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Effects of Nutrition and Physical Activity Intervention in Improving Children's BMI-for-Age Percentiles

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RESEARCH SNAPSHOT

Research Question: Does the completion of a seven-week nutrition and physical activity intervention improve the Body Mass Index (BMI)-for-age percentiles of rural Arkansas children at risk for childhood obesity or improve child knowledge of nutrition and physical activity?

Key Findings: In this study of 110 school-aged children from childcare programs in Arkadelphia researchers found that at the end of a seven-week period no statistically significant changes occurred in the BMI-for-age percentiles for either the control nor the treatment group. However, out of the three age groups assessed, only two demonstrated a significant increase in nutrition and physical activity knowledge as illustrated by improved questionnaire scores.

ABSTRACT

Background: The number of obese children and adolescents in the United States (U.S.) is estimated to be 12.7 million according to the Centers for Disease Control and Prevention (CDC). Therefore, approximately 17% of the nation's children are obese. Rates of childhood obesity in Arkansas (22%) are consistently higher than the national average. To address this issue, a nutrition and physical activity intervention was designed by researchers from Ouachita Baptist University (OBU) Nutrition and Dietetics Program.

Objective: To determine the effectiveness of a nutrition and physical activity intervention in improving the Body Mass Index (BMI)-for-age percentiles of rural Arkansas children at risk for childhood obesity.

Design: The research included a treatment group that received weekly nutrition and physical activity lessons and a control group that did not receive nutrition and physical activity lessons. The baseline and ending BMI-for-age percentiles were recorded for all children. Nutrition knowledge was assessed in the treatment group at baseline and at the end of a seven-week period using a multiple choice pre- and post-test.

Participants/setting: In the summer of 2018, 110 children ages 2- to 12-years-old from the three childcare programs in Arkadelphia were selected.

Intervention: Treatment groups received weekly nutrition and physical activity lessons over a seven-week period.

Main Outcome Measures: Children's BMI and test scores were analyzed.

Statistical analyses performed: t test and z-scores.

Results: Test scores improved in the 7- to 9-year-old group and the 10- to 12-year-old group, but there was no improvement in the 4- to 6-year-old group. For the control group, the mean pre-assessment BMI was 16.0 ± 2.9 and at post-assessment, the mean BMI was 15.8 ± 2.8 ($p=0.295$). The mean BMI of the

control group did not change significantly during the summer. For the treatment group, the mean pre-assessment BMI was 18.5 ± 3.1 and at post-assessment, the mean BMI was 18.6 ± 3.2 (p=0.395). The mean BMI of the treatment group did not change significantly during the summer.

Conclusions and Implications: The majority of children participating in the nutrition and physical activity intervention had improved nutrition knowledge test scores at the end of the intervention. BMI-for-age percentiles remained statistically the same for the seven-week program. Pre- and post-test for 7- to 9-year-old and 10- to 12-year-old children are useful for accessing nutrition and physical activity knowledge but are not useful for 4- to 6-year-old children.

INTRODUCTION

Childhood obesity, defined as having a body mass index (BMI) over the 95th BMI-for-age percentile, affects one child out of every five children in the US.[1,2] The Centers for Disease Control and Prevention (CDC) report that the number of children and adolescents with obesity has tripled since the 1970s reaching the current proportion of seventeen percent (12.7 million) of the 73.9 million children and adolescents in the US.[3-12]

The 2015-2016 National Health and Nutrition Examination Survey (NHANES) found that 14% of 2- to 5-year-olds, 18% of 6- to 11-year-olds, and 21% of 12- to 19-year-olds are obese.[13] Obesity rates among children age 2- to 5-years-old have varied throughout the years. In 2003-2004 the prevalence was 14%, in 2011-2014 rates decreased to 8% and then increased significantly in 2015-2016.[3,12-14] Twenty-six percent Hispanic, 11% Asian, 22% African American, and 14% Caucasian school-aged children are obese.

In Arkansas, 39% of children are overweight or obese.[15] Out of the 39% of overweight or obese children, 30% are Hispanic, 25% African American, 22% Native American, 20% Caucasian, and 15% Asian.[15] In Arkadelphia, 11-28% of children age 4- to 12-years-old are obese.[15]

Childhood obesity is influenced by behaviors of consuming high-calorie, low-nutrient dense foods and beverages, not getting enough physical activity or doing sedentary activities like playing on screen

devices, and not getting enough sleep. Environments such as low income or low accessibility to food areas also increase obesity. Genetics plays a role in obesity, as well.[1,11]

Childhood obesity often continues into adulthood and leads to increased health risks of high blood pressure, high cholesterol, cardiovascular disease, insulin resistance, type 2 diabetes, asthma, sleep apnea, joint problems, musculoskeletal discomfort, fatty liver disease, gallstones, heartburn, psychological problems (anxiety and depression), low self-esteem, and social problems (bullying).[1,8-9,5,16-17] Obesity-related cancer in 2010 was 47,390 cases and is projected to exceed 116,050 cases by 2030.[18] Preventing and treating childhood obesity now may reduce or eliminate the risk of obesity related health problems for present and future generations.

Nutrition and physical activity interventions are needed to combat the growing rate of childhood obesity. These programs are effective with children as their attitudes towards food are still malleable and they have the capacity to make changes for the sake of health.[17, 19-20] Children reportedly enjoy tasting new foods and participating in activities, while parents benefit from the cooking and nutrition guidance they receive.[21-22]

Nutrition interventions come with many unique foci depending on the program. Some programs like It's All About Kids, School Kids Access to Treats to Eat (SKATE), Preschool Obesity Prevention Series (POPS), Incredible Years Series (IYS), Body Quest, Coordinated Approach to Child Health (CATCH), and EatSmart concentrate only on food knowledge and healthy eating by providing information about label reading, portion sizes, nutrients, healthy snacks, and the importance of fruits and vegetables.[17,19,23-26] However, some programs present this information as well as curriculum relating to physical activity. Interventions like Team Nutrition, All 4 Kids, Kids Living Fit, Catch Kids Club, Active Generations, the Healthy Choices Intervention, and Shaping Healthy Choices Program include an emphasis on exercise by incorporating games and activities that get kids moving.[17,32] In addition to specific health emphasis, other characteristics including the length, target audience, setting and form of instruction.

Nutrition interventions have proven to be effective in addressing different areas surrounding obesity. Team Nutrition, School Kids Access to Treats to Eat, and EatSmart all employ pre- and post-tests to

establish a significant increase in the nutrition knowledge of the intervention group.[17,19,27] All 4 Kids, It's All About Kids, Active Generations, Body Quest, and CATCH employ pre- and post-tests to indicate an increase in nutrition knowledge as well as a self-reported survey which found an increased consumption of healthy food choices like fruits and vegetables.[23,25-26,28,31] Catch Kids Club, Healthy Choices Intervention, and Shaping Healthy Choices Program found post-intervention BMI decreased compared to the baseline, and also demonstrated an increased knowledge of nutrition through pre- and post-test results.[17,30,32] In the same way, Kids Living Fit showed evidence of a decrease in participant BMI after completion of the intervention although it did not include a written assessment of nutrition knowledge.[29]

The primary goal of this research was to assess the effectiveness of a nutrition and physical activity intervention in improving the BMI-for-age percentiles of rural Arkansas children at risk for childhood obesity.

MATERIALS AND METHODS

Study Design and Participants

The three summer childcare programs for school-aged children in Arkadelphia, Arkansas agreed to serve as research sites for the project. Informed consent was obtained from a parent of each child. A total of 114 children (63 males and 51 females) participated in the study. Seventy-seven children (63 Caucasian, 13 African American, and 1 Hispanic) were in the treatment group that received weekly nutrition and physical activity lessons presented by two undergraduate research students in the Ouachita Baptist University (OBU) Nutrition and Dietetics program. Thirty-seven children (31 Caucasian, 5 African American, and 1 Hispanic) were in the control group that received no nutrition lessons

Approval was granted by the OBU Institutional Review Board (IRB). The first interaction with children from the treatment and control group consisted of obtaining anthropomorphic measurements for each child using a Health O Meter electronic standing scale for weighing to the nearest tenths and a SECA stadiometer for measuring height in inches. Measurements were used to calculate BMI and BMI-for-age percentiles. Age, race, and gender were also recorded. Also, children in the treatment group (n=77) were given an age appropriate pre-test developed in reference to the MyPlate® dietary guidelines to assess

baseline knowledge of food groups, portion sizes, exercise, and calorie needs. Pre-tests were multiple choice, and students were instructed to work individually and answer all questions. Questions were only read aloud if requested by the students. Researchers scored the pre-tests.

At the end of a seven-week intervention period, a post-test identical to the pre-test was administered to the treatment group. Anthropomorphic measurements of the treatment and control groups were recorded. Post-tests were graded for the treatment and BMIs and BMI-for-age percentiles were calculated for the treatment and control groups.

Intervention

The intervention consisted of seven nutrition focused lessons ranging from 35 minutes to one hour in length. These lessons were planned and facilitated by two undergraduate students with the supervision of a mentor. The lessons were designed to increase the nutrition knowledge of children in the treatment group and in turn normalize BMI levels. A monthly newsletter written by the undergraduates and a weekly nutrition handout were sent home to parents.

Week One: Pre-test and Anthropomorphic Measurements. Researchers introduced themselves and the summer lesson series to the students using a MyPlate®banner. The pre-tests were administered and each child's weight, height and demographic information was collected as described above.

Week Two: Fruits and Veggies. The importance of fruits and vegetables was highlighted through a MyPlate®banner and food models. Activities included a game in which students named a fruit or vegetable before tossing a ball, a craft in which students colored paper plates with a rainbow of fruits and vegetables, and a cherry taste test.

Week Three: Fats and Nutrition Labels. Benefits of healthy fat were emphasized by showing a MyPlate®banner and a plastic representation of a pound of fat. A paper traffic light was made to represent "Go" fats, "Slow" fats and "No" fats. Nutrition labels were introduced and ordered by amount of fat present. Fast food menus were also evaluated by children based on healthy food choices available. Children were given dark chocolate as a taste test.

Week Four: Dairy. A Get Up and Move survey was used to review information from previous weeks. Appropriate portion sizes and daily calcium needs were discussed by showing a MyPlate® banner, food models, and 3D bone display. Paper bag cows were made as a craft. Experiments revealing the amount of fat in whole and skim milk were performed using dish soap and food coloring.

Week Five: Grains. "Like it, don't like it, haven't tried it" game was played to introduce the subject of grains. The MyPlate® banner was shown as well as food models to illustrate portion sizes. Students colored pictures of whole grains and discussed their health benefits in comparison to refined grains. A nutrition label whole grain scavenger hunt was completed by finding whole grain ingredients. Cereal and pasta bracelets were made as a craft.

Week Six: Protein. A cup stacking game was used to introduce proteins as the "building blocks" of life. The MyPlate® banner was shown and portion sizes were discussed. Protein facts were reinforced through the game telephone. Children made a bean and lentil mosaic in the shape of their favorite protein food. Plant versus animal protein was introduced by playing "Plant, plant, animal protein!" (Duck, duck, goose).

Week Seven: Yoga and Post-Test. A brief review of each food group was completed using the MyPlate ® banner as well as food models. The importance of physical activity and strength-building activities comprised the lesson. One researcher led the children in yoga while the other took each child's anthropomorphic measurements. The post-test was administered and finished by students individually.

Statistical Analysis

Descriptive statistics included mean and frequency comparisons of pre-assessment and post-assessment scores on the nutrition knowledge questionnaire. A paired-sample *t* test was run comparing pre-assessment BMI with post-assessment BMI for the control and treatment groups. Comparisons were also made between pre-assessment z-scores with post-assessment z-scores. Statistical significance was set a $p<0.05$. SPSS version 25 was used for all analysis.[33]

RESULTS

Participants

A total of 110 children were assessed, of which 58 (53%) were male and 52 (47%) were female. Ethnicities represented were Caucasian (n=92), African American (n=16), and Hispanic (n=2).

In the pre-assessment control (n=35) group, 15 (43%) were male and 20 (57%) were female. Of the ethnicities represented 29 (83%) children were Caucasian, 5 (14%) were African American, and 1 (3%) was Hispanic. Out of the ages represented 4 (11.43%) children were 2-3-year-olds, 27 (77.14%) were 4-6-year-olds, 4 (11.43%) were 7-9-year-olds, and there were no 10-12-year-olds. In the post-assessment control (n=24) group, 10 (42%) children were male and 14 (58%) were female. Of the ethnicities represented 20 (83%) children were Caucasian, 4 (17%) were African American, and there were no Hispanic representation. Of the ages represented 3 (12.5%) children were 2-3-years-old, 17 (70.8%) were 4-6-years-old, 4 (16.7%) were 7-9-years-old, and there were no 10-12-year-olds. Twenty-four (69%) of the 35 children were present at both pre- and post-assessment.

In the pre-assessment treatment (n=72) group, 42 (58%) were male and 30 (42%) were female. Sixty (83.3%) Caucasian, 11 (15.3%) African American, and 1 (1.4%) Hispanic were present. Of the ages represented there were 18 (25%) 4-6-year-olds, 34 (47%) 7-9-year-olds, and 20 (28%) 10-12-year-olds. In the post-assessment treatment (n=55) group, 31 (56%) children were male and 24 (44%) were female. Forty (84%) Caucasian, 8 (15%) African American, and 1 (2%) Hispanic were present. Of the ages represented there were 15 (27.3%) 4-6-year-olds, 25 (45.5%) 7-9-year-olds, and 15 (27.3%) 10-12-year-olds. Forty-eight (64%) of the 75 children were present at both pre- and post-assessment.

BMI

At pre-assessment, the control group's mean BMI was 16.0 ± 2.9 with 5 (14%) children being underweight, 23 (66%) being normal weight, 2 (6%) being overweight, and 5 (14%) being obese. At post-assessment, the mean BMI was 15.8 ± 2.8 (p=0.295) with 4 (16.7%) children being underweight, 15 (62.5%) being normal weight, 2 (8.3%) being overweight, and 3 (12.5%) being obese. The mean BMI of the control group did not change significantly during the seven-week intervention. At pre-assessment, the treatment group's mean BMI was 18.5 ± 3.1 with 2 (2.8%) children being underweight, 33 (45.8%) being normal weight, 17 (23.6%) being overweight, and 20 (27.8%) being obese. At post-assessment, the mean BMI was 18.6 ± 3.2 (p=0.395) with 1 (2%) child being underweight, 24 (44%) being normal weight, 15 (27%) being overweight, and 15 (27%) being obese. The mean BMI of the treatment group did not change significantly during the seven-week intervention. (Refer to Figure 1)

Test Scores

Test scores improved significantly in the 7- to 9-year-old group and the 10- to 12-year-old group from the pre-test to the post-test. The percent of correct answers increased for six out of the seven questions in the 7- to 9-year-old age group. The percent of correct answers increased for each of the nine questions in the 10- to 12-year-old age group. Test scores did not improve in the 4- to 6-year old group from the pre-test to the post-test. Only one question showed an increase in the percentage of correct answers in the 4- to 6-year-old age group. (Refer to figure 2)

DISCUSSION

Summary in Comparison

The BMI-for-age percentiles did not demonstrate statistically significant change in the treatment group that received nutrition and physical activity lessons or in the control group that did not receive the

lessons. The nutrition and physical activity lessons had no impact on the children's BMI after a seven-week period.

The questionnaires indicated an increase in nutrition and physical activity knowledge for the 7- to 9-year-old and 10- to 12-year-old groups, however there was no improvement for the 4- to 6-year-old group. This reveals that children from 7- to 12-years-old benefited from the lessons and increased their nutrition and physical activity knowledge over the course of the seven-week programs. However, the written questionnaire did not prove to be appropriate for the 4- to 6-year-old group. This group obviously struggled when completing the assessment and many needed to be given multiple copies of the test after circling multiple answers to a question or drawing on the page. This conclusion agrees with other published studies on the value of nutrition and physical activity lessons on improving nutrition knowledge in children.[19,21, 23, 25-27,30-31]

Limitations and Strengths

In contrast to this research, there are many studies which have shown that nutrition education can directly impact a child's BMI.[22,29-30,32] Possible reasons for this dissonance will be discussed in limitations. When looking at studies that have had success in lowering elevated BMIs in children, often a parent is involved in the program as well.[22,32] While our parents were given handouts and two monthly newsletters through their children, they did not personally receive any type of nutrition education. Some children even commented in the course of the lessons that they had shared about nutrition labels and the benefit of low-fat options with their parents but that the parents continued to buy the unhealthy items.

The length of an intervention also has an effect on the significances of the results. For example, many studies indicated a decrease in child BMI after a period of three months of intensive meetings or a year of in school nutrition and physical activity education.[29-30] This study only allowed researchers 30 to 60 minutes with the children each week, and many struggled to remember information from the week before.

CONCLUSION

The intervention program was not successful in normalizing child BMIs in the limited time period given. Further research should consider increasing the number of lessons with children in addition to adding a parental element to ensure real life applications are being made. However, nutrition knowledge did increase significantly in treatment groups of 7- to 9-year-olds and 10- to 12-year-olds. Visuals such as food models and MyPlate® diagrams were effective in holding the children's attention. The lack of improvement in the 4- to 6-year-old age group should be addressed in the future by using an assessment method that is interactive and excludes writing.

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Figure 2. Comparison of pre- and post-nutrition and physical activity knowledge test scores

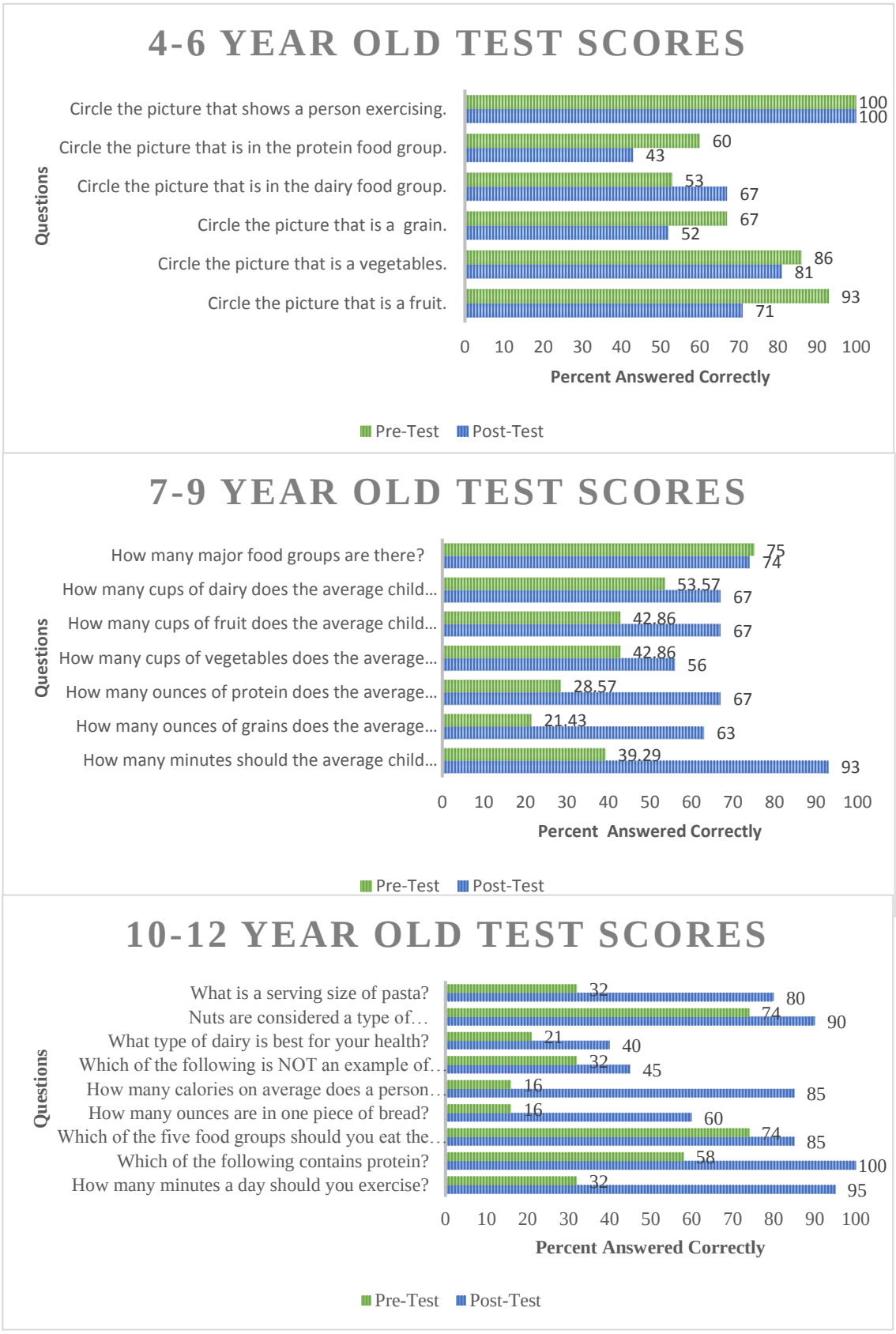

Figure 1. BMI z-scores for pre- and post- assessment control and treatment groups