Journal of Nutrition and Health Sciences
Volume 4 | Issue 3
ISSN: 2393-9060

Research Article | Open Access

A Nutrition and Physical Activity Education Model for Cancer Risk Reduction Improves Knowledge and Dietary Behaviors among Students in the Alabama Black Belt

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Citation: Rotich-Mukigi D, Bovell-Benjamin AC (2017) A Nutrition and Physical Activity Education Model for Cancer Risk Reduction Improves Knowledge and Dietary Behaviors among Students in the Alabama Black Belt. J Nutr Health Sci 4(3): 302. doi: 10.15744/2393-9060.4.302

Received Date: June 20, 2017 **Accepted Date**: November 29, 2017 **Published Date:** December 04, 2017

Abstract

An age-appropriate, culturally sensitive Nutrition and Physical Activity Education Model (NPAEM) for cancer risk reduction was developed and implemented. NPAEM was underpinned by the social-cognitive theory. Participants (N=86) were 8 to 11-year-old students from public elementary schools in Macon County, Alabama. The NPAEM comprised of 11 topics and activity/worksheets. Lesson plans, evaluation and hands-on activity/worksheets were developed. The 15-week intervention was cross-sectional, with a pre- and post-assessment design and weekly 45-minute lessons. Nutrition and physical activity knowledge and dietary behavior were assessed using pre- and post-test, food frequency questionnaires, physical activity questionnaires and anthropometrics (weight, height, waist circumference, body mass index and waist-to-height ratio). Descriptive analysis, categorical analysis and t-test were used to analyze the data. Complete datasets were obtained for 81 boys and girls. Overall, the nutrition and physical activity knowledge scores for students increased significantly ($P<0.001$) from pre-test (75.5±19.5) to post-test (94.2±6.9). The student's percent energy from protein and carbohydrates were within the recommended ranges. The percent calories from fat for pre- and post-assessments was 36.5±5.6 and 35.1±5.1, respectively. Sodium intake was significantly ($P<0.0003$) lower at post- than pre-assessment (6494.2±3886.8 versus 4577.6±2491.5). Daily intake of grains increased significantly ($P<0.001$) at post-assessment. In the post-assessment, significant reductions were seen in the intakes of: red meat (79.4±2.7 g; $P\leq0.004$); lunch meat (31.2±0.9 g; $P\leq0.004$); and poultry (31.2±0.9 g; $P\leq0.005$). The findings from this study demonstrated that implementing a 15-week school-based NPAEM for cancer risk reduction could positively impact on young children.

Keywords: African American; Cancer risk; Nutrition and physical activity knowledge; Dietary behavior; Nutrition and physical activity education model

Introduction

Cancer is a worldwide pandemic with about 14.2 million new cancer cases, 8.2 million cancer deaths and 32.6 million people living with cancer, within 5 years of diagnosis [1]. Despite advancement in cancer treatment options, cancer is the second leading cause of death in the United States (U.S.) [2]. In the U.S., cancer mortality is higher among men than women (207.9 per 100,000 men and 145.4 per 100,000 women). It is highest in African American men (261.5 per 100,000) and lowest in Asian/Pacific Islander women (91.2 per 100,000) [3]. Alabama has one of the highest cancer mortality rates in the U.S. Alabama's cancer incidence and mortality rates are higher than the national rates (444.0 versus 439.0; and 182.1 versus 162.0, respectively) [4].

African Americans have the highest death rate and shortest survival of any racial/ethnic group in the U.S. for most cancers. The causes of these inequalities are complex, reflecting social and economic disparities more than biological differences [3]. In 2012, the death rate for all cancers combined was 24% higher in African American men and 14% higher in African American women than in Caucasian men and women, respectively [5]. Additionally, compared with white women, African American women have lower rates of breast cancer incidence [6]. However, breast cancer mortality is higher in African-American women [7]. For example, from 2010-2014, breast cancer mortality was 41% higher among African American women (29.2 deaths per 100,000 population) than white women (20.6 deaths per 100,000 population) [7].

Reduction of cancer risk remains a global priority because of the personal and economic costs associated with cancer morbidity and mortality [8]. It is estimated that 30 to 35% of all cancer cases are caused by inadequate diets. For example, diet is linked to 70% of colorectal and prostate cancer; 50% of all cases of breast, endometrial, pancreatic and gallbladder cancers; and approximately 20% of lung, mouth and esophageal cancers [9-11].

Persistent poverty, unemployment, low education levels, poor health, unhealthy eating habits, single parenthood and heavy dependence on public assistance programs are major characteristics of the Alabama Black Belt (ABB) [12]. The ABB is also characterized by its rural communities with inherently sparse populations, and high prevalence of chronic diseases such as cancer, heart disease and diabetes. In Alabama, roughly 50% of the children from rural African American families are overweight or obese [13]. Older studies have indicated that the geographic distribution of obesity illustrates the highest burden in the ABB counties. The long term health-related problems of overweight and obesity include some types of cancer, type 2 diabetes and other types of chronic diseases [8]. It is well known that increased consumption of fruits, vegetables, whole grains, low-fat dairy products and decreased consumption of sugary beverages, fried foods and red meat, along with adequate physical activity may decrease nutrition-related diseases. However, according to the State Indicator Report on Fruits and Vegetables, 2013, 44.4% of Alabama adolescents reported consuming fruits once daily versus 36.0% for adolescents nationally [14]. Similar low daily intakes of vegetables were reported for Alabama's adolescents (45.7% versus 37.7% nationally) [14]. Furthermore, 38.8% of Alabama's adolescents drank a can, bottle, or glass of soda or pop (excluding diet soda or diet pop) at least once per day during the seven days before the survey was administered [15].

Cultural, social, health, environmental, lifestyle, and economic factors influence individual's dietary behaviors [11]. Physical inactivity and unhealthy eating contribute to chronic diseases such as cardiovascular disease, diabetes, and cancer, as well as adverse health conditions such as obesity, which are preventable [16]. Studies have established that eating and physical activity habits developed during childhood continue to adulthood [17]. Interventions designed to influence eating habits may have positive impacts in school-aged children. These interventions will form the foundation for good nutrition and physical activity throughout life [17,18]. Young children and youths are ideal for interventions that address dietary and physical activity factors associated with cancer because their habits are in process of being developed; and they generally have fewer risk factors as compared to adults [19]. Consequently, the school environment can be an effective medium to influence nutrition and physical activity knowledge behaviors among children; classrooms provide a formal and informal environment for learning and teaching approaches, that is, teacher modeling [20]. Therefore, the objective of this study was to develop and implement an age-appropriate, culturally-sensitive nutrition and physical activity education model for cancer risk reduction among third and fourth grade children in the Alabama Black Belt.

Methods

Research Setting

The study was conducted in Macon County, Alabama, U.S., which has a population of 19,425. Macon County, one of the 18 traditional counties of the ABB has a predominantly African American (80.9%) population. In 2015, the median household income of Macon County residents was $30,738 and 26% of Macon's residents live in poverty.

Development of the Nutrition and Physical Activity Education Model (NPAEM)

The Nutrition Education and Physical Activity Model (NPAEM) presented in this paper considered the age, social, and cultural backgrounds of the participants during development. The model is underpinned by Bandura's (1986) social-cognitive theory, which posits that there is a continuous, dynamic interaction among personal factors, behavioral patterns and environmental factors, and a change in any one of these factors impacts on the others [21]. Briefly, the NPAEM integrated two approaches, which have been found to be advantageous to school-aged audience [22]. Firstly, it incorporated knowledge-based nutrition and physical activity education to enhance the knowledge, skills, and attitudes needed by the children to make the dietary and physical activity changes required for cancer prevention, both at school and home. Secondly, it focused education on cancer prevention and enhancement of overall health through diet and physical activity.

Information for the development of NPAEM came from multiple sources, including: Food and Nutrition Professors, Registered Dietitians and Certified Food Scientists at Tuskegee University, Federal Agencies [mainly, the United States Department of Agriculture], American Cancer Society, American Diabetes Association, Academy of Nutrition and Dietetics, American Heart Association, peer-reviewed journals, relevant databases (e.g. Medline, Science Direct) and Nutrition Education Materials Online [23]. The development steps and topics of the NPAEM are shown in Figure 1. Briefly, the NPAEM comprised of 11 topics and activity/worksheets with a focus on behavioral skills.

The lesson plans, evaluation, and hands-on activity/worksheets were developed by the researchers and reviewed by Nutrition Educators in the Department of Food and Nutritional Sciences, Tuskegee University. Each lesson was divided into: i) a 15-minute lecture with the accompanying audiovisuals when the concepts were presented; and ii) a 30-minute hands-on activity/worksheet segment in which the students engaged in activities such as hand washing marathon, craft, creation of the human body system, and worksheet completion on the presented lesson. The worksheets consisted of a mixture of multiple choice questions, filling the blanks, listings and some open-ended questions. The activity/worksheet segment served a dual purpose, reinforcement of the nutrition and physical activity concepts taught through behavioral skill building, and as an evaluation tool. Parenting education was done through delivery of weekly newsletters, which summarized and communicated the concepts students learned that week. The newsletter also included tips on healthy eating and suggestions for various family-oriented physical activities. This was also viewed as a reinforcement strategy, and the opportunity for students and parents to practice what was taught.

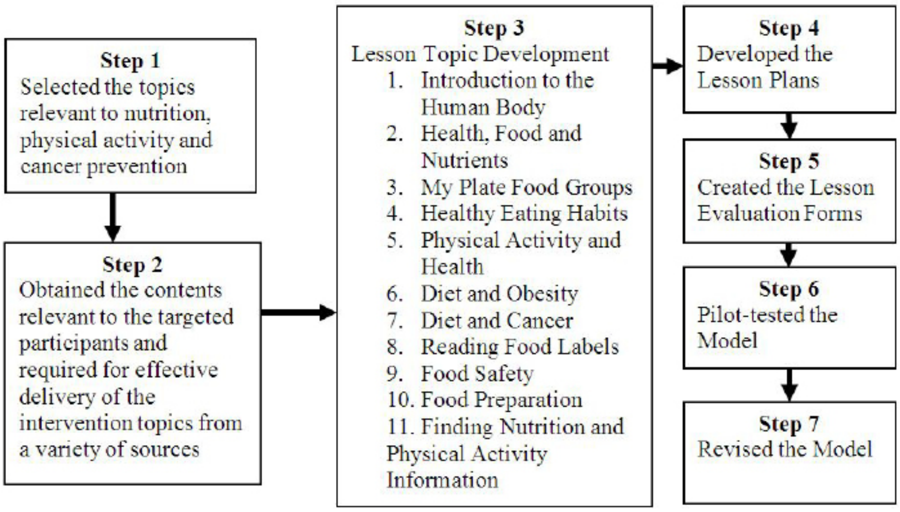


Figure 1: Steps in the Development of the Nutrition and Physical Activity Education Model (NPAEM)

The NPAEM was piloted among 15 children aged 8 to 15 years to determine age and cultural appropriateness; identify potential logistical problems regarding the proposed methods; assess the proposed data analysis techniques for potential problems; and for content validity. In the pilot study, the researchers implemented the NPAEM and completed a process evaluation to detail its strengths and weaknesses. Based on the feedback, some items were either retained unchanged, revised or removed. The Nutrition Educators again reviewed the revised model. The objectives of the lessons are shown in Appendix 1.

Participants and Informed Consent

Third and fourth grade students attending three public elementary schools in Macon County, Alabama, U.S. were recruited for the intervention. The intervention was conducted at the schools during designated science and physical education lesson periods. Permission to conduct the intervention in the schools was received from the Superintendent of Education for Macon County Schools and Principals. Ethical approval for the intervention was received from the Human Participant Research Committee (HPRC) at Tuskegee University. Informed consent and assent forms were signed by the parents and children, respectively, prior to the intervention.

Delivery of Intervention

The 15-week intervention was cross-sectional, with a pre- and post-assessment design. A trained, nutrition educator taught all the classes to ensure consistency. All students received the same curriculum, materials and activity/worksheets. Weekly 45-minute lessons were taught (15 minutes teaching and 30 minutes guided activity time).

Participant's Characteristics

A total of 86 boys and girls, recruited from three elementary schools in three different cities (Shorter, Tuskegee and Notasulga), Macon County, Alabama, participated in the NPAEM. Complete datasets were obtained for 81 students, 43 and 38 boys and girls, respectively. The schools are identified as GWC, NHS and DCW. The students (97.5%) were predominantly African Americans. The student's characteristics are shown in Table 1.

PARTICIPATING SCHOOLS						
Characteristics	**GWC n=18**		**NHS n=25**		**DCW n=38**	
	Number	*%*	*Number*	*%*	*Number*	*%*
Gender						
Boys	8	44	13	52	22	58
Girls	10	56	12	48	16	42
Age (Years)						
8	15	83	10	40	16	42
9	3	17	12	48	10	26

PARTICIPATING SCHOOLS						
Characteristics	GWC n=18		NHS n=25		DCW n=38	
	Number	*%*	*Number*	*%*	*Number*	*%*
10	0	0	2	8	7	18
11	0	0	1	4	5	13
Ethnicity						
% African American	18	100	23	92	38	100
% White	0	0	2	8	0	0
% Hispanic	0	0	0	0	0	0

Table 1: Characteristics of the 8 to 11-year-old students (N=81) in the Nutrition and Physical Activity Education Model (NPAEM)

Measures

Pretest (Nutrition and Physical Activity Knowledge): Baseline data, including a pre-test and markers for cancer (dietary intake, anthropometrics and physical activity assessments) were collected from the students at the start of the intervention. The student's knowledge of nutrition and physical activity were assessed with a 12-item pre-test, which was reviewed for suitability, relevance and accuracy in the pilot study. The pre/posttest, drawn from the lesson topics, assessed nutrient-food associations, nutrients and disease linkages, physical activity awareness and MyPlate for kids.

Food Frequency Questionnaire (Dietary Consumption): The Block Kids Food Frequency Questionnaire (FFQ), designed for children aged 8 to 17 years was administered at the start of the intervention. The 77-food item questionnaire collected information on the number of times a food item was consumed in the previous week and the individual portion size [24]. Pictures of portion sizes were provided to enhance precision of quantification.

Anthropometrics: The anthropometrics [weights, heights, and waist circumference (WC)] were measured; body mass index (BMI) and waist to height ratio (WHTR) were calculated.

Physical Activity Questionnaires for Children (PAQ-C): The PAQ-C was administered to assess each student's typical level of activity (self-reported) in different settings and different times of the day [25,26]. The PAQ-C collected information on the children's participation in vigorous activities over the last 7 days. The PAQ-C checklist was used to determine if a child engages in physical activity during a given time period, such as the weekend or a weekday. The nutrition educator administered the PAQ-C for students to recall the time they spent sleeping, in moderate-intensity activities, and hard and very hard activities on each day of the previous week.

Lesson Scores: Scoring criteria for the lessons were established during development and piloting of the NPAEM. Score determination sheets were set up for the lessons. On average, each lesson's worksheet had six questions. Each correctly answered question was awarded 1, 2 or 3 points depending on level of difficulty for a maximum score of 10 for each worksheet (assignment). For each student, the score was calculated to a percentage, and then all scores were added together, and multiplied by 100 to get the overall percentage.

Post Assessments: The students were given a post-assessment at the end of the intervention. The knowledge test, FFQ, anthropometrics, and PAQ-C were again administered at the end of the intervention.

Statistical Analysis: Data were analyzed using Statistical Analysis System (SAS) software, version 9.3, SAS Institute Inc., Cary, NC, 2011. The FFQs were analyzed by NutritionQuest Berkley, California. Descriptive statistics were conducted to compare pre- and post-intervention of: i) calorie intake from protein, carbohydrate, fat, minerals, vitamins, fat (total fat-total F, saturated fatty acids-S.F, monounsaturated fatty acids (MUFAs), polyunsaturated fatty acids [PUFAs], dietary cholesterol), different food groups and physical activity levels. Means and standard deviations of pre- and post-intervention were computed; differences between means were analyzed by use of paired t test. A P value of 0.05 was used to verify the differences.

Results and Discussion

Nutrition and Physical Activity Model

Test Scores: Children demonstrated understanding of the nutrition and physical activity knowledge areas as shown in the completed lesson activities in Figure 2.

The pre- and post-test scores are shown in Figure 3. The students at DCW had the highest mean score in the pre-test (83.8±8.6), followed by NHS (77±13.5). Students at GWC had the lowest pre-test score when compared to DCW and NHS (62.2±26.3). Significantly ($P \leq 0.0006$) higher post-test scores were seen among the students in the schools.

(a) (b) (c) (d)

(a-d) Body system craft; Coloring by nutrients; Jumping rope; Coloring bacteria

Figure 2 a-d: Sample lesson activities completed by participants in the Nutrition and Physical Activity Education Model (NPAEM) (*with permission*)

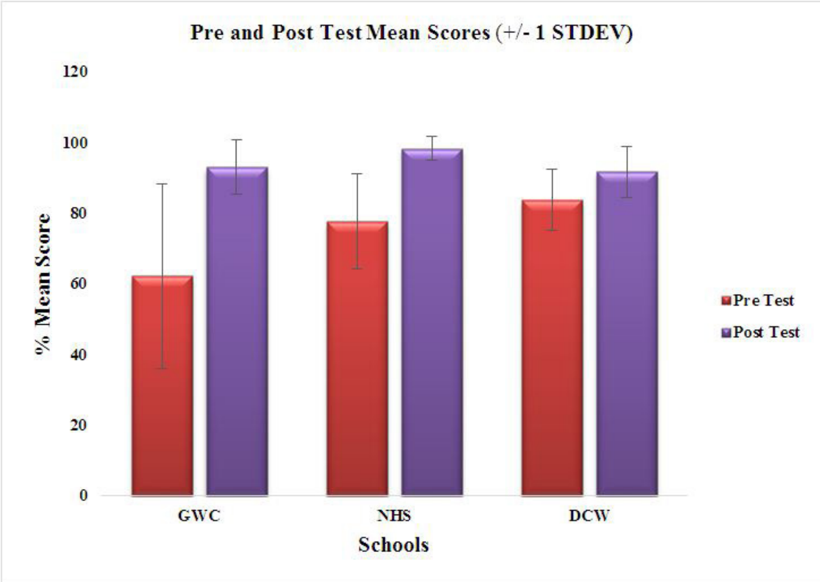


Figure 3: Pre- and posttest mean scores for the Alabama Black Belt students participating in the Nutrition and Physical Activity Education Model (NPAEM) for the three schools, GWC, NHS and DCW

Exposure Scores

The test scores of the lessons taught were computed; the mean scores are presented in Table 2. The physical activity lesson was

Lessons	Mean lesson scores for each school ± standard deviation			
	GWC n=18	NHS n=25	DCW n=38	P value
Introduction to the Human Body	58.2±3.6^{a}	68.7±3.0^{a}	87.9±2.5^{b}	0.0001
Health, Food and Nutrients	60±3.8^{b}	84±3.1^{a}	87.9±2.6^{a}	0.0001
MyPlate Food Groups	60.4±2.7^{b}	91.7±2.2^{a}	88.9±1.8^{a}	0.0001
Healthy Eating Habits	77.6±3.5^{b}	96.1±2.9^{a}	82.4±2.4^{b}	0.0001
Physical Activity and Health	94.1±3.2^{a}	92±2.6^{a}	91.9±2.1^{a}	0.8201
Diet and Obesity	82.9± 3.1^{a}	83.6±2.5^{a}	88.6±2.1^{a}	0.177
Diet and Cancer	79.4±2.0^{a}	98.1±1.6^{b}	87.2±1.3^{c}	0.0001
Reading Food Labels	97.5±3.0^{a}	96±2.5^{a}	87.4±2.2^{b}	0.006
Food Safety	95.9±2.4^{ab}	96.5±2.0^{a}	89.4±1.6^{b}	0.011
Food Preparation	86.4±2.4^{b}	98.8±2.0^{a}	89.4±1.7^{b}	0.0002
Finding Nutrition and Physical Activity Information	90.9±2.8^{ab}	83.2±2.3^{b}	91.3±1.9^{a}	0.022

Means with the same letter in the same row are not significantly different at P<0.05

Table 2: Mean lesson scores for the Alabama Black Belt students (N=81) in the three participating schools in the Nutrition and Physical Activity Education Model (NPAEM)

received equally well by all students in all schools. Overall, the highest performing students in most of the lessons were those at NHS, followed by DCW and GWC. The performance by GWC students may have been affected by other environmental interferences, such as competing activities during lesson time. In general, the students performed very well, the scores were impressive and indicated that learning took place. Students at NHS had the highest post-test mean score 98.4±3.4; followed by GWC (93.2±7.6); and DCW (91.9±7.2), respectively.

Overall, the nutrition and physical activity scores for students participating in NPAEM increased significantly (P<0.001) from pre-test (75.5±19.5) to posttest (94.2±6.9). Previous research has shown an increase in knowledge after nutrition and knowledge physical activity intervention among children [27]. According to Bergen (1993), at least 10 to 15 lesson hours are needed to achieve changes in nutrition knowledge, and at least 50 hours to produce behavioral changes [28,29]. In the NPAEM, students participated in 11.3 hours of nutrition and physical activity education; this may explain the significant increase in post-test scores in all the participating schools. Our knowledge outcomes are consistent with those of Heneman, *et al*. (2008) who reported improvement in nutrition knowledge among elementary students using lessons from the "Reading across My Pyramid (RAMP)" curriculum [30].

The importance of the findings from the current study, which demonstrated that the implementation of a 15-week school-based NPAEM positively impacted on young children in the Alabama Black Belt, cannot be overemphasized. Cancer is the second leading cause of death in Alabama [31]. The age adjusted cancer incidence rate for Macon County, Alabama is *418.9*/100,000 persons versus 466.9 and 457.6 for Alabama and the U.S., respectively [31]. Alabama's cancer incidence rate is significantly higher than the U.S. rate [31]. In Alabama, Black males have a significantly higher cancer incidence rate than white males, with a rate of 602.5 versus 545.3.3 [31].

Additionally, Alabama has one of the highest cancer mortality rates in the nation. The age adjusted cancer death rate for Macon County, AL is *232.1*/100,000 persons versus 193.2 and 186.0 for Alabama and the nation, respectively [31]. In Alabama, Black males have a significantly higher cancer mortality rate than white males with a rate of 307.5 versus 240.0 [31]. Similarly, Black females have a significantly higher cancer mortality rate than white females with a rate of 167.6 versus 150.8 [31]. Given this situation, our findings are particularly encouraging and promising. Additionally, the intervention was school-based, and it is known that healthy dietary behaviors learned by children are usually carried into adulthood – promising cancer risk reduction dietary behavior practices among children in the Alabama Black Belt.

Dietary Consumption

The student's dietary consumption behaviors exhibited positive changes over the 15-week intervention.

Percent calories from fat, carbohydrate and protein: The student's mean caloric intake from protein, fat, and carbohydrate at baseline and post-assessment are shown in Table 3. The paired t test (pre and post-assessment) analyses showed that there were significant decreases (P<0.05) in percent energy from protein and carbohydrates. The results for percent energy from protein and carbohydrate were within the recommended ranges of 10 to 35 and 45 to 65% of total energy, respectively [32]. There is evidence suggesting that by systematically reducing the amount of dietary carbohydrates one could suppress, or at least delay, the emergence of cancer, and the proliferation of already existing tumor cells could be slowed down [32].

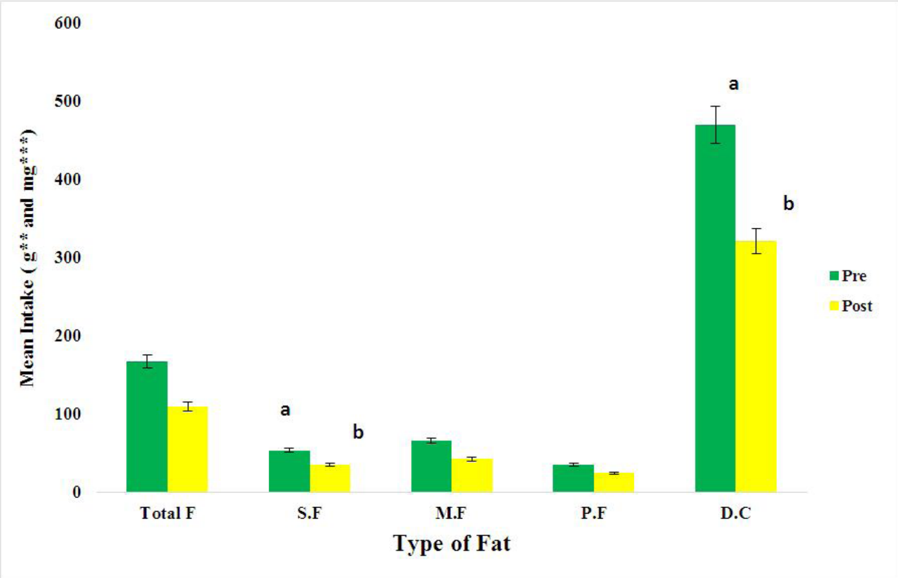
Nutrients	Pre-assessment (Mean±SD)	Post-assessment (Mean±SD)	P value
Protein	15.0±2.7	14.0±2.3	0.01
Carbohydrate	52.4±8.0	51.1±6.6	0.03
Fat	36.5±5.6	35.1±5.1	0.5

Table 3: Alabama Black Belt students (N=81) in the Nutrition and Physical Activity Education Model (NPAEM): Mean percent calories consumed from protein, carbohydrate and fat; pre- and post-assessment

At pre- and post-assessment, the student's percent calories from fat were above the set recommendations of the World Cancer Research Fund/American Institute for Cancer Research [32] (Table 3). However, a reduction, even though not statistically significant was noted at post-assessment. The recommendations indicate that total fats should provide 15, but no more than 30% of total energy. The student's mean intakes of saturated, monounsaturated, polyunsaturated, saturated fats, and dietary cholesterol are shown in Figure 4. Even though the students' total fat intakes were still above the recommended levels in the post-assessment, significant (P≤0.05) reductions were seen in the mean intake of saturated fat and dietary cholesterol.

WCRF/AICR (2007) recommends that no more than 5 to 6% of total daily calories should come from saturated fats [32]. Studies have found that saturated fat is positively associated with incidence of cancers of the breast, colon, and prostate cancers [32]. Saturated fats can also induce expression of certain inflammatory mediators associated with carcinogenesis.

Vitamins: The student's mean intake of vitamins for the pre- and post-assessments are shown in Table 4. There were significant increases in the intake of most of the vitamins, except for vitamins D and E. The student's mean intake of vitamin A was above the recommended 600μg RAE for children between 9 to 13 years [33]. We could only speculate that the high intakes in vitamin A may be attributed to over and/or under reporting by the students, and some shift in dietary behaviors as they acquired nutrition and physical activity knowledge. For example, the increased intakes of vitamins A and C could be related to the increase intake of fruit and vegetables, which students reported during the intervention. Dietary antioxidants like vitamins A, C, E, and carotenoids found in fruits and vegetables interact with, and neutralize free radicals, which play a role in carcinogenesis [34].



Total F = total fat; S.F = saturated fat; M.F. = monounsaturated fat; P.F. = Polyunsaturated fat; D.C = dietary cholesterol

Letters '*a*' and '*b*' for each type of fat indicate significant (P<0.05) reductions in mean dietary intake at pre- and post-assessment

** Total fat and total saturated fats measured in grams.

*** Monounsaturated fat, polyunsaturated fat and dietary cholesterol measured in milligrams

Figure 4: Alabama Black Belt student's mean dietary intakes from different types of fat in the Nutrition Physical Activity Education Model (NPAEM) during pre- and post-assessment

Dietary Vitamins	Pre-assessment (Mean±SD)	Post-assessment (Mean±SD)	P value
Vitamin A (μg RAE)	1153.3±567.5	1217.8±720.3	0.05
Vitamin B_1(Thiamine) (mg)	2.2±1.1	3.09±1.9	0.0002
Vitamin B_2 (Ribo-flavin) (mg)	2.6±1.2	3.5±2.0	0.0013
Niacin (mg)	27.3±15.0	39.5±24.6	0.002
Vitamin B_6 (mg)	2.4±1.2	3.4±1.9	0.0009
Vitamin B_{12} (mg)	5.5±3.7	16.8±12.7	0.005
Vitamin C (mg)	231.8±155.7	319.4±215.3	0.004
Vitamin D (IU)	196.6±98.9	223.9±146.4	0.17
Vitamin E (mg)	8.7±6.5	12.1±8.0	0.12

Table 4: Alabama Black Belt students (N=81) in the Nutrition and Physical Activity Education Model (NPAEM): Mean dietary intake of vitamins; pre- and post-assessment

Minerals: The results of the participant's intake of important minerals are shown in Table 5. In general, the student's mineral intakes were above the recommended daily intake [35]. The intakes of sodium in pre-and post-intervention were above the recommended intake of 2,300 milligrams per day [36]. In the pre-assessment phase, student's sodium intakes almost tripled the recommended daily intake, this behavior was significantly (P<0.0003) reduced in the post-assessment phase. Selected minerals and vitamins have been found to be beneficial in cancer prevention and management. The potential role of calcium in the prevention of colon cancer is being researched; experimental results suggest an inhibition of cancer by dietary selenium [37].

In animal studies, selenium supplementation has been particularly effective in inhibiting colon and mammary carcinogenesis, but enhanced carcinogenesis was observed in some studies on skin, liver and pancreas cancer [38,39]. Data suggest that zinc deficiency may be a factor in esophageal cancer; however, studies on tumor growth have demonstrated retarded growth in zinc-deficient animals [34].

Contrary to Bergen's (1993) report, which states that at least 50 hours are needed to produce dietary behavior changes, dietary consumption behavior improved over the 15-week intervention and 11.3 hours in the present study [29]. Shariff, *et al.* (2008) reported that participants showed improvements in nutrition practices after six hours of nutrition education [40]. Other studies have reported variable impact on behaviors after five to 13 weeks of health and nutrition education [41,42].

Intake from selected food groups: The mean intake from selected food groups is shown in Table 5. Fiber intake from grains increased significantly (P<0.0004) at post-assessment. Daily servings of grains consumed increased significantly (P<0.001) at post-assessment. This is borne out by the fact that there was also a significant (P<0.004) increase in fiber intake from grains (Table 6). Servings of dairy food intake increased significantly (P<0.0002) at post-assessment. Intake of servings from fat and meat groups showed significant decreases at post-assessment. In NPAEM, in the lesson exposure on MyPlate, the students were informed about the recommended intakes from the five food groups (namely, grains, meat, dairy, fruits and vegetables). The observed changes such as increased fiber consumption from grains indicated the students and parents understood the importance of increased fiber intake in cancer risk reduction.

Dietary Minerals	Pre-assessment (Mean±SD)	Post-assessment (Mean±SD)	P value
Calcium (mg)	1220.5±600.6	1612.3±951.5	0.002
Phosphorous (mg)	1720.5±872.4	2396.7±1458.4	0.0004
Iron (mg)	21.0±10.7	28.9±17.2	0.0008
Sodium (mg)	6494.2±3886.8	4577.6±2491.5	0.0003
Potassium (mg)	3683.9±1756.4	4890.1±2802.1	0.002
Zinc (mg)	16.1±9.3	22.4±14.0	0.001
Zinc from animal source (mg)	9.0±5.9	12.9±8.6	0.001
Magnesium (mg)	385.2±197.0	516.6±311.2	0.002
Copper (mg)	2.6±1.6	1.8±1.0	0.0004
Selenium (μg)	190.2±119.7	132.9±75.5	0.0004

Table 5: Alabama Black Belt students (N=81) in the Nutrition and Physical Activity Education Model (NPAEM): Mean dietary intake of minerals; pre- and post-assessment

Food Groups	Pre-assessment (Mean±SD)	Post-assessment (Mean±SD)	P value
Fiber from Beans (g)	3.6±2.6	3.6±3.0	0.99
Fiber from Grain (g)	6.5±4.1	9.5±6.10	0.0004
Fiber from Fruits and Vegetables (g)	12.9±7.0	13.3±8.5	0.8
Vegetable (servings/day)	4.1±3.7	4.3±2.5	0.7
Fruit and fruit juices (servings/day)	2.7±1.5	3.0±1.8	0.4
Grain (servings/day)	6.6±3.7	9.1±6.0	0.001
Meat (servings/day)	4.9±3.3	3.5±2.2	0.002
Dairy (servings/day)	1.9±1.1	2.4±1.7	0.0002
Fat (servings/day)	6.6±4.4	4.34±2.9	0.0002

Table 6: Alabama Black Belt students (N=81) in the Nutrition and Physical Activity Education Model (NPAEM): Mean dietary intake from different food groups; pre- and post-assessment

Dietary fibers not only bind carcinogens, bile acids, and other potential toxins but also essential nutrients, such as minerals, which can prevent the carcinogenic process [43]. Available evidence from the literature indicates that eating a variety of foods containing high dietary fiber has a protective effect against colon cancer [44]. Both in the pre- and post-assessments, the students consumed a mean of four vegetable and two fruit servings daily; these are within the United States Department of Agriculture (USDA) choose MyPlate recommendations of one and half fruit and two and half vegetables servings for boys and girls aged between nine and 13 years [23].

Red Meat, Lunch Meat and Poultry: In the pre-assessment, the mean intakes of red meat, lunch meat and poultry were 121.9±1.2; 48.2±1.3; 53.9±1.7 g, respectively. In the post-assessment, the mean intakes of red meat were 79.4±2.7; lunch meat 31.2±0.9 g; and poultry 31.2±0.9 g. Intakes of red meat, lunch meat and poultry reduced significantly (P≤0.004; P≤0.0004; and P≤0.0005, respectively), when pre- and post-assessments total intake were compared. It is speculated that significant reduction in red meat and lunch may have been due to participants' increased comprehension of the roles of red and processed meats in cancer risk. In two lessons that were taught ('Healthy Eating Habits' and 'Diet and Cancer'), students were presented with information on how reduced intakes of red and processed meats, may contribute to cancer risk reduction.

Intakes of high amounts of red and processed meats have been associated with increased cancer risk by several studies [45]. Processed meats such as lunch meats contain heme-iron, saturated fat, sodium, nitrites, and certain carcinogens that are formed during cooking. It is known that replacing one serving of red meat with any of the following healthy protein sources was associated with lower cancer mortality risk. Cancer mortality risk reductions were: 7% for fish, 14% for poultry, 19% for nuts, 14% for whole grains and 10% for low-fat dairy products and legumes [46].

A number of hypotheses have been advanced to explain the connection between meat consumption and cancer risk. In general, meat does not contain fibers which are known to have a protective effect. Additionally, sometimes meat also contains carcinogenic compounds such as heterocyclic amines (HCAs) and polycyclic aromatic hydrocarbons (PAHs) formed during processing or cooking. HCAs are formed when meat is cooked at high temperatures while PAHs are formed during the burning of organic substances. HCAs and PAHs are believed to increase cancer risk. Furthermore, the high fat content of meat increases hormone production, thus increasing the risk of hormone-related cancers such as breast and prostate [45]. During the lesson entitled 'Food Preparation', the students were presented with information regarding consumption of barbecued, well-done meat, fried meat and cancer risk.

The current study developed and implemented an age-appropriate, culturally-sensitive nutrition and physical activity education model for cancer risk reduction among third and fourth grade children in the Alabama Black Belt. Findings of the study revealed that the program improved nutrition and physical activity knowledge and dietary consumption behavior. It is important to implement nutrition and physical activity education at an early age so as to increase knowledge among children and therefore help mold their dietary behavior early in life.

Strengths and Limitations

The lessons were age-appropriate and culturally-specific, and presented in a manner, which was familiar to the students, and which they could relate to. The many hands-on activities reinforced learning. Parental awareness was increased in this study through weekly newsletters containing summaries of the lessons covered by the children in school, healthy recipes, and suggested healthy family-oriented physical activity. The current study lacked a control group, which would have given more reliable baseline data to compare our results. The school, which was to serve as the control withdrew from the intervention.

In filling the FFQ, the students may have over and/or under-reported their dietary consumption. The sample was small and the results are not generalizable to any other population. The effects of the intervention were assessed immediately after its completion. The short period between completion of the intervention and the post-assessment may have contributed to the retention of improved nutrition and physical activity knowledge, and dietary consumption behaviors. However, whether these positive effects will be sustained or diminished in the long term was outside the scope of this study.

Conclusion

Our findings indicate that the culturally specific NPAEM developed for third and fourth graders could improve their nutrition and physical activity knowledge and dietary consumption behavior in relation to cancer risk reduction. In terms of effectiveness, the importance of cultural-specificity in the development and implementation of the NPAEM for cancer risk reduction in African American children cannot be over-emphasized. Finally, although improvements in nutrition and physical activity knowledge and dietary consumption behaviors were seen, the model needs to be tested on a larger sample of children to ascertain whether it can form part of a sustained educational strategy to reduce cancer risk among children and their parents in the Alabama Black Belt and elsewhere.

Acknowledgement

This work was financially supported by the State of Alabama AALGA 2010/2014 grant and the College of Agriculture, Environment and Nutrition Sciences. The Superintendent, teachers, principals, parents and students are acknowledged for their support and participation in the study.

References

1. American Cancer Society (2016) Cancer facts and figures for African Americans 2016-2018, Georgia.

2. Nicklas T, Johnson R, American Dietetic Association (2004) Position of the American Dietetic Association: Dietary guidance for healthy children ages 2 to 11 years. J Am Diet Assoc 104: 660-77.

3. Anthamatten P, Brink L, Lampe S, Greenwood E, Kingston B, et al. (2011) An assessment of schoolyard renovation strategies to encourage children's physical activity. Int J Behav Nutr Phys Act 8: 27.

4. Alabama Statewide Cancer Registry (2016) Alabama cancer facts and figures 2015, USA.

5. Bandura A (1986) Social Foundations of thought and action: a social cognitive theory. Englewood Cliffs, NJ, USA.

6. Bergen D (1993) Authentic performance assessment. Child Educ 70: 99-102.

7. Birt DF (1989) Effects of the intake of selected vitamins and minerals on cancer prevention. Magnesium 8: 17-30.

8. Bray F, Jemal A, Grey N, Ferlay J, Forman D (2012) Global cancer transitions according to the Human Development Index (2008-2030): a population-based study. Lancet Oncology 13: 790-801.

9. Carter BJ, Birnhaum AS, Hark L, Vickery B, Potter C, et al. (2005) Using Media Messaging to Promote Healthful Eating and Physical Activity Among Urban Youth. J Nutr Educ Behav 37: 98-9.

10. Centers for Disease Control and Prevention (2009) 2009 Youth Risk Behavior Survey, USA.

11. Centers for Disease Control and Prevention (2013). State indicator report on fruits and vegetables 2013. U.S. Department of Health and Human Services, Atlanta, Georgia.

12. Centers for Disease Control and Prevention (1996) Guidelines for School Health Programs to Promote Lifelong Healthy Eating. MMWR 45: 1-33.

13. Centers for Disease Control, National Center for Chronic Disease Prevention and Health Promotion (2003) Physical activity and good nutrition: essential elements to prevent chronic diseases and obesity 2003. Nutr Clin Care 6: 135-8.

14. Connelly-Frost A, Poole C, Satia JA, Kupper LL, Millikan RC, et al. (2009) Selenium, folate, and colon cancer. Nutr Cancer 61: 165-78.

15. Cross AJ, Ferrucci LM, Risch A, Graubard BI, Ward MH, et al. (2010) A large prospective study of meat consumption and colorectal cancer risk: an investigation of potential mechanisms underlying this association. Cancer Res 70: 2406-14.

16. Danaei G, Ding EL, Mozaffarian D, Taylor B, Rehm J, et al. (2009) The preventable causes of death in the United States: comparative risk assessment of dietary, lifestyle, and metabolic risk factors. PLoS Med 6: e1000058.

17. DeSantis CE, Fedewa SA, Goding Sauer A, Kramer JL, Smith RA, et al. (2016) Breast cancer statistics, 2015: Convergence of incidence rates between black and white women. CA Cancer J Clin 66: 31-42.

18. Edwards BK, Ward E, Kohler BA, Eheman C, Zauber AG, Anderson RN, et al. (2010) Annual report to the nation on the status of cancer, 1975-2006, featuring colorectal cancer trends and impact of interventions (risk factors, screening, and treatment) to reduce future rates. Cancer 116: 544-73.

19. Friedenreich CM, Orenstein MR (2002) Physical activity and cancer prevention: etiologic evidence and biological mechanisms. J Nutr 132: 3456S-64S.

20. Harris PJ, Ferguson LR (1993) Dietary fibre: its composition and role in protection against colorectal cancer. Mutat Res 290: 97-110.

21. Centers for Disease Control and Prevention (2016) Health, United States, 2016. US Department of Health and Human Services, Washington, USA.

22. Heneman K, Sharon KJ, Zidenberg-Cherr S (2008) Reading across My Pyramid, a Nutrition and Health Education Curriculum, Increases the Health Behavior Knowledge of Lower Elementary Students. J Child Nutr & Management 32: 1-7.

23. Howlader N, Noone AM, Krapcho M, Garshell J, Miller D, et al. (2015). SEER Cancer Statistics Review, 1975-2012. National Cancer Institute.

24. International Agency for Research on Cancer (2012) Estimated cancer incidence mortality and prevalence worldwide in 2012.

25. Institute of Medicine (1997) Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride. National Academic Press, Washington, USA.

26. Institute of Medicine (2001) Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc. National Academic Press, Washington, USA.

27. Janz KF, Lutuchy EM, Wenthe P, Levy SM (2008) Measuring activity in children and adolescents using self-report: PAQ-C and PAQ-A. Med Sci Sports Exerc 40: 767-72.

28. Kant AK (2004) Dietary patterns and health outcomes. J Am Diet Assoc 104: 615-35.

29. Kowalski KC, Crocker PRE, Donen RM (2004) The Physical Activity Questionnaire for Older Children (PAQ-C) and Adolescents (PAQ-A) Manual. College of Kinesiology, University of Saskatchewan, Canada.

30. Kushi LH, Doyle C, McCullough M, Rock CL, Demark-Wahnefried W, et al. (2012) American Cancer Society Guidelines on nutrition and physical activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. CA Cancer J Clin 62: 30-67.

31. Li Y, Robinson LE, Carter WM, Gupta R (2015) Childhood obesity and community food environments in Alabama's Black Belt region. Child Care Health Dev 41: 668-76.

32. Newberne PM, Locniskar M (1990) Roles of micronutrients in cancer prevention: recent evidence from the laboratory. Prog Clin Biol Res 346: 119-34.

33. Nutrition Quest (2009) Questionnaires and Screeners.

34. Pan A, Sun Q, Bernstein AM, Schulze MB, Manson JE, et al. (2012) Red meat consumption and mortality: results from 2 prospective cohort studies. Arch Intern Med 172: 555-63.

35. Powers AR, Struempler BJ, Guarino A, Parmer SM (2005) Effects of a nutrition education program on the dietary behavior and nutrition knowledge of second-grade and third-grade students. J Sch Health 75: 129-33.

36. Richardson LC, Henley SJ, Miller JW, Massetti G, Thomas CC (2016) Patterns and Trends in Age-Specific Black-White Differences in Breast Cancer Incidence and Mortality – United States, 1999-2014. MMWR 65: 1093-8.

37. Glanz K, Lewis FM, Rimer BK (1997) Health behavior and health education: Theory, research, and practice, 2nd Edition. Annals of Epidemiology 7: 425-6.

38. Shariff ZM, Bukhari SS, Othman N, Hashim N, Ismail M, et al. (2008) Nutrition education intervention improves nutrition knowledge, attitude and practices of primary school children : a pilot study. Int Electron J Health Educ 11: 119-32.

39. Snyder TD, Dillow SA (2011) Digest of Education Statistics 2010. National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education, Washington, USA.

40. Brown JE, Isaacs J, Krinke B, Lechtenberg E, Murtaugh M (2010) Nutrition throughout the lifecycle, 4th Edition. Boston, USA, 26-40, 226-261.

41. Thompson PA, Ashbeck EL, Roe DJ, Fales L, Buckmeier J, et al. (2016) Selenium Supplementation for Prevention of Colorectal Adenomas and Risk of Associated Type 2 Diabetes. J Natl Cancer Inst 108: djw152.

42. United States Cancer Statistics (2016) 1999-2013 Incidence and Mortality Web-based Report. Atlanta, Georgia.

43. United States Department of Agriculture (2014) ChooseMyPlate.gov, USA.

44. World Cancer Research Fund/American Institute for Cancer Research (2007) Food, nutrition, physical activity, and the prevention of cancer: A global perspective, Washington, USA.

45. Worsley A (2005) Children's healthful eating: from research to practice. Food Nutr Bull 26: S135-43.

46. Zekeri AA, Nnedu CC, Popoola S, Diabate Y (2016) Household Food Insecurity and Health among African American Women in Black Belt Counties of Alabama: Evidence from Mixed-Methods Research. J Comm Pub Health Nurs 2: 138.