Supplement Article

Diabetes and obesity prevention: changing the food environment in low-income settings

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Innovative approaches are needed to impact obesity and other diet-related chronic diseases, including interventions at the environmental and policy levels. Such interventions are promising due to their wide reach. This article reports on 10 multilevel community trials that the present authors either led (n = 8) or played a substantial role in developing (n = 2) in low-income minority settings in the United States and other countries that test interventions to improve the food environment, support policy, and reduce the risk for developing obesity and other diet-related chronic diseases. All studies examined change from pre- to postintervention and included a comparison group. The results show the trials had consistent positive effects on consumer psychosocial factors, food purchasing, food preparation, and diet, and, in some instances, obesity. Recently, a multilevel, multicomponent intervention was implemented in the city of Baltimore that promises to impact obesity in children, and, potentially, diabetes and related chronic diseases among adults. Based on the results of these trials, this article offers a series of recommendations to contribute to the prevention of chronic disease in Mexico. Further work is needed to disseminate, expand, and sustain these initiatives at the city, state, and federal levels.

INTRODUCTION

The worldwide obesity epidemic is a multilevel and complex public health issue. Innovative multicomponent approaches are needed to impact this problem, including tested interventions at the environmental and policy levels.[1] Populations living in poor food environments are at greater risk of inadequate diets and of developing diet-related chronic disease. Thus, nutrition interventions to address the obesity and diabetes epidemics need to focus at multiple levels, including potentially the individual, family, community food and physical activity environments, and policy levels.

The past decade has seen substantial advances in this work, including multilevel community-based obesity trials with low-income, urban African American populations (Baltimore Healthy Eating Zones),[2] mixed urban minority populations (Shape Up Somerville),[3] indigenous adult populations (Healthy Foods North [HFN]),[4] and rural populations (Change!).[5] Key aspects of these programs involve changing the retail food environment, focusing on improvements in access to and promotion of healthy foods, in order to increase sales and consumer purchasing of healthier products.[1,6,7] Yet substantial gaps remain. The best approaches for improving the food environment in low-income settings are not well understood. Nor have there been published literature reviews of efforts to improve the food environment in rural and urban minority settings.

This article addresses this gap by providing a narrative synthesis of work conducted in the last decade to

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improve the food environment in low-income rural and urban settings in the United States and internationally. It concludes with a case study of a multilevel, multicomponent intervention trial currently underway in the city of Baltimore. By drawing on these experiences, this article provides an assessment of best practices and lessons learned and recommends tested strategies to decrease obesity rates in Mexico and other countries undergoing the nutrition transition. A final key question that is addressed here is: what is the potential of these interventions to reduce the prevalence of obesity and diabetes?

INTERVENTION TRIALS MATERIALS AND METHODS

Since 2001, the present authors have conducted 10 trials in low-income minority populations in the United States and in other countries to test interventions to improve the food environment and to reduce risk for developing obesity and other diet-related chronic diseases. These trials have centered on changing the retail food environment (supermarkets, small stores), prepared food sources (carryout), wholesalers/distributors, schools, worksites, churches, recreation centers, and community and social media; more recently, the trials have taken policy-level approaches. The work has included educational strategies to increase demand for healthier foods, complemented by environmental strategies to increase the supply of these foods. These community-based interventions were developed through formative research and a community engagement process (generally community workshops) in which community members and other key stakeholders contributed ideas and strategies to plan and implement the program.[8–10] Efforts have centered on increasing access to healthier foods (availability, pricing) and promoting these foods through point-of-purchase materials (shelf labels, posters), interactive sessions (taste-testing healthier foods, flyers), and promotional giveaways. The work has been conducted in rural regions targeting American Indians, First Nations, and Pacific Islanders – and in urban settings focusing on African American, Pacific Islander, and Hispanic communities. All studies have examined changes from pre- to postintervention, comparing a treatment group with a comparison group to assess the impact of the program. All trials have been multilevel, seeking to change individual and family behavior, as well as change access to food choices and information at the community institution level.

TRIAL RESULTS AND FINDINGS

Presented first is a brief summary of each of the completed trials and their main findings, stratified by rural vs urban geography, and then in rough chronological order. All studies were led by the first author unless otherwise indicated.

Trials in remote and rural settings

Marshall Islands Healthy Stores. Marshall Islands Healthy Stores was a pilot food store–based intervention program developed in collaboration with the Republic of the Marshall Islands Ministry of Health and Environment. The trial took place in 2001. Formative research was conducted with store owners and costumers to develop materials, messages, and strategies for the intervention.[11] The intervention focused on changing the broader environment by directly influencing the availability of healthier food options and increasing general awareness of these options through individual and mass media approaches.[11] The program was implemented and evaluated in 23 large and small stores (12 intervention, 11 control). Increased exposure to the intervention was associated with higher knowledge of diabetes and label reading in a sample of consumers.[12] The intervention was associated with increased purchasing of certain promoted foods ($P < 0.005$), including oatmeal, turkey chili, fish, canned fruit, and local vegetables, and with improvements in healthiness of cooking methods.[12]

Apache Healthy Stores. In 2002–2005, an environmental intervention in food stores on 2 Apache reservations was developed and evaluated to increase the availability of healthy foods and promote them at the point of purchase.[8] Media approaches included shelf labels, interactive taste tests at food stores, educational displays, and radio announcements in Apache and English. Sales of promoted foods increased significantly more in intervention than in comparison stores. Intervention respondents increased their total intake of higher-fiber cereals, vegetables, and lower-fat milks and decreased their consumption of fatty snacks, whole milk, and fried foods.[13]

Healthy Foods Hawaii. Healthy Foods Hawaii (HFH) was a large retail food store trial conducted in Pacific Islander communities, led by Dr Rachel Novotny (University of Hawaii). HFH was designed to strengthen the network between local food producers, food distributors, store owners, and consumers to increase the availability of healthier, less energy-dense foods for children in underserved rural communities of Hawaii.[14] Point-of-purchase promotions and local media stimulated demand for these foods. HFH was implemented over a 9- to 11-month period in 5 food stores in 2 low-income multiethnic communities and was evaluated in 116 child-caregiver dyads. The impact of the HFH intervention on caregiver and child food-related psychosocial factors, behaviors, and dietary intake was significant ($P = 0.004$ and $P = 0.02$, respectively).[15] Intervention children significantly increased their Healthy Eating Index

(HEI) score for servings of grains, their total consumption of water, and showed an average 8.5-point increase in overall HEI score.[15]

Navajo Healthy Stores. Between 2008 and 2010, the Apache Healthy Stores program was expanded to the Navajo Nation. Navajo Healthy Stores was implemented entirely by Navajo Special Diabetes Prevention Program staff, with Johns Hopkins University materials, capacity building, and evaluation support. The intervention focused on increasing the availability of healthy food choices in large and small stores and point-of-purchase promotions, including shelf labels, posters, and interactive sessions. Greater exposure to the intervention was associated with significantly reduced body mass index (BMI) ($P \leq 0.05$), improved healthy food intentions ($P \leq 0.01$), healthy cooking methods ($P \leq 0.05$), and healthy food getting ($P \leq 0.01$).[16]

Zhiwaapenewin Akino'maagewin Feasibility Trial. The Zhiwaapenewin Akino'maagewin Feasibility Trial was a 9-month multi-institutional study to modify type 2 diabetes mellitus risk factors in 7 Ontario First Nations communities. Formative research was used to develop intervention strategies and materials.[17] The Zhiwaapenewin Akino'maagewin Feasibility Trial intervention worked with schools, food stores, and local health services agencies and included stocking and labeling of healthier foods, classroom curricula for grades 3 and 4, cooking demonstrations, mass media, and community events. The intervention had a positive impact on knowledge ($P < 0.019$), led to a trend toward higher healthy food intentions ($P < 0.11$), and increased frequency of getting healthy foods among community members.[18,19]

Healthy Foods North. HFN was implemented over the course of 12 months in 7 phases, between October 2008 and 2009 (Nunavut) and June 2008 and 2009 (Northwest Territories), led by Dr Sangita Sharma (University of Alberta).[20] HFN promoted the consumption of traditional foods and nutrient-dense and/or low-energy store-bought foods, the utilization of food preparation methods that do not add fat content, decreased consumption of high-energy store-bought foods, and increased physical activity through a community activity program. Extensive use of community media (radio, TV) was used to reinforce key messages. Respondents living in intervention communities showed significant improvements in food-related self-efficacy ($P = 0.003$) and intentions ($P = 0.001$), compared with comparison communities.[4] Postintervention assessment showed a reduction in total fat and saturated, monounsaturated, and polyunsaturated fatty acids, as well as increases in iron intake in the intervention group.[21] Intervention respondents significantly reduced their energy intake and increased their vitamins A and D intake.[21,22]

Trials in low-income urban settings

Baltimore Healthy Stores. Between 2005 and 2007, 2 trials (Baltimore Healthy Stores [BHS] 1 and 2) were completed in 21 retail food stores, including supermarkets and small food stores. Small store owners received gift cards to local wholesalers to incentivize their stocking of healthier foods. Shelf labels, posters, fliers, giveaways, and taste tests/education sessions were utilized to promote healthy foods to low-income African American adults. The study was implemented with high reach, dose, and fidelity regarding stocking of promoted foods, displaying materials at the store level, and implementation of in-store taste tests.[26] Intervention stores were more likely to increase and sustain the promoted food availability at intervention, post intervention, and follow-up.[27] The BHS intervention had a positive impact on the healthfulness of food preparation methods, and respondents in the intervention areas were significantly more likely to report purchasing promoted foods because of the presence of a BHS shelf label.[28]

Baltimore Healthy Eating Zones. The BHS trial was later expanded to target youth. This program[29] was implemented in 7 recreation centers and 21 nearby corner stores. The 8-month intervention aimed to increase the availability and selection of healthful foods through nutrition promotion and education using point-of-purchase materials such as posters and flyers in stores around recreation centers and via interactive sessions.[29] The intervention program was associated with reductions in youth BMI percentile among children who were overweight or obese at baseline ($P = 0.04$). Intervention youth significantly improved food-related outcome expectancies ($P = 0.02$) and knowledge ($P < 0.001$).[30]

Baltimore Healthy Carryouts. A piloted intervention was conducted in 8 carryout food locations in low-income areas of Baltimore City. The pilot included replacing menu boards to promote existing healthy menu options with photos, promotional posters, introduction of healthier beverages and side dishes, lower-cost condiments, and substitution of low-fat cooking ingredients and condiments.[31] Acceptability, fidelity, and perceived sustainability of the new menu board and poster interventions were high.[32] The BHC intervention was associated with increased sales of healthy foods and total revenues[33]; consumers significantly increased their purchases of healthier food items.[33]

B'More Healthy Retail Rewards. B'More Healthy Retail Rewards is the first randomized controlled trial to involve food wholesalers in a food access intervention program on healthy food purchasing and consumption among low-income small store customers.[34] Twenty-four small corner stores located in low-income census tracts of Baltimore were randomized to 1 of 4 treatment groups: communications only (n = 6), pricing only (n = 6), combined communications and pricing (n = 6), or control (n = 6). Performance allowances in the form of healthy food discounts (10%–30% off wholesale price) were directed from the wholesaler to the pricing only and combined intervention stores (12 stores total) at checkout for 6 months during 2012–2013. Analyses are ongoing.

Summary of findings of completed trials

Process evaluation reveals that these multilevel community trials were implemented with moderate to high reach, dose, and fidelity at all intervention levels assessed.[6] All trials used formative research to identify culturally appropriate messages and targeted food items. Consistent positive effects of these multiple intervention trials were found on psychosocial factors, such as knowledge, healthy food intentions, self-efficacy, and outcome expectations among low-income adults and youth in different ethnic minority populations. Improvements in the healthiness of cooking methods was also seen in adult respondents. The food store–based intervention trials also had a positive impact on healthy food-purchasing behavior, with increased frequency and improved quality of foods purchased, especially those foods promoted by the program. Furthermore, exposure to the intervention was associated with dietary improvements (particularly in terms of consumption of promoted foods), increased HEI scores, and decreased fat and energy intake. In some instances, when measured, it was possible to find a significant change in body composition, such as a decrease in waist circumference and reduction in BMI.[2,15] Positive changes were seen at institutional levels, such as improved stocking and sales of healthier foods. Level of exposure to different intervention components was strongly associated with impact.

Case of ongoing multilevel trial to improve the food environment

The work described above has culminated in an ongoing trial in Baltimore City called B'More Healthy Communities for Kids (BHCK). This is a multilevel, multicomponent obesity prevention trial that utilizes a systems science approach to improve the food environment in 28 urban, low-income, predominantly African American food desert neighborhoods of Baltimore City.[35]

Baseline data reveal high levels of overweight and obesity among both children (45.3%) and adults (86.9%) living in low-income food deserts in Baltimore as well as worrisomely high rates of reported diet-related chronic disease in adults. Dietary behaviors, such as low intake of fruits and vegetables and high intake of sugar-sweetened beverages as markers for diet quality,[36] are among the most important risk factors for diet-related chronic diseases.[37] Baseline data revealed low purchasing frequency of fruits and vegetables and high purchasing frequency of regular soda over diet soda among adults. In the majority of Americans' diets, most added sugar comes from caloric drinks, such as soft drinks and sugar-sweetened beverages.[38–42] On average, youth in our sample consumed 170 kcal per day from sugary drinks, which equates to roughly 1 can of soda per day.

These high risk factor rates are reflected in very high reported rates of diet-related chronic disease in the baseline sample. Fully 51.8% reported a diagnosis of hypertension, 18.5% cardiovascular disease, and 14.8% diabetes (Table 1).

In order to address these issues, BHCK is working to achieve the following: (1) improve the healthy food supply chain from wholesalers to small food stores to consumers; (2) increase the demand for healthy foods at the consumer and retail levels; (3) provide the evidence needed to develop systems models on obesity prevention strategies; and (4) inform plans for sustaining a healthy food environment through policy changes by working with city policymakers and other agencies. This intervention targets multiple levels of the urban food environment, including the following: (1) policy; (2) wholesalers; (3) corner stores/carryouts; (4) recreation centers; and (5) children and their caregivers. The policy work has involved extensive collaborations and planning meetings over the past 2 years with city council members, city health authorities, planning and recreation department leaders, local and regional retailers, and local community organization representatives. The BHCK trial is being implemented in 2 waves, each with its own intervention and evaluation activities. The wave 2 intervention was modified based on the wave 1 intervention experience. Data collection involves extensive assessments of children (psychosocial factors, food purchasing, food preparation, dietary intake, BMI) and adult caregivers (psychosocial factors, shopping patterns, BMI).

DISCUSSION

This article summarizes work on environmental change interventions to reduce obesity and related chronic

Table 1 **Diabetes risk factors for low-income African American adult caregivers (n = 298)**

Caregiver characteristics	No. of respondents	Percentage or mean (SE)
Sociodemographics		
Mean age in years ± SE	298	38.9 (9.6)
Female (%)	298	85.9
African American, self-reported (%)	298	91.3
Income (%)		
0–10 000	78	26.1
10 001–20 000	62	20.7
20 001–30 000	60	20.1
>30 000	100	33.1
Educational level (%)	298	
<High school		18.2
High school		42.8
>High school		39.1
Mean BMI[a] (kg/m^2) ± SE	290	33.3 ± 7.5
Normal weight (%)	38	13.1
Overweight (%)	63	21.7
Obesity (%)	189	65.2
Individual medical history[b]	27	
CVD (%)	5	18.5
Hypertension (%)	14	51.8
T2DM (%)	4	14.8
Family medical history[c]	27	
CVD (%)	13	48.1
Hypertension (%)	23	85.2
T2DM (%)	12	44.5

[a]Body mass index (BMI): adult obese BMI $\geq$30 kg/m^2; overweight BMI $\geq$25 <30 kg/m^2 (World Health Organization).
[b]Self-reported chronic diseases – preliminary data from postintervention interview.
[c]Self-reported family chronic disease history – preliminary data from postintervention interview.
Abbreviations: CVD, cardiovascular disease; T2DM, type 2 diabetes mellitus; SE, standard error.

disease among low-income populations in the United States and internationally. Environmental interventions comprise a set of promising approaches for addressing the global obesity epidemic. They may be most effective in low-income populations, which have reduced access to healthy food options – as they generally improve supply of these foods.

These interventions work best when combined with educational approaches to increase demand for healthier foods and they are applicable to the Mexican context. Mexico has experienced great changes in its economy, as well as a significant shift in immigration, demographics, and eating patterns that affect the health status of the population.[43,44] This has led to lifestyle changes that are resulting in higher obesity rates due to an increase in sedentary behavior and increased access to low-priced, highly energy-dense foods.[42,45] Diabetes mellitus type 2 and cardiovascular disease are now leading causes of death.[46–48] In Mexico, overweight/obese children consume a 9.7 kcal/100 g denser diet than normal-weight children,[49] stemming particularly from sugar-sweetened beverages.[39,50] In response to the obesity epidemic, in 2010 the Secretary of Health developed a multistakeholder, multisector initiative, *Acuerdo Nacional para la Salud Alimentaria: Estrategia Contra el Sobrepeso y la Obesidad*, which provided a framework for a range of policies, programs, and guidelines in an effort to promote and encourage healthy eating and physical activity.[51]

The regulation of foods and beverages sold in schools is an approach used in many Latin American countries to improve the food environment and address childhood obesity.[52] Mexico started the gradual implementation of guidelines for foods and beverages in 2011 to allow time for the affected organizations and schools to adapt to the new regulations.[51,53] Although regulations at schools are extremely important, there is a need to also intervene in other food sources around schools.

In order to address the double burden of undernutrition and overnutrition in Brazil the National Food and Nutrition Policy was incorporated into the national healthcare system, which aims to combat obesity and encourage nutrition.[54] In the past decade, the country has tackled obesity through new food guidelines, enhanced training of health workers, programs to improve physical activity, the institution of a new food-labeling system, and investing in infrastructure for healthy foods through the Brazil School Feeding Program.[52,55,56] For instance, in 2001 all schools in the country were required to have at least 70% of the offered food be minimally processed food or fresh food. In 2009, another policy was implemented requiring that 30% of the school's food be sourced from small or local food producers.[57]

Another set of strategies to address obesity in Latin American countries is the improvement of food labeling systems. Due to the varying levels of numeracy and literacy among consumers and inconsistencies in serving size calculations and labeling, food labeling efforts have been found to cause confusion, instead of informing consumers.[58] To address this, Chile and Ecuador have recently launched their front-of-package labeling system. Chile's front-of-package label indicates the amount(s) of calories, sugar, saturated fat, and sodium in the product that surpass government-established limits.[59,60]

Based on the present review of the literature and the authors' own research, the following key recommendations are offered to improve the food environment in Mexico and other Latin American countries undergoing a nutrition transition: (1) Effective environmental interventions require rigorous monitoring and cost-effectiveness evaluation in order to measure the impact of the polices on reducing obesity and other diet-related chronic disease and to inform implementation of national large-scale programs.[61,62] Pilot trials and simulation studies are needed to establish these cost benefits in order to select the best choices for each setting. (2) Sustainable improvements to the food system require improved relationships between communities and key local food source stakeholders (such as store owners and managers).[8,32] Long-term improvements must affect both supply and demand.[27,33] Therefore, means of communication and dialogue need to be established between retailers and consumers, and between retailers and wholesalers/distributors, among others. At the community level, this can be done through the community workshop approaches we have employed. (3) Formative research is needed to aid in program planning.[31,63,64] Both qualitative and quantitative information gathering are needed to assess stakeholder perspectives and to adapt approaches to specific community contexts. This includes quantitative assessment of the food environment, detailed dietary assessment to select food for intervention, and qualitative information gathering to understand decision-making around food stocking, sales, and choice. (4) Environmental interventions can be slow acting and require multiple components/media to achieve adequate exposure. Therefore, planning must include multiple components – for example, working with both prepared and retail food sources, as well as schools and worksites, etc. A key focal point in the Mexican context is changing the food environment near schools. (5) Environmental approaches should be supported and sustained by policy that act to institutionalize initiatives and programs.

Limitations exist in the work reported. First, the information provided in this article represents the work of the authors only and is not a systematic review of the literature on environmental/multilevel interventions; such reviews are needed. Second, the demographic, dietary intake, medical history, and diet-related behavior data used in these studies are self-reported. As a result, there is the potential for reporting bias and misclassification. A significant gap remains in linking environmental interventions to health outcomes beyond obesity, such as diabetes and heart disease. This will require extended, long-term trials.

The interventions reported here used a variety of strategies to increase access to healthful food in retail food stores such as increasing the availability of targeted food items, manipulating price, using posters, shelf labels, and point-of-purchase promotions. However, more research is needed to identify the most effective approaches with the greatest impacts on diet-related behavior, both alone and in combination. Moreover, few studies have been able to directly assess sales information and predict profitability due to the difficulty of tracking sales in small food stores.[65] Therefore, tracking sales of specific foods should be improved in order to motivate store owners to sustain stocking of these items.

CONCLUSION

In conclusion, environmental interventions, particularly in combination with policy and/or educational approaches, represent a strong and, now, largely proven approach for obesity prevention. It is recommended here that future intervention research plan for the long-term sustainability of the programs by involving policy makers, store owners, and the community throughout the entire research process and allowing them to have a more active voice and participation. Further work is needed to disseminate, expand, and sustain these initiatives at the city, state, and federal levels.

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