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Impact of Baltimore Healthy Eating Zones: An Environmental Intervention to Improve Diet Among African American Youth

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Abstract

This study assessed the impact of a youth-targeted multilevel nutrition intervention in Baltimore City. The study used a clustered randomized design in which 7 recreation centers and 21 corner stores received interventions and 7 additional recreation centers served as comparison. The 8-month intervention aimed to increase availability and selection of healthful foods through nutrition promotion and education using point-of purchase materials such as posters and flyers in stores and interactive sessions such as taste test and cooking demonstrations. Two hundred forty-two youth–caregiver dyads residing in low-income areas of Baltimore City recruited from recreation centers were surveyed at baseline using detailed instruments that contained questions about food-related psychosocial indicators (behavioral intentions, self-efficacy, outcome expectancies, and knowledge), healthful food purchasing and preparation methods, and anthropometric measures (height and weight). The Baltimore Healthy Eating Zones intervention was associated with reductions in youth body mass index percentile ($p = .04$). In subgroup analyses among overweight and obese girls, body mass index for age percentile decreased significantly in girls assigned to the intervention group ($p = .03$) and in girls with high exposure to the intervention ($p = .013$), as opposed to those in comparison or lower exposure groups. Intervention youth significantly improved food-related outcome expectancies ($p = .02$) and knowledge ($p < .001$). The study results suggest that the Baltimore Healthy Eating Zones multilevel intervention had a modest impact in reducing overweight or obesity among already overweight low-income African American youth living in an environment where healthful foods are less available. Additional studies are needed to determine the relative impact of health communications and environmental interventions in this population, both alone and in combination.

Keywords

adolescent health, African American youth; childhood obesity, community-based research, corner store intervention, social cognitive theory

The current childhood obesity epidemic calls for immediate solutions. In the United States, 17% of children and adolescents aged 2 to 19 years are obese (Ogden, Carroll, Kit, & Flegal, 2012). Among 9th to 12th graders, the prevalence of overweight and obesity was estimated as 15.8% and 12.0%, respectively, with the highest prevalence among African American (AA) youth (21.0% for overweight and 15.1% for obesity; Eaton et al., 2010). In Baltimore, 33.9% of third graders are reportedly overweight or at risk for overweight (Jehn, Gittelsohn, Treuth, & Caballero, 2006), with a higher proportion of overweight in AA and low-income children. Low-income youth, and particularly low-income female youth, are more likely to

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remain overweight or obese into adolescence and adulthood (Dekkers et al., 2004; Lee et al., 2010).

To reverse these trends, environmental and policy-level interventions have been recommended and implemented across the United States. However, most obesity prevention programs targeting youth have primarily focused on the school environment, not the community food environment (Economos et al., 2007; Foster et al., 2008).

In low-income Baltimore City neighborhoods, community-based environmental interventions have significantly increased healthful food availability and consumption among low-income AA adults (Gittelsohn, Song, et al., 2010; Gittelsohn, Suratkar, et al., 2010), but no evidence-based interventions have been implemented to improve diet or obesity among children in this setting. Food availability and accessibility are known to affect low-income AA dietary patterns (Kumanyika & Grier, 2006). In Baltimore City, small corner stores are the most frequently visited food outlets among AA youth (Dennisuk et al., 2011). These stores are mostly Korean American–owned and stock fewer healthful foods, such as low-fat dairy products and fresh produce as compared to supermarkets (Laska, Borradaile, Tester, Foster, & Gittelsohn, 2010). To address this issue, the Baltimore Healthy Stores (BHS) trial was implemented. BHS was an environmental intervention in which two supermarkets and seven local corner stores were encouraged to stock healthier foods and built consumer demand through point-of-purchase signage as well as nutrition education activities. The program resulted in overall positive impacts on consumer psychosocial variables and behaviors related to healthful eating and a modest increase in the availability of healthful foods (Gittelsohn, Song, et al., 2010; Gittelsohn, Suratkar, et al., 2010; Song et al., 2009).

The Baltimore Healthy Eating Zones (BHEZ) study was developed from BHS (Sharma et al., 2009) but primarily targeted AA youth. The primary hypothesis was that a combined environmental and behavioral intervention would improve youth food-related psychosocial factors (behavioral intentions, self-efficacy, knowledge, and outcome expectancies) and food purchasing and preparation patterns, and decrease youth's body mass index (BMI) for age.

Method

Formative Research and Initial Recruitment

Prior to this study, formative research conducted by our group included in-depth interviews, focus groups, and dietary recall questionnaires among local AA youth, store owners, and recreation center staff to determine the most appropriate foods to be promoted, evaluation methods, and intervention messages (Dennisuk et al., 2011; Kramer et al., 2012; Surkan et al., 2011). Specifically, 15 in-depth interviews with adolescents and youth, 1 focus group with girls, and 1 paired interview with 2 boys were conducted. Also, 7 adults who were familiar with local youths' eating behavior were interviewed. In addition, 15 food outlets, including supermarket, carryout, and fast-food restaurants in East Baltimore, were observed. In the present study, 432 AA youth-caregiver dyads were initially recruited from 14 randomly selected recreation centers in East and West Baltimore. To be eligible for the study, youth had to be 10 to 14 years of age, and live within 1 mile of a study recreation center without the intention to move within the next year. In settings where two recreation centers were within 1 mile of each other, children were considered part of the zone of the closest of the two centers to their place of residence. "Caregiver" was defined as a main food shopper and preparer for the youth's household. Only one youth per household was eligible. Of the 432 youths approached, 176 did not return consent forms and 14 dyads did not complete the child or caregiver interview, resulting in 242 completed baseline dyad interviews (i.e., 63% response rate). The study originally planned to recruit 300 dyads. To recontact the respondents at postintervention, multiple strategies were used, including mailings, phone contacts, house visits, recreation center visits, and web searches. After the 8-month BHEZ intervention, 152 youths and 161 caregivers were reinterviewed with a postintervention survey (63% and 67% response rate, respectively). No systematic differences in demographic characteristics were observed between postintervention survey respondents and those who were lost to follow-up ($242 - 152 = 90$). All surveys were conducted in person by a trained data collector. Respondents received a $40 gift card at each of the two rounds of data collection. The Institutional Review Board of the Johns Hopkins Bloomberg School of Public Health approved the study. Baseline surveys were administered between 2008 and 2009, and postintervention surveys were conducted between 2010 and 2011. Impact of the intervention on caregivers (mean age = 42, 52% employed, 94% female) will be presented in a future paper.

BHEZ Intervention

The Baltimore City Department of Recreation and Parks provided overall approval to work in the recreation centers, and identified potential centers for participation based on those having adequate size, resources, and supportive staff. The study team met with each recommended center director and recruited 14 centers. After the initial recruitment, the centers were randomly assigned to intervention (seven centers) or control group (seven centers). The study recreation centers were at least a mile apart from each other (Gittelsohn et al., 2013). Three corner stores and/or carryouts were also recruited per intervention recreation center to receive the intervention. The food outlets were selected based on their proximity to each recreation center (within ½ mile of the recreation center) and on recreation center staff reporting they were frequently used by children in the area. Intervention strategies were developed based on formative research or modified from a previous trial with small food stores (Gittelsohn, Song, et al., 2010) to include youth-specific materials and methods. During the 8-month intervention, materials and activities, such as taste

tests, cooking demonstrations, giveaways, shelf labels, and point-of-purchase health communication materials such as posters and flyers, were introduced in intervention recreation centers, local corner stores, and carryout restaurants. Interventions in each venue were interconnected and reinforced each other. For instance, increased stocking of healthful foods at corner stores was reinforced by nutrition education at recreation centers by directing community residents to purchase the promoted healthful foods from the store. Venues were incentivized to stock additional healthier, affordable foods. Each of the intervention's five phases focused on a single aspect of healthful eating: healthful beverages, healthful breakfast, cooking at home/healthful lunch, healthful snacks, and selecting more healthful options at carryout restaurants (Table 1). Youth peer educators were recruited from each intervention recreation center and trained by interventionists to assist in health promotions.

Youth Impact Questionnaire

Informed by social cognitive theory, a Youth Impact Questionnaire measured youth food purchasing patterns, preparation patterns, psychosocial factors (behavioral intentions, self-efficacy, outcome expectancies, knowledge), and anthropometric measures (height and weight). Food purchasing patterns at baseline assessed daily food expenditures reported and frequencies of food shopping at specific venues (supermarkets, corner stores, etc.). Additionally, the questionnaire inquired about the frequency of food purchases for 29 healthful and unhealthful foods and beverages, and the type of food outlet where each was purchased. The same questions were included in postintervention surveys. Food preparation questions included the frequency that specific food items were prepared both by youth themselves and by their primary caregivers. For each food prepared by youth, the specific preparation method was ascertained. (The questionnaire score variables are available online at http://heb.sagepub.com/supplemental.)

The survey also assessed food-related psychosocial factors. It included 7 behavioral intention questions (e.g., If you wanted a snack, which would you pick?—sunflower seeds/French fries/candy), 7 outcome expectancies questions (e.g., I would have more energy if I ate more fruits and vegetables—true/sometimes true/not true/ don't know), 6 self-efficacy questions (e.g., I can regularly eat vegetables several times a day—Sure I can do it/Maybe I can do it/Sure that I cannot do it), and 12 food knowledge questions testing for the promoted foods during intervention (e.g., Which fast food has less fat?—Chinese chicken wings/chicken box/turkey sub/don't know). Height and weight were measured using the Invicta Portable Height Measure (Invicta Plastics, Leicester, United Kingdom) and Tanita Body Fat/Body Water Monitor (Tanita, Arlington Heights, Illinois). The survey was administrated at each respondent's home or in a conference room at a school by research assistants from the Johns Hopkins Bloomberg School of Public Health. Study data were collected over an 8- to 10-month period at baseline and postintervention.

Intervention Exposure Evaluation

We assessed intervention exposure in both youth and caregivers as part of the postintervention evaluation. Respondents were asked their frequency of visiting intervention stores and recreation centers, if they had ever seen any intervention materials (logo, shelf label, etc.), or if they had participated in any intervention activities (taste test, cooking demonstration, educational activities). To facilitate recall, a booklet containing pictures of intervention materials and intervention corner stores was shown to the respondents as a prompt. The booklet included some "red herring" materials to detect possible response bias. Only a few respondents reported seeing any of the fake materials, and none reported seeing more than two out of the total of four such materials shown.

Score Construction

Youth Impact Questionnaire. Food-related psychosocial factor (behavioral intentions, outcome expectancies, self-efficacy, and knowledge) scores were created by assigning numerical scores to answers based on their healthfulness or correctness. For behavioral intentions, healthful choices were assigned 1 point and unhealthful choices were assigned 0 point. Outcome expectancy questions were scored as follows: *true* = 3 points, *sometimes true* = 2, *not true* = 1, and *don't know* = 0. Self-efficacy questions were scored: *Sure I can do it* = 3, *Maybe I can do it* = 2, and *Sure that I cannot do it* = 1. Knowledge questions were given 1 point for a correct answer, while other responses received 0 points. Aggregate scores were created by summing scores in each question, separately for baseline and at postintervention, while excluding questions that lowered Cronbach's alpha (internal consistency indicator) value (Behavioral intentions: .52, outcome expectancies: .59, self-efficacy: .54, knowledge: .65, healthful food purchasing frequency: .55, unhealthful food purchasing frequency: .67).

To create healthful/unhealthful food purchasing scores, 24 healthful and unhealthful foods were identified from answer choices in the Youth Impact Questionnaire. One point was assigned per purchase of a healthful food, and no point was given for the purchase of unhealthful foods. Scores were then calculated by adding purchasing frequencies. Again, answers that were not consistent with the rest of the items were excluded from score creation based on Cronbach's alpha value. In addition, the scores were subdivided into five categories: healthful beverage, healthful snack, unhealthful beverage, unhealthful snack, and fast food scores. The BHEZ intervention focused more on promoting healthful beverages and snacks than on encouraging avoidance of fast foods.

Last, answer choices from food preparation questions were used to generate healthful food preparation scores. These food preparation questions asked which kinds of foods

Table 1. BHEZ Intervention Phases.

Phase	Name of the phase	Promoted Behavior	Promoted foods	Taste tests/cooking demonstrations[a]
0 (Pilot)	Teaser	Increasing awareness of BHEZ program in local stores Building anticipation for the BHEZ program Follow the 10% rule	None	None
1	Healthful beverages	Choose more healthful and low-calorie drinks—water or diet sodas over regular sodas	Diet sodas: Diet Pepsi, Pepsi One, Sprite Zero, etc.) 100% fruit juice Water Low-calorie drink mix (Crystal Light, Wyler's Light)	Diet soda taste test, Crystal Light taste test
2	Healthful breakfast	Eat a healthful breakfast to give you energy Consume low-sugar, high-fiber cereals and low-fat milk Try fruit in your cereal	Low-sugar cereals: Cheerios, Wheat Chex, Toasted O's, Special K, Cornflakes, Kix High-fiber cereals: Wheaties, Cheerios, Wheat Chex, Raisin Bran, Total Whole Grain, oatmeal Milk: 1% and skim milk	Low-fat milk taste test, fruit in cereal taste test
3	Cooking at home/ healthful lunch	Use cooking spray when making eggs, pancakes, and vegetables Drain and rinse excess fat from ground beef Buy healthier foods Add vegetables into cooked meals Pack a healthful lunch	Cooking sprays Fresh/canned/frozen vegetables Fresh/canned (in light syrup/juice) fruit 100% whole wheat bread	Sandwich on whole wheat bread taste test, cheese and crackers taste test, pancakes with cooking spray demo
4	Healthful snacks	Eat fruits or vegetables for snacks Try new ways to eat fruits and vegetables Choose baked instead of fried snacks Choose lower fat carryout meals Request less mayonnaise on foods Choose whole wheat bread over white bread	Fruits: apple, bananas, tangerines, strawberries, raisins Vegetables: celery, carrots Low-fat snacks: baked chips, pretzels, sun chips, yogurt, granola bars Low-sugar snacks: trail mix, nuts, seeds Whole wheat bread Low-fat and fat-free mayonnaise, ketchup, mustard	Trail mix taste test, baked chips taste test, peanut butter/banana/ raisin roll-up, yogurt with granola and fruit
5	Carryout	Choose more healthful sides	Healthful sides: fruits, vegetables	Various fruits taste tests

Note. BHEZ = Baltimore Healthy Eating Zones.
[a]Taste test was conducted both in recreation centers and in corner stores. Cooking demonstration was conducted only in recreation centers. Additionally, point-of-purchase materials such as shelf labels, posters, and flyers were used in corner stores and in recreation centers (only posters and flyers), as described in the Intervention section.

youth prepared in the past 7 days and which cooking method they used for each. Answers were recoded as deep fried (−2 points), pan fried (−1 point), microwaved or not cooked (0 point), and grilled, boiled, or baked (+1 point). Scores were then summed for all the foods a youth prepared, and were divided by the total number of foods they prepared, generating an "average" cooking score, with higher scores representing healthier cooking methods.

Intervention Exposure Evaluation. The direct exposure score reflecting the amount of exposure to each of the intervention materials and activities was created by coding "yes" (2 points), "maybe" (1 point), and "no" (0 point) to a series of questions regarding whether the youth or caregiver remembered seeing intervention materials such as the BHEZ logo and posters, or participated in certain activities. Then answers in the same category of exposure were added together. The

Table 2. Demographic Comparison Between Comparison and Intervention Youth.

Total sample[a] (*N* = 152)	Comparison group (*n* = 63)	Intervention group (*n* = 89)	*p*
Female (%)	57.1	59.6	.77
Mean age, years (*SD*)[b]	13.0 (1.6)	13.1 (1.4)	.66
Mean years of education (*SD*)	6.0 (1.6)	6.0 (1.4)	.82
% Overweight or obese (≥85 BMI percentile)			
Male	15	36	.06
Female	49	53	.60
Overweight or obese youth (*N* = 62)	Comparison group (*n* = 21)	Intervention group (*n* = 41)	*p*
Female (%)	81	68	.29
Mean age, years (*SD*)	13.1 (1.6)	13.2 (1.5)	.90
Mean years of education (*SD*)	6.1 (1.5)	6.0 (1.4)	.90
Overweight or obese girls (*N* = 45)	Comparison group (*n* = 17)	Intervention group (*n* = 28)	*p*
Mean age, years (*SD*)	13.1 (1.6)	13.3 (1.6)	.78
Mean years of education (*SD*)	6.0 (1.3)	6.0 (1.3)	.93

Note. BMI = body mass index.
[a]Chi-square test was used for categorical data, and Wilcoxon rank-sum test was used for continuous data. [b]Measured at postintervention.

final score for each category was standardized to range 0 to 1 by dividing it by the maximum score. The intervention store score reflected the number of visits to intervention stores in the week preceding the interview. The recreation center score was calculated as the number of visits to each intervention recreation center per month. The indirect exposure score was the sum of the intervention store and recreation center scores. The total exposure score was the sum of direct and indirect exposure scores. Direct, indirect, and total exposure scores were stratified by low, medium, and high for the analysis by exposure level (data not shown).

Statistical Analysis

Basic demographics (gender, age, years of education, overweight/obese percentage) were compared between the intervention and comparison group youth using a *t* test (or Wilcoxon rank-sum test if the distribution was nonnormal) or chi-square test (for categorical variables; Table 2). The Wilcoxon signed-rank test or paired *t* test was used depending on the normality of the distribution for pre–post comparison of food-related psychosocial factors, behaviors, and BMI (Table 3). The Wilcoxon rank-sum test was used to compare the amount of exposure between intervention and comparison groups (Table 4). The Kruskal–Wallis test was used when comparing three BMI percentiles by direct exposure level and the *t* test or Wilcoxon rank-sum test was used when comparing two BMI percentiles by treatment group (Table 5). For all of the analyses above, subgroup analyses were also performed with a subsample of children who were either overweight or obese at baseline (BMI for age percentile ≥85% at baseline). This subgroup analysis was planned because we were interested in knowing if there would be a more or less pronounced impact on high-risk youth, whose purchasing behaviors and demographics may be different from that of other youth. In addition, regression analysis was performed using postintervention scores as outcome variables. Each regression model was adjusted for baseline value, sex, baseline age, dichotomized intervention status (or total exposure level), and household income, which was dichotomized at $30,000. Resistant regression or bootstrap regression was used to account for overly influential data points (i.e., extreme values), unusual leverage, and residuals. Data analyses were performed using STATA 11 (StataCorp, College Station).

Results

Sex, mean age, mean years of education, and the percentage of overweight or obese youth did not significantly differ between youth in the intervention and comparison groups (Table 2).

Exposure to the Intervention

Direct exposure, intervention store exposure, recreation center exposure, indirect exposure, and total exposure scores were significantly higher in the intervention youth (Table 4). However, comparison group youth were also exposed to all the components of the intervention.

Impact on BMI Percentile

BMI for age percentiles significantly decreased on average in the intervention group but not in the comparison group in all analyses (entire sample: $p = .04$, overweight and obese girls and boys: $p < .001$, and overweight and obese girls only: $p = .001$; Table 3). Overweight and obese youth in the intervention group significantly decreased their BMI percentile an average of 2.37 points more than youth of the same

Table 3. Youth Indicator Differences Between Pre- and Postintervention and Between Intervention and Comparison Groups.

	Comparison (n = 63)				Intervention (n = 89)			
Youth indicator	Pre	Post	Diff.[a]	p[b]	Pre	Post	Diff.[a]	p[b]
Behavioral intentions	1.92 (1.45)	1.56 (1.30)	−0.36	.18	1.88 (1.28)	1.47 (1.39)	−0.41	.01
Outcome expectancies	15.5 (2.07)	15.7 (2.19)	0.20	.53	15.2 (2.38)	15.8 (2.20)	0.60	.02
Self-efficacy	13.2 (1.66)	13.1 (1.83)	−0.08	.96	13.3 (1.68)	13.1 (1.84)	−0.26	.54
Knowledge	7.65 (2.15)	8.54 (1.77)	0.89	<.001	8.02 (1.78)	8.72 (1.37)	0.70	<.001
Healthful food purchasing	1.10 (2.17)	0.48 (0.94)	−0.62	.14	1.00 (1.89)	0.68 (1.61)	−0.32	.13
Healthful beverage	1.11 (1.82)	0.89 (1.23)	−0.22	.73	1.35 (2.12)	0.66 (1.26)	−0.69	.003
Healthful snack	1.46 (1.90)	0.79 (1.09)	−0.67	.01	1.48 (1.90)	0.97 (1.51)	−0.51	.01
Unhealthful food purchasing	9.02 (7.65)	6.49 (6.26)	−2.53	.01	9.14 (9.37)	8.24 (7.56)	−0.90	.31
Unhealthful beverage	2.46 (3.00)	2.22 (2.64)	−0.24	.42	2.26 (3.20)	2.24 (2.68)	−0.02	.52
Unhealthful snack	4.57 (4.59)	2.86 (2.99)	−1.71	.004	2.86 (2.99)	4.07 (4.63)	1.21	.03
Fast food	2.08 (2.34)	1.75 (2.33)	−0.33	.20	1.40 (2.00)	2.01 (2.30)	0.61	.02
Healthful food preparation	−0.05 (0.66)	0.02 (0.48)	0.07	.17	0.01 (0.76)	−0.18 (0.63)	−0.19	.13
BMI percentile	67.9 (27.7)	68.2 (27.7)	0.27	.83	73.6 (26.5)	71.4 (26.8)	−2.23	.04

Note. BMI = body mass index.
[a]Diff. = Postintervention score − preintervention (baseline) score. [b]Wilcoxon signed-rank or matched t test was used depending on the normality of the data.

Table 4. Exposure Levels Between Intervention and Comparison Youth.

Exposure score	Range	Comparison (n = 63)	Intervention (n = 89)	Intervention − comparison	p[a]
Direct exposure score[b]	0-6.49	0.89 (1.19)	1.68 (1.33)	0.79	<.001
Intervention store score[c]	0-1.00	0.07 (0.18)	0.18 (0.27)	0.11	<.001
Recreation center score[d]	0-1.00	0.02 (0.07)	0.16 (0.20)	0.14	<.001
Indirect exposure score[e]	0-1.33	0.09 (0.19)	0.34 (0.33)	0.25	<.001
Total exposure score[f]	0-6.74	0.98 (1.26)	2.02 (1.46)	1.04	<.001

[a]Wilcoxon rank-sum test was used to compare intervention and comparison. [b]Sum of the standardized exposure score of logo, label, taste test, poster, flyer, giveaway, button, education activity, and menu. [c]Frequency of intervention store visit. [d]Frequency of intervention recreation center visit. [e]Intervention store score + Recreation center score. [f]Indirect score + direct score.

Table 5. ΔBMI (the Difference in BMI Percentile Change From Pre to Post, Between Intervention and Comparison Youth).

	By direct exposure				By treatment group		
BMI change indicator	Low	Medium	High	p[a]	Control	Intervention	p[a]
ΔBMI	−1.74 (n = 45)	1.44 (n = 49)	−2.91 (n = 48)	.34	0.22 (n = 57)	−1.88 (n = 85)	.33
ΔBMI (Baseline BMI >85)	−1.17 (n = 16)	−2.85 (n = 26)	−2.73 (n = 19)	.10	−0.78 (n = 20)	−3.15 (n = 41)	.05
ΔBMI (boys)	−2.12 (n = 29)		−1.5 (n = 32)	.58	−0.58 (n = 25)	−2.66 (n=36)	.57
ΔBMI (girls)	0.38 (n = 41)		−1.3 (n = 40)	.09	0.86 (n = 32)	−1.31 (n = 49)	.25
ΔBMI (baseline BMI >85), boys	−0.18 (n = 6)		−4.83 (n = 11)	.23	−3.43 (n = 4)	−3.12 (n = 13)	.73
ΔBMI (baseline BMI >85), girls	−1.00 (n = 22)		−3.1 (n = 22)	.01	−0.12 (n = 16)	−3.16 (n = 28)	.03

Note. BMI = body mass index.
[a]Three-way comparison = Kruskal–Wallis test, two-way comparision = t test or rank-sum test.

initial weight status in the comparison group (p = .05; Table 5). No significant difference in BMI percentile change was observed by direct exposure level in the overall sample. Among overweight girls, those with higher direct exposure levels or those in the intervention group decreased their BMI percentile more than those with lower exposure level or in comparison group (p = .01 and .03, respectively; Table 5).

Impact on Food-Related Psychosocial Factors and Behaviors

Intervention youth significantly improved their food-related outcome expectancies scores as compared to control youth (p = .02; Table 3). At the same time, intervention youth also significantly decreased their food-related behavioral

intentions score compared to baseline levels ($p = 0.01$). Both groups increased their food knowledge score significantly ($p < .001$ for both groups; Table 3).

In a subgroup analysis of overweight and obese youth, food-related behavioral intention scores worsened in both the intervention and comparison groups, but the change was significant only in the comparison group ($p = .19$ and .03, respectively). The food-related outcome expectancies score improved among youth in the intervention group ($p = .01$; data not shown).

Overweight or obese girls in both groups decreased their purchasing of healthful snacks, but the decrease was significant only in the control group (data not shown). In other cases, no impact of the intervention was found on healthful food purchasing or food preparation by treatment group. Unexpectedly, the groups who were highly exposed to our interventions reported purchasing unhealthful foods more frequently by the end of the intervention ($p = .01$; data not shown).

Regression Analyses

In regression analyses, no significant impact of the intervention (assessed by intervention status or exposure level) on psychosocial factors or healthful purchasing and preparation scores was observed, except for unhealthful snack purchasing score, which significantly increased as total exposure score increased (Table 6). The intervention did show a trend ($p = .10$) for reducing BMI percentile among overweight/obese girls in these analyses (data not shown).

Discussion

The childhood obesity intervention trial presented here is one of the first to work in multiple environments, outside of schools. The majority of obesity interventions targeting AA youth have primarily focused on changing the school environment (Greening, Harrell, Low, & Fielder, 2011; Naar-King et al., 2009; Newton et al., 2010; Perman et al., 2008; Topp et al., 2009), neglecting the important role of the community food environment. BHEZ sought to address this gap by implementing an intervention that sought to change the community food environment. In addition, BHEZ is the first multilevel nutrition intervention in Baltimore City targeting youth consumers, their adult caregivers, and food vendors. BHEZ was able to establish a basis for sustainable, scaled-up future programs by collaborating with local stores and recreation centers.

BMI percentile decreased significantly among overweight or obese females in the intervention group. Intervention youth had more exposure to the intervention than comparison youth. Overall, however, the intervention was not associated with statistically significant changes in many of the youth indicators measured. Possible explanation for observed changes in BMI without significant changes in some of the behavioral and intention outcomes is that we did not measure the most relevant aspects of these behaviors or intentions, or that other measures and concepts have not been accounted for. Alternatively, it could be that the measures we used did not adequately tap into the desired constructs. It is possible that a lengthier intervention or later follow-up measures would have detected more significant changes, as found in other studies (Economos et al., 2007).

We found that the BHEZ study did not have as great an impact in changing the food environment as our previous trial (Gittelsohn et al., 2013; Song et al., 2009), which may also have contributed to the limited study effects. Overall, the marginal significant results in the regression analyses suggest that there may be merit to a combined environmental/educational approach to dealing with the child obesity epidemic in a low-income urban setting and that further work needs to incorporate more successful environmental interventions.

The study has several limitations. Because intervention and control centers were often located about a mile from each other, some individuals in the comparison group were apparently exposed to the intervention. Although this is a challenge inherent in community-based interventions, here it made assessing the impact of the intervention more difficult in the analysis stage. In addition, our sample size was smaller than initially planned based on sample size calculations. While we originally planned to recruit 300 youth–caregiver dyads (the sample size with which the intervention effect can be determined), we reached only 242 pairs because of difficulty in obtaining signed parental consent. Postintervention, the sample size was further decreased to 152 because of loss to follow-up greater than was anticipated. Therefore, the final sample size used for the analysis may not have been sufficient to accurately assess the impact of the intervention. Additionally, Cronbach's alphas for psychosocial and healthful eating indicators were generally low, despite our efforts to remove inconsistent questions. This meant low internal consistency for our scales, which may mean they did not adequately assess the constructs they were intended to measure. Finally, the exposure instrument did not distinguish between BHEZ-specific intervention activities and other nutrition interventions in the community. For instance, when we asked youth if they recognized BHEZ poster or flyers, the respondents often said they had seen them in supermarkets or schools, places where we did not implement the intervention.

Implications for Practice

The BHEZ intervention had some positive impact on youth BMI for age percentile but little impact on food-related behaviors. We surmise that our intervention selectively enabled a subset of motivated youth participants, those who were obese or overweight at baseline, to better access available healthful food resources in the community. As mentioned above, BHEZ's environmental intervention might have had little success in improving the overall food environment for multiple reasons. In addition to increasing the study

Table 6. Impact of the BHEZ Intervention on the Youth Sample: Regression Analyses.

Independent variable	Self-efficacy[a]	Intention	Knowledge	Outcome expectancies	Unhealthful food	Unhealthful beverage	Unhealthful snack
Sex	0.367 (.242)[b]	0.105 (.674)	0.475 (.014)	−0.571 (.092)	−0.253 (.819)	−0.590 (.058)	0.501 (.292)
Exposure score	−0.056 (.594)	−0.035 (.727)	−0.065 (.235)	0.031 (.799)	−0.476 (.123)	0.195 (.065)	0.432 (.011)
Age	0.037 (.728)	−0.191 (.012)	−0.005 (.945)	0.032 (.760)	0.318 (.489)	0.270 (.030)	−0.175 (.357)
Income	0.273 (.304)	0.044 (.842)	0.135 (.463)	−0.009 (.977)	−1.363 (.179)	−0.001 (.996)	−0.150 (.738)
Preintervention score	0.145 (.115)	0.283 (.006)	0.357 (<.001)	0.255 (.046)	0.335 (.003)	0.413 (.000)	0.115 (.068)
Constant	10.293 (<.001)	2.898 (.004)	5.374 (<.001)	12.641 (<.001)	1.655 (.734)	−1.544 (.267)	2.618 (.219)
Observations	143	145	145	145	142	145	145
Adjusted R^2	.018	.112	.337	.087	.255	.411	.097

Independent variable	Fast food	Healthful food	Healthful beverage	Healthful snack	Healthful food preparation	BMI percentile
Sex	0.269 (.375)	−0.311 (.229)	0.136 (.509)	0.193 (.397)	−0.109 (.154)	3.518 (.058)
Exposure score	0.098 (.383)	−0.097 (.154)	−0.052 (.395)	0.031 (.641)	−0.019 (.457)	−0.757 (.223)
Age	0.410 (.007)	−0.053 (.460)	0.146 (.108)	−0.085 (.284)	−0.052 (.074)	0.048 (.944)
Income	0.062 (.855)	0.081 (.703)	0.145 (.496)	0.190 (.367)	−0.044 (.554)	0.165 (.926)
Preintervention score	0.369 (.005)	0.207 (.032)	0.127 (.045)	0.249 (.002)	0.098 (.056)	0.929 (<.001)
Constant	−4.378 (.006)	1.585 (.164)	−1.266 (.250)	1.056 (.240)	0.749 (.035)	−1.298 (.879)
Observations	145	140	145	145	145	135
Adjusted R^2	.273	.085	.042	.112	.037	.864

Note. BHEZ = Baltimore Healthy Eating Zones; BMI = body mass index.
[a]All the outcome variables were postintervention scores. [b]*p* values in parentheses.

sample and duration of the program, increasing rapport with store owners would enhance the intervention, as the Korean American store owners tend to respond better to culturally oriented interventions (training materials in Korean, etc.; Song et al., 2009). Peer education, which was implemented in recreation centers, could have been more effective if we used older and more experiences mentors, as has been done in other studies (Black et al., 2010). Another issue was maintaining consistent data collection quality as the study experienced a high amount of turnover among student research assistants. Last, dietary assessment should be conducted along with behavior indicators to measure an impact of the intervention on the actual diet of the participants. To that end, we conducted a Youth Food Frequency Questionnaire that will be analyzed in the future.

Healthful foods tend to be more expensive in low-income communities, and high price appears to direct consumers to unhealthful foods in these settings (Gustafson, Hankins, & Jilcott, 2012). We have recently begun working with wholesalers to manipulate the price of healthful foods in corner stores, a strategy that could motivate owners to stock more healthful foods and provide affordable options to community residents. Finally, family-centered interventions that incorporate efforts to increase physical activity would be an important additional intervention for this population (Hudson, 2008).

In conclusion, a community-based intervention to change the food environment and promote healthful choices in a low-income AA setting showed some success in reducing children's BMI percentile and was associated with some improvements in psychosocial variables. These effects were seen most strongly in bivariate analyses and were greatly attenuated in regression analyses. We credit some of this success to a multilevel approach, which included work with recreation centers, small food stores, and interpersonal support through peer mentoring. Despite the promising findings reported, there were challenges to achieving desired changes at the community level. We faced difficulties in getting a high level of engagement from small food stores and in obtaining long-term commitment to the program from recreation center personnel. More support from multiple levels is needed for such multicomponent community-based health interventions. Future studies should promote more community involvement to obtain greater buy-in from participating food stores.

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