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Evaluation of a Health Education Intervention for Rural Preschool and Kindergarten Children in the Southeastern United States: A Cluster Randomized Trial

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Evaluation of a Health Education Intervention for Rural Preschool and Kindergarten Children in the Southeastern United States: A Cluster Randomized Trial

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This research employed a matched-pairs randomized field experiment design to evaluate a classroom-based health education intervention for pre-Kindergarten and Kindergarten children in a rural region of the southeastern United States. Schools were matched on demographic characteristics, then one school from each pair was randomly assigned to the treatment group and one to the delayed treatment group. The intervention included a field trip experience and an integrated curriculum designed to increase knowledge about nutrition, physical activity, and sleep. Staff conducted individual assessments of changes in knowledge with a random sample of children from each classroom (252 children from treatment classrooms; 251 children from delayed treatment classrooms). We used a multilevel linear regression with maximum likelihood estimation to incorporate the effects of clustering at the classroom and school level while examining the effects of the intervention on individual assessment change scores. During the intervention period, an estimated 3,196 children (treatment: 1,348 students in 68 classrooms in 10 schools; delayed treatment: 1,848 students in 86 classrooms in 10 schools) participated in the intervention. Children in the treatment group had significantly larger assessment change scores than children in the delayed treatment group. Findings suggest significant beneficial effects of the intervention on health knowledge.

Keywords: child health, obesity, nutrition, physical activity, school-based health promotion, childcare center, rural health, randomized trials

Introduction

The health consequences of childhood obesity are numerous and include increased risk of cardiovascular disease (Cote et al., 2013), obstructive sleep apnea (Narang & Mathew, 2012), depression (Morrison et al., 2015), and obesity in adulthood (Gordon-Larsen et al., 2010). Although multiple factors contribute to childhood overweight and obesity, some risk factors, such as physical activity and nutrition, are considered modifiable (Benjamin et al., 2008).

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Interventions focusing on physical activity and nutrition modifiable risk factors have been proposed to be the most effective in preventing childhood obesity (Wilson, 2009), and there are a number of initiatives that focus on physical activity and nutrition in school-aged children. However, fewer have addressed obesity prevention or reduction in early childhood. In fact, prior systematic reviews of obesity-related interventions for young children (Campbell & Hesketh, 2007; Bluford et al., 2007) identified a lack of existing interventions for young children in the scientific literature and articulated a need for further research.

The need for obesity interventions in the southeastern United States is particularly profound. In particular, Mississippi has one of the highest rates of obesity in the United States (Centers for Disease Control and Prevention, 2015), as 26.2% of children between the ages of 10 and 17 are obese in this state, compared to a nationwide average of 16.1% (Data Resource Center for Child and Adolescent Health, 2016). Additionally, the Centers for Disease Control and Prevention (2009) report that many children in Mississippi have low levels of physical activity and poor nutrition, which provides an opportunity for programming that addresses these modifiable risk factors for obesity.

The purpose of the present study was to develop, implement, and evaluate the effects of "WannaBee Healthy?" a science-based health promotion curriculum and field trip experience, on knowledge about nutrition, physical activity, and sleep among pre-kindergarten and kindergarten children in Mississippi.

Theoretical Framework

The intervention design was inspired by the ecological approach to health promotion (McLeroy et al., 1988), which acknowledged the role of multiple factors in determining health-related behaviors. This is especially important for interventions seeking to shape children's behavior, as the behaviors of children in the priority age range are heavily influenced by others. The intervention focused on influencing intrapersonal (e.g., child knowledge, attitudes, behavior, and skills), interpersonal (e.g., interactions with parents/caregivers), and institutional (e.g., implementation of classroom education) level factors, as child, family, and school factors have been shown to account for a large amount of variance in childhood overweight and obesity (Boonpleng et al., 2013).

Context of the Study

Reynolds et al. (1999) provided an overview of the many advantages of using schools as settings for health promotion. First, implementing public health interventions for children in school settings can allow for high intervention penetration with a diverse segment of the priority population, as "more than 95% of children ages 5 to 17 are enrolled in school" (Reynolds et al., 1999, p. 399). Second, the consistency of school attendance provides an opportunity to implement interventions that require repeat exposure and follow-up data collection. Finally,

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school settings offer the additional benefit of creating change that goes beyond the children who participate in the intervention. Specifically, teachers trained as a part of the intervention may make environmental changes that support healthy behaviors, and parents exposed to intervention materials may also gain knowledge about the health topic and make changes in the home that support the goals of the intervention.

Like schools, preprimary programs (sometimes housed in childcare centers) also offer desirable environments in which to implement a health promotion intervention due to wide reach, consistency of child attendance, and the ability to reach parents and children. In 2015, 67% of four-year-olds in the United States attended a preprimary program (National Center for Education Statistics, 2017), and students enrolled in these programs come from diverse racial, ethnic, and socioeconomic backgrounds (National Center for Education Statistics, 2016). As in schools, training teachers in preprimary programs also has the potential to multiply the effects of the intervention by increasing the spread of the message to future classes or by inspiring desirable environmental changes.

Review of the Literature

A number of obesity-related interventions for young children have been evaluated (Campbell & Hesketh, 2007, Bluford et al., 2007, Waters et al., 2011), but none have been designed specifically for kindergarten and pre-kindergarten classes in the southeastern United States. Campbell and Hesketh (2007) reviewed two U.S. preschool- or childcare-based interventions. Dennison et al. (2004) focused primarily on reducing television viewing, while Fitzgibbon et al. (2005) was a successful dietary and physical activity intervention designed for children in Head Start preschool programs in Chicago, Illinois. A review by Bluford et al. (2007) included the interventions mentioned above and a well-designed comprehensive health education program for preschool children called Healthy Start (D'Agostino, D'Andrea, Nix, et al., 1999; Williams et al., 1998, 2002, 2004). Healthy Start included an extensive developmentally and culturally appropriate curriculum (D'Agostino, D'Andrea, Liebman, et al., 1999) that was designed to be integrated into the existing educational activities of participating New York State Head Start Centers (Williams et al., 1998). However, because the curriculum was combined with food service modification in Head Start Centers, it was difficult to determine the effects of the curriculum alone on nutritional and physical activity outcomes. One existing obesity prevention program designed for a rural southeastern community (Greening et al., 2011) focused on children ranging from six to 10 years of age rather than younger children.

The southeastern United States has a particularly high need for obesity-related interventions for young children due to a high level of obesity in the region (Centers for Disease Control and Prevention, 2015). People living in this region experience higher rates of poverty than those in other regions, which limits their access to education and nutritious foods (Moore, 2018). People living in a particular place also share a culture, "a system of shared understanding that shapes and, in turn, is shaped by experience" (Caprio et al., 2008, p. 2214).

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As it pertains to obesity, culture can influence preferences for different forms of physical activity; food consumption; and perceptions about obesity's "cause, course, and cure, and the extent to which a society or ethnic group views obesity as an illness" (Caprio et al., 2008, p. 2214). Because of this shared understanding, it is important to develop interventions that are culturally targeted or tailored, as interventions that include "both these levels of cultural integration have tended to show the most impact on altering health behaviors and adiposity" (Wilson, 2009, p. 241).

The present study reports results from the development, implementation, and evaluation of the WannaBee Healthy? health promotion curriculum and field trip experience. This new obesity prevention intervention was developed and evaluated to meet the demonstrated need for evidence-based obesity prevention efforts in Mississippi and the lack of prior interventions for very young children (pre-kindergarten and kindergarten) in this region.

Methods

Research Design

To evaluate the intervention, we employed a matched-pairs randomized field experiment. Directors of all public pre-kindergarten programs and principals of elementary schools with kindergarten classrooms in a 20-county region in northeast Mississippi ($N = 63$ programs/schools) were contacted and invited to participate. Twenty schools responded and were included in the program over the course of the project: six in Fall 2014, six in Spring 2015, and eight in Fall 2015.

Each semester, participating schools were matched in pairs on race distribution and percent of children receiving free and reduced lunch (a proxy measure for low socioeconomic status) using statistics from the Mississippi Department of Education. One school from each pair was randomly assigned to the treatment group, and the other was assigned to the delayed treatment group. All classrooms within each school were assigned to the same experimental group to reduce the threat of contamination between conditions. See Figure 1 for the participant flow diagram.

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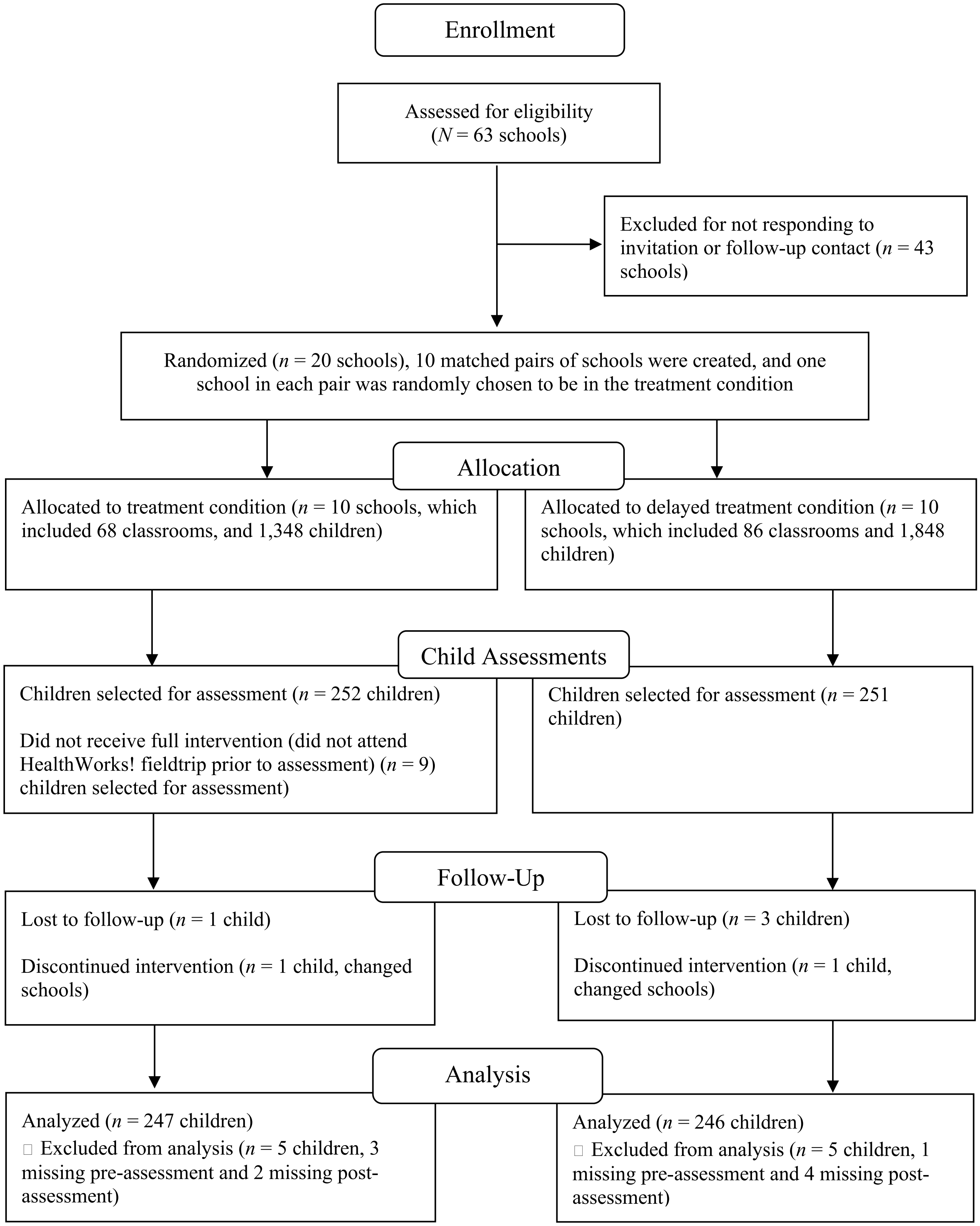
Figure 1. Participant Flow Chart Following Consolidated Standards of Reporting Trials (CONSORT) Guidelines



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Participants

The research protocol was approved by the Institutional Review Boards at Mississippi State University and North Mississippi Health Services. To evaluate the implementation and outcomes of the health promotion intervention, child assessments were conducted, and surveys were distributed to teachers and one parent or guardian of each participating child. Participant characteristics are presented in Table 1.

Table 1. Demographic Characteristics of Participants, 2014-2015

	Children		**Teachers**		**Parents**[a]	
	T	**DT**	**T**	**DT**	**T**	**DT**
n	252	251	57	69	372	464
Grade						
Pre-K, %	17.9	17.5				
Kindergarten, %	82.1	82.5				
Age, *M* (*SD*)	5.02 (0.58)	5.04 (0.54)	35.5 (9.3)	37.2 (9.9)	33.2 (7.4)	32.8 (7.6)
Gender						
Female, %	48.4	43.4	98.2	97.1	74.2	73.0
Male, %	51.2	55.8	0.0	0.0	5.9	6.3
Ethnicity						
Hispanic or Latino, %	4.4	3.6	1.8	1.4	5.4	2.8
Not Hispanic or Latino, %	93.7	94.4	93.0	92.8	73.1	75.4
Race						
American Indian/Alaska Native, %	0.0	0.8	1.8	0.0	0.0	0.2
Asian, %	0.4	0.0	0.0	1.4	0.8	1.1
Black or African American, %	42.5	45.4	14.0	10.1	27.2	32.3
White, %	51.2	45.0	78.9	87.0	44.9	41.4
Other, %	1.6	2.0	1.8	0.0	2.4	0.9
Multiple Races, %	3.6	6.4	0.0	0.0	1.9	1.7

Note. T = Treatment condition. DT = Delayed treatment condition. Percentages are calculated using the total number of participants completing the survey and may not add to 100 due to missing data (e.g., parent data on ethnicity).
[a]One parent/guardian survey was sent home with each child.

Children. Across the three semesters in which the intervention was implemented, an estimated 3,196 pre-kindergarten or kindergarten children were exposed to the intervention (1,348 treatment; 1,848 delayed treatment). Parents or guardians of all children were asked for consent to allow their child to be assessed. A random sample of children whose parents or guardians consented was selected for individual assessment and asked for their assent to participate (252 treatment; 251 delayed treatment). Child participant characteristics (Table 1) closely mirrored the demographic characteristics of children in public schools in the study region (Mississippi Department of Education, 2016).

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Teachers. Across 154 participating classrooms (68 treatment; 86 delayed treatment), 57 teachers in treatment classrooms responded to the survey, and 70 teachers in delayed treatment classrooms responded to the survey (for response rates of 83.8% and 81.4%, respectively).

Parents or Guardians. Parent/guardian surveys were to be distributed through students and collected by teachers in participating classrooms. Of 3,196 surveys that could have been distributed (1,348 treatment; 1,848 delayed treatment), 372 from treatment classrooms and 464 from delayed treatment classrooms were collected (for response rates of 27.6% and 25.1%, respectively).

Intervention

Development. To inform the intervention's development, the project team conducted an in-depth assessment of factors affecting obesity-related health behaviors among the priority population. After conducting assessments with children, focus groups with parents/guardians and teachers, and a population-based telephone survey (N = 500 adults) in the 20 targeted northeast Mississippi counties, the project team identified three major themes to be addressed by the intervention: improving nutrition knowledge ("Be Smart"), improving physical activity and sleep knowledge ("Be Active"), and increasing opportunities for children to be advocates for healthy behaviors ("Be a Leader"). Based on this formative research, materials were culturally targeted using images, language, activities, and food that were familiar to children in the region.

The intervention was informed by the ecological approach to health promotion (McLeroy et al., 1988) and the bioecological model (Bronfenbrenner, 1979; Bronfenbrenner & Morris, 2007). Working with an interdisciplinary team of nutrition, child development, and early childhood education experts, the project team developed an integrated curriculum for pre-kindergarten and kindergarten students. An early childhood integrated curriculum was designed to promote young children's efforts in mastering early academic skills (e.g., writing, counting, measuring) and content knowledge and "implies learning that is synthesized across traditional subject areas and learning experiences that are designed to be mutually reinforcing" (Kelly, 2001, p. 553). The curriculum was designed to be incorporated into daily activities over a two-week period by the classroom teacher.

There were four activities for each day, which included health-related activities in the areas of creative expression, language and literacy, math, and science to align with early learning standards (Mississippi Department of Education, 2018), Next Generation Science Standards (National Academy of Sciences, 2012), and CDC National Health Education Standards (Centers for Disease Control and Prevention, 2019). In addition to the curriculum, the team also developed a 31-page family activity booklet that supported ten key concepts the children were learning in the classroom and shared the information through family-friendly activities and games. The curriculum and family activity booklet are available from the corresponding author.

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The development team also worked with education specialists at HealthWorks! North Mississippi to develop a 90-minute field trip experience to reinforce curriculum messages.

Procedure. The curriculum was implemented in a different set of schools each semester for three consecutive semesters. The teachers were provided the WannaBee Healthy? curriculum and the instructional materials. The study was introduced during a scheduled workshop for the participating teachers. The workshop was initially a brief introduction to the curriculum and materials, but after the first wave of data was collected, the workshop was revised.

The remaining workshops were one hour long, and the curriculum and instructional materials were provided, and selected activities were demonstrated. The workshop provided the teachers with an opportunity to ask questions about the curriculum, discuss how they may use the curriculum and instructional materials in their classroom, and agree upon dates the curriculum would be implemented.

Prior to implementation, evaluation staff blinded to participant condition conducted pretest assessments with children in treatment and delayed treatment schools. Treatment schools were then given approximately four weeks to implement the two-week curriculum and take a field trip to HealthWorks! North Mississippi. After implementation of the curriculum and field trip in the treatment schools, but before implementation in the delayed treatment schools, evaluation staff completed posttest assessments of children in both groups, such that pretest and posttest assessments were separated by the same amount of time for both groups. The delayed treatment group was then exposed to the curriculum and field trip.

Evaluation Strategies

Child Assessments. Pairs of research team members completed individual child assessments in schools in a location outside the classroom (e.g., library). They assessed children's knowledge of nutrition and physical activity using a series of ten questions and visual tasks developed by the project team or adapted from other sources (see Table 2). The "healthy food choices" items and "activities that burn energy" items were adapted from Calfas et al. (1991) and have reported test-retest reliabilities of $r = 0.72$, $p < .001$ and $r = 0.43$, $p = .001$, respectively. The "activities that burn energy" items were adapted from Mobley and Evashevski (2000), who report high test-retest reliability but did not report a statistic.

The project team developed the remaining assessment procedures based on data collected from the pre-assessment of what children knew about health-related topics like food groups, food origin, how to make a healthy plate, and activities that make their hearts beat faster. These data, combined with information gathered during parent and teacher focus groups, were used to develop an age-appropriate and standards-based child assessment that had an assessment activity for each of the key learning objectives in the curriculum.

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Table 2. Child Assessment Procedures, Scoring, and Source

Concept and Source	Procedure and Score
Food group classification	Children were presented with a container of 10 plastic food and drink models, with two models from each of five food groups. Children were then asked to select a vegetable, a grain, a protein, and a dairy. This item was scored by assigning one point for each food group for which a representative food was correctly chosen, for a maximum of five points.
USDA MyPlate recommendations	Children were shown an image with four plates, each containing a different proportion of fruits and vegetables (0%, 25%, 50%, and 100%), and asked to identify the plate with the recommended proportion of fruits and vegetables. This item was scored by assigning one point if a child correctly identified Option 3 as the plate with the recommended proportion of fruits and vegetables.
Integration of food group classification and USDA MyPlate	Children were presented with a plastic MyPlate model and images of 10 food items (two for each food group). After the assessor named each of the food items and showed the student the MyPlate model, the assessor asked children to pick one food or drink picture for each food group and place it in its food group section on the plate to make a healthy plate. This item was scored by assigning one point for each food group for which a representative food was correctly chosen.
Sugar in beverages	Children were shown pictures of chocolate milk, soda, and water, and the assessor identified each beverage. Children were asked to order beverages by their amount of sugar. Children earned one point if the water was identified as having no sugar and one point if soda was identified as having the most sugar.
Healthy food choices; adapted from Calfas et al. (1991)	The assessor used sets of image cards to assess children's ability to identify the healthiest of three food choices (i.e., the one that is least processed and has the lowest amount of sugar, salt, and/or fat). This item was scored by assigning one point for each set of foods for which the child correctly chose the healthiest option.
Food origins	To assess knowledge about the origins of foods, children were presented with a single sheet of paper that had images of seven possible food origins (tree, garden, chicken, cow, wheat, grocery store, and restaurant). They were then presented with images of five food and beverage items (apple, carrot, chicken leg, milk, and bread) one at a time and asked to put each image on top of the image that showed the food origin. This item was scored by assigning one point for each correctly identified food origin.
Food benefits	Food benefits were assessed by presenting to the child a single sheet of paper depicting five body parts: a bone, a pair of eyes, a stomach, a runny nose, and a flexed muscle. Children were then given an image of five foods (milk, a carrot, wheat bread, an apple, and a grilled chicken leg), one at a time, and asked to select the food that would help each body part. This item was scored by assigning one point for each correctly identified food benefit.
Activities that increase heart rate; adapted from Mobley and Evashevski (2000)	The assessor set out images of children doing ten different activities and named each activity (e.g., playing a video game, jumping rope, riding a bike, watching TV, playing on a computer, running, playing soccer, playing with toys, playing on a playground, and drawing). Children were asked to "choose four activities that make your heart beat faster." This item was scored by assigning one point for each active item chosen.
Activities that burn energy; adapted	Children were shown an image of a soda (item 1) or potato chips (item 2) and asked to choose which of a list of activities (playing on a computer, watching

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Concept and Source	Procedure and Score
from Calfas et al. (1991)	television, playing soccer/running) a child could do to burn energy and keep their body healthy. This item was scored by assigning one point for each item if children chose "play soccer" or "run" for a maximum of two points.
Healthy body needs	The children were presented with images of a child sleeping, a child eating a healthy plate, a child playing soccer, a child watching TV, a child drinking soda, a child eating a candy bar, and a child playing a video game. Children were asked to select three things they could do to keep their body healthy. This item was scored by assigning one point each for choosing images of a child sleeping, a child eating a healthy plate, and a child playing soccer.

Note. A two-person team composed of an assessor and a recorder conducted individual assessments with child participants using these procedures. In Fall 2014, the maximum number of points that could be assigned for the assessment was 39. In Spring and Fall 2015, due to changes in items, the maximum score was 42.

Teacher Surveys. The teacher survey was distributed to all participating teachers, who were asked to complete it after the conclusion of the curriculum and field trip. On the survey, a curriculum implementation item read, "Not including the 'Additional Activities' in the back, how much of the curriculum were you able to complete during your scheduled time?" Response options included *all of it*, *most of it*, *some of it (less than half)*, and *none of it*. A Family Activity Booklet implementation item read, "To the best of your knowledge, what percentage of your students completed the Family Activity Booklets?" Response options included *<25%, 25%-50%, 51%-75%,* and *>75%.* Additionally, teachers were asked to report their students' observations. In the first semester, teachers were asked, "After completing the curriculum and field trip, have your students: a) Talked about what they learned? If so, what are some things they've talked about? b) Talked about or modeled the behaviors of the Character Bees (Sunny, Andy, and LaToya)? If so, what?" These open-ended items were recoded as *yes* or *no* to allow for quantitative summary of results, and the teacher survey in the second and third semesters was edited to make this a *yes* or *no* question with room for optional feedback.

Family Surveys. Parents or guardians of children in participating classrooms were asked to complete the family survey after students had completed the curriculum and field trip. The survey included one item to assess fidelity of implementation of the family component: "How much of the Family Activity Booklet were you and your child able to complete?" (*all of it, most of it, some of it (less than half),* or *none of it).* The survey also asked parents or guardians a series of *yes* or *no* questions to assess their observations of child behavior change, including whether the child had "talked to [the parent/guardian] or other family members about what they were learning about healthy foods and exercise at school," "talked to [the parent/guardian] or other family members about what they learned on the HealthWorks! field trip," "shown more interest in what he or she is eating," and "shown more interest in being active/exercising."

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Analysis

We used an intent-to-treat approach to analyze the effects of the intervention on child knowledge, and each child's pretest score was subtracted from their posttest score to create a change score. Because observations of children were clustered at both the classroom and school level (and randomization occurred at the school level), we used a multilevel linear regression with maximum likelihood estimation to incorporate the effects of clustering while examining the effects of the intervention on the assessment change score. Because the assessment instrument changed between Fall 2014 and Spring 2015, the most complete version of the model included the intervention semester and the interaction between semester and intervention group as covariates. Cases missing an assessment change score (i.e., because the student had a missing or incomplete pre- or post-assessment, n = 10 children) were excluded from the analysis.

Results

Implementation

Among 57 teachers in the treatment group responding, four (7.0%) reported implementing all of the curriculum, 41 (71.9%) reported implementing most of it, and 12 (21.1%) reported implementing less than half of it. Additionally, 23 of 53 (43.4%) estimated that <25% of their students completed the Family Activity Booklet, 17 (32.1%) estimated that 25% to 50% of their students completed it, 12 (22.6%) estimated that 51% to 75% of their students completed it, and 1 (1.9%) estimated that >75% of their students completed the booklet. Among parents and guardians of children in the treatment group, 116 of 357 (32.5%) reported that they completed all of the Family Activity Booklet, 144 (40.3%) completed most of it, 89 (24.9%) completed less than half of it, and 8 (2.2%) completed none of the booklet.

Outcomes

Child Assessments. Descriptive statistics for items in child assessments are in Table 3.

Table 3. Descriptive Statistics for Individual Child Assessment Items, by Group, 2014-2015

Concept tested	Range	Treatment *M* (*SD*), *n* = 252 children		Delayed Treatment *M* (*SD*), *n* = 251 children	
		Pretest	Posttest	Pretest	Posttest
Food group classification[a]	0-5	2.25 (1.17)	3.06 (1.39)	2.10 (1.16)	2.10 (1.13)
USDA MyPlate recommendations	0-1	0.10 (0.30)	0.17 (0.38)	0.12 (0.32)	0.12 (0.33)
Integration of food group classification and USDA MyPlate	0-5	1.61 (1.27)	3.14 (1.47)	1.65 (1.21)	1.67 (1.24)
Sugar in beverages					
Fall 2014[b]	0-3	1.62 (1.03)	2.35 (1.05)	1.67 (1.12)	1.92 (1.12)
Spring/Fall 2015[a]	0-2	1.42 (0.65)	1.74 (0.55)	1.27 (0.76)	1.32 (0.75)

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Concept tested	Range	Treatment *M* (*SD*), *n* = 252 children		Delayed Treatment *M* (*SD*), *n* = 251 children	
		Pretest	Posttest	Pretest	Posttest
Healthy food choices					
Fall 2014 [b]	0-6	2.68 (1.65)	3.00 (1.75)	2.63 (1.43)	2.47 (1.58)
Spring/Fall 2015[a]	0-5	2.05 (1.36)	2.74 (1.54)	1.94 (1.34)	2.07 (1.40)
Food origins	0-5	2.75 (1.37)	3.50 (1.32)	2.51 (1.38)	2.89 (1.43)
Food benefits					
Fall 2014 [b]	0-5	0.97 (1.11)	1.21 (1.10)	0.95 (0.99)	1.16 (1.18)
Spring/Fall 2015[a]	0-5	1.03 (0.96)	1.17 (1.08)	1.03 (0.83)	1.18 (0.95)
Activities that increase heart rate	0-4	3.02 (1.01)	3.45 (0.92)	2.87 (0.99)	3.09 (1.02)
Activities that burn energy					
Fall 2014 [b]	0-2	1.18 (0.71)	1.33 (0.76)	1.15 (0.65)	1.11 (0.66)
Spring/Fall 2015[a]	0-2	1.13 (0.84)	1.46 (0.79)	1.09 (0.82)	1.14 (0.80)
Healthy body needs	0-3	2.10 (0.83)	2.43 (0.82)	2.00 (0.81)	2.06 (0.79)
Total scores					
Fall 2014	0-39	19.6 (4.75)	23.8 (6.18)	19.4 (3.98)	19.8 (4.87)
Spring/Fall 2015	0-42	21.20 (5.20)	27.6 (6.29)	20.3 (4.91)	21.6 (5.34)

Note. Child assessment items are described in Table 2. Participating schools were matched in pairs based on race distribution and percent of children receiving free and reduced lunch, and one school from each pair was randomly assigned to the treatment condition (while the other was assigned to the delayed treatment condition). Thus, children are clustered in classrooms and schools, and direct comparison between conditions should account for clustering (see Table 4).
[a]This item was added or altered in Spring 2015. The number of participants for Spring 2015 and Fall 2015 combined was 175 in the delayed treatment group and 176 in the treatment group.
[b]The number of participants for Fall 2014 was 76 in the delayed treatment group and 76 in the treatment group.

The primary intervention outcome measure was the change in score from pretest to posttest. Results of multilevel linear regression models estimating the effects of intervention group, intervention semester, and the interaction between group and semester on child assessment change score are presented in Table 4.

Table 4. Multilevel Linear Regression Models Estimating the Effects of Treatment Group and Treatment Semester on Child Assessment Change Score, 2014-2015

Parameter	Model 1	Model 2	Model 3	Model 4 [a]
Fixed effects, Coefficient (*SE*)				
Intercept	3.39 (0.60)*	1.21 (0.45)*	0.73 (0.56)	0.59
Group (Treatment vs. Delayed Treatment) [b]		4.39 (0.65)*	3.42 (0.80)*	3.67 (0.84)*
Semester[c]				
Spring 2015			1.24 (0.77)	1.24 (0.64)
Fall 2015			0.37 (0.74)	0.49 (0.61)
Group*Semester				
Treatment*Spring 2015			2.64 (1.12)*	2.57 (1.24)*
Treatment* Fall 2015			0.40 (1.05)[d]	-0.13 (1.06)

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Parameter	Model 1	Model 2	Model 3	Model 4 [a]
	Random parameters, Variance component (*SE*)			
Level 3 (school) variance	6.23 (2.33)*	1.08 (0.73)*	<0.001	<0.001
Level 2 (classroom) variance	2.67 (0.90)*	2.76 (0.93)*	2.49 (0.79)*	4.84 (2.09)*
Level 1 (student) variance	13.02 (0.97)*	13.00 (0.97)*	12.97 (0.96)*	12.70 (0.96)*
Log likelihood	-1388.7054	-1376.8223	-1366.0261	-1262.0829

Note. Group is coded as Treatment = 1 and Delayed Treatment = 0. Semester is coded as 0 = Fall 2014, 1 = Spring 2015, 2 = Fall 2015.
[a]Model 4 includes teachers' self-reported amount of the curriculum completed (0 = "none of it" or "some of it (less than half)," 1 = "All of it" or "Most of it") as a classroom-level variable. Because 11 teachers in the treatment group did not complete this item, those classrooms are missing, bringing the total number of children included in Model 4 down from 493 to 459.
[b]Comparison group is Delayed Treatment.
[c]Comparison group is Fall 2014. [d]When Spring 2015 was used as the comparison group, the interaction terms for Treatment*Fall 2014 and Treatment*Fall 2015 were both negative and significant.
*$p < .05$

Support from Teacher Surveys. Among teachers of treatment classrooms, 49 (86.0%) reported that students had talked about what they learned. Sample open-ended comments from teachers included reports that students "talked a lot about food groups," "identify fruits and vegetables at lunch," and "talked about the field trip and activities there." In the same sample, 40 (70.2%) reported that students had demonstrated behavior change. Sample open-ended comments from teachers included reports that students "exercised in the classroom," "loved the characters and want to please," and "want to eat more fruits and veg."

Support from Family Surveys. Of parents and guardians who responded to the family survey and whose children were in the treatment group, 293 (78.8%) reported that their child had talked to them or other family members about what they were learning about healthy foods and exercise at school. Among the same group of respondents, 248 (66.7%) reported that their child had talked to them or another family member about what they learned on the HealthWorks! field trip; 32 (8.9%) reported that their child had not yet attended the field trip. Nearly three-quarters (72.8%; $n = 271$) of parents and guardians of children in the treatment group reported that their child had shown an increased interest in what he or she was eating, and 308 (82.8%) reported that their child had shown more interest in being active or exercising.

Discussion

This classroom-based health promotion intervention for kindergarten and pre-kindergarten students in a rural region of the southeastern United States produced significant improvements in knowledge about nutrition and physical activity. Children in the treatment group had significantly larger differences in pre- and post-assessment scores than children in the delayed treatment group. When self-reported completion of the curriculum was included as a classroom-

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level variable in the model, the effect of the intervention increased slightly. There were significant differences in gains by semester, with differences between treatment and delayed treatment schools participating in the second round of implementation (Spring 2015) being higher than the other two semesters. Because the assessment instrument was consistent between the Spring 2015 semester and the Fall 2015 semester, the difference between round of implementation is unlikely to be attributed to the adjustments made in the measurement instrument. It may instead be due to an increase in targeted training for the teachers. In Fall 2014, teachers received minimal training, and additional training was added in Spring 2015. There were also consistent reports by parents and teachers that children in the treatment group talked about what they were learning, shared lessons with family members, demonstrated greater interest in nutrition and physical activity, and demonstrated changes in behavior.

The reported increases in nutrition and health knowledge in the treatment group were expected and are consistent with similar interventions developed for other populations (D’Agostino, D’Andrea, Nix, et al., 1999). This program may be the first integrated obesity prevention curriculum to be developed for and tested with kindergarten and pre-kindergarten children in a rural region of the southeastern United States. The success of this project demonstrates the feasibility of implementing a health promotion intervention that is integrated into pre-kindergarten and kindergarten curricula (i.e., it includes math, science, and language arts lessons that meet state standards, rather than being an extra component). The WannaBee Healthy? curriculum and materials, part of a larger grant-funded project, were provided to all teacher participants. The curriculum and materials were reusable and could be embedded for use with future classes. Additionally, after the project period ended, a project website housed the curriculum and instructional materials and allowed free downloads. Successfully implementing this intervention in multiple classrooms and having activities carried out by existing teachers (78.9% of whom reported completing most or all of the activities) and parents (72.8% of whom reported completing all or most of the Family Activity Book) suggests that this intervention could be sustainable without a large, continued investment of funding.

Limitations

This research has limitations in the areas of design, implementation, and measurement. Specifically, the design did not allow us to disentangle the effects of the intervention components, as they were treated as one intervention. This becomes problematic because we do not know if the field trip to HealthWorks! North Mississippi added appreciably to the knowledge gains. If it did, the results reported here might underestimate effects, as some children were not able to take part in the field trip experience. Additionally, 21% of teachers in the treatment group reported implementing only half of the curriculum. If all curriculum components are equally effective, with full implementation, the intervention effects could be even stronger than those reported. However, lack of full implementation could also be an indicator of barriers to implementation or issues with the acceptability of the program. There is a need for future

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research that evaluates the effects of each component of the intervention (e.g., the field trip; curriculum; and accompanying materials, including family activity booklets) alone and investigates barriers to implementation.

There were also limitations associated with assessment. Responses from parent and teacher surveys were self-reported and may have been subject to social desirability bias. Children who were not present or whose parents did not consent could not be assessed, so data are not representative of children who are more likely to be absent from school or whose parents did not consent to allow them to participate in the research component.

The measurement instruments also present limitations. For example, the child assessment was changed slightly after the first semester, so it is unclear whether changes from Fall 2014 to Spring 2015 were partially due to the change in the instrument. Finally, this evaluation measured short-term effects (changes in knowledge) rather than longer-term effects, such as changes in behavior or adiposity. Although the teachers, parents, and guardians reported changes in behavior among participating students, there were no comparable data available for children in the delayed treatment group. Further research should investigate the effects of the intervention on long-term behavior changes and adiposity.

Strengths and Implications

Despite these limitations, this research has valuable strengths and implications. The intervention was created for and tested in a population with a high need for obesity prevention interventions—young children living in the rural southeastern United Stated (Bethell et al., 2010). Framed by a bioecological approach (Bronfenbrenner & Morris, 2007), the intervention featured an integrated curriculum designed by an interdisciplinary team that included child development specialists, a family booklet that bridged school to home learning activities, and a field trip that provided additional learning and practice opportunities for the children.

Additionally, the curriculum provides health education while also meeting current requirements for early childhood education, so it can be taught in place of other lessons instead of in addition to existing content. Finally, the rigorous design of the evaluation, which included multiple classes within multiple schools across the region, provides evidence that training teachers in this curriculum is linked to improvements in student knowledge in a real-world setting.

This research has clear implications for health education practice. For health educators, it provides a rigorously evaluated and publicly available curriculum that has been demonstrated to be successful in improving health knowledge among young children and can be implemented in similar settings (i.e., pre-kindergarten and kindergarten classrooms in the rural southeastern United States). It is possible that the curriculum could be adapted for use in other areas, but because language, food choices, images, and other curriculum components (such as books,

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songs, and activities) were chosen based on what was familiar to children in the region, these components would need to be tested for cultural appropriateness and acceptability.

There are further implications for children exposed to the intervention: improved health knowledge can influence child and family behavior related to nutrition and physical activity, which are all linked to obesity prevention (Baranowski et al., 2003). Further, children who meet recommendations for healthy lifestyle behaviors (e.g., nutrition, physical activity, and sleep) are more likely to perform well in fundamental academic areas such as math, reading, and writing (Faught et al., 2017). Thus, addressing childhood obesity through the application of an integrated health curriculum that addresses the foundational needs of young children and influences healthy behaviors can have a positive impact on both health and academic success.

Conclusions

This classroom-based health promotion intervention for kindergarten and pre-kindergarten students in a rural region of the southeastern United States—the first designed and evaluated for this particular population—produced significant improvements in knowledge about nutrition and physical activity. These findings suggest the curriculum could be implemented with success in other kindergarten and pre-kindergarten classrooms in this region. Further research should examine whether findings replicate in additional locations and in the absence of the field trip component and whether the gains in knowledge produce significant desirable changes in health behavior and adiposity.

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