Primary Prevention of Type 2 Diabetes in High-Risk Populations

Type 2 diabetes and its complications constitute a major worldwide public health problem. The prevalence of type 2 diabetes is increasing exponentially, and it is estimated that more than 300 million people will have diabetes by the year 2025 (1). Type 2 diabetes is primarily a lifestyle disorder, and, not surprisingly, the highest prevalence rates are occurring in developing countries and in populations that are undergoing "westernization" or modernization. Under such circumstances, it would appear that genetic susceptibility for diabetes is interacting with environmental change (adoption of a sedentary lifestyle and changing nutrition). These communities have the highest reported prevalence of diabetes in the world, ranging from 25 to 50% (2,3), and share the common experience of acculturation and rapid transition of their lifestyle. They have frequently been forced to abandon their traditional hunter-gatherer or agricultural-based existence for a sedentary way of life and a diet of energy-dense processed foods. They are now experiencing high rates of diabetes-related morbidity and mortality. Furthermore, epidemic obesity, young age at onset of type 2 diabetes, and elevated rates of diabetes in women of child-bearing age underscore the urgency for effective prevention strategies. The development, therefore, of population-based, community-grounded, and culturally appropriate primary prevention strategies that target healthy lifestyle activities is a priority.

Primary prevention can best be defined as the prevention of a disease by targeting or controlling modifiable risk factors in a population. Programs instituting primary prevention are best suited for populations with high prevalence rates of a disease or a condition. Proponents of prevention programs postulate that greater benefits are accrued by targeting the total population rather than by attempting to screen and treat high-risk individuals (4). Diabetes is an ideal condition for an approach that focuses on lifestyle changes (diet and activity). Lifestyle is invariably linked to community, culture, and values. Thus, to maximize the success of population-based primary prevention programs, the incorporation of social and cultural components in the intervention is critically important.

The use of study designs for community-based primary prevention strategies that target cultural as well as community life (also known as "participatory research") are highly suited to well-defined high-risk populations. Participatory research requires collaboration with the community participating in the study (5). This strategy appears to be valued by indigenous communities because it helps to ensure cultural relevance, create local knowledge and skills, and facilitate joint decision-making and collaboration between researchers and the community. This strategy further helps to ensure cultural relevance in the intervention program. Participation rates also tend to be exceptionally high when participatory research methodology is used. The ultimate aim of participatory research is to empower those individuals participating in the research process and to use the results of the study to improve the quality of life (6). These studies, however, are difficult to implement due to the length of time required to carry out such studies, the lack of funding for trials of this design, and the effort required to establish a collaborative relationship between the study population and researchers. Therefore, there is a dearth of studies that have described the outcome of such interventions.

Macaulay et al. (7) used this participatory approach in a 3-year community-based primary prevention program for type 2 diabetes that incorporated native culture and local community expertise in a Mohawk community near Montreal, Canada. Elementary school children and their families, combined with community-wide educational activities that emphasized health promotion and cultural pride, formed the basis of the intervention. Preliminary results have indicated a high level of awareness and participation by the community and the adoption of healthy behaviors in the school (7). Similar studies are underway in other Native American populations identified with high rates of impaired glucose tolerance (IGT) and diabetes (8,9).

Population approaches to the primary prevention of diabetes and related metabolic disorders are not limited to indigenous populations. A Finnish (North Karelia) and 3 American heart health (Stanford, Pawtucket, and Minnesota) studies (10–13) are the best known primary prevention chronic disease studies. The investigators of these studies hypothesized that there would be greater benefits for the study communities by targeting cardiovascular disease and its associated risk factors through the delivery of an integrated health education program that included intensive social marketing, health services, and behavioral modification. Unfortunately, the results of these programs have been disappointing. Only modest reductions in cardiovascular disease risk factors were observed, and there was no change in overall mortality. The lack of success in these studies has been attributed in part to the fact that these communities were relatively large and heterogeneous and did not incorporate any specific cultural components in the intervention. Project Salsa, a culturally oriented and smaller primary prevention study that aimed to improve heart care and nutrition in the Mexican American community of San Ysidro, California, achieved somewhat better results in a shorter period of time (14).

In this issue of *Diabetes Care*, Rowley et al. (15) describe the results of a successful community-based primary prevention program that incorporated the principles of participatory research in several remote homestead communities of Australian Aborigines. After the baseline screening for diabetes in 1988, which revealed high rates of IGT, diabetes, and obesity, an intervention program that promoted the benefits of exercise and diet was implemented. A follow-up survey of the same population was performed in 1995. The authors documented the success of their intervention strategy by demonstrating a significant reduction in the prevalence of IGT, hypercholesterolemia, and smoking in men. However, there was no change in the prevalence of diabetes and obesity, and mean BMI increased.

The usefulness of IGT as an epidemiological marker or a clinical criterion of success has been controversial. Much of the criticism results from the poor short-term reproducibility of this diagnosis on glucose tolerance testing (16), although there is general consensus of the high risk of progression to diabetes in those individuals identified with IGT. Conversion rates vary considerably within populations. Absolute fasting and 2-h post-glucose challenge levels have been the most consistent variables that have been found to determine progression to diabetes (17). In the study by Rowley et al. (15), the demonstration that both fasting and 2-h blood glucose levels were lower at follow-up supports their findings of a reduced prevalence of IGT. An interesting finding of this study concerns the increase in BMI. Most studies have demonstrated a consistent relationship between BMI and progression from IGT to diabetes (18). Unfortunately, no measurements of adiposity distribution and central obesity were performed. The authors postulate that the reduction in IGT, despite an increase in BMI, was due to increased physical activity. However, they do not provide objective evidence that there was a change in exercise or fitness.

There is limited information regarding the role of lifestyle factors and IGT progression. Marshall et al. (19) identified fat intake as an independent risk factor in 123 subjects with IGT identified from a population-based survey in Colorado and followed for 1–3 years. Eriksson and Lindgarde (20) identified fitness as an independent protective factor for a group of middle-aged Swedish men with both normal glucose tolerance and IGT (although the effect was weaker and not significant when the analysis was limited to those with IGT alone). The level of physical activity determined from self-report questionnaires has also been associated with progression to diabetes in other studies (19,21,22).

There is conflicting evidence concerning the usefulness of lifestyle modification therapy that targets diet, exercise, or both to prevent the development of diabetes. The Da Qing Study reported a 42% reduction in the progression to diabetes in individuals previously identified with IGT who received a diet plus exercise intervention (23). In Malmö, Sweden, subjects with IGT who participated in a 5-year prospective study and were on a diet and exercise regimen were less likely to progress to diabetes than those subjects in the control group (20). However, a prospective study in New Zealand that implemented dietary and exercise interventions in the target population reported no change in mean FPG after 2 years (24). Generally, these trials did not include randomized control populations. Studies that have used only physical activity interventions have suggested that adopting more active lifestyles may protect against the development of diabetes. O'Dea (25) demonstrated an improvement in carbohydrate and lipid metabolism in a group of volunteer diabetic Australian Aborigines who reverted to their ancestral lifestyle for 7 weeks (25). This improvement was believed to be primarily due to changes in physical activity. These studies, however, focused on small groups of individuals in highly controlled situations. Narayan et al. (26) described the results from a 1-year pilot study in a Pima population in which 95 obese nondiabetic adults were randomized to a program that focused on activity and nutrition versus an educational program that focused on tribal cultures and traditions (26). Both groups showed a significant improvement in self-reported levels of activity, but modification of dietary factors was less successful. Moreover, over the duration of the study, both groups experienced weight gain as measured by BMI, and adherence to the interventions declined.

In summary, the epidemic of diabetes and the complications of diabetes are having devastating effects on populations throughout the world. The need to develop effective validated interventions that are grounded in sound community-based participatory research is urgently needed. True partnerships, such as those represented by collaborations between academic centers and affected communities, are the most likely to yield beneficial outcomes.

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