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The Development and Evaluation of a Portion Plate for Youth: A Pilot Study

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ABSTRACT

Objective: To develop and evaluate a portion plate for adolescents (Nutri-plate).

Methods: Sixteen African American adolescents (mean age = 12.94 years; 66% male) were randomized to participate in either plate design or nutrition education sessions. Adolescents' input was used to create the Nutri-plate, and participants' food selection and intake was evaluated.

Results: Adolescents indicated the plate should include simple yet colorful visual and textual information about healthful eating. Participants left less food on their plate when dining with the Nutri-plate as compared with a plain plate ($P < .01$). Examination of effect sizes suggested that when using the Nutri-plate, participants selected less food overall ($d = 0.73$), more fruit ($d = -0.64$), more broccoli au gratin ($d = -0.85$), and less steamed broccoli ($d = 0.87$). Participants with higher body mass index selected a greater amount of healthful food when using the Nutri-plate ($P < .05$).

Conclusions and Implications: Further evaluation is needed to determine the influence of a portion plate on adolescents' nutritional behaviors.

Key Words: adolescents, diet, overweight, portion control (*J Nutr Educ Behav.* 2011;43:268-273.)

INTRODUCTION

Obesity among children and adolescents has reached epidemic proportions, particularly for low-income, minority youth. Recent estimates suggest that 37% of African American adolescents are overweight or at risk of overweight.¹ Being overweight during puberty is the most robust predictor of obesity in adulthood beyond family history of obesity²; up to 80% of overweight adolescents will become obese adults.^{3,4}

A major challenge encountered in efforts to reduce obesity is the prominence of large portion sizes of energy-dense food across multiple settings.⁵⁻⁷ Numerous studies conducted in both laboratory and restaurant settings have demonstrated that participants increase their energy intake when provided with larger portion sizes.^{6,8,9} Further, package size can influence overconsumption of energy-dense food,⁹⁻¹¹ even among preschool-aged children.^{12,13}

Given the current rates of obesity, it is essential to: (1) provide adolescents with healthful visual cues that discourage overeating,¹⁴ and (2) deliver effective educational messages that stress limiting intake of energy-dense food and encourage consumption of low-density food, such as fruits and vegetables.¹⁵ Adolescents are often taught to use various portion size measurement aids (a deck of cards or their hands) to estimate food portion sizes.¹⁶ A dining plate designed for youth that uses visual cues about portion size and healthful nutrition, however, may be more effective because it provides immediate visual reminders of healthful nutrition at the time when food is being selected and consumed. Findings from a recent clinical trial indicated that obese adults who used a plate designed to guide their selection of healthful food portions daily for 6 months demonstrated significant weight loss as compared to adults receiving standard nutrition education.¹⁷ Further,

evidence suggests that parents do not feel confident in their ability to change their family's eating behaviors.¹⁸ A portion plate may be 1 way that parents can introduce and reinforce messages about healthful eating.

The aims of this pilot study were to develop a specially designed portion control dining plate (Nutri-plate) and evaluate its efficacy in modifying adolescents' food selection and intake. In order to consider whether adolescents who participated in the development of the Nutri-plate (Design group) demonstrated additional benefits when using this plate, differences between food selection and consumption were examined using 4 possible group combinations (Design-Nutri-Plate, Non-Design-Nutri-Plate, Design-Plain Plate, or Non-Design-Plain Plate). The relation between adolescents' body mass index (BMI), perceptions of current body type, and amount of healthful food selected when using the Nutri-plate versus a plain plate was also examined.

METHODS

Participants

Participants ($n = 16$) were volunteers aged 11-17 years, with the mean age of 12.94 years ($SD = 1.87$). All of the participants were African American, and 66% were male. The majority of

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participants' parents (54%) reported a family income under \$29,999 per year. Thirteen (7 males, 6 females) of the 16 participants attended 1 or more dining sessions and were included in the quantitative analyses, and 2 of these participants did not consent to be weighed. Using Centers for Disease Control and Prevention's age- and sex-specific cutoffs, BMI was calculated using participant's weight in kg/height in m² and transformed into BMI-for-age percentiles. The average BMI for consenting participants was 30.0. Using 2007 American Medical Association guidelines,¹⁹ participants were considered overweight if their BMI-for-age percentiles were between the 85th and 95th percentiles and obese if their BMI was equal to or above the 95th percentile. Based on these criteria, 2 adolescents were normal weight, 2 were overweight, and 10 were obese.

Procedure

After obtaining Institutional Review Board approval, participants were recruited from a predominately African American community within a large midwestern city, which was targeted because of its proximity to the study site (local community hospital). Other than age, there were no specific selection criteria. Participants, ages 11-17, were recruited via fliers and newspaper ads (*n* = 10; 62%) or were present or former clients in an outpatient weight control program (*n* = 6; 38%).

All study sessions were held in a large conference room at a local community hospital. Once consent and assent forms were obtained, adolescents were randomly assigned to either the Design (*n* = 8) or Non-Design (*n* = 8) group for Phase 1 of the study. In Phase 1, all participants received 30 minutes of nutrition education programming. The programming (1) reviewed the United States Department of Agriculture MyPyramid food guide,²⁰ (2) focused on how to make healthful food selections, and (3) educated participants about portion sizes.

Following the 30-minute nutrition education session, the Design group participants spent 30 minutes brainstorming about the optimal design of a plate that would provide guidance

on the selection of recommended food portion sizes. Five of the 8 participants assigned to the Design group attended the first brainstorming session. To facilitate brainstorming, participants were asked to engage in the following standard design-generative drawing activities. First, they were given a large roll of white paper and markers and asked to sketch out their ideas for plates that would encourage healthful eating. Second, they were provided with blank plate templates and asked to sketch their responses to the question, "Think about what kind of plate you would want to eat on that would help you make healthful food choices." Finally, they were asked to add any of the information from the 30-minute nutrition education session that might be relevant for their sketches. A product design consultant took detailed notes of participants' comments during the drawing activities, and also encouraged them to think and express their ideas through drawing. Following this session, the product design consultant used content analysis to extract themes and reviewed the participants' sketches and comments to create refined concept drawings of 7 dining plates (see Figure). The Non-Design group participants engaged in 30 minutes of nutrition-related games and activities (eg, nutrition bingo) while the Design group was brainstorming.

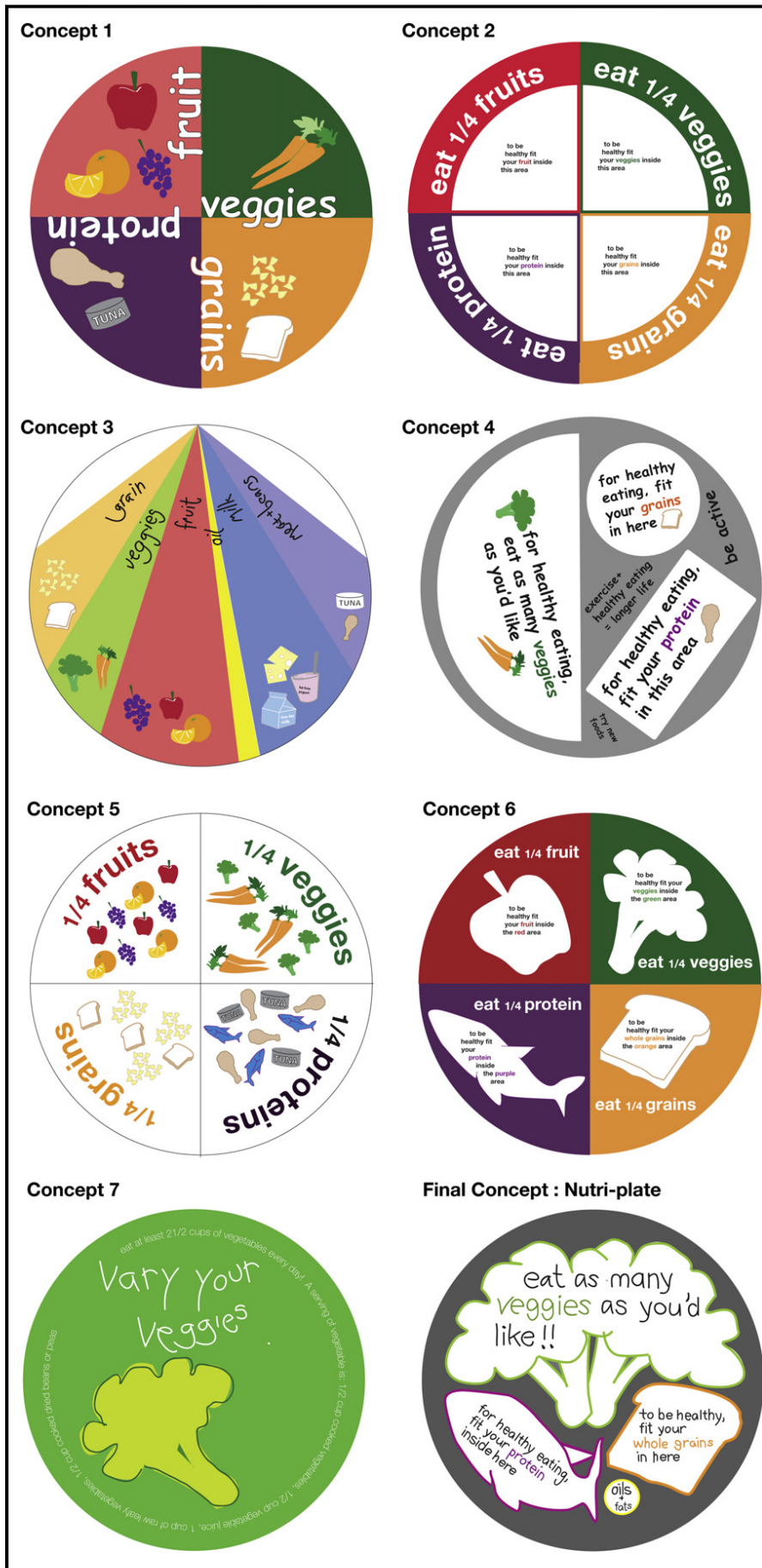
The second session of Phase 1 was conducted 1 week later and was formatted similarly to the first session. For the first 30 minutes, both the Design and Non-Design group received nutrition education programming that focused on the same 3 themes as the first session (United States Department of Agriculture MyPyramid food guidelines, making healthful food selections, and appropriate portion sizes). Design group participants then spent the last 30 minutes engaged in a focus group interview about the 7 dining plate concept drawings led by the product design consultant (see Figure). Seven of the 8 participants assigned to the Design group attended this focus group interview. The participants were asked by the product design consultant what they liked and disliked about each of the plate concept drawings. The consultant wrote down all of the participants' comments and then reviewed

these notes to produce a final concept drawing (Nutri-plate), which was manufactured on a white, 10-inch melamine plate and used during Phase 2 of this project.

To minimize the potential for a group contagion effect in the Phase 2 dining sessions, participants assigned to the Design and Non-Design groups in Phase 1 were randomly reassigned to 1 of 2 hour-long dining groups scheduled to meet at different times. Each participant attended 2 hour-long weeknight dining sessions with approximately 5 other participants. Prior to the start of both dining sessions, participants and their parents/guardians completed several brief questionnaires. Thirteen participants attended the dining sessions on the first weeknight, whereas 10 attended the second week's dining sessions.

For both of the Phase 2 dining sessions, the conference room was partitioned into separate serving and dining areas. Participants were invited into the serving area 1 at a time. The serving area was set up to resemble a buffet, and participants were informed by dining staff that they should serve themselves. Two variants of each food group were presented. More specifically, as an entrée, both baked and fried chicken were offered. For side dishes, steamed broccoli and broccoli au gratin were offered, as were roasted and fried potatoes. For dessert, participants could select cookies and/or fruit. Participants were instructed by dining staff that they could take and eat as much or little of the food as they desired, but they were not allowed to share their food or have second helpings. Once a participant made his or her food selections, he or she was instructed to proceed to the dining area. After each participant left the serving area, all of the serving bowls were weighed by dining staff prior to inviting the next participant into the serving area.

Upon entering the dining area, each participant was asked to give his or her plate to a research assistant to be weighed. The scale was visible to all participants, but only the research assistant could see the weight measurement. Participants were then invited to take a seat at a table and eat with other dining group participants. They were reminded by



research assistants that they had to remain in the dining area of the conference room for the entire session, and they were required to leave their plates at the table once they were finished eating. Once all the participants had left the dining area, research assistants weighed each plate.

The type of plate provided at the dining sessions was counterbalanced across dining groups to account for any order effects. At 1 of the 2 dining sessions, all participants within a dining group served themselves using a standard, white 10-inch melamine dining plate (Plain plate) and at the other dining session, these same participants were offered identical food choices but were given the specially designed 10-inch dining plate (Nutri-plate).

During the first session of Phase I and after providing written informed consent, parents completed a form that obtained demographic information (eg, child's ethnicity, level of family income, parents' highest level of education, parents' employment status, and number of family members). Consenting adolescent participants' height and weight measurements were taken using a scale and stadiometer. Adolescents also completed Gardner's 13-figure schematic contour scale,²¹ which measured perceptions of their current body type. Higher scores indicate endorsement of a larger body type.

To assess food selection and intake, the following weight measurements were recorded for each participant during the dining session: (1) pre-dinner plate (weight of plate + food prior to eating at the dining session), (2) weight of the food (fried chicken) served from each of the serving bowls (weight of the serving bowl prior to food selection minus weight of the serving bowl after each participant's food selection), and (3) post-dinner plate (weight of plate + food after consumption). Indices of food selection and intake were then calculated based on these measurements: (1) food consumed (pre-dinner plate weight minus post-dinner plate weight), (2) healthful food selected (weights of baked chicken + steamed broccoli + potatoes + fruit), and (3) percentage of healthful food selected (weight of healthful food/total weight of food selected).

Figure. Proposed refined concept drawings of the Nutri-plate.

RESULTS

Qualitative Findings

Based on participants' initial drawings and comments generated during Phase 1 sessions, the product design consultant used content analysis to extract 5 central design-defining themes/criteria: (1) there should be information on the plates about healthful eating, including the importance of recommended food portion sizes and a varied diet including fruits and vegetables, (2) the information could be presented visually and/or textually, (3) the design should be simple to use and understand, (4) the plate design should be colorful and fun, and (5) the plate should be instructional. The product design consultant used these design criteria to generate the refined concept drawings of 7 dining plates (see Figure).

During the second design session, when asked by the product design consultant to comment on the 7 plate concept drawings, a content analysis of participants' comments indicated that they preferred the following plate characteristics: (1) space that showed them where to put their food, (2) recommended portion size shown on their plate, (3) visual differentiation among food groups (visually showing which food groups to consume more of and which to limit), (4) brighter

colors balanced with more neutral ones, (5) food icons, (6) text that was easy to read, and (7) written messages about healthful eating. Adolescents indicated that they liked 2 plate designs best (Concepts 4 and 6), which contained many, but not all of these elements. Following this session, the product design consultant used the most desirable elements from these 2 plates to create the Nutri-plate (see Figure).

Quantitative Findings

Although the authors planned to analyze mean differences in food selection and consumption using the 4 possible group combinations (Design-Nutri-Plate, Non-Design-Nutri-Plate, Design-Plain Plate, or Non-Design-Plain Plate), doing so was not feasible given the small sample size of each group. Thus, comparisons were made between only the Nutri-Plate and plain plate.

In addition to using independent, 2-tailed *t* tests to analyze mean differences (see Table), effect sizes (*d*) were calculated, which is recommended with small samples in which findings may not reach statistical significance owing to low power.²² According to Cohen,²² a small effect size for *d* is 0.20, a medium effect size is 0.50, and a large effect size is 0.80. For the

purposes of this study, mean differences were interpreted if there were moderate to large effect sizes. Correlational analyses were also conducted to determine if there were significant concurrent relations between BMI, perceptions of adolescents' current body type, and food selection and consumption variables.

Participants consumed approximately the same amount of food (in grams) (*d* = -0.31) and selected about the same amount of healthful food (*d* = -0.17) when dining with either plate. However, when dining on the Nutri-plate, participants selected less food overall (*d* = 0.73) and more fruit (*d* = 0.64) but also selected more broccoli au gratin (*d* = -0.85), less steamed broccoli (*d* = 0.87) and left less food on their plate (*d* = 0.96) than when dining with the plain plate (see Table). As shown in the Table, *t* test analyses indicated that only 1 of these mean differences was significant: the amount of food left on participants' plates at the end of the dining session (*t* [20] = 3.76, *P* < .01). Significant positive correlations between the amount of healthful food selected and participants' ratings on the Gardner 13-figure schematic contour scale of current body type and BMI were found for the Nutri-plate only (*r* = 0.66, *P* < .05; *r* = 0.69, *P* < .05, respectively).

Table. Mean Differences in Food Selection and Consumption Variables (n = 13)

Variable ^a	Plain Plate, ^b mean (SD)	Nutri-plate, ^b mean (SD)	<i>d</i> ^c	<i>t</i> ₂₁ ^d	<i>P</i> Value
Fried chicken	37.33 (43.13)	54.27 (65.96)	-0.30	-0.74	.47
Baked chicken	56.50 (70.38)	62.55 (66.02)	-0.11	-0.21	.83
Potatoes	47.17 (47.59)	47.81 (45.43)	-0.01	-0.03	.97
French fries	18.33 (27.67)	15.27 (24.47)	0.08	0.28	.78
Broccoli au gratin	7.92 (27.42)	38.64 (43.39)	-0.85	-2.05	.61
Steamed broccoli	54.25 (64.56)	25.45 (38.40)	0.87	1.28	.21
Fruit	82.58 (87.11)	120.73 (54.60)	-0.64	-1.24	.23
Cookies	21.67 (47.23)	27.64 (23.91)	-0.09	-0.38	.71
Pre-dinner plate	654.25 (102.66)	574.45 (99.74)	0.73	1.89	.07
Post-dinner plate	373.33 (30.88)	286.00 (73.43)	0.96	3.76	<.001
Food consumed	280.92 (96.88)	303.30 (103.50)	-0.31	-0.52	.61
Healthful food selected	240.50 (129.73)	256.55 (93.45)	-0.17	-0.34	.74
% Healthful food selected	71	66	—	—	—

^aIndividual food items listed (eg, fried chicken) indicate the weight of the particular food that was served from each of the serving bowls; ^bWeight in grams; ^cIn absolute values, a small effect size for *d* is .20, a medium effect size is .50, and a large effect size is .80²²; ^d*df* = 21 for all variables except post-dinner plate, food consumed, and healthful food selected (*df* = 20).

DISCUSSION

The aims of this study were to develop and evaluate a portion control dining plate for youth (Nutri-plate) that provides visual cues and educational messages about healthful nutritional intake. With respect to plate development, participants actively engaged in drawing and discussion with study personnel that led to 7 refined concept drawings of portion plates. Participants' discussion and feedback about these drawings were used to create the final design (Nutri-plate) that was manufactured. Based on their input, findings suggest that the adolescents had a preference for portion control plates that include simple, yet colorful, visual and textual information about healthful eating. They liked being told where to put their food on their plate, and they thought that incorporating visual images of food icons indicating portion sizes was important. Finally, they preferred designs that have simple text, thereby making them more instructive rather than decorative.

With respect to evaluation, findings suggested that there were several notable differences related to food selection and consumption depending on which plate participants used. Specifically, when dining with the Nutri-plate, participants selected more fruit and less food overall, but they also selected more broccoli au gratin, less steamed broccoli, and left less food on their plate than when dining with the plain plate. Dining with the Nutri-plate, however, did not appear to influence the proportion of healthful food selected by participants. Approximately 2/3 of their food was healthful regardless of which plate they were using. Importantly, although results indicate that participants selected significantly more broccoli au gratin when dining on the Nutri-plate, with this food option deemed the "unhealthful" alternative, it is possible that participants were encouraged by the plate design (see Figure) to select broccoli and were not fully aware that this version was the poorer choice. It is noteworthy, however, that participants selected considerably more fruit when dining on the Nutri-plate. Another notable finding related to plate type was that participants with higher BMIs and those

who endorsed a larger body type selected a greater amount of healthful food when using the Nutri-plate.

Prior work has found that portion plates are more effective in reducing weight than standard dietary teaching strategies among obese adults.¹⁷ Thus, although no study to date has considered whether the Nutri-plate or any other portion plate is effective as an obesity prevention tool, the current study, along with past research, suggest that portion control plates should be further explored as an effective obesity prevention strategy.

The use of a small sample, which was further exacerbated by youth not attending all planned sessions, is the primary limitation of the present study. Prior research indicates that structural barriers, such as work schedule conflicts and transportation issues, often impede low-income parents' participation in programming and contributes to retention difficulties, as was the case in this study.²³ In addition to having a sample consisting entirely of urban African American adolescents, 54% of the participants were drawn from a weight control clinic, further limiting the representativeness of the sample and generalizability of the findings, as these participants may have been more receptive to using the Nutri-plate. Further, although the current methodology allowed us to measure the weight of each type of food selected as well as total weight of food consumed, it was not possible to assess whether there were differences in the *type* of food the participants consumed based on plate type. In addition, weight composites (pre-dinner plate, post-dinner plate, food consumed) do not clearly reflect whether healthful or unhealthful food was consumed, as an energy-dense food item (eg, cookies) may weigh less than a more healthful option (eg, fruit).

IMPLICATIONS FOR RESEARCH AND PRACTICE

Changing the eating environment is essential to addressing the obesity epidemic. One of the challenges of the current eating environment is the prominence of larger portion sizes of energy-dense food.^{5,7} Prior work has found that portion plates are more

effective in reducing weight than standard dietary teaching strategies among obese adults.¹⁷ The use of a portion plate designed for youth may enable parents to feel more confident in their ability to introduce and reinforce messages about healthful eating and portion size within the home environment. Thus, a promising direction for future research involves investigating the use of a portion plate such as the Nutri-plate as part of a larger, comprehensive strategy to address obesity among youth.

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