# Community-Based Lifestyle Interventions to Prevent Type 2 Diabetes

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**OBJECTIVE** — To conduct a literature review of community-based interventions intended to prevent or delay type 2 diabetes.

**RESEARCH DESIGN AND METHODS** — Recently published findings about the potential to prevent or delay type 2 diabetes with intensive lifestyle interventions prompted a literature search for community-based diabetes prevention interventions. The literature review design was a search of databases for publications in 1990–2001 that identified reports on community-based interventions designed to prevent or modify risk factors for type 2 diabetes.

**RESULTS** — The search revealed 16 published interventions, 8 of which were conducted in the U.S. and involved populations disproportionately burdened by diabetes (e.g., American Indians, Native Hawaiians, Mexican Americans, and African Americans). Of the studies reporting results among youth, there were posttest improvements in intervention groups in knowledge, preventive behaviors, and self-esteem. Among studies reporting results among adults, most reported improvements in intervention groups in knowledge or adoption of regular physical activity. Several investigators offered important reflections about the process of engaging communities and sharing decision making in participatory research approaches, as well as insights about the expectations and limitations of community-based diabetes prevention research. Many of the studies reported limitations in their design, including the lack of control or comparison groups, low response rates or lack of information on nonresponders, or brief intervention periods.

**CONCLUSIONS** — There is a critical need to conduct and publish reports on well-designed community-based diabetes prevention research and share information on the process, results, and lessons learned. Armed with recent positive findings about diabetes prevention and literature documenting community-based efforts, advocates at local, state, and national levels can collaborate to stem the rising tide of diabetes in communities.

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I n a decade's time (1990–2001), the prevalence of self-reported (diagnosed) diabetes increased 61% in the U.S. (1), including a startling 76% increase from 1990 to 1998 among people in their 30s (2). Accounting for roughly 95% of all diabetes, type 2 diabetes is associated with obesity and weight gain (3), which also increased over the same time period. One projection is that the 11 million U.S. residents with diagnosed diabetes will increase to 29 million in 2050 (4). The escalating prevalence of type 2 diabetes portends serious consequences for the quality of life of those affected and their families and communities.

To stem the rising tide of diabetes, public health policies need to move upstream toward prevention or at least a delay in the onset of type 2 diabetes. A number of recent studies offer scientific evidence and new hope for curtailing the epidemic of type 2 diabetes with support for intensive lifestyle modification and modest weight loss as effective interventions among adults at high risk for developing type 2 diabetes (5–7). The transitional state in the natural history of diabetes when impaired glucose tolerance (IGT), impaired fasting glucose, or both are present has recently become known as "pre-diabetes," which affects 12 million overweight Americans aged 45–74 years (8), also raising their risk for cardiovascular disease (9). Detection of pre-diabetes is not a goal of most diabetes screening programs (10), but the lengthy developmental period of diabetes, coupled with the potential to prevent or delay the onset of type 2 diabetes, offers an opportunity for multifaceted prevention efforts.

Distinct preventive medicine strategies have been described by Rose (11) as follows: *1)* the "high-risk approach," which identifies and focuses exclusively on individuals at highest risk for developing diseases; and *2)* the "population or public health approach," which attempts to reduce risk factors for or causes of diseases within communities, which are generally defined in terms of localities but can also represent groups who share a common cause or interest (12). Rose identified advantages and disadvantages for both approaches. For example, the high-risk approach is generally cost-effective with a high likelihood of benefit for motivated individuals. The population approach, often called the community-based approach, offers a smaller benefit to individuals but more potential for benefiting the larger population. Whereas the high-risk approach is palliative, the community-based approach aims to address the underlying causes of ill health (11); the latter is typically predicated on respect for community strengths, including cultural practices and wisdom, with mean-

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**Table 1—Population-based interventions designed to prevent type 2 diabetes in youth**

| Reference | Study descriptions | | | | | Results | | |
|---|---|---|---|---|---|---|---|---|
| | Geographic location Target audience Sample size | Study design and duration | Goal(s) for prevention of type 2 diabetes | Intervention | Community involvement/cultural relevance | Knowledge, attitudes, behaviors | Clinical markers | Prevalence of diabetes |
| Cook and Hurley (19) | Gila River Indian Community, Arizona Akimel O'odham (Pima) and Pee Posh (Maricopa) children (Kindergarten–grade 2) Sample size not discussed | Quasi-experimental; no control group Initial pilot: 2 years | Maintain healthy body and weight to promote diabetes awareness | Classroom instruction for 20 classes (10 weeks) about diabetes prevention with take-home information One-mile walk each day with teacher Structured school breakfast/lunch | Program endorsed by tribal council Use of traditional symbols such as saguaro cactus, maize, and roadrunner | Not reported | Not reported | Not reported |
| Gittelsohn et al. (21) | Ontario, Canada First Nations Ojibwe-Cree Reserve school (grades 4–6) Sample size not discussed | Quasi-experimental; no control group Duration not discussed | Prevent diabetes and its risk factors, particularly obesity | Health and nutrition curriculum focused on healthier food choices and increased physical activity Improved access to low-fat foods where students and families eat and shop for groceries | Ethnographic data collection to aid in problem definition and development of culturally appropriate intervention strategies Intervention strategies generated by and pretested with community | Not reported | Not reported | Not reported |
| Holcomb et al. (31) | Webb County, Texas, Mexico border (94% Hispanic) 5th grade students (aged 10–12 years) in 14 schools n = 835 (completed both pre- and posttests) | Quasi-experimental; comparison group ≈3 months | Encourage healthier lifestyles; improve knowledge, self-efficacy, and behaviors | Curriculum-based program that integrates program's goals into reading, writing, mathematics, science, and physical education and encourages students to eat low-fat foods and exercise regularly | Not discussed | Significant gains in knowledge about diabetes, self-efficacy, and healthy dietary-and exercise-related behavior from pretest to posttest; also from posttest through 4 weeks of follow-up, but on fewer variables | Not targeted | Not targeted |
| Macaulay et al. (24) | Kahnawake, Quebec, Canada Native Mohawk children (grades 1–6) n = 1,200 (different sample sizes in 63 distinct interventions) | Quasi-experimental; nonequivalent comparison community 3 years | Long-term goal: decrease occurrence of type 2 diabetes Short-term goal: reduce prevalence of obesity, high-calorie and high-fat diets, and low physical inactivity | Health education programs for each grade on nutrition, fitness, diabetes, the human body, with a focus on creating positive attitudes and increasing self-esteem Family activities in the community: to expose children to healthy lifestyles of adults (e.g., pow-wow dances) Supportive environments (e.g., walk/bike path) | Community advisory board to advise on objectives, activities, and traditions Incorporation of traditional foods and activities Study performed by Native researchers | Not reported | Not reported | Not reported |

| Reference | Setting/Population | Study design | Goals | Intervention | Cultural adaptation | Results | | |
|---|---|---|---|---|---|---|---|---|
| Marlow et al. (23) | Winnebago Indian reservation, Nebraska. Adolescents (aged 13–18 years) $n = 24$ | Quasi-experimental; no control group. Half-day workshop (pilot) | Use aspects of traditional Indian culture to develop culturally sensitive program. Provide opportunity for adolescents to take leadership role in diabetes education. Design health education program addressing specific needs of adolescents | Educational intervention designed to provide information about diabetes prevention through physical activity and good nutrition within a cultural context | Program designed by Winnebago adolescents; coyote name used by instructors to symbolize indirect education (i.e., one can learn from the coyote's mistakes and successes). Use of Native American stories, games, and legends | On nine sets of matched pretests and posttests of knowledge, 89% achieved higher scores (no statistical analysis) | Not targeted | Not targeted |
| Teufel and Ritenbaugh (30) | Zuni Pueblo reservation, New Mexico. Zuni adolescents (grades 9–12) at two high schools. Baseline: $n = 119$; mid-project (2 years after baseline) $n = 173$ | Quasi-experimental; no control group. 4 years | Reduce prevalence of diabetes risk factors. Support increased physical activity, increased fruit and vegetable intake, and reduced consumption of soft drinks | Supportive social networks established within community, faculty, and youth. Teen wellness facility established to emphasize physical activity. Curriculum-based diabetes education introduced. Food supply in schools modified | Formative assessment of target audience before intervention, including exploration of attitudes and beliefs on health, food, and exercise | Significant reduction in consumption of sugared beverages. Decrease in pulse rates, suggesting improved cardiovascular fitness | Significant increase in glucose-insulin ratios | Not yet measured |
| Trevino et al. (32) | San Antonio, Texas. Mexican–American 4th graders in two schools in poorest school district of San Antonio $n = 102$ | Quasi-experimental; no control group. 2 years; results reported at 9 months | Primary goal to decrease risk factors for diabetes: specifically body fat. Secondary goal to increase fruit and vegetable intake, health knowledge, self-efficacy, self-esteem, and activity levels | Parent health education. School classroom intervention designed to supplement existing health curriculum. School cafeteria component. After-school component promoting physical activity | Lessons developed by use of culturally relevant educational materials | Diabetes health knowledge significantly improved. Significant decreases in dietary fat servings and total calories; and total calories; significant increases in fruit and vegetable servings | No significant changes | Not targeted |

ingful participation of the community from the beginning.

Both high-risk and community-based approaches are likely to be required for the challenging goals of preventing or delaying type 2 diabetes (13). Participatory action research, which involves collaboration of those affected by the issue being studied (14), with researchers in the position of co-learners (15), may be particularly suited to strategies for primary prevention of diabetes in well-defined communities (13). Such approaches tend to be valued by local communities because they can ensure the cultural relevance of interventions (16,17).

Federal agencies, voluntary organizations, and others aim to reduce the burden of diabetes by translating research findings into practice at multiple levels, including providing support and assistance to states and territories to develop comprehensive, sustainable programs to prevent and treat diabetes among their constituents. To evaluate the promise of primary prevention of diabetes using community-based approaches, the Centers for Disease Control and Prevention conducted a literature review to examine community-based interventions. The purpose of this review was to inform translation efforts for diabetes primary prevention at local, state, and national levels.

**RESEARCH DESIGN AND METHODS** — This literature review was part of a larger review conducted to examine all interventions specifically designed to prevent or delay type 2 diabetes or modify its risk factors among youth or adults, whether from high-risk or community-based approaches. Medline, the Educational Resources Information Center, and the Combined Health Information Database were searched to find interventions specifically focused on diabetes prevention.

Inclusion criteria included English-language articles published between 1990 and 2001 that reported on diabetes prevention interventions in any country. Search terms included "prevention," "control," "intervention," "primary prevention," "prospective studies," "program development," and the names of drugs used to prevent or control diabetes (e.g., "metformin")—all in association with type 2 diabetes, cardiovascular disease, obesity, and exercise. Articles were

**Table 2—***Population-based interventions designed to prevent or delay type 2 diabetes in adults*

| Reference | Study descriptions — Geographic location, Target audience, Sample size | Study design and duration | Goal(s) for prevention of type 2 diabetes | Interventions | Community involvement and culturally relevant components | Results — Knowledge, attitudes, behaviors | Results — Clinical markers | Results — Prevalence of diabetes |
|---|---|---|---|---|---|---|---|---|
| Bjaras et al. (33, 34) | Stockholm, Sweden Population in three municipalities $n$ = 3,200 men and 3,200 women | Quasi-experimental; three intervention groups, two comparison municipalities 10 years | Reduce incidence of type 2 diabetes by 25% by influencing risk factors (e.g., reduce dietary fat intake, increase physical activity) Reduce the prevalence of IGT correspondingly | Community interventions: • Create supportive policy environment for interventions • Obtain media coverage • Inform public about planned activities Intervention within communities (e.g., workplaces, residential areas): • Implement strategies related to dietary change, weight control, and physical activity (e.g., walking groups) | Not discussed | Results reported for walking campaign conducted in one municipality. increased (by one-third) the proportion of adults participating in regular exercise | Not reported | Not targeted |
| Daniel et al. (20) | British Columbia, Canada Okanagan Indian Band Cohort survey: mean of 105 adults at "high risk" (individuals with or at familial risk for type 2 diabetes) X-sectional survey: baseline: $n$ = 150 adults; 16 months; $n$ = 145 | Quasi-experimental; one intervention group, two comparison groups 16 months | Reduce incidence of type 2 diabetes by reducing risk factors (e.g., overweight enhancing) and environmental supports (e.g., walking groups, hiring community members) | Physical activity events (e.g., 100-mile club), cooking demonstrations, supermarket and restaurant tours, media campaign, environmental support | Interviews with community to examine knowledge, attitudes, and behaviors related to diabetes and to identify prevention strategies Sanction of Band Council for distribution of fliers. Use of community facilities. Hired recreation coordinator to promote physical activity | Cohort: significant reduction in proportion of intervention participants who engaged in sweat-producing activity Cross-sectional survey: significant increases in knowledge of diabetes and prevalence of sweat-producing activity at least once per week in intervention group | Intervention community: • Six new cases of IGT • Substantially lower systolic blood pressure and BMI than in comparison communities Comparison communities: • Four new cases of IGT | Intervention community: • No new cases of diabetes Comparison communities: • Six new cases of diabetes |
| Engelgau et al. (18) | Raleigh, North Carolina African Americans ≥18 years old Intervention: $n$ = 14,950; comparison: $n$ = 16,099 | Quasi-experimental; comparison community 5 years | Reduce modifiable risk factors for diabetes in the general population Raise awareness (e.g., use of radio and newspapers) about risk factors for diabetes and increase use of screening services | Health promotion in general population: • Increase in regular physical activity (e.g., walking programs) • Decrease in fat intake (e.g., cooking demonstrations) Outreach intervention: Use of media, awareness activities and distribution of educational materials at key community sites | Involvement of community members in project development Work group of community members and representatives of local organizations | Not reported | Not reported | Not reported |

| Source | Setting/sample | Study design | Purpose | Intervention description | Culture/community component | | | |
|---|---|---|---|---|---|---|---|---|
| Gittelsohn et al. (21) | Ontario, Canada First Nations Ojibwe-Cree Reserve, Canada Sample size not discussed | Quasi-experimental Duration not discussed | Modify risk factors for diabetes, particularly obesity | Work with churches, community centers, civic groups, and public housing community groups to help with screening promotion Community education about healthier lifestyle choices through mass media (e.g., radio and television programs) Presentations at major community events (e.g., Treaty Days, annual health fairs) One-to-one education through series of home visits includes nutrition education and physical activity component | Ethnographic data collection to aid in problem definition and development of culturally appropriate intervention Intervention strategies generated by and pretested with community | Not reported | Not reported | Not reported |
| Herbert (22) | British Columbia, Canada Two First Nations villages Sample size not discussed | Study design not discussed 12 months | Develop culturally sensitive approaches to diabetes prevention | Briefly mentions intervention components, including walking groups and groups to gather traditional foods | Significant involvement of the community in design of intervention | Not reported | Not reported | Not reported |
| Mau et al. (25) | Two rural communities in Hawaii, U.S. Hawaiians at risk for diabetes n = 147 | Quasi-experimental 4 years | Determine if lifestyle intervention with family support person improves lifestyle behaviors compared with standard intervention | Lifestyle intervention in both communities Trained family support person to attend diabetes-related functions with participant | Development of culturally responsive lifestyle intervention | Intervention group in pre-action stage more likely to advance to action stage for dietary fat and physical activity vs. comparison group | Not targeted | Not targeted |
| Narayan et al. (26) | Gila River Indian Community, Arizona Akimel O'odham (Pima) adults who are overweight but normoglycemic n = 95 | Randomized 1 year | Test adherence to specific lifestyle interventions and compare them for changes in diabetes risk factors (e.g., obesity) | Intervention group: activity-based intervention involving structured physical activity and nutrition interventions; behavioral techniques, such as modeling and roleplay group problem solving, and food preparation demonstrations Comparison group: unstructured lifestyle intervention based on self-directed learning, facilitated by incorporation of history and culture | Akimé O'odham (Pima) community created intervention, including local speakers on culture and history, group facilitation by community members, and newsletters with culture focus | Increased levels of physical activity in both groups but no statistically significant differences between groups | Intervention group: • Significant increases in BMI, weight, systolic blood pressure, diastolic blood pressure, and plasma concentrations of glucose and insulin after 2-hr fast • Significantly greater weight gain and increase in plasma concentrations of glucose than comparison group Comparison group: • Significant decreases in waist circumference and starch intake | Not measured |

*Community-based lifestyle interventions*

**Table 2—Continued**

| Reference | Study descriptions | | | | | Results | | |
|---|---|---|---|---|---|---|---|---|
| | Geographic location Target audience Sample size | Study design and duration | Goal(s) for prevention of type 2 diabetes | Interventions | Community involvement and culturally relevant components | Knowledge, attitudes, behaviors | Clinical markers | Prevalence of diabetes |
| Rowley et al. (27) | Central Australia Aboriginal population >15 years old *n* = 267 | Quasi-experimental 7 years | Examine trends in glucose tolerance and coronary risk | Informal education by physicians on diet and exercise Health educator for 1–2 years Subsequent ongoing health promotion by health service staff including trained diabetes community health educators | Extensive discussions with community council and community members on diabetes and role of diet and exercise in treatment and prevention | Not targeted | Significant increases in mean BMI; greater increase for study participants residing adjacent to a store compared with those far from a store Significant decreases in prevalence of IGT and hypercholesterolemia among women only | Prevalence of diabetes unaltered |
| Simmons et al. (28) | South Auckland, New Zealand Polynesian workforce Intervention: *n* = 108; comparison: *n* = 99 | Quasi-experimental; comparison group 4 months (ended early) | Evaluate acceptability and impact of pilot program for diabetes awareness and exercise | One educator presentation, one video presentation, and 4-month exercise program | Article states that project is developing "culturally appropriate strategies" Same ethnicity for diabetes community health educators and study participants | Significantly more retention of diabetes knowledge in intervention group than in comparison group; significant increase in amount of exercise in intervention group but decline in comparison group | Weight control in intervention group; weight gain in comparison group | Not targeted |
| Simmons et al. (29) | South Auckland, New Zealand Two church congregations of Western Samoans Intervention: *n* = 78; comparison: *n* = 144 | Quasi-experimental; comparison group 2 years (pilot) | Evaluate impact of diabetes-related lifestyle program on diabetes knowledge, exercise habits, dietary habits, and body size | Diabetes awareness sessions followed by exercise groups Reduced membership fees at local gymnasium Cooking demonstrations and local health promotion services involving diabetes community health educators | Evaluation and validation of intervention materials among Pacific Island people in area | Significant differences between intervention and comparison churches for diabetes knowledge, exercise amount, and dietary fat intake | Significant differences between intervention and comparison churches for weight gain, BMI, and waist circumference | Not targeted |

grouped by their focus on type 2 diabetes or other categories (e.g., prevention of obesity). Articles were then grouped by the approach to intervention (high-risk or community-based). Studies using the high-risk approach were defined as those based in a clinical trial setting. Community-based approaches included those in which authors described the intervention as a "community-based prevention effort" or a "population-based approach."

This review reports on the original research articles that used community-based approaches to prevent type 2 diabetes. The interventions may have had more than a primary prevention component (i.e., a secondary or tertiary prevention component). For example, Project DIRECT targeted the general population, as well as individuals with diabetes in the community (18). However, because the intent of this report was to review community-based interventions designed to modify risk factors for or prevent type 2 diabetes, only Project DIRECT intervention components targeted at primary prevention are discussed.

## RESULTS

### Description of studies

The search revealed 16 reports published in peer-reviewed journals that met the inclusion criteria, and most included targeted populations known to be at higher risk for the development of type 2 diabetes than the U.S. population at large (18–34). In the U.S., these populations included the Akimel O'odham (Pima) (19,26), Ho-Chunk (Winnebago) (23), and Zuni Pueblo (30) peoples; Native Hawaiians (25); Mexican Americans (31,32); and African Americans (18). Four studies were conducted in Canada (20–22,24), two in New Zealand (28,29), and one each in Australia (27) and Sweden (33,34). Table 1 presents an overview of the methods and results (if reported) for each of the studies targeted at youth; Table 2 presents the same information for adult-focused studies.

Of the 16 interventions, 6 targeted youth, 9 targeted adults, and 1 targeted both groups. Because Gittelsohn et al. (21) targeted both youth and adults, this intervention is included in both tables but is counted as only 1 of the 16 interventions.

The majority of studies reported using a quasi-experimental design and a pre-/posttest methodology. There was a wide range of sample sizes: from 24 adolescents on a U.S. Indian Reservation (23) to all residents living in several municipalities in Stockholm, Sweden (33,34). The length of programs ranged widely, from a half-day workshop (23) to a 10-year multiple-county intervention (33,34).

All interventions but one (28) combined diet and exercise strategies in their program. Many of the interventions offered nutrition education that included cooking and food preparation demonstrations, grocery store tours, and recipe exchanges. Exercise components included residential walking programs, creation of exercise facilities, gentle exercise classes, and running clubs.

The various program components were designed to engage the target population in the development, implementation, and promotion of the interventions. Many incorporated culturally relevant messages, symbols, and strategies, with respect for and inclusion of traditional foods, activities, and knowledge. Many were also based on a holistic view of health, embracing spiritual, mental, emotional, and physical dimensions.

### Intervention outcomes

Results were reported for 11 of the 16 interventions. The articles that did not present results focused on the process of developing the program, or results were not available at publication time.

**Interventions targeting youth.** For the four articles reporting results for youth (23,30–32), none of the studies included a control group; thus, all results are reported for the intervention group(s), from baseline to follow-up periods. Below, we provide a brief description of each study targeting youth and their reported results. Table 1 includes further details on each study.

Marlow et al. (23) worked with adolescents residing on an Indian reservation in Nebraska to develop a culturally appropriate education program to improve healthy eating and physical activity among adolescents. Four adolescents led a half-day workshop using Native American stories and activities to support behavioral adaptations. Pre- and posttest comparisons were used to measure knowledge change, although only 9 sets of the 24 questionnaires were completed. Eight of the nine achieved an increased diabetes knowledge score, although statistical analyses were not conducted.

In a program designed for students at two high schools in Zuni, New Mexico, Teufel and Ritenbaugh (30) targeted the reduction of diabetes risk factors (e.g., obesity and insulin resistance) through various strategies, including integration of diabetes education into the school curriculum and modification of the school food supply. Knowledge, attitudes, and behaviors surrounding type 2 diabetes were targeted as secondary risk factors.

The article we reviewed reported results from baseline to mid-project (2 years after baseline). Risk factors were assessed using various measures, such as BMI, bioelectrical impedance analysis (BIA), 30-min oral glucose tolerance test, activity, and 24-h dietary recalls. Knowledge, attitudes, and beliefs were measured using a questionnaire. The 24-h dietary recalls showed nonsignificant increases in fiber consumption and significant decreases in consumption of sugary beverages. From baseline to mid-project, BMI in both females and males decreased in individuals with a BMI $\geq 24$ kg/m$^2$; however, these results were not significant. Significant improvements in sitting pulse rates and glucose-insulin ratios were also seen, thus suggesting improved cardiovascular fitness and a decline in hyperinsulinemia.

The third study reporting results (31) targeted a predominantly Hispanic population of fifth-grade students in schools on the Texas-Mexico border. The program was designed to encourage healthy lifestyles through a curriculum focused on improving self-efficacy, knowledge and behaviors regarding type 2 diabetes, diet, and exercise. Two groups of teachers and their students were involved, with both groups using the curriculum and one group receiving training on implementing the program. Pre- and posttests were administered to determine knowledge of diabetes, foods, exercise, exercise self-efficacy, and related behaviors. Use of the program showed significant improvements in knowledge and self-efficacy and diet- and exercise-related behavior change. The program was effective with or without the training.

Trevino et al. (32) targeted at-risk Mexican-American fourth graders attending schools in San Antonio to reduce overweight and dietary fat intake by implementing educational and behavioral change components within four influen-

tial social systems for youth (parents, the classroom, the cafeteria, and after-school care). Body fat was measured by BIA and BMI; dietary fat intake was measured through three 24-h dietary recalls. Preliminary results were presented for their 2-year intervention at a 9-month period, and significant decreases in dietary fat servings and percent calories, significant increases in fruit and vegetable servings, and significant increases in diabetes knowledge were found.

**Interventions targeting adults.** Seven of the ten interventions that targeted adults reported results (20,25–29,33). Many of the studies targeting adults did include comparison groups, although these may not have been used in all components of the intervention. Below are descriptions of the seven interventions.

Bjaras et al. (33) targeted three major risk factors for diabetes among residents of several Stockholm municipalities: improving physical activity levels, improving healthy food intake, and decreasing obesity levels. The article reviewed for this work focused on the results of walking campaigns targeted at residents in one municipality who were not regularly exercising. Information on knowledge and attitudes about health was collected via self-report questionnaires after the walking programs. Knowledge about the relationship between physical activity and several chronic diseases was fairly high, although only 50–57% of all participants thought that exercise could prevent diabetes. One-third of the survey respondents had previously not been exercising regularly.

Daniel et al. (20) conducted an intervention to reduce prevalence of risk factors for and the development of diabetes among an indigenous population living on a reservation in British Columbia, Canada. Both behavior change and environmentally supportive interventions were used, including walking groups, cooking demonstrations, a media campaign, and hiring people in the community to promote the intervention. The intervention community was matched with two comparison communities, and cohort (relatives of people with diabetes) and cross-sectional (adults in the general community) populations were surveyed in all communities. Questionnaires on physical activity and dietary behavior, diabetes knowledge, and health beliefs were used in cohort and cross-sectional popu-

lations within each community; clinical markers such as blood pressure, cholesterol, and glucose were also assessed among cohort groups. Among cohort populations, both BMI and systolic blood pressure significantly decreased for the intervention community relative to comparison communities; however, no other significant changes were seen. Among cross-sectional populations, the intervention group showed a significant increase in knowledge of diabetes and an increased prevalence of sweat-producing activity.

Among Native Hawaiians with or at risk for diabetes, a family support intervention was compared with a standard intervention in Hawaii to examine any association between the Stages of Change construct and diet and exercise behaviors (25). Both groups received a lifestyle intervention for 6 months, and participants in the family support intervention received a trained self-identified family support person. Although mean changes in diet and exercise behaviors from baseline to follow-up varied widely and were not significant for either group, patterns of change based on the Stages of Change model for individuals in pre-action stages were encouraging for the idea of including a family support person in a lifestyle intervention. Participants in the family support group who progressed from pre-action to action/maintenance stage generally made healthier changes than the standard intervention group.

In a randomized pilot trial of lifestyle interventions in an Akimel O'odham community in Arizona, normoglycemic obese adults were randomized to an "Action" group and a "Pride" group for 12 months of intervention to reduce risk factors for diabetes (26). Participants in the Action group were guided by a structured activity and nutrition intervention, whereas participants in the Pride group engaged in self-directed learning experiences grounded in an appreciation for their culture and history.

At 6 and 12 months, both groups reported increased levels of physical activity and the Pride group reported a decreased intake of starch; however, group differences were not statistically significant. After 12 months, weight, BMI, systolic and diastolic blood pressure, 2-h plasma glucose, and 2-h insulin had significantly increased in the Action group, whereas waist circumference had decreased significantly in the Pride group. Although dif-

ferences were not statistically significant, members of the Action group gained more weight on average than members of the Pride group.

Rowley et al. (27) conducted a community-wide prevention program among indigenous people in Australia to examine trends in glucose tolerance and risk of coronary heart disease. The intervention included discussions held in clinical settings on the benefits of diet and physical activity in preventing diabetes. Results included decreases in IGT prevalence; however, BMI increased significantly during the 7-year period. The increase in BMI was greater among participants who lived in close proximity to a store compared with those residing far from a store.

Two groups of hospital workers, divided between an intervention and comparison group, participated in a pilot diabetes awareness and exercise program in New Zealand (28). At 6 months from baseline, significant differences were seen between groups in the report of regular exercise activity (increases in the intervention group, decreases in the control group). No differences occurred in BMI or weight change.

An urban program conducted among Western Samoans in New Zealand involved an intervention and comparison group from two different churches (29). The intervention involved diabetes awareness sessions, exercise groups, and cooking demonstrations. Baseline and repeat assessments involving clinical markers (e.g., glucose or fructosamine, anthropometric measurements) and a diabetes knowledge questionnaire were used to assess outcomes. Results for the intervention church included stability of weight contrasted to a weight gain in the comparison church. The intervention group demonstrated a significant reduction in waist circumference as well as an increase in diabetes knowledge and regular exercise.

**CONCLUSIONS** — Research on community-based prevention of diabetes is in its beginning phases, reflected in the paucity of studies found by this review. Among the studies that have been published, most have been conducted among populations disproportionately affected by diabetes, with their communities either initiating or collaborating with researchers. This finding, in itself, is important and likely reflects the concern

of leaders about diabetes from these communities.

Many researchers and collaborative communities are breaking ground by implementing culturally relevant prevention programs in settings where many socioeconomic and environmental challenges exist. The inclusion of community health workers, traditional practices (e.g., bush food), and the use of metaphors and stories in a number of these studies provides examples of genuine community involvement and application of cultural knowledge.

Although the studies we have reviewed are to be lauded for using participatory approaches, said to be the new gold standard for federally funded research (35), most had a number of limitations. Only one of the interventions we found used an experimental design (26), likely because of the cultural unacceptability of this approach (25). Some comparison groups find this design discomfiting enough to mount their own interventions, even when promised a delayed intervention (31). The successful Pride group (26) was essentially meant to be a comparison group that chose to incorporate traditional ways (36). Interventions that show the most promise were associated with well-designed research combined with participatory approaches.

Other common study limitations included the shortness of intervention duration, large numbers of nonresponders, and the inability to match pre- and posttest data or to link self-reported lifestyle changes to health outcomes/indicators (e.g., BMI, prevalence of IGT). Few studies demonstrated positive outcomes in all the intermediate outcomes of interest (e.g., healthy eating behaviors and physical activity/exercise). Further, few studies assessed whether the interventions are effective in reducing plasma glucose levels or other diabetes risk factors among target populations.

The limitations of the studies also provide us with the gaps in the literature and directions for future research. Researchers should be encouraged to use more rigorous designs to evaluate community- and population-based interventions, including pre- and posttest designs. In addition, more community-based studies that examine proximal outcomes such as self-reports or measured reports of physical activity (e.g., pedometer) and weight loss, as well as clinical outcomes

(e.g., plasma glucose levels, HbA$_{1c}$ levels), are needed. Studies that include examination of community change indicators such as store buying patterns or the use of walking paths might be revealing, particularly in programs that use an ecological framework.

Although recent clinical trials have shown that intensive lifestyle modification and moderate weight loss can prevent or delay the development of type 2 diabetes (5–7), many of these clinical trials were conducted in resource intensive settings; adopting preventive measures on a population-wide basis will be more challenging. Community-based interventions can dovetail with high-risk approaches and are valuable for reasons that differ from the high-risk approach. In addition to promoting lifestyle adaptations, population-based approaches, governed by the community, can identify and support protective factors within the culture that can be supported in meaningful ways. They may also help garner social support among family and community members and have far-reaching influences that, along with environmental changes, can help support adaptive responses among people at various points along a continuum of risk.

However, to document these benefits, community-based interventions should use strong research designs with participatory approaches. These two approaches, used together, can help confirm the potential effectiveness of population-based endeavors to foster conditions that allow populations to be healthy, make healthy choices, and prevent diabetes.

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