes care in a multiethnic community in New Zealand. *Diabetes Res Clin Pract* 34 (Suppl.):S89–S93, 1996
 9. Norris SL, Lau J, Smith SJ, Schmid CH, Engelgau MM: Self-management education for adults with type 2 diabetes: a meta-analysis of the effect on glycemic control. *Diabetes Care* 25:1159–1171, 2002
 10. Thomson O'Brien MA, Freemantle N, Oxman AD, Wolf F, Davis DA, Herrin J: Continuing education meetings and workshops: effects on professional practice and health care outcomes. *Cochrane Database Syst Rev* 2:CD003030, 2001
 11. Thomson O'Brien MA, Oxman AD, Davis DA, Haynes RB, Freemantle N, Harvey EL: Educational outreach visits: effects on professional practice and health care outcomes. *Cochrane Database Syst Res* 2:CD000409, 2000
 12. Thomson O'Brien MA, Oxman AD, Haynes RB, Davis DA, Freemantle N, Harvey EL: Local opinion leaders: effects on professional practice and health care outcomes. *Cochrane Database Syst Rev* 2:CD000125, 2000
 13. Jamtvedt G, Young JM, Kristoffersen DT, Thomson O'Brien MA, Oxman AD: Audit and feedback: effects on professional practice and health care outcomes. *Cochrane Database Syst Rev* 3:CD000259, 2003
 14. Lexchin J, Grootendorst P: Effects of prescription drug user fees on drug and health services use and on health status in vulnerable populations: a systematic review of the evidence. *Int J Health Serv* 34: 101–122, 2004
 15. Middleton J: The effect of case management on glycemic control in patients with type 2 diabetes. *Case Manager* 14:43–47, 2003
 16. Arblaster L, Lambert M, Entwistle V, Forster M, Fullerton D, Sheldon T, Watt I: A systematic review of the effectiveness of health service interventions aimed at reducing inequalities in health. *J Health Serv Res Policy* 1:93–103, 1996
 17. Elasy TA, Ellis SE, Brown A, Pichert JW: A taxonomy for diabetes educational interventions (Review). *Patient Educ Couns* 43: 121–127, 2001
 18. Jadad AR, Moore RA, Carroll D, Jenkinson C, Reynolds DJ, Gavaghan DJ, McQuay HJ: Assessing the quality of reports of randomized clinical trials: is blinding necessary? *Control Clin Trials* 17:1–12, 1996
 19. Kawamoto K, Houlihan CA, Balas EA, Lobach DF: Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success. *BMJ* 330: 765–768, 2005
 20. Fanning EL, Selwyn BJ, Larme AC, DeFronzo RA: Improving efficacy of diabetes management using treatment algorithms in a mainly Hispanic population. *Diabetes Care* 27:1638–1646, 2004
 21. Rothman RL, DeWalt DA, Malone R, Bryant B, Shintani A, Crigler B, Weinberger M, Pignone M: Influence of patient literacy on the effectiveness of a primary care-based diabetes disease management program. *JAMA* 292:1711–1716, 2004
 22. The California Medi-Cal Type 2 Diabetes Study: Closing the gap: effect of diabetes case management on glycemic control among low-income ethnic minority populations: the California Medi-Cal type 2 diabetes study. *Diabetes Care* 27:95–103, 2004
 23. Davidson MB: Effect of nurse-directed diabetes care in a minority population. *Diabetes Care* 26:2281–2287, 2003
 24. Echeverry DM, Dike MR, Washington C, Davidson MB: The impact of using a low-literacy patient education tool on process measures of diabetes care in a minority population. *J Natl Med Assoc* 95:1074–1081, 2003
 25. Gary TL, Bone LR, Hill MN, Levine DM, McGuire M, Saudek C, Brancati FL: Randomized controlled trial of the effects of nurse case manager and community health worker interventions on risk factors for diabetes-related complications in urban African Americans. *Prev Med* 37: 23–32, 2003
 26. Miller CD, Barnes CS, Phillips LS, Ziemer DC, Gallina DL, Cook CB, Maryman SD, El Kebbi IM: Rapid A1C availability improves clinical decision-making in an urban primary care clinic. *Diabetes Care* 26: 1158–1163, 2003
 27. Chapin RB, Williams DC, Adair RF: Diabetes control improved when inner-city patients received graphic feedback about glycosylated hemoglobin levels. *J Gen Intern Med* 18:120–124, 2003
 28. Clancy DE, Brown SB, Magruder KM, Huang P: Group visits in medically and economically disadvantaged patients with type 2 diabetes and their relationships to clinical outcomes. *Top Health Inf Manage* 24:8–14, 2003
 29. Brown SA, Garcia AA, Kouzekanani K, Hanis CL: Culturally competent diabetes self-management education for Mexican Americans: the Starr County border health initiative. *Diabetes Care* 25:259–268, 2002
 30. Keyserling TC, Samuel-Hodge CD, Ammerman AS, Ainsworth BE,quez R, Elasy TA, Skelly AH, Johnston LF, Bangdiwala SI: A randomized trial of an intervention to improve self-care behaviors of African American women with type 2 diabetes: impact on physical activity. *Diabetes Care* 25:1576–1583, 2002
 31. Davidson MB, Karlan VJ, Hair TL: Effect of a pharmacist-managed diabetes care program in a free medical clinic. *Am J Med Qual* 15:137–142, 2000
 32. Basch CE, Walker EA, Howard CJ, Shamoon H, Zybert P: The effect of health education on the rate of ophthalmic examinations among African Americans with diabetes mellitus. *Am J Pub Health* 89:1878–1882, 1999
 33. Agurs-Collins TD, Kumanyika SK, Ten Have TR, Adams-Campbell LL: A randomized controlled trial of weight reduction and exercise for diabetes management in older African-American subjects. *Diabetes Care* 20:1503–1511, 1997
 34. Elshaw EB, Young EA, Saunders MJ, McGurn WC, Lopez LC: Utilizing a 24-hour dietary recall and culturally specific diabetes education in Mexican Americans with diabetes. *Diabetes Educator* 20:228–235, 1994
 35. Heath GW, Leonard BE, Wilson RH, Kendrick JS, Powell KE: Community-based exercise intervention: Zuni Diabetes Project. *Diabetes Care* 10:579–583, 1987
 36. Mulrow C, Bailey S, Sonksen PH, Slavin B: Evaluation of an audiovisual diabetes education program: negative results of a randomized trial of patients with non-insulin-dependent diabetes mellitus. *J Gen Intern Med* 2:215–219, 1987
 37. Brown SA, Harris CL: Culturally competent diabetes education for Mexican Americans: the Starr County Study. *Diabetes Educ* 25:226–236, 1999
 38. Keyserling TC, Ammerman AS, Samuel-Hodge CD, Ingram AF, Skelly AH, Elasy TA, Johnston LF, Cole AS, Henriquez-Roldan CF: A diabetes management program for African American women with type 2 diabetes. *Diabetes Educ* 26:796–805, 2000
 39. Turner RC, Holman RR, Cull CA, Stratton IM, the UK Prospective Diabetes Study (UKPDS) Group: Intensive blood glucose control with sulfonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet* 352: 837–853, 1998
 40. Gaede P, Vedel P, Larsen N, Jensen GV, Parving HH, Pedersen O: Multifactorial intervention and cardiovascular disease in patients with type 2 diabetes. *N Engl J Med* 348:383–393, 2003
 41. Eakin EG, Bull SS, Glasgow RE, Mason M: Reaching those most in need: a review of diabetes self-management interventions in disadvantaged populations. *Diabetes Metab Rev* 18:26–35, 2002
 42. Brown SA: Interventions to promote diabetes self-management: state of the science. *Diabetes Educ* 25 (Suppl. 6):52–61, 1999